bulletin

2016-17

BIRLA INSTITUTE OF TECHNOLOGY & SCIENCE, PILANI

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BITS Pilani

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INSTITUTE EMBLEM

The Emblem of the Institute represents a synthesis of Science, Humanities and Engineering with Lotus representing Humanities & Social Sciences, the Structure of Molecule representing Science, and the Figure of Rocket representing Engineering & Technology.

The Motto is –

'Knowledge is power supreme'

BITS VISION

“What do we propose to do here? We want to teach real science whether it is engineering, chemistry, humanities, physics or any other branch. We want to develop a scientific approach in Pilani, which means there would be no dogma. There will be a search for truth. What we propose to do here is to cultivate a scientific mind.”

— The Late Shri G.D. Birla
Founder Chairman, BITS, Pilani

“ … to prepare young men and women to act as leaders for the promotion of the economic and industrial development of the country and to play a creative role in service to humanity.”

— The Late Dr. K.K. Birla
Former Chancellor, BITS, Pilani

“What is it that can empower our nation? The most obvious answer is education. Education that enhances livelihoods but also education that is value-based. Education that gives roots and gives wings as well”.

—Dr. Kumar Mangalam Birla
Chancellor, BITS, Pilani

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HIGHLIGHTS

- Multi-campus University with campuses at Dubai, Goa and Hyderabad
- *Admission in both semesters*
- *Admission only on merit through a unique computer based on-line admission test, BITSAT*
- *20 – 30 Board toppers join every year*
- *Scholarship to 30% of students*
- *Academic flexibilities – Dual Degree – a unique combination of Science and Engineering education*
- *Modular and flexible academic structure*
- *Vertical transfer options from First Degree to Higher Degree/ Ph.D.*
- *Continuous, internal, transparent evaluation system*
- *Practice School – strong linkages with industries*
- *Work-Integrated Learning Programmes for employed professionals*
- *State-of-the-art institutional library with over 2 lac books*
- *State-of-the-art Campus-wide computer network*
- *Large number of Alumni in top positions in India and abroad*
- *Very strong Alumni network*
- *Collaboration with foreign universities of repute*
- *Entrepreneurial Leadership Development*
- *Many societal development projects – Rain Water Harvesting, Desert Development Technologies, Women Empowerment, Healthcare*
- *Major cultural, academic and sports events – OASIS, APOGEE and BOSM - organized by students*
- *Privately funded with an affordable fee structure*

PART I

GENERAL INFORMATION

HISTORY AND PURPOSE

The Birla Institute of Technology and Science (BITS), Pilani is an all-India Institution declared as deemed to be university established under Section 3 of the UGC act. It is privately supported, fully residential and admits both male and female students. The primary objectives of the Institute are "to provide for and otherwise promote education and research in the fields of Technology, Science, Humanities, Industry, Business, Public Administration and to collate and disseminate in such fields effective ideas, methods, techniques and information as are likely to promote the material and industrial welfare of India" and to "train young men and women able and eager to create and put into action such ideas, methods, techniques and information".

The Institute was initially registered as a Society under the Rajasthan Societies Registration Act of 1958 on the 13th May, 1964. Subsequently, by notification published in the Gazette of India dated the 27th June, 1964, the Ministry of Education, Government of India, declared that the Institute being an institution for higher education shall be "deemed to be a University". The Institute started functioning with effect from 1st July, 1964 with late Shri G.D. Birla as its Founder Chairman.

The Institute started as a small "Pathshala" in Pilani way back in the year 1901 by Seth Shiv Narainji Birla with one teacher for educating his grandsons, late Shri G.D. Birla and late Shri R.D. Birla. Pilani was then a small isolated desert village in Rajasthan. The Pathshala evolved slowly and steadily into a High School in 1925 and became an Intermediate College in 1929. The Birla Education Trust was founded in the same year. The Intermediate College developed into a Degree College in 1943. In 1947, this college was raised to postgraduate level. In 1950, Pharmacy courses were started in this college, and in 1952, it was bifurcated into College of Arts and the College of Science, Commerce and Pharmacy.

During World War II, the Government of India established a Technical Training Centre at Pilani for the supply of technicians for Defence Services and industry. In 1946, late Shri G.D. Birla decided to convert it into an engineering college with degree programmes in Electrical and Mechanical Engineering. Master's programme in Electronics was started in 1955. B.E. programmes in Civil Engineering and Chemical Engineering were started later. In 1964 with the inception of the Birla Institute of Technology and Science, the colleges, viz., Birla College of Science, Commerce and Pharmacy, Birla College of Arts and Birla College of Engineering situated at Pilani, as also all properties, movable and immovable, together with educational facilities, hostels, staff quarters, playgrounds, etc., became part of the Institute and all these properties were vested in it. During the early years of its inception, i.e., 1964 to 1970, the Institute with the support of Ford Foundation Grant had the advantage of having collaboration with Massachusetts Institute of Technology (MIT), USA. It adopted the semester system, modular structure of courses, continuous and internal evaluation, letter grading, etc. It also created institutionalized linkages with the industries. Over a period of time, the Institute also introduced several flexibilities in its educational programmes.

Dr. K.K. Birla who took over as the Chairman of BITS in 1983 was deeply involved and closely associated with his visionary father in running both the earlier Birla Colleges and the current institute BITS, since its inception. With his spirited involvement in all the activities of the Institute, he was able to see the vision of his father Late Shri G.D. Birla unfolding. Taking over the responsibility of running the institute, Dr. K.K Birla who became the Chancellor in 2003 realized the need for greater number of promising graduates in the field of science and technology in shaping up the nation’s development. Hence he initiated an increase in the number of students at Pilani campus during 1999 which gradually carried the total strength from 2500 to 4000. Under his patronage, BITS started expanding by establishing three campuses, one in Dubai in the year 2000, in Goa in the year 2004 and in Hyderabad in the year 2008.

Consequent upon the sad demise of Dr. K.K. Birla on 30 August 2008, Dr. Kumar Mangalam Birla was elected as the Chancellor and Smt. Shobhana Bhartia was appointed as the Pro-

Chancellor of the Institute. Under the leadership of young and dynamic Chancellor, BITS is taking steps to scale greater heights.

In the year 2000, BITS was accredited by NAAC with the highest possible rank in University
accreditation. In 2008-2009, the NAAC peer team visited BITS campuses at Pilani, Goa and Dubai and BITS has been reaccredited with CGPA 3.71 on four point scale at the highest 'A' grade.

2020 – A Strategic Plan for BITS

The Institute has embarked on a journey to become one of the leading universities in the world by the year 2020. Initially, a task force was constituted to prepare the Vision 2020 document and the draft 'Vision 2020' was released in February 2009. After several deliberations and discussions, Vision 2020 was formalized and logically split into 3 year long milestones, known as 'Mission Programmes'. First such milestone, **Mission 2012**, was accomplished in the year 2012, after being formally launched in October 2009.

Mission 2012 focused and achieved significantly in six thrust areas - Academic Programs and Pedagogy, People, Research & Consultancy, Campus Life, Infrastructure & Facilities and University Administration. 16 Task Forces comprising of more than 110 faculty members were involved in realizing 33 different goals under these six thrust areas.Several initiatives such as curriculum benchmarking and redesign, strengtheningstudent feedback, seed grant, research initiation grant, sabbatical leave policy, performance appraisal, faculty recruitment among others were fully completed and institutionalized into regular operations at BITS.

Other initiatives with varying degrees of completion would be taken up by existing offices, completed and institutionalized. Off Campus programmes (WILP), initially an intrinsic part of the People thrust area, was recognized to be a significant component in realizing Vision 2020. Several initiatives to engage with the industry have been taken up that will be achieved over 2-3 years.

Mission 2012 was formally concluded on a celebratory note, with a formal event 'Reflections 2012', presided by the Chancellor, Dr Kumar Mangalam Birla. The event was held in the K K Birla Goa campus, and was attended by several faculty & staff members. The Task force members were felicitated for their valuable contribution towards Mission 2012 goals.

In March 2013, **Mission 2015**, the next milestone in the journey towards Vision 2020, was formally launched. The Mission 2015, expected to bring a quantum jump in the aspirations of the objectives set forth, entails focusing on 7 imperatives: Faculty & Staff Development, Industry Engagement, Inter-Disciplinary Research, Internationalization, Innovation & Entrepreneurship, Quality Assurance & Assessments and Technology Enablement. One team per imperative has been identified and the teams are working on refining and actioning the goals.

A growth plan for the next 10 years has been developed and is under implementation. While projecting growth in number of students from 11,000 to more than 17,000 by 2020-21 across its four campuses, the plan outlines a strategy for transforming BITS into a research-focused university while continuing to consolidate its First degree and Higher degree programmes. Establishment of new research labs is an important ingredient of the growth plan, for which the plan envisages an aggressive push to sponsored research grants from Govt. agencies and from industry. As a result of extensive efforts to benchmark the First degree and Higher degree programmes against the best in the world, the curricula of all First degree and Higher degree programmes have been completely re-designed while ensuring greater focus on discipline-specific courses, on courses in Humanities, and on hands-on learning through lab-based experimentation and thesis work. The new curriculum was implemented starting August 2011.

Transforming BITS into a research-focused university is at the top of BITS' agenda. To take that forward, BITS has undertaken several measures. These include (i) Significant increase in the number of "teaching assistantships" that offer tuition waiver and stipend to full-time PhD students and (ii) Streamlining of its processes from admissions

to evaluation of PhD dissertation. BITS has undertaken several initiatives to encourage, facilitate and incentivize faculty to seek and execute research grants.

In November 2011, the Chancellor Dr Kumar Mangalam Birla formally announced the project "Parivartan" to modernize and expand the physical infrastructure in Pilani. The project, with an outlay of over Rs. 600 Cr., is well on its way to completion by 2016-17. Phase-I of the project, consisting of a new academic building, new student hostel, a workshop, and faculty housing has already been completed. The phase-II involves renovation of existing academic spaces, hostels and houses. The plan also covers complete overhaul of the underlying systems for water supply, electricity distribution, sewage treatment, etc. While the Hyderabad campus became functional in 2008, works undertaken in Phase 2 of the project are in various stages of completion.

In particular, swimming pool, faculty houses and hostels are under construction. Master-plans for Goa and Hyderabad campuses are currently being revised to cater to increased demand for housing for faculty and students and for expansion in teaching and research labs.

CAMPUSES OF BITS

BITS Pilani - Pilani Campus

BITS Pilani, Pilani Campus is located in the Vidya Vihar campus adjacent to Pilani town in Jhunjhunu district, in Rajasthan. Pilani is the home town of the Birla family and has a population of about 50,000. It is about 200 km west of Delhi and about 220 km north of Jaipur. The temperatures during the year go to extremes like 45°C in summer and 0°C in winter. The climate is generally dry and healthy. Annual rainfall is about 30 cms.

The Institute buildings, hostels and residential quarters for staff with neatly laid out roads, lawns and gardens constitute the BITS Campus of about 240 acres.

Pilani can be reached either by rail or by road. The nearest railway stations are Chirawa on W.R. (16 km) and Loharu on N.R. (24 km). There are connecting buses to Pilani from Loharu and Chirawa railway stations. There are regular bus services between Delhi-Pilani and Jaipur-Pilani. The buses leave Delhi from Inter-State Bus Terminal, Kashmere Gate and Jaipur from Rajasthan State Roadways bus stand, Sindhi Camp. The Pilani campus is very close to the Pilani bus stand.

BITS Pilani - Dubai Campus

BITS Pilani, Dubai Campus (BPDC) was established with the approvals of the Ministry of HRD (Vide Letter No. F.1-8/2000(CM) dated 4th August 2000) and the University Grants Commission (UGC) (Vide Letter No. F.34-18/2000-U.3 dated 6th November 2000) in association with ETA-ASCON group in the year 2000 in response to the growing need for quality engineering education among the residents of the Middle East. In 2013, BITS Pilani acquired the infrastructure of its Dubai Campus. The beautiful campus is spread over an area of 14.7 acres in Dubai International Academic City in Dubai, with a built up area of approximately 5,36,436 sq.ft. It is about 16 kms from the Dubai International Airport. All the programmes offered at the campus are also approved by Knowledge and Human Development Authority (KHDA), Government of Dubai, UAE. BITS Pilani is the first Indian Higher Educational Institution to set up its campus abroad.

BITS Pilani - K.K. Birla Goa Campus

BITS Pilani - K.K. Birla Goa Campus started functioning in August 2004 and was formally inaugurated by Hon'ble Prime Minister of India, Dr. Manmohan Singh on May 5, 2006.

The Campus is spread over an area of 180 acres and the location on campus is unique with respect to scenic beauty and panoramic view of the picturesque surroundings with Zuari river, hillocks, waterways and forest. The Campus is about 25 km south of Panaji (capital of Goa), 10 km west of Vasco-Da-Gama and 22 km north of Madgaon. It is 5.5 km east of Goa Airport, along National Highway – 17B, bypass road.

BITS Pilani - Hyderabad Campus

BITS Pilani has established its fourth Campus in the city of Hyderabad in 200 acres area in Jawahar Nagar, Shameerpet Mandal in 2008.

For the academic session 2015-'16, the campus had admitted 710 students in its eighth batch of First Degree programmes, 67 students in Higher Degree programmes and 47 students in Ph.D. programmes.

International Student Admission in Integrated First Degree Programmes

In order to introduce trans-national diversity and to embark upon making BITS Pilani a global university, the Senate has approved an alternate merit based mode for admitting international students to the integrated first degree programmes. Any student who is a not a citizen of India is eligible to apply through this scheme for which the admission will be based on performance in Scholastic Assessment Test (SAT) conducted by the College Board (USA) in Mathematics, Physics, and Chemistry. In the academic year 2015-'16, 28 international students have been admitted to the Hyderabad campus. An office of international students has been established in Hyderabad campus and furthermore, Goa Campus is starting to admit international students to its undergraduate programmes in Science and Engineering from this academic year 2016-'17.

The campus is located on the Karimnagar highway and is about 25 kms from Secunderabad railway station; 40 kms from Hyderabad (Nampally) railway station; and 70 kms from Hyderabad Rajiv Gandhi International Airport.

FACILITIES AT CAMPUSES

PILANI CAMPUS AND ITS ADJOINING FACILITIES

Shiv Ganga and Saraswati Temple

Shiv Ganga is a central beauty spot of the Vidya Vihar Campus with 400 meters circular canal and the Sharda Peeth, a beautiful white marble temple dedicated to Goddess Saraswati.

Guest Accommodation

Limited facilities are available for board and lodging on payment at the VFAST Hostel (Visiting Faculty and Students Hostel) which is near the entrance of the Campus. Other accommodation facilities are also available at (i) Alumni Home (Requests should be addressed to Public Relations Officer, Birla Education Trust, Pilani), (ii) CEERI Guest House (Requests should be addressed to Administrative Officer, CEERI, Pilani) and (iii) Some guest houses and dharamshalas in the city operated by private agencies.

Schools/Colleges

There are several Middle and Primary Schools in Pilani. The Secondary schools are affiliated to Central Board of Secondary Education; prominent being Birla Public School, Birla Senior Secondary School, Birla Balika Vidyapeeth (for Girls upto 10+2) and Birla Shishu Vihar, a Co-educational Secondary School, located in Vidya Vihar Campus. Adjoining the Vidya Vihar Campus, there is Engineering and Technology Institute, Commerce & Arts College and a Polytechnic Institute. There is a Home Science College for girls in Pilani town. These schools and colleges are run by Birla Education Trust and other Educational Societies.

Blossom Kids-zone

The Blossom Kids-zone (BKz) is run voluntarily by faculty wives and it takes care of the pre-school training and education of the children in the age group of 3-5years. The center primarily caters to the needs of children belonging to staff of BITS and its sister organizations. BKz has a dedicated team of teachers and support staff who provide a very fertile and comfortable atmosphere for children to learn and grow.

Bank and P & T Service

Within the Vidya Vihar Campus there is a branch of UCO Bank with ATM facility. In the adjoining CEERI Campus there is a branch of the State Bank of Bikaner and Jaipur, with ATM facility. Vidya Vihar Campus also have ATM facility of Axis & ICICI Bank. Pilani also have ICICI, Axis, SBI, PNB Banks. The Pilani Post office is located within the Campus, while a Telegraph office is situated in the CEERI Campus.

Shopping Centres

AKSHAY, a Supermarket, located in the heart of the campus in an area of 7500 sq.ft. with an elegant modern building is a part of BITS

Consumers' Cooperative Stores Ltd. (BITS Coop). Student volunteers of the Institute have worked with management of the BITS Coop in the establishment of the Supermarket. It has various sections for consumable items where the customers can choose and pick-up the items of their choice and pay on the cash counter. General provision, sanitary goods, cosmetics, snacks and other food items, Bakery and Dairy products, books & stationery, fruits & vegetables are made available to the students and staff at reasonable rates.

The Vidya Vihar Campus has another shopping center (popularly known as "Connaught") with books and magazine stores, stationery shops, general merchandise and provision stores, photocopying and STD phone facilities and several restaurants.

Birla Museum

The Birla Museum is located adjacent to the Institute Building. It is the first science and technology museum established in the country. Most of the exhibits and models incorporate stimulating animations and visual effects.

Central Electronics Engineering Research Institute (CEERI)

Adjoining the Campus, there is the Central Electronics Engineering Research Institute. It is one of the National Laboratories under the Council of Scientific & Industrial Research (CSIR).

STUDENT LIFE

Student Housing

The Institute is fully residential and hostel accommodation is provided to all students. Permission to become day-scholar may be granted only under exceptional circumstances where student's parents or close relatives are residents of Pilani.

There is a common kitchen cum mess unit for every set of two boys' hostels. Each unit of the mess serves vegetarian and non-vegetarian food and the unit operates under the management of different students' committees. The girls' hostel, however, has a separate mess of its own, situated within the boundary of the hostel. Students staying in the hostel have to necessarily take their food in the Hostel Messes. The messes attached to hostels are fully managed by the students. Every inmate of the hostel is provided with necessary furniture and fixtures in the room. Each hostel is equipped with solar water heating systems. Common room facilities are available in each hostel. Internet connectivity has been provided in all hostel rooms.

There are 13 hostels for boys and one hostel complex for girls, the details of which are given below:

Name of the Hostel	***No. of single seated rooms***	***No. of double seated rooms***
Boys' Hostel:		
Ashok Bhawan	152	-
Bhagirath Bhawan	152	-
Budh Bhawan	176	96
CV Ramanunjam Bhawan	203	-
Gandhi Bhawan	174	112
Krishna Bhawan	190	36
Malaviya Bhawan – A	140	-
Malaviya Bhawan – B	140	-
Malaviya Bhawan – C	182	-
Malaviya Extension – D	-	105
Ram Bhawan	180	110
Rana Pratap Bhawan	152	-
Shankar Bhawan	190	36
Vishwakarma Bhawan	192	38
Vyas Bhawan	190	36
Srinivas Ramanujam Bhawan	-	207
Girls' Hostel:		
Meera Bhawan	371	117

Student Activities Centre

The Institute has a Student Activities Centre housed in a separate building where students have their union office and rooms for various activities. This building also has badminton courts, a squash court, a Table tennis room, a Health Club, an open air amphi theatre and a cafeteria.

Cultural and Recreational Activities

The Institute has following clubs and societies: Music, Dance, Hindi Drama, English Drama, Hindi Press, English Press, Creative Activities, and Mime clubs; English Language Activity and Hindi Activity societies. These are entirely managed by the students and have been nurturing the creative and cultural talents of the students. In addition, the Institute runs Recreational Activity Forum, Photography Club, Swimming Club, and Health Club whose membership is open to students and staff. The Institute also organises Theatre and Dance workshops. A classical music group called 'Ragamalika' aims at encouraging budding talent among the students in music and dance. It also arranges performances by leading artists in the field of classical music and dance. In addition, there is also a BITS Pilani Chapter of SPIC-MACAY which organizes programmes to promote Indian classical music and culture amongst youth.

Recreational Activity Forum (RAF) regularly organizes film shows and cultural programmes for the BITS community. BITS being an all-India Institute, students have also established regional associations representing almost all Indian States conducting several special programmes on festive occasions.

Physical Education

Physical Education of the Institute aims at providing a safe atmosphere to enable students and staff members to exercise to their potential whilst achieving their goals. It offers a variety of fitness, wellness, and recreation opportunities, and Fitness Programmes including Yoga and Martial Arts. The Physical Education has major facilities that include Health Club, Swimming Club and Sports Club. Health Club is equipped with single and multi-stationed machines and weight training facilities to provide students with an opportunity of doing exercise for physical fitness. Swimming Club has a swimming pool of 25 m length while Sports Club has various indoor and outdoor facilities for students to take part in sports and games. The indoor facilities are Badminton, Table Tennis and Squash with synthetic flooring while outdoor facilities are Basketball, Football, Hockey, Volleyball, Cricket, Tennis, Track & Field (400 m) etc. Sports and fitness activities are supervised by the qualified and experienced staff members of the Institute.

Festivals on Campus

Traditionally students organize three festivals during an academic year. BOSM (BITS Open Sports Meet) in September, a sports festival; OASIS, a cultural festival in October and APOGEE (A Professions-Oriented Gathering Over Educational Experience), an Academic Festival in February thus bringing about a beautiful blend of sports, cultural and academic milieu of the campus. All the three festivals are entirely managed by students in which a large number of students from all over India actively participate.

Students' Participation in Institute Activities

Students actively participate in various continuing and developmental activities of the Institute as follows:

There are four students as members of the Senate – one representing each campus, two students in the Senate-appointed Academic Counselling Board and one student in the Senate-appointed Standing Committee for Students' Discipline in each campus. In addition, senior students act as mentors to junior students in the registration process. Some students are also associated with the course development activities. Students participate as associate members in the activities of various Divisions of the Institute. Their contribution in projects and research activities of the Institute has proved to be very useful.

STUDENT SERVICES

Orientation and Counselling

At the time of admission, the Institute organises an orientation programme in order to familiarise the new students with the Academic Programmes at BITS and to give them an idea about their campus-life and co-curricular activities. The Vice Chancellor, Director, Pilani Campus and senior faculty members meet the parents of Freshmen at an interaction session organized at the time of admission.

Faculty members act as Advisors and Mentors for groups of students to guide them in the registration process, and encourage them to discuss any matter –academic and non-academic with them during their stay at BITS. Students can also approach their wardens for any help or guidance related to academic or personal matters. Hostels have Resident and Non-resident Wardens drawn from the faculty. In addition, there are Hostel Superintendents to assist the Wardens in matters related to the upkeep of the hostels and attending to the needs of the students.

DISCIPLINE ASSOCIATIONS

Associations formed by students of various academic disciplines organize extension lectures, paper reading seminars, etc. They also arrange symposia in which professionals from industries and other universities participate. These associations organize exhibitions of working models during APOGEE, the academic festival.

Medical Facilities

The Campus has a Medical Centre, which caters to the medical needs of the students and staff. It has a full time Physician (MD) and a Gynecologist, who attend to the patients both in the morning and evening outdoor hours. A dental surgeon and a Pediatrician visit the centre once in every week. Similarly the centre also provides services of part time ENT, homeopathy, and Ayurvedic specialists. The Centre has a good clinical laboratory for all major biochemical, hematological, urine, stool and other routine tests. The biochemical tests are performed by a fully automated analyzer.The hematological tests are performed by fully automated five- part hemotology analyzer. Certain Serological tests are also done using ELISA plate analyzer counter. A computerized ECG machine and a computerized spirometer are also used as diagnostic tools. The centre also has a small Physiotherapy unit and a digital dental X-ray unit. Health awareness camps are organized in the centre from time to time. BITS Coop Medical Store is located in the Medical Centre where medicines prescribed by the doctor can be procured on credit. Other medical needs of the students are attended to at the Birla Sarvajanik Hospital, which is situated at a distance of about 3 kms from the Institute Campus. The hospital is not controlled by BITS. We have an arrangement with it. It is a 170-bed hospital staffed with Surgeons, Physician, Gynecologists, Pediatrician, Orthopedic and ENT surgeon, etc. The hospital has facilities for pathological tests, X-ray, CT scan, Blood bank etc. There is a special ward reserved for students. However, for serious illness it becomes necessary to go to nearby cities like Delhi/Jaipur. The Institute maintains Ambulance services and has arrangement with hospitals in Delhi (Fortis group), Gurgaon (Medanta) and Jaipur (Fortis and SDMH) for this purpose. The Mahadeo Singhi eye hospital at Pilani caters to the eye and dental care of the campus residents. The medical centre has been renovated and facilities like observation room, medical shop and physiotherapy room have been additionally created / expanded. Computerization of OPD records, laboratory reports and medical billing is being implemented now.

INTERNATIONAL STUDENTS ASSOCIATION

The International Students Association is a body of foreign students studying at BITS with a faculty member as the International Students Advisor. The association organises cultural activities and extends all possible help to foreign students whenever required.

PLACEMENT AND CAMPUS INTERVIEWS

A separate unit deals with this important activity. About 182 companies visit the institute every year to interview students who are about to graduate. The number of such interviews has actually grown considerably over the years. As the student population in the final year is divided into two batches, one going to practice school in the first semester and the other in the second semester, only one half of the final year students will be available for campus interviews during a particular semester. Hence many organizations find it worthwhile to conduct the campus interviews in both semesters so that they can interview both the batches on campus itself. The institute also tries to arrange interviews for practice school students in and around their own practice school centers. The impressions given by the representatives of

industries about students are continuously fed back to the concerned divisions and departments. Some of the organizations that have been conducting campus interviews are shown in the following table.

Organizations conducting Campus Interviews

1. Aditya Birla Science & Technology
2. Adobe
3. Airtel
4. Amazon Area Manager
5. Amazon IT
6. American Express
7. Anand Automotive
8. Arvind Internet
9. Avaya
10. Axis Bank
11. Axtria Consulting
12. Bain Capability Centre
13. Bank of America
14. Blue Jeans Network
15. Bosch Limited
16. Boston Consulting Group
17. CA Technologies
18. Capgemini
19. Capillary Tech
20. CATech
21. Chalk Studio (OC)
22. CISCO
23. Cisco - Engineering
24. CISCO- NEC
25. CITI Corp
26. Clicklabs IT
27. Codigami
28. Cognizant
29. CommonFloor
30. Coupondunia
31. Credit Suisse- ORM
32. CVENT
33. Cypress
34. DE Shaw
35. Dell
36. Diamond Consulting
37. Direct i
38. Dr. Reddy's Laboratories
39. Earnst & Young (OC)
40. Eaton Technologies (OC)
41. eBay / Paypal
42. Edelweiss
43. Edge Verve
44. Edge Verve (Infosys)
45. Emaar MGF
46. EPIC Systems
47. Ericsson
48. Ernst & Young
49. Essex Lake Group
50. Evalueserve
51. Exicom
52. EXL Services
53. ExxonMobil
54. Fair Issac (FICO)
55. Feedback Infra (OC)
56. Fidelity
57. Flipkart
58. Funtoot
59. Futures First
60. Goldman Sachs
61. Google India
62. Google Mountview
63. Grasim Industries
64. Grey Orange Robotics
65. Grey Orange Robotics Analytics
66. Grey Orange Robotics IT
67. Grey Orange Server Role
68. GSFC
69. Gwynniebee
70. Harman
71. HERO Motocorp
72. Hestabit Technologies
73. HILTI
74. Honda 2W
75. Hospira
76. Housing SD
77. HP R&D
78. Huawei
79. IBM R&D
80. ICICI Bank
81. Idea Cellular
82. IMS Health
83. In Mobi
84. Indus Insights
85. JMITRA

86. Johnson & Johnson (OC)
87. JP Morgan Services
88. JPMC
89. L&T ECC
90. Latentview
91. Lea Associates (CW)
92. Lindstrom
93. Linkedin
94. Mafoi Analytics (OC)
95. Maruti AIGET (OC)
96. McKinsey & Co
97. Mehta Group
98. Michelin
99. Microsoft IDC
100. Microsoft Redmond
101. Microsoft SMSG
102. MU SIGMA
103. My SmartPrice
104. Myntra
105. Nagarro
106. NBC Bearings
107. Nestle
108. National Instruments R&D
109. NirSan Health
110. Novartis
111. Nvidia
112. OFSS
113. Opera Consulting
114. Opera Solutions
115. Oracle
116. Orbees
117. Orient Electric
118. Orient Electric (CW)
119. OTIS - UTC
120. Pantaloons
121. Persistent
122. Phyzok
123. PI Industries
124. Practo
125. PwC
126. Qualcomm
127. Quikr
128. Raja Software
129. Rapid BizApps
130. Reckit
131. RIL
132. S&P Capital IQ (OC)
133. Sabre
134. Samsung R&D
135. Sandisk
136. SAP
137. Schlumberger
138. Sentiss Pharma
139. Service Now
140. Shell (OC)
141. Smart Analyst
142. Smartrak
143. Snapdeal Analytics
144. Snapdeal IT
145. Sokrati BA
146. Sprinkler
147. Sprinkler
148. Stayzilla
149. Strand Life Sciences
150. Synopsis
151. Systango
152. Tata Advanced Systems
153. Tata Communications
154. Tata Consulting Engineers
155. TATA HOUSING
156. Tata Motors
157. Tata Steel
158. Tata Technologies
159. TCS IT
160. TCS IT
161. Tejas Networks
162. Texas Instruments
163. Thermax
164. Thyssen Krupp
165. Tiny Owl
166. Tolexo
167. Tonbo
168. Total Environment
169. Total Environment Builders (CW)
170. Tresvista Finiserv
171. UHG
172. UOP Honeywell
173. UTC Carrier
174. Value Edge
175. Vidyarthi Academy
176. VMware
177. Vodafone

178. Walmart
179. Wipro Star
180. Wipro Technologies
181. Zinnov
182. ZS Associates

BITS Alumni Affairs Division

The BITS Alumni Association (BITSAA) has been functioning since 1989 as a nodal agency for maintaining liaison with Alumni all over the world and to involve them with the development of the institute. Since 1989 the institute has grown manifold. An overseas campus at Dubai is functioning since 2000, and the K K Birla Goa and Hyderabad campuses are in operation since 2004 and 2008 respectively.

A new division, BITS Alumni Affairs (BITSAA) Division, was created in 2010 to give distinct thrust to the activities related to Alumni and to connect and engage students, alumni, friends and well-wishers for a longtime relationship with BITS Pilani. It focuses on development of alumni support to the continuing development of the Institute's academic, research, and off-campus programs, expansion and renewal of its facilities, and providing scholarships and financial aid to students through annual fundraising campaigns. It manages various events – Silver Jubilee Meet, Golden Jubilee Meet, fare well to passing out students etc. and brings the news about Alumni. It coordinates its efforts with BITSAA International and BITSAA chapters in various cities in India and abroad.

The role of BITS Alumni Affairs Division includes the following:

- Plan, implement and promote alumni programs that support the BITS Pilani strategic initiatives.
- Establish and build relationships with a wide range of alumni as well as local, regional, national and international alumni chapters.
- Serve as the single point of contact for alumni & Institute for all matters related to alumni affairs, and maintain regular communication with alumni.
- Educate graduating students about alumni benefits and engage them in various programs.
- Partner with various offices of the institute to spearhead the introduction of alumni involvement in the growth and continued leadership of the University.
- Collaborate closely with BITSAA Chapters throughout the world and enable increased support from alumni, and provide platforms and programs for such support.
- Raise funds for select special projects and events.

Seek alumni involvement for placements of graduating students and for promotion of entrepreneurship amongst students.

NATIONAL SERVICE SCHEME

The Institute has a National Service Scheme (NSS) chapter which enrolls about 200 students every year. NSS aims at developing amongst students a sense of participation in nation building through social work. In recent years the NSS volunteers of the Institute work in the surrounding villages and involve the villagers in activities like awareness camps, health camps, tree plantation drives etc.. Other activities like Blood Donation Camps and seminars on RTE are organized successfully. The Blood Donation Camp conducted in Jan, 2016 had collected a total 731 units of blood. NSS also has a small school in campus where tutorials and personality development classes are conducted for local students from schools in Pilani with great zeal and enthusiasm. Counselling sessions are also conducted at regular intervals. The students also work in the surrounding villages to impart computer literacy to children studying in government schools.

NIRMAAN

Nirmaan Organization is a constructive citizen movement for an empowered India. This social Organization founded on 12th February, 2005 by a group of BITS-Pilani University Students is now spread over all the BITS campuses Pilani, Hyderabad and Goa and also with full time chapters in Bengaluru and Hyderabad. Nirmaan has been phenomenal in creating greater impact in areas of educational initiatives, livelihood opportunities and socio-technological sectors. Currently the Nirmaan workforce

stands at 1200 across India and corporate chapters at US, UK and Singapore.

IEEE - STUDENT BRANCH

IEEE Pilani student chapter conducted a recruitment test to feed the enthusiasm of the freshers batch along with testing their analytical skills which can be helpful for them to do interesting projects in IEEE and 150 students participated. The chapter initiated **Aavishkaar lecture series** to boost the research related activities amongst students. The first lecture in this series was conducted on 28th September, 2015 on the basics of introduction to Matlab in Image Processing by Krishna Murthy a senior and experienced student of Team robocon BITS Pilani. A talk on "Carrier & Scope of Research in ANALOG DESIGN" was delivered on 16th Oct., 2015 by SAURABH CHAUBEY ex-Bitsian on Chip Power Transfer Analog Design. Mr. Saurabh is a Ph. D. research student from the University of Minnesota, Twin City, USA. In November, Anupam Purwar, a scientist at IISc Bangalore and a BITSian graduate of 2013 delivered lectures on a variety of topics:

1) Career and Research at IISc including internships, M. Tech, MS and Ph.D.
2) Unmanned Aerial Vehicles (UAVs) and allied research areas like Avionics, image processing and propulsion in depth.
3) His own initiative to take up BITSIANs for research work.

IEEE keeping in view the Apogee projects and Events shortlisted the projects in the areas of

Joystick Control Car Mechanism for Physically Challenged People, Unaided Braille Encryption: An android app for all household appliances and an autonomous mobile robot for assisting the elderly people. Students were guided to particular projects to ensure a better result for the projects. During Apogee two events, Robotetrics and plA were organized.

IEEE brought an extravaganza in robotics in the event APOGEE'15.The IEEE Pilani chapter chairman P V G Sai Subrahmanyam got selected to present his work at the 42nd Photovoltaic Specialists Conference, New Orleans in June 2015 at Louisiana, USA.

CENTRAL FACILITIES

Central Library

The BITS Pilani library is housed in a state-of-the-art new building, covering about 65000 sq.ft area and is located close to all academic blocks of the Institute. With attractive palatial interiors and a seating capacity of 750, the library includes, well-lit reading halls, stacks, display areas, e-library zones, audio-visual library and study carrels. This year the library undertook a major air-conditioning project of Hall No. 1. Besides this, there are a couple of air-conditioned reading rooms in the library. The **library is fully automated** with a new library management system called **KOHA** which is an Open Source Software has been implemented this year. It provides user-friendly features to explore library resources. The library catalogue is completely computerized The library has also implemented **RFID technology** this year to make it technologically advanced thus enhancing its efficiency further. It has a collection of over 2,38,650, books, manuscripts, a good collection of rare books with bound volumes of journals since 1920s. Library subscribes to over 265 print National and International journals. One can avail the **Issue and Return** service for books and overnight issue of Textbooks and reference books during the working hours of the library.

Over 16000 full-text e-journals are available through 32 online databases. These databases are made available through an **interactive and dynamic library portal** called **infoBITS** which was launched on 7th August 2015 by Prof. Ashok Sarkar, Director, BITS Pilani, Pilani campus and can be accessed from anywhere within the campus including hostel rooms and staff residences. These Databases include the journals of ACM, IEEE, ASCE, ASME, IIMCHe, Springer, Science Direct, Wiley, IOP, Project Muse, ACS, PROQUEST, SciFinder, Emerald, EBSCO,JSTOR, OUP, CUP, etc.. There are 30 public access terminals in the library. The wireless internet in the library provides Internet connectivity even for the readers' laptops. BITS Library is also a partner in the networking of university library programme of INFLIBNET. Educational CDs, videos, theses, dissertations, old question papers and Practice School reports are available in the library. The Text

Book section provides all text and reference books for study in the library and overnight issue. Photocopying facility is also available in the library premises.

BITS Library has signed up MoU with UGC-INFLIBNET to upload all the Ph.D Theses to **Shodhganga** – A platform for research students to deposit their Ph.D. theses and make it available to the entire scholarly community in open access ETD. As a part of this MOU, the library has also received free access to Anti-plagiarism software called **URKUND** which faculty members can use.

The library has an arrangement with *Central Electronics Engineering Research Institute (*CEERI) library under which a student/faculty can become a member of the latter and borrow books. The Inter Library Loan (ILL) System can be used to share resources with other Libraries. As a member of American Center Library and DELNET, BITS library also makes arrangements for getting books on ILL and photocopies of articles from foreign libraries such as British Library, UK, Australian National Library and DU Delft (Netherlands) for faculty and research scholars. It also operates satellite libraries at some Practice School stations.

The library remains open throughout the year (except on three national holidays) from 9 am to 11:00 p.m. on all working days. The opening hours of the library are extended till 12 midnight during semester-end (Comprehensive) examinations

BITS Library keeps organizing book displays to promote reading among the faculty and students. To name some of these events, Teachers Day on 5th September, National Unity Day on 31st October, World Book and Copyright day on 23rd April. On 31st August 2015, the library organized **"Creative Short Story Contest"** for the students. First three prizes and 10 consolation prizes were given to the students. The library has compiled a collection of 21 Short stories which will be published as booklet soon. The library also organized a week long major book festival called **Basant Book Festival** from 15-21 February 2016 inviting six leading booksellers from Delhi and displaying more than 25000 latest books covering all subject areas. During this festival, a series of motivational talks to promote reading were also held. Some of the initiatives like "Winter Reading Challenge", "Summer Reading Challenge", Thematic books displays are quite popular among students. A list of New Arrivals is sent to all students and faculty members through root mail every month.

Through the interactive **Library Portal** infoBITS, many new services such as Table of Contents for the select print journals, Reference Service, Daily News, Monthly infoBITS Bulletins, Book Finder, Periodical Finder, Books@MyDesk, Lost and Found Items, Suggestions/Complaints, Book Reviews, Feedback, are made available. Preparatory materials and reference books added to the collection to support the students to prepare for competitive exams.

A new LED Screen is installed to promote library services actively.

This year new CCTV cameras have also been installed for security purpose.

Central Workshop

The central workshop of the Institute imparts training to the students as well as caters to the maintenance & fabrication needs of the Institute. Student's training consists of training all integrated first degree students through the course "Workshop Practice" by imparting skills in various production processes like machining, fitting, carpentry, smithy, sheet metal, electroplating, welding, etc. In addition, students are imparted training for other discipline specific courses like 'Production Techniques', 'Metal Forming and Machining' and 'Casting and Welding'. Apart from routine maintenance, fabrication and training, the workshop also accepts jobs on precision fabrication of project work of students, staff and research scholars. Workshop store caters to the needs of regular and urgent purchasing of materials for departments, units and divisions of the Institute.

The workshop housed in 3519 sqm built up area comprises of the following sections: machining, welding, electroplating, fitting, smithy & sheet metal, carpentry, foundry & patterns, tool room, metrology, painting, metal processing & metallurgy, electrical, CNC training centre and stores.

The major equipments include industrial vertical machining center (LMW KODI 40 Klein); five CNC trainers (three turning centers and two vertical machining centers); industrial robot (pick and place); five universal milling machine tools; universal cylindrical, centreless, surface (hydraulic), and tool & cutter grinders; gear hobbing machine tool; NC machine tool (retrofitted at workshop); twenty eight lathes (centre, turret, precision and dc supply heavy duty); seven shapers; planner; slotter; twelve drilling machines; ten wood working lathes; two wood working planers; band, circular and universal wood saws; TIG, MIG, gas and arc welding equipments; power press, pneumatic hammer, etc.

Instrumentation Centre

The centre provides and maintains public address system, stage lights, video recording equipment, overhead projectors, LCD/DLP projectors, and Cable TV network in the Institute. The Instrumentation Centre is involved in the installation, testing, service and maintenance of instruments/equipment across the Institute. Centre also conducts programs to train the technical staff in computer hardware, software installation and operation & maintenance of instruments.

Reprography Services

The Reprography section provides services such as word processing, off-set printing and binding. All Institute publications and forms, etc. are printed in this section. The equipments include off-set printing machines, photocopiers and machines for finishing, cutting, stitching, laminating, etc. This section takes care of the centralised postal dispatch service for the Institute and also houses a color laboratory for photography.

Computing Facilities

The central computing facility of BITS Pilani referred to as the IPC (Information Processing Centre) hosts and manages the computing/ networking infrastructure for the campus. The infrastructure includes local and external connectivity including email as well as computer services. IPC operates early morning to midnight on 360 days a year. Some specialized labs/centers offer round the clock computing facility.

The campus hosts about 1000 latest desktops/workstations (including 350 in a central location), about a dozen compute-servers (Intel-based SMP Systems, IBM Blade Center with several blades), multi-Tera-byte storage (including a SAN) a variety of peripherals (printers/scanners/ plotters). These systems support heterogeneous operating environments (Sun Solaris, Linux, and Windows), compilers, development tools/packages (e.g. MS Visual and RDBMS for students and staff.

Campus-wide Computer Network

The campus hosts a state-of-the-art, completely switched, voice-enabled local network. The network enables 5000 Ethernet ports providing connectivity to all hostel rooms and all residences (of staff) as well as to instructional/ administrative and library buildings. A few wireless hotspots are also part of the network. The campus backbone is a 1Gbps fiber optic cable on a dual ring configuration. The external (Internet) connectivity is supported through 500 Mbps of leased line.

Computer Assisted Housekeeping Unit

The Computer Assisted Housekeeping Unit (CAHU) was created for the purpose of design, development, management and operations of software services for maintenance and processing of institute-wide information pertaining to academics, finances and administration. As per institute developmental plans the above processes are getting shifted to PeopleSoft ERP system and CAHU is helping in a smooth transition and in the coming years ERP will be fully active. Currently CAHU takes care of pilani campus pay roll and staff data, institute wide budget processing and all on-campus students' degree processing, alumni data, etc., and other residual processes left after ERP implementation.

CAHU is equipped with HP-9000 (E35 and rp3440), HP ML-350 and intel servers, HP-8150, 9050, 3700 and 1536 printers, PC nodes, Oracle 10G database, ANSI-C and FORTRAN-90 compilers. Apart from administrative work, CAHU also provides computer facilities to

students working on administrative and application oriented software projects.

Central Analytical Laboratory

Central Analytical Laboratory (CAL) at BITS Pilani, Pilani campus houses many sophisticated instruments, catering to the needs of the various research Departments like Pharmacy, Biological Sciences, Chemistry, Physics and Chemical Engineering etc. The facility is used for training of the student's as well doctoral research. CAL has a spacious area of 2600 sq.ft and an is equipment with latest instruments which include - Stability Cabinets (For stability tesing of drugs and organic molecules) , UV-Visible Spectrophotometers, UV-Visible-NIR Scanning Spectrophotometer, IR Spectrophotometer, FTIR Spectrophotometer, Scanning Spectroflourimeter, High Voltage Electrophoresis, Digital Polarimeter, Ultra and Refrigerated Centrifuges, Gas Liquid Chromatography and High Performance Liquid Chromatography (with auto-sampler and various detectors). Currently it is capable of carrying out research work at all levels including the industrial projects. Recently the laboratory has been upgraded with 400 MHz NMR spectrophotometer (Bruker AVANCE III) equipped with BBFO probe and auto-sampler. Also the latest addition is Elemental Analyser (vario MICRO cube) for estimating the elemental compositions of organic compounds.

Central Animal Facility

Central Animal Facility at BITS Pilani, Pilani campus is a CPCSEA approved facility with total floor area of 5330 sq. ft. Recently, the facility have received the approval for breeding. The facility maintains the animal species like Rats, Mice, Guinea Pigs, Rabbits and Hamsters. The facility was build up in accordance with guidelines issued by CPCSEA and other regulatory bodies. It is also equipped with Incinerator (electrically operated) facility for disposal of the biological and other biomedical waste. The air conditioned facility is maintained by well trained personnel, with a full time veterinarian to take care of the various requirements of the animals. Central Animal Facility caters to the needs of the various research departments like Pharmacy, Biological Sciences and Chemistry, etc. The facility also incorporates pharmacokinetics and pharmacology research laboratory for carrying out advanced research in the areas of pre-clinical pharma-cokinetics, bioavailability studies, pharmacological screening of various synthetic/natural origin drugs. The laboratory has sophisticated instruments such as two chamber automated organ bath, laser doppler, non invasive blood pressure recorder, RT-PCR, electroconvulsiometer, actophotometer, analgesiometer, light dark apparatus, rotarod etc. Equipments such as surgical anaesthesia machine, electrical cautery, and spare air-conditioners are also utilized. The laboratory is upgraded with video documentation system for various animal behavioural studies. Facility is geared to take up various industrial or governmental funded projects in various pre-clinical areas.

BITS Astronomical Observatory

BITS Pilani houses an astronomical observatory that is equipped with two telescopes, a 6" refracting telescope, and an 11" Celestron's Schmidt-Cassegrain telescope which is completely computerized. The observatory has recently procured a CCD camera which can be used with the 11" telescope to obtain long-exposure, high quality images, of nebulae and star-clusters. The observatory is maintained by the Physics Department of the institute. A group of 20 students, known as, Astro Club, makes a regular use of the telescopes to observe celestial objects on a fortnightly basis. In addition, the club conducts regular astronomical observation sessions as well as workshops for general public, i.e. entire BITS community of students and staff, several times during a semester. Moreover, students registered in the elective course on Introduction to Astronomy and Astrophysics, offered by the physics department faculty, also make use of the observatory on a regular basis to augment their understanding of celestial objects.

Pilani Meteorological Observatory

The Institute runs and maintains Pilani Meteorological Observatory on behalf of the Meteorological Department of the Government of India. Daily meteorological data regarding

the weather at Pilani are recorded and transmitted by the observer, under the supervision of a professor in-charge, appointed by the Institute. The observatory has an automated weather station.

CENTRES OF RESEARCH AND DEVELOPMENT

The Institute has established the following centres of Research and Development:

Technology Innovation Centre

Engineers/Scientists from industry bring their research and developmental projects for investigation in the campus. Such investigations are carried out in collaboration with Institute faculty associated with students registered in assigned research or project courses. Several industries have been participating in this programme. While in the campus, these engineers and scientists from industry are given a de-facto status of faculty members, so that they are encouraged to extend their professional interest much beyond the original scope of operation. Students also undertake identified projects by the industry wherein professional guidance is extended by professionals from industry virtually.

Centre for Innovation, Incubation & Entrepreneurship (CIIE)

The Institute has set up a Centre for Innovation, Incubation and Entrepreneurship (CIIE) which will be an integrated Centre for academic and incubation services related to entrepreneurship at BITS Pilani across its 4 campuses. The mandate of the CIIE includes facilitating technology transfer and commercialization, executing filing of patents, custodian of intellectual property of BITS, supporting entrepreneurial activities, interfacing with Technology business incubators of all campuses and fostering collaboration with alumni and industry for several entrepreneurial activities.

Pilani Innovation and Entrepreneurship Development Society

BITS Pilani has formed Pilani Innovation and Entrepreneurship Development Society (PIEDS) in 2013-14 to give a distinct emphasis on creation of technology or innovation based New Enterprises. The society takes up various activities to promote, encourage, and sustain activities and programmes contributing to technology based innovation, incubation & entrepreneurship education and development. The main objectives of the society are to aid and help in the creation of technology or innovation based New Enterprises; creating Value-added Jobs and Services; fostering the Entrepreneurial Spirit; speedy commercialization of R&D outputs; developing New Tools for Technology transfer; and provide mentoring and consulting services to aspiring innovators and entrepreneurs.

Teaching Learning Centre (TLC)

The institute has set up teaching learning centres (TLC) at each of its four campuses. These centres will be involved in improving the overall teaching-learning environment at BITS Pilani. They will encourage and support research on innovative teaching pedagogy, collect good practices of teaching-learning from across the world and disseminate these among the faculty, conduct intensive teaching workshops and organize regular seminars on relevant topics by experts from India and abroad.

The centre is headed by a Professor-in-charge, who is supported by Faculty-in-charges from all four campuses. There are a few nucleus members at each campus to support the respective Faculty-in-charge.

Centre for Software Development (CSD)

The Centre for Software Development (CSD) is first of the two major centres that comprise the newly formed Software Development and Educational Technology Unit (SDET Unit) at BITS-Pilani.

The CSD has three wings namely *Media Laboratory*, the *BITS-IBM Laboratory for Open Source Computing* and *BITS-Microsoft Laboratory for Mobile Computing*.

Its focus is on Web-media, E-learning Support, Networking (wireline and wireless: sensor, mobile and ad-hoc variants), wearable computing, Web-services as current thrust areas. It is involved in the Open-source Moodle LMS based *deployment for on and off-campus*

requirements of the Institute in form of the Nalanda and Taxila portals on a regular basis.

In the past, the CSD had been involved is the Journal Server Project which is a freeware international virtual digital library project, being led by Oxford University and BITS, involves over fifteen major universities in UK, India, USA, Norway, Italy, South Africa, Germany, Pakistan, Taiwan and Bangladesh, BITS had contributed to the overall architecture and Search Engine aspects of this project.

The CSD has played a major role nationally and internationally in several areas including the research, development and deployment specific to the next-generation internetworking technologies like IPv6. It has brought several firsts to BITS and has contributed to funded international research projects in this area.

Members of the team have also presented, the research and development work being done at BITS at several international fora apart from being actively involved in IEEE and IETF activities in the area of networking research and standardization. In addition to large number of first degree and master's level students, at present, two full-time doctoral scholars students are working towards their Ph.D. at the SDET UNIT in the area of wearable computing both of whom have won the TCS Doctoral Research Fellowships after joining BITS Pilani.

Recently, CSD has successfully created a small cloud computing test-bed with an objective of internal experimentation before embarking on creation of a large multi-tenancy hybrid academic cloud for the institute.

The Centre has also created a biometric attendance system for use across all campuses of the Institute which has been piloted in three campuses this semester.

Centre for Educational Technology (CET)

The Centre for Educational Technology *(CET)* is the second of the two major centres run by the Software Development and Educational Technology Unit (SDET Unit) at BITS-Pilani. It comprises of modern digital video studio and is equipped with the Leased Line based high-quality Video-conferencing facilities meant for use of the University for Delivery of live interactive lectures to its various campuses in India as well as cater to select student groups of work-integrated off-campus learning programmes.

This is further complemented by the Internet-based, highly scalable distributed desktop video-conferencing facility allowing medium–quality but more interactive live classroom sessions where all students cannot come to on or off-campus classrooms and may be resident in different parts of country / world. The Centre is equipped with the IP-based Video-on-Demand and Scheduled Video Multicast facilities which can allow reuse / review / streaming of lectures delivered earlier for the benefit of students. Incidentally, the above referred Project Embryo makes effective use of this technology already and allows ALL campuses of BITS-Pilani to be benefitted simultaneously whenever an Alumnus expert delivers a scheduled lecture from elsewhere in the world.

Its focus is on E-learning delivery systems, related web-services, live and stored video streaming as current thrust areas. Its mandate is to identify suitable educational technology solutions for on as well as off-campus operations of the Institute and helping in their deployment.

The CET has played the leading role in co-designing and establishing (along with alumni of the Institute) a University-wide, Integrated immersive Telepresence Infrastructure with seamless support for very high-quality eye-to-eye contact based meetings between people present in three telepresence rooms in three campuses along with integrated multi-campus interactive lecture delivery and recording support for three class rooms spread over all Indian campuses of the Institute which would be further integrated gradually with the interactive-web-conferencing system capable of involving numerous live interactions amongst faculty and off-campus students along with recording and view-on-Demand capabilities. This has been done as part of the BITS-connect 2.0 initiative and has benefitted from significant contributions from BITS Pilani and BITS Alumni spread over the Globe.

Currently, the CET is in the process of evolving a long-term and near-term blueprint and strategic plan of sustainable dual-purpose

large-scale open or partly-closed global instruction delivery for BITS Pilani.

Centre for Robotics and Intelligent Systems

The objective of the Centre for Robotics and Intelligent Systems (CRIS) is to develop prototypes that provide greater intelligence and higher versatility for robotic tasks under ever-changing constraints of the environment. This objective is set forth to make Indian industry competitive by developing indigenous technical skills, manpower and innovative spirit. Each prototype is developed in four different stages viz.(i)Conceptualization, (ii) Algorithmic development and verification in simulated environment, (iii) Real-time testing and (iv) Integration to automated system. The Centre is well equipped with good computational facilities; advanced software packages for circuit design, image processing and mechanical design; micro controller and DSP based driver card for real-time experimentation; experimental bed such as ABB-IRB-1410, CRS-Plus robot manipulator, 4-DOF SCARA manipulator, 5-DOF articulated manipulator, Hydra mobile base, Pendubot inverted pendulum, Labmate, mobile base and pH reactor. The facilities in the center are geared to provide research facilities in areas such as intelligent robotics and system design, intelligent control, neural and fuzzy neural based system modeling and control, evolutionary computation, robotic vision and virtual reality.

During the year under review, the students working at CRIS developed a number of models and working robots. To name a few of these, mention may first be made of *Acyut-VII* (humanoid series) which can walk and play football, won laurels at international competitions such as RoboCup. The models were also demonstrated at Iran, Korea, Japan, USA. Looking at the expertise Department of Information Technology (DIT) has sponsored this project with 45 Lakhs to develop Humanoids with different features. In addition to these, there are groups involved in development of technologies for Medical and Defense applications. This center has prototypes of autonomous glider, autonomous hovercraft, a 4-DOF robotic arm, a mechatronics ball, a micro-mouse platform and a micro-mouse testing bed.

Embedded Controller Application Centre

This Centre was set up in Collaboration with Motorola India Ltd. The objective of the Centre is to impart detailed understanding of important features of embedded controller architectures and familiarization of advanced concepts in the field of embedded controllers through

- Students projects/Industrial projects
- Imparting training to the industry professionals and running short term courses in the field of Embedded System design
- Developing course modules

The infrastructure of the centre includes Pentium machines, Microcontroller Modular Evaluation Systems, Microcontroller Development Systems, Emulators, Assemblers and Cross compilers for various microcontroller families (ARM, ATMEL, Microchip, Cypress, ST Microelectronics, etc.) DSP processors, logic analyser and other bench equipments.

Centre for Renewable Energy and Environment Development (CREED)

CREED is an interdisciplinary Centre that co-ordinates educational and research activities in the active areas of renewable energy and environment. The objectives of the Centre are (i) to conceive, develop and implement renewable energy applications and environment protection projects, (ii) to develop courses and organize awareness programmes, and (iii) to collaborate with external organizations in the areas of renewable energy education, training and technology development. The Centre is presently collaborating with MNRE, DST and RRECL. Some of the existing facilities at CREED include solar resource assessment equipments, an experimental set up for solar water heating, solar air-heating system, solar stills, parabolic trough collector, fuel cell, solar photovoltaic power pack with storage battery bank, SPV lighting systems, and portable energy audit instruments.

Currently, active research areas of CREED include solar thermal engineering, geothermal cooling, exergy analysis, emissions and

environmental impact of thermal power plants, planning and economics of renewable energy systems, real time operation and control of renewable systems, CO_2 based refrigeration, biomass gasifier, integrated renewable systems, demand side management and integrated resource planning.

The BITS Renewable Energy Club is an exclusively a student managed body that operates under CREED. The Club has undertaken active work in carbon footprint analysis and carbon credits. Commercial organizations in these areas have evolved out of the Renewable Energy Club, and are currently owned and operated by BITS alumni.

Centre for Biotechnology

The Centre has in-house facilities of Genetic Engineering and Recombinant-DNA Technology. The objectives of the Centre are to take up research and development projects from various sponsoring organizations, establishments of University-Industry linkage through various R&D contract projects and conduct periodic Workshops and hands on training for faculty members, industry personnel and students in the area of advanced molecular biology/biotechnology and bioinformatics. The facilities available are Gel Documentation System, PCR Machines, Hybridization oven, Gel electrophoresis equipments, UV-Cross linker, Temperature Controlled Water Bath Shaker, Refrigerated Centrifuge, Cold Room, Tissue Culture Room, Plant Biotechnology facility, Semi-automated Green House, Radioisotope handling facilities, Liquid Nitrogen Plant Victor-3 Multichannel counter, Inverted microscope with camera attachment, – 80°C Deep Freezer, etc. We developed Insectory to facilitate research on mosquito borne diseases.

Centre for Materials Science and Technology

The objective of the Centre for Materials Science and Technology is to develop and implement projects related to modern materials such as smart materials, biomaterials, fibre-reinforced plastic composites and also related to conventional materials such as metals, ceramics and polymers. The Centre undertakes mechanical and non-destructive testing of various engineering materials and products for evaluating their mechanical properties and for evaluating defects as cracks, voids, delamination, inclusions etc. Other activities include providing consultancy related to materials aspects and testing/development and analysis in the field of materials science and technology in general. The testing facilities available at the Centre include a conventional Universal Testing Machine of 50 Tons capacity, as well as, a fully computerized microprocessor based Electronic Universal Testing Machine of 100 kN capacity, Heating Chamber for UTM for High Temperature Testing, Hounsfield Tensometer, various hardness testing machines such as Brinell, Rockwell, and Vickers Hardness Testers, Rotating Bending Fatigue Testing Machine, Combined Bending and Torsion Fatigue Testing Machine, Circular Polariscope, Strain-gauge testing facility, Izod Impact Testing Machines, Digital impact testing machine, Double disk polisher, Inverted Metallurgy Microscope, Erichsen cupping tester, Single Screw Extruder with Calendering and Pelletization Facilities Ultrasonic Flaw Detectors, Liquid Penetrant Test kit, Magnetic Crack Detector, Eddy Current Tester, Acoustic Emission Testing equipments, Acousto-ultrasonic pocket hand-held AU scanner etc.Wet-lab facility and fume hood for training in materials testing and polymer fabrication is augmented.

Centre for Desert Development Technologies (C-DDT)

Established with the financial support from BITS Alumni, C-DDT functions with the primary objective of developing world-class desert development technologies for making the desert bloom. It has joined hands with the Jacob Blustein Institute for Desert Research (BIDR) of Ben Gurion University, Negev, Israel to work in the area of desert development. The activities of the centre revolve around developing affordable and technically less esoteric technologies and integrating them with the existing practices of the desert areas of Rajasthan for economic upliftment, employment generation and poverty alleviation of the people of Rajasthan. Last four years research has been focused on the energy efficient houses. For the purpose four rooms were constructed with different architectural elements. Last two years three International papers are published in International reputed journals and two reputed International conferences and one

Ph.D. scholar has completed her doctorate along with some first-degree projects at centre this year. Last year the solar house was integrated with rain water harvesting scheme and tank was covered, extended roof is fabricated to harness more rainwater and some roof tops were connected.

SPECIALISED LABORATORIES

Apart from the Centres described above, the following specialised laboratories have been established with a view to strengthen research and development in the respective areas:

Process Control Laboratory: Infrastructure includes Universal Process Trainer, Multiprocessor Trainer and Computer Control of process variables such as temperature, pressure, level, flow and pH in Chemical Engineering Processes etc.

Environmental Engineering Laboratory: Infrastructure of this laboratory includes BOD Incubator Shaker, several gas and water pollutant sampling and analysis equipment such as high volume sampler, air and water analysis kits, underground water sampling kit, respirable dust sampler, pH meter, conductivity meter, dissolved oxygen meter, BOD incubator, BOD incubator shaker, Digital BOD analyzer, digital COD apparatus, etc., Temperature Controlled Shaker Bath, Laminar Hood Chamber, Stack Sampler, Orsat Appratus, Refractometer, Multi Syring Pump and Auto Clave Vertical, Fermenter, Distilled water setup, Peristaltic pump, Compressor, Muffle Furnace, Calony Counter,Balance,Ion Meter,Fluoride Electrode, Hot Plate, etc.

Petroleum Engineering Laboratory: Infrastructure of this laboratory includes ASTM Distillation, flash point and fire point, cloud point and pour point, Reid vapor pressure, Saybolt viscometer, copper corrosion, Conradson carbon residue, Hydrometers and Pycnometers, Red wood Viscometer-1 & 2, Engler Viscometer, Penetrometer apparatus, Bomb calorimeter, Drop point of grease, Melting point apparatus, Smoke point apparatus, Gum content testing apparatus, Oxidation stability tester, Sulfur analyzer etc.

Research Laboratory: Continuous Adsorption Set-up, Biofilter Column Set-up, Biomass Gasifier, Pyrolysis Unit, Reactive Distillation Set-up, Air-Lift Bioreactor, CSTR Unit, Fluidized Bed, Fixed Bed Reactor, Catalytic Reactor, etc

Analytical Laboratory: UV-VI Spectrometer, High Speed Centrifuge, pH Ion Meter, Thermal Gravimetric Analyzer (TGA), High Performance Liquid Chromatograph (HPLC), Digital Scanning Calorimeter (DSC), Automatic Potentiometric Titrator with KF Attachment, Atomic Absorption Spectrophotometer (AAS), Gas Chromatograph (GC), Fourier Transform Infrared Spectrometer (FTIR), Flue Gas Analyzer, Surface Area Analyzer, Foam Analyzer, Volumetric Analyzer (VA), Cooling Micro Centrifuge, Rota Vapor, Digital Viscometer, Ultrasonic cleaner, Auto vacuume desicator, Ultrasonic liquid processor, HPLC Pump, Freeze Drayer(lifolizer),Datalogging Thermameter, 4-channel Thermameter,Nan-contcat Infrared Thermameter, vertex Mixture,etc

Fiber Optics Laboratory: The infrastructure in the laboratory includes facilities for study and characterization of optical waveguides, fibers, Optoelectronic sources and detectors. Facilities are available for fabrication and calibration of fiber optic sensors. Training kits to study Analog and Digital fiber optic communication systems with additional computational facilities are also available.

Flexible Manufacturing Systems Laboratory

The Flexible Manufacturing Systems (FMS) Laboratory conducts hands on training to first degree & higher degree students and cutting edge research in manufacturing science. This laboratory is a center for carrying out practical experiments for various on campus courses such as Flexible Manufacturing Systems (EA C412/BITS F431), Computer Aided Manufacturing (ME F432), Production Techniques-II (ME F313), Metal Forming and Machining (MF 313) etc. This laboratory has been designed and configured to assist the Indian industry to become globally competitive in CNC manufacturing, CAD/CAM and machine tool sectors. The aim of the laboratory is to conduct fundamental as well as integrated research in order to achieve appropriate skill in CNC machining, in-depth knowledge in metal

cutting, designing of manufacturing systems, developing manufacturing management techniques/strategies/practices for revitalization of Indian industries. The FMS lab aims to be foremost research center in CNC manufacturing, design of manufacturing systems and manufacturing excellence practices.

The following facilities are available in the FMS Lab.

- **Hardware:**
  - KODI-40 KLIEN Vertical Machining Center (Industrial)
  - Renishaw Probing System attached to KODI 40 VMC
  - Taylor Hobson Talysurf
  - FLIR Thermal Image System T250
  - MTAB STARRTURN CNC Lathe and Milling Trainer
  - MTAB FMS Cell
  - ROBOT
  - Rapid Prototyping Machines
    - ✓ Dimension Elite 3D Printer
    - ✓ FMD 200mc
  - IBM Intelli Workstations and High Computing Facility
- **Software Tools**
  - Umberto Life Cycle Assessment Tool
  - CATIA-PLM Tool
  - QUEST-3D Simulation Tool
  - ARENA-2D Simulation Tool
  - SIMUFACT Software
  - MINITAB-Quality Control Tool
  - DFMA-Product Design Tool
  - LINDO/LINGO-Optimization Tool
  - Multi-Attribute Decision Models

Oysters Lab. (VLSI DESIGN Laboratory): This laboratory has been established to support the Micro-electronics program and to carry out projects in the field of VLSI design. The facilities in the Lab, with a seating capacity of forty students, include the centralized IBM x3750 M4 servers, Sun Fire X2200, Ultra 20, Ultra-2, DELL Optiplex desktops and the Sun Fire v250 servers operating on RHEL and Sun Solaris operating systems. The servers operate on High Availability platform with parallel computing and cluster configuration. The servers are backed up with network storage via NAS and tape drive. The lab is equipped with the complete set of front-end and back-end EDA (Electronic Design Automation) tools from the top vendors including Cadence, Synopsys and Mentor Graphics for ASIC design, Altera for FPGA design, and Silvaco for device & process simulation.

The lab has collaboration with Europractice to obtain design kits for ASIC design including UMC 90 nm, 130nm, and 180nm, TSMC 180nm and 250nm and the Altera FPGA kits include 40 UP3 kits, 10 DSP development kits and 10 NIOS-II development kits. The lab also has a Mixed Signal Oscilloscope and a Function generator, from Tektronix, to test the fabricated chips.

Instrumentation Technology and Virtual Instrumentation Laboratory: The facility in the laboratory includes general purpose and specialized bench equipments, transducers and signal conditioning kits, PC based data acquisition and control cards, Virtual Instrumentation softwares (LabView) and data acquisition & signal conditioning modules, ELVIS boards, Green Engineering, bioengineering kits, wireless sensor network kits, Programmable Logic Controllers with I/O modules and interfaces.

ST-BITS Systems Laboratory: This laboratory has been setup with hardware and software support from ST Microelectronics, Noida. The laboratory aims to undertake research projects in the area of VLSI design and Embedded systems, with particular focus on Analog-Mixed signal activities.

Structural Engineering Lab: This lab has well-equipped testing facilities for structures and materials. The lab supports various equipment such as Loading frame with Servo-Hydraulic Actuator of 400 kN capacity, 100 kN Dynamic

Universal Testing Machine, 1000 kN Static Universal Testing Machine, 2000 kN Automatic Compression Testing Machine, 1000 N Shake Table, Beam Torsion Testing Machine, Concrete cube permeability apparatus, Cement autoclave, Automatic Blaine apparatus, Rebound hammer, concrete cube cutter apparatus, etc.

Highway/Transportation Engineering Laboratory : The highway / transportation engineering laboratory is equipped with state-of-the-art devices that are used for the testing of pavement materials, conducting traffic engineering studies and to design safe flexible and rigid pavements. The equipment housed in the laboratory includes, among others, Los Angeles Abrasion Testing Machine, Light Weight Deflectometer (LWD), Dynamic Cone Penetrometer (DCP), MERLIN, Bump Integrator, Portable Skid Resistance Tester, Centrifuge Extractor, Viscosity Bath Test Apparatus, Digital Ductility Testing Machine, Speed Radar Gun, Auto Exhaust Multi- gas Analyzer, Global Positioning System (GPS) units, Digital California Bearing Ratio Test Machine, and Marshall Stability Test Apparatus. In addition, the laboratory also hosts several software packages that include VISSIM, ArcGIS, AutoCAD, MX Road, etc. These facilities are available to students, academicians, and researchers for their class and project work, and to outside agencies for consulting work.

Language Laboratory: A language laboratory with 45 booths is functioning to conduct practice sessions pertaining to the various courses offered by the department and to provide adequate practice to the students in various languages namely English, French, German and Japanese. The computer assisted lab facilitates the teacher to instruct and take responses from students through a computer network. Students and faculty across the institute also use these labs for the self-practice and self-assessment of their language and communication skills. The lab has a good collection of audio visual teaching materials in the form of Audio/Video CDs, Audio cassettes and Learning software which are used to enhance the communication, language and interpersonal skills of the students. Recently the Department has procured a new language lab software system named Orell Digital Language Lab (ODLL) which offers cutting edge software solutions and delivers language teaching – learning solutions integrating two – way communication and incognito individual student monitoring. The Lab also houses a 2D Classical Animation Desk for students to practice and do assignment for the course Mass Media Content and Design.

Creative Media Lab: The Department is equipped with a studio-cum-lab for meeting the requirements of asset of courses in the area of Media and Communication. Primarily designed to support the course Short Film and Video Production, the lab is now catering to the recording of institute events, lecture recordings, interviewing of visiting dignitaries and several in-house productions. The lab is equipped with DSLR and video cameras, colour video monitor, Microphones, basic lighting equipment and other accessories. For editing films, the lab has acquired a Mac –Pro 2.4 GHz Quad –core Intel XEON.

DUBAI CAMPUS AND ITS FACILITIES

Dubai Campus houses the academic building (main, library and mechanical blocks), hostels for boys and girls, library, sports facilities (playgrounds, indoor play areas, gyms), ATM facility, grocery and canteen. All classrooms, laboratories, offices, hostels and other indoor areas are centrally air-conditioned. Cisco Telepresence class room and Cisco meeting rooms, campus-wide Wifi infrastructure are the latest addition to our facilities.

STUDENT LIFE

Student Housing

The Campus has segregated, conveniently located, singly occupied, air-conditioned hostel accommodation for more than 900 boys and girls, furnished to suit the student's requirement. Wifi Internet connectivity and provisions for maintaining a small fridge are also provided. The hostels provide a safe and secure learning environment to students. Hostels have televisions, microwave ovens, gymnasium, laundromat, first aid kits and recreation rooms with indoor games, magazines and news papers.

Vegetarian and non-vegetarian food is available in the hostel messes.

STUDENT ACTIVITIES

Cultural and Sports activities

The Campus provides facilities and services that encourage the personality development of every student in the social, cultural and interpersonal domains to produce self reliant young professionals. Students organize various academic activities, social activities, and cultural and sports festivals. A variety of extracurricular activities such as drama, public speaking, debate, poetry and story writing, painting, sketching, singing, dancing, quizzing, gaming, digital art, face painting, rangoli, henna, photography etc. have become a regular feature of the Campus calendar. Students also participate and win several laurels in various inter university events organized by other universities.

Student Clubs

Student clubs formed around academics and themes add to the rich mosaics of student life. The list of clubs includes Dance Club, Music Club, Art Club, Photography Club, Drama Club, Public
speaking and Literary Club, Social and Environment Club, Astronomy Club and Sports Club. These clubs enrich the social and cultural life on the campus by organizing number of inter and intra campus events. The Sports Club is committed to health and well being of student community and encourages students and faculty to be involved in recreational sports through intramural, extramural competitions and tournaments.

Social Activities

The Social and Environment club organizes events with the sole aim of sensitizing students about their responsibility towards environment and community**.** Some of the activities taken up by the club includes awareness programme, blood donation camp, clean up drive, English classes for the support staff, recycling of paper, cans and tetra packs, fund raising events for charity, program for special needs children etc. Students are involved in making paper bags to replace the plastic bags used in the campus.

Student Professional Bodies

Dubai Campus has student branches of leading professional bodies such as the IEEE Inc., ASME, ASHRAE, WIE affinity group, SAE, ACM, Linux Group, Dot Net Club. Students actively engage themselves in the activities of these professional bodies and avail the opportunities provided by the professional bodies and their UAE chapters/sections, in addition to Department Technical Associations, namely, EEE Association, AIChE (American Institute of Chemical Engineers), CHIMERA (Biotechnology).

IEEE

The IEEE Student Branch of Dubai Campus is one of the largest IEEE student branch in UAE Section. It organizes invited lectures from

eminent scholars and successful entrepreneurs for the benefit of students of all disciplines. Students from the Campus also participate in IEEE Xtreme 24hr online International Programming Competition every year.

AIChE (American Institute of Chemical Engineers)

AIChE - The Chemical Engineering Department of BITS Pilani, Dubai Campus was one of the first AICHE Student chapters formed in the region in 2013. The Student chapter comprises of a sub chapter that is active in the intracollege front by organizing industrial field trips as well as interactive sessions and workshops which will equip our chemical engineering graduated with hands on experience to excel in their careers. Fun events like Formulate This and the Big Split are organized for college fest every year. A second component of AIChE student chapter is involved with utilizing other benefits of the student chapter. Over the last two years, we have been interacting with students from our sister chapter at the University of Utah and Brigham Young University. Current communications with the sister chapter has led to the development of a Pen Pal system where chemical engineering students of both universities communicate and share ideas via email.

ASHRAE

The ASHRAE student branch fosters students interested in pursuing a career in the field of heating, ventilating, air conditioning, and refrigeration. Student Branch offers the opportunity to interact and "network" with members of the ASHRAE Chapter, to participate in technical tours, invite guest speakers, and to interact with other students with the same career interests.

ASME

Students participate in several competitions like Engineering Students Renewable Energy Competition (ESREC) etc. The ASME Chapter of the Campus in association with the Pinnacle Knowledge Group held its first ever and the biggest Student Professional Development Conference (SPDC). SPDC is an initiative of ASME to enhance and develop the technical and leadership skills amongst the engineers worldwide.

ACM

With many enthusiastic student members, the student chapter of the Association for Computing Machinery (ACM) was inaugurated at BITS Pilani, Dubai Campus on 1 March 2011. ACM regularly conducts technical events like “Prototype” and organizes several technical talks for the benefit of students of the Campus.

CIIE

To instill entrepreneurial thinking among Dubai Campus students, Center for Innovation, Incubation and Entrepreneurial (CIIE) [formally Centre for Entrepreneurial Leadership (CEL)] was established in 2012. The CEL was inaugurated on 8 September 2012 by Dr. Kumar Mangalam Birla, Chancellor in the presence of several dignitaries including Prof. B.N. Jain, the Vice Chancellor. Currently there are about 100 students enrolled as members with 7 students on its Executive Board.

TiE Dubai is the Middle East chapter of TiE and was established in Dubai in 2003. The Dubai Campus and TiE Dubai have entered into a Memorandum of Understanding on 23 March 2013 to open a TiE student chapter, in association with Dubai International Academic City (DIAC).

Microsoft Tech Club

Microsoft Tech Club is the tech club at BITS Pilani, Dubai Campus, associated with Microsoft Gulf, DIC. Is run by Microsoft Student Partners, and students of the Microsoft Student Community.

The Microsoft Student Partners Program is for students who realize the best tech careers come to those who chase their dreams. MSPS are involved in building apps, training others and social media. They are social, friendly students who enjoy creating global connections. Attend seminars, workshops and developer camps at the Microsoft Dubai office.

FESTIVALS ON CAMPUS

Cultural and Sports Festivals

B-quizzed

B-quizzed, conducted at the Campus is the largest quizzing competition held in UAE where many universities and schools take part every year.

JASHN

JASHN is an annual intercollegiate cultural festival where universities from all over UAE participate in drama, dance and music, photography and many other competitions.

ARTEX

ARTEX is an annual intra college art, craft and photography event, held every year at the Campus. Competitions in different categories like acrylic painting, oil painting, pencil shading, pen art, classroom art, best out of waste and photography etc., are held. Many on the spot events like Blind Art, Face Painting, Rangoli, Graffiti, Mad Art, Henna, AD Banner Making, Pick a Poem, Phycedelic, Clay Modeling-Clay-do-scope, Rainbow Veins, Illusion-de-optica, Art Marathon, Big Picture, Artex Doodle and Poster Making etc. are also conducted.

Sparks

Sparks is an annual cultural intra college event organized every year at BPDC. Various competitions in dance, drama and music are held. Competitions in Duet and Group Dancing are conducted in both Eastern and Western categories. For Music, Solo and Duet singing is conducted in both Eastern and Western categories along with Battle of Bands. Drama events like Histrionics, Ad making etc are popular events. A large number of students participate in Sparks.

BSF

BITS Sports Festival (BSF) is the annual event in which more than 26 colleges and universities participate from all over UAE in the tournaments that include throw ball, football, cricket, table tennis, chess, volleyball and badminton. The Dubai Campus has been the first institution to introduce badminton as an inter university sport event in UAE for both boys and girls.

BITS Sports Festival and the fests were graced with the presence of sports stars like Pullella Gopichand, Sania Mirza, Sushil Kumar, Sania Nehwal, Madan Lal, Koneru Humpy, Vijender Singh and Piyush Chawla. The sports event attracts participants from around U.A.E and witnesses crowds of around 2000-2500 people. It is considered as the largest inter- University /college sports festival in the United Arab Emirates.

Technical Festivals

- **"Technofest"** is the annual technical competition. There are three categories in the competition namely, working models, non – working models and technical paper presentations in the various fields of science, engineering, technology and management. The event generates lot of enthusiasm among the students and stages quality projects and technical papers in fields of current interest.
- **'ENGINuity'** is an intercollegiate tech-festival which challenges the students from various universities in UAE and from other countries to showcase their technological talent and acumen in the various events: Computer Gaming, Computer Programming, Reverse Engineering, Shutter Speed, Parliament Debate, Crusade Corporate Quiz, Online Quiz Competition, Numbers Game, Interviewee, Blitz Idea, Workshops, High Fliers and many more.

Students Participation in Institutional Activities

The campus has a Student Council, the office bearers of which are President, Vice President, General Secretary and an Ex-Officio. Other members of the Student Council include a hostel and day scholar representative from each year. Students are also part of many committees like senate, discipline, library, academic counseling board, etc.

STUDENT SERVICES

Orientation and Counseling

The Institute organises an orientation programme at the time of admission of freshmen, to familiarize them with various aspects of BITS, Pilani education system and academic system, infrastructural facilities, hostel facilities and various other policies and procedures at BITS Pilani, Dubai Campus. The Director and the Institute Officers of other units such as Academic Registration, Instruction, Practice School and Placement, Student Welfare, Library, Information Technology, etc., meet the parents of freshmen at an interactiive

session at the time of admission. Students also receive important information about the Student Services, Learning Resources, Financial Aid, Student Activities, Career Counseling, Academic Advising, and Industry Internship, etc.

Academic Advising

Academic Advising is carried out through the faculty members as academic advisors to students. The academic advisors interact with their advisees on a regular basis and discuss their performance and progress. Students are advised to contact the academic advisors periodically. The goal is to help the students reduce their programme-related stress and maximize opportunities for academic performance improvements leading to a high quality professional life.

Student Counseling

A professional Counselor visits the campus every fortnight to foster well being on campus and to help students actualize both personal and career goals. The sessions are individual and confidential. The counselor interacts with students discussing all issues which affect their academic performance and help students in resolving their psychological issues, if any. Students are advised to contact the counselor directly. The goal is to help students reduce their stress, maximize academic and personal success, enhance personal development and quality of life. Students are also free to meet the faculty for counseling services and many students approach the faculty for the same.

Grievance Cell

The Students Grievances Cell (SGC) addresses the students' grievances, if any, and works to maintain the well-being of the student community in general. The SGC addresses the issues, investigates and recommends feasible solutions for resolving issues for the mutual benefit of the students and the Institution.

Earn-while-you-learn

Students can earn while learning under the earn-while-you-learn scheme. Students are given the opportunity to work as Professional Assistants in laboratories and/or assist the faculty and departments in other academic and professional tasks. They are paid an honorarium based on the work done and a certificate of appreciation is also provided.

Placement and Campus Interviews

The Campus offers a Placement Programme to all its graduating students. Reputed companies from UAE, Middle East Countries, India and multinationals participate in placement. Some of the recent organizations that conducted campus placement are given in Table 1. Many graduating students prefer to go for higher education. The Campus also facilitates admissions to reputed Universities. A sample list of Universities where students have got admissions for Masters or Ph. D. is given in Table 2.

Table 1: Organizations participated in Campus Placement/conducted Campus Interviews

PayPal, India	Google, India
Dabur International, UAE	Ebay, India
DirectI, India	Amazon, India
MuSigma, India	Xiaomi, India
Practo, India	Kuliza Tech, India
Texas Instrument, India	Roamwork, Dubai, UAE
Pacific Control, Dubai, UAE	Bin Ghalib, Dubai, UAE
Al Shirawi Group, Dubai,UAE	Headout, India
Praxis, Dubai, UAE	Zocalo, India
Guardian, Ras Al Khaimah, UAE	Teknoware, Dubai, UAE
Petrofac, Dubai, UAE	Hi-Vision, Dubai, UAE
Johnson Controls, Dubai, UAE	Michael Page, Dubai, UAE

Table 2: List of Universities where students secured admissions for Masters or Ph. D

Columbia University, USA	Bradford University, UK
Symbiosis Institute of Business Management Pune, India	Language And Culture Department in the Arabic Linguistics Institute (ALI) in Saudi Arabia
University of New Orleans, USA	University of Calgary, Canada
University of Texas, Dallas, USA	University of British Columbia, Canada
The University of Chicago, USA	University of Delaware, USA
MIT, USA	University of Pennsylvania, USA

university of Florida, USA	Princeton University, USA
Stanford University, USA	George Mason University, USA
University of Southern California, USA	Georgia Institute of Technology, Atlanta, USA
UC San Diego, USA	National University of Singapore
University of Wisconsin-Madison, USA	IIM, Ahmedabad, India
University of California-Los Angeles, USA	Boston University, USA
Syracuse University, USA	University of Minnesota, USA
University of Dundee, USA	Northeastern University-Graduate School, USA
NewYork University, USA	Wayne State University, USA
University of Illinois at Urbana-Champaign, USA.	University of Texas at Austin, USA.
Carnegie Mellon University, USA.	University of Pennsylvania, USA
Columbia University,USA	Purdue University, USA
University of California, Santa Barbra, USA	Caltech, USA
Cornell University, USA	IIM ,Calcutta, India
NUS Singapore	IIM Bangalore, India
NTU Singapore	ISB Hyderabad India
Graduate School of Business (Booth), Chicago-USA	Wharton School of Business. USA
University of Maryland, USA	University of Vermont, USA
Delft University of technology, Netherlands	XLRI JAMSHEDPUR, India
University of Manchester, UK	University of Sheffield, UK
Hamburg University, Germany	Technische Universitaet Muenchen, Germany

Alumni Cell

The BITS Pilani, Dubai Campus Alumni Cell fosters long term relationships among alumni through various programs. Its mission is to enable the alumni, students, faculty and friends to maintain their connectivity with the Institute and each other for shared benefit. The website is periodically updated to enable the alumni to have an access to the information. The Alumni Cell at the campus consisting of faculty and students actively engages in maintaining the up-to-date information of the passed out students as it provides a great strength to institution building.

CENTRAL FACILITIES

The Campus has a large auditorium with a seating capacity of 1100. It has movable partitions to bifurcate the hall as per the requirements, acoustic paneling and carpeted floor and is equipped with five projectors with remote controlled screens, Bose speakers, a professional grade audio mixer and a carpeted wooden stage with stage focus lights.

A canteen and a grocery shop are there for the students, staff and faculty. Vending machines are also available in the Campus.

Library

BITS Pilani, Dubai Campus Library, a gateway to knowledge resources, is located in a separate building with two floors and total area of about 29,680 sq. ft.

The mission of the Library is to collect, organize, preserve and provide access to the information necessary for the institute, to achieve its educational, research and service goals and to improve and enhance access to information in all forms, using innovative technology thereby having a broad based collection, to assist in meeting the needs of students, faculty and staff.

Library has a contemporary design with reading halls, reference section, stacking area, faculty lounge and digital library with 25 computers, internet browsing centre with 25 computers, 50 individual study carrels, and exclusive 8 (ground and first floors) systems for OPAC. Library has a seating capacity of more than 300 members. The RFID security system has been implemented successfully during the mid of 2014.

The Library operations are completely automated using the AUTOLIB Library Management Software and all the resources are bar-coded and RFID tagged for quick and easy service to the user community. The Online Public Access Catalogue (OPAC) is accessible via internet and intranet. Users can search the resources and check their account. The Library renders standard services such as circulation,

reference, referral services and reprographic services such as networked printing, photocopying, scanning and binding facilities.

At present, the library has a collection of around 17,000 books. The collection of the library is growing continuously on a regular basis. Around 1,000 new volumes of books are added to the existing collection in major disciplines of Engineering, Management and Sciences. The Library has separate collection of Text Books under Book Bank Scheme for the benefit of the students. The Library procures good number of General Aptitude books such as TOEFL, GRE, SAT, IELTS, GATE etc. Fictions and books on Islam and Arabic are also added every year. Library procures latest editions of Encyclopedias, Dictionaries and Handbooks on core disciplines of Engineering, Technology, General Sciences, Management and General Knowledge.

The Library caters the users' needs with the subscription of following E-resources: IEL Online" IEEE Xplore Digital Library, American Society of Mechanical Engineers (ASME) digital collection, ACM Digital Library, ProQuest SciTech Collection and eBrary- collection of e-books. The e-resources has full text of abundant e-journals with back issues, conference proceedings, e-books and reports.

The Library has digitized the question papers of all examinations since 2003 and these are available at library portal. Library subscribes to print version of 43 international journals, 46 magazines and 7 newspapers (4 local print edition and 3 online). The Library has around 350 back volumes of print journals subscribed during the previous years. Library has more than 1400 CD-ROMs on engineering courses and there are 3 computer terminals exclusively meant for accessing these. Library has available for reference more than 3000 practice school reports, project reports and thesis reports submitted by students.

The Library has an MOU with the Al Ain University of Science and Technology in UAE for the mutual benefit of both the institutions. The Library also offers Inter Library Loan (ILL) facilities to the users. Library has Wi-Fi facility which enables the users to use their laptops for internet browsing / project / thesis work.

The Library remains open from 7.30 AM to 10.00 PM on all working days and 10.00 AM to 10.00 PM on Saturdays. The Library service is extended till Midnight during comprehensive examinations. The Library is open on Fridays for 2 hours and closed on national holidays.

ICT Facilities

The Campus and the hostels are covered with the latest Cisco network Infrastructure of both wired and wireless hotspot environment which provides the internal and external connectivity to fulfill the computing needs of the students.

We have Cisco sponsored networking research lab equipped with the required network components such as routers, switches, firewall, wireless controllers and access points to build the network from the base level to high level of networking. The Cisco lab has all the paper and soft copy material to help the students to learn and start the practical training on Cisco. This Cisco lab will lead the students to achieve the Cisco certifications and software defined Network projects.

Our data centre equipped with the following servers and Network components.

Servers

HP DL 380 series new generation

HP Storage serve (SAN)

QNAP NAS for Backup

Network Components

Cisco Core switches Nexus series

Cisco Edge switches

Cisco Firewall

Cisco Prime system

Cisco Wireless controller

Cisco Network admission control and access control system

Cisco IP Telephony system

Panasonic IP camera setup

Most of our key critical applications are configured in Virtualized environment with load balancing and cluster mode. We have Business

continuity and disaster recovery plan in place and we have a disaster recovery site is configured in different location to continue our operation in case of any unforeseen scenario. Periodic backup is scheduled by disk to disk method to backup the data as snapshots.

CISCO Telepresence Systems

Cisco Telepresense system (under BITS Connect 2.0 project) is implemented in the campus which is interconnected to all BITS' campuses in India. The Cisco Telepresense classroom, capacity of 160 seating will help the students to participate in the online classroom sessions.

CISCO Telepresence Meeting Room: The Telepresence Systems (Model: IX5200 – CISCO) is the 1st device of its kind in the entire CCG installed by CISCO in BITS Pilani, Dubai Campus. This model incorporates an elegant triple 4K Ultra High Definition camera cluster, three high-definition 70 inch LCD screens and theater quality audio to bring people together as if they were just across the table. Other meeting rooms are equipped with Model No.: EX-90 & SX-10 used for a smaller group members or individual can have one to one interaction across all the campuses. These technologies make it possible for users to communicate as naturally as they would in person.

CISCO Telepresence Classroom: Is equipped with C90 system with 160 seating capacity used for inter campus meetings and lectures. The benefits of this technology will be easy to connect with management across all three campuses, offering more specialized electives to students, knowledge exchange between students from the other three campuses, helping students to attend guest lecture sessions from a remote locations, expediting the recruitment process.

Medical Facilities

A Naif Medical Center with one doctor and nurse is there on the campus. The nurse is available on the campus round the clock to provide first aid and emergency care. Vehicles are available for taking students to the hospital in case of emergency. The NMC regularly ensures that all students are vaccinated for chicken pox or any other such contagious diseases. From time to time free medical camps are organized for faculty and staff.

Sports Facilities

The Campus has sports facilities for boys and girls. The indoor Sports Complex consists of badminton courts, TT tables, boxing training room. In addition, the outdoor games facilities like ground for football, cricket, basketball, volleyball, throw ball and handball courts. Separate gyms of international standards are there for girls and boys in the institute and in hostels. Four Cricket practicing nets of sizes 20m x 5m are also there.

Central Workshop

The central workshop imparts training to the students in workshop practice course and caters to the needs of maintenance work of the campus. It also caters to the fabrication needs of students working on experimental setups and various projects. The workshop comprises of Machine shop, Welding, Electroplating, Smithy, Carpentry, Foundry, Tool room, Metrology, Fitting sections, CNC, tool crib and stores.

The major equipment include all geared lathes and shapers, universal milling machine, radial drilling machine, wood turning lathe, and smithy hearth furnace, AC & DC welding machines and Universal testing machines. In addition to these facilities there is provision for sheet cutting & bending, wood planning, grinding, sawing and casting. The workshop has sophisticated machines like CNC train master T70, CNC trainer VMC200, microstructure examination, Ultrasonic Testing, TIG Welding, lathe tool dynamometer and Surface roughness tester.

Laboratories

The Campus has well equipped engineering and sciences laboratories with latest instruments and software tools for students, faculty and research scholars. Viz., Biology Lab, Chemistry Lab, Physics Lab, Advanced Molecular Biology Lab, Bioprocess Engineering Lab, Genetic Engineering Lab, Instrumental Methods of Analysis Lab, Microbiology Lab, Computer Aided Design Lab, Engineering Graphics Lab, Heat Transfer Lab, Mechanical Engineering Lab, Prime Movers & Fluid Machinery Lab, Production Techniques Lab Workshop Practice Lab, Analog Electronics

Lab, Communication Systems Lab, Digital Electronics Lab, Electrical Machines Lab, Instrumentation Lab, Power Electronics Lab, Signal Processing & Simulation Lab, Microprocessor Programming & Interfacing Lab, Computer Programming Lab, Software Systems Lab, Chemical Engineering Labs – I & II,

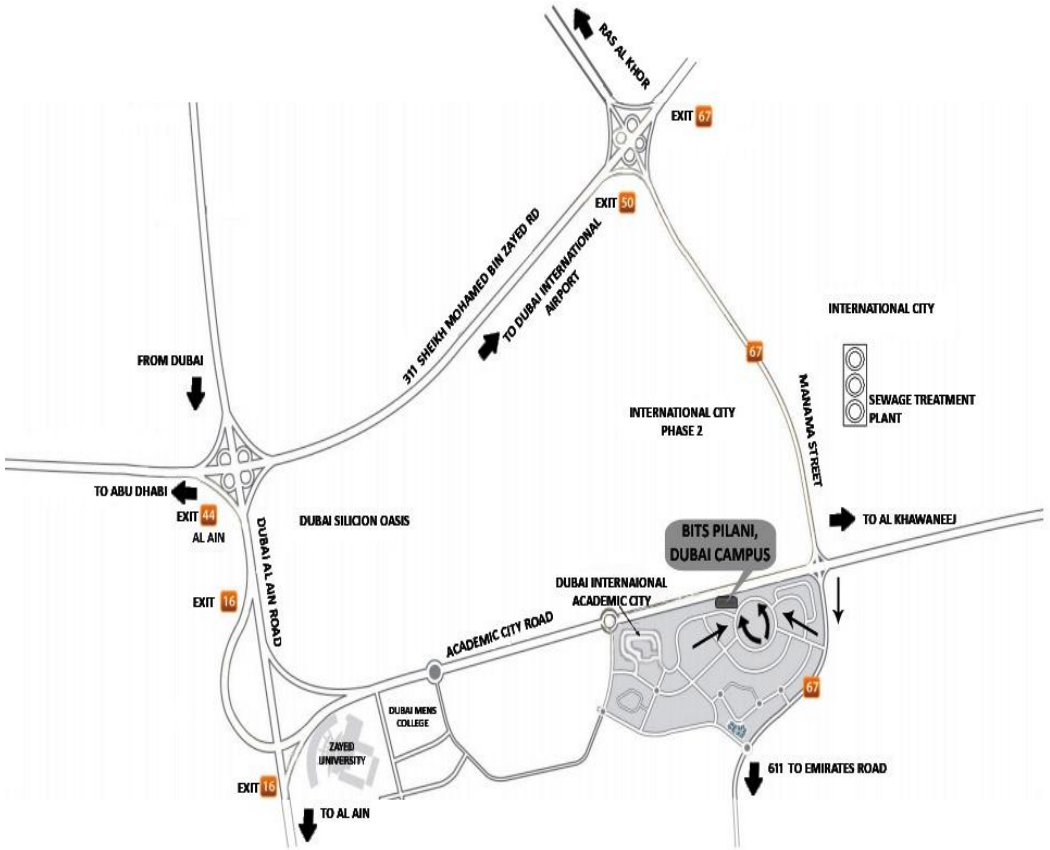
For more details, please visit:

For more details, please visit:

http://universe.bits-pilani.ac.in/Dubai

http://www.bits-dubai.ac.ae

Route Map



K.K. BIRLA GOA CAMPUS AND ITS FACILITIES

The facilities available at BITS Pilani - K.K. Birla Goa campus include:

Student Housing

The institute is fully residential. There are separate hostels for boys and girls comprising of 2468 rooms, providing single-seat accommodation for each student.

Each room of the hostel is provided with modern furniture and Internet connectivity. Hostel common rooms are equipped with recreational facilities like Table Tennis, Carrom & Chess along with LED TV with Dish connection, newspaper and telephones. Badminton court illuminated with solar lights inside the hostel lawn. Hostels are provided with Aqua guard purified drinking water facility with water coolers, coffee vending machines and solar/electric geyser hot water for bathing. Each hostel is fitted with a CC camera and a security guard for the security of students & hostel. The external housekeeping agency maintains the cleanliness of common areas of hostel & its surroundings daily. Both messes are run by outsourced mess contractors."

There are two large sized Dining Halls with a seating capacity of 1200 students at a time. Each dining hall is well equipped with modern equipment and furniture.

Guest Accommodation

Excellent facilities are available for boarding and lodging on payment at Visitor's Guest House built in the southern corner of the campus.

Central Library

Spread over 3512 sq mts. area, the central library has a seating capacity of 550+ and includes several reading halls, a digital library with internet access terminals, and a large area for book storage. It has a good collection of over 35,550 books on a wide range of subjects. The library subscribes to 89 print journals. Subscription to important digital libraries and databases like IEEE Xplore online, Science Direct, ASME, Proquest and ACM DL etc. provide full access to thousands of online journals to faculty, students and researchers.

Educational CDs, audio/video cassettes and question bank are also available. The textbook section keeps copies of all prescribed text books and reference books. A digital repository of resources curated from these as well as from the publications and dissertations of the Campus' faculty members and students is being built up.

A new initiative for making the Library a "Happening Place", taking a cue from the NAAC recommendations, is evolving through the leadership of the Library Committee. New comfortable and aesthetically pleasing furniture has been procured; spaces like lounge area and exhibition area and peripheral utility infrastructure have been developed to make the 'reading space library' experience more comfortable and enjoyable for the users.

The library has been provided with a wireless network whereby users can access the internet using laptops. The library transactions and search are managed using the (FLOSS) KOHA Library Management Software to automate its entire housekeeping activities. In this, the Campus is among leading campuses in the country. The bibliographic and holdings databases of books and e-journals can be accessed from anywhere in the campus through a Local Area Network. Indigenous projects are afoot to harness the same to a mobile phone-based social network.

Computer Centre

Computer Centre (CC) has a central computing lab having 300 workstations (DELL & Lenovo) connected through LAN. These workstations operate under LINUX and Windows environments and support a variety of software tools such as C, C++, Java, Python, Microsoft visual studio, MySQL, Xilinx, ModelSim, Adobe photoshop, OpenCV, Pro-Engineer, ANSYS, COMSOL, Matlab, AutoDesk etc. CC supports all Departments for their software, hardware and storage requirements. CC provides computing and storage facilities for students, staffs and faculties of the Institute. Presently,

with the existing facilities, the centre provides support for conducting online examinations in several courses including Computer Programming, Data Structure and Algorithms, Operating Systems, Computer Networks, Creative Multimedia, Computer Architecture, Database Systems, Engineering Graphics, Control Systems, etc. BITSAT, Admissions, students' elections and other online events are also conducted in the central computing lab. Apart from the computing facilities, CC supports a LAN of 3000 nodes with intranet and internet facilities in the academic block, hostel rooms, staff quarters, guest house and other places. There are two internet lines: 150 Mbps from GWave for hostel rooms, 155 Mbps from Vodafone for academic block and staff quarters. 45Mbps dedicated internet bandwidth is provided for WILP classes. 30Mbps MPLS line is provided for video conferencing applications in Telepresence rooms. Secured Wireless connectivity is provided in the Institute building, student hostels, student activity centre, visitor's guest house and medical centre. The centralized e-mail solution is supported by Google. This solution is an integrated solution covering e-mail with 30 GB space, file storage with 5 GB space, collaboration tool, file sharing, personal web pages, calendaring system, etc.

Voice Communication

All faculty members have been provided with a laptop and IP phone facility in their chambers. The IP phone facilitates receiving of incoming calls directly on the individual's telephone.

Video Communication

An 18 + 16 seat CISCO Telepresence conference room allows impressive multipoint teleconferencing facility among all the BITS campuses. A 180 seat Telepresence classroom is provided for delivering and receiving interactive lectures between all the BITS campuses. These facilities are used for cross campus courses, guest lectures, administrative meetings and online meetings of research groups in India as well as across the world.

Workshop

The workshop is spread over 24,800 sq.ft. area and is well equipped with metal cutting machine tools like lathes, milling machines, shapers, pedestal grinders, tool and cutter grinders, cylindrical grinder, drilling machines, etc. It also has machines like pipe bending machine, plastics processing using rotational moulding machine, Compression Moulding Press, etc.

There is a separate CNC machining section with production machines like CNC lathe, CNC Milling, Co-ordinate Measuring Machine and CNC Engraving Machine. These machines are based on FANUC controller. To introduce the concepts of layered manufacturing in product development, a 3-D printer or a Rapid Prototyping machine is also available.

An Electric Discharge Machine is used to introduce the students for un-conventional machining.

The carpentry section has the facilities of wood working lathes, planning machines and band saw machine.

A welding shop with the welding machines to facilitate arc, gas, TIG and MIG welding exists separately in the workshop.

The casting section includes an Aluminum melting furnace and casting testing laboratory to test the sand properties like strength, moisture, etc. A separate Metrology laboratory is also well equipped with measuring instruments like sine bar, dial gauge indicators, gauges, etc.

There exists an electroplating section where Ni and Zn plating is carried out on the workpieces produced.

Apart from the above facilities Central Workshop houses a well equipped polymer and composite lab with equipments like screw extruder, Melt flow index tester, Dynamic Mechanical Analyser (DMA), HDT& VSP tester, Universal testing machine (0-10KN), 32-T Hydraulic Press for compression moulding, Izod Charpy impact tester, etc. An Injection Moulding Machine is being installed.

To test the formability of the sheets for metal forming an Ericcson's Cup testing equipment is housed.

The Non destructive testing (NDT) equipments like Ultrasonic Flaw Detector, Magnetic Particle

Testing device is housed to introduce the concepts of NDT.

The KD2 Pro, a fully portable field and lab thermal properties analyzer is available. It uses the transient line heat source method to measure thermal conductivity, resistivity, diffusivity, and specific heat.

A Pneumatic Section with pneumatics and electro pneumatics set ups and a pick & place pneumatic manipulator is used to teach the concepts of Low Cost Automation using Pneumatics.

Laboratories

The Institute provides labs equipped with sophisticated instruments and apparatus for students, faculty and research scholars. Some of these include: Nonlinear Optics Lab, Solid State Physics Lab; Physics Teaching Labs (Mechanics, Optics and Electricity and Magnetism, Modern Physics and Advanced Physics Lab), IMA Central Lab, Advanced Computing Lab, Materials Testing Lab, Measurement Techniques (Biology) Lab, Biotechnology Lab, Genetic Engineering Lab, Animal Cell & Tissue Culture Lab, Microbiology Lab, Applied & Environmental Biotechnology Lab, Proteomics Lab, Analog Electronics, Embedded Systems, Electric Machines Lab, Digital Communications Lab, Instrumentation Lab, Microelectronics Lab, Power Electronics Lab, Reconfigurable Computing Lab, Renewable Energy Lab, Weather Observatory, Advanced Measurement Techniques Lab, Robotics & Automation Lab, MEMS Design Center, Thermal Science Lab, Fluid Mechanics and Machines Lab, IC Engines Lab with Low Speed Wind Tunnel Facility, Dynamics& Vibration Lab,Polymer & Composite Lab,Material Science Lab, Material Testing Lab, Mechanical Engineering.Process Engineering Technology lab, Process Control lab, Phase Equilibrium lab, Scientific Computing Lab and Language Lab and Language Lab.

Incubator

A Technology Business Incubator has been set up in 2013 with support from the Technology Incubation Development and Entrepreneurship Scheme of Department of Information Technology, Government of India. The focus is to incubate high impact technology driven enterprises.

The incubator's state of the art infrastructure provides great resource support to the startups in the initial phase. It is equipped with a conference room with state-of-the-art media equipment and video conferencing facility besides seven office spaces with excellent computing systems.

The network of BITS faculty and alumni provide a network for mentorship support for the startup entrepreneurs. The incubator also, gives the added advantage of seed funding to deserving start ups.

At present 3 companies are being incubated in diverse areas of interactive learning, waste management and medical devices.

Students Activity Centre (SAC)

SAC is constructed in an area of 37,000 Square feet; The Students Activity Centre is equipped with indoor sports facilities like Badminton, Table Tennis, Billiards, Squash, Carom, Dance room and well-equipped gymnasium with all the modern training machines. It also has a music room with both eastern and western musical instruments, and a Prayer room.

Student Activity Center (SAC) also has outdoor facilities like Cricket Ground Net practice arena, Football Ground, Volleyball Courts, Lawn Tennis Courts, Basketball courts, and a Futsal court.

Auditorium

A centrally air-conditioned auditorium with a seating capacity of 2200 is available for cultural activities, seminars, annual functions and other such activities.

Shopping Complex & Bank

The Shopping complex provides the facilities of a a supermarket, vegetable and fruit shop, cafeteria, gent's saloon, beauty parlor, laundry, book store, stationery shop with public telephone and photocopying facility. HDFC Bank has provided ATM facility and State Bank of India, Zuarinagar, Goa has provided a branch and ATM facility centre within the campus for all banking requirements of residents.

Medical Centre

The Medical Centre provides primary medical care as an outpatient and in-patient services. 24 x 7 Emergency care is provided for the in campus
residents through dedicated medical team. Medical facilities with modern equipment like Multi-parameter monitors, Defibrillator, Syringe pumps, ECG, X-ray, Ultrasonic therapy, etc. are available on campus to provide modern medical care. Dental Unit is operational with a visiting dentist on the prior appointment basis. Specialists are available on routine and on-call basis for outpatient care are General Medicine / Surgery / Orthopedics/ Pediatrics / Gynecology. In house Pharmacy is available. The Institute is empanelled with corporate, private hospitals and Goa Medical College for higher care.

Children Activity Centre

A Children Activity Centre has been started to provide day care and education for small children in the campus. The Centre runs a playschool for infants in the morning and a Day Care in the afternoon. It is provided with all necessary facilities (toys, activities, educational material and infrastructure).

Campus Placements

The Placement Unit coordinates the placement process along with the Placement Unit at Pilani & Hyderabad Campuses.

Practice School

The Practice School division coordinates the PS-I and PS-II activities for student of the campus along with PSD Pilani. It also helps in facilitating arranging Faculty for PS-I and PS-II operations. On campus faculty are also deputed to various PSII stations, across the country, to provide their input in the ongoing PSII projects.

Activities

Games and Sports

The Institute encourages students to participate in sports and recreation. The Gymnasium at SAC is equipped with mechanized treadmill and other latest exercise equipment. The campus has well maintained football, volleyball, hockey and cricket grounds, and lawn tennis and basketball courts.

Cultural and Recreational Activities

Various student clubs – photography, music, foreign languages, movie, painting, dance and drama – enrich the quality of campus life at Goa.

Students organize various inter-institute festivals: “Waves” is the Annual Cultural Festival and

“Quark” the Annual Technical Festival. An inter-institutional sports festival “Spree” draws enthusiastic participation from young sportspersons.

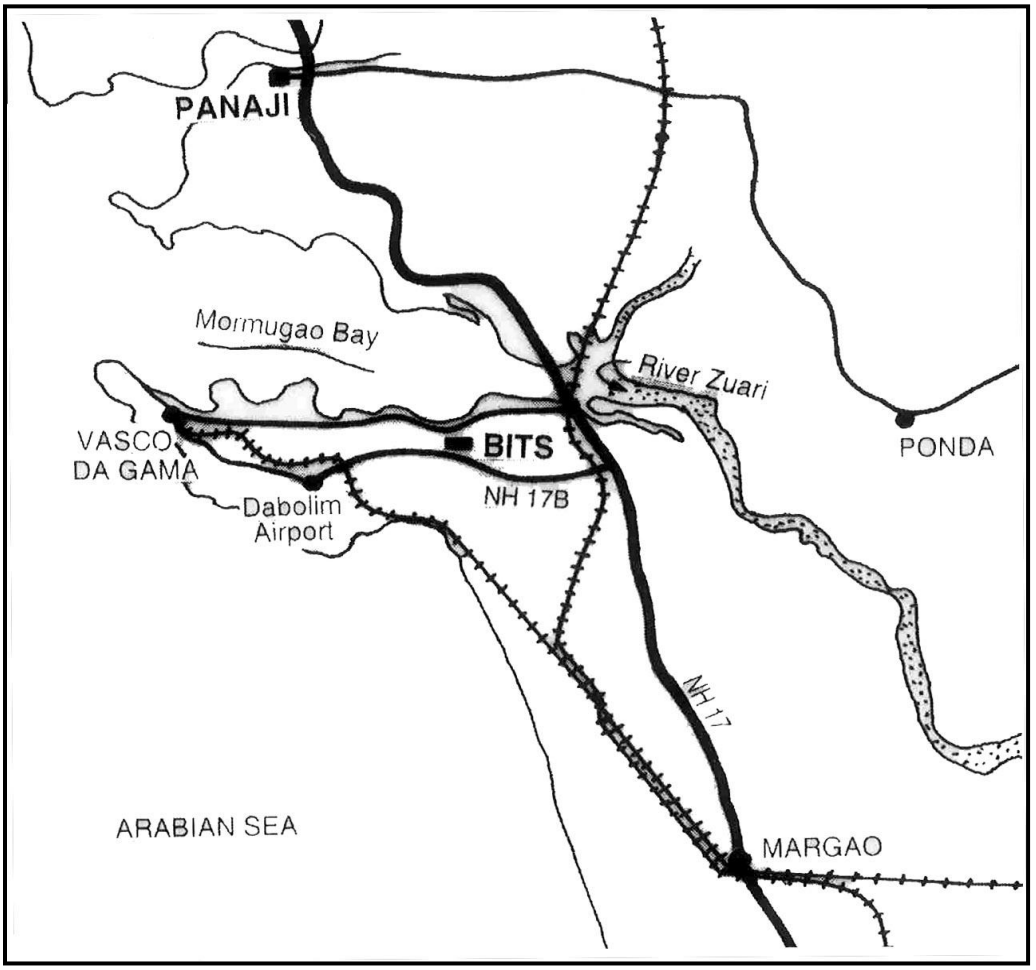
Students and staff also, celebrate major Indian festivals such as Ganesh Chaturthi, Onam, Durga Puja, Diwali, Holi and Christmas with enthusiasm.

Environmental Awareness

The *Plant a Tree* drive is an ongoing activity and has resulted in 3200 trees in the campus. In addition, there are campaigns to promote social awareness for energy conservation, utilization of renewable energy and environment protection.

ROUTE TO BITS PILANI – K.K. BIRLA GOA

CAMPUS



Institutional Address:

BITS Pilani – K.K. Birla Goa Campus

NH17 B, By-Pass Road

Zuari Nagar – 403 726

GOA

Phone: 0832 – 2580101

Home page: http://www.bits-goa.ac.in

HYDERABAD CAMPUS AND ITS FACILITIES

The campus houses the main academic building, hostels for boys and girls, Student Activity Centre (SAC), library, residential quarters for faculty and staff, medical centre, playgrounds and a shopping complex. The main building comprises of centrally air conditioned classrooms, Central library, Auditorium, laboratories, lecture theatres, faculty chambers and administrative offices.

Student Housing

BITS Pilani, Hyderabad Campus is fully residential with 6 boys hostels & 2 girls hostels. 2 boys hostels & MESS 2 extension are under development. The campus provides single room accommodation to each student. Each room is provided with modern furniture, internet connectivity and round the clock security. Floor wise common room facilities like cable TV, magazines, newspapers, Table Tennis and other recreational facilities like volley ball, Chess and carom boards are available. Potable drinking water is available in each floor and telephones are provided in all the hostels. There are two large dining halls well furnished with modern equipment in the kitchen and equipped with RO plant for drinking water.

Information Processing Centre

Information Processing Center (IPC) manages a central pool of resources for the computing requirements of all faculty, staff and students of the Institution. IPC has seven terminal rooms for students' use, one server room, and provides computing facilities at centralized laboratories, offices and faculty chambers. In the server room, there is an IBM Blade server H with 14 Blade Chassis out of which 6 blades are populated and a 3 TB DS 3400 IBM SAN box is available on the network supporting 800 Pentium based PCs and Workstations of Lenovo, HP and Dell make. These machines are equipped with Windows and Linux environments supporting a variety of software tools like C, Jdk 1.3, Visual Studio, QualNet, VMware, Oracle, Xilinx and a few open source software for the practical components of courses like Computer programming, Network security, Computer networks, Distributed systems, Data structures, Operating systems, Computer graphics, Object oriented programming and Multimedia computing etc. The campus LAN is connected to a 155 Mbps (STM line) dedicated fiber leased line, and two 90 Mbps RF lines for the Internet connectivity to the entire campus community. All these three WAN links are load balanced through a Radware linkproof load balancer for better monitoring of WAN links, bandwidth management to different VLANs, and to provide application level QoS to users. A Cyberoam UTM device also seats at the periphery for authenticating users, web filtering, spam filtering etc. IPC provides support to VMware virtualization by managing VMware infrastructure environment server of 250 virtual machines placed in the IBM server (47 GHz of CPU, 250 GB of memory and total SAN capacity of 5 TB). IPC provides computing & storage infrastructure for students, staff and faculty and also manages the website specific to Hyderabad Campus. IPC also maintains the Voice over IP (VoIP) infrastructure and the Telepresence infrastructure. Using Telepresence facility, BITS Hyderabad establishes connectivity between three other BITS campuses to conduct conferences, meetings and online lecture sessions live. IPC also conducts BITSAT online exam at Hyderabad campus. IPC also supports IT workshops, academic activities for all branches of students. The networking activities, computing support and maintenance for different sponsored research projects are also being taken care of by this unit at BITS Hyderabad.

Workshop

The Central Workshop imparts training to students and caters to the maintenance & fabrication needs of the Institute. Students' training involves training all first degree students through the course "Workshop

Practice" by imparting skills in various manufacturing processes like machining, fitting, carpentry, smithy, foundry, sheet metal, electroplating, welding, etc. and two computer oriented exercises, CNC Programming using Pro-E and Master CAM softwares and Manufacturing Simulation using FlexSim software. For B.E. (Mechanical Engineering) and B.E. (Manufacturing Engineering) degree courses, students are also imparted in-depth training in various other courses such as "Production Techniques-I and II", “Manufacturing Processes” and "Computer Aided Manufacturing". Apart from routine maintenance and training, the workshop also accepts fabrication jobs concerning the project works of students and also technical support for TBI works.

The workshop housed in 1800 sqm built up area comprises of the following sections: Machine shop, Welding, Electroplating, Fitting, Smithy, Sheet Metal, Carpentry, Foundry, Metrology & CAM Lab. Major equipment include Vertical Machining Center (Bridgeport VMC GX600), 9 Lathes, 2 Shapers, 1 Radial Drilling Machine, 1 Universal Milling Machine with indexing attachment, 1 Cylindrical Grinding Machine with internal grinding attachment, 1 Tool and Cutter Grinder, 1 Pedestal Grinder, 1 Surface Grinder (HMT make), 1 Slotting Machine, 1 Open-Hearth Furnace for Smithy, 1 Gas-Fired Furnace for Foundry, 5 Wood-Working Lathes, 2 Arc-Welding equipment (1 Rectifier & 1 DC Welding Generator), 1 Oxy-Acetylene gas welding equipment, 1 Gauge Planner for wood works, Electroplating setup for zinc coating, Power Hacksaw and Metrology instruments. In addition, 1 CNC Lathe (HMT make), 1 Wire-cut EDM, 1 Hydraulic Press with 40 ton capacity and 1 TIG welding equipment.

Medical Centre

A full-fledged medical center with three doctors (including a gynecologist) has been established with all necessary facilities including a 24x7 ambulance service. The institution has also tied up with reputed corporate hospitals in the city. A consulting Dentist and Pediatrician visit the medical center regularly. Efforts are underway to get other specialists from reputed hospitals in the city as consultants. A lab technician takes care of a diagnostics lab which has become fully operational in the medical center.

Shopping Complex & Bank

The Shopping complex (Connaught Place) comprises of Super Market, Restaurant, Gents Saloon, Beauty Parlours, Laundry, Medical Shop, Post Office, Book Shop, Stationery Shop with photocopying facilities, Bakery, Dairy Parlour, a Fruit and Vegetable Shop, Juice Parlour and a Telephone Service outlet. An ice cream parlor is located close to the Shopping Complex. State Bank of Hyderabad, Jawaharnagar Branch and two ATMs are located in the shopping complex. In addition, two Food Kiosks are located near Dining Hall – I & Dining Hall – II.

Laboratories

Advanced research laboratories for pharmacy, chemistry and biology have been setup. Research laboratories in Analytical, Organic, Inorganic and Physical Chemistry have been set up.

The department of biological sciences at BITS-Pilani Hyderabad Campus is a young department, established in 2008. Nonetheless, our department has attained success in almost all spheres of academia, in line with the aims and objectives of BITS-Pilani University. As highlighted above, we have established a strong research culture, replete with sponsored funding, publications and patents in the designated thrust areas and are constantly striving towards enhancing our research programmes through individual and collaborative contributions. We have been successfully running M.Sc., M.E. and Ph.D. programmes in the department, making the department a preferred destination for several graduate and undergraduate students across the country. The department has several national CSIR, UGC, DBT fellowship holders at both Junior and Senior Research Fellow levels. We have also established strong industry linkages and are presently working towards strengthening these and establishing more. The department has ten faculty members and all of them are Ph.D holders. The thrust

research areas of the department are Medical biotechnology, Agriculture biotechnology, Food and Nutrition, Environment and bioenergy, Bio resources, Structural Biology and Bioinformatics, Technology development, Biophysics, Microbiology, Biochemistry and Molecular biology, Health Sciences and Public/ Global Health.

The department has several Inter-institutional collaborative projects both at the national and the international level. The national institutes that the department collaborates with Apollo hospitals, Bangalore; All India Institute of Medical Sciences, New Delhi, National Institute of Ayurveda, Jaipur; Ranbaxy Research Labs, New Delhi, India; SP College of Medicine, Bikaner, Rajasthan; Indian Institute of Science, Bangalore; LV Prasad Eye Institute, Hyderabad; Sankar Netralaya, Chennai, Tamil Nadu; Elite School of Optometry, Chennai, Tamil Nadu and Grasim Industries, Nagda. The International collaborations are with Mälardalens Högskola, Swedish Council of Higher Education, Sustainable Innovations Inc, Virginia, USA; Equate Health, Silicon Valley, California, USA;

There are twelve laboratories, out of which three laboratories i.e biology laboratory, microbiology and genetic engineering are basic undergraduate facilities. Department also has separate lab for Animal Cell Technology, Structural Biology and Bioinformatics, and Biotechnology, which are laboratories for Higher Degree Students as well as Research Scholars. Department has also advance research laboratories such as Genomics, Stem Cell and plat biotechnology, Environmental Biotechnology and Virology. There is also a research lab, which take care of the general need of research scholar.

The research equipment in the department include refrigerators, freezers, deep freezers, pH meters, small centrifuges, laminar flow hoods, orbital shakers, incubators, ovens, autoclaves, heaters, stir plates, weighing balances, compound microscopes, inverted microscopes, computers etc. are present in a number of laboratories. Specialized equipment for high quality, cutting-edge research are also present and growing in number, include laminar flow hoods for animal cell cultures, CO2 incubators, HPLC, water de-ionization/purification system, plant growth chamber, visible and UV spectrophotometers, multimode readers, advanced PCR machines, QRT-PCR machines, hybridization oven, advanced table and floor top centrifuges, ELISA reader, cold room, gel documentation system, Nanodrop, flow cytometer, fermenter, servers for computational work etc. The department also has access to equipment in the central instrumentation facility provided by the institute which houses instruments such as nano-drop, HPLC, GC, AAS, spectro-fluorimeter, LC-MS, FPLC, FTIR, confocal microscope, etc. A specialized laboratory has been set up with financial support from DST-FIST laboratory, funded by the Department of Science and Technology having equipment such as flow-cytometer, real-time PCR machine, phosphorimager.

The department publishes the research work in peer reviewed national and international journals and has filed several patents and transferred a technology to a start-up company. The department has a student association by the name Synapsis and conducts several invited lectures on a weekly basis. Some of the eminent speakers who visited the department in the last year are Dr.G. Bhanuprakash Reddy, PhD, scientist-F & Head, Biochemistry Division, National Institute of Nutrition, Hyderabad, Dr Venkatesh Balan, Department of Chemical Engineering and Material Science, Michigan State University, MBI Building, Lansing; Dr Eswar Iyer from Harvard Medical School and the Wyss Institute; Dr Srividya from Whitehead Institute, MIT; Dr. Rakesh Kumar, George Washington University, USA; Sivaprakash Ramalingam, Johns Hopkins University, USA.

The central analytical facility is located in the B-Block, Chemistry department. A number of important instruments like LC-MS, GC, HPLC, AAS-7000, Flame photometry, DSC-60, TGA-DTA, FP-6300, UV-Vis-650,UV-Vis-NIR spectrophotometer, FTIR-4200 spectrometer, Polarimeter, Karl-Fischer Titrator, Electrophoresis, Milli Q water facilities are

established for catering to the needs of the researchers and students in various disciplines across the institute. State of the art new equipment are in the process of installation. Laser scanning confocal microscope is already installed in addition Powder X-ray Diffractometer (Powder XRF), Single crystal X-ray diffractometer (Single crystal XRD), X-ray fluorescence spectrometer (XRF), Circular Dichroism (CD) spectrophotometer are expected to be installed in near future.

The faculty in physics research in Astrophysics, Computational Physics; Materials Physics; Bio-sensing, Microfluidics, and Pedagogy and for this purpose research labs also double up as teaching labs. The current existing facilities include Scanning Tunneling Microscope, Atomic force microscope, Fluorescence Microscope, AC Impedance Analyzer, Dynamic Mechanical Analyzer, Faraday rotation measurement unit, thin-film deposition unit, and four-probe resistivity measurement unit; Soft-lithography based micro fabrication unit, Dell server for computation, Igor Pro and Microcal Origin software for data analysis. Apart from this the undergraduate lab has been bolstered with apparatus to measure the Zeeman Effect, Velocity of light, forced resonance of cantilever bridges.

The department of Pharmacy offers B. Pharm and M. Pharm courses where the students are trained in well-equipped laboratories for their practical exposure. The laboratory facilities include analytical instruments, equipment for pharmaceutical dosage form preparations, computer aided drug design lab, medicinal chemistry lab, cell culture facility. The department has recently added state of art BSL-3 and animal housing facility to its existing infrastructure. The faculty for the department are involved in various projects including development new lead molecules for TB, cancer, neuropathic pain; formulation development, Nano-delivery systems, transdermal delivery systems, natural product chemistry and pharmacological systems.

The civil engineering department has eleven laboratories out of which three are research laboratories housing advanced apparatus such as a 200 ton capacity Reaction Load Frame, several highway material and soil testing equipments.

The civil engineering department is also home to the Center for Excellence in Water Resources Management (CEWRM) which was initiated for innovation in sustainable research, education and training in water resources management and allied fields.

The Department of Chemical Engineering has five undergraduate labs namely Selected Chemical Engineering Operations including boiler house, Transport Phenomena, Chemical Reaction Engineering and Process Control labs. The department also houses a Petroleum Engineering lab, Multiphase Systems lab, Environmental Engineering lab, Advanced Separation processes lab including RO water plant, Materials Science and Engineering lab for the Master's program. The department houses common apparatus such as Supermasscolloider MKCA6-2J (Ultrafine friction grinding machine), Micro Gaschromatography (Agilent G3581A-490, used to detect C1-C5 gases, CO2, N2, H2, O2 using TCD and FID detectors), Vacuum Oven (LMVO 24), Moisture Analyzer (50 to 200 OC, Shimadzu MOC63U), Karl Fisher Titrator (Moisture measurement in solids and liquids using chemical agents), Electrospinning Machine (Super-ES-2, nanoscale fibres and core-shell fibres), Fluidized bed Granulator, BET Surface area analyser (0.1-1500 m2 /g), Gas Liquid Chromatography (Agilent 7820 A, suitable for liquids having boiling points below 300 OC, FID detector), Muffle furnace (1000 OC), Fixed bed reactor (Chemito, up to 1200 OC), Brookfield Rheometer (coaxial cylinder 0.026 to 8830 Pa.s) Potentiostat & Galvanostat (Metroohm, used to measure the Electrochemcial energy conversion and storage), Temperature controller bath (PP07R-20 refrigerating/ heating, -20 to 200 OC), High pressure Autoclave (PARR reactor, 350 OC, 140 Kg/cm2), Reid Vapor Pressure Bath (Koehler Instrument Company, K11459), Rotary Microtome (Leica, sections of 500 nm using tungsten carbide and diamond knife, automated), Humidity Chamber (40 to 80% RH,

10 OC - 60 OC), Tray Fermenter (Biomate India, BI-FERM-8D), Rotary Pulp Digester (160 OC, 10 Kg/cm2), UV-Visible double beam Spectrophotometer (Hitachi, U-2900, 190-1100nm), Optical Microscope (transmission mode, 10X, 40X including software to measure parameters), Injection moulding (200OC) , Compression moulding (250OC), Ultrasonic processor (VCX 130 Sonic Vibra cell.), Autoclave (Ambient to 140OC), Thermax Boiler (REVOMAX, 200 Kg/hr), Bubble cap distillation column, Filtration equipment, Software tools such as ANSYS-CFD, COMSOL, MATLAB, MATHCAD, ASPEN, etc are also available for computational work in the Central Computer Aided Design laboratory.

The CS&IS department has access to around 400 DELL/Lenovo machines (made available by IPC) as workstations and desktop PCs catering to the needs of Computer Science & Information Systems students for running their labs/programming assignments related to the lab oriented courses. In addition to these, the department has IBM e-Server Blade Center running Windows 2003 Enterprise edition and Linux with servers like Redhat Enterprise Compute server, and FTP servers for use in the courses. The development tools and software available in these labs include TC Plus, Visual Studio 2008, Compliers (gcc /g++ & Sun's JDK), Script Interpreters (Tcl/Tk, Perl 5.0, and gawk), GNU Assemblers, flex, flex++, X-development tools, IBM Rational Rose, Clementine, NetSim, IBM DB2, Oracle, and Microsoft Virtual PC etc. The department has recently setup a virtual Infrastructure which comprises Academic vCloud Suite 5 (4 CPU license), vCenter Server for vSphere as software and 2 Servers with Dual processor 6 cores (E2620) with Total 48 logical cores, 128 GB RAM, 6 GBPS HBA and Single Controller DAS with 8 TB.

The department has 15 Atom processor kits and embedded software (sponsored by Intel) for developing embedded systems. The lab is used by the students of Software for embedded systems. Also used for developing state of art projects in embedded systems.

The department has following 10 labs with necessary hardware and software facilities available for use by students to work on regular assignments and Computer Oriented projects. i.e Computer Networks Lab, Operating Systems Lab, Database Systems Lab, Data Storage Lab, Software Engineering Lab, Intel Embedded Systems Lab, Distributed Systems and Information Security Lab, Compilers lab, Computer Org and Advanced Architecture Lab and Programming and Data Structures Lab.

Department of Humanities and Social Sciences has a computer based English language lab to strengthen communication skills of students. It has software that offers language teaching-learning solutions through interactive practice sessions.

The Mechanical Engineering Department has nine laboratories, out of which three are advanced research laboratories like Tribology Laboratory, Robotics and Mechatronics Laboratory and Refrigeration Air-conditioning & Energy (RACE) Laboratory and one is a Center of Excellence, namely the Centre for Product Design and Realization (CPDR). The remaining five laboratories that are catering to the undergraduate and postgraduate teaching and research activity of the Department are Dynamics and Vibration Laboratory, Heat Transfer Laboratory, Hydraulic Machines Laboratory, IC Engines Laboratory and Materials Testing Laboratory. Also Mechanical Engineering Department is supported by a Central Workshop, which is equipped with numerous manual, semi-automatic and automatic machine tools, welding equipment and metrology equipment. The Central Workshop is an autonomous unit and lends support to other departments and divisions. FlexSim Software and Manufacturing Simulation Software are recent additions to the facility. Together with this, the workshop also is equipped with Coordinate Measuring Machine (CMM), Electrochemical Machining facility (ECM) and Surface Roughness Tester. The Computer Aided Manufacturing (CAM) laboratory of the Mechanical Engineering Department is located in the Central Workshop premises. In the financial year 2014-15 new

equipments were added to the workshop to strengthen the facilities for manufacturing and mechanical engineering streams laboratories. To name a few are injection moulding equipment, Hydraulic press of 20 T capacity with computerised control, CNC lathe-PTC-200, EDM wire cut etc.

The Department has certain specific research facilities including high temperature tensile testing, micro Vickers hardness testing (Bowers, UK), 500X metallurgical microscope (Meiji, Japan), pin-on-disc tribometer, Four Ball Tester, Tool Makers Microscope (Japan), Infra Thermal Imaging Camera (Flir-Sweden), Digital Oscilloscope (Tektronix), Scratch Tester with humidity Controller. Other facilities available with the Department are Intellitek Scorbot-4RU robotic manipulator and Hardinge-Bridgeport GX600 CNC Vertical Milling Machining Centre (VMC), Rank-Taylor-Hobson computerized profilometer and Additive Manufacturing Machine (rapid prototyping by fused deposition modelling (FDM)) (Stratasys, USA).

A dynamics and vibration laboratory was introduced in the year 2014-15. Miniature Shakers, Uniaxial and Triaxial Accelerometers, Universal Vibration Apparatus, Whirling of Shaft Apparatus, Gyroscopes, Static and Dynamic Balancing Machines are some of the main apparatus with which the laboratory is equipped with. In Materials Testing Laboratory, a Torsion testing machine (500Nm). Three Point Bend setup for Tensile Testing, and Simply Supported Beam Apparatus were recently added. A good quality computerized Stereo Microscope with image analysis software and digital camera facility was recently added. In Heat Transfer Laboratory, state-of-the-art Thermal Systems/ Equipment are available for conducting high quality Experiments. Computerized SI and CI engine test rigs (made by KC Engineers), pyranometer for solar and wind energy measurement and data logger (Campbell, UK) are installed to cater to FD and HD student needs. In Prime Movers and Fluid Machines Laboratory equipment like centrifugal Pumps, submersible pumps, hydraulic turbines, and other equipment needed to study and understand the Hydraulics and fluid mechanics principles are installed. Together with these facilities such as boundary layer apparatus, and jet efficiency apparatus were recently added. The Robotics and Mechatronics laboratory is under a plan to be upgraded into a Centre of Excellence soon. This is presently instrumented with facilities such as 5-axis industrial robot, Myrio Robot, sbriorobot, smart camera evaluation kit to name a few.

In I C Engines Laboratory, a nozzle performance test module and modular air flow bench were recently added. It also houses AVL Ditest MDS 650 system with features such as smoke meter and gas analyzer, a computerized petrol and diesel engine test rig, and a test rig for evaluating alternate fuels. Solar PV Training & Research Systems, solar concentrator training system and solar thermal training systems were the recent additions to the RACE Laboratory.

The Department has access to variety of computer aided design and engineering software from the Centralized CAD laboratory facility. Many courses are integrated with software like Pro/Engineer, ANSYS, COMSOL and MATLAB, and are teaching in CAD laboratory.

There are some additional specialized software purchased through research project funding and they include ABAQUS and DEFORM-3D in the Tribology Laboratory and LS-DYNA and Design-Expert in the Centre for Product Design and Realization (CPDR).

As far as the Department's laboratories having collaborative activity with industries are concerned, the Mechanical Engineering Department has so far signed two memoranda of understanding. One Agreement was signed with FMC Technologies, Hyderabad, under the aegis of which students from the Department are getting the opportunity to work on the real industrial problems from their industrial activity within the scope of different project type courses (design projects and computer oriented projects), first degree thesis and higher degree dissertation of the Institute, with the CPDR as the nodal Centre of Excellence in this area. Most of these projects are related to the area of

computer aided design and engineering of ground based or under-sea crude oil exploration technologies.

The second is the collaboration with Hemair Systems Ltd. Hyderabad, for establishing an ISO-6 (Class-1000) Clean Room in the institute premises for micro-electro-mechanical systems (MEMS) fabrication, which is part of the Institute's Technology Business Incubation (TBI) programme funded by the Department of Science and Technology (DST), Government of India and it is in completion stage.

The EEE department at Hyderabad campus, over the last 8 years, has established laboratories with equipment and Software worth more than Rs. 6.5 Crores. The labs include, Analog Electronics Lab, Communication Systems Lab, Microwave Engineering Lab, Microelectronic Circuits Lab, Digital Electronics Lab, Microprocessor Applications Lab, Digital Signal Processing Lab, Electrical Machines Lab, Control System lab, power Electronics Lab, power systems lab and Instrumentation lab to supplement the undergraduate programs in EEE, ECE & EI. In addition, EEE department also has VLSI Lab, Signal & Image processing Lab, PSOC lab to satisfy the needs of Higher Degree and Research needs. The EEE department has also been equipped with software's such as Cadence, Synopsys, Silvaco, Opnet, NetSim, DSA tools & PSCad for power systems, PSIM, Ansys HFSS, Coventorware, Intellisuite and NI Vision Tools. The EEE department plans to add Optical Communication Lab and device fabrication tools costing Rs.0.5 Core in the next one year.

The Central Computer-Aided-Design (CAD) Laboratory facilitates the computational requirements for teaching and research in Hyderabad campus. This facility manages three partitions; two labs for teaching and one lab for research. The two dedicated lab rooms equipped with 140 desktops is accommodating integrated teaching with computational/numerical tools. In the academic year 2015-16, CAD lab facilitated 40 courses mainly from Chemical, Civil and Mechanical departments, and this number may increase in this academic year. A dedicated research lab equipped with 50 high-end desktops is facilitating the research needs of the faculty and students working in funded projects, dissertations as well as in design-oriented - projects. The PCs are configured with Intel processors and run under Windows 7 operating system. The facility maintains 26 network based software/numerical tools which include the course specific software and the general application software. The course specific licenses include Design Tools- Auto CAD, FLEXSIM and PTC Creo, Numerical Computing Tools- MATLAB, MATHEMATICA and MATHCAD, Computational Fluid Dynamics (CFD) Tools- ANSYS CFD, Open Foam and COMSOL, Finite Element Method (FEM) analysis Tools- ABAQUS and ANSYS Mechanical, and several other Statistical and Geographical Information System (GIS) tools. The facility also involved in the procurement and maintenance of computer aided tools or software and the supporting hardware infrastructure for the institute.

The vision of the Central CAD Laboratory is to facilitate advanced computing facilities to faculty and students to enhance teaching and research endeavors of the institute. To achieve its aim, CAD laboratory is constantly conducting training that provide basics and advancements in software/numerical tools. The facility is expanding its activities to centralize the institute computational requirements by setting up High Performance Computation (HPC) cluster. Pooling computation resources help faculty funding opportunities, and control expenses and reduce overheads as well as it benefit more faculty and students.

Sandboxx

Sandboxx is a multi-disciplinary platform to develop technologies in the domains of Internet of Things, Wearable Technologies and Consumer Electronics. The lab is envisioned as a platform that enables students in the creation of technologies that solve real world problems at the interface of engineering (Mech, EEE, CS, etc) sciences (biology, pharmacy, physics, etc) and design. This lab is for facilitating student ideas and implementation with easy access to

equipment and tools such as sensors, microprocessors, power tools etc

Technology Business Incubator (TBI)

BITS Pilani Hyderabad Campus in collaboration with the Department of Science and Technology, Government of India, has established a Technology Business Incubator. TBI@BITS Hyderabad aims to provide a low cost and resource intensive sandbox for Health-Tech, Bio-Tech and Devices where entrepreneurs can develop their product, services or process ideas towards commercialization. TBI@BITS Hyderabad provides office and lab space equipment, seed funding and vitally, mentorship from an international network of successful business leaders. Prospective entrepreneurs, BITS students, faculty, staff and alumni are invited to engage with TBI in a friendly and hassle free environment. Professional staff will quickly gauge your requirements and provide custom-made services and solutions in a timely manner.

Library facility

The Library at BITS Pilani – Hyderabad Campus is a gateway to knowledge resources. The Library is one of the central support services of BITS Pilani - Hyderabad Campus. It provides information services and access to textual and bibliographic digital and print resources to the BITS Community. Institute's state-of-the-art library with two floors spread over 45000sq.ft. Open 7 days a week, it has a collection of over 28000 books, 900 educational CD-ROMs and subscribes to over 120 Indian and foreign journals. The Library also subscribes to 4200+ e-journals like, American Society for Civil Engineers (ASCE), American Society of Mechanical Engineers (ASME), Association of Computing Machinery (ACM), JSTOR, SciFinder, Nature, IEEE, Science Direct etc. The Digital Library has a collection of e-books and question papers of previous years' examinations. The library operations are fully computerised and students can have access to the Online Public Access Catalogue (OPAC) from their hostel rooms. The Library is equipped with the most modern furniture and is specially designed taking into consideration the future growth of the library collection and needs of the users in the coming years. The air conditioned Library has WI-FI facility as well.

Students Activity Centre (SAC)

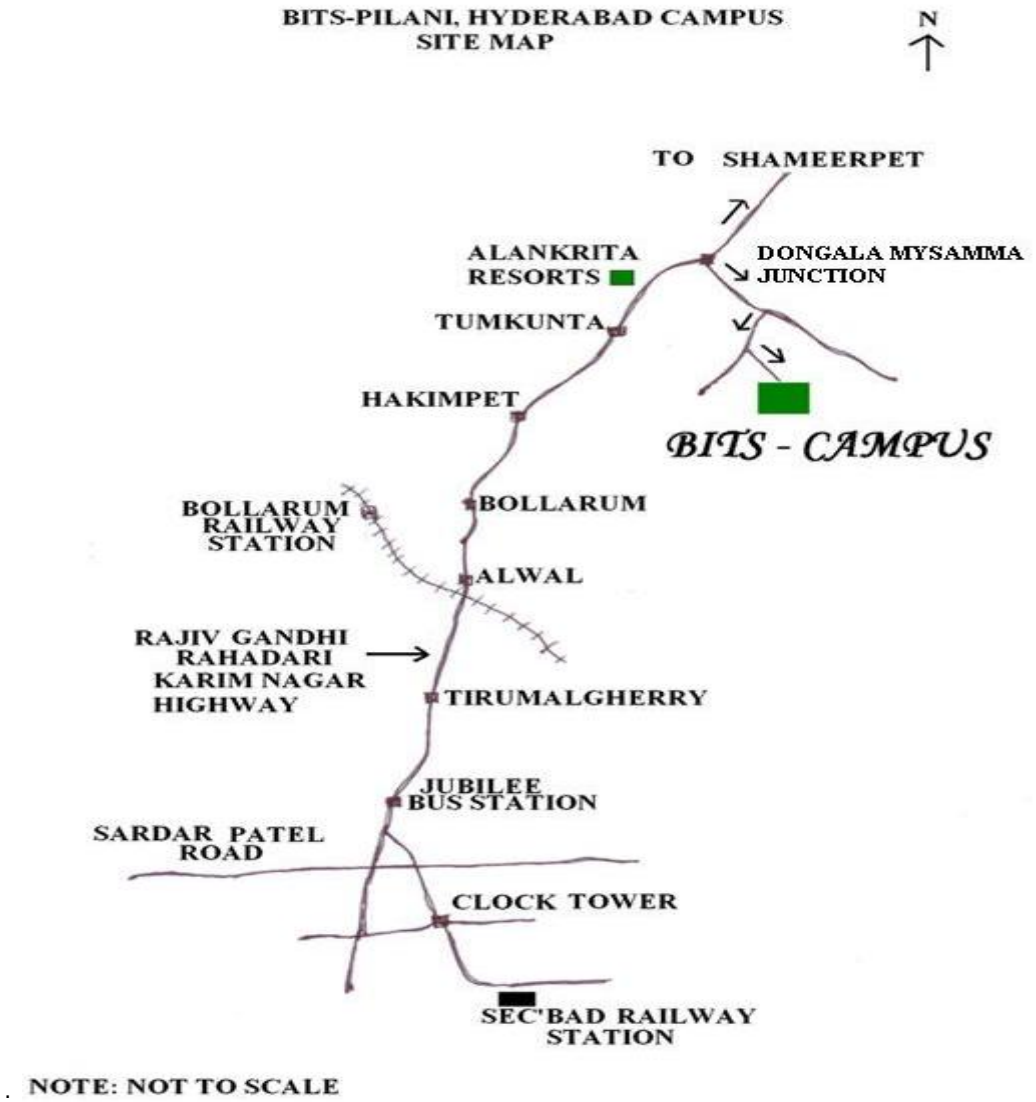
Student Activity Centre (SAC) offers facilities for various Games & Sports facilities like Squash court, Caroms, Chess, Table Tennis, Pool Table/ Billiards and Indoor badminton courts. Two Gymnasiums (one each for Boys and Girls) with state-of-the-art equipment are also available here.

A separate hall with wooden flooring is being provided for Dance, Yoga and Aerobics training. Various clubs namely Dance club, Music club (Indian and Western), VFX club, Photography club, Dramatics club, Shades (Fine Arts) and English Language Activities Society are provided with rooms inside SAC to pursue their activities.

A variety of musical instruments like synthesizers, drums, guitars, etc., have been made available for students of the Music Club to encourage them to practice and perform.

Games and Sports

Various outdoor games like lawn tennis, basketball, volleyball and throw ball have courts in SAC premises. Two indoor badminton courts with wooden flooring with gallery, two lawn tennis and two volleyball courts with synthetic surface are all provided with flood light facilities. Three Cricket pitches with synthetic grass turf for practice along with two turf full length pitches with grass play fields with gallery are also available. Volley ball courts with synthetic grass turf are under development. In addition the institute also offers several sports and recreational facilities like volley ball, table tennis, chess and carom boards in the hostels too.



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Home page: http://universe.bits-pilani.ac.in/ /Hyderabad

MEMBERSHIP OF DISTINGUISHED BODIES

The Institute is an institutional member of the following Associations and Bodies:

(i) Association of Commonwealth Universities, London.

(ii) Association of Indian Universities, New Delhi.

(iii) Current Science Association, Bangalore.

(iv) Federation of Indian Chambers of Commerce and Industry – Higher Education Network, New Delhi.

(v) India International Centre, New Delhi.

(vi) Indian Association of Social Science Institutions, New Delhi.

(vii) Indian Distance Education Association, Hyderabad.

(viii) Indian Institute of Foreign Trade, New Delhi.

(ix) Indian Society for Technical Education, New Delhi.

(x) Institution of Communication Engineers and Information Technologists, New Delhi.

(xi) International Association of Universities, Paris.

(xii) International Council for Open and Distance Education, Oslo, Norway.

(xiii) National Council of Applied Economic Research, New Delhi.

(xiv) Petrotech Society, New Delhi.

(xv) Pharmacy Council of India, New Delhi.

(xvi) The Institution of Engineers (India), Kolkata.

(xvii) World Association for Cooperative Education, Boston, USA.

COLLABORATION WITH FOREIGN EDUCATIONAL INSTITUTIONS

The Institute has collaborative arrangements in terms of exchange of students, faculty and information with the following institutions:

1. The University of Oklahoma, Norman, Oklahoma, U.S.A.
2. Tulane University Medical Centre, New Orleans, Louisiana, U.S.A.
3. Purdue University, West Lafayette, Indiana, U.S.A.
4. Uniformed Services University of the Health Sciences, Bethesda, Maryland, U.S.A.
5. Kathmandu University, Kathmandu, Nepal.
6. University of Otago, Dunedin, New Zealand.
7. Rivers State University of Science and Technology, Nigeria.
8. University of Colombo, Srilanka.
9. George Mason University, Fairfax, USA.
10. ETA Network of Education and Training, Dubai, UAE.
11. University of Windsor, Windsor, Canada.
12. The George Washington University, Washington, USA.
13. Massachusetts Institute of Technology, Cambridge, Massachusetts,USA.
14. Cornell University, Ithaca, USA.
15. Northeastern University, Boston, USA.
16. Waseda University, Tokyo, Japan.
17. Högskolan i Borås (University College of Borås), Sweden.
18. The University of New South Wales, Sydney, Australia.
19. Binghamton University (State University of New York), Binghamton, New York, USA.
20. Victoria University of Technology, “Victoria University”, Melbourne, Australia.
21. University of Southern California, California, USA.
22. Iowa State University of Science and Technology, Ames, Iowa, USA.
23. University of Maryland, College Park, USA.

24. Kansas State University (KSU), Manhattan, Kansas, USA.
25. Arizona State University IRA A. Fulton School of Engineering, USA.
26. The Tun Hussein Onn National Eye Hospital, Petaling Jaya, Malaysia and National Institute of Ophthalmology, Petaling Jaya, Sede Boquer Campus, Malaysia.
27. Universities of Ontario, Canada.
28. The Jacob Blaustein Institute for Desert Research (BIDR) of Ben Gurion University (BGU), Israel.
29. Utah State University, Logan, USA.
30. York University, Toronto, Ontario, Canada.
31. University at Buffalo, The State University of New York, USA.
32. University of Dundee, United Kingdom.
33. Lund University, Sweden
34. Helsinki University of Technology, Espoo, Finland.
35. Carnegie Mellon University, Software Engineering Institute, Pittsburgh, PA 15213, USA.
36. TELECOM Bretagne, Cedex 3, France.
37. The University of North Carolina at Greensboro, Greensboro, NC, USA.
38. The University of Toledo, College of Engineering Toledo, Ohio, USA.
39. Lunghwa University of Science and Technology, Taoyuan, Taiwan.
40. Ecole Nationale Supérieure D'Ingénieurs De Limoges (ENSIL), Université de Limoges, France.
41. Concordia University, Montereal, Quebec, Canada.
42. Technische Universität Braunchweig, Germany.
43. Faculty of Engineering and Graduate School of Science and Technology, Kumamoto University, Japan.
44. Carleton University, Ottawa, Canada.
45. University of Savoie, Chambéry Cédex, France.
46. Carnegie Mellon University, Software Engineering Institute, Pittsburgh, PA 15213, USA.
47. La Trobe University in Australia.
48. University of Rhode Island, Rhode Island, Kingston, USA.
49. USC Viterbi School of Engineering, USA.
50. RAK Medical & Health Sciences University, UAE.
51. New Mexico State University, USA.
52. "n+i" Network of Engineering Institutes, France.
53. Pace University, New York, USA.
54. Florida International University, Miami, Florida, USA.
55. Norwegian University of Life Sciences (NMBU), Norway.
56. University College Dublin, National University of Ireland, Dublin.
57. Macquaire University, Australia.
58. Michigan State University, College of Engineering, East Lansing, Michigan, USA
59. The University of Wisconsin-Madison, USA
60. University of Tartu, Estonia, EU
61. University of Limoges, France
62. CSIR National Institute of Oceanography(NIO), Goa
63. The Universite De Perpignan Via Domitia, France
64. Tunghai University, Taichung, Taiwan
65. Carleton University, Ottawa, Canada
66. University of Leeds, Leed, United Kingdom

PART II

EDUCATIONAL PROCESS & PROGRAMMES OF STUDIES

EDUCATIONAL PROCESS

The mission of BITS is to prepare young men and women to act as leaders for the promotion of the economic and industrial development of the country and to play a creative role in society. It has the reputation of a highly purposive and innovative university often setting the pace for workable reforms in higher education, suitable and relevant for the Indian cultural milieu.

BITS has been following semester system with continuous and internal evaluation since its inception. The educational programmes are modular and flexible. Through its Practice School programme, BITS has established purposeful linkages with industries. The Institute has evolved a direction for Research which makes research relevant to the national development and social needs. It has developed and adopted a unique academic administrative structure which makes all its innovations possible and workable.

The Institute operates educational programmes at three tiers of education, namely, the Integrated First Degree programmes, Higher Degree programmes and the Doctoral programmes. All programmes in the Institute are designed to allow as many components of science and applied science as are necessary for the graduates of the programmes to function effectively and efficiently in the technological society. All programmes contain certain structural commonality and the common courses are invariably operated together irrespective of the clientele who are required to take the courses. Similarly, irrespective of the ultimate degree for which a student qualifies, the large factor of this commonality between all students creates an educational basis which provides easy professional linkage, communication and group activity among students graduating in different degrees. This similarity among different students graduating with different degrees is further welded in a stronger professional bond when they work as internees in the Practice School stations or as members in a team working on mission-oriented time-bound research and development projects.

The various structural flexibilities provide not only scope for multiple point entries but also enable the system to accommodate many legitimate educational and operational needs of students. Some of these aspects are described in various sections that follow.

PROGRAMMES OF STUDIES

All programmes of studies are based on the principle that a series of courses make up the hierarchy of the structure where each course is self-contained but nevertheless acts as a bridge between what precedes and what comes after. A formal contact hour is such that a student is invariably required to spend several times of these hours towards self-study. Attempt here is to awaken curiosity in the mind of the student and train him to think rationally and scientifically and enable him to face the unfamiliar. Through the Practice School option, the flavour of the professional world is sought to be imbibed by the student as well as the teacher. Even many co-curricular activities are converted into a learning situation whereby the growth of a student becomes a continuing operation.

The Institute also conducts Off-campus Work-Integrated degree programmes as a means of continuing education for employed professionals as part of the human resource development programmes of specific organizations at the various off-campus centres. In all these programmes, emphasis is on self-learning and the pedagogy attempts to incorporate as many modern technologies as desirable. While each one of these programmes requires collaboration of an organization, some programmes have a highly structured collaboration with planned classroom activities and some programmes may have less structured planning. While a number of degrees are offered through structured collaboration with many collaborating organizations, there are also degrees, which are available in an open manner for a large number of organizations, each of which may sponsor only few students.

For all these programmes, faculty/resource persons are drawn from the Institute and the participating organizations as well as other Institutions.

The Three Tier Structure shown on page II-3 gives all the programmes offered by the Institute.

Integrated First Degree Programmes

The Integrated First Degree Programmes are offered at the first tier with nomenclatures like B.E., B.Pharm. and M.Sc.. These are all level wise equivalent degrees. These are called integrated degrees for two reasons: (i) there are several common courses amongst these degrees, and (ii) no intermediate degrees, like, B.Sc. etc. are awarded. These degrees are based on a modular structure and their academic requirements are spelt out in respect of the number of courses and units rather than the number of years. All these programmes are structured in such a way that normally a student will be able to finish a programme in eight semesters. Of course, the flexibility of the Institute allows a student to do his programme at a faster pace and finish it earlier than 8 semesters or at a slower pace to finish it later than 8 semesters.

(a) B.E.

These programmes in engineering are mathematics and hard science based and incorporate many up-to-date techniques of analysis and synthesis.

(b) B.Pharm.

This programme has been so structured that it not only meets the requirements of the Pharmacy Council of India but also has additional courses which give a shape and flavour of both engineering and fundamental sciences to the programme.

(c) M.Sc. (Programmes under Group B)

These are integrated degree programmes without any intermediate B.Sc. degree. While these programmes ensure the required science component in any comparable postgraduate science degrees of other universities, they also incorporate many courses which have been notionally considered to be the preserves of engineers. The integrated nature of the programmes and their analytical and engineering science contents give them a professional character and enable students to participate usefully in industrial jobs. While a good 10+2 input may be able to complete these programmes in four years, any person coming from 10+2+3 system with a B.Sc. degree admitted on advanced standing basis will require two to three years to finish the programme. Almost all students who are admitted for these degrees also aspire and work for a second degree from B.E. and B.Pharm. degrees under the dual degree scheme.

(d) M.Sc. (Programmes under Group C)

These programmes are basically multi-disciplinary and technological in character and are designed to meet the requirements of newly emerging professional activities. The areas which are currently incorporated in these degree programmes are Information Systems, Finance and General Studies.

The programme on Information Systems gives among other things a good exposure to the students on computer software and software engineering techniques, both at the conceptual and application levels. The Finance degree has been designed to meet the manpower needs arising due to the new thrust given to growth patterns in the economy. The courses planned for this programme are of such a nature that they fulfil the requirements of financial institutions as well as financial management needs of any industry. This programme is complementary to the M.Sc. Economics programme.

Details of Work Integrated Learning Programmes are given in Part V.

Birla Institute of Technology & Science, Pilani

Three Tier Structure of Education

Ph. D. Degrees	
Higher Degrees	
On-campus programmes	**Work-Integrated Learning Programmes**
M.E. Biotechnology, Chemical, Chemical with specialization in Petroleum Engineering, Civil with specialization in Structural Engineering, Civil with specialization in Infrastructure Engineering & Management, Civil with specialization in Transportation Engineering, Civil with specialization in Water Resources Engineering, Communication Engineering, Computer Science, Computer Science with specialization in Information Security, Design Engineering, Electrical with specialization in Power Electronics & Drives, Embedded Systems, Manufacturing Systems Engineering, Mechanical, Mechanical with specialization in Thermal Engineering, Microelectronics, Software Systems **M. Pharm.** M.Pharm., M.Pharm. with specialization in Pharmaceutics, M.Pharm. with specialization in Pharmaceutical Chemistry **M. Phil.** Biological Sciences, Chemistry, Economics, English, Management, Mathematics, Physics **Master of Business Administration (MBA)** Engineering & Technology Management, IT Enabled Services Management, Finance, Marketing	**M.B.A.** Consultancy Management, Manufacturing Management, Quality Management, Finance. **M. Tech.** Automotive Engineering, Design Engineering, Embedded Systems, Engineering Management, Environmental Engineering, Manufacturing Management, Microelectronics, Pharmaceutical Operations and Management, Quality Management, Science Communication, Software Engineering, Software Systems, Structural Engineering, Systems Engineering, Telecommunications and Software Engineering, Transportation Engineering **M. Phil.** Hospital & Health Systems Management

Integrated First Degrees			
On-campus programmes			**Work-Integrated Learning Programmes**
Group A **B.E.** Biotechnology, Chemical, Civil, Computer Science, Electrical & Electronics, Electronics & Communication, Electronics & Instrumentation, Manufacturing, Mechanical **B. Pharm.**	**Group B** **M.Sc.** Biological Sciences, Chemistry, Economics, Mathematics, Physics	**Group C** **M.Sc.** General Studies, Information Systems Finance	**M.Sc.** Business Analytics, Information Systems **B.Tech.** Engineering Design, Engineering Technology, Information Systems, Manufacturing Technology, Marine Engineering, Nautical Technology, Power Engineering, Process Engineering.
Minor programs			
Minor programs" are being offered in certain areas as options for integrated first degree students with the intent of encouraging them to add focus to their supplemental learning (outside a major area) as well as recognizing and certifying the knowledge obtained in an area that is outside of their major area. A minor would allow a Department (or multiple Departments) to offer a package of courses in an area/sub-area to students for whom this area/sub-area would not be part of their (major) program (e.g. a minor in Finance for students who are not pursuing a program in Finance). A minor will be recognized by means of a separate certificate. The details of minor programs are described in Part IV.			

For Admission to on-campus programmes	
Integrated First Degree :	**Higher Degree :**
For admission to all the above programmes: Candidates should have passed the 12th examination of 10+2 system from a recognized Central or State board or its equivalent with Physics, Chemistry, and Mathematics and adequate proficiency in English.	Normal input: Integrated First Degree of BITS or its equivalent. **Ph.D. Degree:** Normal Input: Higher Degree of BITS or its equivalent.

The General Studies programme aims at providing an opportunity to the students to acquire specific skills to meet varied career objectives through judicious use of electives and project oriented courses. Students are given opportunities to take two different streams, namely Communications and Media Studies or Developmental Studies by choosing courses of specific streams. Further, the requirements of mathematics, science and applied science, etc. are normally different from Group A and Group B Programmes. Candidates admitted to this programme have to take humanities courses as well as certain general science and technology courses.

All the Integrated First Degree programmes described above have a Practice School option which consists of two courses, Practice School I and Practice School II. A student goes to Practice School I of two months' duration during the summer following second year and to Practice School II of five and a half months' duration during the final year. The curriculum, through Practice School, finds a formal method of bringing the reality of professional environment into the educational process.

For the various programmes in all the three tiers of education, the admission policy and the educational process at BITS take care of multiple entry into the programmes and allow several other flexibilities. The on-campus integrated first degree programmes are divided into Groups A, B and C. The following table provides a tabular condensation of the information.

INTEGRATED FIRST DEGREE PROGRAMMES

Name of the Programme	Normal Input	Special features
Group A programmes: B.E. : Biotechnology : Chemical : Civil : Computer Science : Electrical & Electronics : Electronics & Instrumentation : Electronics & Communication : Manufacturing : Mechanical B.Pharm. **Group B Programmes:** M.Sc. : Biological Sciences : Chemistry : Economics : Mathematics : Physics **Group C Programmes:** M.Sc. : General Studies	**For admission to all the programmes:** Candidates should have passed the 12th examination of 10+2 system from a recognized Central or State board or its equivalent with adequate proficiency in English. Except for admission to B. Pharm. the candidates should have Physics, Chemistry, and Mathematics as subjects. For admission to B. Pharm. , candidates should have Physics, Chemistry, and either Biology or Mathematics as subjects. **Admission to all the programmes is subject to the conditions given below:** Admissions will be made purely on merit. The merit position of the candidate will be based on the score obtained by the candidate in a Computer based Online Test (BITSAT) conducted by BITS, Pilani. The candidate should have obtained a minimum of aggregate 75% marks in Physics, Chemistry and Mathematics subjects (if he/she has taken Mathematics in BITSAT) or a minimum of aggregate 75% marks in Physics, Chemistry and Biology subjects (if he/she has taken Biology in BITSAT) in 12th examination, with at least 60% marks in each of the Physics, Chemistry, and Mathematics / Biology subjects.	**Duration:** Planning has been made such that a student will be able to finish any of the integrated first degrees in 4 years (8 semesters). However, the flexibilities available and the modular structure of the system will allow individual student to have variation in the duration of his degrees. Some can finish earlier than 4 years and some may take more than 4 years. Students who take two degrees simultaneously under dual degree scheme will spend about 5 to 5½ years (10 to 11 semesters). **Practice School:** All the integrated first degree programmes have Practice School options. **Dual Degree:** Institute offers dual degree facility to number of students who are admitted. The features of dual degree scheme are described later in this part under the section 'Flexibilities'. **Electives:** A student is required to complete at least 12 elective courses under the categories of Humanities electives, Discipline electives and Open electives. By judicious choice of these courses a student can obtain depth in his/her discipline and/or expand his/her horizon to gain exposure to one or more other areas of study.

For Details of Admission policy to Work Integrated Learning Programmes Refer to Part V.

HIGHER DEGREE PROGRAMMES

M.E./M.Pharm./M.Phil.

The requirements of these programmes are described in terms of the total number of units which a student is required to complete rather than the duration. However, a normal student may be able to complete such a programme in four semesters, wherein the last semester may be spent for either of the two available alternatives, namely, Dissertation and Practice School. The programmes are intended to give a penetrating professional experience and an opportunity to acquire further competence either in one's own discipline or in many other traditional areas of Engineering, Pharmacy as well as interdisciplinary areas, like, Embedded Systems, Microelectronics, Software Systems, Biotechnology, Manufacturing Systems, Design Engineering, Transportation Engineering,etc.

Following is the exhaustive list of all the higher degree programmes approved by the Senate.

Name of the programme	Input
M.E.	**Normal input**
: Chemical	
: Chemical with Specialization in • Petroleum Engineering • Nuclear Engineering	Integrated first degree of BITS in the same discipline or its equivalent.
: Civil with Specialization in • Infrastructure Engineering & Management • Structural Engineering • Transportation Engineering • Water Resources Engineering	
: Computer Science : Mechanical : Mechanical with specialization in Thermal Engineering	
: Communication Engineering : Electrical with specialization in Power Electronics and Drives.	Integrated first degree of BITS in Electrical & Electronics or in Electronics & Instrumentation or its equivalent
: Embedded Systems	Integrated first degree of BITS in Electrical & Electronics or Electronics & Instrumentation or Computer Science or its equivalent.
: Design Engineering : Manufacturing Systems Engineering	Integrated first degree of BITS in Mechanical or its equivalent. Any other Integrated first degree of A & B groups or M. Sc. Engineering Technology of BITS or its equivalent with the requirement of taking certain additional courses.
: Microelectronics	Integrated first degree of BITS in Electrical & Electronics or Electronics & Instrumentation or Computer Science or Physics or its equivalent.
: Software Systems	Any first degree of the Institute, provided the minimum component of MATH, TA, Science, ENGG, prescribed in each of the groups A, B and C through compulsory requirements or conventional options. **Other inputs:** (a) For those Integrated first degree programmes under Work Integrated Learning Programmes which have no counterpart in Groups A, B and C, the minimum requirement should be at least what is prescribed in Group C. (b) Any equivalent degree from other University with preparation indicated above.
: Biotechnology	Any Integrated first degree of BITS or its equivalent with adequate preparation in Bio-Chemistry and Microbiology.
M.Pharm.	Integrated first degree of BITS in Pharmacy or its equivalent.
: M.Pharm.	
: M.Pharm. with Specialisation in Pharmaceutics	
: M.Pharm. with Specialization in Pharmaceutical Chemistry	
M.Phil.	Any Integrated first degree of BITS or its equivalent in respective discipline.

Special features of Admissions to any M.E. programme:

Students coming with integrated first degree of BITS in A & B groups may be considered for admission to any M.E. Programme with the requirement of taking additional courses. The duration in these cases may be more than the normal duration and will be determined on a case by case basis. Similar dispensation may also be possible for students coming with an engineering degree from IITs and other reputed institutions.

Note: While no direct admissions are planned for M.Phil. degree, students who are admitted to Ph.D. may be asked whenever necessary, to register for this degree.

Master of Business Administration

The Institute is running an MBA programme with input requirement as first degree of BITS or its equivalent. The programme endeavors to create manpower who have scientific and engineering approach to business administration. Students will also have a reasonable exposure to certain modern technologies. The programme is designed to have many flexibilities and a very strong component of industry project experience. The input for the programme may have multiple entry points. While principal input will be students already possessing an engineering degree, those who have other qualifications like B.Sc., B.A., B.Com. may also apply provided they have aptitude towards having training in science, mathematics and technology as well. The requirements of the programme will necessitate such students to spend additional time which may vary from 1 to 4 semesters depending upon their qualifications. For students not having an engineering degree, the course requirement will be worked out, looking at the earlier training on a case-by-case basis at the time of admission. However, for the current year, admissions are planned for an input with engineering degree only in which case the normal duration is 4 semester.

Master of Business Administration (MBA) in		Input
(i)	Engineering & Technology Management	Any Integrated first degree of BITS or BE/BTech in Engineering from other recognized Universities
(ii)	IT enabled Services Management	
(iii)	Finance	
(iv)	Marketing	

DOCTORAL PROGRAMMES

The Institute's Ph.D. programme is structured on the basis of a preferred input of those who have completed one of the Institute's higher degrees. It requires each student to finally qualify for formal acceptance in the programme only after passing a qualifying examination.

The Institute also offers a unique opportunity for working professionals to work for Ph.D. in the settings of their own work environments through part-time, Off-campus Ph.D. scheme.

Ph.D.	**Normal input** Any Higher degree of BITS or its equivalent. **Other inputs** a) Integrated First Degree of BITS or its equivalent. b) Any preparation between the above described first degree and higher degree. c) High professional standing and proven competence even without a formal degree. Note: Each case of other inputs will be decided on a case by case basis regarding admission and with the requirement of doing higher degree courses before taking qualifying examination. In the case of inputs with qualification like B.E., M.Sc., etc. the selected candidates will be required to do course work.	**Structure:** Qualifying examination, Research Methodology, Teaching practice, Foreign language when required, Thesis and Seminar. Course work as specified for various input and prior preparation. **Locale:** Normally any of the BITS campuses and other off-campus locations with prior approval. **Ph.D. Aspirant:** To help in the development of professionals at large, provision exists for taking directly the qualifying examination as a `Ph.D. Aspirant' even before seeking admission to the Ph.D. Programme. The Aspirants can work in the settings of their own work environment with the approval of Research Board.

PROGRAMMES OFFERED AT BITS PILANI – PILANI CAMPUS

Integrated First Degree Programmes

B.E. Chemical

B.E. Civil

B.E. Computer Science

B.E. Electrical & Electronics

B.E. Electronics & Instrumentation

B.E. Manufacturing

B.E. Mechanical

B.Pharm.

M.Sc. Biological Sciences

M.Sc. Chemistry

M.Sc. Economics

M.Sc. Mathematics

M.Sc. Physics

M.Sc. General Studies

Higher Degree Programmes

M.E.:

: Biotechnology

: Chemical

: Civil with specialization in Structural Engineering

: Civil with specialization in Infrastructure Engineering & Management

: Civil with specialization in Transport Engineering

: Communication Engineering

: Computer Science

: Design Engineering

: Electrical with specialization in Power Electronics & Drives

: Embedded Systems

: Manufacturing Systems Engineering

: Mechanical

: Microelectronics

: Software Systems

M.Pharm:

: M.Pharm.

: M.Pharm. with specialization in Pharmaceutics

: M.Pharm. with specialization in Pharmaceutical Chemistry

Master of Business Administration (MBA)

PROGRAMMES OFFERED AT BITS PILANI – K.K. BIRLA GOA CAMPUS

Integrated First Degree Programmes

B.E. Chemical

B.E. Computer Science

B.E. Electrical & Electronics

B.E. Electronics & Instrumentation

B.E. Mechanical

M.Sc. Biological Sciences

M.Sc. Chemistry

M.Sc. Economics

M.Sc. Mathematics

M.Sc. Physics

Higher Degree Programmes

M.E.:

: Biotechnology

: Chemical

: Computer Science

: Embedded Systems

: Microelectronics

All these programmes have the same educational process, syllabus, evaluation method and academic flexibilities like transfer, dual degree etc. as followed at BITS, Pilani – Pilani Campus..

PROGRAMMES OFFERED AT BITS PILANI – HYDERABAD CAMPUS

Integrated First Degree Programmes

B.E. – Chemical Engineering

B.E. – Civil

B.E. – Computer Science

B.E. – Electrical & Electronics

B.E. – Electronics & Communication

B.E. – Electronics & Instrumentation

B.E. – Mechanical

B.E. – Manufacturing

B. Pharm.

M.Sc. – Biological Sciences

M.Sc. – Chemistry

M.Sc. – Economics

M.Sc. – Mathematics

M.Sc. – Physics

Higher Degree Programmes

Biotechnology

Chemical Engineering

Civil with specialization in Structural Engineering

Communication Engineering

Computer Science

Design Engineering

Microelectronics

Embedded Systems

Mechanical with specialization in Thermal Engg.

M.Pharm:

M.Pharm. with specialization in Pharmaceutics

M.E (Integrated):

Computer Science with specialization in Information Security.

All these programmes have the same educational process, syllabus, evaluation method and academic flexibilities like transfer, dual degree etc. as followed at BITS, Pilani – Pilani Campus.

PROGRAMMES OFFERED AT BITS PILANI – DUBAI CAMPUS

First Degree Programmes

- B.E. Chemical Engineering
- B.E. Civil Engineering
- B.E. Electrical & Electronics Engineering
- B.E. Mechanical Engineering
- B.E. Computer Science
- B.E. Electronics & Instrumentation Engineering
- B.E. Biotechnology
- B.E. Electronics & Communication Engineering

Higher Degree Programmes

M.E.:

- M.E. Software Systems
- M.E. Microelectronics
- M.E. Biotechnology
- M.E. Design Engineering

M.B.A. (Master of Business Administration)

Doctoral Programme

Doctor of Philosophy (Ph.D.)

TEACHING-LEARNING PROCESS

The objective of class room education is to awaken the curiosity of the student, generate habits of rational thinking in him/her, gear his/her mind to face the unfamiliar and train him/her to be able to stand on his/her own. With its team of committed and dedicated faculty, BITS aims at maximizing the learning through teaching. Through their innovative

teaching, the teachers enable the student search for knowledge on his/her own and motivate him/her to use the facilities like the library, laboratory and the environment to optimise his/her learning process. Self-study by the student is therefore an important factor in the planning of teaching and evaluation and in this environment the student exhibits interest and responds to this challenge. Teaching and evaluation form a unity of function and operate in a climate of mutual understanding and trust.

Every course whether single section or multi-section is conducted by a member of the faculty called instructor-in-charge, with the assistance, where necessary, of the required number of instructors – who will be partners with him in meeting the full academic perceptions and organisational needs of teaching the course and evaluating the students.

Within one week of the beginning of classwork, the instructor-in-charge/ instructor announces to his class/section through a hand-out, the necessary information in respect of (i) the operations of the course (its pace, coverage and level of treatment, textbooks and other reading assignments, home tasks etc.); (ii) various components of evaluation, such as tutorials, laboratory exercises, home assignment, project, several quizzes/tests/examinations (announced or unannounced, open book or closed book), regularity of attendance, etc., (iii) the frequency, duration, tentative schedule, relative weightage etc. of these various components; (iv) the broad policy which governs decisions about make-up; (v) mid-semester grading; (vi) grading procedure (overall basis, review of border line cases, effect of class average, etc.) and (vii) other matters found desirable and relevant.

EVALUATION

All courses are conducted and evaluated in a continuous & internal manner by the faculty who teach these courses. The student registers for a certain number of courses each semester; the year being divided into two semesters, and a summer term, whenever offered. A faculty member, as registration advisor, helps a student to draw up his programme, suitable to his pace and needs, which is made possible by the coursewise time-table of the Institute. Every student gets, incidentally, a training in decision-making through (i) choice of load, i.e. number of courses per semester to suit his/her pace, (ii) selection of his/her own time-table to suit his/her convenience, and (iii) picking up courses as electives to meet his/her own aspirations. It is the responsibility of the student to attend classes regularly and to maintain a required level of scholastic standing.

The performance of a student in each course is assessed by the teacher by means of continuous evaluation throughout the semester in classwork, periodical quizzes (sometimes unannounced), tests (both open and closed book), tutorials, laboratory work, home work, seminars, group discussions, project, etc., and a comprehensive examination at the end of the semester. The student is thereby given a large number of opportunities to carryout various academic assignments and be evaluated. Besides encouraging and rewarding continuous and systematic study, the system provides a constant feedback to the student as to where he/she stands, thus enabling him/her to cultivate regular habits of studying and preparing himself/herself for the future.

The system discards the conventional emphasis on a single final examination and numerical marks as the only absolute indication of the quality of student's performance. Thus, at the end of the semester the teacher of the course awards letter grades **A, A$^-$, B, B$^-$, C, C$^-$, D, E** to the student based on the total performance of the student and it

is relative to the performance of others taking the same course. These letter grades stand for quality of performance: A (Excellent), A⁻ (Very Good), B (Good), B⁻ **(**Above Average), C (Average), C⁻ (Below Average), D (Poor) and E (Exposed). Further, these letter grades have points associated with them in a quantified hierarchy: a maximum of 10 (for an A) to a minimum of 2 (for an E). There are also courses in which the teacher awards non-letter grades which have only a qualitative hierarchy. The teacher may also pronounce the performance of a student in a course in terms of certain reports which should not be misconstrued as grades.

Although BITS does not stipulate a minimum percentage of attendance before a student is permitted to appear in any test/examination, the Institute, being a fully residential university with internal and continuous evaluation system, expects every student to be responsible for regularity of his/her attendance in classrooms and laboratories, to appear in scheduled tests and examinations and to fulfil all other tasks assigned to him/her in every course. The system hasadequate resilience to accommodate unforeseen situations through withdrawal from a course, make-up test, feedback from examinations and interaction with teachers. In spite of all these facilities when a student fails to cooperate with the teacher in the discharge of his/her part of the contract to such an extent that the teacher is unable to award any grade, the teacher is authorised to give a “Not Cleared” (**NC**) report.

A student is deemed to have cleared a course if he/she obtains a grade in the course. However, the educational philosophy of the Institute interlinks and at the same time distinguishes between the performance of a student in a single course and his/her overall cumulative performance. The overall performance of a student is indicated by an index known as the “Cumulative Grade Point Average” (CGPA). It is the weighted average of the grade points of all the letter grades received by the student since his/her entry into the Institute and is expressed on a 10-point scale. In the case of Integrated First Degree programmes the final division for the degree is decided on the basis of CGPA and there are three classifications, namely Distinction, First Division and Second Division. However, in the case of Higher Degree and the Doctoral programmes no division is awarded.

During the student’s stay in the Institute, the Institute expects him/her to show a certain minimum performance and progress. The minimum academic requirements regarding the performance and progress for the Integrated First Degrees and Higher Degrees are:

(i) A CGPA of at least 4.5 at the end of every semester for integrated first degree students and 5.5 for higher degree/Ph.D. students.

(ii) Not more than one E grade in a semester for integrated first degree programmes and no E grade in the higher degree programmes.

(iii) The pace of progress of a student should be such that at any stage of reckoning he/she should not have spent more than 50% extra time than what is prescribed for him/her upto that stage in his/her programme.

The Institute's Academic Regulations must be consulted regarding the minimum academic requirements for the pursuit of the Ph.D. programme and also for off-campus programmes.

Students who fail to meet the minimum academic requirements stipulated above are put under an appropriate committee which monitors their programmes and give guidance so that they are properly rehabilitated at the

earliest. In case of Ph.D., this is done by the Departmental Research Committee (DRC) and Doctoral Counselling Committee and in the case of higher degrees and integrated first degrees this is done by Academic Counselling Board (ACB). These Committees are appointed by the Senate and are given authority to take appropriate action including discontinuance of the student or transfer to other programme.

FLEXIBILITIES

The admission policy and the educational process at BITS take care of multiple entry into the programmes and allow several other flexibilities.

Wherever a flexibility is possible according to the Academic Regulations of the Institute, the implementation of the decision invariably takes place along with registration at the beginning of a semester for the continuing students. As in the admission process, the decision is guided by the principle of merit, preferences and facilities available.

It is obvious that CGPA cannot serve as the only measure of merit when the total number of courses/units is different between two competing candidates. To normalise all competing candidates, generally the Institute uses a Progressive Branching Index (**PBI**).

Admissions in both the Semesters

The structural flexibilities available in the Institute make it possible to admit students in both the semesters. However, in the case of both first degree and higher degree programmes most of the admissions are made during the first semester itself. In the case of Ph.D. and off-campus degree programmes, admissions are planned in both the semesters. However, a separate advertisement is given for the second semester admissions and applications for the same are made available only after an advertisement is issued.

Admission with Marginal Deficiency

While the academic preparation required for the admission to each degree has been clearly spelt out there is a provision in the Institute Academic Regulations whereby brilliant students whose prior preparation has been marginally deficient in terms of stated courses/subjects may also be admitted with the condition that they are required to do additional courses over and above those prescribed for a student with normal preparation and the sequence is determined by the institute. This flexibility is invariably used in the case of higher degree programmes where students may come without sufficient exposure to courses like computer programming.

Admission with Advanced Standing

When a candidate for any programme in the three tiers of education of the Institute comes with a preparation beyond the minimum requirement for admission in that programme, the admission of such a candidate is handled under what is known as admission with advanced standing. While such admission is not available as a matter of right, at the time of admission the Institute would spell out in detail the advanced credit it proposes to give to the candidate and the matter would be handled within the framework of the Institute's operation for normal students. Essentially the guiding principle is two-fold : the courses the candidate has already done before entering the Institute cannot be repeated and also that the time spent elsewhere is not wasted. Such an open-ended situation is handled on a case by case basis. It is important that the candidate supplies all the pertinent data in respect of syllabus of courses taken by him/her, examinations passed, question papers of the examinations and the grades/marks obtained by him/her in different subjects. A candidate who is shortlisted for

such admissions would be asked to come to Pilani and explore a workable programme that would be appropriate for him/her before admission is completed. If required, the candidate may have to take certain examinations in various subjects that he/she has completed before a prescribed programme is pronounced for him/her there onwards.

However, there are certain situations which cannot be treated as advanced standing. In view of the uncertainty of the level to which some of the courses of the First Degree programmes is treated as optional subjects in the 10+2 system, to be consistent with the past tradition, no student is allowed to register in a course if he/she is considered to be overprepared in relation to the content of the course. Some examples of such courses are: General Biology, Engineering Graphics and Workshop Practice. Such an overprepared student is required to take an appropriate higher level course, as determined by the Associate Dean, Instruction.

Dual Degree Scheme

To meet the ambitions of the students who could not get admission to B.E./B.Pharm. programmes, the Institute has created facilities by which any student who is admitted to M.Sc. programmes (offered under Group B) is accommodated in a dual degree scheme for a second degree in B.E. /B.Pharm. programmes. This assignment is made by competition on their performance at BITS at the end of the first year, separately in Pilani, Goa and Hyderabad campuses.

Students in any other group seeking a second degree from amongst the programmes in the same group or another group will also be considered under other 'priorities'.

Transfer

(i) Within the same tier

It is possible for a student to seek transfer from one programme to another in the middle of a programme without starting from the beginning. This is possible because he/she is given credit for what he/she has done till then towards the requirements of the programme to which he/she seeks the transfer. Details have to be seen in the Academic Regulations. Transfer is possible from M.E. (all branches) and M.Pharm. to M.Phil. On the other hand, very restricted and tutored transfer would be possible from M.Phil. to M.E./ M.Pharm.

Since admission to a programme is done on assigned and competitive basis, there cannot be any scope of undoing the fact of an assigned admission through transfer. Thus only exceptionally meritorious students in a limited number of cases can expect to compete for transfer to a more sought-after programme. On the other hand, transfer to a less sought-after programme for a student who is unable to cope with the rigours of the programme in which he/she has been admitted would be readily used to rehabilitate him/her without much loss of time. In any event, transfer must be treated as an admission process.

(ii) From first degree to higher degree / Ph.D. degree:

In the case of bright and promising student of the Integrated First degree programmes a transfer to Higher Degree and/or Ph.D. degree may also be provided.

(iii) Between Ph.D. and higher degree programmes:

Under special situations a transfer between Ph.D. and higher degree programmes may be permitted. Movement in either direction is theoretically possible. The Institute's Academic Regulations must be consulted for details.

Audit

The facility of taking a course on audit is principally conceived to give an opportunity to a student to update his/her knowledge in selected courses. It is expected to meet primarily the needs of casual students (not enrolled for degree). No degree of the Institute can be acquired by merely taking courses on audit.

There are certain courses like Foreign Languages, Music, etc. which are neither part of a degree programme nor are available through electives. Any student who wishes to take such courses can take them only on audit basis and also on payment of additional fees.

Other Flexibilities

The structure of degree programmes and the Academic Regulations also provide certain other flexibilities like choice of electives, number of electives, repetition of courses, departure from normal pace, withdrawal from or substitution of course(s) etc.

Academic Regulations

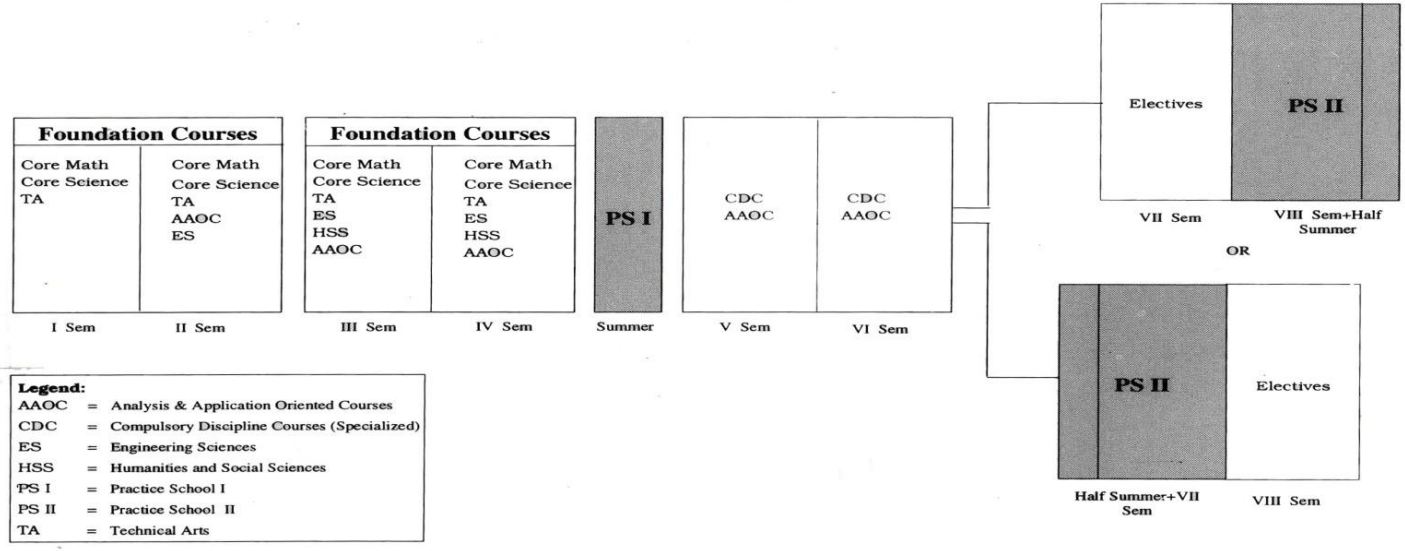
The operations described above are not exhaustive. For precise rules, Academic Regulations of the Institute may be consulted.

UNIVERSITY-INDUSTRY LINKAGE

A recurring theme in the realm of educational reform and innovation has been that of linking university education with industry experience. Since its very inception in 1964, the Institute has been committed to University-Industry Collaboration. Beginning in 1973, the Institute has taken pioneering initiatives towards the development of institutionalized linkages with industry, through its (i) Practice School, (ii) Technology Innovation Center, and (iii) Off-campus work-integrated learning programmes. The details of Practice School are described here.

PRACTICE SCHOOL

All Integrated First Degree and Higher Degree Programmes of the Institute provide a Practice School option. A student who exercises this option receives, on successful completion of the requirements of the programme, a degree which carries the tag, “With Practice School”.



The Structure of Integrated First Degree Programme
(Practice School Option)

Theme

BITS is strongly committed to the view that university education must be oriented so as to (i) meet the rapidly changing needs and challenges of the environment, (ii) help people use their intelligence and become capable of facing unfamiliar, open-ended real-life situations, and (iii) bear an economic relevance to the society.

The Practice School (PS) method of education links the university with the professional world, by infusing the reality of the world of work into the educational process. The classroom is shifted for a period of 7½ months to a professional location where the students, under the supervision of the faculty, are involved in applying the knowledge acquired in the classroom to finding solutions to real life problems. The PS experiment began with a small group of 12 students in 1973 and has been extended to accommodate all students from all disciplines. The distinguishing features of the PS method of education - (i) the work of the students is supervised and evaluated by faculty, (ii) the credits earned by the student count towards the total credit requirement of the degree, and (iii) the PS option is available to students of all disciplines - make it a bold and radical educational reform with no parallel.

Operation of the PS Programme

The **PS** programme for the Integrated First Degree has two components, namely **PS-I** of two months duration implemented during the summer following the 2nd year and **PS-II** of five and a half months duration implemented during either of the semesters of the final year. (Refer to the chart on page II-12) Dual degree students can also opt for PS-II in both the semesters of the final year.

The PS Programme for Higher Degree has a single component, namely Practice School for Higher Degree operating in an identical fashion to PS-II, in the final semester of the Higher Degree Programme.

Practice School - I (PS-I)

This component is the first exposure to the world of work, necessary for the subsequent problem solving experience during PS-II. It is implemented at large industrial complexes, research and development centers, software development houses, pharmaceutical companies, etc. While the general aim of PS-I is to afford an opportunity for the student to learn how work is organized and carried out; by a process of observation and participation, the learning can be quite varied and exhaustive depending on the nature of the organization. It provides an opportunity for a detailed understanding of vast engineering operations and its various facets such as inventory, productivity, management, information systems, human resource development, etc. Students observe science and technology in action, develop an awareness of the method of scientific experimentation, and often get an opportunity to see, study and operate sophisticated and costly equipment. They also learn about the implementation of the principles of management they have learnt in class, when they observe multidisciplinary teams of experts from engineering, science, economics, operations research, and management deal with techno-economic problems at the micro and macro levels. Finally, it enables them to develop and refine their language, communication and inter-personal skills, both by its very nature, and by the various evaluation components, such as seminar, group discussion, project report preparation, etc. The broad-based core education, strong in mathematics and science and rich in analytical tools, provides the foundation necessary for the student to understand properly the nature of real-life problems. The students are accompanied by a teacher, who is responsible for coordination with the organization and the day-to-day educational as well as evaluation details.

Some of the places where this component has been implemented are Indian Bank, Chennai; Rourkela Steel Plant, Rourkela; National Aluminium Company Ltd., Angul; Indian Institute of Remote Sensing, Dehradun; The Institute of Minerals & Materials Technology,

Bhuvaneshwar; Texmaco Ltd., Kolkata; Central Scientific Instruments Organization, Chennai; Century Rayon, Kalyan; Orchid Bio Medical Systems, Goa; Carborundum Universal Ltd., Kochi; Bharat Heavy Electricals Ltd., Trichy.

Practice School - II (PS-II)/ PS for Higher Degree

PS-II is attended by the students of the Integrated First Degree Programmes in their final year of study. This is also faculty supervised, and for this purpose, teachers are located at various centers around the country where PS stations operate. In order to maintain continuity of operation, the students are divided into two batches, about half the students doing PS-II in the first semester and the other half in the second semester. In either case, the time duration is augmented by a part of the summer term (preceding or following the semester). The operation is therefore round the year with batches coming about every six months. PS for Higher Degree is however available only in the final semester of the programme, after completion of the campus-based courses. The PS-II/PS component is implemented at Production and Manufacturing units, Design, Development and Consulting Agencies, Research and Development Centers, Financial Institutions, Software Development organizations, etc. The student education here is in terms of the direct involvement of the student in problem solving efforts of specific interest to the host organization. The assignments are identified by the PS faculty well in advance in consultation with experts from the host organization. The problems are often multidisciplinary in nature, which are assigned to a group of students drawn from different disciplines. The professional expert in charge of a particular problem and the PS faculty play the roles of consultant and supervisor respectively. The students are encouraged to work independently and are required to defend the technical aspects of their work through periodic written and oral presentations. Emphasis is laid on realizing the importance of teamwork, development of leadership qualities, and the need for effective time management.

Some of the typical assignments that the students have undertaken are: Development of Category Configuration Portal; System on Chip Design and Verification; Design and Development of Features in the Mtg-Automation; Risk and Control Tools in Operations; Integrating HP Performance and HP Nonstop Measure; Planning and Implementing Events at ECLUB and Work at Resource Bureau; Partial Metadata Get/Set Support in CDMI Server; Sabre Cruises Booking Analytics Tool; Mobile Engineering at Pocket Gems; Data Management and Organizaion of Datasets.

Typical PS Station – A Model

The PS station is the analogue, in the professional world, of the university classroom and laboratory. The Institute endeavours to ensure that each PS station has all the physical facilities necessary to carry out meaningful education. In fact, host organizations have always come forward with all possible assistance. At least one faculty member is attached with each PS station. Since a city may have more than one PS station, the term PS Centre is used to designate a location where one or more PS stations are present.

PS Assignments

The general nature of PS-I assignments is of study and orientation. However, the assignment plays a pivotal role in PS-II and is of direct and immediate relevance to the host organization. The educational challenge is therefore that of evolving the pedagogy for teaching, learning, and evaluation while the students are involved in their problem solving efforts. The tasks are generally multidisciplinary, mission oriented and therefore time bound and open ended. The development of solutions to such problems requires a scientific attitude, technical competence, discipline and adherence to procedure, decision making ability, and a spirit of curiosity and exploration. Often, the assignments form a part of long term research and development projects.

Student Allotment in PS

Allotment in PS-I is done keeping the student's preferences and academic performance in view, along with the availability of physical facilities, in particular, accommodation. Student allotment in PS-II is, however, a much more complex and multi-dimensional task. With the help of the PS faculty, information about the total set of skills and attributes required of the student for the task at hand is collected from the host organization. Simultaneously, a profile of each student is prepared, incorporating details such as CGPA, performance in various categories of courses including electives and projects, assignment worked on in PS-I, professional interests, and extra-curricular achievements. With this information base, a matching is carried out, keeping in view the student's preferences and constraints of physical facilities.

Computerization of the various activities related to PS, such as profile preparation, allotment, monitoring, and feedback has made the entire process expeditious and efficient.

Evaluation in PS courses

The PS method of education, as has been emphasized earlier, is a medium for integrating real-life situations with the learning process. In line with this objective, the student is given the responsibility of planning, scheduling, implementing, and defending the steps to the solution of the assigned problem. The students work under the supervision of the faculty, in consultation with the professional expert(s). As with all other courses, a process of continuous evaluation is followed. The PS method of education seeks out and focuses attention on many latent attributes which do not surface in the normal classroom situation. These include professional judgment and decision making capacity, inter-disciplinary approach, data-handling skills, ability in written and oral presentation, leadership qualities, ability for team work, sense of responsibility, ability to meet deadlines, etc. These attributes are judged by the faculty through various instruments of evaluation, namely quiz, viva, seminar, group discussion, project report, diary, and daily observation. At the end of each PS course, a student is awarded a letter grade based on his total performance. Supplementing the degree transcript issued by the Institute, the PS Division issues a 'Practice School Transcript' to those students who opt for the PS stream. This transcript gives a complete record of the performance of the student in the PS programme. It also includes a rating sheet which describes qualitatively the student's personality traits mentioned earlier.

Since the PS programme interfaces with the world outside the campus, whenever the progress of a student in a PS course is found to be unsatisfactory and/or guilty of conduct unworthy of the professional world, the PS option may be withdrawn by the Institute, without any reason being assigned.

Role of Professional Experts in PS

The PS programme clearly places demands on the time and energy of various officers from the host organization. However, every effort is made to ensure that they are not burdened with the day-to-day details concerning the educational and administrative organization of the PS programme, these being the responsibility of the PS faculty.

In the case of PS-I, the preparation of the educational schedule is initiated at the Institute itself. On reaching the PS station, the faculty discusses the same with officers from the host organization, seeking their concurrence and their suggestions. The faculty engages the students on various assignments and periodically informs the experts of the progress made. The faculty may also arrange meetings of the students with the experts and also invite them to participate in seminars given by the students from time to time. At the end of the course, the faculty seeks the expert's critical comments on the report submitted by the student, to receive essential feedback on the quality of the work.

In respect of PS-II, the officers from the host organization first come into picture when the faculty is compiling the problem bank for the

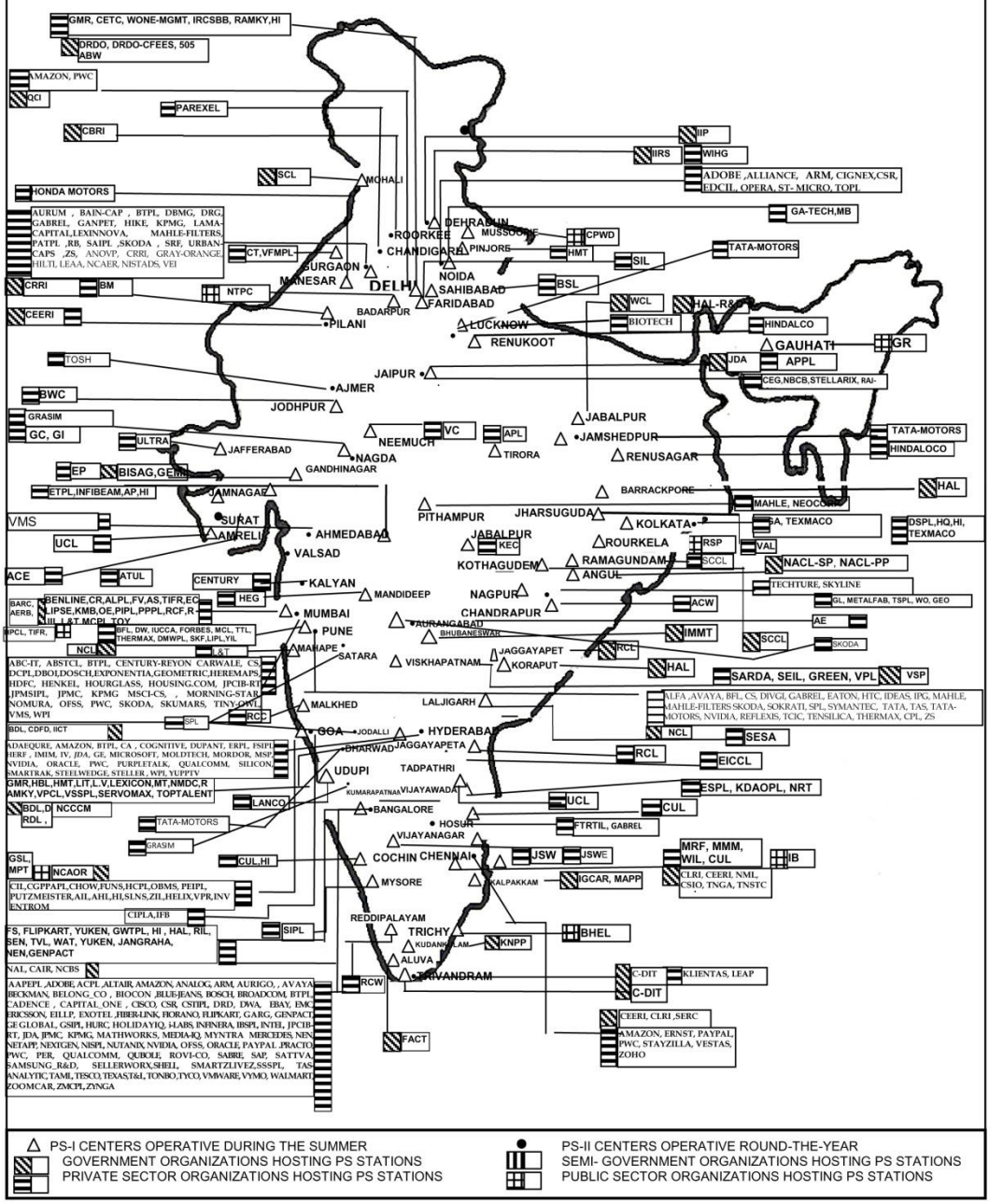
batch of students to come. At this stage, the experts provide the details of the various problems on which the students will work, as well as their requirements in terms of the type of student input for each assignment. After the arrival of the students at the PS station too, the faculty remains at the helm of affairs, forming student groups, assigning projects, conducting evaluation components, etc. The faculty also ensures that each student blends well with the group of fellow students and staff from the host organization, in which he/she is working. When seminars or group discussions are held, the faculty invites the officers to participate. During the course of the assignment, the students seek consultation with the expert, normally through the faculty, who ensures that the student is well-prepared for these meetings. At the end of the course, the student is required to present a seminar and defend the technical credibility of the work before as large a gathering of experts as possible. Detailed discussions ensue on various technical aspects of the problem, often resulting in the resolution of critical issues involved.

Some PS Statistics

Ever since its beginning in the year 1973 with just one station accommodating 12 students and 4 faculty members, the PS has grown immensely. In the academic year 1975-76 the programme was thrown open to all the students of the Institute. During an academic year arrangements have to be made for PS programme for a steady number of 4542 students, accompanied by nearly 123 faculty members. Specifically, it means accommodating a steady number of 2467 students and 108 faculty members at about 178 different organisations for PS-I in the summer term and arranging for about 2075 students accompanied by about 53 faculty members to attend PS-II operated round the year at about 261 different host organizations. So far about 57,781 students have been benefited by this programme. While all the host organisations pay the students out-of-pocket allowance, some organizations provide the students and the faculty with housing and other facilities as well.

The list of organisations where PS programmes are in operation is given below. There are also organizations outside India where the PS programme is being conducted for several years. (Refer to the following map showing PS Stations).

BITS PRACTICE SCHOOL STATIONS
2016–2017



LIST OF PS-I STATIONS

Ahmedabad

Adani power (AP), Elitecore Technologies Pvt. Ltd (ETPL), Helpage India (HI)

Infibeam (INFIBEAM).

Aluva (Kerala)

The Fertilizers And Chemicals Travancore Ltd (FACT).

Amreli

Ultratech Cement Limited (UCL)

Angul

National Aluminium Company Limited - Smelter Plant (NACL-SP), National Aluminium Company Ltd - Power Plant (NACL-PP)

Aurangabad

Aurangabad Electricals (AE).

Badarpur (Delhi)

National Thermal Power Corporation (NTPC)

Bangalore

Fiberlink Software, An IBM-Company (FS), Flipkart Internet Services Pvt. Ltd (FLIPKART), Garg Web Tech. Pvt. Ltd. (GWTPL), Genpact (GENPACT), Jangraha (JANGRAHA) , Helpage India (HI), Hindustan Aeronautics Limited (HAL), NEN (Wadhwani Foundation), Ramky Infrastructure Limited (RIL), Sen Sei Technologies (SEN), Triton Valves Ltd (TVL), WATConsult (WAT), Yuken India Ltd (YUKEN)

Barrackpore

Hindustan Aeronautical Division, Barrackpore Division (HAL)

Bhubaneswar

The Institute Of Minerals and Materials Technology (IMMT).

Chandrapur (Maharashatra)

Awarpur Cement Works (ACW).

Chennai

Carborundum Universal Ltd. (CUL), Central Electronics Engineering Research Institute (CEERI), Central Leather Research Institute (CLRI), Central Scientific Instruments Organization (CSIO), Indian Bank (IB), Medical Research Foundation (MRF), National Metallurgical Laboratory (NML), The Madras Medical Mission (MMM), Tamil Nadu eGovernance Agency (TNGA), Tamil Nadu Science and Technology Centre (TNSTC), Wheels India Ltd (WIL).

Cochin

Carborundum Universal Ltd. (CUL), Helpage India (HI)

Dehradun

Indian Institute Of Remote Sensing (IIRS), Wadia Institute of Himalayan Geology (WHG).

Delhi

DRDO, DRDO-CFEES, Helpage India (HI), 505 Army Base Workshop (505 ABW), Center Of Exellence In Telecommunication (CETC), Gmr Varalakshmi Foundation (GMR), Indian Red Cross Society Blood Bank (IRCSBB), Ramky Infrastructure Limited (RAMKY), Wone Management Systems Pvt Ltd (WONE-MGMT).

Eluru

East India Commercial Company Limited (EICCL)

Faridabad

Superseals India Ltd (SIL).

Gandhinagar

Bhaskaracharya Institute for Space Applications and Geoinformatic (BISAG), Gujarat Environment Management Institute (GEMI).

Gauhati

Gauhati Refinery (GR).

Goa

Abbott India Ltd. (AIL), Amanta Healthcare Limited (AHL), Cartini India Ltd (CIL), CG PPI Adhensive Products Ltd (CGPPAPL), Chowgule & Co. Ltd (CHOW), Funskool (India) Ltd (FUNS), Goa Shipyard Ltd (GSL), Helpage India (HI), Himigiri Castings P Ltd (HCPL), Mormugao Port Trust(MPT), Inventrom (INVENTROM), National Centre For Antartic And Ocean Research (NCAOR), Orchid Bio Medical Systems (OBMS), Power Engineering India Pvt. Ltd (PEIPL), Putzmeister (PUTZMEISTER), Smart Link Network Systems (SLNS), Vergo Pharma Research (VPR), Helix Tech (HELIX).

Gurgaon

Convergent Technologies (CT), Value First Digital Media Pvt. Ltd. (VFMPL).

Hosur

Carborundum universal ltd (CUL)

Hyderabad

Bharat Dynamics Ltd (BDL),DRDL, GMR Varalakshmi Foundation (GMR), HBL Power Systems Ltd (HBL), HMT Bearings Ltd (HMT), Landmark IT Solutions (LIT), L.V. Prasad Eye Institute (LV), Lexicon Infotech Ltd (LEXICON), Mold-tek Technologies Ltd. (MT), National Mineral

Development Corporation (NMDC), NCCCM (NCCCM), Ramky Infrastructure Limited (RAMKY), Servomax India Pvt. Ltd (SERVOMAX), Toptalent.IN (TOPTALENT), Vasudha Pharma Chem Limited (VPCL), Vasudhaika Software Solutions Pvt. Ltd. (VSSPL).

Jabalpur

West Central Railway (WCL)

Jafferabad

Ultratech Cement Limited (ULTRA)

Jaggayapet

The Ramco Cements Ltd. (RCL)

Jaipur

Amol Pharmaceuticals Pvt Ltd (APPL), Jaipur Development Authority (JDA).

Jamnagar

Essar Power (EP).

Jharsuguda

Vedanta Aluminium Ltd (VAL).

Jodhpur

Birla White Cements (BWC).

Kalpakkam

Indira Gandhi Centre for Atomic Research (IGCAR), Madras Atomic Power Plant (MAPP).

Kolkata

Delta Step Learning Pvt. Ltd (DSLP), Hedge Quants (HQ), Helpage India (HI),Texmaco Ltd (TEXMACO).

Koraput

Hindustan Aeronautics Limited (HAL).

Kothagudem

The Singareni Collieries Company Ltd. (SCCL)

Kudankulam

Kudankulam Nuclear Power Plant (KNPP).

Laljigarh

Sesa Sterlite Ltd. (Vedanta Aluminium & Power)(SESA)

Lucknow

Biotech Park (BIOTECH), Hindustan Aeronautics Limited**-** Aerospace Systems and equipment R&D Center (HAL-R&D).

Mahape (Maharashtra)

Larsen & Toubro Limited Infotech Ltd (L&T).

Malkhed (Maharashtra)

Rajshree Cement (RC).

Mandideep (MP)

HEG Limited (HEG).

Manesar

Honda Motors (HONDA MOTORS).

Mohali

Semi- conductor labs (SCL)

Mumbai

Alka Lifestyles Pvt. Ltd. (ALPL), Astech Systems (AS), Atomic Energy Regulatory Board (AERB), Ben Line Agencies (India) Pvt. Ltd (BEN LINE), Bhabha Atomic Research Centre (BARC), Century Rayon (CR), Eclipse Instrumentation Pvt. Ltd. (ECLIPSE), Fact Ventures Pte Ltd (FV), Hindustan Petroleum Corporation Limited (HPCL), Homi Bhabha Centre For Science Education (TIFR), L & T Infotech (L&T), Monarch Catalyst Pvt. Ltd. (MCPL), Orient Enterprises (OE), Prama Instruments Private Limited (PIPL), PRS Permacel Pvt Ltd (PPPL), Rashtriya Chemicals and Fertilizers Ltd. (RCF), Reliance Jio(RJIL), Toy Bank (TOY), WATConsult (WAT)

Mussoorie

Central Public Works Department (CPWD).

Mysore

South Indian Paper Mills (SIPM)

Nagda

Grasim Chemicals (GC), Grasim Industries (GI).

Nagpur

Global Logic (GL), Metal Fab High Tech Pvt Ltd (METAL FAB), Techture Structures Pvt Ltd (TSPL), Windals Operation (WO), Geomitra (GEO).

Neemuch (MP)

Vikram Cement Works (VC).

Noida

Global Autotech (GA-TECH), Moser Baer (MB).

Pilani

Birla Museum (BM), Central Electronics Engineering Research Institute (CEERI).

Pinjore

HMT Tractors Ltd. (HMT)

Pithampur

Mahle Engine Components India Pvt Ltd (MAHLE), Neocorp International Limited (NEOCORP).

Pune

Bharat Forge Ltd (BFL), Forbes Marshall (FORBES), Divgi-Warner Ltd (DW), Inter-University Centre For Astronomy And Astrophysics (IUCCA), Liveweaver India Pvt.Ltd (LIPL), Minda Corporation Ltd (MCL), Tata Technologies Limited (TTL), Thermax (THERMAX), Divgi Metalwares Private Ltd(DMWPL), SKF India Ltd (SKF), National Chemical Laboratory (NCL), Yazaki India Ltd (YIL)

Ramagundam

The Singareni Collieries Company Ltd. (SCCL)

Reddipalayam(TN)

Reddipalayam Cement Works (RCW).

Renukoot

Hindalco Industries Limited (HINDALCO).

Renusagar

Hindalco Industries Limited (HINDALCO).

Rourkela

Rourkela Steel Plant (RSP).

Tadpathri

Ultratech Cement Limited (UCL).

Tirora (MH)

Adani Power Limited (APL).

Trichy

Bharat Heavy Electricals Ltd (BHEL).

Trivandrum

Centre for Development of Imaging Technology (C-DIT).

Udupi

Lanco-Udupi Power Corporation (LANCO).

Vijayanagar

JSW Steel (JSW), JSW Energy (JSWE).

Vijayawada

Efftronics Systems Pvt. Ltd. (ESPL), Kanaka Durga Agro Oil Products Ltd (KDAOPL), Navata Road Transport (NRT).

Visakhapatnam

Sarda Metals & Alloys (SARDA), Steel Exchange India Ltd (SEIL), The Green City (GREEN), Vijaynirman Pvt. Ltd. (VPL), Vishakapatnam Steel Plant (VSP).

LIST OF PS-II STATIONS

Ahmedabad

VMS (Vakil Mehta Seth) Consultants Private Limited (VMS)

Ajmer

Toshniwal Industries Pvt. Ltd (TOSH)

Aurangabad

Skoda Auto India Pvt. Ltd. (SKODA)

Bangalore

[24]7 iLabs (i-LABS), Aditya Auto products & Engg (I).P.Ltd (AAPEPL),Adobe Systems (ADOBE), Akira Consultancy Private Limited (ACPL),Altair Engineering India Pvt. Ltd (ALTAIR),Amazon Development Center (AMAZON), Analog Devices (ANALOG),ARM Embedded Technologies Private Limited (ARM), AurigoSoftware (AURIGO),Avaya India Private Limited(AVAYA) ,Beckman Coulter (formerly ReaMetrix India P Ltd) (BECKMAN),belong.co (BELONG_CO),Biocon (BIOCON),Blue Jeans Network India Pvt. Ltd. (BLUE-JEANS),Bosch (BOSCH),Broadcom India Pvt Ltd (BROADCOM), Bundl TechnologiesPrivate Limited (Swiggy) (BTPL)Cadence Design Systems India Pvt Ltd.(CADENCE) ,Capital One (CAPITAL_ONE),Centre for Artificial Intelligence & Robotics (CAIR),Cisco Systems (India) Pvt. Ltd.(CISCO),CSR (CSR),Cypress Semiconductor India Pvt Ltd(CSTIPL),Dell R&D (DRD),DreamWorks Animation (DWA),EBay India Development Centre (EBAY),EMC(EMC),Ericsson Global India Pvt. Ltd(ERICSSON),Ernst & Young L.L.P.(EILLP), Exotel Techcom Pvt. Ltd. (EXOTEL),Fiber Link(FIBER-LINK), Flipkart Internet Services Pvt. Ltd(FLIPKART), Fiorano Software Technologies Pvt. Ltd.(FIORANO) , Garg Webtech Pvt. Ltd.(GARG) , Genpact(GENPACT),Global Logic (GLOBAL),Goldman Sachs India Pvt. Ltd(GSIPL), Hindustan Unilever Research Centre(HURC),HolidayIQ.com(HOLIDAYIQ),Infinera(INFINERA),Informatica Business Solutions PVT. LTD (IBSPL),Intel India Technology Pvt. Ltd(INTEL), J P Morgan CIB-RFT(JPCIB-RT),J.P. Morgan Chase(JPMC), JDA Software Solutions(JDA),John F Welch Technology Center (GE), KPMG(KPMG), MathWorks India Private Limited(MATHWORKS),Media Iq Digital(Media Iq),Mercedes Benz(MERCEDES),Myntra.com(MYNTRA), National Aerospace Laboratories(NAL), National Centre for Biological Sciences(NCBS),National Entrepreneurship Network(NEN),National Instruments Systems (India) Pvt. Ltd. (NISPL), NetApp (NetApp), NextGen PMS Pvt. Ltd. (NEXTGEN), Nutanix Technologies India Pvt. Ltd(NUTANIX),Nvidia Graphics(Nvidia),Oracle Financial Services Software Ltd. (OFSS), Oracle India Pvt Ltd. (ORACLE), PAYPAL(PAYPAL),Practo Technologies Pvt. Ltd. (PRACTO),Price Waterhouse Coopers (PWC),Probe Equity Research(PER),

QUALCOMM INDIA PRIVATE LIMITED(QUALCOMM), Qubole (Qubole), Rovi Corporation(ROVI-CO) ,Sabre Holdings(Formely Sabre Travels) (SABRE),SAP Labs (SAP), Sattva Media & Consulting Pvt Ltd (SATTVA),Samsung R &D Institute(SAMSUNG_R&D) , Sellerworx Online Services Limited (SELLERWORX), Shell Technology Center (SHELL), SmartLivez (SMARTZLIVEZ),Symantec Software Solutions Pvt. Ltd (SSSPL),TAS Analytic Services (TAS-ANALYTIC),Tata Advanced Materials Ltd (TAML),TESCO Hindustan Service Centre (TESCO) , Texas Instruments (I) Pvt. Ltd (TEXAS),Think and learn (T&L), Tonbo Imaging Pvt Ltd (TONBO),TYCO International Ltd (TYCO),VMware Software India Pvt. Ltd. (VMware),Vymo (VYMO), Walmart Global Technology Services(WALMART),Zoomcar India Pvt. Ltd (ZOOMCAR), Zynga Game Network India Pvt. Ltd. (ZYNGA), Zinnov Management Consulting Pvt. Ltd(ZMCPL)

Chandigarh

Parexel Company (PAREXEL)

Chennai

Amazon Development Center(AMAZON), Central Electronics Engineering Research Institute (CEERI),Central Leather Research Institute (CLRI),Ernst & Young Pvt Ltd (ERNST),PAYPAL(PAYPAL), Price waterhouse Coopers (PWC) , Stayzilla - Inasra Technologies (STAYZILLA),Structural Engineering Research Centre(SERC).,VESTAS TECHNOLOGY LTD(VESTAS),ZOHO corporation(ZOHO)

Dehradun

Indian Institute of Petroleum (IIP)

Delhi

Amazon Development Center(AMAZON), Price waterhouse Coopers (PWC), Quality Council of India.(QCI)

Dharwad

Tata Motors (TATA-MOTORS),

Goa

CIPLA Ltd (CIPLA), IFB Industries (IFB)

Greater Noida

ST Microelectronics (I) Pvt.Ltd. (ST-MICRO),

Gurgaon

Aurum Equity Partners (AURUM), Bain Capability Center Pvt. Ltd (BAIN-CAP),

Bundl Technologies Private Limited (Swiggy) (BTPL), DB MUdra Group (DBMG), Decisionresourcesgroup (DRG), Gabrel India Ltd(GABREL), Genpact(GANPET),Hike(HIKE), KPMG(KPMG), Lama Capital Management (LAMA-CAPITAL), LEXINNOVA (LEXINNOVA),Mahle Filters India Ltd (MAHLE-FILTERS), Pluss Advanced Technologies Pvt. Ltd(PATPL),Reckitt Benckiser (RB),Skoda Auto India Pvt. Ltd.(SKODA),SmartAnalyst India Private Limited(SAIPL),SRF Ltd (SRF),Urban Clap(URBAN-CAPS),ZS Associates (ZS)

Hosur

Faiveley Transport Rail Technologies India Ltd (FTRTIL), Gabrel India Ltd (GABREL)

Hyderabad

Adaequre(ADAEQURE),Amazon Development Center(AMAZON), BHARAT DYNAMICS LTD(BDL), Bundl Technologies Private Limited (Swiggy)(BTPL) ,CA Technologies (CA),Centre for DNA Fingerprinting and Diagnostics(CDFD) ,Cognitive Scale(COGNITIVE),Dupont Knowledge Center (DUPANT), Endless Robotics Pvt. Ltd(ERPL),Freescale Semiconductor India Pvt. Ltd(FSIPL),Hyderabad Eye Research Foundation (HERF), IMI Mobile (IMIM), Indian Institute of Chemical Technology (IICT),InsideView Technologies (India) Pvt. Ltd (IV),JDA Software Solutions (JDA),John F Welch Technology Center (GE), Microsoft(MICROSOFT), Moldtek India (MOLDTECH)Mordor Intelligence(MORDOR), My smart price(MSP), Nvidia Graphics (NVIDIA) ,Oracle India Pvt Ltd(ORACLE), Price waterhouse Coopers (PWC), PURPLE TALK (PURPLETALK) , QUALCOMM INDIA PRIVATE LIMITED (QUALCOMM), Silicon Image R&D Pvt Ltd (SILICON) ,Smartrak (SMARTRAK),Steelwedge Software Inc. (STEELWEDGE),Stellar Software Technologies Pvt Ltd(STELLER),Worley Parsons India(WPI),YUPPTV(YUPPTV)

Jaipur

CEG Limited (CEG), NBC Bearings (NBCB), RAJPUTANA CONSTRUCTIONS (RAJ-CON),Stellarix Consultancy Services Pvt Ltd(STELLARIX)

Jamshedpur

Tata Motors (TATA-MOTORS)

Jodalli

Spicer India Ltd.(SPL)

Kolkata

Tega Industries(TEGA), Texmaco Ltd (TEXMACO).

Kumarapatnam

Grasim Industries Ltd. (GRASIM)

Lucknow

Tata Motors (TATA-MOTORS)

Mumbai

Aditya Birla Corporate IT(ABC-IT),Aditya Birla Science & Technology Company Ltd(ABSTCL),Bundl Technologies Private Limited (Swiggy), (BTPL)Carwale (Automotive Exchange Pvt. Ltd.) (CARWALE),Century Rayon(CENTURY-REYON),Credit Suisse (CS), DBOI (Deutsche Bank) (DBOI), Development Consultants Pvt. Ltd. (DCPL), Dorsch Consult (India) Pvt. Ltd.(DOSCH),Exponentia data(EXPONENTIA), Geometric Limited(GEOMETRIC), HDFC Bank(HDFC), HENKEL(HENKEL), Here Maps - A Nokia Company(HEREMAPS), Hourglass Research(HOURGLASS), Housing.com (Locon Solutions Private Limited) (HOUSING.COM),J P MORGAN –CIB(JPCIB-RT),J.P. Morgan Chase(JPMC), J.P. Morgan Services India Pvt. Ltd(JPMSIPL), KPMG(KPMG),Morningstar(MORNING-STAR), MSCI Barra Quantitative Equity Research(MSCI-CS), Nomura Services IndiaPvt(NOMURA), Oracle Financial Services Software Ltd. (OFSS), Price waterhouse Coopers (PWC), Skoda Auto India Pvt. Ltd(SKODA), Skumars Online(SKUMARS), Tiny Owl Technology Pvt. Ltd.(TINY-OWL),VMS (Vakil Mehta Seth) Consultants Private Limited(VMS), Worley Parsons India(WPI)

Nagda

Grasim Industries Ltd (GRASIM).

Nagpur

Skyline Consulting Engrs Pvt. Ltd. (SKYLINE), Techture Structures Pvt Ltd. (TENCHTURE)

New Delhi

anovIP (ANOVP),Central Road Research Institute(CRRI), Grey Orange Robotics Pvt. Ltd (GRAY-ORANGE), HILTI India Pvt. Ltd. (HILTI),LEA Associates(LEAA),

National Council of Applied Economic Research (NCAER), National Institute of Science and Tech. Dev. Studies (NISTADS), Value Edge India (VEI).

Noida

Adobe Systems (ADOBE), Alliance Infotech (ALLIANCE), ARM Embedded Technologies Private Limited (ARM), Cignex Datamatix Technology (CIGNEX), CSR Ltd. (CSR), Edcil India Ltd (EDCIL), Opera Solutions (OPERA SOLUTIONS), Tolexo Online Pvt Ltd (TOPL)

Pilani

Central Electronics Engineering Research Institute (CEERI).

Pune

Alfa Laval (India) Limited (ALFA), Avaya India Private Limited (AVAYA),

Bharat Forge Ltd (BFL),Credit Suisse (CS), Divgi Warner Pvt Ltd (DIVGI),Eaton Technologies (EATON), Gabrel India Ltd (GABREL), Halliburton Technology Center (HTC),IDeaS – SAS(IDEAS),Mahle Beher India Pvt Ltd(MAHLE), Mahle Filters India Ltd (MAHLE-FILTERS) , National Chemical Laboratory (NCL),Nvidia Graphics(NVIDIA), Reflexis Systems India Pvt Ltd(REFLEXIS),Skoda Auto India Pvt. Ltd. (Chakan) (SKODA),Sokrati Technologies Pvt. Ltd(SOKRATI), Spicer India Ltd.(SPL),Symantec Software Solutions Pvt. Ltd(SYMANTEC),Tata Autocomp Systems Ltd(TAS),Tata Chemical Innovation Center(TCIC),Tata Motors(TATA-MOTORS), Tata Technologies (TATA), Tensilica (TENSILICA), Thermax India(THERMAX), vConstruct Private Limited (CPL) , ZS Associates(ZS).

Roorkee

Central Building Research Institute (CBRI)

Satara

Spicer India Ltd (SPL)

Thailand

Aditya Birla Chemicals (Thailand) Ltd-Sulphites (ABCL)

Trivandrum

Centre For Development Of Imaging Technology(C-DIT),Klientas (KLIENTAS), Leap Consulting (LEAP)

Valsad

Atul Ltd (ATUL)

USA

Knox Payments (KNOX)

RESEARCH AT BITS

Research is an important academic activity at BITS Pilani. Large number of students at all levels of the educational programmes are involved in research that exploits the multidisciplinary educational base emerging out of the broad-based integrated education in engineering, science and humanities. Strong emphasis is laid on interdisciplinary, mission-oriented and relevant research. The Practice School, which is an important component of the integrated programmes of BITS, provides an opportunity to identify research problems relevant to industrial needs. The participation of students and the faculty members in research ensures a team effort towards problem solving activities. Such a total

involvement of the faculty as well as the student population integrate research and teaching activities of the Institute in such a manner that they draw strength and support from each other.

Research Areas

Topics of Research can be chosen from any of the disciplines in which the Institute offers Higher Degree and First Degree programmes and also from the areas given in Table at the end of this Part.

Research Linkages

The Institute has built up research linkages with a large number of R & D organizations in the country and abroad and provisions exist for candidates to work for a part or whole of the research work at these organizations in their thrust areas. Some of the organizations are: Uniformed Services University of Health Sciences, Bethesda, USA; Tata Institute of Fundamental Research, Mumbai; Central Electronics Engineering Research Institute, Pilani; Central Drug Research Institute, Lucknow; Institute of Pathology, New Delhi; Sankara Nethralaya and Elite School of Optometry, Chennai; LV Prasad Eye Institute, Hyderabad; and Institute of Cardio-Vascular Diseases, Chennai.

Research Components in the Educational Programme

Research is emphasized in all the educational programmes of the Institute. At the first degree level, Thesis and at the higher degree level Dissertation are optional alternatives to the Practice School. Thesis is an integral component of the Ph.D programme.

While some salient features are described below, for further details, please refer to Academic Regulations.

(A) First Degree

(i) In the First tier, a single degree student must take either Thesis or PS and a dual degree student has to normally do Thesis for one degree and PS for the other degree. Such a student can also opt for PS/Thesis for both the degrees.

(ii) Students will be assigned a topic of research and a supervisor after giving due consideration to the student's preference, the research goals of the Institute and the equalization of the work-load of the supervisors.

(iii) A first degree student opting for a Thesis has two options: (i) register for a 16-units Thesis, in which case the student cannot be simultaneously registered in any other course; or (ii) register for a 9-units Thesis, in which case it may be necessary for the student to take additional elective courses to meet graduation requirements and He/she may be permitted to register in courses simultaneously with the Thesis

(iv) Thesis is graded in terms of same letter grades.

(v) Thesis can also be done at collaborating organization, industries under joint supervision.

(B) Higher Degree

For students who opt out for Practice School, Dissertation of 15-25 units is a required component. Student may be registered for one full semester after completing all courses or may be registered concurrently for varied units along with other courses. This is a course in which the student takes up a research topic under the supervision of a faculty. Pursuit of research through this course in any semester must end up in a written report at the end of the semester. The performance is graded in terms of same letter grades. Dissertation can also be done at collaborating organizations, industries under joint supervision.

(C) Ph.D. Degree

Thesis is an integral component in the Ph.D. degree programme. It requires a minimum of 40 units to be distributed normally in four semesters. A Ph.D. student can register for the Thesis course only after passing the Qualifying Examination and after approval of his topic of research and supervisor(s) by the Dean, Academic Research.

The pursuit of the thesis can be done on campus or at Practice School Centres and in certain circumstances at other specific centres with prior permission.

Other Components and Features of the Ph.D. Programme

(i) Types of Input

While the preferred input is a Higher Degree of BITS or its equivalent, the Institute's Academic Regulations permit an input which is at least a first degree of BITS or its equivalent or any input between these two extremes. Further, in a rare case of a person of high professional standing and proven competence who is deemed to have acquired mastery over all or substantial part of the course-work of a higher degree of the Institute through long professional experience exhibited through published papers, technical reports, etc. would also be an acceptable input.

(ii) Qualifying Examination

Every student admitted to Ph.D. must pass the qualifying examination which is based on two areas chosen by the candidate depending on his intended area of research and courses done. The qualifying examination tests the student's knowledge, grasp of fundamentals and his ability to use them in unknown situations.

The admission to On-campus Ph.D. programme is provisional in the first instance and gets confirmed only after passing the Qualifying examination within the prescribed time. Whenever a candidate is unable to pass the qualifying examination within the prescribed time, he will automatically be discontinued from the programme.

(iii) Seminar / Independent Study

Normally a Ph.D. student will have to register every semester in the Seminar course or in the Independent Study course.

(iv) Course work

The various categories of courses including Research Methodology, for the whole possible range of input of Ph.D. students are described in the Academic Regulations. In most cases, the course work consists of courses which are required for obtaining the knowledge in the area of research. Further, the qualifying examination is conducted on the basis of chosen two sub-areas approved by the Senate

(v) Research Methodology and Teaching Practice

These are two courses required to be done by every Ph.D. student. These courses attempt to train the student in the art, methodology and skill of teaching and research. Alternatively, Dean, ARD may permit a student to register in Practice Lecture Series courses *in leu* of Teaching Practice.

(vi) Language Requirement

The foreign language is prescribed as an eligibility requirement for the Ph.D. only when the supervisor(s) and/or the Dean, ARD approve the same. Otherwise English or an Indian language, as the case may be, would suffice.

A Ph.D. student for whom foreign language is prescribed is expected to demonstrate an ability to translate a piece from current periodicals in the area of major interest of the student in one of the modern European languages into English with the help of a dictionary.

(vii) Fellowships and Scholarships

Students admitted to Ph.D. Programme normally get fellowship from some funding agencies like UGC, CSIR, DBT, DST, ICMR, MNES or Industries, etc. However, Institute has also instituted fellowship stipends from its own resources intended to take care of needs of Ph D students.

Ph.D. programme for working professionals

The Institute also offers an unique opportunity for employed professionals working in industries and R&D Organizations and having experience to work towards Ph.D. degree of the Institute. Such students can be admitted either under 'Part- Time' Ph D or under 'Ph D aspirants' scheme. While the 'Part- Time' Ph D students will work on the thrust area identified by the Institute, a “Ph D aspirant will work in the settings of their respective work environments. Normally candidates working in an organization collaborating with BITS are considered under aspirant scheme. Industries/organizations interested in the scheme for the development of their manpower at the doctoral level are invited to seek collaboration with BITS and sponsor their suitable candidates.

A supervisor and/or co-supervisor from within the BITS system is required for such candidates.

Admission

The admission modalities given in the next part also apply to Ph.D. wherever applicable.

Eligibility

- A candidate with a formal higher degree which is the minimum qualification for the Ph.D. programme; namely M.E./ M.E. (Coll.)/ M.Phil./ M.Phil. (Applied)/ M.Pharm./M.S. of BITS or an equivalent degree of another university of standing.
- A person of a long and high professional standing and proven competence not possessing a higher degree but whose experience, in terms of professional documents, can measure upto a higher degree.
- A student coming after clearing the courses prescribed by Departmental Research Committee of the Institute or its equivalent without completing the degree.

There may be occasions where the admissions of Ph.D. Aspirants end up in protracted correspondence. If the admissions are finalized before the starting of the semester the students will be registered in that semester. Otherwise the admission will be deferred to a subsequent semester. For administrative purposes there will be a last date for submission of application in each semester.

All 'Ph.D. Aspirants' after passing the qualifying examination shall seek formal admission to the Ph.D. programme at the earliest opportunity

available to them and register in the Ph.D. Courses.

Components of Ph.D. Programmes

The components are (a) Course work, if necessary; (b) Qualifying Examination; (c) Foreign Language, when required; (d)Research Methodology (e) Teaching Practice/Practice Lecture Series; (f) Seminar/Independent Study; and (g) Ph.D. Thesis.

Operational Features

a) Place of work: On-Campus: Any of the BITS Campuses. Off-campus Centre: Any of the Off-Campus centres of BITS where Practice School, Work-Integrated Learning programmes are conducted and organizations having collaborations and research linkages with BITS.

Outside Centre: In worthy circumstances, an outside centre not covered by the above may be approved.

b) Topic of Thesis: From areas of focus of the Institute or from problems of intimate concern to the in-house R & D needs of the host organization and matching with focus of the Institute.

c) Supervisor: Subject to final approval by the Dean, ARD, technically any person of standing, authority and competence can become the supervisor for the Ph.D. thesis. A supervisor at any point of time is any senior faculty member of the Institute or a person with equivalent responsibility in the campus or in an off-campus centre. However, rules provide for any outstanding person outside the Institute and the name can be suggested by the candidate. If supervisor is taken from outside, a co-supervisor is expected to be taken from faculty member of any of the BITS, Pilani campuses.

d) Places and Dates of Qualifying Examination: Normally arranged in twice each year at all campuses of BITS.

Areas of Research

1. **Biological Sciences:** Environmental Biotechnology, Bioinformatics, Microbial Biotechnology, Molecular Biology, Molecular Parasitology & Vector Biology, Molecular Diagnostics, Genomics, Plant Biotechnology.
2. **Bioengineering**: Biomaterials, Biomechanics, Bioinstrumentation, Bio-transport Process.
3. **Civil Engineering**: Structures, Water Resources, Geotechnical, Transportation, Environmental Engineering, Image Processing and G.I.S., Disaster Management, Earthquake Engineering, Solar Architecture, Finite Element Method, Non-traditional optimization algorithms, Artificial Neural Networks, Fuzzy Logic and Multicriterion Decision Making and their applications.
4. **Chemical Engineering:** Biochemical Engineering, Biomass Gasification, Computation Fluid Dynamics, Energy Engineering, Environmental Engineering, Evolutionary Computation, Modeling and Simulation, Multi-Objective Optimization, Multiphase Reactors, Process Dynamics and Control, Process Integration and Process Intensification, Reaction Engineering, Polymer Science and Engineering, Process Synthesis and Design, Separation Processes and Petroleum Refining and Petrochemicals.
5. **Chemistry:** Organic including Natural products, Bioorganic, Inorganic, Bioinorganic, Physical, Biophysical, Medicinal, Analytical, Green, Theoretical and Computational Chemistry; Nanomaterials; X-Ray Crystallography.
6. **Computer Science & Information Systems:** Computer Networks, Distributed Systems, Database Systems, Software Engineering, Operating Systems, Multimedia, Computer Control Systems, Computer Architecture, Compilers, Formal Methods, Information Retrieval
7. **Economics and Finance**: Macroeconomic Models and Policy, Microeconomic Analysis, Money and Financial Markets, Financial Engineering, Econometric Studies, Financial Modeling, Mathematical Economics, Environmental Economics, Resource Management Systems, Growth Economics, Banking, Micro Finance, Capital Markets, Macroeconomic Modeling, Applied Finance, Environment and Resource Economics International Trade and Finance, Strategy, Financial Management, Corporate Planning, Entrepreneurship, Project Management.
8. **Electrical and Electronics Engineering:** Communication Systems, Wireless and Mobile Ad-hoc Networks, Optical Communication and Networks, Microelectronics and VLSI Design, Signal Processing and Embedded Systems, Power Electronics and Drives, Power Systems, Telecommunication, Robotics and Intelligent Systems, Fiber Optic Sensors, Artificial intelligence techniques in robotics, Instrumentation & Control, Wearable computing, Energy and Power Systems.

Areas of Research

9. **Humanities and Languages:** Film Studies, Music, Theatre, History and Politics, Language, Communication and Soft Skills, Literature and Cultural Studies, Comparative Indian Literature, ELT, Media Studies and Advertisement, Ethics and Indian Philosophy, Psychology, Public Policy, Public Administration and Development Studies, Urban and Landscape Studies, Digital Humanities, Journalism, Tourism and Travel, Sociology, Philosophy, Ethics, Higher Education, Spiritual Intelligence, Development Studies, Computer-Mediated Communication, Technology Enabled Learning / Education.

10. **Mathematics:** Coding Theory, Cryptology, Algebraic Geometry, Parallel Computing, Fuzzy Logic and its applications, Water pollution, Mathematical Modelling, Nonlinear functional analysis, Computational fluid dynamics, Optimization, Operations Research, Mathematical Biology, Differential equations, Fractional Calculus, Dynamical System, Epidemiology.

11. **Mechanical Engineering:** Product Design and Development, Manufacturing Engineering, Manufacturing Excellence Practices, Design Engineering, Materials Engineering, Fracture Studies, Non-destructive Testing, Robotics and Intelligent Systems, Nano Technology, Thermal Engineering, Energy Systems Engineering and Energy Management.

12. **Management**: Indian Management Practices, Management Practices in MNC, Cross Cultural Management, Performance Appraisal, Strategic Marketing, Retail, Brand Management, Clustering Methodology, Strategy, Sustainable Development, Evolving Capitalism& Regulations, Project Management, Production Management, Facility Layout Planning, Application of TOC in Operations Management, Supply Chain Management, R&D Management, R&D Performance Measurement, Technology Management, ERP, MIS, E-business, Image Processing, Risk Management, Capital Markets, Quantitative Methods, Business Modeling, Stochastic Modeling of Production Systems, Reliability Analysis & Modeling, Organizational Behavior, Positive Health Psychology, I/O Psychology, Indian Psychology, Innovation and Creativity, Negotiation Skills, Managerial Skills, Entrepreneurship and Health Care Management.

13. **Pharmacy**: Drug Design, Synthesis and Screening of New Bioactive Molecules, Drug Delivery Systems, Phytochemistry and Natural Drugs.

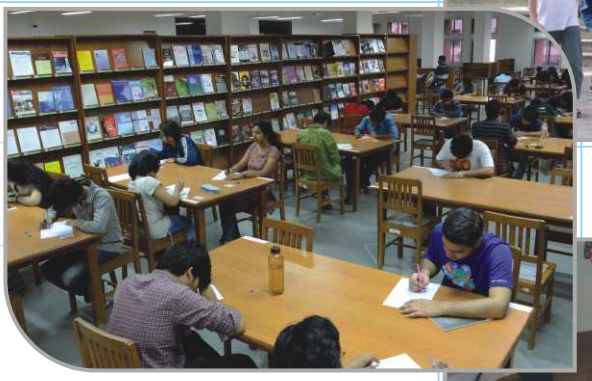
14. **Physics**: Materials Physics; Condensed Matter Physics; Nuclear, Particle and High Enerrgy Physics; Optics & Spectroscopy.

15. **Interdisciplinary Research:** Nanotechnology and nanoscience, Nano-robotics, Micro-electro-mechanical systems (MEMS), Nanomaterials, Mechatronics

16. **Educational Innovation and Institutional Development**

PART III

ADMISSION MODALITY



ADMISSION MODALITY

Admissions are made on an all India basis. English is the medium of instruction for all the programmes in the Institute. Selection is based entirely on candidate's merit, his/her preference, facilities available and availability of seats. Some details of admission modality for all the three tiers of education are described in the following paragraphs.

INTEGRATED FIRST DEGREE PROGRAMMES

Admissions will be made purely on merit. The merit position of the candidate will be based on the score obtained by the candidate in a Computer based Online Test (BITSAT) conducted by BITS, Pilani.

Eligibility for admission:

For admission to all the integrated first degree programmes candidates should have passed the 12th examination of 10+2 system from a recognized Central or State board or its equivalent with adequate proficiency in English. Except for admission to B. Pharm. the candidates should have Physics, Chemistry, and Mathematics as subjects. For admission to B.Pharm., candidates should have Physics, Chemistry, and either Biology or Mathematics as subjects.

The candidate should have obtained a minimum of aggregate 75% marks in Physics, Chemistry and Mathematics subjects (if he/she has taken Mathematics in BITSAT) or a minimum of aggregate 75% marks in Physics, Chemistry and Biology subjects (if he/she has taken Biology in BITSAT) in 12th grade examination, with at least 60% marks in each of the Physics, Chemistry, and Mathematics / Biology subjects.

For **BITSAT–2016,** candidates who fulfill the following conditions are eligible to appear:

- Students appearing for 12^{th} grade examination in 2016.
- Students who have passed the 12^{th} grade examination in 2015 provided they explain the reasons for the gap. The admissions committee will examine all such cases before taking a final decision on their eligibility.
- Students should have taken Physics, Chemistry, and either Mathematics or Biology (PCM/PCB) subjects in 12th class.

Note:

1. Students should have appeared in/ passed the 12^{th} examination of the 10+2 system from a recognized Central/ State board.
2. Students who have passed 12^{th} grade examination in 2015 or previous years and have already joined any other educational Institution for higher studies will be considered for admission under 'Advanced standing' basis, which is explained in the earlier part.
3. Students who are presently studying in BITS at any of its campuses are NOT eligible to appear in BITSAT.
4. The Institute considers only the latest performance through a public examination for admission. If the results of the latest examination are not available within the due date for submission of application, the candidate will not be considered even if there are some earlier performances of 12^{th} class or its equivalent or any higher examination available with him/her. If a candidate has taken more than one attempt in 12^{th} class or its equivalent, only his latest performance is considered, provided this attempt has been for the full component of subjects/courses prescribed.

The mechanism of admission procedure through BITSAT:

(i) Applying for admission:

All candidates who have appeared in BITSAT-2016 and are interested in admission will be required to submit application forms with 12^{th} class marks and programme preferences **before 30th June 2016. All applications are to be filled online.** The filled forms are to be printed and should be posted along with the enclosures to reach the Institute before the deadline, which is **30th June 2016.**

(ii) Preparation of Merit List for Admission:

The merit position of all eligible candidates (i.e., those who have appeared in BITSAT-2016 and have submitted application form for admission in the prescribed format with 12^{th} marks,

preferences and the required fees) will be prepared on the basis of their total scores in BITSAT-2016.

When the BITSAT score of two candidates are the same:

- First their scores obtained in Mathematics/Biology in BITSAT will be considered for separating them.
- If the tie still exists, then their scores in Physics in BITSAT will be considered for separating them.
- Further tie is eliminated using their scores in Chemistry in BITSAT.
- Finally, their PCM total marks in 12^{th} examination will be considered for their separation.

The candidates have to fill only a single application form for seeking admission to all the degree programmes offered at Pilani, Goa and Hyderabad campuses. The candidate's order of preference for different programmes offered at Pilani, Goa, and Hyderabad campuses of the Institute is processed through a computer software and the offers are made accordingly. This may take a few iterations and at each stage, the status is made available to the candidates at the Institute's website www.bitsadmission.com through Internet.

For a candidate to remain in the race, it is mandatory that the following conditions are fulfilled and strictly adhered to by the candidate:

(i) The Data provided by the candidate in the application form with respect to the candidate's background, academic performance, and order of preference for various degree programmes etc. is final.

(ii) The required fees as mentioned in the communication from the Institute are paid in advance and the candidate does not raise any new arguments in this connection.

(iii) A candidate, whether offered admission/ placed on waiting list, cannot withdraw and claim refund of fees once he has entered the competition.

Any candidate who seeks to alter the above conditions in the middle of this process is liable to disqualify himself/herself and forfeit fee as per Institute rules. See the section on 'Advance Fees, Refund and Forfeiture of Fees' later in this part.

(iii) The Actual Mechanism of Admission:

The facilities of the Institute are pronounced invariably in terms of the ratio of seats allotted between the different programmes rather than in terms of a fixed number of seats. The total number of admissions made may vary from year to year. The change in the total number of seats takes place primarily to adjust to the requirements of a highly flexible system which accommodates dual degree, admission with advanced standing, transfer, etc.

In order to reduce the number of iterations, based on earlier experience and on a statistical projection of the responses received, the Institute might make admission offers to a larger number of candidates than the number of seats earmarked.

The computer is programmed to assign the seats starting from the first candidate on the merit list and going down the same until all seats are filled up. At any time when the computer considers a candidate, it first tries to accommodate the first preference of the candidate and goes to his/her second preference if his/her first preference could not be accommodated and so on. Assignments for all programmes are thus completed and immediate admission offers are made.

Based on our past experience, a certain number of candidates would be placed on waiting list. Whenever vacancies arise, the procedure of assignment would be exactly the same as described above. During each iteration, a *de novo* assignment starting from the first candidate in the merit list will be made. Of course, in this operation, candidates who have declined the offer and/or who have not paid fees would be removed from the merit list. It is now clear that in this process not only some of the candidates who are on the waiting list will get an assignment but also certain students who have already got an assignment may now

get a new assignment to one of their higher preference if seats are now available. The waiting list of the Institute has the following characteristics namely:

(i) The cut-off point for the waiting list is arrived at by our past experience in terms of the responses from the candidates, the number and the quality of candidates who have applied in the current year with a view to complete the admissions and start the classes in time.

(ii) Those who are admitted to a programme will continue to be on the waiting list for their higher preferences.

(iii) The waiting list is for admission to the Institute and not for a particular programme, Hence it will not be possible to assign a waiting list number for a student for a particular programme.

(iv) A student who has a higher BITSAT score may be on the waiting list while a student who has a lesser BITSAT score may have got admission because the former crossed out a programme which the later had opted for and seats were available in that particular programme.

(v) Those who cross out a programme not only cease to be candidates for admission to the programme but also for consideration on the waiting list of the programme.

(vi) Those who get offers to be on the waiting list must pay their fees in advance to remain in the waiting list.

Some tips on showing preferences and crossing out: The candidates are strongly advised to exercise their preferences after careful consideration. ***No candidate at any time of the operation can change his/her preferences or refuse to slide up in his/her order of preference till the entire admission process is completed***. If a candidate wishes to join BITS irrespective of the programme so that he can float up until the admission process is complete or he can avail of certain unusual flexibilities like dual degree etc. it would not be in his interest to cross out any programme. The other extreme is where a candidate is absolutely sure of his inclination and such candidates would be advised to show preferences to those limited programmes only and cross out the rest.

Normally a candidate cannot change the preferences once submitted. However, if for any reason a candidate discovers a mistake in his preferences already submitted, he can submit a request for change of preferences in the prescribed format, before the last date for submitting applications. Please see BITS website for details.

Admissions at Pilani campus, K. K. Birla Goa Campus and Hyderabad Campus:

As already announced, admissions to BITS, Pilani- Pilani campus, BITS, Pilani – KK Birla, Goa campus and BITS, Pilani – Hyderabad Campus will be made through a single admission process. In the different admission iterations mentioned in the earlier paragraphs, it is possible that a student who has got an admission offer for a programme in one campus gets slided up for a programme at the other campus in the next iteration. Once a student reports for admission at a particular campus, he remains in the waiting list for the programmes of his higher preferences at the other campuses, till all admissions are finalized. To minimize inconvenience to students, once the student has reported for admission at any one of the campuses, he/she will be given a chance to opt out of the race for the programmes offered at the other campuses and he/she will be considered only for programmes of his/her higher preferences at the campus where he/she has joined. The student has to make the decision on this option on the day of reporting for admission. Further instructions in this regard will be sent to those who have been offered admission.

In all the above matters, the Vice-chancellor's decision shall be final.

Dual degree for students of M.Sc. (Biology, Chemistry, Economics, Mathematics and Physics) programmes: To meet the ambitions of the students who could not get admission to B.E. programmes, the Institute has created facilities by which any student who is admitted to M.Sc. programmes is accommodated in a dual degree scheme for a second degree in B.E. programmes. This assignment is made by competition on their performance at BITS at the end of first year, separately in Pilani, Goa and

Hyderabad campuses. Requirements of both the degrees are structured to be completed normally in five years.

Note: There will be restriction on the availability of flexibility such as transfer and dual degree allotment for students admitted to B. Pharm. programme with PCB input. Since all the first degree programmes other than B. Pharm. programme requires PCM input, no transfer/dual degree allotment is possible with PCB input.

Direct Admission to Board Toppers:

In the past, admission process of the Institute always ensured guaranteed admission to all the students who obtained first ranks in their respective board examinations. This has given a very vital input of highly meritorious students from all over India. Continuing this tradition, the Institute will give direct admission to first rank students of all the central and state boards to the programme of their choice, irrespective of their BITSAT-2016 score.

While the first rank student in PCM stream will be considered for admission to any of the first degree programmes of his/her choice, the first rank holder of PCB stream will be considered for admission to B. Pharm. programme only.

Moreover, they should have obtained the minimum marks in PCM/PCB subjects in 12^{th} examination, as described above. For more details, see the later sections in this part and also the BITS website.

Eligibility criteria for admission under 'Direct admission to Board toppers' scheme:

To be eligible for admission under the 'Direct admission to Board toppers' scheme, the candidate should be the topper from the science stream having taken Physics, Chemistry, Mathematics subjects in 12^{th} standard. To identify the topper the following criteria will be adopted (see below for PCB students).

The topper is the student who fulfills the following criteria:

a) has taken Physics, Chemistry, and Mathematics subjects in 12th class and

b) has obtained the highest aggregate percentage of marks in 12th class among all the students who have taken Physics, Chemistry, and Mathematics subjects in 2016 from the Board. For the purpose of calculating the aggregate percentage, the aggregate marks should include the marks of Physics, Chemistry, and Mathematics subjects in addition to other subjects which are required to pass the 12th examination from the Board under consideration. Further, the Physics, Chemistry, Mathematics subject marks should be included in the aggregate, irrespective of whether the Physics, Chemistry, and Mathematics subjects are identified as main/optional/elective in his marksheet(s).

In the case of first rank candidate of Physics, Chemistry, Biology stream, the criteria is same as above, replacing the word 'Mathematics' with 'Biology' in the above paragraph. However, the first rank holder of PCB stream will be considered for admission to B. Pharm. programme only.

Applicants under the scheme should attach documentary proof in support of their claim, along with the 12th mark sheet and a letter from the Board declaring the candidate as the topper in the specified stream. The Institute will also make efforts to get these data from the different boards on its own. In all cases, the Institute will be guided by the data provided by the concerned Board. In cases where for a particular board, the data available before the deadline is insufficient or inconclusive, the admission committee may decide not to make any offer under the scheme for that specified Board. In all such cases, the decision of the Vice chancellor will be final and binding on the applicants.

The applications are to be made online. The filled forms are to be printed and should be posted along with the enclosures to reach the Institute before the deadline, which is **30^{th} June 2016**. See the BITS website for more details.

Admission of International students through 'International Student Admission (ISA) Scheme':

Candidates holding foreign passport and having valid Scholastic Assessment Test (SAT) and

SAT Subject Tests scores are eligible to apply for admission under "International students scheme" at BITS Pilani-Hyderabad Campus and BITS Pilani-Goa Campus for Academic Year 2016-17. This is another mode of admission for integrated first degree programmes which does not require BITSAT-2016 score. Candidates who have taken SAT and SAT Subject Tests conducted by College Board (USA) can apply for admission to different first degree programmes at Hyderabad and Goa Campus of BITS Pilani for Academic Year 2016-17. Such international candidates should meet the following eligibility criteria.

- Candidates holding passport issued by a country other than India only are eligible under this scheme.
- The candidate should have passed the qualifying examination (grade 12) with Physics, Chemistry, Mathematics and English conducted by the country's or province's Board of Higher/Senior Secondary Education, including those in India, or its equivalent examination recognized by Association of Indian Universities such as the "A" levels (conducted by Cambridge International) or the International Baccalaureate, etc.
- Candidates should be proficient in English.
- The candidate should have obtained a minimum of 75% aggregate marks (or average grade of 7.5 on 10 point scale), in Physics, Chemistry and Mathematics in the above examination. Additionally, he/she should have scored at least 60% marks (or grade of 6.0 on 10 point scale) in each Physics, Chemistry, and Mathematics.
- The candidate should have a minimum aggregate score of 1600 (out of maximum of 2400) in SAT, as also a minimum aggregate score of 1600 (out of maximum of 2400) in SAT Subject Tests in Physics, Chemistry and Mathematics Level 2.
- The candidate should have written the SAT and SAT subject tests not earlier than February 1, 2014.
- Scores of candidates writing SAT as per new format will be mapped using concordance tables available from College Board (USA).

Admissions will be made on merit determined by score obtained by the candidate in SAT Subject Tests in Physics, Chemistry and Mathematics Level 2, subject to candidate meeting above eligibility criteria. For more details on SAT & SAT Subject Tests visit website: www.collegeboard.com. SAT and SAT subject test scores have to be sent to BITS Pilani directly through College Board using the Designated Institution (DI) code: 7759 - BITS Pilani.

Candidates who have passed the qualifying examination in 2015 or 2016 are eligible to apply under this scheme. Students who are appearing in the examination in 2016 are also eligible to apply. For more details please visit http://www.bitsadmission.com/ois.

Preparation of Merit List for Admission (ISA):

The merit position of all eligible candidates (i.e., those who have applied under ISA scheme and have submitted application form for admission in the prescribed format with 12^{th} marks, preferences and the required fees) will be prepared on the basis of their aggregate scores in SAT subject tests (SAT 2) in Physics, Maths, and Chemistry. To resolve tied scores so as to draw up the merit list the following methodology shall be applied in given order: SAT Mathematics Level 2 score, SAT Physics score, SAT Chemistry score, diversity in nationality, number of years of education in a foreign country, and exceptional talent.

Advance fees, Refund and Forfeiture of fees:

For the International students the rules concerning payment of fees and refund thereof are as follows:

1. Candidates offered admission (or provisional admission) to any programme have to pay the required fee within the deadline mentioned in the offer letter. This includes the admission fee and first semester fees.
2. If a candidate does not report for admission on the specified date then his or her admission will be automatically cancelled and the candidate will forfeit the entire

admission fee. The balance of the fees paid by the candidate will be refunded.

3. If the candidate joins the Institute and subsequently withdraws either before the registration for courses or after the registration for courses, he or she will forfeit the entire amount of fees paid by him or her.
4. Candidates placed on the waiting list will have to pay the admission fee of 865 USD and subsequently if admission is offered they should pay first semester fees mentioned in the offer letter within the stipulated time. If admission is not offered to a wait-listed candidate, the entire admission fee will be refunded.
5. If a candidate, who has been placed on the waiting list and has paid the admission fee and is subsequently offered admission, then chooses to withdraw his or her application, he or she cannot claim refund of admission fee.
6. If a candidate with provisional admission offer does not meet eligibility requirements and informs BITS Pilani (or withdraws his application) before date of reporting for admission, s/he will forfeit the admission fees.
7. If a candidate with provisional admission offer does not meet eligibility requirements and informs BITS Pilani after joining the institute, s/he will forfeit the fees as specified in 3 above.
8. While paying fees a candidate cannot stipulate any conditions such as changing order of preferences, addition or deletion of preferences etc. If any such condition is mentioned by the candidate while paying fees, the fee will not be accepted.

Scholarship policy for International students admitted through ISA Scheme:

All International students admitted under the scheme will be provided merit scholarships in the form of tuition fee waiver as follows:

10% of the students will be granted 80% tuition fee waiver, the next 20% of the students will be granted 50% tuition fee waiver, the next 70% of the students will be granted 30% tuition fee waiver. The number of scholarships will depend on the total number of seats for the particular Academic Year in a campus.

Scholarships will be for one semester at a time. Scholarships for the first semester will be decided based on the position in the merit list within foreign students (admitted under International Students Admission scheme). Scholarships will be reviewed in each subsequent semester and will be awarded based on the academic performance of the student at BITS. These students will not be eligible for any other scholarship/aid offered by BITS Pilani but may avail other scholarships. Though the minimum CGPA cutoff for each category of scholarship (80%, 50% or 30% tuition fee waiver), the conditions for scholarship after first semester shall be decided by the Scholarships and Fellowship Committee. The student must maintain the absolute minimum academic performance to be eligible to receive any form of tuition waiver in the subsequent semesters, viz.

a) The student should have a Cumulative Grade Point Average (CGPA) of at least 4.5 at the end of the previous semester/Term.

b) The student should not have obtained more than one 'E grade' or one 'NC report' in the registered courses in the previous semester.

Further, scholarships will be provided only for the normal duration of the programme.

HIGHER DEGREE (PG) PROGRAMMES

Admissions to **Higher degree Programmes** are based on the performance of the candidates in the **computer based online test** and/or written test, group discussions and interviews conducted by BITS at its campuses/any other places. The final selection is based on the performance of the candidates in the tests, group discussions and interviews. The details of test, syllabus for the test, etc., are available at the BITS website, http://www.bitsadmission.com.

Ph.D. PROGRAMME

For admission to the on-campus Ph.D. programme of the Institute, the marks/grades of the candidate in the latest examination as well as his/her performance in a specially designed

admission test and/or interview would be considered.

OFF-CAMPUS Ph.D. UNDER Ph.D. ASPIRANT SCHEME

The Institute offers a unique opportunity for employed professionals working in Industries and R&D organizations and having long experience and proven competence in various fields to work towards Ph.D. degree of the Institute in the settings of their respective work environments. Candidate holding any of the BITS degree or working in an organization collaborating with BITS will normally be considered under this scheme. Industries interested for the development of their manpower at the doctoral level are invited to seek collaboration with BITS and sponsor their suitable candidates along with their applications in the prescribed format.

FOREIGN STUDENTS OR INDIAN STUDENTS HAVING QUALIFICATIONS FROM FOREIGN COUNTRIES

The Institute welcomes foreign students but the admission is strictly made on the basis of merit. There is no separate provision for admission of such candidates and they have to compete with all other candidates, as per the procedure already described above for various degree programmes.

In order to verify the eligibility for admissions, the candidates should enclose, with their application, documents explaining grading/marking system and calculation of cumulative grade point average/ aggregate percentage of marks along with their transcript/ mark sheet. Further the candidates must send a copy of syllabus of courses and rules and regulations for the examinations they have passed well in advance.

Students should request their examining authorities to send the transcript/ mark sheet with relevant documents directly to Dean Admissions, BITS, Pilani - 333031, Rajasthan-India so as to reach him before the deadline.

A specially appointed committee examines all applicants with foreign qualifications regarding their eligibility for admissions.

Graduates of BITS

Candidates who come with a degree where the structure and the features of the programme are similar to that of BITS are naturally ready to fit more effectively into the BITS educational system. This experience prompts the Institute often to describe the prior preparation for another degree in the same tier or a degree in a higher tier in terms of not only a minimum qualification but also specific courses which they should have done.

Admission with advanced standing

For details refer to the section on flexibilities in the previous part.

Admission with marginal deficiency

For details refer to the section on flexibilities in the previous part.

Casual Students

Persons, other than regular students of BITS who desire to register for some courses to update their knowledge are designated as casual students. Casual students can register for courses on audit only and cannot enroll for a degree. The facility of taking a course on audit is principally conceived to give an opportunity to a person to update his knowledge and he cannot claim acceptance of such a course for the fulfillment of requirements of any programme, current or future.

This scheme has been devised to take care of professionals from various industries and organizations who express a desire to update their knowledge, although they, ipso-facto, have no desire to work for a degree.

Persons desiring to register as casual students should apply on the prescribed form within the last date.

Whenever such a student is admitted he may be allowed to continue as a student for a maximum period of eight registered semesters. However, he should request at the end of every semester for permission to continue him as a casual student in the succeeding semester.

The Institute may offer direct admission to a limited number of children of the staff of BITS and BET and also to some meritorious students

from the schools of BET in Pilani to non-professional programmes with a proviso that the students admitted to these programmes will not be eligible for any of the flexibilities like transfer to and dual degree in any of the professional programmes.

INFORMATION FOR CANDIDATES

(To be read in conjunction with the instructions given in the application form and any other communications sent from the Institute).

APPLICATION PROCEDURE

Application for admission should be made on the prescribed form. Separate application forms are prescribed for (i) Integrated First Degree Programmes (ii) Higher Degree Programmes (iii) MBA Programmes (iv) Doctoral Programmes.

(i) Integrated First degree Programmes:

In order to apply for admission to the Integrated First Degree programmes, the candidate should have appeared in the online computer based test (BITSAT) as per the announcement made by the Institute through separate advertisement and brochures. The last date for registering for BITSAT-2016 is 5th March 2016 and BITSAT-2016 tests are scheduled between 14th May and 28th May 2016.

In addition to the application made earlier for registering for BITSAT test, they should apply for admission by submitting the prescribed form, complete in all respect, so as to reach the Institute before the deadline, i.e., 5:00 PM on 30th June 2016.

The application forms are available at the BITS admission website (i.e. www.bitsadmission.com) and are to be filled online. The print out of the filled forms should be sent to the Institute along with receipt of payment towards fee of FD admission application form of Rs. 400/- (Non-refundable) only with each form.

Last Date for Submission of Completed application for Integrated First degree Programmes:

30th June 2016 (5.00 P.M.)

(ii) Higher Degree and Ph.D. programmes:

Interested and eligible candidates should apply through the prescribed application form available online at **http://www.bitsadmission.com/** and take the printout of the filled form and submit the filled form to the Institute before the deadline mentioned below. The filled form should be accompanied by requisite fee of Rs. 2200/- for higher degree and Ph.D. programme.

Last Date for Submission of Completed applications:

First Semester: 5.00 P.M. on 19th May 2016

Second Semester: 5.00 P.M. on 30th November 2016 (Refer to section on Flexibilities in the previous part).

Some Important Instructions

1. The application process, announcement of results after each iteration, detailed instructions etc. are all announced at BITS website during the various stages of the admission process. It is the responsibility of the candidate to follow these announcements and instructions.
2. Application forms sent by FAX or Email will not be accepted.
3. The number on your application form is unique. Quote this application number in all subsequent correspondence with the Institute.
4. If you are accepting the offer of admission/ accepting to be placed on the waiting list you will be required to pay fees in advance, as per the instructions mentioned along with the offer.
5. Whenever admissions are made in the second semester a separate notification to this effect will be issued. Applications for second semester admission should be submitted only after such a notification.
6. If you desire to be considered for the award of Institute merit-cum-need scholarships, you will be required to submit an income

certificate showing gross income of your Parents/Guardian, duly signed by the 1st Class Magistrate/Notary Public. Persons in service should submit a certificate from employer showing separately basic salary and other allowances.

Enclosures with Application

Applications for admission to integrated first degree programmes should be accompanied by the following documents:

1. An attested photocopy of the X pass/ Matriculation/Secondary School certificate issued by the Board.
2. An attested photocopy of the marksheet of the qualifying and any other higher University/Board examinations passed.

The BITSAT score for each of the candidate will be taken from the Institute records.

SELECTION FOR ADMISSION

Candidates are finally admitted to the Institute subject to the following conditions:

1. They have paid the requisite fees asked for in their admission/waiting list letters.
2. They are declared medically fit by a registered medical practitioner.
3. They have submitted all required original mark sheets & certificates, with photocopies, and the statements made in their application forms are verified against their originals.
4. They fulfill the eligibility requirements.

For Integrated first degree programmes, on the reporting day at Pilani/Goa/Hyderabad, a Dean/Senior faculty member of the Institute will interact with the candidates. If any candidate fails to be personally present on that day, his admission will stand automatically cancelled.

Every admitted student is required to undergo a registration process on the day announced for the purpose. One of the objectives of the registration process is to name the courses to be pursued during a given semester, after allowing for the student's options within the prescribed rules and regulations. By this process, each student makes his own Time Table at his own responsibility, to be followed in that semester. **No student will be permitted to attend classes or use any of the Institute facilities without completing the registration process.**

Advance fees, Refund and Forfeiture of fees:

In the Integrated First Degree programmes, a candidate selected for admission/placed on the waiting list through BITSAT will be required to pay fees in advance subject to the following conditions:

1. If a candidate is offered admission to any programme of his/her preference as specified in the application form, he/she has to pay admission fee of Rs. 28,050/- and requisite one semester tuition fee of Rs. 1,13,300/- within the stipulated deadline. However, if a candidate is placed on the waiting list, he/she has to pay only admission fee of Rs. 28,050/- in advance and subsequently, if he/she is offered admission he/she has to remit the semester tuition fee of Rs.1,13,300/- as announced in the wait list offer.
2. (a) If a candidate, who is offered admission, accepts the offer by remitting the above fees but fails to report at the Institute on the date specified
   i. He/she will forfeit the total fee (Admission fee Plus the one semester tuition fee fees) of Rs. 1,41,350/- paid by him/her if the seat that falls vacant* due to his/her withdrawal is not filled up.
   ii. In case the seat that falls vacant* due to his/her withdrawal is filled up, the fees collected from the student will be refunded after deducting a processing fee of Rs 1000/-
   iii. If a candidate in wait list, is offered admission, but does rejects the offer by not remitting the semester tuition fee of Rs 1,13,300/-, he/she will forfeit the admission fee if Rs 28,050 paid by him/her if the seat that falls vacant due to his/her withdrawal is not filled up.

   b) If a candidate accepts the admission offer but withdraws after reporting to the assigned campus on the specified date, he/she will forfeit the admission fee of Rs. 28,050. Further

i. He/she will forfeit the one semester fees of Rs. 1,13,300/- paid by him/her if the seat that falls vacant* due to his/her withdrawal is not filled up.

ii. In case the seat that falls vacant* due to his/her withdrawal is filled up, he/she will forfeit part of the semester tuition fee of Rs. 1,13,300/- paid by him/her in proportion to the time spent on campus.

* When a candidate withdraws from the Institute, the seat falling vacant in the programme to which he/she was admitted will be attempted to be filled up in next iterations. In the iteration process, the vacant seat might be filled up by another already admitted candidate due to slide up process. This may create a vacancy in another programme/campus. If this vacancy in any programme/ campus is not filled up till the admission process is concluded then it will be treated as a vacant seat.

3. If the Institute is not able to offer admission to a wait-listed candidate in any of programmes of his/her preferences as specified in his/her application form, the total amount of fee paid will be refunded to him/her in due course of time.

4. A candidate who accepts an offer of admission or who accepts to be placed on waiting list by paying the requisite fees (as above) cannot subsequently withdraw from the admissions process that involves “sliding up” (or re-assigning a programme and/or campus depending upon his his/her preferences). Should he/she do so, he/she will forfeit the fees paid by him/her as per clauses and above. The refund of balance fee, if any, would be done in due course of time after the complete admission process is over.

5. While remitting fees, no candidate can stipulate any conditions such as changing order of preferences, addition/deletion of preferences etc. Even if any such conditions are mentioned while remitting fees, these will be ignored.

For higher degrees, conditions stipulated in the Instructions sheet sent to the shortlisted candidates, will be applicable.

The Institute reserves the right to refuse admission to any candidate without assigning any reason. The decision of the Vice-chancellor in the matter of admission and allotment of programmes of study shall be final.

Instructions for Payment

1. The schedule of fees given below is for a normal situation. Wherever a student's programme gets modified or his progress is delayed beyond the maximum permissible time, such a student is advised to consult the appropriate authority before registration.

2. The below mentioned schedule of fees is applicable for all the students admitted in July 2011 or after. All students admitted earlier than July, 2011 will continue to be governed by the schedule of fees as shown in the bulletin corresponding to their year of admission. However, it should be clear that they will have to pay along with the new students the same amount of fees for students' union fee, students' aid fund, hostel fee and mess & electricity advance.

3. The fees and other charges are payable in advance in each semester/term on the notified dates before registration. No withdrawal from a course or courses will entitle a student for refund of fees.

4. Students who go for Practice School II will be charged semester fees and the summer term fees because the practice school is longer than a semester and extends in to summer.

5. Casual students will pay fees prescribed for regular students.

6. Institute caution deposit is refundable only at the time of graduation or withdrawal from the Institute.

7. If there are dues outstanding from a student, his grades will be withheld.

8. Mess dues are to be cleared by each student every month. Students who accumulate mess arrears would be required to pay a prescribed additional advance at the time of next registration.

9. Refunds, if any, will be made through crossed cheques/Bank drafts.

SCHEDULE OF FEES#

A. The following is the details of the fees payable by all students admitted in the academic year 2016-2017 at **BITS-Pilani, Pilani Campus.**

Fees	Integrated First Degrees	Higher Degrees	Ph.D. Programme	
			Full Time	**Part Time**
Admission Fees$	28,050/-	28,050/	28,050/-	28,050/-
Semester/Term Fees$				
First Semester	1,13,300/-	1,13,300/-	11,330/-	22,660/-
Second Semester	1,13,300/-	1,13,300/-	11,330/-	22,660/-
Summer term	39,700/-	39,700/-	3,970/-	7,940/-
Students' Union fee	450/- pa	450/- pa	—	
Students' Aid Fund	225/- pa	225/- pa	225/- pa	225/- pa
Hostel fee (for on-campus students only)				
First Semester	9000/-	9000/-	9000/-	
Second Semester	9000/-	9000/-	9000/-	
Summer term	4500/-	4500/-	4500/-	
Ph.D. thesis examination fees	-	-	22,060/-	22,060/-
Mess & Electricity advance				
First Semester	10000/-	10000/-	10000/-	
Second Semester	10000/-	10000/-	10000/-	
Summer term	5000/-	5000/-	5000/-	
(Payable at the beginning of each semester/term and adjustable at the end of the same)				
Institute Caution Deposit	3000/-	3000/-	3000/-	3000/-
Fee for Eligibility Test(s)/Ph.D. Qualifying Examination	Institute reserves its right to charge such a fee, which would be adjustable against admission fees if the candidate secures admission			

B. The following is the details of the fees payable by all students to be admitted in the academic year 2016-2017 at **BITS-Pilani, K. K. Birla Goa Campus.**

Fees	Integrated First Degrees	Higher Degrees	Ph.D. Programme	
			Full Time	**Part Time**
Admission Fees$	28050/-	28050/-	28,050/-	28,050/-
Semester/Term Fees$				
First Semester	1,13,300/-	1,13,300/-	11,330/-	22,660/-
Second Semester	1,13,300/-	1,13,300/-	11,330/-	22,660/-
Summer term	39,700/-	39,700/-	3,970/-	7,940/-
Students' Union fee	450/- pa	450/- pa	—	
Students' Aid Fund	225/- pa	225/- pa	225/- pa	225/- pa
Hostel fee (for on-campus students only)				
First Semester	12000/-	12000/-	9000/-	
Second Semester	12000/-	12000/-	9000/-	
Summer term	6000/-	6000/-	4500/-	
Ph.D. thesis examination fees	-	-	22,060/-	22,060/-
Mess & Electricity advance				
First Semester	10000/-	10000/-	10000/-	
Second Semester	10000/-	10000/-	10000/-	
Summer term	5000/-	5000/-	5000/-	
(Payable at the beginning of each semester/term and adjustable at the end of the same)				
Institute Caution Deposit	3000/-	3000/-	3000/-	3000/-
Fee for Eligibility Test(s) / Ph.D. Qualifying Examination	Institute reserves its right to charge such a fee, which would be adjustable against admission fees if the candidate secures admission			

C. The following is the details of the fees payable by all students to be admitted in the academic year 2016-2017 at **BITS-Pilani, Hyderabad Campus.**

Fees	Integrated First Degrees	Higher Degrees	Ph.D. Programme	
			Full Time	**Part Time**
Admission Fees$	28,050/-	28,050/-	28,050/-	28,050/-
Semester/Term Fees$				
First Semester	1,13,300/-	1,13,300/-	11,330/-	22,660/-
Second Semester	1,13,300/-	1,13,300/-	11,330/-	22,660/-
Summer term	39,700/-	39,700/-	3,970/-	7,940/-
Students' Union fee	450/- pa	450/- pa	—	
Students' Aid Fund	225/- pa	225/- pa	225/- pa	225/- pa
Hostel fee (for on-campus students only)				
First Semester	12,000/-	12,000/-	9000/-	
Second Semester	12,000/-	12,000/-	9000/-	
Summer term	6,000/-	6,000/-	4500/-	
Ph.D. thesis examination fees	-	-	22,060/-	22,060/-
Mess & Electricity advance				
First Semester	10,000/-	10,000/-	10000/-	
Second Semester	10,000/-	10,000/-	10000/-	
Summer term	5,000/-	5,000/-	5000/-	
(Payable at the beginning of each semester/term and adjustable at the end of the same)				
Institute Caution Deposit	3,000/-	3,000/-	3000/-	3000/-
Fee for Eligibility Test(s) / Ph.D. Qualifying Examination	Institute reserves its right to charge such a fee, which would be adjustable against admission fees if the candidate secures admission			

Notes: (Applicable to Pilani, Goa and Hyderabad Campus candidates):

1.$ The above prescribed semester fees is for students admitted in the academic year 2016-17. For these students, the semester, term and admission fees will be revised upwards every year, but will not increase beyond 15% each year (unless the government announces any new levy/tax, which will be passed on to all existing students irrespective of their year of entry)

2. If a student is admitted to a second degree programme under dual degree scheme, he/she has to pay admission fees of the second programme at the time such admission is made.

3. Course-wise Fees (Per Course): Rs. 2325 (*Applicable to only certain limited courses outside academic* requirement after paying full semester fees. No semester fee is computable on the basis of course wise fees).

4. If any continuing student is also admitted to a minor programme, he/she has to pay a fee of Rs. 14000/- for AY 2016-17 in addition to fees for the semesters / summer terms enrolled in. The fee is payable in two installments – Rs.7000/- at the time of admission and Rs. 7000/- on completion of requirements. Admission fees for minor programme will be revised in subsequent years as per Institute norms.

5. All fees are to be paid in advance. Only caution deposit and mess advance are refundable after adjustment of dues at the time of graduation or withdrawal from the Institute. This applies to prospective candidates who are seeking admission as well as ongoing students of the Institute.

5.# For some specific programs requiring special treatment, fees and mode of their payment will be determined by the Vice-Chancellor in consultation with the Chancellor**.**

SCHEDULE OF FEES UNDER INTERNATIONAL STUDENTS ADMISSION SCHEME

The following is the details of the fees payable at the time of Admission by the students admitted under International Students Admission scheme for First Semester, 2016-2017 at BITS-Pilani, Hyderabad/Goa Campus.

Description of Fees Details	**(All figures in USD**
Application Fees	**50**
Admission Fees	**865**
Facilitation Fees (covering charges for local travel, room and board during "orientation" in 1st month)	**215**
Institute Caution Deposit (Refundable on graduation or leaving the Institute, after adjusting all dues).	**500**
Students' Union, Student Aid Fund for AY 2015-16	**60**
First Semester Tuition Fees *	**5020**
First Semester Hostel Fees and Internet Charges*	**430**
First Semester Mess and Electricity Advance (this is adjusted against mess and electricity bills at the end of semester).	**270**
Total (excluding Application Fees)	**7360**
Less Merit Scholarship @30% (minimum) of Tuition Fees	**1506**
Net payment required at the time of Admission with minimum tuition Fee waiver @30%	**5854**

*The above prescribed semester fees are for students admitted in the academic year 2016-17. For these students, the semester, term and admission fees will be revised upwards every year, but will not increase beyond 10% each year (unless the government announces any new levy/tax, which will be passed on to all existing students irrespective of their year of entry).

SCHOLARSHIPS

A large number of scholarships, fellowships and other financial assistance are available to the students of the Institute. Past experience shows that about 30% of the students receive some form of financial assistance or other. For continuance of scholarships, scholarship holders are required to maintain good scholastic standing and good conduct.

Some of the scholarships/financial assistance normally available are listed below:

1. Institute's own merit or merit-cum-need awards for students:

   (a) For FD students admitted from the academic year 2011-12 onwards these may cover 80% reimbursement of semester fees for 1% and 40% of semester fees for 2% students under merit based scholarship while 3% students will receive the reimbursement of 80%, 6% students will get 40% and 12% students will get 25% of their semester fees under merit-cum-need awards. There will be no waiver of admission fee.

   All awards are made for one semester only and their continuance in the subsequent semester(s) will depend on the candidate's performance in the institute and his/her needs.

   (b) The fee-waiver for Higher Degree (HD) and Ph.D. students will be merit based only. 50% of ME/M Pharm/M Phil students and 25% of MBA students may receive 40% of fee waiver.

   HD and Ph.D. students may also get monthly stipend which again will be merit based and will be in the form of assistantship for which they will be required to devote 10 hours/week for assisting in teaching/research or in administration. 50% of ME/M Pharm/M Phil and 25% of MBA students may get a monthly stipend of Rs. 11200. 50% of full time Ph.D. Students without any other aid may get stipend given by the institute. Ph.D. stipends are Rs.13200 and Rs.18200 respectively for candidates with First Degree and Higher Degree of BITS or equivalent input qualifications.

   The Institute's decision on these awards/stipends is entirely worked out by the Institute's own pre-declared procedure and is not dependent on the nationally conducted tests such as GATE, etc.

2. Students admitted to Higher degrees and Ph.D. will also be recommended for award of scholarships /Fellowships from various sources like UGC, CSIR, DST, DBT, ICMR, etc. These Scholarships are operated as per rules & regulations stipulated by the awarding authorities. Students admitted to higher degree programmes and who are qualified in GATE may apply to the UGC for the GATE scholarship and the Institute will forward such applications to the UGC. It should be noted that the decision regarding award of the GATE scholarship to admitted students is made by UGC as per its existing norms and the Institute cannot guarantee such awards.
3. Scholarships under National Talent Search/ National Science Talent Search Schemes.
4. Government of India National Scholarships.
5. Merit Scholarships, Merit-cum-need Scholarships and Need-cum-Merit Scholarships awarded by State Governments.
6. Government of India Scholarships for Scheduled Caste and Scheduled Tribe students.
7. National Scholarships to the children of Primary and Secondary School teachers.
8. Scholarships from various charitable trusts.
9. Financial assistance from Students Aid Fund.
10. The Ministry of Non-conventional Energy Sources (MNES), Govt. of India has sanctioned two research fellowships to the Institute for advanced study in the area of Renewable Energy.
11. HP Lab India provides three doctoral fellowships of Rs. 40,000/- p.m.
12. Microsoft Research India provides one

doctoral fellowship of Rs. 17,000/- p.m.

13. Students can also participate in the nationwide competitions for prestigious scholarships such as Aditya Birla Scholarship, Lucent Global Science Scholars Program and GE Fund India Scholarship.

14. Goldmann Sachs Global Leader Scholarship of US $ 3000.

15. Financial Assistance from BITS Alumni. BITS and BITSAA International Travel Fellowship is co-sponsored by the Institute and BITSAA International. Meritorious students are supported with 75% of travel cost for traveling abroad for presenting selective papers at international conferences.

STUDENT RECORD

The students' records are computerized and a grade sheet for each semester is issued to the student normally within one week after the comprehensive examination.

The grade sheet will be withheld when a student has not paid his dues or when there is a pending case of breach of discipline or a case of unfair means against him.

The Institute issues a transcript (an up-to-date performance of a candidate from the date of his entry to the date of his leaving the Institute) to all the passing out candidates at the end of each semester/summer term normally within four weeks of the last examination. The provisional certificate and a cheque for refund of deposits in the Institute are also issued at the same time. This estimate is based on an assumption that each candidate has ensured by prior initiative that there is nothing pending against him on academic, financial and disciplinary matters.

Since all student records are computerized, each student is assigned a unique identification number (ID No.) which is constructed by building in the number certain information to assist in data storage and data retrieval. No two ID numbers are ever identical.

Degree programmes are assigned codes as below and the ID No. carries the degree programme code(s) along with other information such as year of admission, whether in Practice School (PS) or Thesis (TS) stream and the last character indicates the campus which a student belongs to For example, 2015A1PS350P refers to a student admitted in 2015-16 to B.E. Chemical Engineering (with Practice School) programme at Pilani Campus. The higher degree students are assigned ID No. indicating whether the candidate is in PS stream (K1) or in the Dissertation (H1) stream. For example, 2015K103350P refers to a student admitted in 2015-16 to M.E. Computer Science (with Practice School) programme at Pilani Campus.

Programme Codes

First Degree Programmes	
B.E. Chemical	A1
B.E. Civil	A2
B.E. Electrical & Electronics	A3
B.E. Mechanical	A4
B. Pharm.	A5
B.E. Computer Science	A7
B.E. Electronics and Instrumentation	A8
B.E. Biotechnology	A9
B.E. Electronics & Communication	AA
B.E. Manufacturing Engineering	AB
M.Sc. Biological Sciences	B1
M.Sc. Chemistry	B2
M.Sc. Economics	B3
M.Sc. Mathematics	B4
M.Sc. Physics	B5
M.Sc. General Studies	C2
M.Sc. Engineering Technology	C5
M.Sc. Information Systems	C6
M.Sc. Finance	C7
Higher Degree Programmes	
M.E. Biotechnology	29

M.E. Chemical	01
M.E. Chemical with specialization in Petroleum Engineering	32
M.E. Civil with specialization in Structural Engineering	43
M.E. Civil with specialization in Transportation Engineering	30
M.E. Civil with specialization in Infrastructure Engineering & Management	44
M.E. Civil with specialization in Water Resources	11
M.E. Communication Engineering	24
M.E. Computer Science	03
M.E. Design Engineering	41
M.E. Electrical with specialization in Power Electronics & Drives	31
M.E. Embedded Systems	40
M.E. Manufacturing Systems Engineering	42
M.E. Mechanical	06
M.E. Mechanical with specialization in Thermal Engineering	48
M.E. Microelectronics	23
M.E. Software Systems	12
M.Pharm.	08
M.Pharm. with specialization in Pharmaceutics	46
M.Pharm. with specialization in Pharmaceutical Chemistry	47
M.B.A.	49
MPH	37

RULES AND REGULATIONS

All students admitted to the Institute will be governed by the Rules and Regulations that are prescribed from time to time.

Anti-Ragging

The Institute has formulated strict anti-ragging guidelines and all students are required to sign an undertaking to abide by these guidelines. Students, if found violating these guidelines are liable to disciplinary action including expulsion from the Institute and also possible legal action as per the directive from the Honourable Supreme Court of India.

The Institute has formed a committee and anti-raging squads at hostel and institute level to combat raging. The students can also communicate directly with the Dean, Students Welfare, through the Institute website.

INFORMATION FOR CANDIDATES FOR ALL OFF-CAMPUS PROGRAMMES

Prospective candidates must consult the separate section in the Institute Bulletin. They should note that a separate application form is provided for admission to Off-Campus programmes. It is further to be noted that all rules, regulations will automatically apply in the Off-campus programmes. Information about these can also be obtained at http://www.bits-pilani.ac.in/university/wilp/ wilpoverview

INFORMATION FOR CANDIDATES APPLYING FOR BITS PILANI - DUBAI CAMPUS

Admissions to Dubai Campus are made on merit in qualifying examinations. All equivalent international qualifications are considered. A specially appointed committee examines all applicants with foreign qualifications regarding their eligibility for admissions.

For educational process and programmes of studies, refer section II. For candidates admitted from countries other than UAE, student residence visa is facilitated.

APPLICATION PROCEDURE

Application for admission to Dubai Campus should be made on the prescribed form available at: www.bits-pilani.ac.in/dubai. Separate application forms are prescribed for (i) Integrated First Degree Programmes (ii) Higher Degree, MBA Programmes (iii) Doctoral Programme.

INTEGRATED FIRST DEGREE PROGRAMMES

Admissions are made purely on overall aggregate in the qualifying examination (12^{th} Grade or its equivalent examination), secured

by the candidate. Admission is offered based on merit, seats in the preferred discipline and facilities available.

Eligibility for admission

For admission to all integrated first degree programmes, the eligibility requirement is a minimum of 60% overall aggregate* marks in the qualifying examination and a minimum aggregate of 60% in the Physics, Chemistry and Mathematics subjects with at least 50% marks in each subject in the Senior School Certificate Examination of the Central Board of Secondary Education (CBSE-12th grade), New Delhi, India, or its equivalent from any recognized International, National, or State examination with adequate proficiency in English. However, for admission to B.E Biotechnology, candidates with Physics, Chemistry and Biology will also be accepted with a minimum aggregate of 60% in Physics, Chemistry & Biology subjects with at least 50% marks in each subject.

** Aggregate: Aggregate is the total marks of all subjects in the Qualifying Examination, considered essential by the Board/University for passing the examination. The Aggregate must compulsorily contain the required subjects, namely, Physics, Chemistry and Mathematics.*

The mechanism of admission for Dubai Campus:

Applying for admission:

(i) In order to apply for admission to the Integrated First Degree programmes, the candidate should submit the application in prescribed form. The application form is available at the website: www.bits-dubai.ac.ae/admission and can be filled online. The printout of the filled form should be sent along with an Admission Application fee of AED 220/- only, complete in all respects, so as to reachp Dubai Campus by the due date: 14 June 2016 for First Semester 2016-17 and 15 December 2016 for Second Semester 2016-17:

(ii) The candidate has to fill only a single application form for seeking admission to all the degree programmes offered at Dubai Campus.

Preparation of Merit List and Admission process:

(i) The merit list will be prepared on the basis of aggregate percentage of marks obtained by the candidates in the Qualifying Examination (12th grade or equivalent), for all eligible candidates, whose application, complete in all respects with 12th marks, preferences and required fees, is received till last date.

(ii) If a candidate with a higher merit position is not able to get any of his/her programme preference due to non-availability of seats in the indicated preferences, such a candidate is kept in Waiting List. For a candidate to secure the seat or remain in the race, it is mandatory to pay the required fees in advance as mentioned in the Admission/Wait list letter.

(iii) Normally a candidate cannot change the preferences once submitted. Candidates are strongly advised to exercise their preferences after careful consideration and give preference for all programmes to better the chances of admission.

(iv) Admission Offer letter is sent to candidates above the cut-off of merit. To accept the offer of admission, candidate must comply with all the requirements specified in the Admission Offer letter including submission of various documents and payment of fee on or before the date mentioned in the Admission Offer letter. If the requirements are not met by the specified due date, the admission offer letter will be deemed to be cancelled and the seat will be allotted to Wait List candidates.

HIGHER DEGREE PROGRAMMES

The Higher Degree Programmes offered at Dubai Campus are uniquely designed and structured to meet the learning aspirations of Engineers, who are employed Executives,

Entrepreneurs and Professionals. The admission is based on the performance of the candidate in the qualifying degree and Admission test.

Admissions to Higher Degree Programmes are done in both the semesters. Candidates interested in applying can fill the application form online or collect the application form from the Admissions Office of Dubai Campus. Deadline for submission of Application form is 9 June 2016 for First Semester 2016-17 and 15 December 2016 for the Second Semester 2016-17.

DOCTORAL PROGRAMME (Ph.D.)

The Doctoral programme is offered in Engineering and allied interdisciplinary areas. A candidate with a higher degree: namely M.E./M.S./M.B.A./ M.Phil. of BITS Pilani or its equivalent from any other recognized university can apply for the doctoral programme.

For admission to the Ph.D. programme, the marks/grades of the candidate in the latest examination as well as the performance in a specially designed admission test and/or interview would be considered.

Admissions to Doctoral Programme are done in both the semesters. Candidates interested in applying for Doctoral Programmes can collect the application form from the Admissions Office or download it from the website: www.bits-dubai.ac.ae/admission. Deadline for submission of Application form is 9 June 2016 for First Semester 2016-17 and 15 December 2016 for the Second Semester 2016-17.

FLEXIBILITIES FOR FIRST DEGREE PROGRAMMES AT DUBAI CAMPUS

The educational process permits multiple entry points into the programmes and allows several other flexibilities. As in the admission process, the decision for use of flexibilities is guided by the principle of merit, preferences and facilities available.

Practice School, Dual Degree and Transfer

For details, refer to the section on flexibilities in the previous part.

Admission with Advanced Standing

For details, refer to the section on flexibilities in the previous part and the website: www.bits-pilani.ac.in/admission.

Second Semester Admission

The structural flexibilities available in the Institute make it possible to admit students in both the semesters. However, most of the admissions are made during the first semester itself. The second semester admissions provide opportunity to candidates who could not apply in time for the first semester admissions.

The second semester admission students are merged with the students admitted in the first semester. They may be doing courses with the students admitted in the same academic year or in the next academic year. The total normal duration of programme will be eight semesters.

A separate admission notification for second semester admissions will be issued in October 2016.

Other Flexibilities

For details, refer to the section on flexibilities in the previous part

Some Important Instructions

1. The application process, announcement of admission, detailed instructions, etc., will be available at Dubai Campus website. It is the responsibility of the candidate to follow these announcements and instructions.
2. Application forms sent by Fax or Email will not be accepted.
3. The application number allotted to you on submission of application form is unique. Quote this application number in all subsequent correspondence.
4. To accept the offer of admission/accepting to be placed on the waiting list, you are required to pay fees in advance, as per the instructions mentioned along with the offer.

SELECTION FOR ADMISSION

Candidates are finally admitted to the Dubai Campus of BITS Pilani subject to the following conditions:

1. They have paid the requisite fees as specified in their admission/waiting list letters.
2. They are declared medically fit by a registered medical practitioner and local medical examination, if required.
3. They have submitted all required original marksheets & certificates, with photocopies, and the statements made in their application forms are verified against their originals.
4. They fulfil the eligibility requirements.
5. They have or shall get a UAE residence visa. Any student not having a valid residence visa, at any time during the study, will not be permitted to register.
6. For Integrated first degree programmes, on the reporting day at Dubai, a Dean/Senior faculty member of the Institute will interact with the candidates. If a candidate fails to be personally present on that day, his/her admission will stand automatically cancelled.
7. Every admitted student is required to undergo a registration process every semester, on the day announced for the purpose. One of the objectives of the registration process is to name the courses to be pursued during a given semester, after allowing for the student's options within the prescribed rules and regulations. By this process, students make their own Time Table at their own responsibility, to be followed in that semester. No student will be permitted to attend classes or use any of the Dubai Campus facilities without completing the registration process.

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Advance fees, Refund and Forfeiture of fees

1. A candidate offered admission/placed on the waiting list will be required to pay all requisite fees in advance.
2. If a candidate is offered admission either directly or from the waiting list but does not join the Institute, then the refund will be based on the following:
   i. If a candidate completes the admission formalities but withdraws before the date of registration, the admission will automatically stand cancelled and 80% of first instalment of first semester tuition fees is refundable.
   ii. If a student joins and subsequently withdraws within one week of the date of registration, 50% of the first instalment of first semester tuition fee will only be refundable.
   iii. If a student joins and subsequently withdraws after one week of the date of registration, the entire first instalment of first semester tuition fees paid will be forfeited.
   iv. If the Institute is not able to offer admission to a Waitlisted candidate to any programme of preferences as shown in his application form, the total amount of advance fees will be refunded.
   v. While remitting advance fees no candidate can stipulate any conditions such as changing order of preferences, addition/ deletion of preferences etc. Even if any such conditions are mentioned while remitting fees, they will be ignored.
   vi. Application Fee, Admission Fee and all Visa related fees are non-refundable.

   For hostel and transport fees, conditions stipulated in the Admission Bulletin will be applicable.

SCHEDULE OF FEES

D. The following are the details of the fees payable by all students to be admitted in the academic year 2016-17 at **BITS Pilani, Dubai Campus** (all figures are in AED).

Fees	Integrated First Degree	Higher Degree	Ph.D. Programme
Application Fees	220	220	220
Admission Fees	1600	1600	1600
Activity Fees	1000	1000	1000
Caution Deposit	5000	2000	2000
Semester/Term Fees			
First Semester	20000	15000	12000
Second Semester	20000	15000	12000
Summer Term	5000		
Hostel fee			
First Semester	15000	15000	15000
Second Semester	15000	15000	15000
Summer Term	5200	5200	5200
Hostel Caution Deposit	2000	2000	2000
Facility Fee	750	750	750
Visa related fees (if visa required)			
Fresh Visa Fee	2700	2700	2700
Visa Renewal Fee	2100	2100	2100
Medical Insurance Fees	1550	1550	1550
Transport Fees			
For Dubai	1750	1750	1750
For Sharjah & Ajman	2000	2000	2000

Notes:

1. Caution deposits are refundable after adjustment of all dues on graduation or on leaving the institute.
2. Visa fee payable annually and is subject to change by Government of U.A.E.
3. If a student is admitted to a second degree programme under dual degree scheme, he/she has to pay admission fees of the second programme at the time such admission is made.
4. A fee of AED 3000 per course is applicable for casual students registering for any course on audit only during any semester apart from a one-time Admission fee.
5. The fees and other charges are payable in advance in each semester/term on the notified dates before registration. Non-payment of fees and dues may result in semester registration cancellation. No withdrawal from a course or courses will entitle a student for refund of fees.
6. If there are dues outstanding grades will be withheld.
7. Refunds, if any, will be made through Bank Transfers/ Bank drafts.

SCHOLARSHIPS AT DUBAI CAMPUS

A large number of scholarships, fellowships and other financial assistance are available to the students admitted to Dubai Campus. Experience shows that more than 25% of the students receive some form of financial assistance. For continuance of scholarships, scholarship holders are required to maintain good scholastic standing and good conduct.

All awards are made for one semester only and their continuance in the subsequent semester(s) will depend on the candidate's performance in the institute.

Some of the scholarships/financial assistance normally available are listed below:

Merit Scholarships for First Degree Students

(a) New Admission students

1. **Board Toppers:** Top three ranks (First, Second and Third position) in 12th standard in their respective boards (General Secondary Education Certificate Examination of Ministry of Education, UAE or CBSE-India or any other State, National or International Board) get a merit scholarship of 100%, 75% and 50% of the first semester tuition fee, respectively for the first semester.
2. **Merit in Qualifying Examination:** Students who have obtained aggregate marks of above 80% but less than 90% in the Qualifying Examination are given a merit scholarship of 15% of first semester tuition fee and students obtaining 90% and above are given a merit scholarship of 20% of first semester tuition fee.
3. **Merit in BITSAT 2016:** Students with **BITSAT 2016 (or BITSAT 2015)** score of 200 or above are given merit scholarship of 25% to 75% of tuition fees based on the BITSAT score for one semester in the first year.

(b) Merit Scholarship for continuing students

. All Students with a CGPA of 9.00 or above on a 10.00 point scale at the end of a previous semester are given a merit scholarship of 20% of tuition fee for the current semester

(c) Other Special Concessions (First Degree Programmes)

1. **Hostel Fee Concession**: Admitted students with 90% or above in the qualifying examination (Grade 12 or equivalent) or BITSAT 2016/2015 score of 150 or above will be offered a 25% concession in the Hostel fee for the normal duration of the programme (four years).
2. **Arab Nationals:** Meritorious GCC/Arab Nationals will be offered a scholarship of 50% to 100% on the tuition fee for the normal duration of the programme based on their performance in the qualifying exam (Grade 12) and continuity of certain minimum performance during the programme. This will be restricted to specific number of students under each of the above mentioned scholarship category.
3. **For Sudden bereavement of earning member of the family:** Such students are helped by waiving off up to 100% tuition fee for the current semester.

(d) Other financial assistances:

Physically Challenged Students and Siblings, are given concession on the tuition fee, subject to satisfactory academic performance in each semester.

Scholarships for Higher Degree Programmes

1. Merit in Qualifying Examination: Students who have obtained aggregate marks of 80% or above in the Qualifying Examination (B.E./B.Tech) are given a merit scholarship of 20% of first semester tuition fee.

2. Students who are UAE Nationals will be offered 50% tuition fee scholarship for the normal duration of the programme based on their performance in the qualifying exam and continuity of certain minimum performance during the programme.
3. BITS Alumni, employees of Collaborative Organizations and Siblings/Parents of continuing students will be offered a 10% concession on the tuition fee, during the normal duration of the programme.
4. Merit Scholarship for continuing students: All Students with a CGPA of 9.00 or above on a 10.00 point scale at the end of a previous semester are given a merit scholarship of 20% of tuition fee for the current semester
5. Hostel Fee Concession: Higher degree students who have obtained aggregate marks of 80% or above in the Qualifying Examination (B.E./B.Tech) are given a concession of 25% on the hostel fee for the normal duration of the programme.

Scholarships for Ph.D. Programmes

Full-time, on-campus Ph.D. Scholars will be considered for 80% tuition fee waiver and part-time Ph.D Scholars will be considered for 70% tuition fee waiver for the normal duration of the programme subject to terms and conditions.

PART IV

DETAILS OF PROGRAMMES

Legend

AAOC	Analysis and Application Oriented Courses
Bio	Biological Sciences
BIOT	Biotechnology
CDP	Courses on Development Process
CE	Civil Engineering
Che	Chemical
Chem	Chemistry
CHI	Chinese
CS/Comp/Comp Sc	Computer Science
Econ	Economics
ECE	Electronics and Communication Engineering
EEE	Electrical & Electronics Engineering
EI	Electronics & Instrumentation
ES	Engineering Science
ET	Engineering Technology
Engg	Engineering: Chemical, Civil, Computer Science, Electrical & Electronics, Electronics & Instrumentation, Electronics and Communication, Manufacturing, Mechanical
ENGL	English
Exptl Sc	Experimental Science: Biological Sciences, Chemistry, Physics
FIN	Finance
FRE	French
GER	German
HSS	Humanities and Social Sciences
IS	Information Systems
ITEB	Internet Technology and e-Bussiness
JAP	Japanese
L	Lecture hours per week
MATH	Mathematics
MBA	Master of Business Administration
MECH	Mechanical
MF	Manufacturing Engineering
Min/Max	Indicates minimum/maximum number of units specified in a course or semester programme
Mgts	Management
MGSYS	Management Systems
MM	Manufacturing Management
MPH	Master in Public Health
MST	Material Science and Technology
P	Practical, Seminar & Project, etc. hours per week
PHIL	Philosophy
PHARM	Pharmacy
PHY	Physics
RUS	Russian
SS	Software Systems
Sc.	Biological Sciences, Chemistry, Economics, Mathematics, Physics
T	Suffixed to a course number indicates that a non-letter grade will be awarded in such a course
TA	Technical Arts
TOC	Technique Oriented Courses
U	Number of units associated to a course

Course descriptions are available at: **www.bits-pilani.ac.in/courses/fs_coursedescriptions.html**

(I) Structure of the Integrated First Degree Programmes

The structure and the requirements of the first degree programs, namely, B.E., B. Pharm., and M.Sc., are provided in the following sections.

[Note for students admitted from 2011 to 2015

The structure and the requirements of the first degree programs, namely, B.E. (Hons), B. Pharm (Hons), M.Sc. (Hons), and M.Sc.(Tech) are the same as provided in the following sections although the nomenclature of these programs is indicated without the Hons. / Tech. tag in the rest of the section**]**

The category-wise structure of each program:

Category	Number of Units Required	Number of Courses Required
(I) General Institutional Requirement		
Humanities Electives	8	3
Science Foundation	12	6
Mathematics Foundation	12	4
Engineering Foundation	6	2
Technical Arts	10	4
General Awareness / Professional Courses	3 to 6	1 to 3
Sub-Total	**51 to 54**	**20 to 22**
(II) Discipline Requirement		
Core	33 to 48	10 to 16
Elective	12 to 27	4 to 9
Sub-Total	57 to 60	15 to 20
(III) Open Electives	15 to 27	5 to 9
Course-work Sub-Total	**126 (min)**	**40 (min)**
(IV) PS-I and II **OR** **Thesis**	25 OR 9 to 16	2 OR 1
Total	**141 (min)**	**41 (min)**

A student should complete the minimum number of courses and units required in each category as well as meet the minimum requirements of courses (41) and units (141) in total.

1. The following courses are needed to meet the General Institutional Requirement:

a) General Biology, Biology Laboratory, General Chemistry, Chemistry Laboratory, Mechanics, Oscillations and Waves, and Physics Laboratory under the head of Science Foundation. For specific programs, General Physics may replace Mechanics, Oscillations and Waves.

b) Electrical Sciences, Thermodynamics and Process Engineering under the head of Engineering Foundation.

c) Computer Programming, Workshop Practice, Engineering Graphics, and Technical Report Writing under the head of Technical Arts.

d) Principles of Economics and Principles of Management under the head of General Awareness / Professional courses.

2. The courses under the following heads are designed to meet the General Institutional Requirement under the head of Humanities Electives:
    - Languages and Literature
    - History and Philosophy
    - Political and Social Sciences
    - Fine Arts and Professional Arts
3. A thesis is for 16 units and for a full semester duration. But a student has the option of pursuing a Thesis of 9 units concurrently with coursework over a full semester, in which case the additional coursework would be at least 2 courses of total 6 units to meet the minimum unit requirements.

The nominal semester-wise chart for first degree programs are given in the Pages IV-3-20.

Dual Degree Programs:

Based on the above, the structure of a dual degree program has been derived using the following principles.

- General Institute Requirements will remain the same for both the degrees of the composite dual-degree program and therefore need not be repeated.
- While the Discipline Requirements of each of the two degrees in a dual degree program have to be met separately, any course that meets the discipline requirements of both the degree programs need not be repeated.
- In addition the Discipline Elective courses of either of the two degrees in a dual degree program may be used to fulfill the open elective requirement of the other degree.
- A PS-II or Thesis must be done to meet the requirements of each degree. Therefore to complete the dual degree program a student must complete one of the following:
    - 2 Practice School-II courses
    - 2 Thesis courses
    - 1 Practice School-II course and 1 Thesis course.

A thesis for 9 units with concurrent course work for at most 9 units over a full semester duration is also possible as an option.

Based on these principles, the semester-wise patterns for a composite dual degree program as options for the student are shown in pages IV-20-22. However the charts mentioned on pages IV-23-62 are designed to enable the students to complete the composite dual degrees in their respective programmes in 10 semesters.

Semester-wise Pattern for Students Admitted to B.E. Biotechnology Programme								
Year	**First Semester**			**U**	**Second Semester**			**U**
I	BIO	F110	Biology Laboratory	1	MATH	F112	Mathematics II	3
	BIO	F111	General Biology	3	ME	F110	Workshop Practice	2
	CHEM	F110	Chemistry Laboratory	1	CS	F111	Computer Programming	4
	CHEM	F111	General Chemistry	3	EEE	F111	Electrical Sciences	3
	MATH	F111	Mathematics I	3	BITS	F112	Technical Report Writing	2
	PHY	F110	Physics Laboratory	1	MATH	F113	Probability and Statistics	3
	PHY	F111	Mechanics, Oscillations and Waves	3	BITS	F111	Thermodynamics	3
	BITS	F110	Engineering Graphics	2				
				17				**20**
II	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics	3
			Open/Humanities Electives	3(min)			or	or
	BIOT	F211	Biological Chemistry	3	MGTS	F211	Principles of Management	3
	BIOT	F212	Microbiology	4			Open/Humanities Electives	3(min)
	BIOT	F215	Biophysics	3	BIOT	F241	Genetic Engineering Techniques	4
	BIOT	F213	Cell Biology	3	BIOT	F243	Genetics	3
					BIOT	F245	Introduction to Environmental Biotechnology	3
					BIOT	F244	Instrumental Methods of Analysis	4
				19				**20**
Summer	**BITS F221 Practice School – I (for PS Option Only)**							
III			Open/Humanities Electives	3 to 6			Open/Humanities Electives	3 to 6
	BIOT	F311	Recombinant DNA Technology	3	BIOT	F342	Immunology	3
					BIOT	F343	Experiments in Biotechnology	3
	BIOT	F314	Industrial Microbiology & Bioprocess Engineering	4	BIOT	F344	Downstream Processing	3
			Discipline Electives	8			Discipline Electives	6
				18/21				**18/21**
IV			Open Electives	5 to 11	BITS	F412	Practice School-II	20
			Discipline Electives	3			or	or
					BITS	F421T	Thesis	16
							or	
							Thesis (9) and Electives (6 to 9)	15 to 18
				8/14				**15/20**

Discipline Core - 43 Units (13 Courses)

Discipline Electives - 17 Units (5 Courses)

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise Pattern for Students Admitted to B.E. Chemical Programme								
Year	**First Semester**			**U**	**Second Semester**			**U**
I	BIO	F110	Biology Laboratory	1	MATH	F112	Mathematics II	3
	BIO	F111	General Biology	3	ME	F110	Workshop Practice	2
	CHEM	F110	Chemistry Laboratory	1	CS	F111	Computer Programming	4
	CHEM	F111	General Chemistry	3	EEE	F111	Electrical Sciences	3
	MATH	F111	Mathematics I	3	BITS	F112	Technical Report Writing	2
	PHY	F110	Physics Laboratory	1	MATH	F113	Probability and Statistics	3
	PHY	F111	Mechanics, Oscillations and Waves	3	BITS	F111	Thermodynamics	3
	BITS	F110	Engineering Graphics	2				
				17				**20**
II	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics	3
			Humanities Electives	3(min)			or	or
	CHE	F211	Chemical Process		MGTS	F211	Principles of Management	3
			Calculations	3			Humanities Electives	3(min)
	CHE	F214	Engineering Chemistry	3	CHE	F241	Heat Transfer	3
	CHE	F213	Chemical Engineering		CHE	F242	Numerical Methods for	
			Thermodynamics	3			Chemical Engineers	3
	CHE	F212	Fluid Mechanics	3	CHE	F243	Material Science &	
							Engineering	3
					CHE	F244	Separation Processes I	3
				18(min)				**18(min)**
Summer	**BITS F221 Practice School – I (for PS Option Only)**							
III			Open/Humanities Electives	3to6			Open/Humanities Electives	3 to 6
	CHE	F312	Chemical Engineering Laboratory I	3	CHE	F341	Chemical Engineering Laboratory II	3
	CHE	F313	Separation Processes II	3	CHE	F342	Process Dynamics &	3
	CHE	F311	Kinetics & Reactor Design	3			Control	
	CHE	F314	Process Design Principles I	3	CHE	F343	Process Design	
			Discipline Electives	3			Principles II	3
							Discipline Electives	6
				18/21				**18/21**
IV			Open Electives	5 to 11	BITS	F412	Practice School-II	20
			Discipline Electives	6			or	or
					BITS	F421T	Thesis	16
							or	
							Thesis (9) and Electives	
							(6 to 9)	15 to 18
				11/17				**15/20**

Discipline Core - 45 Units (15 Courses)

Discipline Electives - 15 Units (5 Courses)

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise Pattern for Students Admitted to B.E. Civil Programme								
Year	**First Semester**			**U**	**Second Semester**			**U**
I	BIO	F110	Biology Laboratory	1	MATH	F112	Mathematics II	3
	BIO	F111	General Biology	3	ME	F110	Workshop Practice	2
	CHEM	F110	Chemistry Laboratory	1	CS	F111	Computer Programming	4
	CHEM	F111	General Chemistry	3	EEE	F111	Electrical Sciences	3
	MATH	F111	Mathematics I	3	BITS	F112	Technical Report Writing	2
	PHY	F110	Physics Laboratory	1	MATH	F113	Probability and Statistics	3
	PHY	F111	Mechanics, Oscillations and Waves	3	BITS	F111	Thermodynamics	3
	BITS	F110	Engineering Graphics	2				
				17				**20**
II	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics	3
			Humanities Electives	3 (min)			or	or
	CE	F211	Mechanics of Solids	3	MGTS	F211	Principles of Management	3
	CE	F212	Transport Phenomena	3			Humanities Electives	3 (min)
	CE	F213	Surveying	4	CE	F241	Analysis of Structures	3
	CE	F214	Construction Materials	3	CE	F242	Construction Planning & Technology	3
					CE	F243	Soil Mechanics	4
					CE	F244	Highway Engineering	4
				19 (min)				**17(min)**
Summer	**BITS F221 Practice School – I (for PS Option Only)**							
III			Open/Humanities Electives	1 to 4			Open/Humanities	2 to 5
	CE	F311	Design of Concrete				Electives	
			Structures	4	CE	F342	Water & Waste Water	4
	CE	F312	Hydraulic Engineering	4			Treatment	
	CE	F313	Foundation Engineering	3	CE	F341	Hydrology & Water	
			Discipline Electives	6			Resources Engineering	3
					CE	F343	Design of Steel Structures	3
							Discipline Electives	6
				18/21				**18/21**
IV			Open Electives	8to14	BITS	F412	Practice School-II	20
							or	or
					BITS	F421T	Thesis	16
							or	
							Thesis (9) and Electives	
							(6 to 9)	15to18
				8/14				**15/20**

Discipline Core - 48 Units (14 Courses)

Discipline Electives - 12 Units (4 Courses)

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise Pattern for Students Admitted to B. E. Computer Science Programme									
Year	**First Semester**			**U**	**Second Semester**			**U**
I	BIO	F110	Biology Laboratory	1	MATH	F112	Mathematics II	3
	BIO	F111	General Biology	3	ME	F110	Workshop Practice	2
	CHEM	F110	Chemistry Laboratory	1	CS	F111	Computer Programming	4
	CHEM	F111	General Chemistry	3	EEE	F111	Electrical Sciences	3
	MATH	F111	Mathematics I	3	BITS	F112	Technical Report Writing	2
	PHY	F110	Physics Laboratory	1	MATH	F113	Probability and Statistics	3
	PHY	F111	Mechanics, Oscillations and Waves	3	BITS	F111	Thermodynamics	3
	BITS	F110	Engineering Graphics	2				
				17				**20**
II	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics	3
			Humanities Electives	3(min)			or	or
	CS	F214	Logic in Computer Science	3	MGTS	F211	Principles of Management	3
	CS	F222	Discrete Structures for Computer Science	3			Humanities Electives	3(min)
	CS	F213	Object Oriented Programming	4	CS	F211	Data Structures & Algorithms	4
	CS	F215	Digital Design	4	CS	F241	Microprocessors & Interfacing	4
					CS	F212	Database Systems	4
				20(min)				**18(min)**
Summer	**BITS F221 Practice School – I (for PS Option Only)**							
III			Open/Humanities Electives	3to6			Open/Humanities	2to5
	CS	F351	Theory of Computation	3			Electives	
	CS	F372	Operating Systems	3	CS	F363	Compiler Construction	3
	CS	F301	Principles of Programming Languages	2	CS	F364	Design & Analysis of Algorithms	3
	CS	F342	Computer Architecture	4	CS	F303	Computer Networks	4
			Discipline Electives	3(min)			Discipline Electives	6(min)
				18/21				**18/21**
IV			Open Electives	6to12	BITS	F412	Practice School-II	20
			Discipline Electives	3(min)			or	or
					BITS	F421T	Thesis	16
							or	
							Thesis (9) and Electives (6 to 9)	15to18
				9/15				**15/20**

Discipline Core - 48 Units (14 Courses)

Discipline Electives - 12 Units (4 Courses)

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise Pattern for Students Admitted to B.E. Electrical & Electronics Programme									
Year	**First Semester**			**U**	**Second Semester**			**U**
I	BIO	F110	Biology Laboratory	1	MATH	F112	Mathematics II	3
	BIO	F111	General Biology	3	ME	F110	Workshop Practice	2
	CHEM	F110	Chemistry Laboratory	1	CS	F111	Computer Programming	4
	CHEM	F111	General Chemistry	3	EEE	F111	Electrical Sciences	3
	MATH	F111	Mathematics I	3	BITS	F112	Technical Report Writing	2
	PHY	F110	Physics Laboratory	1	MATH	F113	Probability and Statistics	3
	PHY	F111	Mechanics, Oscillations and Waves	3	BITS	F111	Thermodynamics	3
	BITS	F110	Engineering Graphics	2				
				17				**20**
II	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics	3
			Humanities Electives	3(min)			or	or
	EEE	F211	Electrical Machines	4	MGTS	F211	Principles of Management	3
	EEE	F212	Electromagnetic Theory	3			Humanities Electives	3(min)
	EEE	F215	Digital Design	4	EEE	F241	Microprocessors & Interfacing	4
	EEE	F214	Electronic Devices	3	EEE	F242	Control Systems	3
					EEE	F243	Signals & Systems	3
					EEE	F244	Microelectronic Circuits	3
				20(min)				**19(min)**
Summer	**BITS F221 Practice School – I (for PS Option Only)**							
III			Open/Humanities Electives	4to6			Open/Humanities Electives	3to6
	EEE	F311	Communication Systems	4	EEE	F341	Analog Electronics	4
	MATH	F212	Optimization	3	EEE	F342	Power Electronics	4
			or		EEE	F312	Power Systems	3
	ME	F344	Engineering Optimization	2			Discipline Electives	4(min)
	EEE	F313	Analog & Digital VLSI Design	3				
			Discipline Electives	5(min)				
				18/21				**18/21**
IV			Open Electives	5to11	BITS	F412	Practice School-II	20
			Discipline Electives	3(min)			or	or
					BITS	F421T	Thesis	16
							or	
							Thesis (9) and Electives	
							(6 to 9)	15to18
				8/14				**15/20**

Discipline Core - 47 or 48 Units (14 Courses)

Discipline Electives - 12 Units (4 Courses)

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise Pattern for Students Admitted to B.E. Electronics & Communication Programme								
Year	**First Semester**			**U**	**Second Semester**			**U**
I	BIO	F110	Biology Laboratory	1	MATH	F112	Mathematics II	3
	BIO	F111	General Biology	3	ME	F110	Workshop Practice	2
	CHEM	F110	Chemistry Laboratory	1	CS	F111	Computer Programming	4
	CHEM	F111	General Chemistry	3	EEE	F111	Electrical Sciences	3
	MATH	F111	Mathematics I	3	BITS	F112	Technical Report Writing	2
	PHY	F110	Physics Laboratory	1	MATH	F113	Probability and Statistics	3
	PHY	F111	Mechanics, Oscillations and Waves	3	BITS	F111	Thermodynamics	3
	BITS	F110	Engineering Graphics	2				
				17				**20**
II	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics	3
			Humanities Electives	3(min)			or	or
	ECE	F211	Electrical Machines	4	MGTS	F211	Principles of Management	3
	ECE	F212	Electromagnetic Theory	3			Humanities Electives	3(min)
	ECE	F215	Digital Design	4	ECE	F241	Microprocessors and	
	ECE	F214	Electronic Devices	3			Interfacing	4
					ECE	F242	Control Systems	3
					ECE	F243	Signals & Systems	3
					ECE	F244	Microelectronic Circuits	3
				20(min)				**19(min)**
Summer				**BITS F221 Practice School – I (for PS Option Only)**				
III			Open/Humanities Electives	3 to 6			Open/Humanities Electives	3 to 6
	ECE	F311	Communication Systems	4	ECE	F341	Analog Electronics	4
	ECE	F314	Electromagnetic Fields &		ECE	F343	Communication Networks	3
			Microwave Engineering	3	ECE	F344	Information Theory &	
	ECE	F434	Digital Signal Processing	4			Coding	3
			Discipline Electives	4(min)			Discipline Electives	5(min)
				18/21				**18/21**
IV			Open Electives	5 to 11	BITS	F412	Practice School-II	20
			Discipline Electives	3			or	or
					BITS	F421T	Thesis	16
							or	
							Thesis (9) and Electives	
							(6 to 9)	15 to 18
				8/14				**15/20**

Discipline Core - 48 Units (14 Courses)

Discipline Electives - 12 Units (4 Courses)

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise Pattern for Students Admitted to B.E. Electronics and Instrumentation Programme									
Year	**First Semester**			**U**	**Second Semester**			**U**
I	BIO	F110	Biology Laboratory	1	MATH	F112	Mathematics II	3
	BIO	F111	General Biology	3	ME	F110	Workshop Practice	2
	CHEM	F110	Chemistry Laboratory	1	CS	F111	Computer Programming	4
	CHEM	F111	General Chemistry	3	EEE	F111	Electrical Sciences	3
	MATH	F111	Mathematics I	3	BITS	F112	Technical Report Writing	2
	PHY	F110	Physics Laboratory	1	MATH	F113	Probability and Statistics	3
	PHY	F111	Mechanics, Oscillations and Waves	3	BITS	F111	Thermodynamics	3
	BITS	F110	Engineering Graphics	2				
				17				**20**
II	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics	3
			Humanities Electives	3(min)			or	or
	INSTR	F211	Electrical Machines	4	MGTS	F211	Principles of Management	3
	INSTR	F212	Electromagnetic Theory	3			Humanities Electives	3(min)
	INSTR	F215	Digital Design	4	INSTR	F241	Microprocessors & Interfacing	4
	INSTR	F214	Electronic Devices	3	INSTR	F242	Control Systems	3
					INSTR	F243	Signals & Systems	3
					INSTR	F244	Microelectronic Circuits	3
				20(min)				**19(min)**
Summer	**BITS F221 Practice School – I (for PS Option Only)**							
III			Open/Humanities Electives	3to6			Open/Humanities Electives	3to6
	INSTR	F311	Electronic Instruments &		INSTR	F341	Analog Electronics	4
			Instrumentation Technology	4	INSTR	F342	Power Electronics	4
	INSTR	F312	Transducers & Measurement Systems	3	INSTR	F343	Industrial Instrumentation & Control	3
	INSTR	F313	Analog & Digital VLSI Design	3			Discipline Electives	4(min)
			Discipline Electives	5(min)				
				18/21				**18/21**
IV			Open Electives	5to11	BITS	F412	Practice School-II	20
			Discipline Electives	3			or	or
					BITS	F421T	Thesis	16
							or	
							Thesis (9) and Electives	
							(6 to 9)	15to18
				8/14				**15/20**

Discipline Core - 48 Units (14 Courses)

Discipline Electives - 12 Units (4 Courses)

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise Pattern for Students Admitted to B.E. Mechanical Programme									
Year	**First Semester**			**U**	**Second Semester**			**U**
I	BIO	F110	Biology Laboratory	1	MATH	F112	Mathematics II	3
	BIO	F111	General Biology	3	ME	F110	Workshop Practice	2
	CHEM	F110	Chemistry Laboratory	1	CS	F111	Computer Programming	4
	CHEM	F111	General Chemistry	3	EEE	F111	Electrical Sciences	3
	MATH	F111	Mathematics I	3	BITS	F112	Technical Report Writing	2
	PHY	F110	Physics Laboratory	1	MATH	F113	Probability and Statistics	3
	PHY	F111	Mechanics, Oscillations and Waves	3	BITS	F111	Thermodynamics	3
	BITS	F110	Engineering Graphics	2				
				17				**20**
II	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics	3
			Humanities Electives	3(min)			or	or
	ME	F213	Materials Science &		MGTS	F211	Principles of Management	3
			Engineering	2			Humanities Electives	3(min)
	ME	F212	Fluid Mechanics	3	ME	F241	Machine Design & Drawing	4
	ME	F211	Mechanics of Solids	3	ME	F242	IC Engines	2
	ME	F214	Applied Thermodynamics	3	ME	F243	Production Techniques I	3
	ME	F215	Mechanical Engineering Laboratory	2	ME	F244	Kinematics & Dynamics of Machinery	3
				19(min)				**18(min)**
Summer	**BITS F221 Practice School – I (for PS Option Only)**							
III			Open/Humanities Electives	1 to 4			Open/Humanities Electives	3 to 6
	ME	F311	Heat Transfer	4	ME	F341	Prime Movers & Fluid	
	ME	F312	Advanced Mechanics of				Machines	3
			Solids	3	ME	F343	Mechanical Vibrations	3
	ME	F313	Production Techniques II	4	ME	F342	Computer Aided Design	4
			Discipline Electives	6(min)	ME	F344	Engineering Optimization	2
							Discipline Electives	3(min)
				18/21				**18/21**
IV			Open Electives	7to13	BITS	F412	Practice School-II	20
			Discipline Electives	3(min)			or	or
					BITS	F421T	Thesis	16
							or	
							Thesis (9) and Electives (6 to 9)	15 to 18
				10/16				**15/20**

Discipline Core - 48 Units (16 Courses)

Discipline Electives - 12 Units (4 Courses)

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise Pattern for Students Admitted to B.E. Manufacturing Programme								
Year	**First Semester**			**U**	**Second Semester**			**U**
I	BIO	F110	Biology Laboratory	1	MATH	F112	Mathematics II	3
	BIO	F111	General Biology	3	ME	F110	Workshop Practice	2
	CHEM	F110	Chemistry Laboratory	1	CS	F111	Computer Programming	4
	CHEM	F111	General Chemistry	3	EEE	F111	Electrical Sciences	3
	MATH	F111	Mathematics I	3	BITS	F112	Technical Report Writing	2
	PHY	F110	Physics Laboratory	1	MATH	F113	Probability and Statistics	3
	PHY	F111	Mechanics, Oscillations and Waves	3	BITS	F111	Thermodynamics	3
	BITS	F110	Engineering Graphics	2				
				17				**20**
II	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics	3
			/Humanities Electives	3(min)			or	or
	MF	F213	Materials Science &	2	MGTS	F211	Principles of Management	3
			Engineering				Humanities Electives	3(min)
	MF	F212	Fluid Mechanics	3	MF	F241	Machine Design & Drawing	4
	MF	F211	Mechanics of Solids	3	MF	F242	Manufacturing Management	2
	MF	F214	Applied Thermodynamics	3	MF	F243	Manufacturing Processes	3
	MF	F215	Mechanical Engineering Laboratory	2	MF	F244	Kinematics & Dynamics of Machinery	3
				19(min)				**18(min)**
Summer	**BITS F221 Practice School – I (for PS Option Only)**							
III			Open/Humanities Electives	2 to 5			Open/Humanities Electives	2 to 5
	MF	F311	Mechatronics & Automation	3	MF	F341	Design of Machine Tools	3
	MF	F312	Tool & Fixture Design	3	MF	F343	Casting & Welding	4
	MF	F313	Metal Forming & Machining	4	MF	F342	Computer Aided Design	4
			Discipline Electives	6(min)	MF	F344	Engineering Optimization	2
							Discipline Electives	3(min)
				18/21				**18/21**
IV			Open Electives	7 to 13	BITS	F412	Practice School-II	20
			Discipline Electives	3(min)			or	or
					BITS	F421T	Thesis	16
							or	
							Thesis (9) and Electives	
							(6 to 9)	15 to18
				10/16				**15/20**

Discipline Core - 48 Units (16 Courses)

Discipline Electives - 12 Units (4 Courses)

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise Pattern for Students Admitted to B. Pharm. Programme									
Year	**First Semester**			**U**	**Second Semester**			**U**
I	BIO	F110	Biology Laboratory	1	MATH	F112	Mathematics II	3
	BIO	F111	General Biology	3	ME	F110	Workshop Practice	2
	CHEM	F110	Chemistry Laboratory	1	CS	F111	Computer Programming	4
	CHEM	F111	General Chemistry	3	EEE	F111	Electrical Sciences	3
	MATH	F111	Mathematics I	3	BITS	F112	Technical Report Writing	2
	PHY	F110	Physics Laboratory	1	MATH	F113	Probability and Statistics	3
	PHY	F111	Mechanics, Oscillations and Waves	3	BITS	F111	Thermodynamics	3
	BITS	F110	Engineering Graphics	2				
				17				**20**
II	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics	3
			Humanities Electives	3(min)			or	or
	PHA	F211	Pharmaceutical Analysis	3	MGTS	F211	Principles of Management	3
	PHA	F214	Anatomy, Physiology & Hygiene	3			Humanities Electives	3(min)
					PHA	F241	Pharmaceutical Chemistry	3
	PHA	F212	Dispensing Pharmacy	3	PHA	F242	Biological Chemistry	3
	PHA	F213	Microbiology	3	PHA	F243	Industrial Pharmacy	3
					PHA	F244	Physical Pharmacy	3
				18(min)				**18(min)**
Summer	**BITS F221 Practice School – I (for PS Option Only)**							
III			Open/Humanities Electives	2 to 5			Open/Humanities Electives	4 to 6
	PHA	F311	Pharmacology I	3	PHA	F341	Pharmacology II	3
	PHA	F312	Medicinal Chemistry I	3	PHA	F342	Medicinal Chemistry II	3
	PHA	F313	Instrumental Methods of Analysis	4	PHA	F343	Forensic Pharmacy	2
	PHA	F314	Pharmaceutical Formulations & Biopharmaceutics	3	PHA	F344	Natural Drugs	3
			Discipline Electives	3(min)			Discipline Electives	3(min)
				18/21				**18/20**
IV			Open Electives	6 to 11	BITS	F412	Practice School-II	20
			Discipline Electives	6(min)			or	or
					BITS	F421T	Thesis	16
							or	
							Thesis (9) and Electives (6 to 9)	15 to 18
				12/17				**15/20**

Discipline Core - 48 Units (16 Courses)

Discipline Electives - 12 Units (4 Courses)

Note: This is operative pattern for the students who are admitted during 2011-2013 as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise Pattern for Students Admitted to B. Pharm. Programme						
Year	**First Semester**		**U**	**Second Semester**		**U**
I	BIO F110	Biology Laboratory	1	BITS F114	General Mathematics II*	3
	BIO F111	General Biology	3	OR		
	CHEM F110	Chemistry Laboratory	1	MATH F112	Mathematics II	
	CHEM F111	General Chemistry	3	ME F110	Workshop Practice	2
	BITS F113	General Mathematics I*	3	CS F111	Computer Programming	4
	OR			PHA F214	Anatomy, Physiology, &	3
	MATH F111	Mathematics I			Hygiene	
	PHY F110	Physics Laboratory	1	PHA F212	Dispensing Pharmacy	3
	PHY F112	General Physics	3	BITS F112	Technical Report Writing	2
	OR			MGTS F211	Principles of Management	
	PHY F111	Mechanics, Oscillations and Waves		OR		3
				ECON F211	Principles of Economics	
	BITS F110	Engineering Graphics	2			
			17			**20**
II	Humanities Electives		3	Humanities Electives		3
	BITS F218	General Mathematics III*	3	BITS F111	Thermodynamics	3
	OR			PHA F241	Pharmaceutical Chemistry	3
	MATH F211	Mathematics III		MATH F113	Probability and Statistics	3
	PHA F211	Pharmaceutical Analysis	3	PHA F215	Introduction to Molecular	
	BITS F219	Process Engineering	3		Biology and Immunology	3
	PHA F242	Biological Chemistry	3	PHA F244	Physical Pharmacy	3
	PHA F213	Microbiology	3			
			18			**18**
Summer	**BITS F221 Practice School I (5 Units) Only for PS Option**					
III	Open/Humanities Electives		2 to 5	Open/Humanities electives		4 to 6
	PHA F311	Pharmacology I	3	PHA F341	Pharmacology II	3
	PHA F312	Medicinal Chemistry I	3	PHA F342	Medicinal Chemistry II	3
	PHA F313	Instrumental Methods of	4	PHA F343	Forensic Pharmacy	2
		Analysis		PHA F344	Natural Drugs	3
	PHA F314	Pharm. Formulations & Biopharmaceutics	3	Discipline Electives		3(min)
	Discipline Electives		3 (min)			
			18 /21			**18 /20**
IV	Open electives		6 to 11	BITS F412 Practice School II		20
	Discipline Electives		6 (min)	OR		
				BITS F421T Thesis (16) or Thesis (9) and Electives (6 to 9)		16 or 15 to 18
			12/17			**15/20**

Discipline Core - 48 Units (16 Courses)

Discipline Electives - 12 Units (4 Courses)

* A student must pursue all three courses in one sequence only (i.e. either Mathematics I, Mathematics II, and Mathematics III, or General Mathematics, General Mathematics II, and General Mathematics III).

Note: This is operative pattern for the students who are admitted from August 2014 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise Pattern for Students Admitted to M.Sc. Biological Sciences Programme								
Year	**First Semester**			**U**	**Second Semester**			**U**
I	BIO	F110	Biology Laboratory	1	MATH	F112	Mathematics II	3
	BIO	F111	General Biology	3	ME	F110	Workshop Practice	2
	CHEM	F110	Chemistry Laboratory	1	CS	F111	Computer Programming	4
	CHEM	F111	General Chemistry	3	EEE	F111	Electrical Sciences	3
	MATH	F111	Mathematics I	3	BITS	F112	Technical Report Writing	2
	PHY	F110	Physics Laboratory	1	MATH	F113	Probability and Statistics	3
	PHY	F111	Mechanics, Oscillations and Waves	3	BITS	F111	Thermodynamics	3
	BITS	F110	Engineering Graphics	2				
				17				**20**
II	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics	3
			Humanities Electives	3(min)			or	or
	BIO	F211	Biological Chemistry	3	MGTS	F211	Principles of Management	3
	BIO	F213	Cell Biology	3			Humanities Electives	3(min)
	BIO	F212	Microbiology	4	BIO	F241	Ecology & Environmental	
	BIO	F214	Integrated Biology	3			Science	3
					BIO	F242	Introduction to Bioinformatics	3
					BIO	F243	Genetics	3
					BIO	F244	Instrumental Methods of Analysis	4
				19(min)				**19(min)**
Summer	**BITS F221 Practice School – I (for PS Option Only)**							
III			Open/Humanities Electives	3 to 6			Open/Humanities Electives	0 to 3
	BIO	F311	Recombinant DNA Technology	3	BIO	F341	Developmental Biology	3
					BIO	F342	Immunology	3
	BIO	F312	Plant Physiology	3	BIO	F215	Biophysics	3
	BIO	F313	Animal Physiology	3			Discipline Electives	9(min)
			Discipline Electives	6(min)				
				18/21				**18/21**
IV			Open Electives	8 to14	BITS	F412	Practice School-II	20
							or	or
					BITS	F421T	Thesis	16
							or	
							Thesis (9) and Electives	
							(6 to 9)	15 to18
				8/14				**15/20**

Discipline Core - 44 Units (14 Courses)

Discipline Electives - 15 Units (5 Courses)

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise Pattern for Students Admitted to M.Sc. Chemistry Programme								
Year	**First Semester**			**U**	**Second Semester**			**U**
I	BIO	F110	Biology Laboratory	1	MATH	F112	Mathematics II	3
	BIO	F111	General Biology	3	ME	F110	Workshop Practice	2
	CHEM	F110	Chemistry Laboratory	1	CS	F111	Computer Programming	4
	CHEM	F111	General Chemistry	3	EEE	F111	Electrical Sciences	3
	MATH	F111	Mathematics I	3	BITS	F112	Technical Report Writing	2
	PHY	F110	Physics Laboratory	1	MATH	F113	Probability and Statistics	3
	PHY	F111	Mechanics, Oscillations and Waves	3	BITS	F111	Thermodynamics	3
	BITS	F110	Engineering Graphics	2				
				17				**20**
II	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics	3
			Humanities Electives	3(min)			or	or
	CHEM	F211	Physical Chemistry I	3	MGTS	F211	Principles of Management	3
	CHEM	F212	Organic Chemistry I	3			Humanities Electives	3(min)
	CHEM	F213	Physical Chemistry II	3	CHEM	F241	Inorganic Chemistry II	
	PHY	F212	Electromagnetic Theory I	3	CHEM	F242	Chemical Experimentation I	3
	CHEM	F214	Inorganic Chemistry I	3	CHEM	F243	Organic Chemistry II	3
					CHEM	F244	Physical Chemistry III	3
				21(min)				**18(min)**
Summer	**BITS F221 Practice School – I (for PS Option Only)**							
III			Open/Humanities Electives	2 to 5			Open/Humanities Electives	2 to 5
	CHEM	F313	Instrumental Methods of Analysis	4	CHEM	F341	Chemical Experimentation II	4
	CHEM	F311	Organic Chemistry III	3	CHEM	F342	Organic Chemistry IV	3
	CHEM	F312	Physical Chemistry IV	3	CHEM	F343	Inorganic Chemistry III	3
			Discipline Electives	6(min)			Discipline Electives	6(min)
				18/21				**18/21**
IV			Open Electives	7 to13	BITS	F412	Practice School-II	20
							or	or
					BITS	F421T	Thesis	16
							or	
							Thesis (9) and Electives (6 to 9)	15 to18
				7/13				**15/20**

Discipline Core - 47 Units (15 Courses)

Discipline Electives - 12 Units (4 Courses)

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise Pattern for Students Admitted to M. Sc. Economics Programme								
Year	**First Semester**			**U**	**Second Semester**			**U**
I	BIO	F110	Biology Laboratory	1	MATH	F112	Mathematics II	3
	BIO	F111	General Biology	3	ME	F110	Workshop Practice	2
	CHEM	F110	Chemistry Laboratory	1	CS	F111	Computer Programming	4
	CHEM	F111	General Chemistry	3	EEE	F111	Electrical Sciences	3
	MATH	F111	Mathematics I	3	BITS	F112	Technical Report Writing	2
	PHY	F110	Physics Laboratory	1	MATH	F113	Probability and Statistics	3
	PHY	F111	Mechanics, Oscillations and Waves	3	BITS	F111	Thermodynamics	3
	BITS	F110	Engineering Graphics	2				
				17				**20**
II	MATH	F211	Mathematics III	3	MGTS	F211	Principles of Management	3
			Humanities Electives	3(min)			Humanities Electives	3(min)
	ECON	F211	Principles of Economics	3	ECON	F241	Econometric Methods	3
	ECON	F212	Fundamentals of Finance &		ECON	F242	Microeconomics	3
			Accounts	3	ECON	F243	Macroeconomics	3
	ECON	F213	Mathematical & Statistical		ECON	F244	Economics of Growth &	
			Methods	3			Development	3
	ECON	F214	Economic Environment of Business	3				
				18(min)				**18(min)**
Summer	**BITS F221 Practice School – I (for PS Option Only)**							
III			Open/Humanities Electives	3 to 6			Open/Humanities Electives	3 to 6
	ECON	F311	International Economics	3	ECON	F341	Public Finance Theory &	
	ECON	F312	Money Banking & Financial	3			Policy	3
			Markets		ECON	F342	Applied Econometrics	3
	ECON	F313	Issues in Economic Development	3	ECON	F343	Economic Analysis of Public Policy	3
			Discipline Electives	6(min)			Discipline Electives	6(min)
				18/21				**18/21**
IV			Open Electives	5 to 11	BITS	F412	Practice School-II	20
			Discipline Electives	6			or	or
					BITS	F421T	Thesis	16
							or	
							Thesis (9) and Electives	
							(6 to 9)	15to18
				11/17				**15/20**

Discipline Core - 42 Units (14 Courses)

Discipline Electives - 18 Units (6 Courses)

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise Pattern for Students Admitted to M.Sc. Mathematics Programme								
Year	**First Semester**			**U**	**Second Semester**			**U**
I	BIO	F110	Biology Laboratory	1	MATH	F112	Mathematics II	3
	BIO	F111	General Biology	3	ME	F110	Workshop Practice	2
	CHEM	F110	Chemistry Laboratory	1	CS	F111	Computer Programming	4
	CHEM	F111	General Chemistry	3	EEE	F111	Electrical Sciences	3
	MATH	F111	Mathematics I	3	BITS	F112	Technical Report Writing	2
	PHY	F110	Physics Laboratory	1	MATH	F113	Probability and Statistics	3
	PHY	F111	Mechanics, Oscillations and Waves	3	BITS	F111	Thermodynamics	3
	BITS	F110	Engineering Graphics	2				
				17				**20**
II	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics	3
			Humanities Electives	3(min)			or	or
	MATH	F212	Optimization	3	MGTS	F211	Principles of Management	3
	MATH	F213	Discrete Mathematics	3			Humanities Electives	3(min)
	MATH	F214	Elementary Real Analysis	3	MATH	F241	Mathematical Methods	3
	MATH	F215	Algebra I	3	MATH	F242	Operations Research	3
					MATH	F243	Graphs & Networks	3
					MATH	F244	Measure & Integration	3
				18(min)				**18(min)**
Summer	**BITS F221 Practice School – I (for PS Option Only)**							
III			Open/Humanities Electives	3 to 6			Open/Humanities	
	MATH	F311	Introduction to Topology	3			Electives	0 to 3
	MATH	F312	Ordinary Differential		MATH	F341	Introduction to Functional	
			Equations	3			Analysis	3
	MATH	F313	Numerical Analysis	3	MATH	F342	Differential Geometry	3
			Discipline Electives	6	MATH	F343	Partial Differential Equations	3
							Discipline Electives	9
				18/21				**18/21**
IV			Open Electives	8 to14	BITS	F412	Practice School-II	20
							or	or
					BITS	F421T	Thesis	16
							or	
							Thesis (9) and Electives	
							(6 to 9)	15 to18
				8/14				**15/20**

Discipline Core - 42 Units (14 Courses)

Discipline Electives - 15 Units (5 Courses)

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise Pattern for Students Admitted to M. Sc. Physics Programme									
Year	**First Semester**			**U**	**Second Semester**			**U**
I	BIO	F110	Biology Laboratory	1	MATH	F112	Mathematics II	3
	BIO	F111	General Biology	3	ME	F110	Workshop Practice	2
	CHEM	F110	Chemistry Laboratory	1	CS	F111	Computer Programming	4
	CHEM	F111	General Chemistry	3	EEE	F111	Electrical Sciences	3
	MATH	F111	Mathematics I	3	BITS	F112	Technical Report Writing	2
	PHY	F110	Physics Laboratory	1	MATH	F113	Probability and Statistics	3
	PHY	F111	Mechanics, Oscillations and Waves	3	BITS	F111	Thermodynamics	3
	BITS	F110	Engineering Graphics	2				
				17				**20**
II	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics	3
			Humanities Electives	3(min)			or	or
	PHY	F211	Classical Mechanics	4	MGTS	F211	Principles of Management	3
	PHY	F212	Electromagnetic Theory I	3			Humanities Electives	3(min)
	PHY	F213	Optics	3	PHY	F241	Electromagnetic Theory II	4
	PHY	F214	Electricity, Magnetism &		PHY	F242	Quantum Mechanics I	3
			Optics Laboratory	2	PHY	F243	Mathematical Methods of Physics	3
					PHY	F244	Modern Physics Laboratory	2
				18(min)				**18(min)**
Summer	**BITS F221 Practice School – I (for PS Option Only)**							
III			Open/Humanities Electives	3 to 6			Open/Humanities Electives	3 to 6
	PHY	F311	Quantum Mechanics II	3	PHY	F341	Solid State Physics	3
	PHY	F312	Statistical Mechanics	3	PHY	F342	Atomic & Molecular	
	PHY	F313	Computational Physics	3			Physics	3
			Discipline Electives	6(min)	PHY	F343	Nuclear & Particle Physics	3
					PHY	F344	Advanced Physics Laboratory	3
							Discipline Electives	3(min)
				18/21				**18/21**
IV			Open Electives	5 to 11	BITS	F412	Practice School-II	20
			Discipline Electives	6(min)			or	or
					BITS	F421T	Thesis	16
							or	
							Thesis (9) and Electives (6 to 9)	15 to 18
				11/17				**15/20**

Discipline Core - 45 Units (15 Courses)

Discipline Electives - 15 Units (5 Courses)

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

*****Discipline Core - 45 Units (15 Courses) and *Discipline Electives - 15 Units (min)-(4 Courses (min))

Note: *This is operative pattern for the students who are admitted from August 2014 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise Pattern for Students Admitted to M.Sc. General Studies – Communication & Media Studies Stream								
Year	**First Semester**			**U**	**Second Semester**			**U**
I	BIO	F110	Biology Laboratory	1	MATH	F112	Mathematics II	3
	BIO	F111	General Biology	3	ME	F110	Workshop Practice	2
	CHEM	F110	Chemistry Laboratory	1	CS	F111	Computer Programming	4
	CHEM	F111	General Chemistry	3	EEE	F111	Electrical Sciences	3
	MATH	F111	Mathematics I	3	BITS	F112	Technical Report Writing	2
	PHY	F110	Physics Laboratory	1	MATH	F113	Probability and Statistics	3
	PHY	F111	Mechanics, Oscillations and Waves	3	BITS	F111	Thermodynamics	3
	BITS	F110	Engineering Graphics	2				
				17				**20**
II	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics	3
			Humanities Electives	3(min)			or	or
	GS	F221	Business Communication	3	MGTS	F211	Principles of Management	3
	GS	F222	Language Lab Practice	3			Humanities Electives	3(min)
	GS	F223	Introduction to Mass Communication	3	GS	F244	Reporting & Writing for Media	3
	GS	F224	Print & Audio Visual	3	GS	F241	Creative Writing	3
			Advertising		GS	F245	Effective Public Speaking	3
					GS	F243	Current Affairs	3
				18(min)				**18(min)**
Summer	**BITS F221 Practice School – I (for PS Option Only)**							
III			Open/Humanities Electives	3 to 6			Open/Humanities	
	GS	F321	Mass Media Content &				Electives	3 to 6
			Design	3	GS	F342	Computer Mediated	
	GS	F322	Critical Analysis of Literature	3			Communication	3
			& Cinema		GS	F343	Short Film & Video Production	3
			Discipline Electives	9(min)			Discipline Electives	9(min)
				18/21				**18/21**
IV			Open Electives	5 to 11	BITS	F412	Practice School-II	20
			Discipline Electives	3(min)			or	or
					BITS	F421T	Thesis	16
							or	
							Thesis (9) and Electives	
							(6 to 9)	15 to18
				8/14				**15/20**

Discipline Core - 36 Units (12 Courses)

Discipline Electives - 21 Units (7 Courses)

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise Pattern for Students Admitted to M.Sc. General Studies – Developmental Studies Stream								
Year	**First Semester**			**U**	**Second Semester**			**U**
I	BIO	F110	Biology Laboratory	1	MATH	F112	Mathematics II	3
	BIO	F111	General Biology	3	ME	F110	Workshop Practice	2
	CHEM	F110	Chemistry Laboratory	1	CS	F111	Computer Programming	4
	CHEM	F111	General Chemistry	3	EEE	F111	Electrical Sciences	3
	MATH	F111	Mathematics I	3	BITS	F112	Technical Report Writing	2
	PHY	F110	Physics Laboratory	1	MATH	F113	Probability and Statistics	3
	PHY	F111	Mechanics, Oscillations and Waves	3	BITS	F111	Thermodynamics	3
	BITS	F110	Engineering Graphics	2				
				17				**20**
II	MATH	F211	Mathematics III	3	MGTS	F211	Principles of Management	3
			Humanities Electives	3(min)			Humanities Electives	3(min)
	GS	F211	Modern Political Concepts	3	GS	F231	Dynamics of Social	
	GS	F212	Environment, Development				Change	3
			& Climate Change	3	GS	F232	Introductory Psychology	3
	GS	F213	Development Theories	3	GS	F233	Public Policy	3
	ECON	F211	Principles of Economics	3	GS	F234	Development Economics	3
				18(min)				18(min)
Summer	**BITS F221 Practice School – I (for PS Option Only)**							
III			Open/Humanities Electives	3 to 6			Open/Humanities	
	GS	F311	Introduction to Conflict				Electives	0 to 3
			Management	3	GS	F331	Techniques in Social	
	GS	F312	Applied Philosophy	3			Research	3
			Discipline Electives	9(min)	GS	F332	Contemporary India	3
					GS	F333	Public Administration	3
					GS	F334	Global Business Technology & Knowledge Sharing	3
							Discipline Electives	6(min)
				18/21				**18/21**
IV			Open Electives	8 to 14	BITS	F412	Practice School-II	20
							or	or
					BITS	F421T	Thesis	16
							or	
							Thesis (9) and Electives	
							(6 to 9)	15 to 18
				8/14				**15/20**

Discipline Core - 42 Units (14 Courses)

Discipline Electives - 15 Units (5 Courses)

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Pattern 1 Semester-wise Pattern for Composite Dual Degree Programmes (Option A: Duration 10 Sem.)								
Year	**First Semester**			**U**	**Second Semester**			**U**
I	BIO	F110	Biology laboratory	1	MATH	F112	Mathematics II	3
	BIO	F111	General Biology	3	ME	F110	Workshop Practice	2
	CHEM	F110	Chemistry Laboratory	1	CS	F111	Computer Programming	4
	CHEM	F111	General Chemistry	3	EEE	F111	Electrical Sciences	3
	MATH	F111	Mathematics I	3	BITS	F112	Technical Report Writing	2
	PHY	F110	Physics Laboratory	1	MATH	F113	Probability and Statistics	3
	PHY	F111	Mechanics, Oscillations		BITS	F111	Thermodynamics	3
	BITS	F110	and Waves	3				
			Engineering Graphics	2				
				17				**20**
II	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics	3
			First Discipline Core				or	
			Courses	13 to 17	MGTS	F211	Principles of Management	
			Electives	3 to 6			First Discipline Core	
							Courses	13 to 17
							Electives	3 to 6
				23/24				**23/24**
Summer	**BITS F221 Practice School – I (for PS Option Only)**							
III			Second Discipline Core				Second Discipline Core	
			courses	12 to 16			Courses	12 to 16
			First Discipline Courses-Core/Elective	7 to 11			First Discipline Courses – Core / Elective	7 to 11
				23/24				**23/24**
IV			First Discipline Elective Courses	3 to 10			First Discipline Elective Courses	3to10
			Second Discipline Courses – Core + Elective	14 to 18			Second Discipline Courses - Core + Elective	14 to 18
							Electives (0 to 6)	0 to 6
				23/24				**23/24**
V			Electives	5 to 9	BITS	F412	Practice School-II	20
	BITS	F423T	Thesis	9			or	or
					BITS	F421T	Thesis	16

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Pattern 2	**Semester-wise Pattern for Composite Dual Degree Programmes (Option B: Duration 10 Sem. and a Summer Term)**								
Year	**First Semester**			**U**	**Second Semester**			**U**
I	BIO	F110	Biology laboratory	1	MATH	F112	Mathematics II	3
	BIO	F111	General Biology	3	ME	F110	Workshop Practice	2
	CHEM	F110	Chemistry Laboratory	1	CS	F111	Computer Programming	4
	CHEM	F111	General Chemistry	3	EEE	F111	Electrical Sciences	3
	MATH	F111	Mathematics I	3	BITS	F112	Technical Report Writing	2
	PHY	F110	Physics Laboratory	1	MATH	F113	Probability and Statistics	3
	PHY	F111	Mechanics, Oscillations and Waves	3	BITS	F111	Thermodynamics	4
	BITS	F110	Engineering Graphics(2)	2				
				17				**20**
II	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics	
							or	
			First Discipline Core Courses	13 to 17	MGTS	F211	Principles of Management	3
			Electives	3 to 6			First Discipline Core Courses	13 to 17
							Electives	3 to 6
				23/24				**23/24**
Summer	**BITS F221 Practice School – I (for PS Option Only)**							
III			Second Discipline Core Courses	12 to 16			Second Discipline Core Courses	12 to 16
			First Discipline Courses - Core / Elective	7 to 11			First Discipline Courses - Core / Elective	7 to 11
				23/24				**23/24**
IV			First Discipline Elective Courses	3/10			First Discipline Elective Courses	3 to 10
			Second Discipline Courses – Core + Elective	14 to 18			Second Discipline Courses - Core + Elective	14 to 18
			Electives	0 to 6			Electives	0 to 6
				23/24				**23/24**
Summer			Electives	5/9				
V	BITS	F412	Practice School - II	20	BITS	F413	Practice School - II	20
			or	or			or	or
	BITS	F421T	Thesis	16	BITS	F422	Thesis	16

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Pattern 3			Semesterwise Pattern for Dual Degree (Duration 11 Sem.)				
Year	**First Semester**			**U**	**Second Semester**		**U**
I	BIO	F110	Biology laboratory	1	MATH F112	Mathematics II	3
	BIO	F111	General Biology	3	ME F110	Workshop Practice	2
	CHEM	F110	Chemistry Laboratory	1	CS F111	Computer Programming	4
	CHEM	F111	General Chemistry	3	EEE F111	Electrical Sciences	3
	MATH	F111	Mathematics I	3	BITS F112	Technical Report Writing	2
	PHY	F110	Physics Laboratory	1	MATH F113	Probability and Statistics	3
	PHY	F111	Mechanics, Oscillations and Waves	3	BITS F111	Thermodynamics	3
	BITS	F110	Engineering Graphics	2			
				17			**20**
II	MATH	F211	Mathematics III	3	ECON F211	Principles of Economics	13
						or	
			First Discipline Core Courses		MGTS F211	Principles of Management	
			Electives	3 to 6		First Discipline Core Courses	13 to 17
						Electives	3 to 6
				21/22			**21/22**
Summer			**BITS F221 Practice School – I (for PS Option Only)**				
III			Second Discipline Core courses	12 to 16		Second Discipline Core	
			First Discipline Courses -			Courses	12 to 16
			Core/Elective	7 to 10		First Discipline Courses – Core / Elective	7to11
				21/22			**21/22**
IV			First Discipline Elective Courses	3 to 10		First Discipline Elective Courses	3 to10
			Second Discipline Courses – Core+Elective	14 to 18		Second Discipline Courses - Core + Elective	14 to 18
			Electives	0 to 6		Electives	0 to 6
				21/22			**21/22**
V			Electives	17 to 23	BITS F412	Practice School-II	20
						or	or
					BITS F421T	Thesis	16
VI	BITS	F413	Practice School-II	20			
			or	or			
	BITS	F422T	Thesis	16			

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise pattern for composite Dual Degree Programmes
(M.Sc. Biological Sciences with B.E. Chemical)

Year	First Semester			U	Second Semester			U
I	**Same as First degree Programme**				**Same as First degree Programme**			
	First Semester			**U**	**Second Semester**			**U**
II	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics/ Principles of Management	3
	BIO	F211	Biological Chemistry	3				
	BIO	F213	Cell Biology	3	BIO	F241	Ecology & Environmental Science	3
	BIO	F212	Microbiology	4				
	BIO	F214	Integrated Biology	3	BIO	F242	Introduction to Bioinformatics	3
			Humanities Elective	3				
					BIO	F243	Genetics	3
					BIO	F244	Instrumental Methods of Analysis	4
							Humanities Electives	5
				19				**21**
Summer	**BITS F221 Practice School -1 (for PS Option Only) (5 Units)**							
III	**First Semester**			**U**	**Second Semester**			**U**
	BIO	F311	Recombinant DNA Technology	3	BIO	F341	Developmental Biology	3
					BIO	F342	Immunology	3
	BIO	F312	Plant Physiology	3	BIO	F215	Biophysics	3
	BIO	F313	Animal Physiology	3	CHE	F241	Heat Transfer	3
	CHE	F211	Chemical Process Calculations	3	CHE	F242	Numerical Methods for Chemical Engineers	3
	CHE	F212	Fluid Mechanics	3	CHE	F243	Material Science & Engineering	3
	CHE	F214	Engineering Chemistry	3				
	CHE	F213	Chemical Engineering Thermodynamics	3	CHE	F244	Separation Processes I	3
				21				**21**
IV	**First Semester**			**U**	**Second Semester**			**U**
	CHE	F311	Kinetics & Reactor Design	3	CHE	F341	Chemical Engineering Laboratory II	3
	CHE	F312	Chemical Engineering Laboratory I	3	CHE	F342	Process Dynamics & Control	3
					CHE	F343	Process Design Principles II	3
	CHE	F313	Separation Processes II	3			First Discipline Electives	9
	CHE	F314	Process Design Principles I	3			Second Discipline Electives	6
			First Discipline Electives	6				
			Second Discipline Electives	3				
				21				**24**
V	**First Semester**			**U**	**Second Semester**			**U**
	Second Discipline Electives			6	BITS F412		Practice School - Ii	20
	BITS F423T		Thesis	9				
				15				**20**

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise pattern for composite Dual Degree Programmes (M.Sc. Biological Sciences with B.E. Civil)								
Year	**First Semester**			**U**	**Second Semester**			**U**
I	Same as First degree Programme				Same as First degree Programme			
II	**First Semester**			**U**	**Second Semester**			**U**
	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics	
	BIO	F211	Biological Chemistry				or	
	BIO	F213	Cell Biology	3	MGTS	F211	Principles of Management	3
	BIO	F212	Microbiology	4	BIO	F241	Ecology & Environmental Science	3
	BIO	F214	Integrated Biology	3	BIO	F242	Introduction to Bioinformatics	3
			Humanities Elective	3	BIO	F243	Genetics	3
					BIO	F244	Instrumental Methods of Analysis	4
							Humanities Electives	5
				19				**21**
Summer	**BITS F221 Practice School -1 (for PS Option Only) (5 Units)**							
III	**First Semester**			**U**	**Second Semester**			**U**
	BIO	F311	Recombinant DNA Technology	3	BIO	F341	Developmental Biology	3
	BIO	F312	Plant Physiology	3	BIO	F342	Immunology	3
	BIO	F313	Animal Physiology	3	BIO	F215	Biophysics	3
	CE	F211	Mechanics of Solids	3	CE	F241	Analysis of structures	3
	CE	F212	Transport Phenomena	3	CE	F242	Construction Planning & Technology	3
	CE	F214	Construction Materials	3	CE	F243	Soil Mechanics	4
	CE	F213	Surveying	4	CE	F244	Highway Engineering	4
				22				**23**
IV	**First Semester**			**U**	**Second Semester**			**U**
	CE	F311	Design of Concrete Structures	4	CE	F342	Water & Waste Water Treatment	4
	CE	F312	Hydraulic Engineering	4	CE	F341	Hydrology & Water Resources Engineering	3
	CE	F313	Foundation Engineering	3	CE	F343	Design of Steel Structures	3
			First Discipline Electives	6			First Discipline Electives	9
			Second Discipline Electives	6			Second Discipline Electives	3
				23				**22**
V	**First Semester**			**U**	**Second Semester**			**U**
	Second Discipline Electives			3	BITS F412 Practice School - II			20
	BITS F423T		Thesis	9				

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise pattern for composite Dual Degree Programmes (M.Sc. Biological Sciences with B.E. Computer Science)								
Year	**First Semester**			**U**	**Second Semester**			**U**
I	Same as First degree Programme				Same as First degree Programme			
	First Semester			**U**	**Second Semester**			**U**
II	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics	
	BIO	F211	Biological Chemistry	3			or	
	BIO	F213	Cell Biology	3	MGTS	F211	Principles of Management	3
	BIO	F212	Microbiology	4	BIO	F241	Ecology & Environmental Science	3
	BIO	F214	Integrated Biology	3	BIO	F242	Introduction to Bioinformatics	3
					BIO	F243	Genetics	3
			Humanities Elective	3	BIO	F244	Instrumental Methods of Analysis	4
							Humanities Electives	5
				19				**21**
Summer	**BITS F221 Practice School -1 (for PS Option Only) (5 Units)**							
III	**First Semester**			**U**	**Second Semester**			**U**
	BIO	F311	Recombinant DNA Technology	3	BIO	F341	Developmental Biology	3
	BIO	F312	Plant Physiology	3	BIO	F342	Immunology	3
	BIO	F313	Animal Physiology	3	BIO	F215	Biophysics	3
	CS	F215	Digital Design	4	CS	F241	Microprocessors & Interfacing	4
	CS	F214	Logic in Computer Science	3	CS	F212	Database Systems	4
	CS	F222	Discrete Structures for Computer Science	3	CS	F211	Data Structures & Algorithms	4
	CS	F213	Object Oriented Programming	4				
				23				**21**
IV	**First Semester**			**U**	**Second Semester**			**U**
	CS	F351	Theory of Computation	3	CS	F363	Compiler Construction	3
	CS	F372	Operating Systems	3	CS	F364	Design and Analysis of Algorithms	3
	CS	F342	Computer Architecture	4	CS	F303	Computer Networks	4
	CS	F301	Principles of Programming Languages	2			First Discipline Elective	9
			First Discipline Electives	6			Second Discipline Electives	3
			Second Discipline Electives	3				
				21				**22**
V	**First Semester**			**U**	**Second Semester**			**U**
	Second Discipline Electives			6	BITS F412		Practice School - II	20
	BITS F423T		Thesis	9				

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise pattern for composite Dual Degree Programmes (M.Sc. Biological Sciences with B.E. Electrical & Electronics)								
Year	**First Semester**			**U**	**Second Semester**			**U**
I	Same as First degree Programme				Same as First degree Programme			
II	**First Semester**			**U**	**Second Semester**			**U**
	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics	3
	BIO	F211	Biological Chemistry	3			or	
	BIO	F213	Cell Biology	3	MGTS	F211	Principles of Management	3
	BIO	F212	Microbiology	4	BIO	F241	Ecology & Environmental Science	3
	BIO	F214	Integrated Biology	3	BIO	F242	Introduction to Bioinformatics	3
			Humanities Elective	3	BIO	F243	Genetics	3
					BIO	F244	Instrumental Methods of Analysis	4
							Humanities Electives	`5
				19				**21**
Summer	**BITS F221 Practice School -1 (for PS Option Only) (5 Units)**							
III	**First Semester**			**U**	**Second Semester**			**U**
	BIO	F311	Recombinant DNA Technology	3	BIO	F341	Developmental Biology	3
	BIO	F312	Plant Physiology	3	BIO	F342	Immunology	3
	BIO	F313	Animal Physiology	3	BIO	F215	Biophysics	3
	EEE	F212	Electromagnetic Theory	3	EEE	F243	Signals and Systems	3
	EEE	F211	Electrical Machines	4	EEE	F244	Microelectronic Circuits	3
	EEE	F214	Electronic Devices	3	EEE	F241	Microprocessors & Interfacing	4
	EE	F215	Digital Design	4	EEE	F242	Control Systems	3
				23				**22**
IV	**First Semester**			**U**	**Second Semester**			**U**
	EEE	F311	Communication Systems	4	EEE	F341	Analog Electronics	4
	MATH	F212	Optimization	3	EEE	F342	Power Electronics	4
			or	or	EEE	F312	Power Systems	3
	ME	F344	Engineering Optimization	2			First Discipline Electives	6
	EEE	F313	Analog & Digital VLSI Design	3			Second Discipline Elective	4
			First Discipline Electives	3				
			Second Discipline Electives	8				
				20/21				**21**
V	**First Semester**			**U**	**Second Semester**			**U**
	First Discipline Electives			6	BITS F412 Practice School - II			20
	BTS F423T		Thesis	9				

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise pattern for composite Dual Degree Programmes (M.Sc. Biological Sciences with B.E. Electronics & Communication)								
Year	**First Semester**			**U**	**Second Semester**			**U**
I	Same as First degree Programme				Same as First degree Programme			
II	**First Semester**			**U**	**Second Semester**			**U**
	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics	3
	BIO	F211	Biological Chemistry	3			or	
	BIO	F213	Cell Biology	3	MGTS	F211	Principles of Management	3
	BIO	F212	Microbiology	4	BIO	F241	Ecology & Environmental Science	3
	BIO	F214	Integrated Biology	3	BIO	F242	Introduction to Bioinformatics	3
					BIO	F243	Genetics	3
			Humanities Elective	3	BIO	F244	Instrumentation of Analysis	4
							Humanities Electives	5
				19				**21**
Summer	**BITS F221 Practice School -1 (for PS Option Only) (5 Units)**							
III	**First Semester**			**U**	**Second Semester**			**U**
	BIO	F311	Recombinant DNA Technology	3	BIO	F341	Developmental Biology	3
	BIO	F312	Plant Physiology	3	BIO	F342	Immunology	3
	BIO	F313	Animal Physiology	3	BIO	F215	Biophysics	3
	ECE	F212	Electromagnetic Theory	3	ECE	F241	Microprocessors & Interfacing	4
	ECE	F215	Digital Design	4	ECE	F242	Control Systems	3
	ECE	F211	Electrical Machines	4	ECE	F243	Signals and Systems	3
	ECE	F214	Electronic Devices	3	ECE	F244	Microelectronic Circuits	3
				23				**22**
IV	**First Semester**			**U**	**Second Semester**			**U**
	ECE	F311	Communication Systems	4	ECE	F341	Analog Electronics	4
	ECE	F315	Digital Signal Processing	4	ECE	F344	Information Theory & Coding	3
	ECE	F314	Electromagnetic Fields & Microwave Engineering	3	ECE	F343	Communication Networks	3
			First Discipline Electives	3			First Discipline Elective	6
			Second Discipline Electives	7			Second Discipline Electives	5
				21				**21**
V	**First Semester**			**U**	**Second Semester**			**U**
	First Discipline Electives			6	BITS F412 Practice School - II			20
	BTS F423T Thesis			9				

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise pattern for composite Dual Degree Programmes (M.Sc. Biological Sciences with B.E. Electronics & Instrumentation)								
Year	**First Semester**			**U**	**Second Semester**			**U**
I	Same as First degree Programme				Same as First degree Programme			
II	**First Semester**			**U**	**Second Semester**			**U**
	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics	3
	BIO	F211	Biological Chemistry	3			or	
	BIO	F213	Cell Biology	3	MGTS	F211	Principles of Management	3
	BIO	F212	Microbiology	4	BIO	F241	Ecology & Environmental Science	3
	BIO	F214	Integrated Biology	3	BIO	F242	Introduction to Bioinformatics	3
			Humanities Elective	3	BIO	F243	Genetics	3
					BIO	F244	Instrumental Methods of Analysis	4
							Humanities Electives	5
				19				**21**
Summer	**BITS F221 Practice School -1 (for PS Option Only) (5 Units)**							
III	**First Semester**			**U**	**Second Semester**			**U**
	BIO	F311	Recombinant DNA Technology	3	BIO	F341	Developmental Biology	3
	BIO	F312	Plant Physiology	3	BIO	F342	Immunology	3
	BIO	F313	Animal Physiology	3	BIO	F215	Biophysics	3
	INSTR	F212	Electromagnetic Theory	3	INSTR	F241	Microprocessors & Interfacing	4
	INSTR	F215	Digital Design	4	INSTR	F242	Control Systems	3
	INSTR	F211	Electrical Machines	4	INSTR	F243	Signals & Systems	3
	INSTR	F214	Electronic Devices	3	INSTR	F244	Microelectronic Circuits	3
				23				**22**
IV	**First Semester**			**U**	**Second Semester**			**U**
	INSTR	F311	Electronic Instruments &		INSTR	F341	Analog Electronics	4
			Instrumentation Technology	4	INSTR	F342	Power Electronics	4
	INSTR	F312	Transducers and Measurement Systems	3	INSTR	F343	Industrial Instrumentation & Control	3
	INSTR	F313	Analog & Digital VLSI Design	3			First Discipline Electives	6
			First Discipline Electives	9			Second Discipline Electives	4
			Second Discipline Electives	3				
				22				**21**
V	**First Semester**			**U**	**Second Semester**			**U**
	First Discipline Electives			5	BITS F412 Practice School - II			20
	BTS F423T Thesis			9				

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise pattern for composite Dual Degree Programmes (M.Sc. Biological Sciences with B.E. Manufacturing)									
Year	**First Semester**			**U**	**Second Semester**			**U**
I	Same as First degree Programme				Same as First degree Programme			
	First Semester			**U**	**Second Semester**			**U**
II	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics	3
	BIO	F211	Biological Chemistry	3			or	
	BIO	F213	Cell Biology	3	MGTS	F211	Principles of Management	3
	BIO	F212	Microbiology	4	BIO	F241	Ecology & Environmental Science	3
	BIO	F214	Integrated Biology	3	BIO	F242	Introduction to Bioinformatics	3
			Humanities Elective	3	BIO	F243	Genetics	3
					BIO	F244	Instrumental Methods of Analysis	4
							Humanities Electives	5
				19				**21**
Summer	**BITS F221 Practice School -1 (for PS Option Only) (5 Units)**							
	First Semester			**U**	**Second Semester**			**U**
III	BIO	F311	Recombinant DNA Technology	3	BIO	F341	Developmental Biology	3
	BIO	F312	Plant Physiology	3	BIO	F342	Immunology	3
	BIO	F313	Animal Physiology	3	BIO	F215	Biophysics	3
	MF	F212	Fluid Mechanics	3	MF	F243	Manufacturing Processes	3
	MF	F214	Applied Thermodynamics	3	MF	F241	Machine Design & Drawing	4
	MF	F215	Mechanical Engineering Laboratory	2	MF	F244	Kinetics & Dynamics of Machinery	3
	MF	F211	Mechanics of Solids	3	MF	F242	Manufacturing Management	2
	MF	F213	Materials Science & Engineering	2				
				22				**21**
	First Semester			**U**	**Second Semester**			**U**
IV	MF	F313	Metal Forming & Machining	4	MF	F341	Design of Machine Tools	3
	MF	F312	Tool & Fixture Design	3	MF	F343	Casting & Welding	4
	MF	F311	Mechatronics & Automation	3	MF	F342	Computer Aided Design	4
			First Discipline Electives	9	MF	F344	Engineering Optimization	2
			Second Discipline Elective	3			First Discipline Electives	6
							Second Discipline Elective	3
				22				**22**
	First Semester			**U**	**Second Semester**			**U**
V	Second Discipline Electives			6	BITS F412 Practice School - II			20
	BTS F423T		Thesis	9				

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise pattern for composite Dual Degree Programmes (M.Sc. Biological Sciences with B.E. Mechanical)								
Year	**First Semester**			**U**	**Second Semester**			**U**
I	**Same as First degree Programme**				**Same as First degree Programme**			
	First Semester			**U**	**Second Semester**			**U**
II	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics	3
	BIO	F211	Biological Chemistry	3			or	
	BIO	F213	Cell Biology	3	MGTS	F211	Principles of Management	3
	BIO	F212	Microbiology	4	BIO	F241	Ecology & Environmental Science	3
	BIO	F214	Integrated Biology	3	BIO	F242	Introduction to Bioinformatics	3
			Humanities Elective	3	BIO	F243	Genetics	3
					BIO	F244	Instrumental Methods of Analysis	4
							Humanities Electives	5
				19				**21**
Summer	**BITS F221 Practice School -1 (for PS Option Only) (5 Units)**							
III	**First Semester**			**U**	**Second Semester**			**U**
	BIO	F311	Recombinant DNA Technology	3	BIO	F341	Developmental Biology	3
	BIO	F312	Plant Physiology	3	BIO	F342	Immunology	3
	BIO	F313	Animal Physiology	3	BIO	F215	Biophysics	3
	ME	F212	Fluid Mechanics	3	ME	F242	IC Engines	2
	ME	F214	Applied Thermodynamics	3	ME	F241	Machine Design & Drawing	4
	ME	F215	Mechanical Engineering Lab	2	ME	F244	Kinematics & Dynamics of Machinery	3
	ME	F211	Mechanics of Solids	3	ME	F243	Production Techniques I	3
	ME	F213	Materials Science & Engineering	2				
				22				**21**
IV	**First Semester**			**U**	**Second Semester**			**U**
	ME	F311	Heat Transfer	4	ME	F341	Prime Movers and Fluid Machines	3
	ME	F312	Advanced Mechanics of Solids	3	ME	F343	Mechanical Vibrations	3
	ME	F313	Production Techniques- II	4	ME	F342	Computer Aided Design	4
			First Discipline Electives	9	ME	F344	Engineering Optimization	2
			Second Discipline Electives	3			First Discipline Electives	6
							Second Discipline Electives	3
				23				**21**
V	**First Semester**			**U**	**Second Semester**			**U**
	Second Discipline Electives			6	BITS F412 Practice School - II			20
	BTS F423T		Thesis	9				

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise pattern for composite Dual Degree Programmes (M.Sc. Chemistry with B.E. Chemical)								
Year	**First Semester**			**U**	**Second Semester**			**U**
I	**Same as First degree Programme**				**Same as First degree Programme**			
	First Semester			**U**	**Second Semester**			**U**
II	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics	3
	CHEM	F211	Physical Chemistry I	3			or	
	CHEM	F212	Organic Chemistry I	3	MGTS	F211	Principles of Management	3
	CHEM	F213	Physical Chemistry II	3	CHEM	F241	Inorganic Chemistry II	3
	CHEM	F214	Inorganic Chemistry I	3	CHEM	F242	Chemical Experimentation I	3
	PHY	F212	Electromagnetic Theory I	3	CHEM	F243	Organic Chemistry II	3
			Humanities Elective	3	CHEM	F244	Physical Chemistry III	3
							Humanities Electives	5
				21				**20**
Summer	**BITS F221 Practice School -1 (for PS Option Only)**							
	First Semester			**U**	**Second Semester**			**U**
III	CHEM	F313	Instrumental Methods of Analysis	4	CHEM	F341	Chemical Experimentation II	4
					CHEM	F342	Organic Chemistry IV	3
	CHEM	F311	Organic Chemistry III	3	CHEM	F343	Inorganic Chemistry III	3
	CHEM	F312	Physical Chemistry IV	3	CHE	F241	Heat Transfer	3
	CHE	F211	Chemical Process Calculations	3	CHE	F242	Numerical Methods for Chemical Engineers	3
	CHE	F212	Fluid Mechanics	3	CHE	F243	Material Science & Engineering	3
	CHE	F213	Chemical Engineering Thermodynamics	3	CHE	F244	Separation Processes I	3
				19				**22**
IV	**First Semester**			**U**	**Second Semester**			**U**
	CHE	F311	Kinetics & Reactor Design	3	CHE	F341	Chemical Engineering Laboratory II	3
	CHE	F312	Chemical Engineering Laboratory I	3				
	CHE	F313	Separation Processes II	3	CHE	F342	Process Dynamics & Control	3
	CHE	F314	Process Design Principles I	3	CHE	F343	Process Design Principles II	3
			First Discipline Electives	6			First Discipline Electives	6
			Second Discipline Electives	3			Second Discipline Electives	6
				21				**21**
V	**First Semester**			**U**	**Second Semester**			**U**
	Second Discipline Electives			6	BITS F412 Practice School - II			20
	BTS	F423T	Thesis	9				

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise pattern for composite Dual Degree Programmes (M.Sc. Chemistry with B.E. Civil)									
Year	**First Semester**			**U**	**Second Semester**			**U**
I	**Same as First degree Programme**				**Same as First degree Programme**			
	First Semester			**U**	**Second Semester**			**U**
II	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics	3
	CHEM	F211	Physical Chemistry I	3			or	
	CHEM	F212	Organic Chemistry I	3	MGTS	F211	Principles of Management	3
	CHEM	F213	Physical Chemistry II	3	CHEM	F241	Inorganic Chemistry II	3
	CHEM	F214	Inorganic Chemistry I	3	CHEM	F242	Chemical Experimentation I	3
	PHY	F212	Electromagnetic Theory I	3	CHEM	F243	Organic Chemistry II	3
			Humanities Elective	3	CHEM	F244	Physical Chemistry III	3
							Humanities Electives	5
				21				**20**
Summer	**BITS F221 Practice School -1(for PS Option Only)**							
	First Semester			**U**	**Second Semester**			**U**
III	CHEM	F313	Instrumental Methods of Analysis	4	CHEM	F341	Chemical Experimentation II	4
	CHEM	F311	Organic Chemistry III	3	CHEM	F342	Organic Chemistry IV	3
	CHEM	F312	Physical Chemistry IV	3	CHEM	F343	Inorganic Chemistry III	3
	CE	F211	Mechanics of Solids	3	CE	F241	Analysis of structures	3
	CE	F212	Transport Phenomena	3	CE	F242	Construction Planning & Technology	3
	CE	F214	Construction Materials	3	CE	F243	Soil Mechanics	4
	CE	F213	Surveying	4	CE	F244	Highway Engineering	4
				23				**24**
IV	**First Semester**			**U**	**Second Semester**			**U**
	CE	F311	Design of Concrete Structures	4	CE	F342	Water & Waste Water Treatment	4
	CE	F312	Hydraulic Engineering	4	CE	F341	Hydrology & Water Resources	
	CE	F313	Foundation Engineering	3			Engineering	3
			First Discipline Electives	6	CE	F343	Design of Steel Structures	3
			Second Discipline Electives	3			First Discipline Electives	6
							Second Discipline Electives	6
				20				**22**
V	**First Semester**			**U**	**Second Semester**			**U**
	Second Discipline Electives			3	BITS F412 Practice School - II			20
	BTS F423T Thesis			9				

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise pattern for composite Dual Degree Programmes (M.Sc. Chemistry with B.E. Computer Science)								
Year	**First Semester**			**U**	**Second Semester**			**U**
I	**Same as First degree Programme**				**Same as First degree Programme**			
	First Semester			**U**	**Second Semester**			**U**
II	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics	3
	CHEM	F211	Physical Chemistry I	3			or	
	CHEM	F212	Organic Chemistry I	3	MGTS	F211	Principles of Management	3
	CHEM	F213	Physical Chemistry II	3	CHEM	F241	Inorganic Chemistry II	3
	CHEM	F214	Inorganic Chemistry I	3	CHEM	F242	Chemical Experimentation I	3
	PHY	F212	Electromagnetic Theory I	3	CHEM	F243	Organic Chemistry II	3
			Humanities Elective	3	CHEM	F244	Physical Chemistry III	3
							Humanities Electives	5
				21				**20**
Summer	**BITS F221 Practice School -1 (for PS Option Only)**							
	First Semester			**U**	**Second Semester**			**U**
III	CHEM	F313	Instrumental Methods of Analysis	4	CHEM	F341	Chemical Experimentation II	4
	CHEM	F311	Organic Chemistry III	3	CHEM	F342	Organic Chemistry IV	3
	CHEM	F312	Physical Chemistry IV	3	CHEM	F343	Inorganic Chemistry III	3
	CS	F215	Digital Design	4	CS	F241	Microprocessors & Interfacing	4
	CS	F214	Logic in Computer Science	3	CS	F212	Database Systems	4
	CS	F222	Discrete Structures For Computer Science	3	CS	F211	Data Structures & Algorithms	4
	CS	F213	Object Oriented Programming	4				
				24				**22**
	First Semester			**U**	**Second Semester**			**U**
IV	CS	F351	Theory of Computation	3	CS	F363	Compiler Construction	3
	CS	F372	Operating Systems	3	CS	F364	Design and Analysis of	
	CS	F342	Computer Architecture	4			Algorithms	3
	CS	F301	Principles of		CS	F303	Computer Networks	4
			Programming Languages	2			First Discipline Electives	6
			First Discipline Electives	6			Second Discipline Electives	3
			Second Discipline Electives	3				
				21				**19**
	First Semester			**U**	**Second Semester**			**U**
V	Second Discipline Electives			6	BITS F412 Practice School - II			20
	BTS F423T		Thesis	9				

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise pattern for composite Dual Degree Programmes
(M.Sc. Chemistry with B.E. Electrical & Electronics)

Year	First Semester			U	Second Semester			U
I	Same as First degree Programme				Same as First degree Programme			
II	**First Semester**			**U**	**Second Semester**			**U**
	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics	3
	CHEM	F211	Physical Chemistry I	3			or	
	CHEM	F212	Organic Chemistry I	3	MGTS	F211	Principles of Management	3
	CHEM	F213	Physical Chemistry II	3	CHEM	F241	Inorganic Chemistry II	3
	CHEM	F214	Inorganic Chemistry I	3	CHEM	F242	Chemical Experimentation I	3
	PHY	F212	Electromagnetic Theory I	3		F243	Organic Chemistry II	3
			Humanities Elective	3	CHEM	F244	Physical Chemistry III	3
					CHEM		Humanities Electives	5
				21				**20**
Summer	**BITS F221 Practice School -1 (for PS Option Only)**							
III	**First Semester**			**U**	**Second Semester**			**U**
	CHEM	F313	Instrumental Methods of Analysis	4	CHEM	F341	Chemical Experimentation II	4
	CHEM	F311	Organic Chemistry III	3	CHEM	F342	Organic Chemistry IV	3
	CHEM	F312	Physical Chemistry IV	3	CHEM	F343	Inorganic Chemistry III	3
	EEE	F211	Electrical Machines	4	EEE	F243	Signals and Systems	3
	EEE	F214	Electronic Devices	3	EEE	F244	Microelectronic Circuits	3
	EEE	F215	Digital Design	4	EEE	F241	Microprocessors & Interfacing	4
					EEE	F242	Control Systems	3
				21				**23**
IV	**First Semester**			**U**	**Second Semester**			**U**
	EEE	F311	Communication	4	EEE	F341	Analog Electronics	4
			Systems		EEE	F342	Power Electronics	4
	MATH	F212	Optimization	3	EEE	F312	Power Systems	3
			or				First Discipline Elective	6
	ME	F344	Engineering Optimization	2			Second Discipline Elective	4
	EEE	F313	Analog & Digital VLSI Design	3				
			First Discipline Electives	6				
			Second Discipline Electives	5				
				20/21				**21**
V	**First Semester**			**U**	**Second Semester**			**U**
	Second Discipline Electives			3	BITS F412 Practice School - II			20
	BTS F423T Thesis			9				

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise pattern for composite Dual Degree Programmes
M.Sc. Chemistry with B.E. Electronics & Communication

Year	First Semester			U	Second Semester			U
I	**Same as First degree Programme**				**Same as First degree Programme**			
	First Semester			**U**	**Second Semester**			**U**
II	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics	3
	CHEM	F211	Physical Chemistry I	3			or	
	CHEM	F212	Organic Chemistry I	3	MGTS	F211	Principles of Management	3
	CHEM	F213	Physical Chemistry II	3	CHEM	F241	Inorganic Chemistry II	3
	CHEM	F214	Inorganic Chemistry I	3	CHEM	F242	Chemical Experimentation I	3
	PHY	F212	Electromagnetic Theory I	3	CHEM	F243	Organic Chemistry II	3
			Humanities Elective	3	CHEM	F244	Physical Chemistry III	3
							Humanities Electives	5
				21				**20**
Summer	**BITS F221 Practice School -1 (for PS Option Only)**							
III	**First Semester**			**U**	**Second Semester**			**U**
	CHEM	F313	Instrumental Methods of Analysis	4	CHEM	F341	Chemical Experimentation II	4
	CHEM	F311	Organic Chemistry III	3	CHEM	F342	Organic Chemistry IV	3
	CHEM	F312	Physical Chemistry IV	3	CHEM	F343	Inorganic Chemistry III	3
	ECE	F215	Digital Design	4	ECE	F241	Microprocessors &	
	ECE	F211	Electrical Machines	4			Interfacing	4
	ECE	F214	Electronic Devices	3	ECE	F242	Control Systems	3
					ECE	F243	Signals and Systems	3
					ECE	F244	Microelectronic Circuits	3
				21				**23**
IV	**First Semester**			**U**	**Second Semester**			**U**
	ECE	F311	Communication Systems	4	ECE	F341	Analog Electronics	4
	ECE	F315	Digital Signal Processing	4	ECE	F344	Information Theory & Coding	3
	ECE	F314	Electromagnetic Fields & Microwave Engineering	3	ECE	F343	Communication Networks	3
			First Discipline Electives	6			First Discipline Electives	6
			Second Discipline Electives	4			Second Discipline Electives	5
				21				**21**
V	**First Semester**			**U**	**Second Semester**			**U**
	Second Discipline Electives			3	BITS F412 Practice School - II			20
	BTS F423T		Thesis	9				

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise pattern for composite Dual Degree Programmes (M.Sc. Chemistry with B.E. Electronics & Instrumentation)									
Year	**First Semester**			**U**	**Second Semester**			**U**
I	**Same as First degree Programme**				**Same as First degree Programme**			
	First Semester			**U**	**Second Semester**			**U**
II	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics	3
	CHEM	F211	Physical Chemistry I	3	MGTS	F211	or	
	CHEM	F212	Organic Chemistry I	3			Principles of Management	3
	CHEM	F213	Physical Chemistry II	3	CHEM	F241	Inorganic Chemistry II	3
	CHEM	F214	Inorganic Chemistry I	3	CHEM	F242	Chemical Experimentation I	3
	PHY	F212	Electromagnetic Theory I	3	CHEM	F243	Organic Chemistry II	3
			Humanities Elective	3	CHEM	F244	Physical Chemistry III	3
							Humanities Electives	5
				21				**20**
Summer	**BITS F221 Practice School -1(for PS Option Only)**							
	First Semester			**U**	**Second Semester**			**U**
III	CHEM	F313	Instrumental Methods of Analysis	4	CHEM	F341	Chemical Experimentation II	4
	CHEM	F311	Organic Chemistry III	3	CHEM	F342	Organic Chemistry IV	3
	CHEM	F312	Physical Chemistry IV	3	CHEM	F343	Inorganic Chemistry III	3
	INSTR	F215	Digital Design	4	INSTR	F241	Microprocessors & Interfacing	4
	INSTR	F211	Electrical Machines	4	INSTR	F242	Control Systems	3
	INSTR	F214	Electronic Devices	3	INSTR	F243	Signals & Systems	3
					INSTR	F244	Microelectronic Circuits	3
				21				**23**
	First Semester			**U**	**Second Semester**			**U**
IV	INSTR	F311	Electronic Instruments & Instrumentation Technology	4	INSTR	F341	Analog Electronics	4
					INSTR	F342	Power Electronics	4
	INSTR	F312	Transducers and Measurement Systems	3	INSTR	F343	Industrial Instrumentation & Control	3
	INSTR	F313	Analog & Digital VLSI Design	3			First Discipline Electives	6
			First Discipline Electives	6			Second Discipline Electives	4
			Second Discipline Electives	5				
				21				**21**
	First Semester			**U**	**Second Semester**			**U**
V	Second Discipline Electives			3	BITS F412 Practice School - II			20
	BTS F423T		Thesis	9				

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise pattern for composite Dual Degree Programmes (M.Sc. Chemistry with B.E. Manufacturing)								
Year	**First Semester**			**U**	**Second Semester**			**U**
I	**Same as First degree Programme**				**Same as First degree Programme**			
	First Semester			**U**	**Second Semester**			**U**
II	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics	3
	CHEM	F211	Physical Chemistry I	3			or	
	CHEM	F212	Organic Chemistry I	3	MGTS	F211	Principles of Management	3
	CHEM	F213	Physical Chemistry II	3	CHEM	F241	Inorganic Chemistry II	3
	CHEM	F214	Inorganic Chemistry I	3	CHEM	F242	Chemical Experimentation I	3
	PHY	F212	Electromagnetic Theory I	3	CHEM	F243	Organic Chemistry II	3
			Humanities Elective	3	CHEM	F244	Physical Chemistry III	3
							Humanities Electives	5
				21				**20**
Summer	**BITS F221 Practice School -1 (for PS Option Only)**							
	First Semester			**U**	**Second Semester**			**U**
III	CHEM	F313	Instrumental Methods of Analysis	4	CHEM	F341	Chemical Experimentation II	4
	CHEM	F311	Organic Chemistry III	3	CHEM	F342	Organic Chemistry IV	3
	CHEM	F312	Physical Chemistry IV	3	CHEM	F343	Inorganic Chemistry III	3
	MF	F212	Fluid Mechanics	3	MF	F243	Manufacturing Processes	3
	MF	F214	Applied Thermodynamics	3	MF	F241	Machine Design & Drawing	4
	MF	F215	Mechanical Engineering Laboratory	2	MF	F244	Kinematics & Dynamics of Machinery	3
	MF	F211	Mechanics of Solids	3	MF	F242	Manufacturing Management	2
	MF	F213	Materials Science & Engineering	2				
				23				**22**
	First Semester			**U**	**Second Semester**			**U**
IV	MF	F313	Metal Forming & Machining	4	MF	F341	Design of Machine Tools	3
					MF	F343	Casting & Welding	4
	MF	F312	Tool & Fixture Design	3	MF	F342	Computer Aided Design	4
	MF	F311	Mechatronics & Automation	3	MF	F344	Engineering Optimization	2
			First Discipline Electives	6			First Discipline Electives	6
			Second Discipline Elective	6			Second Discipline Elective	3
				22				**22**
V	**First Semester**			**U**	**Second Semester**			**U**
	Second Discipline Electives			3	BITS F412 Practice School - II			20
	BTS F423T		Thesis	9				

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise pattern for composite Dual Degree Programmes
(M.Sc. Chemistry with B.E. Mechanical)

Year	First Semester			U	Second Semester			U
I	Same as First degree Programme				Same as First degree Programme			
	First Semester			**U**	**Second Semester**			**U**
II	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics	3
	CHEM	F211	Physical Chemistry I	3			or	
	CHEM	F212	Organic Chemistry I	3	MGTS	F211	Principles of Management	3
	CHEM	F213	Physical Chemistry II	3	CHEM	F241	Inorganic Chemistry II	3
	CHEM	F214	Inorganic Chemistry I	3	CHEM	F242	Chemical Experimentation I	3
	PHY	F212	Electromagnetic Theory I	3	CHEM	F243	Organic Chemistry II	3
			Humanities Elective	3	CHEM	F244	Physical Chemistry III	3
							Humanities Electives	5
				21				**20**
Summer	**BITS F221 Practice School -1(for PS Option Only)**							
	First Semester			**U**	**Second Semester**			**U**
III	CHEM	F313	Instrumental Methods of Analysis	4	CHEM	F341	Chemical Experimentation II	4
	CHEM	F311	Organic Chemistry III	3	CHEM	F342	Organic Chemistry IV	3
	CHEM	F312	Physical Chemistry IV	3	CHEM	F343	Inorganic Chemistry III	3
	ME	F212	Fluid Mechanics	3	ME	F242	IC Engines	2
	ME	F214	Applied Thermodynamics	3	ME	F241	Machine Design & Drawing	4
	ME	F215	Mechanical Engineering Lab	2	ME	F244	Kinematics & Dynamics of Machinery	3
	ME	F211	Mechanics of Solids	3	ME	F243	Production Techniques I	3
	ME	F213	Materials Science & Engineering	2				
				23				**22**
	First Semester			**U**	**Second Semester**			**U**
IV	ME	F311	Heat Transfer	4	ME	F341	Prime Movers and Fluid	
	ME	F312	Advanced Mechanics of Solids	3			Machines	3
	ME	F313	Production Techniques-II	4	ME	F343	Mechanical Vibrations	3
			First Discipline Electives	6	ME	F342	Computer Aided Design	4
			Second Discipline Electives	3	ME	F344	Engineering Optimization	2
							First Discipline Electives	6
							Second Discipline Electives	3
				20				**21**
	First Semester			**U**	**Second Semester**			**U**
V	Second Discipline Electives			3	BITS F412 Practice School - II			20
	BTS F423T		Thesis	9				

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise pattern for composite Dual Degree Programmes (M.Sc. Economics with B.E. Chemical)									
Year	**First Semester**			**U**	**Second Semester**			**U**
I	**Same as First degree Programme**				**Same as First degree Programme**			
	First Semester			**U**	**Second Semester**			**U**
II	MATH	F211	Mathematics III	3	MGTS	F211	Principles of Management	3
	ECON	F211	Principles of Economics	3	ECON	F241	Econometric Methods	3
	ECON	F212	Fundamentals of Finance & Accounts	3	ECON	F242	Microeconomics	3
	ECON	F213	Mathematical & Statistical Methods	3	ECON	F243	Macroeconomics	3
	ECON	F214	Economic Environment of Business	3	ECON	F244	Economics of Growth & Development	3
			Humanities Elective	3			Humanities Electives	5
				18				**20**
Summer	**BITS F221 Practice School -1(for PS Option Only)**							
	First Semester			**U**	**Second Semester**			**U**
III	ECON	F311	International Economics	3	ECON	F341	Public Finance Theory & Policy	3
	ECON	F312	Money Banking & Financial Markets	3	ECON	F342	Applied Econometrics	3
	ECON	F313	Issues in Economic Development	3	ECON	F343	Economic Analysis of Public Policy	3
			First Discipline Elective	3			First Discipline Elective	3
	CHE	F211	Chemical Process Calculations	3	CHE	F241	Heat Transfer	3
	CHE	F212	Fluid Mechanics	3	CHE	F242	Numerical Methods for Chemical Engineers	3
	CHE	F214	Engineering Chemistry	3	CHE	F243	Material Science & Engineering	3
	CHE	F213	Chemical Engineering Thermodynamics	3	CHE	F244	Separation Processes I	3
				24				**24**
	First Semester			**U**	**Second Semester**			**U**
IV	CHE	F311	Kinetics & Reactor Design	3	CHE	F341	Chemical Engineering Laboratory II	3
	CHE	F312	Chemical Engineering Laboratory I	3	CHE	F342	Process Dynamics & Control	3
	CHE	F313	Separation Processes II	3	CHE	F343	Process Design Principles II	3
	CHE	F314	Process Design Principles I	3			First Discipline Electives	6
			First Discipline Electives	6			Second Discipline Electives	6
			Second Discipline Electives	3				
				21				**21**
	First Semester			**U**	**Second Semester**			**U**
V	Second Discipline Electives			6	BITS F412 Practice School - II			20
	BTS F423T		Thesis	9				

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise pattern for composite Dual Degree Programmes (M.Sc. Economics with B.E. Civil)									
Year	**First Semester**			**U**	**Second Semester**			**U**
I	**Same as First degree Programme**				**Same as First degree Programme**			
	First Semester			**U**	**Second Semester**			**U**
II	MATH	F211	Mathematics III	3	MGTS	F211	Principles of Management	3
	ECON	F211	Principles of Economics	3	ECON	F241	Econometric Methods	3
	ECON	F212	Fundamentals of Finance & Accounts	3	ECON	F242	Microeconomics	3
	ECON	F213	Mathematical & Statistical Methods	3	ECON	F243	Macroeconomics	3
	ECON	F214	Economic Environment of Business	3	ECON	F244	Economics of Growth & Development	3
			Humanities Electives	3			Humanities Electives	5
				18				**20**
Summer	**BITS F221 Practice School -1(for PS Option Only)**							
	First Semester			**U**	**Second Semester**			**U**
III	ECON	F311	International Economics	3	ECON	F341	Public Finance Theory & Policy	3
	ECON	F312	Money Banking & Financial Markets	3	ECON	F342	Applied Econometrics	3
	ECON	F313	Issues in Economic Development	3	ECON	F343	Economic Analysis of Public Policy	3
	CE	F211	Mechanics of Solids	3	CE	F241	Analysis of structures	3
	CE	F212	Transport Phenomena	3	CE	F242	Construction Planning & Technology	3
	CE	F214	Construction Materials	3	CE	F243	Soil Mechanics	4
	CE	F213	Surveying	4	CE	F244	Highway Engineering	4
				22				**23**
	First Semester			**U**	**Second Semester**			**U**
IV	CE	F311	Design of Concrete Structures	4	CE	F342	Water & Waste Water Treatment	4
	CE	F312	Hydraulic Engineering	4	CE	F341	Hydrology & Water Resources Engineering	3
	CE	F313	Foundation Engineering	3	CE	F343	Design of Steel Structures	3
			First Discipline Electives	9			First Discipline Electives	9
			Second Discipline Electives	3			Second Discipline Electives	3
				23				**22**
	First Semester			**U**	**Second Semester**			**U**
V	Second Discipline Electives			6	BITS F412 Practice School - II			20
	BTS F423T Thesis			9				

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise pattern for composite Dual Degree Programmes
(M.Sc. Economics with B.E. Computer Science)

Year	First Semester			U	Second Semester			U
I	**Same as First degree Programme**				**Same as First degree Programme**			
	First Semester			**U**	**Second Semester**			**U**
II	MATH	F211	Mathematics III	3	MGTS	F211	Principles of Management	3
	ECON	F211	Principles of Economics	3	ECON	F241	Econometric Methods	3
	ECON	F212	Fundamentals of Finance & Accounts	3	ECON	F242	Microeconomics	3
	ECON	F213	Mathematical & Statistical Methods	3	ECON	F243	Macroeconomics	3
	ECON	F214	Economic Environment of Business	3	ECON	F244	Economics of Growth & Development	3
			Humanities Elective	3			Humanities Electives	5
				18				**20**
Summer	**BITS F221 Practice School -1 (for PS Option Only)**							
	First Semester			**U**	**Second Semester**			**U**
III	ECON	F311	International Economics	3	ECON	F341	Public Finance Theory & Policy	
	ECON	F312	Money Banking & Financial Markets	3	ECON	F342	Applied Econometrics	3
	ECON	F313	Issues in Economic Development	3	ECON	F343	Economic Analysis of Public Policy	3
	CS	F215	Digital Design	4	CS	F241	Microprocessors & Interfacing	4
	CS	F214	Logic in Computer Science	3	CS	F212	Database Systems	4
	CS	F222	Discrete Structures for Computer Science	3	CS	F211	Data Structures & Algorithms	4
	CS	F213	Object Oriented Programming	4				
				23				**21**
IV	**First Semester**			**U**	**Second Semester**			**U**
	CS	F351	Theory of Computation	3	CS	F363	Compiler Construction	3
	CS	F372	Operating Systems	3	CS	F364	Design and Analysis of Algorithms	3
	CS	F342	Computer Architecture	4	CS	F303	Computer Networks	4
	CS	F301	Principles of Programming Languages	2			First Discipline Electives	6
			First Discipline Electives	6			Second Discipline Electives	6
			Second Discipline Electives	6				
				24				**22**
V	**First Semester**			**U**	**Second Semester**			**U**
	First Discipline Electives			6	BITS F412 Practice School - II			20
	BTS F423T Thesis			9				

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise pattern for composite Dual Degree Programmes (M.Sc. Economics with B.E. Electrical & Electronics)							
Year	**First Semester**		**U**	**Second Semester**			**U**
I	**Same as First degree Programme**			**Same as First degree Programme**			
II	**First Semester**		**U**	**Second Semester**			**U**
	MATH F211	Mathematics III	3	MGTS F211	Principles of Management		3
	ECON F211	Principles of Economics	3	ECON F241	Econometric Methods		3
	ECON F212	Fundamentals of Finance & Accounts	3	ECON F242	Microeconomics		3
	ECON F213	Mathematical & Statistical Methods	3	ECON F243	Macroeconomics		3
	ECON F214	Economic Environment of Business	3	ECON F244	Economics of Growth & Development		3
		Humanities Electives	3		Humanities Electives		5
			18				**20**
Summer	**BITS F221 Practice School -1 (for PS Option Only)**						
III	**First Semester**		**U**	**Second Semester**			**U**
	ECON F311	International Economics	3	ECON F341	Public Finance Theory & Policy		3
	ECON F312	Money Banking & Financial Markets	3	ECON F342	Applied Econometrics		3
	ECON F313	Issues in Economic Development	3	ECON F343	Economic Analysis of Public Policy		3
	EEE F212	Electromagnetic Theory	3	EEE F243	Signals and Systems		3
	EEE F211	Electrical Machines	4	EEE F244	Microelectronic Circuits		3
	EEE F214	Electronic Devices	3	EEE F241	Microprocessors & Interfacing		4
	EEE F215	Digital Design	4	EEE F242	Control Systems		3
			23				**22**
IV	**First Semester**		**U**	**Second Semester**			**U**
	EEE F311	Communication Systems	4	EEE F341	Analog Electronics		4
	MATH F212	Optimization	3	EEE F342	Power Electronics		4
		or		EEE F312	Power Systems		3
	ME F344	Engineering Optimization	2		First Discipline Electives		6
	EEE F313	Analog & Digital VLSI Design	3		Second Discipline Elective		4
		First Discipline Electives	6				
		Second Discipline Electives	8				
			23/24				**21**
V	**First Semester**		**U**	**Second Semester**			**U**
	First Discipline Electives		6	BITS F412 Practice School - II			20
	BTS F423T	Thesis	9				

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise pattern for composite Dual Degree Programmes
(M.Sc. Economics with B.E. Electronics & Communication)

Year	First Semester			U	Second Semester			U
I	Same as First degree Programme				Same as First degree Programme			
II	**First Semester**			**U**	**Second Semester**			**U**
	MATH	F211	Mathematics III	3	MGTS	F211	Principles of Management	3
	ECON	F211	Principles of Economics	3	ECON	F241	Econometric Methods	3
	ECON	F212	Fundamentals of Finance & Accounts	3	ECON	F242	Microeconomics	3
	ECON	F213	Mathematical & Statistical Methods	3	ECON	F243	Macroeconomics	3
	ECON	F214	Economic Environment of Business	3	ECON	F244	Economics of Growth & Development	3
			Humanities Elective	3			Humanities Electives	5
				18				**20**
Summer	**BITS F221 Practice School -1 (for PS Option Only)**							
III	**First Semester**			**U**	**Second Semester**			**U**
	ECON	F311	International Economics	3	ECON	F341	Public Finance Theory & Policy	3
	ECON	F312	Money Banking & Financial Markets	3	ECON	F342	Applied Econometrics	3
	ECON	F313	Issues in Economic Development	3	ECON	F343	Economic Analysis of Public Policy	3
	ECE	F212	Electromagnetic Theory	3	ECE	F241	Microprocessors & Interfacing	4
	ECE	F215	Digital Design	4	ECE	F242	Control Systems	3
	ECE	F211	Electrical Machines	4	ECE	F243	Signals and Systems	3
	ECE	F214	Electronic Devices	3	ECE	F244	Microelectronic Circuits	3
				23				**22**
IV	**First Semester**			**U**	**Second Semester**			**U**
	ECE	F311	Communication Systems	4	ECE	F341	Analog Electronics	4
	ECE	F315	Digital Signal Processing	4	ECE	F344	Information Theory & Coding	3
	ECE	F314	Electromagnetic Fields &		ECE	F343	Communication Networks	3
			Microwave Engineering	3			First Discipline Electives	6
			First Discipline Electives	6			Second Discipline Electives	5
			Second Discipline Electives	7				
				24				**21**
V	**First Semester**			**U**	**Second Semester**			**U**
	First Discipline Electives			6	BITS F412 Practice School - II			20
	BTS F423T		Thesis	9				

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise pattern for composite Dual Degree Programmes
(M.Sc. Economics with B.E. Electronics & Instrumentation)

Year	First Semester			U	Second Semester			U
I	Same as First degree Programme				Same as First degree Programme			
	First Semester			**U**	**Second Semester**			**U**
II	MATH	F211	Mathematics III	3	MGTS	F211	Principles of Management	3
	ECON	F211	Principles of Economics	3	ECON	F241	Econometric Methods	3
	ECON	F212	Fundamentals of Finance & Accounts	3	ECON	F242	Microeconomics	3
	ECON	F213	Mathematical & Statistical Methods	3	ECON	F243	Macroeconomics	3
	ECON	F214	Economic Environment of Business	3	ECON	F244	Economics of Growth & Development	3
			Humanities Elective	3			Humanities Electives	5
				18				**20**
Summer	**BITS F221 Practice School -1 (for PS Option Only)**							
	First Semester			**U**	**Second Semester**			**U**
III	ECON	F311	International Economics	3	ECON	F341	Public Finance Theory & Policy	3
	ECON	F312	Money Banking & Financial Markets	3	ECON	F342	Applied Econometrics	3
	ECON	F313	Issues in Economic Development	3	ECON	F343	Economic Analysis of Public Policy	3
	INSTR	F212	Electromagnetic Theory	3	INSTR	F241	Microprocessors & Interfacing	4
	INSTR	F215	Digital Design	4	INSTR	F242	Control Systems	3
	INSTR	F211	Electrical Machines	4	INSTR	F243	Signals & Systems	3
	INSTR	F214	Electronic Devices	3	INSTR	F244	Microelectronic Circuits	3
				23				**22**
	First Semester			**U**	**Second Semester**			**U**
IV	INSTR	F311	Electronic Instruments & Instrumentation Technology	4	INSTR	F341	Analog Electronics	4
	INSTR	F312	Transducers and Measurement Systems	3	INSTR	F342	Power Electronics	4
	INSTR	F313	Analog & Digital VLSI Design	3	INSTR	F343	Industrial Instrumentation & Control	3
			First Discipline Electives	6			First Discipline Electives	6
			Second Discipline Electives	8			Second Discipline Electives	4
				24				**21**
	First Semester			**U**	**Second Semester**			**U**
V	First Discipline Electives			6	BITS F412 Practice School - II			20
	BTS F423T		Thesis	9				

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise pattern for composite Dual Degree Programmes (M.Sc. Economics with B.E. Manufacturing)								
Year	**First Semester**			**U**	**Second Semester**			**U**
I	**Same as First degree Programme**				**Same as First degree Programme**			
	First Semester			**U**	**Second Semester**			**U**
II	MATH	F211	Mathematics III	3	MGTS	F211	Principles of Management	3
	ECON	F211	Principles of Economics	3	ECON	F241	Econometric Methods	3
	ECON	F212	Fundamentals of Finance & Accounts	3	ECON	F242	Microeconomics	3
	ECON	F213	Mathematical & Statistical Methods	3	ECON	F243	Macroeconomics	3
	ECON	F214	Economic Environment of Business	3	ECON	F244	Economics of Growth & Development	3
			Humanities Elective	3			Humanities Electives	5
				18				**20**
Summer	**BITS F221 Practice School -1 (for PS Option Only)**							
	First Semester			**U**	**Second Semester**			**U**
III	ECON	F311	International Economics	3	ECON	F341	Public Finance Theory & Policy	3
	ECON	F312	Money Banking & Financial Markets	3	ECON	F342	Applied Econometrics	3
	ECON	F313	Issues in Economic Development	3	ECON	F343	Economic Analysis of Public Policy	3
	MF	F212	Fluid Mechanics	3	MF	F243	Manufacturing Processes	3
	MF	F214	Applied Thermodynamics	3	MF	F241	Machine Design & Drawing	4
	MF	F215	Mechanical Engineering Laboratory	2	MF	F244	Kinetics & Dynamics of Machinery	3
	MF	F211	Mechanics of Solids	3	MF	F242	Manufacturing Management	2
	MF	F213	Materials Science & Engineering	2			First Discipline Elective	3
				22				**24**
	First Semester			**U**	**Second Semester**			**U**
IV	MF	F313	Metal Forming & Machining	4	MF	F341	Design of Machine Tools	3
	MF	F312	Tool & Fixture Design	3	MF	F343	Casting & Welding	4
	MF	F311	Mechatronics & Automation	3	MF	F342	Computer Aided Design	4
			First Discipline Electives	6	MF	F344	Engineering Optimization	2
			Second Discipline Electives	6			First Discipline Elective	3
							Second Discipline Electives	6
				22				**22**
	First Semester			**U**	**Second Semester**			**U**
V	First Discipline Electives			6	BITS F412 Practice School - II			20
	BTS F423T		Thesis	9				

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise pattern for composite Dual Degree Programmes
(M.Sc. Economics with B.E. Mechanical)

Year	First Semester			U	Second Semester			U
I	**Same as First degree Programme**				**Same as First degree Programme**			
	First Semester			**U**	**Second Semester**			**U**
II	MATH	F211	Mathematics III	3	MGTS	F211	Principles of Management	3
	ECON	F211	Principles of Economics	3	ECON	F241	Econometric Methods	3
	ECON	F212	Fundamentals of Finance & Accounts	3	ECON	F242	Microeconomics	3
					ECON	F243	Macroeconomics	3
	ECON	F213	Mathematical & Statistical Methods	3	ECON	F244	Economics of Growth & Development	3
	ECON	F214	Economic Environment of Business	3			Humanities Electives	5
			Humanities Electives	3				
				18				**20**
Summer	**BITS F221 Practice School -1 (for PS Option Only)**							
	First Semester			**U**	**Second Semester**			**U**
III	ECON	F311	International Economics	3	ECON	F341	Public Finance Theory & Policy	3
	ECON	F312	Money Banking & Financial Markets	3	ECON	F342	Applied Econometrics	3
	ECON	F313	Issues in Economic Development	3	ECON	F343	Economic Analysis of Public Policy	3
	ME	F212	Fluid Mechanics	3	ME	F242	IC Engines	2
	ME	F214	Applied Thermodynamics	3	ME	F241	Machine Design & Drawing	4
	ME	F215	Mechanical Engineering Lab	2	ME	F244	Kinematics & Dynamics of Machinery	3
	ME	F211	Mechanics of Solids	3	ME	F243	Production Techniques I	3
	ME	F213	Materials Science & Engineering	2				
				22				**21**
	First Semester			**U**	**Second Semester**			**U**
IV	ME	F311	Heat Transfer	4	ME	F341	Prime Movers and Fluid Machines	3
	ME	F312	Advanced Mechanics of Solids	3	ME	F343	Mechanical Vibrations	3
	ME	F313	Production Techniques- II	4	ME	F342	Computer Aided Design	4
			First Discipline Electives	6	ME	F344	Engineering Optimization	2
			Second Discipline Electives	6			First Discipline Electives	6
							Second Discipline Electives	6
				23				**24**
	First Semester			**U**	**Second Semester**			**U**
V	First Discipline Electives			6	BITS F412		Practice School - II	20
	BITS F423T		Thesis	9				

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise pattern for composite Dual Degree Programmes
(M.Sc. Mathematics with B.E. Chemical)

Year	First Semester			U	Second Semester			U
I	**Same as First degree Programme**				**Same as First degree Programme**			
	First Semester			**U**	**Second Semester**			**U**
II	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics	3
	MATH	F212	Optimization	3			or	
	MATH	F213	Discrete Mathematics	3	MGTS	F211	Principles of Management	3
	MATH	F214	Elementary Real Analysis	3	MATH	F241	Mathematical Methods	3
	MATH	F215	Algebra I	3	MATH	F242	Operations Research	3
			Humanities Elective	3	MATH	F243	Graphs & Networks	3
					MATH	F244	Measure & Integration	3
							Humanities Electives	5
				18				**20**
Summer	**BITS F221 Practice School -1 (for PS Option Only)**							
	First Semester			**U**	**Second Semester**			**U**
III	MATH	F311	Introduction to Topology	3	MATH	F341	Introduction to Functional Analysis	3
	MATH	F312	Ordinary Differential Equations	3	MATH	F342	Differential Geometry	3
	MATH	F313	Numerical Analysis	3	MATH	F343	Partial Differential Equations	3
	CHE	F211	Chemical Process Calculations	3	CHE	F241	Heat Transfer	3
	CHE	F212	Fluid Mechanics	3	CHE	F242	Numerical Methods for Chemical Engineers	3
	CHE	F214	Engineering Chemistry	3	CHE	F243	Material Science & Engineering	3
	CHE	F213	Chemical Engineering Thermodynamics	3	CHE	F244	Separation Processes I	3
				21				**21**
	First Semester			**U**	**Second Semester**			**U**
IV	CHE	F311	Kinetics & Reactor Design	3	CHE	F341	Chemical Engineering Laboratory II	3
	CHE	F312	Chemical Engineering Laboratory I	3	CHE	F342	Process Dynamics & Control	3
	CHE	F313	Separation Processes II	3	CHE	F343	Process Design Principles II	3
	CHE	F314	Process Design Principles I	3			First Discipline Electives	9
			First Discipline Electives	6			Second Discipline Electives	6
			Second Discipline Electives	3				
				21				**24**
	First Semester			**U**	**Second Semester**			**U**
V	Second Discipline Electives			6	BITS F412 Practice School - II			20
	BTS F423T		Thesis	9				

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise pattern for composite Dual Degree Programmes (M.Sc. Mathematics with B.E. Civil Engineering)								
Year	**First Semester**			**U**	**Second Semester**			**U**
I	**Same as First degree Programme**				**Same as First degree Programme**			
II	**First Semester**			**U**	**Second Semester**			**U**
	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics	3
	MATH	F212	Optimization	3			or	
	MATH	F213	Discrete Mathematics	3	MGTS	F211	Principles of Management	3
	MATH	F214	Elementary Real Analysis	3	MATH	F241	Mathematical Methods	3
	MATH	F215	Algebra I	3	MATH	F242	Operations Research	3
			Humanities Elective	3	MATH	F243	Graphs & Networks	3
					MATH	F244	Measure & Integration	3
							Humanities Electives	5
				18				**20**
Summer	**BITS F221 Practice School -1 (for PS Option Only)**							
III	**First Semester**			**U**	**Second Semester**			**U**
	MATH	F311	Introduction to Topology	3	MATH	F341	Introduction to Functional Analysis	3
	MATH	F312	Ordinary Differential Equations	3	MATH	F342	Differential Geometry	3
	MATH	F313	Numerical Analysis	3	MATH	F343	Partial Differential Equations	3
	CE	F211	Mechanics of Solids	3	CE	F241	Analysis of structures	3
	CE	F212	Transport Phenomena	3	CE	F242	Construction Planning & Technology	3
	CE	F214	Construction Materials	3	CE	F243	Soil Mechanics	4
	CE	F213	Surveying	4	CE	F244	Highway Engineering	4
				22				**23**
IV	**First Semester**			**U**	**Second Semester**			**U**
	CE	F311	Design of Concrete Structures	4	CE	F342	Water & Waste Water Treatment	4
	CE	F312	Hydraulic Engineering	4	CE	F341	Hydrology & Water Resources Engineering	3
	CE	F313	Foundation Engineering	3	CE	F343	Design of Steel Structures	3
			First Discipline Electives	6			First Discipline Electives	9
			Second Discipline Electives	3			Second Discipline Electives	3
				20				**22**
V	**First Semester**			**U**	**Second Semester**			**U**
	Second Discipline Electives			6	BITS F412 Practice School - II			20
	BTS F423T Thesis			9				

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise pattern for composite Dual Degree Programmes (M.Sc. Mathematics with B.E. Computer Science)								
Year	**First Semester**			**U**	**Second Semester**			**U**
I	**Same as First degree Programme**				**Same as First degree Programme**			
	First Semester			**U**	**Second Semester**			**U**
II	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics	3
	MATH	F212	Optimization	3			or	
	MATH	F213	Discrete Mathematics	3	MGTS	F211	Principles of Management	3
	MATH	F214	Elementary Real Analysis	3	MATH	F241	Mathematical Methods	3
	MATH	F215	Algebra I	3	MATH	F242	Operations Research	3
			Humanities Elective	3	MATH	F243	Graphs & Networks	3
					MATH	F244	Measure & Integration	3
							Humanities Electives	5
				18				**20**
Summer	**BITS F221 Practice School -1 (for PS Option Only)**							
	First Semester			**U**	**Second Semester**			**U**
III	MATH	F311	Introduction to Topology	3	MATH	F341	Introduction to Functional Analysis	3
	MATH	F312	Ordinary Differential Equations	3	MATH	F342	Differential Geometry	3
	MATH	F313	Numerical Analysis	3	MATH	F343	Partial Differential Equations	3
	CS	F215	Digital Design	4	CS	F241	Microprocessors & Interfacing	4
	CS	F214	Logic in Computer Science	3	CS	F212	Database Systems	4
	CS	F213	Object Oriented Programming	4	CS	F211	Data Structures & Algorithms	4
				20				**21**
	First Semester			**U**	**Second Semester**			**U**
IV	CS	F351	Theory of Computation	3	CS	F363	Compiler Construction	3
	CS	F372	Operating Systems	3	CS	F364	Design and Analysis of Algorithms	3
	CS	F342	Computer Architecture	4	CS	F303	Computer Networks	4
	CS	F301	Principles of Programming Languages	2			Fist Discipline Elective	6
			First Discipline Electives	3			Second Discipline Electives	6
			Second Discipline Electives	6				
				21				**22**
	First Semester			**U**	**Second Semester**			**U**
V	First Discipline Electives			6	BITS F412 Practice School - II			20
	BTS F423T		Thesis	9				

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise pattern for composite Dual Degree Programmes (M.Sc. Mathematics with B.E. Electrical & Electronics)							
Year	**First Semester**		**U**	**Second Semester**			**U**
I	**Same as First degree Programme**			**Same as First degree Programme**			
	First Semester		**U**	**Second Semester**			**U**
	MATH F211	Mathematics III	3	ECON F211	Principles of Economics		3
	MATH F212	Optimization	3		or		
	MATH F213	Discrete Mathematics	3	MGTS F211	Principles of Management		3
	MATH F214	Elementary Real Analysis	3	MATH F241	Mathematical Methods		3
II	MATH F215	Algebra I	3	MATH F242	Operations Research		3
				MATH F243	Graphs & Networks		3
		Humanities Elective	3	MATH F244	Measure & Integration		3
					Humanities Electives		5
			18				**20**
Summer	**BITS F221 Practice School -1 (for PS Option Only)**						
	First Semester		**U**	**Second Semester**			**U**
	MATH F311	Introduction to Topology	3	MATH F341	Introduction to Functional		
	MATH F312	Ordinary Differential Equations	3		Analysis		3
	MATH F313	Numerical Analysis	3	MATH F342	Differential Geometry		3
	EEE F212	Electromagnetic Theory	3	MATH F343	Partial Differential Equations		3
III	EEE F211	Electrical Machines	4	EEE F243	Signals and Systems		3
	EEE F214	Electronic Devices	3	EEE F244	Microelectronic Circuits		3
	EEE F215	Digital Design	4	EEE F241	Microprocessors &		
					Interfacing		4
				EEE F242	Control Systems		3
			23				**22**
	First Semester		**U**	**Second Semester**			**U**
	EEE F311	Communication Systems	4	EEE F341	Analog Electronics		4
	EEE F313	Analog & Digital VLSI Design	3	EEE F342	Power Electronics		4
				EEE F312	Power Systems		3
IV		First Discipline Electives	6		Fist Discipline Elective		6
		Second Discipline Electives	8		Second Discipline Elective		4
			21				**21**
	First Semester		**U**	**Second Semester**			**U**
V	First Discipline Electives		3	BITS F412 Practice School - II			20
	BTS F423T	Thesis	9				

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise pattern for composite Dual Degree Programmes (M.Sc. Mathematics with B.E. Electronics & Communication)								
Year	**First Semester**			**U**	**Second Semester**			**U**
I	**Same as First degree Programme**				**Same as First degree Programme**			
	First Semester			**U**	**Second Semester**			**U**
	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics	3
	MATH	F212	Optimization	3			or	
	MATH	F213	Discrete Mathematics	3	MGTS	F211	Principles of Management	3
	MATH	F214	Elementary Real Analysis	3	MATH	F241	Mathematical Methods	3
II	MATH	F215	Algebra I	3	MATH	F242	Operations Research	3
					MATH	F243	Graphs & Networks	3
			Humanities Elective	3	MATH	F244	Measure & Integration	3
							Humanities Electives	5
				18				**20**
Summer	**BITS F221 Practice School -1 (for PS Option Only)**							
	First Semester			**U**	**Second Semester**			**U**
	MATH	F311	Introduction to Topology	3	MATH	F341	Introduction to Functional Analysis	3
	MATH	F312	Ordinary Differential Equations	3	MATH	F342	Differential Geometry	3
	MATH	F313	Numerical Analysis	3	MATH	F343	Partial Differential Equations	3
III	ECE	F212	Electromagnetic Theory	3	ECE	F241	Microprocessors & Interfacing	4
	ECE	F215	Digital Design	4	ECE	F242	Control Systems	3
	ECE	F211	Electrical Machines	4	ECE	F243	Signals and Systems	3
	ECE	F214	Electronic Devices	3	ECE	F244	Microelectronic Circuits	3
				23				**22**
	First Semester			**U**	**Second Semester**			**U**
	ECE	F311	Communication Systems	4	ECE	F341	Analog Electronics	4
	ECE	F315	Digital Signal Processing	4	ECE	F344	Information Theory & Coding	3
V	ECE	F314	Electromagnetic Fields & Microwave Engineering	3	ECE	F343	Communication Networks	3
			First Discipline Electives	3			First Discipline Electives	6
			Second Discipline Electives	7			Second Discipline Electives	5
				21				**21**
	First Semester			**U**	**Second Semester**			**U**
V	First Discipline Electives			6	BITS F412 Practice School - II			20
	BTS F423T		Thesis	9				

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise pattern for composite Dual Degree Programmes (M.Sc. Mathematics with B.E. Electronics & Instrumentation)								
Year	**First Semester**			**U**	**Second Semester**			**U**
I	**Same as First degree Programme**				**Same as First degree Programme**			
II	**First Semester**			**U**	**Second Semester**			**U**
	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics	3
	MATH	F212	Optimization	3			or	
	MATH	F213	Discrete Mathematics	3	MGTS	F211	Principles of Management	3
	MATH	F214	Elementary Real Analysis	3	MATH	F241	Mathematical Methods	3
	MATH	F215	Algebra I	3	MATH	F242	Operations Research	3
			Humanities Elective	3	MATH	F243	Graphs & Networks	3
					MATH	F244	Measure & Integration	3
							Humanities Electives	5
				18				**20**
Summer	**BITS F221 Practice School -1 (for PS Option Only)**							
III	**First Semester**			**U**	**Second Semester**			**U**
	MATH	F311	Introduction to Topology	3	MATH	F341	Introduction to Functional Analysis	3
	MATH	F312	Ordinary Differential Equations	3	MATH	F342	Differential Geometry	3
	MATH	F313	Numerical Analysis	3	MATH	F343	Partial Differential Equations	3
	INSTR	F212	Electromagnetic Theory	3	INSTR	F241	Microprocessors & Interfacing	4
	INSTR	F215	Digital Design	4	INSTR	F242	Control Systems	3
	INSTR	F211	Electrical Machines	4	INSTR	F243	Signals & Systems	3
	INSTR	F214	Electronic Devices	3	INSTR	F244	Microelectronic Circuits	3
				23				**22**
IV	**First Semester**			**U**	**Second Semester**			**U**
	INSTR	F311	Electronic Instruments & Instrumentation Technology	4	INSTR	F341	Analog Electronics	4
	INSTR	F312	Transducers and Measurement Systems	3	INSTR	F342	Power Electronics	4
	INSTR	F313	Analog & Digital VLSI Design	3	INSTR	F343	Industrial Instrumentation & Control	3
			First Discipline Electives	3			Fist Discipline Elective	6
			Second Discipline Electives	8			Second Discipline Electives	4
				21				**21**
V	**First Semester**			**U**	**Second Semester**			**U**
	First Discipline Electives			6	BITS F412 Practice School - II			20
	BTS F423T		Thesis	9				

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise pattern for composite Dual Degree Programmes (M.Sc. Mathematics with B.E. Manufacturing)								
Year	**First Semester**			**U**	**Second Semester**			**U**
I	**Same as First degree Programme**				**Same as First degree Programme**			
	First Semester			**U**	**Second Semester**			**U**
	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics	3
	MATH	F212	Optimization	3			or	
	MATH	F213	Discrete Mathematics	3	MGTS	F211	Principles of Management	3
	MATH	F214	Elementary Real Analysis	3	MATH	F241	Mathematical Methods	3
II	MATH	F215	Algebra I	3	MATH	F242	Operations Research	3
			Humanities Elective	3	MATH	F243	Graphs & Networks	3
					MATH	F244	Measure & Integration	3
							Humanities Electives	5
				18				**20**
Summer	**BITS F221 Practice School -1 (for PS Option Only)**							
	First Semester			**U**	**Second Semester**			**U**
	MATH	F311	Introduction to Topology	3	MATH	F341	Introduction to Functional Analysis	3
	MATH	F312	Ordinary Differential Equations	3	MATH	F342	Differential Geometry	3
	MATH	F313	Numerical Analysis	3	MATH	F343	Partial Differential Equations	3
	MF	F212	Fluid Mechanics	3	MF	F243	Manufacturing Processes	3
III	MF	F214	Applied Thermodynamics	3	MF	F241	Machine Design & Drawing	4
	MF	F215	Mechanical Engineering Laboratory	2	MF	F244	Kinematics & Dynamics of Machinery	3
	MF	F211	Mechanics of Solids	3	MF	F242	Manufacturing Management	2
	MF	F213	Materials Science & Engineering	2				
				22				**21**
	First Semester			**U**	**Second Semester**			**U**
	MF	F313	Metal Forming & Machining	4	MF	F341	Design of Machine Tools	3
IV	MF	F312	Tool & Fixture Design	3	MF	F343	Casting & Welding	4
	MF	F311	Mechatronics & Automation	3	MF	F342	Computer Aided Design	4
			First Discipline Electives	6			First Discipline Electives	3
			Second Discipline Elective	6			Second Discipline Elective	6
				22				**20**
	First Semester			**U**	**Second Semester**			**U**
V	First Discipline Electives			6	BITS F412 Practice School - II			20
	BTS F423T		Thesis	9				

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise pattern for composite Dual Degree Programmes (M.Sc. Mathematics with B.E. Mechanical)								
Year	**First Semester**			**U**	**Second Semester**			**U**
I	**Same as First degree Programme**				**Same as First degree Programme**			
	First Semester			**U**	**Second Semester**			**U**
II	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics	3
	MATH	F212	Optimization	3			or	
	MATH	F213	Discrete Mathematics	3	MGTS	F211	Principles of Management	3
	MATH	F214	Elementary Real Analysis	3	MATH	F241	Mathematical Methods	3
	MATH	F215	Algebra I	3	MATH	F242	Operations Research	3
			Humanities Elective	3	MATH	F243	Graphs & Networks	3
					MATH	F244	Measure & Integration	3
							Humanities Electives	5
				18				**20**
Summer	**BITS F221 Practice School -1 (for PS Option Only)**							
III	**First Semester**			**U**	**Second Semester**			**U**
	MATH	F311	Introduction to Topology	3	MATH	F341	Introduction to Functional Analysis	
	MATH	F312	Ordinary Differential Equations	3	MATH	F342	Differential Geometry	3
	MATH	F313	Numerical Analysis	3	MATH	F343	Partial Differential Equations	3
	ME	F212	Fluid Mechanics	3	ME	F242	IC Engines	2
	ME	F214	Applied Thermodynamics	3	ME	F241	Machine Design & Drawing	4
	ME	F215	Mechanical Engineering Lab	2	ME	F244	Kinematics & Dynamics of Machinery	3
	ME	F211	Mechanics of Solids	3	ME	F243	Production Techniques I	3
	ME	F213	Materials Science & Engineering	2				
				22				**21**
IV	**First Semester**			**U**	**Second Semester**			**U**
	ME	F311	Heat Transfer	4	ME	F341	Prime Movers and Fluid Machines	3
	ME	F312	Advanced Mechanics of Solids	3	ME	F343	Mechanical Vibrations	3
	ME	F313	Production Techniques-II	4	ME	F342	Computer Aided Design	4
			First Discipline Electives	6			First Discipline Electives	9
			Second Discipline Electives	3			Second Discipline Electives	3
				20				**22**
V	**First Semester**			**U**	**Second Semester**			**U**
	Second Discipline Electives			6	BITS F412 Practice School - II			20
	BTS F423T Thesis			9				

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise pattern for composite Dual Degree Programmes
(M.Sc. Physics with B.E. Chemical)

Year	First Semester			U	Second Semester			U
I	**Same as First degree Programme**				**Same as First degree Programme**			
	First Semester			**U**	**Second Semester**			**U**
II	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics	3
	PHY	F211	Classical Mechanics	4			or	
	PHY	F212	Electromagnetic Theory I	3	MGTS	F211	Principles of Management	3
	PHY	F213	Optics	3	PHY	F241	Electromagnetic Theory II	4
	PHY	F214	Electricity, Magnetism & Optics Laboratory	2	PHY	F242	Quantum Mechanics I	3
			Humanities Elective	3	PHY	F243	Mathematical Methods of Physics	3
					PHY	F244	Modern Physics Laboratory	2
							Humanities Electives	5
				18				**20**
Summer	**BITS F221 Practice School -1(for PS Option Only)**							
III	**First Semester**			**U**	**Second Semester**			**U**
	PHY	F311	Quantum Mechanics II	3	PHY	F341	Solid State Physics	3
	PHY	F312	Statistical Mechanics	3	PHY	F342	Atomic & Molecular Physics	3
	PHY	F313	Computational Physics	3	PHY	F343	Nuclear & Particle Physics	3
	CHE	F211	Chemical Process Calculations	3	PHY	F344	Advanced Physics Laboratory	3
	CHE	F212	Fluid Mechanics	3	CHE	F241	Heat Transfer	3
	CHE	F214	Engineering Chemistry	3	CHE	F242	Numerical Methods for Chemical Engineers	3
	CHE	F213	Chemical Engineering Thermodynamics	3	CHE	F243	Material Science & Engineering	3
					CHE	F244	Separation Processes I	3
				21				**24**
IV	**First Semester**			**U**	**Second Semester**			**U**
	CHE	F311	Kinetics & Reactor Design	3	CHE	F341	Chemical Engineering Laboratory II	3
	CHE	F312	Chemical Engineering Laboratory I	3	CHE	F342	Process Dynamics & Control	3
	CHE	F313	Separation Processes II	3	CHE	F343	Process Design Principles II	3
	CHE	F314	Process Design Principles I	3			First Discipline Electives	9
			First Discipline Electives	6			Second Discipline Electives	6
			Second Discipline Electives	3				
				21				**24**
V	**First Semester**			**U**	**Second Semester**			**U**
	Second Discipline Electives			6	BITS F412 Practice School - II			20
	BTS F423T Thesis			9				

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise pattern for composite Dual Degree Programmes
(M.Sc. Physics with B.E. Civil)

Year	First Semester			U	Second Semester			U
I	**Same as First degree Programme**				**Same as First degree Programme**			
	First Semester			**U**	**Second Semester**			**U**
II	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics	3
	PHY	F211	Classical Mechanics	4			or	
	PHY	F212	Electromagnetic Theory I	3	MGTS	F211	Principles of Management	3
	PHY	F213	Optics	3	PHY	F241	Electromagnetic Theory II	4
	PHY	F214	Electricity, Magnetism & Optics Laboratory	2	PHY	F242	Quantum Mechanics I	3
			Humanities Elective	3	PHY	F243	Mathematical Methods of Physics	3
					PHY	F244	Modern Physics Laboratory	2
							Humanities Electives	5
				18				**20**
Summer	**BITS F221 Practice School -1(for PS Option Only)**							
III	**First Semester**			**U**	**Second Semester**			**U**
	PHY	F311	Quantum Mechanics II	3	PHY	F341	Solid State Physics	3
	PHY	F312	Statistical Mechanics	3	PHY	F342	Atomic & Molecular Physics	3
	PHY	F313	Computational Physics	3	PHY	F343	Nuclear & Particle Physics	3
	CE	F211	Mechanics of Solids	3	CE	F241	Analysis of structures	3
	CE	F212	Transport Phenomena	3	CE	F242	Construction Planning & Technology	3
	CE	F214	Construction Materials	3	CE	F243	Soil Mechanics	4
	CE	F213	Surveying	4	CE	F244	Highway Engineering	4
				22				**23**
IV	**First Semester**			**U**	**Second Semester**			**U**
	CE	F311	Design of Concrete Structures	4	CE	F342	Water & Waste Water Treatment	4
	CE	F312	Hydraulic Engineering	4	CE	F341	Hydrology & Water	
	CE	F313	Foundation Engineering	3			Resources Engineering	3
			First Discipline Electives	9	CE	F343	Design of Steel Structures	3
			Second Discipline Electives	3	PHY	F344	Advanced Physics Laboratory	3
							First Discipline Electives	6
							Second Discipline Electives	3
				23				**22**
V	**First Semester**			**U**	**Second Semester**			**U**
	Second Discipline Electives			6	BITS F412 Practice School - II			20
	BTS F423T		Thesis	9				

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise pattern for composite Dual Degree Programmes (M.Sc. Physics with B.E. Computer Science)								
Year	**First Semester**			**U**	**Second Semester**			**U**
I	**Same as First degree Programme**				**Same as First degree Programme**			
	First Semester			**U**	**Second Semester**			**U**
II	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics	3
	PHY	F211	Classical Mechanics	4			or	
	PHY	F212	Electromagnetic Theory I	3	MGTS	F211	Principles of Management	3
	PHY	F213	Optics	3	PHY	F241	Electromagnetic Theory II	4
	PHY	F214	Electricity, Magnetism & Optics Laboratory	2	PHY	F242	Quantum Mechanics I	3
			Humanities Elective	3	PHY	F243	Mathematical Methods of Physics	3
					PHY	F244	Modern Physics Laboratory	2
							Humanities Electives	5
				18				**20**
Summer	**BITS F221 Practice School -1 (for PS Option Only)**							
	First Semester			**U**	**Second Semester**			**U**
III	PHY	F311	Quantum Mechanics II	3	PHY	F341	Solid State Physics	3
	PHY	F312	Statistical Mechanics	3	PHY	F342	Atomic & Molecular Physics	3
	PHY	F313	Computational Physics	3	PHY	F343	Nuclear & Particle Physics	3
	CS	F215	Digital Design	4	PHY	F344	Advanced Physics Laboratory	3
	CS	F214	Logic in Computer Science	3	CS	F241	Microprocessors & Interfacing	4
	CS	F222	Discrete Structures For Computer Science	3	CS	F212	Database Systems	4
	CS	F213	Object Oriented Programming	4	CS	F211	Data Structures & Algorithms	4
				23				**24**
	First Semester			**U**	**Second Semester**			**U**
IV	CS	F351	Theory of Computation	3	CS	F363	Compiler Construction	3
	CS	F372	Operating Systems	3	CS	F364	Design and Analysis of Algorithms	3
	CS	F342	Computer Architecture	4	CS	F303	Computer Networks	4
	CS	F301	Principles of Programming Languages	2			First Discipline Electives	9
			First Discipline Electives	6			Second Discipline Electives	3
			Second Discipline Electives	3				
				21				**22**
	First Semester			**U**	**Second Semester**			**U**
V	Second Discipline Electives			6	BITS F412 Practice School - II			20
	BTS	F423T	Thesis	9				

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise pattern for composite Dual Degree Programmes (M.Sc. Physics with B.E. Electrical & Electronics)								
Year	**First Semester**			**U**	**Second Semester**			**U**
I	**Same as First degree Programme**				**Same as First degree Programme**			
	First Semester			**U**	**Second Semester**			**U**
II	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics	3
	PHY	F211	Classical Mechanics	4			or	
	PHY	F212	Electromagnetic Theory I	3	MGTS	F211	Principles of Management	3
	PHY	F213	Optics	3	PHY	F241	Electromagnetic Theory II	4
	PHY	F214	Electricity, Magnetism & Optics Laboratory	2	PHY	F242	Quantum Mechanics I	3
			Humanities Elective	3	PHY	F243	Mathematical Methods of Physics	3
					PHY	F244	Modern Physics Laboratory	2
							Humanities Electives	5
				18				**20**
Summer	**BITS F221 Practice School -1(for PS Option Only)**							
III	**First Semester**			**U**	**Second Semester**			**U**
	PHY	F311	Quantum Mechanics II	3	PHY	F341	Solid State Physics	3
	PHY	F312	Statistical Mechanics	3	PHY	F342	Atomic & Molecular Physics	3
	PHY	F313	Computational Physics	3	PHY	F343	Nuclear & Particle Physics	3
	EEE	F211	Electrical Machines	4	EEE	F243	Signals and Systems	3
	EEE	F214	Electronic Devices	3	EEE	F244	Microelectronic Circuits	3
	EEE	F215	Digital Design	4	EEE	F241	Microprocessors & Interfacing	4
					EEE	F242	Control Systems	3
				20				**22**
IV	**First Semester**			**U**	**Second Semester**			**U**
	EEE	F311	Communication Systems	4	EEE	F341	Analog Electronics	4
	MATH	F212	Optimization	3	EEE	F342	Power Electronics	4
			or		EEE	F312	Power Systems	3
	ME	F344	Engineering Optimization	2	PHY	F344	Advanced Physics Laboratory	3
	EEE	F313	Analog & Digital VLSI Design	3			First Discipline Electives	6
			First Discipline Electives	9			Second Discipline Electives	4
			Second Discipline Electives	5				
				23/24				**24**
V	**First Semester**			**U**	**Second Semester**			**U**
	Second Discipline Electives			3	BITS F412 Practice School - II			20
	BTS F423T		Thesis	9				

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise pattern for composite Dual Degree Programmes (M.Sc. Physics with B.E. Electronics & Communication)								
Year	**First Semester**			**U**	**Second Semester**			**U**
I	**Same as First degree Programme**				**Same as First degree Programme**			
	First Semester			**U**	**Second Semester**			**U**
II	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics	3
	PHY	F211	Classical Mechanics	4			or	
	PHY	F212	Electromagnetic Theory I	3	MGTS	F211	Principles of Management	3
	PHY	F213	Optics	3	PHY	F241	Electromagnetic Theory II	4
	PHY	F214	Electricity, Magnetism & Optics Laboratory	2	PHY	F242	Quantum Mechanics I	3
			Humanities Elective	3	PHY	F243	Mathematical Methods of Physics	3
					PHY	F244	Modern Physics Laboratory	2
							Humanities Electives	5
				18				**20**
Summer	**BITS F221 Practice School -1 (for PS Option Only)**							
III	**First Semester**			**U**	**Second Semester**			**U**
	PHY	F311	Quantum Mechanics II	3	PHY	F341	Solid State Physics	3
	PHY	F312	Statistical Mechanics	3	PHY	F342	Atomic & Molecular Physics	3
	PHY	F313	Computational Physics	3	PHY	F343	Nuclear & Particle Physics	3
	ECE	F215	Digital Design	4	ECE	F241	Microprocessors & Interfacing	4
	ECE	F211	Electrical Machines	4	ECE	F242	Control Systems	3
	ECE	F214	Electronic Devices	3	ECE	F243	Signals and Systems	3
					ECE	F244	Microelectronic Circuits	3
				20				**22**
IV	**First Semester**			**U**	**Second Semester**			**U**
	ECE	F311	Communication Systems	4	ECE	F341	Analog Electronics	4
	ECE	F315	Digital Signal Processing	4	ECE	F344	Information Theory & Coding	3
	ECE	F314	Electromagnetic Fields & Microwave Engineering	3	ECE	F343	Communication Networks	3
			First Discipline Electives	9	PHY	F344	Advanced Physics Laboratory	3
			Second Discipline Electives	3			First Discipline Electives	6
							Second Discipline Electives	5
				23				**24**
V	**First Semester**			**U**	**Second Semester**			**U**
	Second Discipline Electives			4	BITS F412 Practice School - II			20
	BTS F423T		Thesis	9				

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Semester-wise pattern for composite Dual Degree Programmes (M.Sc. Physics with B.E. Electronics & Instrumentation)								
Year	**First Semester**			**U**	**Second Semester**			**U**
I	**Same as First degree Programme**				**Same as First degree Programme**			
	First Semester			**U**	**Second Semester**			**U**
II	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics	3
	PHY	F211	Classical Mechanics	4			or	
	PHY	F212	Electromagnetic Theory I	3	MGTS	F211	Principles of Management	3
	PHY	F213	Optics	3	PHY	F241	Electromagnetic Theory II	4
	PHY	F214	Electricity, Magnetism & Optics Laboratory	2	PHY	F242	Quantum Mechanics I	3
			Humanities Elective	3	PHY	F243	Mathematical Methods of Physics	3
					PHY	F244	Modern Physics Laboratory	2
							Humanities Electives	5
				18				**20**
Summer	**BITS F221 Practice School -1(for PS Option Only)**							
III	**First Semester**			**U**	**Second Semester**			**U**
	PHY	F311	Quantum Mechanics II	3	PHY	F341	Solid State Physics	3
	PHY	F312	Statistical Mechanics	3	PHY	F342	Atomic & Molecular Physics	3
	PHY	F313	Computational Physics	3	PHY	F343	Nuclear & Particle Physics	3
	INSTR	F215	Digital Design	4	INSTR	F241	Microprocessors & Interfacing	4
	INSTR	F211	Electrical Machines	4	INSTR	F242	Control Systems	3
	INSTR	F214	Electronic Devices	3	INSTR	F243	Signals & Systems	3
					INSTR	F244	Microelectronic Circuits	3
				20				**22**
IV	**First Semester**			**U**	**Second Semester**			**U**
	INSTR	F311	Electronic Instruments & Instrumentation Technology	4	INSTR	F341	Analog Electronics	4
	INSTR	F312	Transducers and Measurement Systems	3	INSTR	F342	Power Electronics	4
	INSTR	F313	Analog & Digital VLSI Design	3	INSTR	F343	Industrial Instrumentation & Control	3
			First Discipline Electives	9	PHY	F344	Advanced Physics Laboratory	3
			Second Discipline Electives	3			First Discipline Electives	6
							Second Discipline Electives	4
				22				**24**
V	**First Semester**			**U**	**Second Semester**			**U**
	Second Discipline Electives			5	BITS F412 Practice School - II			20
	BTS F423T		Thesis	9				

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise pattern for composite Dual Degree Programmes
(M.Sc. Physics with B.E. Manufacturing)

Year	First Semester			U	Second Semester			U
I	**Same as First degree Programme**				**Same as First degree Programme**			
	First Semester			**U**	**Second Semester**			**U**
II	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics	3
	PHY	F211	Classical Mechanics	4			or	
	PHY	F212	Electromagnetic Theory I	3	MGTS	F211	Principles of Management	3
	PHY	F213	Optics	3	PHY	F241	Electromagnetic Theory II	4
	PHY	F214	Electricity, Magnetism & Optics Laboratory	2	PHY	F242	Quantum Mechanics I	3
			Humanities Elective	3	PHY	F243	Mathematical Methods of Physics	3
					PHY	F244	Modern Physics Laboratory	2
							Humanities Electives	5
				18				**20**
Summer	**BITS F221 Practice School -1 (for PS Option Only)**							
III	**First Semester**			**U**	**Second Semester**			**U**
	PHY	F311	Quantum Mechanics II	3	PHY	F341	Solid State Physics	3
	PHY	F312	Statistical Mechanics	3	PHY	F342	Atomic & Molecular Physics	3
	PHY	F313	Computational Physics	3	PHY	F343	Nuclear & Particle Physics	3
	MF	F212	Fluid Mechanics	3	PHY	F344	Advanced Physics Laboratory	3
	MF	F214	Applied Thermodynamics	3	MF	F243	Manufacturing Processes	3
	MF	F215	Mechanical Engineering Laboratory	2	MF	F241	Machine Design & Drawing	4
	MF	F211	Mechanics of Solids	3	MF	F244	Kinetics & Dynamics of Machinery	3
	MF	F213	Materials Science & Engineering	2	MF	F242	Manufacturing Management	2
				22				**24**
IV	**First Semester**			**U**	**Second Semester**			**U**
	MF	F313	Metal Forming & Machining	4	MF	F341	Design of Machine Tools	3
	MF	F312	Tool & Fixture Design	3	MF	F343	Casting & Welding	4
	MF	F311	Mechatronics & Automation	3	MF	F342	Computer Aided Design	4
			First Discipline Electives	9	MF	F344	Engineering Optimization	2
			Second Discipline Electives	3			First Discipline Electives	6
							Second Discipline Electives	4
				22				**23**
V	**First Semester**			**U**	**Second Semester**			**U**
	Second Discipline Electives			5	BITS F412 Practice School - II			20
	BTS F423T		Thesis	9				

Note: This is operative pattern for the students who are admitted from August 2011 onwards as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise pattern for composite Dual Degree Programmes (M.Sc. Physics with B.E. Mechanical)								
Year	**First Semester**			**U**	**Second Semester**			**U**
I	**Same as First degree Programme**				**Same as First degree Programme**			
	First Semester			**U**	**Second Semester**			**U**
II	MATH	F211	Mathematics III	3	ECON	F211	Principles of Economics	3
	PHY	F211	Classical Mechanics	4			or	
	PHY	F212	Electromagnetic Theory I	3	MGTS	F211	Principles of Management	3
	PHY	F213	Optics	3	PHY	F241	Electromagnetic Theory II	4
	PHY	F214	Electricity, Magnetism & Optics Laboratory	2	PHY	F242	Quantum Mechanics I	3
			Humanities Elective	3	PHY	F243	Mathematical Methods of Physics	3
					PHY	F244	Modern Physics Laboratory	2
							Humanities Electives	5
				18				**20**
Summer	**BITS F221 Practice School -1 (for PS Option Only)**							
III	**First Semester**			**U**	**Second Semester**			**U**
	PHY	F311	Quantum Mechanics II	3	PHY	F341	Solid State Physics	3
	PHY	F312	Statistical Mechanics	3	PHY	F342	Atomic & Molecular Physics	3
	PHY	F313	Computational Physics	3	PHY	F343	Nuclear & Particle Physics	3
	ME	F212	Fluid Mechanics	3	PHY	F344	Advanced Physics Laboratory	3
	ME	F214	Applied Thermodynamics	3	ME	F242	IC Engines	2
	ME	F215	Mechanical Engineering Lab	2	ME	F241	Machine Design & Drawing	4
	ME	F211	Mechanics of Solids	3	ME	F244	Kinematics & Dynamics of Machinery	3
	ME	F213	Materials Science & Engineering	2	ME	F243	Production Techniques I	3
				22				**24**
IV	**First Semester**			**U**	**Second Semester**			**U**
	ME	F311	Heat Transfer	4	ME	F341	Prime Movers and Fluid Machines	3
	ME	F312	Advanced Mechanics of Solids	3	ME	F343	Mechanical Vibrations	3
	ME	F313	Production Techniques- II	4	ME	F342	Computer Aided Design	4
			First Discipline Electives	9	ME	F344	Engineering Optimization	2
			Second Discipline Electives	3			First Discipline Electives	6
							Second Discipline Electives	3
				23				**21**
V	**First Semester**			**U**	**Second Semester**			**U**
	Second Discipline Electives			6	BITS F412 Practice School - II			20
	BTS	F423T	Thesis	9				

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List of Courses for B.E. / M.Sc. / B.Pharm. Programmes:

The list of Discipline Core Courses and Discipline Electives for all the first degree programmes is given below. To complete the requirements of Humanities electives, a student can take courses which are normally listed under Languages and Literature, History and Philosophy, Political and social Sciences, Fine arts and Professional Arts which have also been mentioned in subsequent paragraphs.

Course No	Course Title	L	P	U
BIOTECHNOLOGY				
CORE COURSES				
BIOT F211	Biological Chemistry	3	0	3
BIOT F212	Microbiology	3	1	4
BIOT F213	Cell biology	3	0	3
BIOT F215	Biophysics	3	0	3
BIOT F241	Genetic Engineering Techniques	1	3	4
BIOT F243	Genetics	3	0	3
BIOT F244	Instrumental Methods of Analysis	1	3	4
BIOT F245	Intro to Environmental Biotechnology	3	0	3
BIOT F311	Recombinant DNA Technology	3	0	3
BIOT F314	Industrial Microbiology and Bioprocess Engineering	2	2	4
BIOT F342	Immunology	3	0	3
BIOT F343	Experiments in Biotechnology	0	3	3
BIOT F344	Downstream Processing	2	1	3
DISCIPLINE ELECTIVE COURSES				
BIOT F242	Introduction to Bioinformatics	3	0	3
BIOT F345	Proteomics	3	0	3
BIOT F346	Genomics	3	0	3
BIOT F347	Immunotechnology	3	0	3
BIOT F352	Cell and Tissue Culture Technology	3	0	3
BIOT F413	Molecular Biology of the Cell	3	0	3
BIOT F416	Introduction to Pharmaceutical Biotechnology	3	0	3
BIOT F417	Biomolecular Modeling	3	0	3
BIOT F420	Introduction to Plant Biotechnology	3	0	3
BIOT F422	Nanobiotechnology	3	0	3
BIOT F423	Drug design and delivery	3	0	3
BIOT F424	Food Biotechnology	3	0	3
BITS F467	Bioethics and Biosafety	3	0	3
CHEMICAL ENGINEERING				
CORE COURSES		**L**	**P**	**U**
CHE F211	Chemical Process Calculations	3	0	3
CHE F212	Fluid Mechanics	3	0	3
CHE F213	Chemical Engineering Thermodynamics	3	0	3
CHE F214	Engineering Chemistry	3	0	3
CHE F241	Heat Transfer	3	0	3
CHE F242	Numerical Methods for Chemical Engineers	3	0	3
CHE F243	Material Science and Engineering	3	0	3
CHE F244	Separation Processes I	3	0	3
CHE F311	Kinetics and Reactor Design	3	0	3
CHE F312	Chemical Engineering Lab I	0	3	3
CHE F313	Separation Processes II	3	0	3
CHE F314	Process Design Principles I	3	0	3
CHE F341	Chemical Engineering Lab II	0	3	3
CHE F342	Process Dynamics and Control	3	0	3
CHE F343	Process Design Principles II	3	0	3
DISCIPLINE ELECTIVE COURSES				
BIO G671	Bioconversion Technology	3	2	5
BIOT F245	Introduction to Environmental Biotechnology	3	0	3
BIOT F344	Downstream processing	2	1	3
BITS F415	Introduction to MEMS	3	1	4
BITS F416	Introduction to Nanoscience	3	0	3
BITS F417	Microfluidics and its application			4
BITS F418	Introduction to Biomedical Engineering	3	1	4
BITS F429	Nanotechnology for Renewable Energy and Environment	3	1	4
CHE F411	Environmental Pollution Control	3	0	3
CHE F412	Process Equipment Design	3	0	3
CHE F413	Process Plant Safety	3	0	3
CHE F414	Transport Phenomena	3	0	3
CHE F415	Molecular and Statistical Thermodynamics	3	0	3
CHE F416	Process Plant Design Project I	-	-	3
CHE F417	Process Plant Design Project II	-	-	3
CHE F418	Modelling and Simulation in Chemical Engineering	3	0	3
CHE F419	Chemical Process Technology	3	0	3

CHE F421	Bio-chemical Engineering	3	0	3
CHE F422	Petroleum Refining Technology	3	0	3
CHE F433	Corrosion Engineering	3	0	3
CHE F471	Advanced Process Control	3	0	3
CHE G511	Fluidization Engineering	3	1	4
CHE G512	Petroleum Refining and Petrochemicals	3	1	4
CHE G513	Environmental Management Systems	3	2	5
CHE G522	Polymer Technology	3	1	4
CHE G523	Mathematical Methods in Chemical Engineering			5
CHE G524	Introduction to Multiphase flow	3	1	4
CHE G526	Nuclear Engineering	3	1	4
CHE G527	Energy Conservation and Management	3	1	4
CHE G528	Introduction to Nanoscience & Technology	3	1	4
CHE G529	Pulp & Paper Technology	3	1	4
CHE G532	Alternate Energy Resources	3	1	4
CHE G533	Petroleum Product Characterization	3	2	5
CHE G551	Advanced Separation Technology	3	2	5
CHE G552	Advanced Transport Phenomena			5
CHE G556	Electrochemical Engineering	3	1	4
CHE G557	Energy Systems Engineering			4
CHE G558	Chemical Process Optimization			4
CHE G613	Advanced Mass Transfer	3	2	5
CHE G614	Advanced Heat Transfer	3	2	5
CHE G616	Petroleum Reservoir Engineering			5
CHE G617	Petroleum Refinery Engineering	3	2	5
CHE G618	Petroleum Downstream Processing	3	2	5
CHE G619	Process Intensification	3	2	5
CHE G620	Energy Integration Analysis	3	1	4
CHE G622	Advanced Chemical Engineering Thermodynamics			5
CHE G641	Reaction Engineering			5
CHEM F325	Polymer Chemistry	3	0	3

CIVIL ENGINEERING

CORE COURSES		**L**	**P**	**U**
CE F211	Mechanics of Solids	3	0	3
CE F212	Transport Phenomena	3	0	3
CE F213	Surveying	3	1	4
CE F214	Construction Materials	3	0	3
CE F241	Analysis of Structures	3	0	3
CE F242	Construction Planning and Technology	3	0	3
CE F243	Soil Mechanics	3	1	4
CE F244	Highway Engineering	3	1	4
CE F311	Design of Concrete Structures	3	1	4
CE F312	Hydraulics Engineering	3	1	4
CE F313	Foundation Engineering	3	0	3
CE F341	Hydrology & Water Resources Engineering	3	0	3
CE F342	Water & Waste Water Treatment	3	1	4
CE F343	Design of Steel Structures	3	0	3

DISCIPLINE ELECTIVE COURSES

BITS F313	Multicriterion Decision Making in Engineering and Management	3	0	3
CE F323	Introduction to Environmental Engineering	3	0	3
CE F324	Numerical Analysis	3	0	3
CE F411	Operation Research for Engineers	3	0	3
CE F412	Disaster Management	3	0	3
CE F413	Advanced Structural Design	3	0	3
CE F415	Design of Prestressed Concrete Structure	3	0	3
CE F416	Computer Applications in Civil Engineering	3	1	4
CE F417	Applications of Artificial Intelligence in Civil Engineering	3	0	3
CE F419	Geotechnical Earthquake Engineering and Machine Foundation	3	0	3
CE F420	Introduction to Bridge Engineering	3	0	3
CE F421	Analysis and Design of FRP Reinforced Concrete Structures	3	0	3
CE F422	Urban Hydrology	2	1	3
CE F423	Green Buildings and Energy Conservation	3	0	3
CE F425	Airport, Railways and Waterways	3	0	3
CE F426	Geosynthetics and Reinforced Soil Structure	3	0	3
CE F427	System Modeling and Analysis	3	0	3

CE F428	Earthquake Resistant Design and Construction	3	0	3
CE F429	Design of Foundation Systems	3	0	3
CE F430	Design of Advanced Concrete Structures	3	0	3
CE F431	Principles of Geographical Information Systems	3	1	4
CE F432	Structural Dynamics	3	0	3
CE F433	Remote Sensing and Image Processing	3	1	4
CE F434	Environmental Impact Assessment	3	0	3
CE F435	Introduction to Finite Element Methods	3	0	3

COMPUTER SCIENCE

CORE COURSES

		L	P	U
CS F211	Data Structures & Algorithms	3	1	4
CS F212	Database Systems	3	1	4
CS F213	Object Oriented Programming	3	1	4
CS F214	Logic in Computer Science	3	0	3
CS F215	Digital Design	3	1	4
CS F222	Discrete Structures for Computer Science	3	0	3
CS F241	Microprocessors & Interfacing	3	1	4
CS F301	Principles of Programming Languages	2	0	2
CS F303	Computer Networks	3	1	4
CS F342	Computer Architecture	3	1	4
CS F351	Theory of Computation	3	0	3
CS F363	Compiler Construction	2	1	3
CS F364	Design & Analysis of Algorithms	3	0	3
CS F372	Operating Systems	3	0	3

DISCIPLINE ELECTIVE COURSES

BITS F311	Image Processing	3	0	3
BITS F312	Neural Networks and Fuzzy Logic	3	0	3
BITS F343	Fuzzy Logic and Applications	3	0	3
BITS F364	Human – Computer Interaction	3	0	3
BITS F386	Quantum Information and Computation	3	0	3
BITS F463	Cryptography	3	0	3
BITS F464	Machine Learning	3	0	3
BITS F465	Enterprise Computing	3	1	4
BITS F466	Service Oriented Computing	3	1	4
CS F314	Software Development for Portable Devices	2	1	3
CS F401	Multimedia Computing	3	0	3
CS F407	Artificial Intelligence	3	0	3
CS F413	Internetworking Technologies	3	0	3
CS F415	Data Mining	3	0	3
CS F422	Parallel Computing	3	0	3
CS F424	Software for Embedded Systems	3	1	4
CS F441	Selected Topics from Computer Science	-	-	3
CS F444	Real Time Systems	3	0	3
CS F446	Data Storage Technologies and Networks	3	0	3
CS F468	Information Security Project	0	3	3
CS F469	Information Retrieval	3	0	3
IS F311	Computer Graphics	3	0	3
IS F341	Software Engineering	3	1	4
IS F462	Network Programming	3	0	3
MATH F231	Number Theory	3	0	3
MATH F421	Combinatorial Mathematics	3	0	3
MATH F441	Discrete Mathematical Structures	3	0	3

ELECTRICAL AND ELECTRONICS ENGINEERING

CORE COURSES

		L	P	U
EEE F211	Electrical Machines	3	1	4
EEE F212	Electromagnetic Theory	3	0	3
EEE F214	Electronic Devices	3	0	3
EEE F215	Digital Design	3	1	4
EEE F241	Microprocessors and interfacing	3	1	4
EEE F242	Control Systems	3	0	3
EEE F243	Signals & Systems	3	0	3
EEE F244	Microelectronic Circuits	3	0	3
EEE F311	Communication Systems	3	1	4
EEE F312	Power Systems	3	0	3
EEE F313	Analog & Digital VLSI Design	3	0	3
EEE F341	Analog Electronics	3	1	4
EEE F342	Power Electronics	3	1	4
MATH F212	Optimization	3	0	3

DISCIPLINE ELECTIVE COURSES

BITS F312	Neural Networks and Fuzzy Logic	3	0	3
BITS F415	Introduction To MEMS	3	1	4
CS F213	Object Oriented Programming	3	1	4
CS F342	Computer Architecture	3	1	4

CS F372	Operating Systems	3	0	3
CS F451	Combinatorial Mathematics	3	0	3
CS G553	Reconfigurable Computing			5
ECE F312	EM Fields and Microwave Engineering Laboratory	0	1	1
ECE F343	Communication Networks	3	0	3
EEE F245	Control System Laboratory	0	1	1
EEE F246	Electrical and Electronic Circuits Laboratory	0	2	2
EEE F345	Power Apparatus & Networks	3	0	3
EEE F346	Data Communication Networks	2	0	2
EEE F348	FPGA Based System Design Laboratory	0	2	2
EEE F414	Telecommunication Switching Systems & Networks	3	0	3
EEE F416	Digital Communication	3	0	3
EEE F417	Computer Based Control System	3	0	3
EEE F418	Modern Communication Technologies	3	0	3
EEE F422	Modern Control Systems	3	0	3
EEE F425	Power System Analysis and control	3	0	3
EEE F426	Fiber Optics & Optoelectronics	3	0	3
EEE F427	Electric Power Utilization and Illumination	3	0	3
EEE F431	Mobile Telecommunication Networks	3	0	3
EEE F432	Medical Instrumentation	3	0	3
EEE F433	Electromagnetic Fields & Waves	3	0	3
EEE F434	Digital Signal Processing	3	1	4
EEE F435	Digital Image Processing	3	0	3
EEE F472	Satellite Communication	3	0	3
EEE F473	Wind Electrical Systems	3	0	3
EEE F474	Antenna Theory and Design	3	1	4
EEE F475	Special Electrical Machines	3	1	4
EEE F476	Switchgear and Protection	3	1	4
EEE F477	Modelling of Field-Effect NanoDevices	3	0	3
EEE F478	Power Systems Laboratory	0	2	2
EEE G512	Embedded System Design	3	1	4
EEE G626	Hardware Software Co-Design			4

ELECTRONICS AND COMMUNICATION ENGINEERING

CORE COURSES		L	P	U
ECE F211	Electrical Machines	3	1	4
ECE F212	Electromagnetic Theory	3	0	3
ECE F214	Electronic Devices	3	0	3
ECE F215	Digital Design	3	1	4
ECE F241	Microprocessors and interfacing	3	1	4
ECE F242	Control Systems	3	0	3
ECE F243	Signals & Systems	3	0	3
ECE F244	Microelectronic Circuits	3	0	3
ECE F311	Communication Systems	3	1	4
ECE F314	Electromagnetic Fields & Microwave Engineering	3	0	3
ECE F341	Analog Electronics	3	1	4
ECE F344	Information Theory & Coding	3	0	3
ECE F434	Digital Signal Processing	3	1	4

DISCIPLINE ELECTIVE COURSES		L	P	U
BITS F415	Introduction to MEMS	3	1	4
BITS F463	Cryptography	3	0	3
CS F213	Object Oriented Programming	3	1	4
CS F342	Computer Architecture	3	1	4
CS F372	Operating Systems	3	0	3
CS F451	Combinatorial Mathematics	3	0	3
CS G553	Reconfigurable Computing			5
ECE F312	EM Fields and Microwave Engineering Laboratory	0	1	1
ECE F414	Telecommunication Switching Systems & Networks	3	0	3
ECE F416	Digital Communication	3	0	3
ECE F418	Modern Communication Technologies	3	0	3
ECE F431	Mobile Telecommunication Networks	3	0	3
ECE F472	Satellite Communication	3	0	3
EEE F245	Control System Laboratory	0	1	1
EEE F246	Electrical and Electronic Circuits Laboratory	0	2	2
EEE F313	Analog & Digital VLSI Design	3	0	3
EEE F345	Power Apparatus & Networks	3	0	3
EEE F346	Data Communication Networks	2	0	2
EEE F348	FPGA Based System Design Laboratory	0	2	2
EEE F417	Computer Based Control System	3	0	3

EEE F422	Modern Control Systems	3	0	3
EEE F432	Medical Instrumentation	3	0	3
EEE F434	Digital Signal Processing	3	1	4
EEE F435	Digital Image Processing	3	0	3
EEE F474	Antenna Theory and Design	3	1	4
EEE F475	Special Electrical Machines	3	1	4
EEE F476	Switchgear and Protection	3	1	4
EEE F477	Modelling of Field-Effect Nano Devices	3	0	3
EEE F478	Power Systems Laboratory	0	2	2
EEE G512	Embedded System Design	3	1	4
EEE G626	Hardware Software Co-Design			4
INSTR F412	Analysis Instrumentation	3	0	3

ELECTRONICS AND INSTRUMENTATION ENGINEERING

CORE COURSES		**L**	**P**	**U**
INSTR F211	Electrical Machines	3	1	4
INSTR F212	Electromagnetic Theory	3	0	3
INSTR F214	Electronic Devices	3	0	3
INSTR F215	Digital Design	3	1	4
INSTR F241	Microprocessors and interfacing	3	1	4
INSTR F242	Control Systems	3	0	3
INSTR F243	Signals & Systems	3	0	3
INSTR F244	Microelectronic Circuits	3	0	3
INSTR F311	Electronic Instrumentation & Instrumentation Technology	3	1	4
INSTR F312	Transducers and Measurement Systems	3	0	3
INSTR F313	Analog & Digital VLSI Design	3	0	3
INSTR F341	Analog Electronics	3	1	4
INSTR F342	Power Electronics	3	1	4
INSTR F343	Industrial Instrumentation & Control	3	0	3

DISCIPLINE ELECTIVE COURSES		**L**	**P**	**U**
BITS F312	Neural Network & Fuzzy Logic	3	0	3
BITS F415	Introduction To MEMS	3	1	4
CS F213	Object Oriented Programming	3	1	4
CS F342	Computer Architecture	3	1	4
CS F372	Operating Systems	3	0	3
CS F451	Combinatorial Mathematics	3	0	3
CS G553	Reconfigurable Computing			5
ECE F312	EM Fields and Microwave Engineering Laboratory	0	1	1
EEE F245	Control System Laboratory	0	1	1
EEE F246	Electrical and Electronic Circuits Laboratory	0	2	2
EEE F311	Communication Systems	3	1	4
EEE F345	Power Apparatus & Networks	3	0	3
EEE F346	Data Communication Networks	2	0	2
EEE F348	FPGA Based System Design Laboratory	0	2	2
EEE F417	Computer Based Control System	3	0	3
EEE F422	Modern Control Systems	3	0	3
EEE F426	Fiber optics & Optoelectronics	3	0	3
EEE F427	Electric Power Utilization and Illumination	3	0	3
EEE F431	Mobile Telecommunication Networks	3	0	3
EEE F433	Electromagnetic Fields & Waves	3	0	3
EEE F434	Digital Signal Processing	3	1	4
EEE F435	Digital Image Processing (check number and description with BITS Image Processing)	3	0	3
EEE F472	Satellite Communication	3	0	3
EEE F474	Antenna Theory and Design	3	1	4
EEE F475	Special Electrical Machines	3	1	4
EEE F476	Switchgear and Protection	3	1	4
EEE F477	Modelling of Field-Effect Nano Devices	3	0	3
EEE F478	Power Systems Laboratory	0	2	2
EEE G512	Embedded System Design	3	1	4
EEE G626	Hardware Software Co-Design			4
INSTR F413	Advanced Process Control	3	0	3
INSTR F414	Telecommunication Switching Systems & Networks	3	0	3
INSTR F415	Digital Control	3	0	3
INSTR F419	Virtual Instrumentation	3	1	4
INSTR F420	Design of Instrumentation Systems	3	0	3
INSTR F422	Instrumentation for Petrochemical Industry	3	0	3
INSTR F432	Medical Instrumentation	3	0	3
INSTR F473	Wind Electrical Systems	3	0	3

MANUFACTURING ENGINEERING

CORE COURSES		**L**	**P**	**U**
MF F211	Mechanics of Solids	3	0	3
MF F212	Fluid Mechanics	3	0	3
MF F213	Materials Science & Engineering	2	0	2

MF F214	Applied Thermodynamics	3	0	3
MF F215	Mechanical Engineering Laboratory	0	2	2
MF F241	Machine Design & Drawing	3	1	4
MF F242	Manufacturing Management	2	0	2
MF F243	Manufacturing Processes	2	1	3
MF F244	Kinematics & Dynamics of Machinery	3	0	3
MF F311	Mechatronics & Automation	2	1	3
MF F312	Tool & Fixture Design	3	0	3
MF F313	Metal Forming & Machining	3	1	4
MF F341	Design of Machine Tools	3	0	3
MF F342	Computer Aided Design	3	1	4
MF F343	Casting & Welding	3	1	4
MF F344	Engineering Optimization	2	0	2
DISCIPLINE ELECTIVE COURSES		**L**	**P**	**U**
BITS F415	Introduction To MEMS	3	1	4
ECON F411	Project Appraisal	3	0	3
ME F415	Noise Engineering	3	0	3
ME F416	Reverse Engineering and Rapid Prototyping	3	0	3
ME F416	Work System Design	3	0	3
ME F417	Advanced Metal Forming	3	0	3
ME F419	Total Product Integration Engineering	3	0	3
ME F432	Computer Aided Manufacturing	3	0	3
ME F443	Quality Control Assurance and Reliability	3	0	3
ME F484	Automotive Technology	3	0	3
MF F411	Fluid Power Systems	3	1	4
MF F412	Automotive Systems	3	0	3
MF F413	Mechanical Vibrations and Acoustics	3	0	3
MF F414	Manufacturing Excellence	3	0	3
MF F418	Lean Manufacturing	3	0	3
MF F421	Supply Chain Management			4
MF F442	Advances in Materials Science	3	0	3
MF F453	Industrial Relations	3	0	3
MF F463	Maintenance and Safety	3	0	3
MF F471	Instrumentation and Control	3	0	3
MF F472	Precision Engineering	3	0	3
MF F473	Product Design and Development	3	0	3
MF F474	Product Design and Development Projects	0	0	3
MF F485	Sustainable Manufacturing	3	0	3

MECHANICAL ENGINEERING

CORE COURSES		**L**	**P**	**U**
ME F211	Mechanics of Solids	3	0	3
ME F212	Fluid Mechanics	3	0	3
ME F213	Materials Science & Engineering	2	0	2
ME F214	Applied Thermodynamics	3	0	3
ME F215	Mechanical Engineering Laboratory	0	2	2
ME F241	Machine Design & Drawing	3	1	4
ME F242	IC Engines	2	0	2
ME F243	Production Techniques I	2	1	3
ME F244	Kinematics & Dynamics of Machinery	3	0	3
ME F311	Heat Transfer	3	1	4
ME F312	Advanced Mechanics of Solids	3	0	3
ME F313	Production Techniques II	3	1	4
ME F341	Prime Movers & Fluid Machines	2	1	3
ME F342	Computer Aided Design	3	1	4
ME F343	Mechanical Vibrations	3	0	3
ME F344	Engineering Optimization	2	0	2
DISCIPLINE ELECTIVE COURSES		**L**	**P**	**U**
BITS F415	Introduction to MEMS	3	1	4
DE G513	Tribology	3	2	5
DE G514	Fracture Mechanics	3	2	5
DE G531	Product Design	3	2	5
ECON F411	Project Appraisal	3	0	3
ME F411	Fluid Power Systems	3	1	4
ME F412	Production Planning & Control	3	0	1
ME F413	Nonlinear Vibrations	3	0	3
ME F415	Gas Dynamics	3	0	3
ME F416	Reverse Engineering and Rapid Prototyping	3	0	3
ME F417	Advanced Metal Forming	3	0	3
ME F418	Rocket and Spacecraft Propulsion	3	0	3
ME F419	Total Product Integration Engineering	3	0	3
ME F420	Power Plant Engineering	3	0	3
ME F423	Microfluidics and Applications	3	0	3
ME F432	Computer Aided manufacturing	3	0	3
ME F433	Solar Thermal Process Engineering	3	1	4

ME F441	Automotive Vehicles	3	0	3
ME F443	Quality Control, Assurance and Reliability	3	0	3
ME F451	Mechanical Equipment Design	3	0	3
ME F452	Composite Materials & Design	3	0	3
ME F461	Refrigeration and Air conditioning	3	0	3
ME F472	Precision Engineering	3	0	3
ME F482	Combustion	3	0	3
ME F483	Wind Energy	3	0	3
ME F484	Automotive Technology	3	0	3
ME F485	Numerical Techniques for Fluid Flow and Heat Transfer	3	0	3
ME G511	Mechanism and Robotics	3	2	5
ME G512	Finite Element Methods	3	2	5
ME G514	Turbomachinery	3	2	5
ME G515	Computational Fluid Dynamics	3	2	5
ME G533	Conduction and Radiation Heat Transfer	3	2	5
ME G534	Convective Heat and Mass Transfer	3	2	5
MF F421	Supply chain management			4
MF F485	Sustainable Manufacturing	3	0	3
MST G522	Advanced Composites	3	2	5

PHARMACY

CORE COURSES		L	P	U
BITS F219	Process Engineering	2	1	3
PHA F211	Pharmaceutical Analysis	2	1	3
PHA F212	Dispensing Pharmacy	2	1	3
PHA F213	Microbiology	2	1	3
PHA F214	Anatomy, Physiology & Hygiene	2	1	3
PHA F215*	Introduction to Molecular Biology and Immunology	3	0	3
PHA F241	Pharmaceutical Chemistry	2	1	3
PHA F242	Biological Chemistry	2	1	3
PHA F243	Industrial Pharmacy	2	1	3
PHA F244	Physical Pharmacy	2	1	3
PHA F311	Pharmacology I	2	1	3
PHA F312	Medicinal Chemistry I	2	1	3
PHA F313	Instrumental Methods of Analysis	2	1	4
PHA F314	Pharmaceutical Formulations and Biopharmaceutics	2	1	3
PHA F341	Pharmacology II	2	1	3
PHA F342	Medicinal Chemistry II	2	1	3
PHA F343	Forensic Pharmacy	2	-	2
PHA F344	Natural Drugs	2	1	3

*** To be offered to B.Pharm. students admitted in 2014 onwards in place of PHA F243**

DISCIPLINE ELECTIVE COURSES		L	P	U
MATH F212	Optimization	3	0	3
PHA F413	Pharmaceutical Management and Quality Control	3	0	3
PHA F414	Biopharmaceutics	3	0	3
PHA F415	Pathophysiology	3	0	3
PHA F416	Chemistry of Synthetic Drugs	3	0	3
PHA F417	Pharmacoeconomics	3	0	3
PHA F422	Cosmetic Science	2	1	3
PHA F432	Hospital Pharmacy	3	0	3
PHA F441	Biochemical Engineering	3	0	3
PHA F442	Applied Pharmaceutical Chemistry	3	0	3
PHA F461	Phytochemistry	2	1	3

BIOLOGICAL SCIENCES

CORE COURSES		L	P	U
BIO F211	Biological Chemistry	3	0	3
BIO F212	Microbiology	3	1	4
BIO F213	Cell Biology	3	0	3
BIO F214	Integrated Biology	3	0	3
BIO F215	Biophysics	3	0	3
BIO F241	Ecology & Environmental Science	3	0	3
BIO F242	Introduction to Bioinformatics	3	0	3
BIO F243	Genetics	3	0	3
BIO F244	Instrumental Methods of Analysis	1	3	4
BIO F311	Recombinant DNA Technology	3	0	3
BIO F312	Plant Physiology	3	0	3
BIO F313	Animal Physiology	3	0	3
BIO F341	Developmental Biology	3	0	3
BIO F342	Immunology	3	0	3

DISCIPLINE ELECTIVE COURSES		L	P	U
BIO F314	Conservation Biology	2	1	3
BIO F352	Cell and Tissue Culture Technology	3	1	4
BIO F411	Laboratory	0	3	3
BIO F413	Molecular Biology of Cell	3	0	3
BIO F417	Biomolecular Modelling	3	0	3

BIO F418	Genetic Engineering Techniques	1	3	4
BIO F419	Molecular Evolution	3	0	3
BIO F421	Enzymology	3	0	3
BIO F431	Reproductive Physiology	3	0	3
BIO F441	Biochemical Engineering	3	0	3
BIO F451	Bioprocess Technology	3	0	3
BIO G510	Application of Computers and Statistics in Biology	5	0	5
BIO G512	Molecular Mechanism of Gene Expression	3	2	5
BIO G513	Microbial and Fermentation Technology	3	2	5
BIO G515	Stem Cell and Regenerative Biology	3	1	4
BIO G522	Interferon Technology	3	1	4
BIO G523	Advanced and Applied Microbiology	3	2	5
BIO G524	Animal Cell Technology	3	2	5
BIO G525	Environmental Biotechnology & Waste Mgnt	3	2	5
BIO G526	Cancer Biology	3	2	5
BIO G544	Bioremediation and biometallurgy	5	0	5
BIO G545	Molecular Parasitology and Vector Biology			5
BIO G561	Advances in Recombinant DNA Technology	3	2	5
BIO G570	Recent Developments in Biology	1	0	1
BIO G612	Human Genetics	3	2	5
BIO G631	Membrane and Liposome Technology	3	1	4
BIO G632	Transgenic Technology	3	2	5
BIO G642	Experimental Techniques		4	4
BIO G643	Plant Biotechnology	3	2	5
BIO G651	Protein and Enzyme Bioengineering	3	2	5
BIO G661	Gene Toxicology	3	1	4
BIO G671	Bioconversion Technology	3	2	5
BIOT F345	Proteomics	3	0	3
BIOT F346	Genomics	3	0	3
BIOT F347	Immunotechnology	3	0	3
BIOT F416	Introduction to Pharmaceutical Biotechnology	3	0	3
BIOT F422	Nanobiotechnology	3	0	3
BIOT F424	Food Biotechnology	3	0	3
BITS F418	Introduction to Biomedical Engineering	3	1	4
BITS F467	Bioethics and Biosafety	3	0	3
CHEM F212	Organic Chemistry I	3	0	3
CHEM F213	Physical Chemistry II	3	0	3
MATH F212	Optimization	3	0	3

CHEMISTRY

CORE COURSES

		L	P	U
CHEM F211	Physical Chemistry I	3	0	3
CHEM F212	Organic Chemistry I	3	0	3
CHEM F213	Physical Chemistry II	3	0	3
CHEM F214	Inorganic Chemistry I	3	0	3
CHEM F241	Inorganic Chemistry II	3	0	3
CHEM F242	Chemical Experimentation I	0	3	3
CHEM F243	Organic Chemistry II	3	0	3
CHEM F244	Physical Chemistry III	3	0	3
CHEM F311	Organic Chemistry III	3	0	3
CHEM F312	Physical Chemistry IV	3	0	3
CHEM F313	Instrumental Methods of Analysis	3	1	4
CHEM F341	Chemical Experimentation II	0	4	4
CHEM F342	Organic Chemistry IV	3	0	3
CHEM F343	Inorganic Chemistry III	3	0	3
PHY F212	Electromagnetic Theory I	3	0	3

DISCIPLINE ELECTIVE COURSES

		L	P	U
CHEM F223	Colloid and Surface Chemistry	3	0	3
CHEM F323	Biophysical Chemistry	3	0	3
CHEM F324	Numerical Methods in Chemistry	3	3	4
CHEM F325	Polymer Chemistry	3	0	3
CHEM F326	Solid State Chemistry	3	0	3
CHEM F327	Electrochemistry: Fundamentals and Applications	3	0	3
CHEM F328	Supramolecular Chemistry	3	0	3
CHEM F329	Analytical Chemistry	3	1	4
CHEM F330	Photophysical Chemistry	3	1	4
CHEM F333	Chemistry of Materials	3	0	3
CHEM F334	Magnetic Resonance	3	0	3
CHEM F335	Organic Chemistry and Drug Design	3	0	3
CHEM F336	Nanochemistry	3	1	4
CHEM F337	Green Chemistry and Catalysis	3	0	3
CHEM F412	Photochemistry and Laser Spectroscopy	3	0	3
CHEM F413	Electron Correlation In Atoms And Molecules	3	1	4

CHEM F414	Bio and Chemical Sensors	3	0	3
CHEM F415	Frontiers in Organic Synthesis	3	0	3
CHEM F422	Statistical Thermodynamics	3	0	3

ECONOMICS

CORE COURSES		**L**	**P**	**U**
ECON F211	Principles of Economics	3	0	3
ECON F212	Fundamentals of Finance and Accounts	3	0	3
ECON F213	Mathematical and Statistical Methods	3	0	3
ECON F214	Economic Environment of Business	3	0	3
ECON F241	Econometric Methods	3	0	3
ECON F242	Microeconomics	3	0	3
ECON F243	Macroeconomics	3	0	3
ECON F244	Economics of Growth and Development	3	0	3
ECON F311	International Economics	3	0	3
ECON F312	Money, Banking and Financial Markets	3	0	3
ECON F313	Issues in Economic Development	3	0	3
ECON F341	Public Finance Theory and Policy	3	0	3
ECON F342	Applied Econometrics	3	0	3
ECON F343	Economic Analysis of Public Policy	3	0	3

DISCIPLINE ELECTIVE COURSES		**L**	**P**	**U**
ECON F314	Industrial Economics	3	0	3
ECON F315	Financial Management	3	0	3
ECON F351	Indian Economic Development	3	0	3
ECON F352	Management of Banks and Financial Institutions	3	0	3
ECON F353	Energy Economics and Policy	3	0	3
ECON F354	Derivatives and Risk Management	3	0	3
ECON F355	Business Analysis and Valuation	3	0	3
ECON F356	Strategic Financial Management	3	0	3
ECON F357	Management Control System	3	0	3
ECON F411	Project Appraisal	3	0	3
ECON F412	Security Analysis and Portfolio Management	3	0	3
ECON F413	Financial Engineering	3	0	3
ECON F414	Creating and Leading Entrepreneurial Organizations	3	0	3
ECON F415	New Venture Creation	3	0	3
ECON F417	Risk Management and Insurance	3	0	3
ECON F422	Functions and Working of Stock Exchanges	3	0	3
ECON F434	International Business	3	0	3
ECON F435	Marketing Research	3	0	3
ECON F471	Resources and Environmental Economics	3	0	3
MATH F212	Optimization	3	0	3
MATH F242	Operations Research	3	0	3

MATHEMATICS

CORE COURSES		**L**	**P**	**U**
MATH F212	Optimization	3	0	3
MATH F213	Discrete Mathematics	3	0	3
MATH F214	Elementary Real Analysis	3	0	3
MATH F215	Algebra-I	3	0	3
MATH F241	Mathematical Methods	3	0	3
MATH F242	Operations Research	3	0	3
MATH F243	Graphs and Networks	3	0	3
MATH F244	Measure & Integration	3	0	3
MATH F311	Introduction to Topology	3	0	3
MATH F312	Ordinary Differential Equations	3	0	3
MATH F313	Numerical Analysis	3	0	3
MATH F341	Introduction to Functional Analysis	3	0	3
MATH F342	Differential Geometry	3	0	3
MATH F343	Partial Differential Equations	3	0	3

DISCIPLINE ELECTIVE COURSES		**L**	**P**	**U**
BITS F343	Fuzzy Logic and Applications	3	0	3
BITS F463	Cryptography	3	0	3
CS F364	Design and Analysis of Algorithms	3	0	3
MATH F231	Number Theory	3	0	3
MATH F314	Algebra-II	3	0	3
MATH F353	Statistical Inference and Applications	3	0	3
MATH F354	Complex Analysis	3	0	3
MATH F420	Mathematical Modeling	3	0	4
MATH F421	Combinatorial Mathematics	3	0	3
MATH F422	Numerical Methodology for Partial Differential Equations	3	1	4
MATH F431	Distribution Theory	3	0	3
MATH F441	Discrete Mathematical Structures	3	0	3

MATH F444	Numerical Solutions of Ordinary Differential Equations	3	0	3
MATH F445	Mathematical Fluid Dynamics	3	0	3
MATH F456	Cosmology	3	0	3
MATH F471	Nonlinear Optimization	3	0	3
MATH F481	Commutative Algebra	3	0	3

PHYSICS

CORE COURSES		**L**	**P**	**U**
PHY F211	Classical Mechanics	3	1	4
PHY F212	Electromagnetic Theory I	3	0	3
PHY F213	Optics	3	0	3
PHY F214	Electricity, Magnetism & Optics Laboratory	0	2	2
PHY F241	Electromagnetic Theory II	3	1	4
PHY F242	Quantum Mechanics I	3	0	3
PHY F243	Mathematical Methods of Physics	3	0	3
PHY F244	Modern Physics Laboratory	0	2	2
PHY F311	Quantum Mechanics II	3	0	3
PHY F312	Statistical Mechanics	3	0	3
PHY F313	Computational Physics	3	0	3
PHY F341	Solid State Physics	3	0	3
PHY F342	Atomic & Molecular Physics	3	0	3
PHY F343	Nuclear & Particle Physics	3	0	3
PHY F344	Advanced Physics Laboratory	0	3	3

DISCIPLINE ELECTIVE COURSES		**L**	**P**	**U**
BIO F215	Biophysics	3	0	3
BITS F316	Nonlinear Dynamics and Chaos	3	0	3
BITS F386	Quantum Information and Computation	3	0	3
BITS F416	Introduction to Nanoscience	3	0	3
EEE F426	Fibre Optics & Optoelectronics	3	0	3
PHY F215	Introduction to Astronomy & Astrophysics	3	0	3
PHY F315	Theory of Relativity	3	0	3
PHY F412	Introduction To Quantum Field Theory	3	1	4
PHY F413	Particle Physics	3	1	4
PHY F414	Physics of Advanced Materials	3	1	4
PHY F415	General Theory of Relativity and Cosmology	3	1	4
PHY F416	Soft Condensed Matter Physics	3	1	4
PHY F417	Experimental Methods of Physics	3	1	4
PHY F418	Lasers and Applications	3	1	4
PHY F419	Advanced Solid State Physics	3	1	4
PHY F420	Quantum Optics	3	1	4
PHY F421	Advanced Quantum Mechanics	3	1	4
PHY F422	Group Theory and Applications	3	1	4
PHY F423	Special Topics in Statistical Mechanics	3	1	4
PHY F424	Advanced Electrodynamics	3	1	4
PHY F425	Advanced Mathematical Methods of Physics	3	1	4
PHY F426	Physics of Semiconductor Devices	3	1	4
PHY F427	Atmospheric Physics	3	0	3
PHY G512	Advanced Quantum Field Theory	3	0	3

GENERAL STUDIES - COMMUNICATION & MEDIA STUDIES STREAM

CORE COURSES		**L**	**P**	**U**
GS F221	Business Communication	3	0	3
GS F222	Language Lab Practice	0	3	3
GS F223	Introduction to Mass Communication	3	0	3
GS F224	Print and Audio Visual Advertising	2	1	3
GS F241	Creative Writing	2	1	3
GS F243	Current Affairs	3	0	3
GS F244	Reporting and Writing for Media	3	0	3
GS F245	Effective Public Speaking	2	1	3
GS F321	Mass Media Content and Design	2	1	3
GS F322	Critical Analysis of Literature and Cinema	3	0	3
GS F342	Computer Mediated Communication	3	0	3
GS F343	Short Film and Video Production	2	1	3

DISCIPLINE ELECTIVE COURSES		**L**	**P**	**U**
BITS F385	Introduction to Gender Studies	3	0	3
GS F211	Modern Political Concepts	3	0	3
GS F212	Environment, Development & Climate Change	3	0	3
GS F231	Dynamics of Social Change	3	0	3

GS F232	Introductory Psychology	3	0	3
GS F242	Cultural Studies	3	0	3
GS F311	Introduction to Conflict Management	3	0	3
GS F325	Journalism	3	0	3
GS F326	Creative Thinking	2	1	3
GS F327	Selected Reading	3	0	3
GS F333	Public Administration	3	0	3
GS F334	Global Business Technology & Knowledge Sharing	3	0	3
GS F344	Copywriting	2	0	2
HSS F227	Cross Cultural Skills	3	0	3
HSS F232	Introduction to Development Studies	3	0	3
HSS F315	Society, Business, and Politics	3	0	3
HSS F317	Introduction to Globalization	3	0	3
HSS F319	Lighting for Theatre and Films			2
HSS F323	Organizational Psychology	3	0	3
HSS F328	Human Resource Development	3	0	3
HSS F341	Performance Design	1	2	3
HSS F343	Professional Ethics	3	0	3
HSS F346	International Relations	3	0	3

GENERAL STUDIES – DEVELOPMENTAL STUDIES STREAM

CORE COURSES		**L**	**P**	**U**
ECON F211	Principles of Economics	3	0	3
GS F211	Modern Political Concepts	3	0	3
GS F212	Environment, Development & Climate Change	3	0	3
GS F213	Development Theories	3	0	3
GS F231	Dynamics of Social Change	3	0	3
GS F232	Introductory Psychology	3	0	3
GS F233	Public Policy	3	0	3
GS F234	Development Economics	3	0	3
GS F311	Introduction to Conflict Management	3	0	3
GS F312	Applied Philosophy	3	0	3
GS F331	Techniques in Social Research	3	0	3
GS F332	Contemporary India	3	0	3
GS F333	Public Administration	3	0	3
GS F334	Global Business Technology & Knowledge Sharing	3	0	3

DISCIPLINE ELECTIVE COURSES		**L**	**P**	**U**
BITS F214	Science, Technology and Modernity	3	0	3
BITS F385	Introduction to Gender Studies	3	0	3
BITS F399	Humanistic Theories of Science and Technology	3	0	3
GS F212	Environment, Development and Climate Change	3	0	3
GS F213	Development Theories	3	0	3
HSS F233	Main Trends in Indian History	3	0	3
HSS F234	Main Currents of Modern History	3	0	3
HSS F235	Introductory Philosophy	3	0	3
HSS F236	Symbolic Logic	3	0	3
HSS F312	Bureaucracy	3	0	3
HSS F315	Society, Business, and Politics	3	0	3
HSS F343	Professional Ethics	3	0	3
HSS F344	Heritage of India	3	0	3
HSS F345	Gandhian Thoughts	3	0	3
HSS F346	International Relations	3	0	3

FINANCE

CORE COURSES		**L**	**P**	**U**
ECON F211	Principles of Economics	3	0	3
ECON F241	Econometric Methods	3	0	3
FIN F212	Fundamentals of Finance and Accounts	3	0	3
FIN F213	Mathematical and Statistical Methods	3	0	3
FIN F214	Economic Environment of Business	3	0	3
FIN F242	Introduction to Financial Mathematics	3	0	3
FIN F243	Functions and Working of Stock Exchanges	3	0	3
FIN F244	Indian Financial System	3	0	3
FIN F311	Derivatives & Risk management	3	0	3
FIN F312	Fundamental of Taxation & Audit	3	0	3
FIN F313	Security Analysis and Portfolio Management	3	0	3
FIN F314	Investment banking and Financial Services	3	0	3

FIN F315	Financial Management	3	0	3
FIN F341	International Financial markets and Services	3	0	3
FIN F342	Project Finance	3	0	3
DISCIPLINE ELECTIVE COURSES		**L**	**P**	**U**
BITS F488	Service Management Systems	3	0	0
BITS F490	Project Management	4	0	4
ECON F312	Money, Banking and Financial Markets	3	0	3
ECON F342	Applied Econometrics	3	0	3
ECON F352	Management of Banks and Financial Institutions	3	0	3
ECON F355	Business Analysis and Valuation	3	0	3
ECON F356	Strategic Financial Management	3	0	3
ECON F357	Management Control System	3	0	3
ECON F411	Project Appraisal	3	0	3
ECON F413	Financial Engineering	3	0	3
ECON F414	Creating and Leading Entrepreneurial Organizations	3	0	3
ECON F415	New Venture Creation	3	0	3
ECON F416	Regional Economics	3	0	3
FIN F413	Risk Management and Insurance	3	0	3

INFORMATION SYSTEMS

CORE COURSES		**L**	**P**	**U**
IS F211	Data Structures & Algorithms	3	1	4
IS F213	Object Oriented Programming	3	1	4
IS F214	Logic in Computer Science	3	0	3
IS F222	Discrete Structures for Computer Science	3	0	3
IS F241	Digital Electronics & Microprocessors	3	1	4
IS F242	Computer Organization	3	1	4
IS F243	Database Systems & Applications	3	1	4
IS F301	Principles of Programming Languages	2	0	2
IS F303	Computer Networks	3	1	4
IS F311	Computer Graphics	3	0	3
IS F322	Software Testing	2	1	3
IS F341	Software Engineering	3	1	4
IS F342	Compiler Design	2	1	3
IS F372	Operating Systems	3	0	3
DISCIPLINE ELECTIVE COURSES		**L**	**P**	**U**
BITS F311	Image Processing	3	0	3
BITS F312	Neural Networks and Fuzzy Logic	3	0	3
BITS F343	Fuzzy Logic and Applications	3	0	3
BITS F364	Human – Computer Interaction	3	0	3
BITS F386	Quantum Information and Computation	3	0	3
BITS F463	Cryptography	3	0	3
BITS F464	Machine Learning	3	0	3
BITS F465	Enterprise Computing	3	1	4
BITS F466	Service Oriented Computing	3	1	4
CS F314	Software Development for Portable Devices	2	1	3
CS F364	Design and Analysis of Algorithms	3	0	3
CS F401	Multimedia Computing	3	0	3
CS F407	Artificial Intelligence	3	0	3
CS F413	Internetworking Technologies	3	0	3
CS F415	Data Mining	3	0	3
CS F422	Parallel Computing	3	0	3
CS F424	Software for Embedded Systems	3	1	4
CS F441	Selected Topics from Computer Science	-	-	3
CS F446	Data Storage Technologies and Networks	3	0	3
CS F469	Information Retrieval	3	0	3
IS F462	Network Programming	3	0	3
MATH C441	Discrete Mathematical Structures	3	0	3
MATH F231	Number Theory	3	0	3
MATH F421	Combinatorial Mathematics	3	0	3

Project Type Courses

In addition to discipline electives mentioned above, the following project type courses are also being offered by the departments for each of their respective programmes. These courses may be taken by the students to meet the discipline elective requirements.

XXX F266	Study Project	3
XXX F366	Laboratory Project	3
XXX F367	Laboratory Project	3
XXX F376	Design Project	3
XXX F377	Design Project	3
XXX F491	Special Project	3

where XXX indicates the Degree programme. For example, CHE F266 Study Project is

intended for a student of B.E. Chemical Engineering.

A student may avail a maximum of 3 Project courses to meet the Discipline Electives Requirement under the head of (Discipline) Electives with the following limitations:

(a) All of these Project courses should be

  (i) within the Discipline (for which the degree is being awarded) or

  (ii) from an allied Discipline if so specified by the Department offering the degree

(b) The projects may be chosen from under these sub-heads.

  (i) Study Projects (maximum of 1)

  (ii) Laboratory (maximum of 2)

  (iii) Design Projects (maximum of 2)

  (iv) Special Projects (maximum of 1)

A student may avail a maximum of 3 Project courses (under any of the heads mentioned above offered by any discipline as an Open Elective. However, in total a student may avail at most 5 Project courses against Electives slots in any category.

Pool of Humanities courses for students admitted in 2011 onwards in first degree programmes:

The following is the list of courses from which Humanities Electives can be taken by the students admitted in 2011 onwards in different first degree programs to meet the general institutional requirement of eight units under the Humanities elective category:

Course No.	Course Title	L	P	U
BITS F419	Management of Cross Cultural Engineering Teams	3	0	3
BITS F214	Science, Technology and Modernity	3	0	3
BITS F385	Introduction to Gender Studies	3	0	3
BITS F399	Humanistic Theories of Science and Technology	3	0	3
GS F211	Modern Political Concepts	3	0	3
GS F212	Environment, Development & Climate Change	3	0	3
GS F221	Business Communication	3	0	3
GS F223	Introduction to Mass Communication	3	0	3
GS F224	Print and Audio-Visual Advertisement	2	1	3
GS F231	Dynamics of Social Change	3	0	3
GS F232	Introductory Psychology	3	0	3
GS F233	Public Policy	3	0	3
GS F234	Development Economics	3	0	3
GS F241	Creative Writing			3*
GS F242	Cultural Studies	3	0	3
GS F243	Current Affairs	3	0	3
GS F244	Reporting and Writing for Media	2	1	3
GS F245	Effective Public Speaking	2	1	3
GS F311	Introduction to Conflict Management	3	0	3
GS F312	Applied Philosophy	3	0	3
GS F313	Marxian Thoughts	3	0	3
GS F321	Mass Media Content and Design	2	1	3
GS F322	Critical Analysis of Literature and Cinema	3	0	3
GS F325	Journalism	3	0	3
GS F326	Creative Thinking	2	1	3
GS F327	Selected Reading	3	0	3
GS F331	Techniques in Social Research	3	0	3
GS F332	Contemporary India	3	0	3
GS F333	Public Administration	3	0	3
GS F343	Short Film and Video Production	2	1	3
GS F344	Copywriting	2	0	2
HSS F221	Readings from Drama	3	0	3
HSS F222	Linguistics	3	0	3
HSS F223	Appreciation of Indian Music	3	0	3
HSS F226	Postmodernism	3	0	3
HSS F227	Cross Cultural Skills	3	0	3
HSS F228	Phonetics & Spoken English	3	0	3
HSS F229	Introduction to Western Music	3	0	3
HSS F232	Introduction to Development Studies	3	0	3
HSS F233	Main Trends in Indian History	3	0	3
HSS F234	Main Currents of Modern History	3	0	3

Course No.	Course Title	L	P	U
HSS F235	Introductory Philosophy	3	0	3
HSS F236	Symbolic Logic	3	0	3
HSS F237	Contemporary Indian English Fiction	3	0	3
HSS F238	Sports and Society	3	0	3
HSS F266	Study Project			3
HSS F315	Society, Business, and Politics	3	0	3
HSS F316	Popular Literature and Culture of South Asia	3	0	3
HSS F317	Introduction to Globalization	3	0	3
HSS F318	Introduction to Anthropology	3	0	3
HSS F319	Lighting for Theatre and Films			2*
HSS F322	Social and Political Ecology	3	0	3
HSS F323	Organizational Psychology	3	0	3
HSS F325	Cinematic Adaptation	3	0	3
HSS F326	Humanities and Design	2	1	3
HSS F327	Contemporary Drama	3	0	3
HSS F328	Human Resource Development	3	0	3
HSS F329	Musicology – An – Introduction	3	0	3
HSS F330	Appreciation of Art	3	0	3
HSS F331	Sankara's Thoughts	3	0	3
HSS F332	Cinematic Art			3*
HSS F333	Comparative Religion	3	0	3
HSS F334	Srimad Bhagavad Gita	3	0	3
HSS F335	Literary Criticism	3	0	3
HSS F336	Modern Fiction	3	0	3
HSS F337	English Literary Forms and Movements	3	0	3
HSS F338	Comparative Indian Literature	3	0	3
HSS F339	Theatre Art Acting and Production	3	0	3
HSS F340	Post Colonial Literatures	3	0	3
HSS F341	Performance Design	1	2	3
HSS F342	Advanced Communicative English	3	0	3
HSS F343	Professional Ethics	3	0	3
HSS F344	Heritage of India	3	0	3
HSS F345	Gandhian Thoughts	3	0	3
HSS F346	International Relations	3	0	3
HSS F347	Introduction to Carnatic Music	3	0	3
HSS F348	Introduction to Hindustani Music	3	0	3
HSS F349	Ecocriticism	3	0	3
HSS F350	Human Rights: History, Theory & Practice	3	0	3
HSS F352	Technology, Work and Society	3	0	3
HSS F353	Philosophy of Aesthetics	3	0	3
HSS F354	Introduction to Islamic Economy	3	0	3
HSS F355	Dictatorship, Democracy & Development	3	0	3
HSS F356	Social Movements and Protest Politics	3	0	3
HSS F399	Introduction to American Literature	3	0	3
SANS F111	Sanskrit	3	0	3

It may be noted that a student cannot count a course (or its equivalent) of his/her own discipline (s) as a humanities elective even if it is listed in this pool of humanities electives.

Other Courses

BIO F231	Biology Project Laboratory			3
BITS C483	Indian Wisdom for Modern Management	3	0	3
BITS F211	Introduction to IPR			1
BITS F212	Introduction to Human Rights			1
BITS F213	Introduction to Environmental studies			1
BITS F215	Applications of Bio-Medical Instrumentation Techniques in Healthcare	2	0	2
BITS F217	Environment, Development and Climate Change	3	0	3
BITS F319	Negotiation Skills and Techniques	2	0	2
BITS F320	Managerial Skills			2*
BITS F321	Legal and Economic Environment of Business			4*
BITS F333	Project on Organisational Aspects			3
BITS F334	Project on Organisational Aspects			3
BITS F372	Data Communications and Networks	3	0	3
BITS F381	TIC Projects			3
BITS F382	Reading Course			3
BITS F383	TIC Projects			3
BITS F398	Creative Multimedia	2	2	3

BITS F414	Introduction to Bioinformatics	3 0 3
BITS F416	Introduction to Nanoscience	3 0 3
BITS F417	Micro Fluidics and its Application	4*
BITS F428	Essentials of Strategic Management	3 0 3
BITS F431	Flexible Manufacturing Systems	3 2 3
BITS F441	Robotics	3
BITS F442	Remote Sensing and Image Processing	3
BITS F443	Image Processing	3 0 3
BITS F444	Artificial Intelligence	3
BITS F445	Neural Networks and Applications	3 0 3
BITS F446	Pattern Recognition	3
BITS F447	Multimedia Computing	3 0 3
BITS F448	Retail Management Systems	3 0 3
BITS F449	Financial Engineering	3 0 3
BITS F461	Software Engineering	3
BITS F462	Renewable Energy	3 0 3
BITS F468	New Venture Creation	3 0 3
BITS F469	Financing Infrastructure Projects	3 0 3
BITS F488	Services Management Systems	3 0 3
BITS F490	Project Management	4
BITS F493	Business Analysis and Valuation	3 0 3
BITS F494	Environmental Impact Assessment	3 1 4
PHY F345	Quantum Mechanics for Engineers	3 0 3

MINOR PROGRAMMES FOR FIRST DEGREE STUDENTS

"Minor programs" are offered as options for first degree students with the intent of encouraging them to add focus to their supplemental learning (outside a major area) as well as recognizing and certifying the knowledge obtained in an area that is outside of their major area.

General Guidelines

- A minor would allow a Department (or multiple Departments) to offer a package of courses in an area/sub-area to students for whom this area/sub-area would not be part of their (major) program.
- A minor option would allow a student to pursue the study of an area or a sub-area through a set of courses but not as exhaustively as required to obtain a degree (i.e. a major) in that area.
- A minor may be inter-disciplinary (e.g. a minor in Computational Science may include courses in Numerical Analysis, Computational Physics, Computational Chemistry, and Bioinformatics among others).
- A minor will be recognized by means of a separate certificate.

Requirements for a minor

- Courses and Units Requirement:

  Each minor would be defined by coursework requirement with the following conditions:

Category	Courses	Units
Minor – Core	4 (max)	12 (max)
Minor – Electives	2 (min)	6 (min)
Minor – Total	5 (min)	15 (min)

- Elective Pool:
  - The pool of electives specific to a minor may include courses from one or more disciplines and may include project / seminar type courses.
  - A student may use at most one project / seminar type course to meet the requirements of a minor.
- Overlap in requirements:
  - At most 2 courses (and at most 6 units) out of the above requirement (of 5 courses and 15 units) may be met by mandatory courses of the student's degree i.e. major (or degrees i.e. majors) :

    i.e. from the general institutional requirement (excluding Humanities requirement) or the (Major) discipline Core(s).
  - No course may be used to meet the requirements of two different minors nor may a course be used to the meet the requirements of two majors and a minor.
- GPA requirement:
  - A student – on completion of the requirements for a minor – must have maintained a cumulative GPA of 4.5 or above (out of 10) in the courses applied to the minor.

Process for declaring / obtaining a minor

- A student – if he/she chooses to pursue a minor – must declare at the end of the 2nd year that he/she will pursue a specific minor. The student will charged a small fee for logistics.
- If and when he/she completes the requirements for the minor – as stipulated above and as stipulated for the specific minor, then he/she may apply for a "minor" certificate.
- If it is verified that the requirements are met then he/she will be awarded a "minor certificate" (separate from a degree - i.e. major - certificate).
- A minor certificate will be issued only on completion of a degree (i.e. a major).

At present five minor programs viz. Finance, Film and Media, Philosophy, Economics and Politics (PEP), English Studies and Materials Science and Engineering have been designed. The details of which are given below:

(a) Minor in Finance

The minor in Finance aims at providing the student a grounding in the basic concepts of accounting and finance so as to complement their existing disciplinary knowledge, enrich their educational experience, enable them to make better financial decisions, and expand their career opportunities. It will also give students an opportunity to learn more about investments and quantitative applications in finance.

Courses: 5 courses (min)

Units: 15 (min)

Core Courses

ECON F212	Fundamentals of Finance and Accounting	3	0	3
FIN F315	Financial Management	3	0	3

Elective Courses

ECON F241	Econometric methods	3	0	3
ECON F312	Money banking and Financial markets	3	0	3
ECON F355	Business Analysis & Valuation	3	0	3
ECON F411	Project Appraisal	3	0	3
ECON F413	Financial Engineering	3	0	3
FIN F242	Financial mathematics	3	0	3
FIN F243	Functions & Working of Stock Exchanges	3	0	3
FIN F311	Derivatives & Risk Management	3	0	3
FIN F312	Fundamentals of Taxation and Audit	3	0	3
FIN F313	Security Analysis & Portfolio Management	3	0	3
FIN F314	Investment Banking & Financial Services	3	0	3

(b) Minor in Film and Media

Film and its derivative forms of media such as television and advertising are dominant cultural forces in the contemporary world. The minor in Film and Media aims to provide:

i. An introduction to media studies with a specific focus on film studies
ii. A basic introduction to Print and Digital Media including film making and film appreciation
iii. Hands-on training in writing for media and film production

GS F223	Introduction to Mass Communication	3	0	3
GS F244	Writing and Reporting for Media	3	0	3
GS F322	Critical Analysis of Literature and Cinema	3	0	3

Courses: 6 courses (min)
Units: 18 (min)

Core Courses

GS F223	Introduction to Mass Communication	3	0	3
GS F244	Writing and Reporting for Media	3	0	3
GS F322	Critical Analysis of Literature and Cinema	3	0	3

Elective Courses

GS F224	Print and Audio Visual Advertising	3	0	3
GS F242	Cultural Studies	3	0	3
GS F321	Mass Media Content and Design	3	0	3
GS F343	Short Film and Video Production	3	0	3
HS F332	Cinematic Arts	3	0	3

(c) Minor in Philosophy, Economics, and Politics

The minor in *Philosophy, Economics & Politics & (PEP)* aims at introducing students to a wide range of approaches to understand the social and human world we live in and to develop skills useful for a range of career opportunities in national and international organizations. It would particularly interest and enthuse those students who wish to complement their core expertise in science and engineering with a good grasp of the humanities and social sciences. As a multi-disciplinary minor, this option will provide a judicious mix of knowledge in social sciences (economics, sociology and politics) and the humanities (philosophy) that would enable students to draw connections among political, economic, and social phenomena as well as equip them with the necessary skills to think through complex challenges of our society in a creative and critical manner.

Courses: 6 courses (min)
Units: 18 (min)

Core Courses

ECON F211	Principles of Economics	3	0	3
GS F211	Modern Political Concepts	3	0	3
PHIL F211	Introductory Philosophy	3	0	3

Elective Courses

BITS F 385	Introduction to Gender Studies	3	0	3
GS F231	Dynamics of Social Change	3	0	3
GS F234	Development Economics	3	0	3
GS F243	Current Affairs	3	0	3
GSF 312	Applied Philosophy	3	0	3
GS F332	Contemporary India	3	0	3
GS F333	Public Administration	3	0	3
HSS F350	Human Rights: History,Theory and Practice	3	0	3
HSS F355	Dictatorship, Democracy & Development	3	0	3
HSS F356	Social Movements and Protest Politics	3	0	3
HUM F411	Professional Ethics	3	0	3
PHIL F221	Symbolic Logic	3	0	3
POL F321	International Relations	3	0	3

(d) Minor in English Studies

English has a rich linguistic, literary and cultural heritage. The classic literary masterpieces of English are still widely read and appreciated. English has also evolved over centuries and is now considered as the pre-eminent means of communication in the various sectors such as business, diplomacy, mass media, education, etc., across the globe. The Minor in English Studies introduces students to the language and literary canons, and renders them with adequate exposure not only to the cultural and linguistic aspects but also to practical applications of English language and literature. In particular, the core and elective courses included in the Minor would encourage students to acquire a critical understanding of literary and linguistic analyses, and the capacity to engage meaningfully in analysis, interpretation, and explanation. The Minor also gives an opportunity for students to choose modules and develop their own interests in language or literature. Students who follow the Minor will have an enhanced understanding of the nature of the English language and literature and also of the tools needed for further independent exploration of literary and linguistic phenomena.

Courses: 5 courses (min)
Units: 15 (min)

Core Courses

HSS F337	English Literary Forms and Movements	3	0	3
HSS F342	Advanced Communicative English	3	0	3

Elective Pool-I (Language)

GS F221	Business Communication	3	0	3
GS F241	Creative Writing	2	1	3
GS F244	Reporting and Writing for Media	3	0	3
GS F245	Effective Public Speaking	3	0	3
HSS F222	Linguistics	3	0	3
HSS F228	Phonetics and Spoken English	3	0	3

Elective Pool-II (Literature)

HSS F221	Readings from Drama	3	0	3
HSS F316	Popular Literature and Culture of South Asia	3	0	3
HSS F327	Contemporary Drama	3	0	3
HSS F335	Literary Criticism	3	0	3
HSS F336	Modern Fiction	3	0	3
HSS F338	Comparative Indian Literature	3	0	3
HSS F340	Postcolonial Literatures	3	0	3
HSS F399	Introduction to American Literature	3	0	3

(e) Minor in Materials Science and Engineering

Materials Science and Engineering is an interdisciplinary subject that makes use of knowledge from Physics, Chemistry, Engineering, Mathematics, Biology and Biotechnology, but which has its own special character. It is always evolving - new and exciting materials such as nanomaterials, high-temperature and lightweight materials, green materials and sustainable biomaterials for tissue engineering are continually emerging. The field of Material Science combines a wide knowledge base and puts it to diverse practical and commercial use.

Courses: 5 courses (min)
Units: 15 (min)

Core Courses

CHE F243 / ME F213	Materials Science and Engineering	3 2	0 0	3 2
MST F 331	Materials Characterization	3	1	4
MST F 332	Materials Processing	3	0	3

Electives Courses

BITS F416	Introduction to Nanoscience	3	0	3
CHE F433	Corrosion Engineering	3	0	3
CHEM F223	Colloidal and Surface Chemistry	3	0	3
CHEM F326	Solid State Chemistry	3	0	3
CHEM F336	Nanochemistry	3	1	4
ME F452	Composite Materials and Design	3	0	3
MST F333	Introduction to Biomaterials	3	0	3
MST F334	Materials for Catalytic Applications	3	0	3
MST F335	Coating and thin film technology	3	0	3
MST F336	Glass Technology	3	0	3
MST F337	Materials for Energy Applications	3	0	3
MST F338	Metals and Alloys	3	0	3
MST F339	Polymer Materials	3	0	3
PHY F414	Physics of Advanced Materials	3	1	4
PHY F416	Soft condensed Matter Physics	3	1	4

HIGHER DEGREE PROGRAMMES

A. Requirements

(i) M. E. and M. Pharm:

The following structure and requirements are:

1. (a) at least 12 courses and at least 48 credit units attributed to coursework; and
   (b) In addition, a Practice School (of at least 5½ months duration and 20 units) or a Dissertation (of at least 1 semester duration and 16 credit units)
2. A 4 unit course on Research Practice is mandatory for all students
   - BITS G540 Research Practice
3. Each Department may stipulate - for each program a set of 4 to 5 courses (of at least 16 units and at most 20 units) per semester.
   (a) This adds up to at least 12 courses and at least 48 units of coursework but with a maximum of 15 courses and at most 60 units of coursework stipulated by the Department.
   (b) The nominal chart for a program would be as follows:

Year	I Semester	II Semester
I year	4 to 5 courses (16 to 20 units)	4 to 5 courses (16 to 20 units)
II year	4 to 5 courses (16 to 20 units)	PS / Dissertation

4. Each Department may identify one-third (1/3) to one-half (1/2) of the coursework requirement for each program as the Core Requirement.
   (a) The Core Requirement is mandatory for all students in the program.
   (b) The Core Requirement will be common across all campuses of BITS offering the same program.

5. Rest of the coursework requirement – other than the Core Requirement and the Research Practice course – may be met by electives of each student's choice.
   (a) The student must choose such electives from a Pool of Electives listed for the specific program.
   (b) The Pool of Electives may vary from campus to campus.
6. Each course in the Core Requirement or in the List of Electives must be a graduate level (5th or 6th level) course or an advanced under-graduate course (4th level) with the restriction that a student may use at the most two 4th level courses to meet the requirements in above.
7. Each Department in each campus may decide the scheduling of Core / Elective courses as per the above chart as deemed fit.
8. A student may choose to overload his/her coursework by at most one course – carrying not more than 5 units - per semester:
   (a) Such courses may be chosen from one of the following

(i) the pool of courses listed as Electives for the program being pursued

   (ii) a general pool of courses listed as Graduate Level Electives available for all higher degree programs
   (iii) any other course under the conditions that the stipulated pre-requisites are met and that the Head of the Department of the student and Head of the Department offering the course both provide their consent
   (b) Such courses may not be counted towards the requirement stated in 1.(a) above.
9. A student who wants to pursue Dissertation may choose between doing the Dissertation on campus and doing the Dissertation in an external industrial / research organization. The Department must identify such locations/ organizations as suitable for a student pursuing Dissertation in that discipline. If a student exercises the option of doing his/her Dissertation in an organization other than BITS, then the Department must identify a co-supervisor for the student from within the Department.
10. The Dissertation will carry 16 credit units for the nominal duration of 1 semester.
    - During this semester a student may not be permitted to do coursework.
    - A student –with the consent of the Department - may extend the duration of the Dissertation over two semesters while concurrently doing coursework during the semester.
    - If the student exercises option (b) then the total weight of the Dissertation will not exceed 25 credit units.
11. In addition to the above courses, the higher degree students will be required to register in the following course, unless the student clears a diagnostic test specially designed for the same.

    BITS F437 Technical Communication 3 0 3

(ii) MPH:

Total number of units required – 60
(Minimum) with a breakup as follows:

(a) Dissertation: 15 (Min) – 25 (Max) Units

OR

Practice School : 20 units

(b) Course work : 35 (Min) units

(other than Dissertation/Practice School)

Courses for the course work will be chosen from the list of Core and elective courses earmarked for each degree. Total number of courses is thirteen. In addition to these thirteen courses all the students are required to do one course on Technical Communication and two courses on Research Practice.

There is also a flexibility for students of Higher Degree Programmes to register in upto a maximum of one more elective, in addition to the prescribed number of electives. The grade obtained in the additional elective will also be counted towards the CGPA but cannot be used to meet the category-wise requirements of the degree. This additional elective can be from the pool of electives of the concerned degree or courses from other disciplines' Core and electives with the permission of HoD of the program pursued by the student and the HoD offering the course.

(iii) M.Phil.:

Total number of units required - 50 (Minimum) with a breakup as follows:

(a) Dissertation : 12 (Min.) - 25 (Max.) units

OR

Practice School : 20 units

(b) Course work : 25 units (min.)

(other than Dissertation/Practice School)

The courses for course work can be chosen from a list of General/Special courses earmarked for the degree. Wherever there is a need, courses can also be drawn from across the course offerings in various Higher Degree programmes as well as advanced First Degree level, provided the students are adequately prepared for the particular course.

(iv) M.B.A.: The course requirements of the MBA programme are spelt out in terms of courses belonging to different categories in the table below:

Category	No. of Units Required	No. of Courses Required
Core Courses	40-60	15-20
Elective(s)	12-18	4-6
Subtotal	55 (Min)	20 (Min)
PS OR Dissertation	20 16	1
Total	70 (Min)	21 (Min)

Courses for the course work will be chosen from the list of Core and elective courses earmarked for the MBA degree.

Dissertation: Normal registration for dissertation is after completion of course work. Normally 16 units of Dissertation will be assigned at the time of this registration. In case of programmes other than MBA, units upto a maximum of 25 may be permitted depending on the total time and work put in by an individual student and the registration in more than 16 units of Dissertation will be normally available only to students who have taken higher degree courses as electives in their first degree programmes or to professionals who have shown competence in some specialized courses through their professional involvement. Concurrent registration for a nominal 8 units per semester in Dissertation with course work is also permissible for motivated, well-prepared and hardworking students. Provision exists for the Dissertation to be carried out as work-integrated dissertation at recognized off-campus centres or in an organization where the student may get employment, subject to all the stipulations of Academic Regulations.

Practice School: Registration for Practice School is possible only after the completion of all course work. Concurrent registration of other courses with Practice School is not permitted. All clauses of Academic Regulations applicable to first degree PS courses will govern the operation of this Practice School also.

B. First Degree students seeking Higher Degree admission

A first degree student can choose upto a maximum of two higher degree courses as electives for his/her first degree from the pool of general/special courses of the corresponding higher degree. When such a student seeks admission to any of the Higher Degree programme of the institute, the student may be given exemption from these courses; however, the student will have to complete the total unit requirements of the higher degree. The minimum units in Dissertation for such a candidate will be increased by the same number of units as exempted from the course work so as to earn the minimum prescribed total units.

Semesterwise Pattern for Students Admitted to Higher Degree Programmes in the First Semester						
Year	**First Semester**		**U**	**Second Semester**		**U**
M.E. Biotechnology						
I	BIO G512	Molecular Mechanism of Gene Expression	5	BITS G540	Research Practice	4
				BIO G524	Animal Cell Technology	5
	BIO G542	Advanced Cell and Molecular Biology	5	BIO G643	Plant Biotechnology	5
					Elective	*
	BIO G525	Environmental Biotechnology and Waste Management	5		Elective	*
		Elective	*			
			18			20
II	BIO G523	Advanced and Applied Microbiology	5	BITS G629T	Dissertation	16
					or	or
		Elective	*	BITS G639	Practice School	20
		Elective	*			
		Elective	*			
		Elective	*			
			17			16/20
M.E. Chemical* [The structure of this program is given in Page IV-103]						

Semesterwise Pattern for Students Admitted to Higher Degree Programmes in the First Semester								
Year	**First Semester**			**U**	**Second Semester**			**U**
M.E. Civil – Infrastructure Engineering and Management								
I	CE	G515	Fundamentals of Systems Engineering	4	BITS	G540	Research Practice	4
	CE	G523	Transportation Systems Planning and Management	4	CE	G520	Infrastructure Planning and Management	4
	CE	G525	Water Resources Planning and Management	4			Elective	*
	CE	G619	Finite Element Analysis	5			Elective	*
				17				14
II			Elective	*	BITS	G629T	Dissertation	16
			Elective	*			or	or
			Elective	*	BITS	G639	Practice School	20
			Elective	*				
				12				16/20
M.E. Civil – Structural Engineering								
I	CE	G551	Dynamics of Structures	4	BITS	G540	Research Practice	4
	CE	G552	Advanced Structural Mechanics and Stability	4	CE	G615	Earthquake Engineering	4
							Elective	*
	CE	G617	Advanced Structural Analysis	4			Elective	*
	CE	G619	Finite Element Analysis	5				
				17				14
II			Elective	*	BITS	G629T	Dissertation	16
			Elective	*			or	Or
			Elective	*	BITS	G639	Practice School	20
			Elective	*				
				12				16/20
M.E. Civil – Transportation Engineering								
I	CE	G523	Transportation Systems Planning and Management	4	BITS	G540	Research Practice	4
					CE	G518	Pavement Analysis and Design	4
	CE	G534	Pavement Material Characterization	4	CE	G524	Urban Mass Transit Planning Operations and Management	4
	CE	G535	Highway Geometric Design	4			Elective	*
	CE	G536	Traffic Engineering and Safety	4				
				16				15
II			Elective	*	BITS	G629T	Dissertation	16
			Elective	*			or	Or
			Elective	*	BITS	G639	Practice School	20
			Elective	*				
				12				16/20
M.E. Civil – Water Resource Engineering								
I	CE	G526	Systems Approach to Water Resources Modeling	4	BITS	G540	Research Practice	4
					CE	G558	Advanced Groundwater Hydrology	4
	CE	G555	Remote Sensing and GIS in Water Resources	4	CE	G559	Soft Computing in Water Resources	4
	CE	G556	Advanced Computational Hydraulics	4			Elective	*
	CE	G557	Stochastic Hydrology	4				
				16				15
II			Elective	*	BITS	G629T	Dissertation	16
			Elective	*			or	Or
			Elective	*	BITS	G639	Practice School	20
			Elective	*				
				16				16/20

Semesterwise Pattern for Students Admitted to Higher Degree Programmes in the First Semester							
Year	**First Semester**		**U**		**Second Semester**		**U**
M.E. Communication Engineering							
	EEE C434	Digital Signal Processing	4	BITS G540	Research Practice		4
	EEE G581	RF and Microwave Engineering	5	EEE G592	Mobile and Personal		
	EEE G612	Coding Theory and Practice	5		Communication		5
		Elective	*	EEE G622	Advanced Digital Communication		5
					Elective		*
			17				17
	EEE G591	Optical Communication	5	BITS G629T	Dissertation		16
		Elective	*		or		Or
		Elective	*	BITS G639	Practice School		20
		Elective	*				
			14				16/20
M.E. Computer Science							
	CS G525	Advanced Computer Networks	5	BITS G540	Research Practice		4
	CS G526	Advanced Algorithms and		CS G513	Network Security		4
I		Complexity	5	CS G524	Advanced Computer Architecture		5
	CS C623	Advanced Operating Systems	5		Elective		*
		Elective	*				
			18				16
		Elective	*	BITS G629T	Dissertation		16
		Elective	*		or		Or
II		Elective	*	BITS G639	Practice School		20
		Elective	*				
			12				16/20
M.E. Electrical – Power Electronics and Drives							
	EEE G542	Power Electronics Converter	5	BITS G540	Research Practice		4
	EEE G541	Distribution Apparatus and		EEE G545	Control and Instrumentation Systems		5
I		Configuration	5	EEE G552	Solid State Drives		5
	EEE G543	Power Devices microelectronics			Elective		*
		and selection	5				
		Elective	*				
			18				17
	EEE G546	System Simulation	5	BITS G629T	Dissertation		16
		Elective	*		or		Or
II		Elective	*	BITS G639	Practice School		20
		Elective	*				
			14				16/20
M.E. Embedded Systems							
	BITS G553	Real Time Systems	5	BITS G540	Research Practice		4
	EEE G512	Embedded System Design	4	CS G523	Software for Embedded Systems		5
I		Elective	*	MEL G642	VLSI Architecture		5
		Elective	*		Elective		*
			17				18
	EEE G626	Hardware Software Co-Design	5	BITS G629T	Dissertation		16
		Elective	*		or		Or
II		Elective	*	BITS G639	Practice School		20
		Elective	*				
			17				16/20

Semesterwise Pattern for Students Admitted to Higher Degree Programmes in the First Semester									
Year	**First Semester**			**U**	**Second Semester**			**U**
M.E. Electronics & Control								
I	EEE	G559	Advanced Power Electronics	5	BITS	G540	Research Practice	4
	EEE	G621	Advanced Electronic Circuits	5	EEE	G512	Embedded System Design	5
	INSTR	G611	Advanced Control Systems	5	EEE	G552	Solid State Drives	5
				15				14
II	EEE	G546	Systems Simulation Lab	4			Elective	*
			Elective	*			Elective	*
			Elective	*			Elective	*
				10				9
III	BITS	G629T	Dissertation	16				
			or	or				
	BITS	G639	Practice School	20				
				16/20				
M.E. Microelectronics								
I	MEL	G611	IC Fabrication Technology	5	BITS	G540	Research Practice	4
	MEL	G621	VLSI Design	5	MEL	G632	Analog IC Design	5
	MEL	G631	Physics & Modeling of		MEL	G641	CAD for IC Design	5
			Microelectronic Devices	5			Elective	*
			Elective	*				
				19				18
II			Elective	*	BITS	G629T	Dissertation	16
			Elective	*			or	Or
			Elective	*	BITS	G639	Practice School	20
			Elective	*				
				13				16/20
M.E. Manufacturing Systems Engineering								
I	EA	C412	Flexible Manufacturing Systems	4	BITS	G540	Research Practice	4
	ME	C443	Quality Control Assurance and		MSE	G512	Manufacturing Planning and	
			Reliability	3			Control	5
	ME	G511	Mechanism and Robotics	5			Elective	*
			Elective	*			Elective	*
				15				15
II	MSE	G521	World Class Manufacturing	5	BITS	G629T	Dissertation	16
	ITEB	G621	Supply Chain Management	4			or	Or
			Elective	*	BITS	G639	Practice School	20
			Elective	*				
				15				16/20
M.E. Mechanical Engineering								
I	ME	C443	Quality Control Assurance and					
			Reliability	3	BITS	G540	Research Practice	4
	ME	G511	Mechanism and Robotics	5	ME	G611	Computer Aided Analysis and	
	ME	G512	Finite Element Methods	5			Design	5
			Elective	*			Elective	*
							Elective	*
				16				15
II	ME	G532	Machine Tool Engineering	5	BITS	G629T	Dissertation	16
	ME	G641	Theory of Elasticity and plasticity	5			or	or
			Elective	*	BITS	G639	Practice School	20
			Elective	*				
				16				16/20

* *Minimum 3 Units*

Note: This is the suggested semesterwise pattern by the appropriate Senate appointed committee, subject to change if the situation warrants.

Semesterwise Pattern for Students Admitted to Higher Degree Programmes in the First Semester									
Year	**First Semester**				**U**	**Second Semester**			**U**
M.E. Design Engineering									
I	DE	G631	Materials Testing and Technology		5	BITS	G540	Research Practice	4
	ME	G511	Mechanism and Robotics		5	ME	G611	Computer Aided Analysis and Design	5
	ME	G512	Finite Element Methods		5			Elective	*
			Elective		*			Elective	*
					18				15
II	DE	G531	Product Design		5	BITS	G629T	Dissertation	16
	DE	G611	Dynamics and Vibration		5			or	or
			Elective		*	BITS	G639	Practice School	20
			Elective		*				
					16				16/20
M.E. Thermal Engineering									
I	BITS	C462	Renewable Energy		3	BITS	G540	Research Practice	4
	ME	G533	Conduction and Radiation Heat Transfer		5	ME	G535	Convective Heat and Mass Transfer	5
	ME	G621	Fluid Dynamics		5			Elective	*
			Elective		*			Elective	*
					16				15
II	ME	G514	Turbomachinery		5	BITS	G629T	Dissertation	16
	ME	G515	Computational Fluid Dynamics		5			or	or
			Elective		*	BITS	G639	Practice School	20
			Elective		*				
					16				16/20
M. Pharma. Pharmacy									
I	PHA	G532	Quality Assurance and Regulatory Affairs		5	BITS	G540	Research Practice	4
	PHA	G543	Clinical Research		5	PHA	G611	Advanced Pharmacology	5
	PHA	G612	Pharmacokinetics and Clinical Pharmacy		5	PHA	G621	Advanced Medicinal Chemistry	5
			Elective		*	PHA	G632	Dosage Form Design	5
					18				19
II			Elective		*	BITS	G629T	Dissertation	16
			Elective		*			or	or
			Elective		*	BITS	G639	Practice School	20
			Elective		*				
					12				16/20
M. Pharma. Pharmacy – Pharmaceutics									
I	PHA	G532	Quality Assurance and Regulatory Affairs		5	BITS	G540	Research Practice	4
	PHA	G543	Clinical Research		5	PHA	G632	Dosage Form Design	5
	PHA	G612	Pharmacokinetics and Clinical Pharmacy		5			Elective	*
	PHA	G542	Advanced Physical Pharmaceutics		5			Elective	*
					20				15
II	PHA	G617	Advanced Drug Delivery Systems		5	BITS	G629T	Dissertation	16
			Elective		*			or	or
			Elective		*	BITS	G639	Practice School	20
			Elective		*				
					14				16/20

* *Minimum 3 Units*

Note: This is the suggested semesterwise pattern by the appropriate Senate appointed committee, subject to change if the situation warrants

Semesterwise Pattern for Students Admitted to Higher Degree Programmes in the First Semester									
Year	**First Semester**			**U**	**Second Semester**			**U**
M. Pharma. Pharmacy – Pharmaceutical Chemistry								
I	PHA	G522	Chemistry of Macromolecules	4	BITS	G540	Research Practice	4
	PHA	G532	Quality Assurance and Regulatory Affairs	5	PHA	G611	Advanced Pharmacology	5
	PHA	G541	Computer Aided Drug Design	5	PHA	G621	Advanced Medicinal Chemistry	5
	PHA	G543	Clinical Research	5			Elective	*
				19				17
II			Elective	*	BITS	G629T	Dissertation	16
			Elective	*			or	or
			Elective	*	BITS	G639	Practice School	20
			Elective	*				
				12				16/20
M.E. Software System								
I	CS	F415	Data Mining	3	BITS	G540	Research Practice	4
	SS	G514	Object Oriented Analysis and Design	4	SS	G515	Data Ware Housing	5
	SS	G562	Software Engineering and Management	5	SS	G653	Software Architecture	5
			Elective	*			Elective	*
				15				17
II			Elective	*	BITS	G629T	Dissertation	16
			Elective	*			or	or
			Elective	*	BITS	G639	Practice School	20
			Elective	*				
				12				16/20
Master of Business Administration								
I	MBA	C312	Managerial Economics	3	MBA	C319	Negotiation Skills & Techniques	2
	MBA	C314	Business Structure & Processes	3	MBA	C412	Human Resource Management	4
	MBA	C320	Managerial Skills	2	MBA	C416	Corporate Finance & Taxation	4
	MBA	C321	Legal and Economic Environment of Business	4	MBA	C418	Marketing	4
	MBA	C322	Management Framework and Functions	2	MBA	C419	Production & Operations Management	4
	MBA	C411	Organizational Behaviour	4	MBA	C421	Supply Chain Management	4
	MBA	C413	Quantitative Methods	4	MBA	C471	Management Information Systems	3
	MBA	C415	Financial & Management Accounting	4				
	MBA	C431	Managerial Communication	2				
				28				25
II	MBA	C422	Business and Society	4	BITS	G561	Dissertation	16
	MBA	C423	Business Policy & Strategic Management	4			or	or
	MBA	C424	International Business	3	BITS	G560	Practice School	20
			Elective	*				
			Elective	*				
			Elective	*				
			Elective	*				
				23				16/20

* *Minimum 3 Units*

Note: This is the suggested semesterwise pattern by the appropriate Senate appointed committee, subject to change if the situation warrants.

Semesterwise Pattern for Students Admitted to Higher Degree Programmes in the First Semester									
Year	**First Semester**			**U**		**Second Semester**			**U**
Master in Public Health									
I	MPH	G510	Biostatistics & Computers in Public Health	5	MPH	G661	Research Methodology I		5
					MPH	G521	Health Care Management		4
	MPH	G512	Environmental and Occupational Health	4	MPH	G522	Preventive Nutrition & Health Promotion		4
	MPH	G513	Public Health & Diseases	4	MPH	G523	Epidemic & Disaster Management		4
	BITS	G515	Management Principles and Practices	4	MPH	G692	Epidemology		2
					MPH	G613	Health System and Society		2
	BITS	F437	Technical Communication	3					
				20					21
II	BITS	G540	Research Practice	4	BITS	G629T	Dissertation		16
							or		or
	MPH	G531	Health Economics & Financial Management	4	BITS	G639	Practice School		20
			Elective	*					
			Elective	*					
			Elective	*					
				17					16/20

* *Minimum 3 Units*

Note: This is the suggested semesterwise pattern by the appropriate Senate appointed committee, subject to change if the situation warrants.

Semester-wise Pattern for Students Admitted to M. Phil. Chemistry Programme in First Semester									
Year	**First Semester**			**U**		**Second Semester**			**U**
I	BITS	G659	Technical Communication	4	BITS	G620	Professional Practice I		3
	CHEM	G551	Advanced Organic Chemistry	5	CHEM	G552	Advanced Inorganic Chemistry		5
	CHEM	G553	Advanced Physical Chemistry	5	CHEM	G554	Physical Methods in Chemistry		5
	CHEM	G555	Chemistry of Life Processes	4			Elective		3
				18					16
II	BITS	G621	Professional Practice II	3	BITS	G629T	Dissertation		16
			Elective	*			or		or
			Elective	*	BITS	G639	Practice School		20
			Elective	*					
				12					16/20

** Minimum 3 units*

Note: This is a currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semester-wise Pattern for Students Admitted to M. E. Computer Science with Specialization in Information Security with B.Sc. input								
Year	**First Semester**			**U**	**Second Semester**			**U**
I	CS	F111	Computer Programming	4	MGTS	F211	Principles of Management	3
	BITS	F437	Technical Communication	3	MATH	F212	Optimization	3
	MATH	F113	Probability and Statistics	3	BITS	F463	Cryptography	3
	CS	F215	Digital Design	4	BITS	F345	Information Law and Cyber Law	3
	CS	F222	Discrete Structures for Computer Science	3	IS	F242	Computer Organization	4
	MATH	F231	Number Theory	3	CS	F211	Data Structures & Algorithms	4
				20				20
Summer	CS	F404	Computer Crime and Forensics					2
	CS	F213	Object Oriented Programming					4
	CS	F468	Information Security Project					3
								9
II	CS	F351	Theory of Computation	3	CS	F303	Computer Networks	4
	CS	F372	Operating Systems	3	CS	F212	Database Systems	4
	IS	F341	Software Engineering	4	CS	G517	Network and System Security	4
	CS	G524	Advanced Computer Architecture	5	CS	F364	Design and Analysis of Algorithms	3
	CS	F301	Principles of Programming Languages	2	CS	F406	Ethical Hacking	2
			Elective	*			Elective	*
				20 (min)				20 (min)
Summer	CS	G566	Secure Software Engineering					5
	CS	F468	Information Security Project					3
			Elective					*
								11 (min)
III	CS	G623	Advanced Operating Systems	5	BITS	G639	Practice School	20
	CS	G525	Advanced Computer Networks	5				
	CS	G526	Advanced Algorithms and Complexity	5	Or			Or
	BITS	G540	Research practice	4				
					BITS	G629T	Dissertation	16
			Elective	*				
				20 (min)				16 (min)

* *Minimum 3 units*

Note: This is a currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

LIST OF COURSES FOR M.E./M.PHARM./ MBA PROGRAMMES:

Biotechnology

Core Courses

BIO G512	Molecular Mechanism of Gene Expression	5
BIO G523	Advanced and Applied Microbiology	5
BIO G524	Animal Cell Technology	5
BIO G525	Environmental Biotechnology and Waste Management	5
BIO G542	Advanced Cell and Molecular Biology	5
BIO G643	Plant Biotechnology	5

Elective Courses (any seven)

BIO F242	Introduction to Bioinformatics	3 0 3
BIO F417	Biomolecular Modeling	3 0 3
BIO F421	Enzymology	3 0 3
BIO F441	Biochemical Engineering	3 0 3
BIO G510	Application of Computers and Statistics in Biology	5
BIO G513	Microbial and Fermentation Technology	3 2 5
BIO G514	Molecular Immunology	3 2 5
BIO G515	Stem Cell and Regenrative Biology	3 1 4
BIO G522	Interferon Technology	3 1 4
BIO G526	Cancer Biology	3 2 5
BIO G532	Biostatistics and Biomodelling	3 1 4
BIO G544	Bioremediation and bio-metallurgy	5
BIO G545	Molecular Parasitology & Vector Biology	5
BIO G561	Advances in Recombinant DNA Technology	3 2 5
BIO G570	Recent Developments in Biology	1 0 1
BIO G612	Human Genetics	3 2 5
BIO G631	Membrane and Liposome Technology	3 1 4
BIO G632	Transgenic Technology	3 2 5
BIO G642	Experimental Techniques	4*
BIO G651	Protein and Enzyme Bioengineering	3 2 5
BIO G661	Gene Toxicology	3 1 4
BIO G671	Bioconversion Technology	3 2 5
BITS F418	Introduction to Biomedical Engineering	3 1 4
BITS F467	Bioethics and Biosafety	3 0 3

BIO G510 Application of Computers and Statistics in Biology (5) may be required to be completed as a deficiency course for ME Biotechnology Programme.

Chemical

Core Courses

CHE G523	Mathematical Methods in Chemical Engineering	5
CHE G613	Advanced Mass Transfer	5
CHE G614	Advanced Heat Transfer	5
CHE G622	Advanced Chemical Engineering Thermodynamics	5
CHE G641	Reaction Engineering	5

Elective Courses (any six)

BITS F418	Introduction to Biomedical Engineering	3 1 4
BITS F429	Nanotechnology for Renewable Energy and Environment	3 1 4
CHE F413	Process Plant Safety	3 0 3
CHE F421	Biochemical Engineering	3 0 3
CHE F471	Advanced Process Control	3 0 3
CHE G512	Petroleum Refining and Petrochemicals	3 1 4
CHE G513	Environmental Management Systems	3 2 5
CHE G522	Polymer Technology	3 1 4
CHE G524	Introduction to Multiphase flow	3 1 4
CHE G525	Chemical Process and Equipment Design	3 1 4
CHE G526	Nuclear Engineering	3 1 4
CHE G527	Energy Conservation and Management	3 1 4
CHE G528	Introduction to Nano Science & Technology	3 1 4
CHE G529	Paper and Pulp Technology	3 1 4
CHE G532	Alternate Energy Resources	3 1 4
CHE G533	Petroleum Product Characterization	3 2 5
CHE G551	Advanced Separation Technology	3 2 5
CHE G553	Statistical Thermodynamics	4
CHE G554	Computational Fluid Dynamics	4
CHE G556	Electrochemical Engineering	4
CHE G557	Energy Systems Engineering	4
CHE G558	Chemical Process Optimization	4
CHE G617	Petroleum Refinery Engineering	3 2 5
CHE G618	Petroleum Downstream Processing	3 2 5
CHE G619	Process Intensification	3 2 5
CHE G620	Energy Integration Analysis	3 2 5

Chemical with Specialization in Petroleum Engineering

Core Courses

CHE G523	Mathematical Methods in Chemical Engineering	5
CHE G616	Petroleum Reservoir Engineering	5
CHE G617	Petroleum Refinery Engineering	5
CHE G618	Petroleum Downstream Processing	5
CHE G622	Advanced Chemical Engineering Thermodynamics	5
CHE G641	Reaction Engineering	5

Elective Courses (any six)

CHE C473	Advanced Process Control	3 1 4
CHE G511	Fluidization Engineering	3 1 4
CHE G513	Environmental Management Systems	3 2 5
CHE G522	Polymer Technology	3 1 4
CHE G532	Alternate Energy Resources	3 1 4
CHE G533	Petroleum Product Characterization	3 2 5
CHE G551	Advanced Separation Technology	3 2 5
CHE G567	Natural Gas Processing	4
CHE G568	Modeling and Simulation in Petroleum Refining	4
CHE G569	Petroleum Production Economics	4
CHE G613	Advanced Mass Transfer	3 2 5
CHE G614	Advanced Heat Transfer	3 2 5
CHE G619	Process Intensification	3 2 5
CHE G620	Energy Integration Analysis	3 2 5

Civil with Specialization in Infrastructure Engineering and Management

Core Courses

CE G515	Fundamentals of Systems Engineering	4
CE G520	Infrastructure Planning and Management	4
CE G523	Transportation Systems Planning and Management	4
CE G525	Water Resources Planning and Management	4
CE G619	Finite Element Analysis	5

Elective Courses (any six)

BITS F469	Financing Infrastructure Projects	3 0 3
BITS F474	Rural Infrastructure Planning	3 0 3
BITS F494	Environmental Impact Assessment	3 1 4
CE F431	Principles of Geographical Information System	3 0 3
CE F433	Remote Sensing and Image Processing	3 0 3
CE G512	Topics in Environmental Engineering	3 1 4
CE G513	Advanced Computational Techniques	3 1 4
CE G516	Multicriteria Analysis in Engineering	3 1 4
CE G517	Waste Management Systems	3 1 4
CE G518	Pavement Design & Analysis	3 1 4
CE G522	Pavement Design, Maintenance and Management	3 2 5
CE G524	Urban Mass Transit Planning, Operations and Management	3 1 4
CE G526	Systems Approach to Water Resources Modelling	3 1 4
CE G527	Construction Management	3 1 4
CE G528	Selection of Construction Equipment and Modelling	3 1 4
CE G529	Construction Project Control Systems	3 1 4
CE G530	Design of Construction Operation	3 1 4
CE G531	Environmental Conservation	3 1 4
CE G533	Advanced Composite Materials for Structures	3 1 4
CE G538	Project Planning & Management	3 1 4
CE G542	Water Resources and Management	3 1 4
CE G545	Airport Planning & Design	3 1 4
CE G610	Computer Aided Analysis and Design in Civil Engineering	3 2 5
CE G614	Prestressed Concrete	3 1 4
CE G616	Bridge Engineering	3 1 4
CE G618	Design of Multi-storey Structures	3 1 4
CE G632	Design of Foundation for Dynamic Loads	3 1 4

Civil with Specialization in Structural Engineering

Core Courses

CE G551	Dynamics of Structures	4
CE G552	Advanced Structural Mechanics and Stability	4
CE G615	Earthquake Engineering	4
CE G617	Advanced Structural Analysis	4
CE G619	Finite Element Analysis	5

Elective Courses (any six)

CE G511	Matrix Method in Civil Engineering	3 2 5
CE G513	Advanced Computational Techniques	3 1 4
CE G514	Structural Optimization	3 1 4
CE G521	Topics in Structural Engineering	3 2 5
CE G532	Advanced Soil Mechanics	3 1 4
CE G533	Advanced Composite Materials for Structures	3 1 4
CE G553	Theory of Plates and Shells	3 1 4
CE G554	Advanced Structural Design	3 1 4
CE G610	Computer Aided Analysis and Design in Civil Engineering	3 2 5
CE G611	Computer Aided Analysis and Design	3 2 5
CE G612	Advanced Steel Structures	3 1 4
CE G613	Advanced Concrete Structures	3 1 4
CE G614	Prestressed Concrete Structures	3 1 4
CE G616	Bridge Engineering	3 1 4
CE G618	Design of Multi-storey Structures	3 1 4
CE G620	Advanced Foundation Engineering	3 1 4
CE G621	Fluid Dynamics	3 2 5
CE G622	Soil-Structure Interaction	3 1 4
CE G623	Ground Improvement Techniques	3 1 4
CE G631	Selected Topics in Soil Mechanics and Geotechnical Engineering	3 1 4
CE G632	Design of Foundation for Dynamic Loads	3 1 4

CE G641	Theory of Elasticity and Plasticity	3 2 5

Civil with Specialization in Transportation Engineering

Core Courses

CE G518	Pavement Analysis and Design	4
CE G523	Transportation Systems Planning and Management	4
CE G524	Urban Mass Transit Planning Operations and Management	4
CE G534	Pavement Material Characterization	4
CE G535	Highway Geometric Design	4
CE G536	Traffic Engineering and Safety	4

Elective Courses (any six)

BITS F494	Environmental Impact Assessment	3 1 4
CE G520	Infrastructure Planning and Management	3 1 4
CE G528	Selection of Construction Equipment and Modeling	3 1 4
CE G537	Transport Economics and Finance	3 1 4
CE G538	Project Planning & Management	3 1 4
CE G539	Introduction to Discrete Choice Theory	4*
CE G543	Traffic Flow Theory	3 1 4
CE G545	Airport Planning and Design	3 1 4
CE G546	Highway Construction Practices	3 1 4
CE G547	Pavement Failures, Evaluation and Rehabilitation	3 1 4
CE G548	Pavement Management Systems	3 1 4
CE G549	Rural Road Technology	3 1 4
CE G616	Bridge Engineering	3 1 4
CE G619	Finite Element Analysis	3 2 5
CE G632	Design of Foundation for Dynamic Loads	3 1 4

Civil with Specialization in Water Resource Engineering

Core Courses

CE G526	Systems Approach to Water Resources Modeling	4
CE G555	Remote Sensing and GIS in Water Resources	4
CE G556	Advanced Computational Hydraulics	4
CE G557	Stochastic Hydrology	4
CE G558	Advanced Groundwater Hydrology	4
CE G559	Soft Computing in Water Resources	4

Elective Courses (any five)

BITS F494	Environmental Impact Assessment	3 1 4
CE G516	Multicriteria Analysis in Engineering	3 1 4
CE G517	Waste Management Systems	3 1 4
CE G525	Water Resources Planning and Management	3 1 4
CE G560	Hydrologic Simulation Laboratory	4
CE G561	Impact of Climate Change on Water Resources and Environment	4
CE G621	Fluid Dynamics	3 2 5

Communication Engineering

Core Courses

EEE F434	Digital Signal Processing	4
EEE G581	RF and Microwave Engineering	5
EEE G591	Optical Communication	5
EEE G592	Mobile and Personal Communication	5
EEE G612	Coding Theory and Practice	5
EEE G622	Advanced Digital Communication	5

Elective Courses (any five)

BITS F415	Introduction to MEMS	4
BITS G553	Real Time Systems	3 1 4
BITS G554	Data Compression	3 1 4
CS F303	Computer Networks	3 0 3
CS F401	Multimedia Computing	3 0 3
CS F413	Internetworking Technologies	3 0 3
CS G541	Pervasive Computing	4
CS G553	Reconfigurable Computing	5
CS G555	Systems Specification and Modeling	3 3 4
EEE F414	Telecom Switching Systems and Networks	3 0 3
EEE F472	Satellite Communication	3 0 3
EEE F474	Antenna Theory and Design	3 1 4
EEE G510	RF Microelectronics	5
EEE G512	Embedded System Design	3 1 4
EEE G521	Optoelectronic Devices, Circuits and Systems	3 2 5
EEE G522	Advanced Satellite Communication	5*
EEE G582	Telecom Network Management	3 2 5
EEE G613	Advanced Digital Signal Processing	5
EEE G626	Hardware Software Co-Design	4
EEE G627	Network Embedded Application	4
IS F462	Network Programming	3 0 3
MEL G621	VLSI Design	3 2 5
MEL G622	Introduction to Artificial Neural networks	2 2 4

Computer Science

Core Courses

CS G513	Network Security	4
CS G524	Advanced Computer Architecture	5
CS G525	Advanced Computer Networks	5
CS G526	Advanced Algorithms and Complexity	5
CS G623	Advanced Operating Systems	5

Elective Courses (any six)

BITS F464	Machine Learning	3 0 3
BITS G553	Real-Time Systems	5
CS F401	Multimedia Computing	3 0 3
CS F407	Artificial Intelligence	3 0 3
CS F413	Internetworking Technologies	3 0 3
CS F415	Data Mining	3 0 3
CS F422	Parallel Computing	3 0 3
CS F446	Data Storage Technologies & Networks	3 0 3
CS F469	Information Retrieval	3 0 3
CS G520	Advanced Data Mining	3 1 4
CS G523	Software for Embedded Systems	3 2 5
CS G527	Cloud Computing	5
CS G541	Pervasive Computing	4
CS G551	Advance Compilation Techniques	5
CS G553	Reconfigurable Computing	5
CS G554	Distributed Data Systems	3 2 5
CS G568	Network Security Project	0 3 3
CS G612	Fault Tolerant System Design	2 3 5
EEE G512	Embedded System Design	3 1 4
EEE G582	Telecom Network management	5
EEE G627	Networked Embedded Applications	3 1 4

Design Engineering

Core Courses

DE G531	Product Design	5
DE G611	Dynamics and Vibration	5
DE G631	Materials Testing and Technology	5
ME G511	Mechanism and Robotics	5
ME G512	Finite Element Methods	5
ME G611	Computer Aided Analysis and Design	5

Elective Courses (any five)

BITS F415	Introduction to MEMS	3 1 4
DE G513	Tribology	3 2 5
DE G514	Fracture Mechanics	3 2 5
DE G522	Design Projects	3 2 5
ME F423	Micro Fluidics and its Application	4*
ME G515	Computational Fluid Dynamics	3 2 5
ME G521	Mechanical System Design	3 2 5
ME G532	Machine Tool Engineering	3 2 5
ME G535	Advanced Engineering Mathematics	3 2 5
ME G612	Plastics Engineering	3 2 5
ME G641	Theory of Elasticity and Plasticity	3 2 5
MSE G511	Mechatronics	3 2 5
MSE G531	Concurrent Engineering	3 2 5
MST G511	Nondestructive Testing Techniques	3 2 5
MST G522	Advanced Composites	3 2 5
MST G531	Experimental Stress Analysis Techniques	3 2 5

Electrical with specialization in Power Electronics & Drives

Core Courses

EEE G541	Distribution Apparatus and Configuration	5
EEE G542	Power Electronics Converter	5
EEE G543	Power Devices Microelectronics and Selection	5
EEE G545	Control and Instrumentation Systems	5
EEE G546	System Simulation	5
EEE G552	Solid State Drives	5

Elective Courses (any five)

BITS F462	Renewable Energy	3 0 3
CHE G526	Nuclear Engineering	3 1 4
EEE F422	Modern Control Systems	3 0 3
EEE C462	Advanced Power Systems	3 0 3
EEE G544	Steady State and Dynamics of Electrical Motors	3 2 5
EEE G553	Utility Applications of Power Electronics	3 0 3
EEE G554	Soft Switching Converter Technologies	3 0 3
EEE G555	Transformer and Motor Design	3 0 3
EEE G557	Drives for Electric Traction	3 0 3
EEE G558	DSP based Implementation Drivers	3 0 3
EEE G572	Digital Signal Processing	3 2 5
EEE G593	Power Quality	5
MEL G622	Introduction to Artificial Neural networks	2 2 4

Embedded Systems

Core Courses

BITS G553	Real Time Systems	5
CS G523	Software for Embedded Systems	5
EEE G512	Embedded System Design	3 1 4
EEE G626	Hardware Software Co-Design	5
MEL G642	VLSI Architecture	5

Elective Courses (any six)

BITS F415	Introduction to MEMS	4
CS G541	Pervasive Computing	4
CS G553	Reconfigurable Computing	5
CS G611	Distributed Processing Systems	2 2 4
CS G612	Fault Tolerant System Design	2 3 5
EEE F434	Digital Signal Processing	3 1 4
EEE G547	Device Drivers	3 2 5
EEE G572	Digital Signal Processing	3 2 5

EEE G594	Advanced VLSI Devices	5
EEE G595	Nanoelectronics and Nanophotonics	5
EEE G613	Advanced Digital Signal Processing	5
EEE G625	Safety Critical Embedded System Design	4
EEE G627	Network Embedded Application #	4
MEL G531	Testable Design and Fault Tolerant Computing	3 2 5
MEL G621	VLSI Design	3 2 5
MEL G622	Introduction to Artificial Neural networks	2 2 4
MEL G623	Advanced VLSI Design	5
MEL G624	Advanced VLSI Architectures	5
MEL G626	VLSI Test and Testability	5
MSE G511	Mechatronics	3 2 5

M.E. Electronics and Control

Core Courses

EEE G512	Embedded System Design	4
EEE G546	Systems Simulation Lab	4
EEE G552	Solid State Drives	5
EEE G559	Advanced Power Electronics	5
EEE G621	Advanced Electronic Circuits	5
INSTR G611	Advanced Control Systems	5

Elective Courses (any five)

BITS F415	Introduction to MEMS	3 1 4
BITS G654	Advanced Instrumentation Techniques	5
EEE F422	Modern Control Systems	3 0 3
EEE G521	Optoelectronic Devices, Circuits & Systems	5
EEE G544	Steady State and Dynamics of Electric Motors	5
EEE G545	Control and Instrumentation Systems	5
EEE G553	Utility Applications of Power Electronics	3
EEE G554	Soft Switching Converter Technologies	3
EEE G556	DSP Based Control of Electric Drives	3
EEE G593	Power Quality	5
EEE G613	Advanced Digital Signal Processing	5
ME G516	Energy Systems Engineering	5
MSE G511	Mechatronics	3 2 5

Manufacturing Systems Engineering

Core Courses

BITS F431	Flexible Manufacturing Systems	4
ITEB G621	Supply Chain Management	4
ME F443	Quality Control Assurance and Reliability	3
ME G511	Mechanism and Robotics	5
MSE G512	Manufacturing Planning and Control	5
MSE G521	World Class Manufacturing	5

Elective Courses (any five)

DE G522	Design Projects	3 2 5
DE G531	Product Design	3 2 5
ME G535	Advanced Engineering Mathematics	3 2 5
ME G538	Toyota Production System	3 2 5
ME G539	Computer Integrated Manufacturing	3 2 5
MSE G511	Mechatronics	3 2 5
MSE G513	Maintenance Engineering	3 1 4
MSE G514	Leadership and Managing Change	3 1 4
MSE G531	Concurrent Engineering	3 2 5

Mechanical Engineering

Core Courses

ME F443	Quality Control Assurance and Reliability	3
ME G511	Mechanism and Robotics	5
ME G512	Finite Element Methods	5
ME G532	Machine Tool Engineering	5
ME G611	Computer Aided Analysis and Design	5
ME G641	Theory of Elasticity and Plasticity	5

Elective Courses (any five)

BITS F415	Introduction to MEMS	3 1 4
DE G513	Tribology	3 2 5
DE G522	Design Projects	3 2 5
DE G531	Product Design	3 2 5
DE G611	Dynamics and Vibrations	3 2 5
ME F423	Micro Fluidics and its Application	4*
ME F472	Precision Engineering	3 0 3
ME F483	Wind Energy	3 0 3
ME G513	Heating and Cooling of Buildings	3 2 5
ME G514	Turbomachinery	3 2 5
ME G515	Computational Fluid Dynamics	3 2 5
ME G535	Advanced Engineering Mathematics	3 2 5
ME G631	Advanced Heat Transfer	3 2 5

Mechanical with specialization in Thermal Engineering

Core Courses

BITS F462	Renewable Energy	3
ME G514	Turbomachinery	5
ME G515	Computational Fluid Dynamics	5
ME G533	Conduction and Radiation Heat Transfer	5
ME G534	Convective Heat and Mass Transfer	5
ME G621	Fluid Dynamics	5

Electives Courses (any five)

BITS F415	Introduction to MEMS	4*
BITS F417	Micro-fluidics and its Applications	4*
ME F433	Solar Thermal Process Engineering	3 1 4
ME F461	Refrigeration & Air-conditioning	3 0 3
ME F482	Combustion	3 0 3
ME F483	Wind Energy	3 0 3
ME G513	Heating and Cooling of Buildings	5
ME G516	Energy Systems Engineering	5
ME G535	Advanced Engineering Mathematics	5
ME G536	Thermal Equipment Design	5
ME G537	Cryogenic Engineering	5

Microelectronics

Core Courses

MEL G611	IC Fabrication Technology	5
MEL G621	VLSI Design	5
MEL G631	Physics & Modeling of Microelectronic Devices	5
MEL G632	Analog IC Design	5
MEL G641	CAD for IC Design	5

Elective Courses (any six)

BITS F415	Introduction to MEMS	3 1 4
CS G553	Reconfigurable Computing	5
CS G562	Advanced Architecture and Performance Evaluation	3 2 5
CS G612	Fault Tolerant System Design	2 3 5
EEE F434	Digital Signal Processing	3 1 4
EEE G510	RF Microelectronics	5
EEE G512	Embedded System Design	3 1 4
EEE G522	Advanced Satellite Communication	5
EEE G572	Digital Signal Processing	3 2 5
EEE G594	Advanced VLSI Devices	5
EEE G595	Nanoelectronics and Nanophotonics	5
EEE G613	Advanced Digital Signal Processing	5
EEE G626	Hardware Software Co-Design	4
MEL G512	Optoelectronic Devices Circuits and Systems	3 2 5
MEL G531	Testable Design and Fault Tolerant Computing	3 2 5
MEL G612	Integrated Electronics Design	2 2 4
MEL G622	Introduction to Artificial Neural networks	2 2 4
MEL G623	Advanced VLSI Design	5
MEL G624	Advanced VLSI Architectures	5
MEL G625	Advanced Analog and Mixed Signal Design	5
MEL G626	VLSI Test and Testability	5
MEL G642	VLSI Architectures	2 2 4

Pharmacy

Core Courses

PHA G532	Quality Assurance and Regulatory Affairs	5
PHA G543	Clinical Research	5
PHA G611	Advanced Pharmacology	5
PHA G612	Pharmacokinetics and Clinical Pharmacy	5
PHA G621	Advanced Medicinal Chemistry	5
PHA G632	Dosage Form Design	5

Elective Courses (any five)

BIO F417	Biomolecular Modelling	3 0 3
BITS F467	Bioethics and Biosafety	3 0 3
PHA G512	Chemistry of Natural Drugs	3 1 4
PHA G521	Molecular Biology and Immunology	3 1 4
PHA G541	Computer Aided Drug Design	3 2 5
PHA G542	Advanced Physical Pharmaceutics	3 2 5
PHA G544	Advanced Pharmaceutical Chemistry	3 2 5
PHA G545	Intellectual property rights and Pharmaceuticals	3 0 3
PHA G613	Pharmaceutical Biotechnology	3 2 5
PHA G614	Clinical Pharmacy and Therapeutics	3 2 5
PHA G615	Pharmacy Practice	3 2 5
PHA G616	Pharmaceutical Administration and Management	3 2 5
PHA G619	Screening Methods & Techniques in Pharmacology	5*
PHA G622	Chemistry of Natural Drugs and Macromolecules	3 2 5
PHA G642	Lab Projects	6
PHA G645	Molecular Pharmacology	3 0 3

M. Pharm. with specialization in Pharmaceutics

Core Courses

PHA G532	Quality Assurance and Regulatory Affairs	5
PHA G542	Advanced Physical Pharmaceutics	5
PHA G543	Clinical Research	5
PHA G612	Pharmacokinetics and Clinical Pharmacy	5
PHA G617	Advanced Drug Delivery Systems	5
PHA G632	Dosage Form Design	5

Elective Courses (any five)

BITS F467	Bioethics and Biosafety	3 0 3
PHA G545	Intellectual property rights and Pharmaceuticals	3 0 3
PHA G611	Advanced Pharmacology	2 3 5
PHA G613	Pharmaceutical Biotechnology	3 2 5
PHA G614	Clinical Pharmacy and Therapeutics	3 2 5

PHA G616	Pharmaceutical Administration and Management	3 2 5
PHA G619	Screening Methods & Techniques in Pharmacology	5*
PHA G642	Lab Projects	6
PHA G645	Molecular Pharmacology	3 0 3

M. Pharm. with specialization in Pharmaceutical Chemistry

Core Courses

PHA G522	Chemistry of Macromolecules	4
PHA G532	Quality Assurance and Regulatory Affairs	5
PHA G541	Computer Aided Drug Design	5
PHA G543	Clinical Research	5
PHA G611	Advanced Pharmacology	5
PHA G621	Advanced Medicinal Chemistry	5

Elective Courses (any five)

BITS F467	Bioethics and Biosafety	3 0 3
PHA G512	Chemistry of Natural Drugs	3 1 4
PHA G544	Advanced Pharmaceutical Chemistry	3 2 5
PHA G545	Intellectual property rights and Pharmaceuticals	3 0 3
PHA G612	Pharmacokinetics and Clinical Pharmacy	3 2 5
PHA G613	Pharmaceutical Biotechnology	3 2 5
PHA G618	Reterosynthetic Analysis	3 2 5
PHA G619	Screening Methods & Techniques in Pharmacology	5*
PHA G642	Lab Projects	6
PHA G645	Molecular Pharmacology	3 0 3

Software Systems

Core Courses

CS F 415	Data Mining	3
SS G514	Object Oriented Analysis and Design	4
SS G515	Data Ware Housing	5
SS G562	Software Engineering and Management	5
SS G653	Software Architecture	5

Elective Courses (any six)

BITS G553	Real-Time Systems	5
CS F422	Parallel Computing	3 0 3
CS F407	Artificial Intelligence	3 0 3
CS F469	Information Retrieval	3 0 3
CS G523	Software for Embedded Systems	3 2 5
CS G541	Pervasive Computing	4
CS F413	Internetworking Technologies	3 0 3
CS F401	Multimedia Computing	3 0 3
IS F462	Network Programming	3 0 3
SS G513	Network Security	3 1 4
SS G520	Advanced Data Mining	3 1 4
SS G527	Cloud Computing	5
SS G551	Advance Compilation Techniques	5
SS G552	Software Testing Methodologies	4
SS G554	Distributed Data Systems	3 2 5

Master of Business Administration

Core Courses

MBA C312	Managerial Economics	3
MBA C314	Business Structure and Processes	3*
MBA C319	Negotiation Skills and Techniques	2 0 2
MBA C320	Managerial Skills	2
MBA C321	Legal and Economic Environment of Business	4*
MBA C322	Management Framework and Functions	2 0 2
MBA C411	Organizational Behavior	4
MBA C412	Human Resource Management	4
MBA C413	Quantitative Methods	4
MBA C415	Financial and Management Accounting	4
MBA C416	Corporate Finance and Taxation	4
MBA C418	Marketing	4
MBA C419	Production and Operations Management	4
MBA C421	Supply Chain Management	4
MBA C422	Business and Society	4
MBA C423	Business Policy and Strategic Management	4
MBA C424	International Business	4
MBA C431	Managerial Communication	2*
MBA C471	Management Information Systems	4

Elective Courses

For Engineering & Technology Management

MBA C414	Technology Management	3 0 3
MBA C425	R & D Management	3 0 3
MBA C429	Recent Advances in ETM	4
MBA C482	Creating and Leading Entrepreneurial Organization	3 0 3
MBA G512	Manufacturing Strategy	4
MBA G522	Total Quality Management	4
MBA G523	Project Management	4
MBA G552	Total Productive Maintenance	4

For IT Enabled Services Management

MBA C426	Database Management Systems	4
MBA C427	e-Business and Internet Marketing	4
MBA C428	Internet Security and Cyber-laws	4
MBA C451	Internetworking Technologies	3 0 3

MBA C481	Expert Systems	4
MBA C482	Creating and Leading Entrepreneurial Organization	3 0 3
MBA C488	Services Management System	3 0 3
MBA C489	Enterprise Resource Planning	3 0 3
MBA G622	Software Project Management	4

For Finance

MBA C315	International Financial Markets & Services	3 0 3
MBA C323	Functions and Working of Stock Exchanges	3 0 3
MBA C432	Risk Management and Insurance	3 0 3
MBA C436	Strategic Financial Management	3 0 3
MBA C437	Security Analysis and Portfolio Management	3 0 3
MBA C341	Investment Banking and Financial Services	3 0 3
MBA C454	Project Appraisal	3 0 3
MBA C475	Financial Engineering	3 0 3
MBA C482	Creating and Leading Entrepreneurial Organization	3 0 3
MBA C493	Business Analysis and Valuation	3 0 3

For Marketing

MBA C433	Advertising and Sales Promotion	3 0 3
MBA C442	Consumer Behaviour	3 0 3
MBA C462	Services Marketing	3 0 3
MBA C463	Industrial Marketing	3 0 3
MBA C474	Retail Management Systems	3 0 3
MBA C482	Creating and Leading Entrepreneurial Organization	3 0 3
MBA C483	Marketing Research	3 0 3
MBA C486	Product and Brand Management	3 0 3

For Human Resources

MBA C482	Creating and Leading Entrepreneurial Organization	3 0 3
MBA G553	Organizational Change and Development	3 0 3
MBA G554	Innovative Leadership	3 0 3
MBA G555	International Human Resource Management	3 0 3
MBA G556	Performance Management	3 0 3

Master in Public Health

Core Courses

BITS G515	Management Principles and Practices	4*
MPH G510	Biostatistics & Computers in Public Health	5
MPH G512	Environmental & Occupational Health	4
MPH G513	Public Health & Diseases	4
MPH G515	Communication in Health Care	4
MPH G521	Health Care Management	4
MPH G522	Preventive Nutrition & Health Promotion	4
MPH G523	Epidemic & Disaster Management	4
MPH G531	Health Economics & Financial Management	4
MPH G613	Health Systems and Society	2
MPH G661	Research Methodology I	5
MPH G692	Epidemiology	2

Elective Courses (any three)

BITS C467	Bioethics and Biosafety	3 0 3
MPH C431	Accounting & Finance	4
MPH G535	Family & Community Health Measures	3
MPH G537	Law & Ethics in Public Health	3
MPH G538	Telemedicine	3
MPH G539	Inter-sectoral co-ordination in Health Services	3
MPH G540	Role of Voluntary Bodies/NGO's in Public Health	3
MPH G665	Hospital Operations Management	3
MPH G681	Strategic Management	3

M. Phil. Chemistry

Core Courses

CHEM G551	Advanced Organic Chemistry	5*
CHEM G552	Advanced Inorganic Chemistry	5*
CHEM G553	Advanced Physical Chemistry	5*
CHEM G554	Physical Methods in Chemistry	5*
CHEM G555	Chemistry of Life Processes	5*

Elective Courses (any four)

BIO G513	Microbial and Fermentation Technology	5*
BITS G654	Advanced Instrumentation Techniques	5*
CHEM C412	Photochemistry and Laser Spectroscopy	3 0 3
CHEM C422	Statistical Thermodynamics	3 0 3
CHEM C431	Stereochemistry and Reaction Mechanism	3 0 3
CHEM G513	Advanced Nuclear and Radio Chemistry	5*
CHEM G521	Environmental Chemistry	5*
CHEM G531	Recent Advances in Chemistry	5*
CHEM G541	Chemical Applications of Group Theory	5*
CHEM G556	Catalysis	4*
CHEM G557	Solid Phase Synthesis and Combinatorial Chemistry	4*
CHEM G558	Electronic Structure Theory	5*

CHEM G559	Bioinorganic Chemistry	4*
CHEM G561	Heterocyclic Chemistry	5*
CHEM G562	Solid State Chemistry	4*
CHEM G563	Advanced Statistical Mechanics	5*
EEE C432	Medical Instrumentation	3 0 3
PHA G621	Advanced Medicinal Chemistry	2 3 5

HDCC is empowered to add the following course as a deficiency course on case by case basis if the student is found to be deficient in Mathematics.

CHEM C453	Mathematics for Chemists	4*

* This is the total units and its break-up in terms of lectures and practical/seminars/project may be announced from time to time through the timetable.

M.E. COMPUTER SCIENCE WITH SPECIALIZATION IN INFORMATION SECURITY WITH B.SC. INPUT

Core Courses

BITS F345	Information Law and Cyber Law	3 0 3
BITS F437	Technical Communication	3 0 3
BITS F463	Cryptography	3 0 3
BITS G540	Research Practice	4
CS F111	Computer Programming	3 1 4
CS F211	Data Structures & Algorithms	3 1 4
CS F212	Database Systems	3 1 4
CS F213	Object Oriented Programming	3 1 4
CS F215	Digital Design	3 1 4
CS F222	Discrete Structures for Computer Science	3 0 3
CS F301	Principles of Programming Languages	2 0 2
CS F303	Computer Networks	3 1 4
CS F342	Computer Architecture	3 1 4
CS F351	Theory of Computation	3 0 3
CS F364	Design and Analysis of Algorithms	3 0 3
CS F372	Operating Systems	3 0 3
CS F404	Computer Crime and Forensics	2 0 2
CS F406	Ethical Hacking	2 2 3
CS F468	Information Security Project	0 3 3
CS G517	Network & Systems Security	4
CS G524	Advanced Computer Architecture	3 0 5
CS G525	Advanced Computer Networks	3 2 5
CS G526	Advanced Algorithms and Complexity	3 2 5
CS G566	Secure Software Engineering	5
CS G568	Network Security Project	0 3 3
CS G623	Advanced Operating Systems	3 2 5
IS F242	Computer Organization	3 1 4
IS F341	Software Engineering	3 1 4
MATH F113	Probability and Statistics	3 0 3
MATH F212	Optimization	3 0 3
MATH F231	Number Theory	3 0 3
MGTS F211	Principles of Management	3 0 3

Elective Courses

CS F401	Multimedia Computing	3 0 3
CS F407	Artificial Intelligence	3 0 3
CS F415	Data Mining	3 0 3
CS F446	Data Storage Technologies & Networks	3 0 3
CS F451	Combinatorial Mathematics	3 0 3
CS G501	Mobile Computing	5
CS G514	Object Oriented analysis and Design	2 2 4
CS G527	Cloud computing	5
CS G557	Distributed Computing	5
CS G559	Database Security	5
CS G564	Advanced Cryptography	5
IS F322	Software Testing	2 1 3

LIST OF GENERAL/SPECIAL COURSES FOR M.PHIL. PROGRAMMES

BIO G511	Population and Quantitative Genetics	5
BIO G522	Interferon Technology	2 2 4
BIO G541	Neural Network Analysis	5
BIO G551	Membrane Biology	5
BITS G511	Advanced Project	5
BITS G513	Study in Advanced Topics	5
BITS G514	Environmental Health	3 0 3
BITS G644	Development and use of Computer Software	5
BITS G654	Advanced Instrumentation Techniques	5
CHEM G511	Nuclear and Radio Chemistry	5
CHEM G513	Advanced Nuclear and Radiochemistry	5
CHEM G521	Environmental Chemistry	5
CHEM G531	Recent Advances in Chemistry	5
CHEM G541	Chemical Applications of Group Theory	5
CHEM G551	Advanced Organic Chemistry	5
CHEM G552	Advanced Inorganic Chemistry	5
ECON G511	Dynamic Modelling and Control of National Economies	5
ECON G521	Modern Cost Engineering	5
ECON G531	Theory of Macroeconomic Policy	5

ECON G541	Economic Systems Analysis	5
ENGL G511	Growth of the English Language	5
ENGL G512	Language and S & T	5
ENGL G513	Social Impact of S & T	5
ENGL G521	Principles of Language Teaching	5
ENGL G522	Aesthetics and Technology	5
ENGL G531	Applied Linguistics	5
ENGL G541	Interpretation of Literature	5
ENGL G551	Information Technology Lab. I	5
ENGL G561	Information Technology Lab. II	5
ENGL G571	Applied Communication I	5
ENGL G581	Applied Communication II	5
ENGL G591	Project Formulation and Preparation	5
ENGL G611	Twentieth Century English Literature	5
ET G511	Science and Technology Dynamics	5
ET G521	Hi-Tech Management	5
ET G531	Systems Engineering	5
ET G541	Overview of Technology	5
HUM G511	Introduction to Health System	3 0 3
MATH G511	Design and Analysis of Algorithms	5
MATH G512	Selected Topics in Advanced Mathematics for Engineering Situations	5
MATH G521	Applied Functional Analysis	5
MATH G531	Number Theory	5
MATH G541	Advanced Methods in Discrete Mathematics	5
MATH G611	Algebraic Number Theory	5
MATH G612	Riemann Surfaces	5
MATH G621	Fibre Bundles	5
MATH G622	Algebraic Geometry	5
MATH G632	Lie Groups & Lie Algebras	5
MATH G642	Complex Manifolds	5
MGTS G511	Advanced Marketing Theories and Advertising	5
MGTS G521	Business Policy - Structure and Organization	5
MGTS G531	Recent Advances in Organization Behaviour Theory	5
MGTS G541	Management Information and Decision Support Systems	5
MGTS G551	Frontiers in Financial Management	5
MGTS G561	Institutional Finance & Project Appraisal	5
PHY G511	Theoretical Physics	5
PHY G521	Nuclear and Particle Physics	5
PHY G531	Selected Topics in Solid State Physics	5
PHY G541	Physics of Semiconductor Devices	5
SKILL G611	Computer Operation and Software Development I	5
SKILL G612	Computer Operation and Software Development II	5
SKILL G621	Computer Maintenance I	5
SKILL G622	Computer Maintenance II	5
SKILL G631	Professional Communication I	5
SKILL G632	Professional Communication II	5
SKILL G641	Modern Experimental Methods I	5
SKILL G642	Modern Experimental Methods II	5
SKILL G651	Techniques in Development Management I	5
SKILL G652	Techniques in Development Management II	5
SKILL G661	Research Methodology I	5
SKILL G662	Research Methodology II	5

All courses given above are unstructured. Actual structuring will be done from time to time.

COMMON COURSES FOR HIGHER DEGREES

BITS F437	Technical Communication	3 0 3
BITS G529	Research Project I	6
BITS G539	Research Project II	6
BITS G540	Research Practice	4
BITS G619	Professional Practice	4
BITS G620	Professional Practice I	3
BITS G621	Professional Practice II	3
BITS G629T	Dissertation	25(Max.)
BITS G639	Practice School	20
BITS G649	Reading Course	5

NOTE: Courses with 4 level numbers given above are advanced level electives from the offering of the Integrated First Degree programmes.

COMMON POOL OF ELECTIVES FOR HIGHER DEGREES

BITS G513	Study in Advanced Topics	5
BITS G649	Reading Course	5

NOTE: The courses from this pool will be available as electives to all higher degree students subject to approval from higher degree counseling committee.

REVISED CURRICULUM STRUCTURE FOR M.E. / M.PHARM. PROGRAMS

[This structure is applicable for students admitted in 2014 or after into the M.E. Chemical Engineering program including any specializations thereof.]

(a) General Structure of M.E. / M.Pharm. programs

Keeping in mind the increasing interest on behalf of the Departments to involve Higher Degree students in research and to provide options for students' interested in pursuing research, there is provision of certain

flexibilities of pursuing Dissertation of duration between one semester and two semesters for these Higher Degree programs as illustrated below.

(i) Duration and Requirements to define a program

- Duration of the program: 4 semesters (2 years)
- Number of Credit Units: 64 (min).
- Coursework: 8 courses and 32 units (min)
- PS/Dissertation: 16 units (min) to 32 units: (max)

(ii) Structure

Prescribed coursework to meet the requirements of the program may not exceed 20 units per semester.

The program is structured primarily as a coursework track wherein the student pursues three semesters of coursework and pursues either a Practice School or a Dissertation for the entire last semester:

or alternatively, to enable a research track wherein the student pursues two semesters of coursework and starts his/her Dissertation in the third semester (possibly concurrent with coursework) and spends the entire fourth semester pursuing Dissertation.

The options are depicted below:

Track 1

Year	Semester I	Semester II
I	Coursework (4 or 5 courses -16 to 20 units)	Coursework (4 or 5 courses -16 to 20 units)
II	Coursework (4 or 5 courses -16 to 20 units)	BITS G639 Practice School (20 units) OR BITS G562T Dissertation (16 units)

Track 2

Year	Semester I	Semester II
I	Coursework (4 or 5 courses -16 to 20 units)	Coursework (4 or 5 courses - 16 to 20 units)
II	Coursework (2 courses - 7 to 9 units) AND BITS G564T Dissertation (9 units)	BITS G563T Dissertation (16 units)

Track 3

Year	Semester I	Semester II
I	Coursework (4 or 5 courses -16 to 20 units)	Coursework (4 or 5 courses - 16 to 20 units)
II	BITS G562T Dissertation (16 units)	BITS G563T Dissertation (16 units)

(Course Description for BITS G562/BITS G563/BITS G564 is the same as BITS G629T; BITS G562T or BITS G564T is a pre-requisite for BITS G563T).

(iii) Flexibilities and Constraints

In addition to the above requirements:

a) a student may be prescribed one or more deficiency courses;

b) a student may overload at most one course per semester when he/she is pursuing only coursework (i.e. no overload during dissertation semesters irrespective of whether he/she is pursuing concurrent coursework);

while this overloaded course need not be within the student's discipline but it will be subject to pre-requisites and operational conditions such as approval of the Heads of Department concerned.

In all, the workload per semester for a student may not exceed

i. 25 units when the student is pursuing only coursework but the limit may be relaxed for students who are prescribed deficiency courses.

ii. 19 units when the student is pursuing concurrent coursework and dissertation (so that the student may pursue 9 units of dissertation and 2 courses of at most 5 units each)

iii. 16 units when the student is pursuing full semester of dissertation

iv. 20 units when the student is pursuing full semester of Practice School.

Operational Aspects and Implementation

It is to be noted that the revised curriculum structure has been designed without prejudice to the existing programs i.e. given the existing structure and flexibilities of M.E./M.Pharm. programs all three tracks are operable.

The above structure will be made applicable for all students admitted to an M.E./M.Pharm program in 2014 or after under the proviso:

- for any new M.E. / M.Pharm. program starting from Academic Year 2014-15 all three tracks mentioned above will be enabled.

(b) Specializations within an M.E./M.Pharm. program

These programs are structured in such a way that a specialization can be obtained by a student:

- The coursework requirement proposed in the structure above can be categorized as follows:
  - Core: 6 courses / 30 units (max.)
  - Specialization **(if applicable)** : 3 courses / 12 units (min.) to 6 courses / 30 units (max.)
  - Some Specialization courses may be mandatory and some may be electives.
  - Total of Core and Specialization courses may not exceed 7 courses / 32 units.
  - A Research Practice or a Research Methodology course will be prescribed for all programs as part of the coursework requirement.
  - Rest of the coursework requirement may be obtained via other electives within the discipline but not necessarily within the specialization.

The name of the degree will be common (e.g. M.E. in Chemical Engineering) and only this will appear in the degree certificate whereas the name of the specialization will be mentioned only in the transcript.

(c) Structure of M.E. (Chemical Engineering) and specializations within

(i) Structure of M.E. (Chemical Engineering)

Year	Semester I	U	Semester II	U
I	CHE G622 Advanced Chemical Engineering Thermodynamics	5	CHE G641 Reaction Engineering	5
	CHE G523 Mathematical Methods in Chemical Engineering	5	CHE G552 Advanced Transport Phenomena	5
	Elective I	*	BITS G661 Research Methodology I	5
	Elective II	*	Elective III	*
	Total	16 (min)	**Total**	16 (min)
	Semester III		**Semester IV**	
II	Elective IV to Elective VII	16 (min)	PS / Dissertation	16/20
	OR Elective IV AND Elective V AND Dissertation (9 units)	16 (min)		
	OR Dissertation (16 units)	16		
	Total	**16 (min)**	**Total**	**16/20**

Structure of M.E. (Chemical Engineering) – Specialization in Nuclear Engineering

The structure of M.E. (Chemical Engineering) with specialization in Nuclear Engineering will be the same as the chart given above for M.E. (Chemical Engineering) with the added constraint that at least 3 electives should be from the pool of Specialization electives for Nuclear Engineering (given below).

Pool of Specialization Electives for Nuclear Engineering

Course No.	Course Title	Units L	P	U
CHE G559	Reactor Physics and Engineering			5
CHE G560	Nuclear Fuel Cycle and Waste Management			5
CHE G561	Nuclear Reactor Control and Instrumentation			4
CHE G562	Thermal Hydraulics and Heat Transfer			4
CHE G563	Nuclear Chemical Engineering			4
CHE G564	Nuclear Materials and Radiation Damage			4
CHE G565	Radiation and Radio Isotopes Applications			4
CHE G566	Nuclear Safety, Security and Safeguards			4

Structure of M.E. (Chemical Engineering) – Specialization in Petroleum Engineering

The structure of M.E. (Chemical Engineering) with specialization in Petroleum Engineering will be the same as the chart given above for M.E. (Chemical Engineering) with the added constraint that at least 3 electives should be from the pool of Specialization electives for Petroleum Engineering (given below).

Pool of Specialization Electives for Petroleum Engineering

Course No.	Course Title	Units L	P	U
CHE G533	Petroleum Product Characterization	3	2	5
CHE G567	Natural Gas Processing			4
CHE G568	Modeling and Simulation in Petroleum Refining			4
CHE G569	Petroleum Production Economics			4
CHE G616	Petroleum Reservoir Engineering			5
CHE G617	Petroleum Refinery Engineering			5
CHE G618	Petroleum Downstream Engineering			5

Ph.D. PROGRAMME

Structure

1. Course Work

The various categories of courses, for the whole possible range of input of Ph.D. students are described in the Academic Regulations. In most cases, this course work would consist of courses which are required to be completed for a higher degree programme of the Institute. Departures from these normal situations are described in the Academic Regulations.

2. Ph.D. Qualifying Examination

Every student admitted to Ph.D. must pass the qualifying examination which is based on two areas chosen by the candidate depending on his intended area of research and courses done. The qualifying examination tests the student's knowledge, grasp of fundamentals and his ability to use them in unknown situations.

3. Foreign Language when required

The foreign language will be prescribed as an eligibility requirement for the Ph.D. only when the supervisor and/or the Dean Academic Research Division have made recommendations for the same justifying its need for the particular topic of research and the literature available and this recommendation has been accepted by the Research Board. Otherwise English or an Indian language, as the case may be, would suffice the requirement of the foreign language.

4. Teaching Practice/Practice Lecture Series/ Research Methodology

BITS C791T	Teaching Practice I	1
BITS E661	Research Methodology	1

The above two separate and independent courses, to be taken one at a time, are designed and operated to provide cumulative experience for a Ph.D. student in the practice of teaching.

BITS E793T	Practice Lecture Series I	1

This course is in lieu of the Teaching Practice I and designed and operated to provide

cumulative experience for a Ph.D. student in the Practice of teaching in his own professional setting where it is not feasible to operate the teaching practice courses. The student will deliver a predetermined series of technical talks before a professional audience as approved by Dean Academic Research Division (ARD).

5. Seminar/Independent Study

1. BITS C797T Ph.D. Seminar (Min) 2

   While the total minimum number of units is 2, registration is done for one unit in each semester/term until the submission of the thesis.

2. BITS C790T Independent Study (Min) 2

   A student may be asked to register in this course in lieu of BITS C797T by Dean, Research & Consultancy if situation so warrants. While the total number of units is 2, registration is done for one unit in each semester/term until the submission of the thesis.

6. Thesis

BITS C799T Ph.D. Thesis (Min) 40

While the total minimum units assigned to this course are 40, the distribution of the units between different semesters/terms would be determined by the Dean, Academic Research Division (ARD).

7. General

The `Doctoral Counselling Committee (DCC)' consisting of (i) Dean, Research & Consultancy Division (Convenor), (ii) Dean, Academic Registration & Counselling Division (iii) Dean, Instruction Division (iv) Dean, Practice School Division (v) Dean, Work Integrated Learning Programmes Division, and (vi) Two members nominated by the Senate monitors the academic progress of Ph.D. students similar to the monitoring of academic progress of students of integrated First Degree and Higher Degree programmes by the ACB. The decisions of the DCC are reported to the Research Board and the Senate.

A Doctoral Advisory Committee (DAC) is appointed by the Dean, R & C for each candidate admitted to the Ph.D. programme. This committee consists of at least two faculty members from the broad area in which the candidate opts to pursue the Ph.D., besides the Dean, Academic Research Division (ARD).

Ph.D. Aspirants Scheme for Professionals

This programme enables experienced personnel and professionals working in industries and R&D organizations that collaborates with BITS to work for a Ph.D. degree of the Institute in their respective work environment. This makes it possible for practicing professionals to be offered the same challenges that are traditionally offered to teachers in universities. Candidates, sponsored by their organizations, work for the Ph.D. degree without any dislocation from their work environment on research problems relevant to their organizations.

Admission to this programme is done through what is known as Ph.D. Aspirants Scheme. Ph.D. Aspirants will be first asked to write the qualifying examination. The Ph.D. qualifying examination is based on two areas chosen by the candidate depending on his intended area of research and courses done. The institute recognizes that there may be professionals who might not possess a degree equivalent to a higher degree of the institute, but has gained knowledge and skills through experience (substantiated by documentary evidence), which could be treated as equivalent to one of the higher degrees of the institute. For convenience of operation, for these cases, the institute has devised a higher degree programme called M.Phil (Applied). A list of courses for M.Phil.(Applied) is given below, from which a minimum number of 8 courses are to be chosen.

M.Phil. (Applied)

BITS E511	Computer Applications I	4
BITS E512	Computer Applications II	4
BITS E521	Technical Communication I	4
BITS E522	Technical Communication II	4
BITS E531	Social, Behavioral & Economic Sciences I	4
BITS E532	Social Behavioral & Economic Sciences II	4
BITS E533	Modern Experimental Techniques-I	4
BITS E534	Modern Experimental Techniques-II	4
BITS E535	Management Methods & Techniques I	4

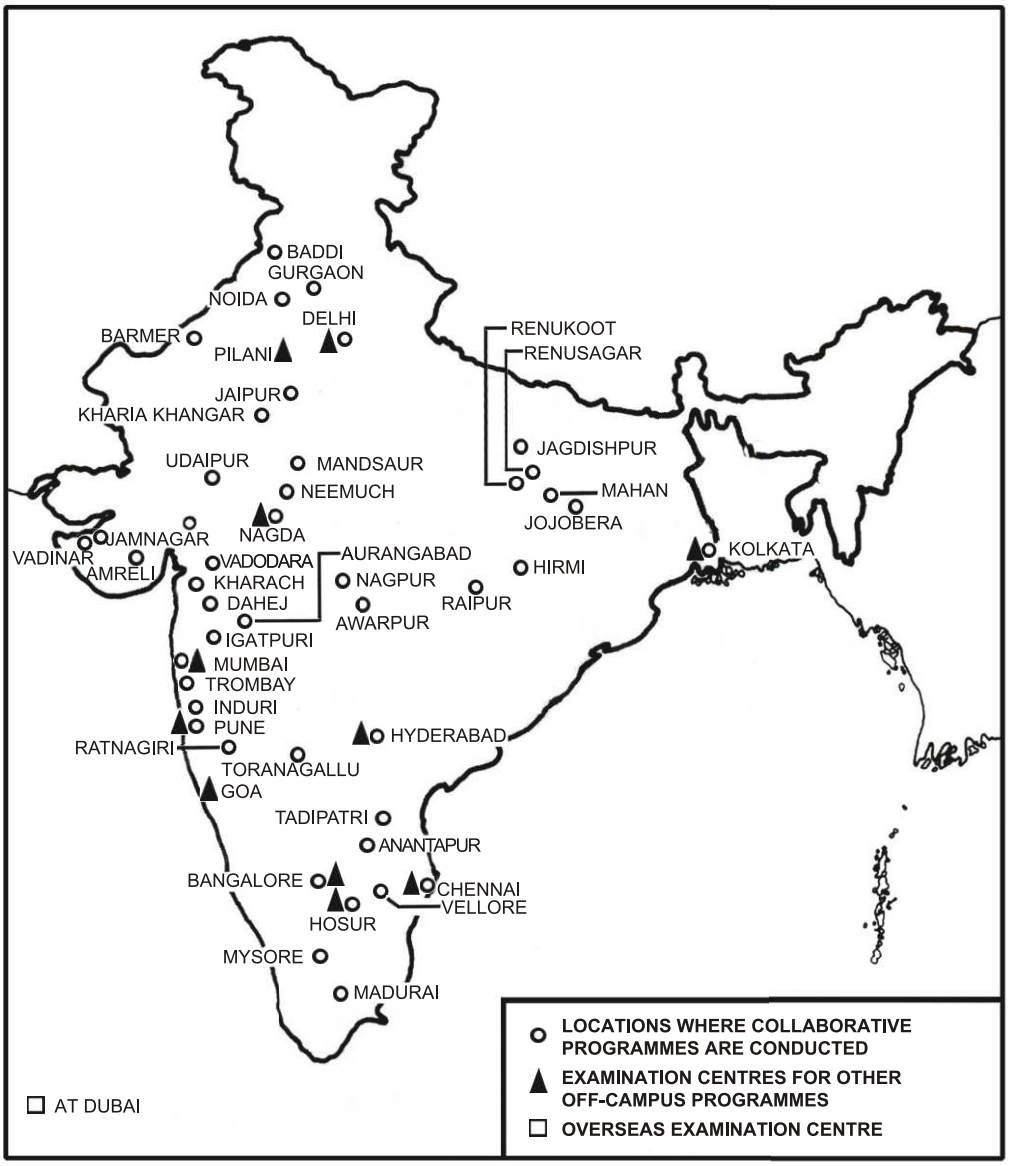
BITS E536	Management Methods & Techniques II	4
BITS E537	Systems Sciences and Engineering I	4
BITS E538	Systems Science and Engineering II	4
BITS E541	Chemical and Life Science I	4
BITS E542	Chemical and Life Science II	4
BITS E543	Instrumentation Engineering I	4
BITS E544	Instrumentation Engineering II	4
BITS E545	Project and Consultancy I	4
BITS E546	Project and Consultancy II	4
BITS E547	Public Administration I	4
BITS E548	Public Administration II	4
BITS E551	Physical and Mathematical Sciences I	4
BITS E552	Physical and Mathematical Sciences II	4
BITS E561	Use of English for Professional Purposes I	4
BITS E562	Use of Eng. for Professional Purposes II	4
BITS E571	Methods of Planning and Development I	4
BITS E572	Methods of Planning and Development II	4
BITS E573	Study in Advanced Topics I	5
BITS E574	Study in Advanced Topics II	5
BITS E583	Case Studies I	4
BITS E584	Case Studies II	4
BITS E591	Science and Technology Development I	4
BITS E592	Science and Technology Development II	4
BITS E593	Reading Course I	5
BITS E594	Reading Course II	5
BITS E611	Internship I	20
BITS E612	Internship II	20
BITS E661	Research Methodology I	5
BITS E662	Research Methodology II	5

Note: *No direct admission to M.Phil.(Applied) will be done. Courses described above will be used for students admitted to the Ph.D. programmes under the Ph.D. Aspirant Scheme.*

PART V

OFF-CAMPUS WORK-INTEGRATED LEARNING PROGRAMMES

MAP OF BITS WORK-INTEGRATED LEARNING & COLLABORATIVE PROGRAMMES 2016-2017



Introduction

Over the past three decades, the educational activities of the Institute have extended beyond the campus. This has been principally due to institutionalized linkages established by the Institute with various industries, R&D organizations, developmental agencies, etc. This activity for all the on-campus programmes is through the Practice School which as an integral component of the academic curriculum takes the classroom for a specified period to a professional location where the students and the faculty along with the industry experts get involved in real-life problems.

Since 1979, the Institute has been participating in the human resources development activities of the industries by evolving several degree programmes by integrating the working environment of the employees with the learning environment required by the Institute. These programmes were first started as M.E. (Collaborative) programmes in 1979. Later, from 1988, the work integrated learning philosophy has been extended to programmes like First Level Diploma in Computer Applications, Footwear Technology, Instrument Servicing & Maintenance, Nautical Sciences, Workshop Technology; M.V.S in Computer Operations & Applications, Footwear Technology, Information Management, Physician Assistant; B.S. in Industrial Management, Engineering & Industrial Technology, Engineering Design, Engineering Technology, Industrial Engineering & Technology, Information Systems, Manufacturing Engineering, Marine Engineering, Nautical Sciences, Nautical Technology, Ophthalmic Assistant, Optometry, Pharmacy Operations, Physician Assistant, Power Engineering, Process Engineering, Technological Operations; B.Tech. Engineering Design, Engineering Technology, Information Systems, Manufacturing Technology, Marine Engineering, Nautical Technology, Power Engineering, Process Engineering, B.Optom. Optometry, M.Sc. Information Systems, M.Sc. (Tech.) Pharmaceutical Chemistry; M.E.(Collaborative) Project Engineering, Industrial Management, Industrial Production; M.S. in Chemical Technology, Computer, Computer Science, Consciousness Studies, Consultancy Management, Design Engineering, e-Business, Educational System Management, Electronic Sciences, Electronics & Control, Embedded Systems, Engineering Management, Habitat Technology, Industrial Production & Management, Life Sciences, Management Systems, Manufacturing Management, Mechanical Systems Design, Medical Laboratory Technology, Microelectronics, Pharmaceutical Operations and Management, Pharmaceutics, Pharmacy Operations, Pharmacy Operations, Physical Sciences, Quality Management, Science & Technology, Science Communication, Software Engineering, Software Systems, Systems & Information, Systems Engineering, Technological Operations, Telecommunications and Software Engineering, Biomedical Sciences; M.B.A. in Consultancy Management, Manufacturing Management, Quality Management, M.Tech. in Automotive Engineering, Design Engineering, Embedded Systems, Engineering Management, Environmental Engineering, Manufacturing Management, Microelectronics, Pharmaceutical Operations and Management, Quality Management, Science Communications, Software Engineering, Software Systems, Systems Engineering, Telecommunications and Software Engineering M.Phil. in Cardiac Sciences, Astronomy & Planetarium Sciences, Hospital & Health Systems Management, Mathematics, Optometry, Physician Assistant,

Science Communication & Journalism, Consciousness Studies and Off-campus Ph.D.

Description of Programmes

The Institute conducts off-campus degree programmes as a means of continuing education for employed professionals as part of the human resource development programmes of specific organizations at various off-campus centres. The Institute's Senate has authorized the Institute to run the off-campus degree programmes in every degree in which an on-campus degree programme is already run in the Institute. For the conduct of all these programmes, the basic requirement is the participation of the collaborative organization by extending physical and other facilities and by agreeing to integrate their work requirements with the academic requirements of the Institute for the pursuit of the degree programme. A separate division of the Institute operates all these programmes. In all these programmes, emphasis is on self-learning and the pedagogy attempts to incorporate as many modern technologies as desirable. A Schematic depicting Person-centered approach to a Student's Programme of Study as viewed from the Student's standpoint is given in Figure 1 on Page V-3. While every one of these programmes requires collaboration of an organization, some programmes have a highly structured collaboration with planned classroom activities and some programmes may have less structured planning. While a number of degrees are offered through structured collaboration with many collaborating organizations, there are also degrees, which are available in an open manner for a large number of organizations, each of which may sponsor only few students. For all these programmes, faculty/resource persons are drawn from the Institute, the participating organizations as well as experts from other Institutions. The currently operative programmes are given in Table 1 on page V-4 and some programmes are also operated for old registered students are given in Table 2 on Page V-5. Index for currently operative programme charts are given on Page V-11 & V-12 and some programme charts are also operated for old registered students are given on page V-13 and V-14.

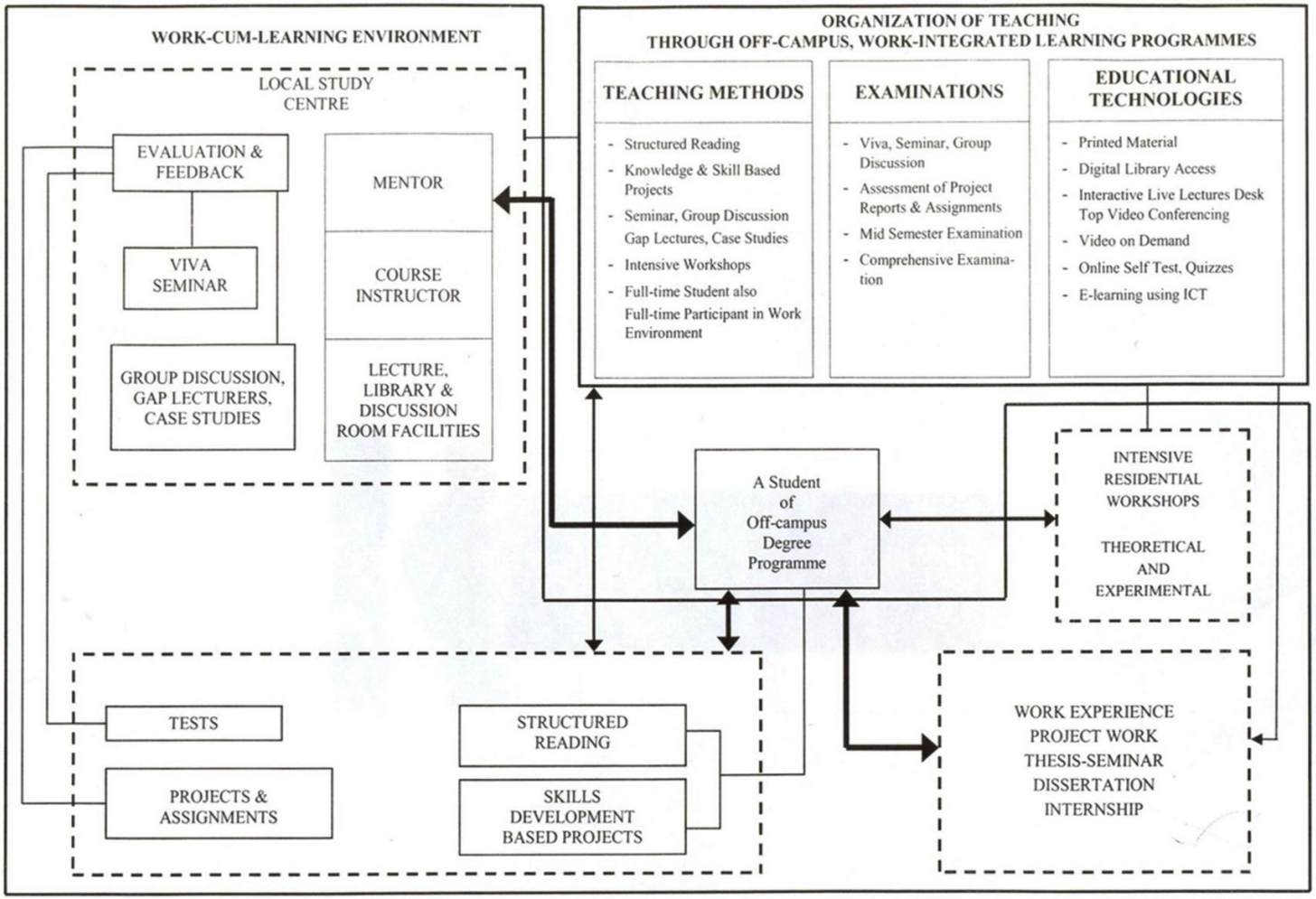


Figure 1: Person-centred Approach in the Off-campus Work-Integrated Learning Programme

Table 1: Currently Operative Off-Campus Work-Integrated-Learning Programmes at a Glance

Programmes	Collaborating / Sponsoring Organization
Post Graduate Diploma in Finance	- Designed for the HRD needs of Business organizations
B.Tech. Programmes	
1. Engineering Design	- Eaton Technologies, Pune; L&T, Vadodara, Cluster, Pune
2. Engineering Technology	- Designed for the HRD needs of a diverse spectrum of Engineering Industries
3. Information Systems	- Designed for the HRD needs of a diverse spectrum of IT Industries and Wipro Bangalore
4. Manufacturing Technology	- Kirloskar Oil Engines, Kolhapur, Bharat Forge, Pune, Tata Motors, Jamshedpur
5. Power Engineering	- Aditya Birla Group, Tata Power, JSW Energy - Mumbai; Essar Power, Hazira
6. Process Engineering	- Aditya Birla Group, Mumbai; JSW Steel, Toranagallu; DRL, Hyderabad; Vedanta, Jharsuguda
M.Sc. Programme	
1. Business Analytics	- Genpact, Gurgaon, Designed for the HRD needs of a diverse spectrum of IT Industries
2. Information Systems	- Designed for the HRD needs of a diverse spectrum of IT Industries
M.B.A. Programmes	
1. Consultancy Management	- Designed for the HRD needs of a diverse spectrum of consulting firms
2. Finance	- Designed for the HRD needs of Business organizations
3. Manufacturing Management	- Designed for the HRD needs of a diverse spectrum of Engineering Industries
4. Quality Management	- Designed for the HRD needs of a diverse spectrum of Engineering Industries
M.Tech. Programmes	
1. Automotive Engineering	- Tata Technologies, Tata Motors, Pune
2. Design Engineering	- John Deere, Pune; Cluster Programme, Pune
3. Embedded Systems	- UTC, Bangalore, Hyderabad; L&T, Vadodara; Cluster programme, Pune, Bangalore
4. Environmental Engineering	- Goa State Pollution Control Board, Goa
5. Manufacturing Management	- Designed for the HRD needs of a diverse spectrum of Engineering Industries, Sesa Sterlite, Jharsuguda
6. Microelectronics	- Cypress, Qualcomm, Texas Instruments, Cluster,

Programmes	Collaborating / Sponsoring Organization
	Bangalore
7. Pharmaceutical Operations and Management	- Lupin, Mumbai; Cipla, Mumbai
8. Quality Management	- Designed for the HRD needs of a diverse spectrum of Engineering Industries
9. Science Communication	- National Council of Science Museums, Kolkata
10. Software Engineering	- EMC, Bangalore; Tech Mahindra, Pune; iGate, Mumbai; Qualcomm, Hyderabad; SAP Labs, Sabre, Bangalore; Persistent, Pune; Cybage, Pune; CTS, Chennai; TCS, Hyderabad; Virtusa, Chennai; Wipro Technologies, Bangalore; Hexaware, Mumbai; Verizon, Chennai
11. Software Systems	- Designed for the HRD requirements of a diverse spectrum of IT Industries; Wipro Technologies, Bangalore; TCS, Hyderabad, Verizone
12. Structural Engineering	- PWD, Goa
13. Systems Engineering	- Wipro Infotech, Bangalore
14. Telecommunications and Software Engineering	- Avaya, Pune, Tech Mahindra, Pune
15. Transportation Engineering	- PWD, Goa
M.Phil.	
1. Consciousness Studies	- Bhaktivedanta Institute, Mumbai
2. Hospital and Health Systems Management	- CMC, Vellore; Bombay Hospital, Mumbai

Note: The Institute looks for the viable minimum number (around 50) of candidates sponsored by an organization or a group of organizations in any centre for a degree programme. Any organization interested in having a dialogue with the Institute for offering any collaborative and innovative programme directed towards the human resource development needs of their industry may write to the Institute. The Institute has an open mind to offer any of the existing programmes or devise any other new programme.

Table 2: The following Work Integrated Learning Programmes are also operated for students registered earlier

Programmes	Collaborating / Sponsoring Organization
B.S. Programmes	
1. Engineering Design	- Eaton Technologies, Pune; L&Ties, Vadodara
2. Engineering Technology	- Designed for the HRD needs of a diverse spectrum of Engineering Industries
3. Information Systems	- Designed for the HRD needs of a diverse spectrum of IT Industries and Wipro Infotech, Mumbai
4. Manufacturing Engineering	- Bharath Forge, TACO, Kirloskar Oil Engines, Pune
5. Physician Assistant	- Madras Medical Mission, Chennai
6. Power Engineering	- Aditya Birla Group, Tata Power, JSW Energy - Mumbai; Essar Power, Hazira
7. Process Engineering	- Aditya Birla Group; Hindalco Industries, Dahej; JSW Steel, Toranagallu; DRL, Hyderabad; Sesa Sterlite, Jharsuguda
B.Tech. Programmes	
1. Marine Engineering	- Tolani Maritime Institute, Induri; RL Institute of Nautical Sciences, Madurai
2. Nautical Technology	- Tolani Maritime Institute, Induri; RL Institute of Nautical Sciences, Madurai
B.Optom. Programme	
1. Optometry	- Sankara Nethralaya, Chennai; LV Prasad Eye Institute, Hyderabad; The Tun Hussein Onn National Eye Hospital, Malaysia
M.S. Programmes	
1. Automotive Engineering	- Tata Technologies, Pune
2. Consultancy Management	- Consultancy Development Centre, New Delhi
3. Design Engineering	- Eaton Technologies, Pune, L&T, Vadodara; SKF, Pune
4. Embedded Systems	- John Deere, iGate, Pune; L&T, Vadodara
5. Manufacturing Management	- Designed for the HRD needs of a diverse spectrum of Engineering Industries
6. Microelectronics	- Wipro Technologies, Cypress, Qualcomm, IBM, Bangalore
7. Pharmaceutical Operations & Management	- Lupin, Mumbai
8. Software Engineering	- Wipro Technologies, EMC, SAP Labs - Bangalore; CTS, Virtusa, Chennai; Tech Mahindra, Pune ; Cybage, Persistent, iGATE, Mumbai, TCS, Hyderabad, Qualcomm, Hyderabad
9. Software Systems	- Designed for the HRD requirements of a diverse spectrum of IT Industries
10. Systems Engineering	- Wipro Infotech - Bangalore
11. Telecommunications & Software Engineering	- Tech Mahindra, Avaya - Pune

Admission Modality

1. The Institute is one of the very few universities in India, which has ventured into off-campus work integrated learning programmes in science and technology areas. In order to maintain the standard as well as rigour required in this area, the Institute could cater only to those inputs, which have the facilities and environment for such a learning process. So the Institute treats these degree programmes as continuing education programmes for employed professionals. Hence admissions are given normally to candidates who are already employed and whose organizations sponsor them in their academic pursuit subject to the candidates having the required academic qualifications. The Institute looks for candidates who have the necessary computer, laboratory and other physical facilities including access to Email and Internet as well as certain intellectual input in terms of guidance by superior / co-officer / professional expert preferably from the workplace of the candidate who will be termed as Mentor, while the candidate is in pursuit of studies. In the case of B.Optom. Optometry, B.S. Physician Assistant and M.Phil. Optometry admissions are done also for open candidates. Even in these cases the admitted students will be involved in the work of the collaborative organization almost like an employee and there will be a great emphasis on work experience and in-service training along with the academic pursuit.

II. These degree programmes are work-integrated learning programmes. Hence, for students to get admission to these programmes, they must be engaged in work in the relevant professional areas. The final offer of admission for B.Tech. in Engineering Technology, Information Systems, M.Sc. in Information Systems, M.B.A. in Consultancy Management, Manufacturing Management, Quality Management, M.Tech. in Software Systems, Manufacturing Management, Quality Management, Integrated Software Systems, M.Phil. Hospital & Health Systems Management programmes, would be based on candidate's educational background, academic achievements, work profile, relevant work experience, profile of the employing organization and Mentor's profile.

III. If the number of applications for a particular programme is less than a critical number, that programme may not be offered in that semester.

IV. For some of the off-campus collaborative programmes like B.Tech. in Marine Engineering, Nautical Technology, B.Optom. Optometry, B.S. in Physician Assistant; M.Phil. in Optometry, a specially designed test and interview may be administered to the candidates for admission. The candidates would be required to attend these tests / interviews at their own expense.

V. Certain off-campus collaborative programmes require the students to be present at the off-campus Centre in which they are conducted. For example, the B.Optom. Optometry is conducted at the off-campus centers in Chennai, Hyderabad and THONEH; B.S. in Physician Assistant, M.Phil. in Optometry, are conducted at the off-campus centres in Chennai; B.Tech. in Marine Engineering, Nautical Technology are conducted at the off-campus centers in Induri and Madurai.

VI. Once the candidate accepts the admission offer and confirms registration, any request for deferment of admission to a subsequent semester cannot be entertained. The candidate can only withdraw from the registered semester.

Fees Structure

The fees schedule applicable for all programmes is as follows:

Admission Fees	: Rs. 15,000/-
Each Semester Fees	: Rs. 40,750/-

A candidate who has been offered admission will have to pay Rs. 53,800/- (Admission fees and Semester fees for the Starting Semester of the programme) immediately on receiving the Admit Offer Letter. Any candidate who desires to discontinue from the programme after confirmation of admission & registration for the courses specified in the admit offer letter will forfeit the total amount of fees paid.

For certain programmes like B.Tech. Marine Engineering, B.Optom. Optometry and B.S. Physician Assistant, where hostel and other facilities are provided, there will be additional fees

prescribed which will be communicated at the time of admission.

Note 1: Additional facilities such as access to digital library, if provided, may be charged extra in addition to the above mentioned fees.

Note 2: For the examination centre at Dubai, in addition to the semester fees, for each semester there will be an examination centre fees of 1000 UAE Dirhams or equivalent per semester out of which 500 UAE Dirhams is to be paid at the time of appearing in Mid-semester examinations at Dubai Centre for that semester, and the remaining 500 UAE Dirhams is to be paid at the time of appearing in Comprehensive Examinations at Dubai centre for that semester.

Educational Process

The education in the off-campus work integrated learning programmes is characterized by person-centered approach where the rigour and standards are maintained on par with Institute's system of education on-campus. These programmes judiciously combine the flexibility and ingenuity of the off-campus educational system with the regular features of the on campus education system. Also, the learning and evaluation process draws upon the successful and established methodologies followed by the Institute.

The off-campus work integrated learning environment of a student consists of two broad-based facets:

1. Academic Environment created by campus-based and off-campus centre-based Instructors who are BITS faculty drawn from different disciplines.
2. Student's own Work Environment from which assignments, projects, seminars etc., may emerge to integrate theory and practice. A (locally-based) Mentor imparts structured guidance and conducts certain evaluation components (see Role of Mentor' below).

Central to the educational philosophy of the Institute being the dialectical link between theory and practice, the student's own work environment provides an ideal ground where theory could be meaningfully combined with practice through Assignments, Case Studies, Laboratory-Oriented Projects, Work Experience, In-service Training, Internship, Thesis-Seminar, Project Work and Dissertation. These evaluation components and courses search for evidence of self-study, time planning, conceptual understanding & application of the concepts in a real-life situation, self-reliant articulation, enthusiasm for, awareness of and participation in new pedagogy. One of the distinctive features of this system is the complete formalization of pursuit of education at the work-learning environment. An organization creates a work learning environment by providing academic sponsorship for the candidates as well as infrastructural facilities such as place for conducting formal classes / mentor interactions / examination apart from library, computer and laboratory access. The work learning environment form a strict requirement in order to infuse a strong component of teacher-student contact through course instructors as well as Mentor (a senior officer of the student's own organization). Thus work-learning environment is a very important component of the person-centered learning process. There is in the design, a clear arrangement of periodic personal discussion in the work-learning environment with the students so that their progress is directly monitored by planned interaction. Further, the students at the work-learning environment receive help from mentors. Throughout the student's learning process, which is conducted in his own work place, through systematic self-study, and self-learning process, the student remains continually in contact with the course instructors for any clarifications. Thus the operation is an imaginative combination of the contact hours and tutoring of the on-campus system with the student-centered self-study feature of the off-campus system and an organizational and pedagogic commitment of the collaborating organizations. The student is at once, a fulltime student as well as full-time employee.

Work-Integrated Learning: For each course offered by the Institute, there would be an Instructor, who is a BITS faculty, drawn from the relevant discipline. He is charged with the responsibility of the conduct of that course. This will be in terms of preparing question papers, evaluation of answer papers and answering student's queries. He will also prepare instruction manuals, question bank, supplementary notes, etc. wherever required in order to strengthen the course.

For each course, there will be a handout, which will spell out the plan of study and evaluation scheme, apart from other details. The evaluation schedule is also announced in the beginning of the semester itself. All details pertaining to the operation of the course including study plan are shared with the students through this document.

The BITS, Pilani model of cooperative education has a structured method of integrating education with practical work experience, faculty-student interaction as well as mentor-employer involvement. Further, the BITS model of education deploys ICT both in synchronous and asynchronous modes. Synchronous instruction through Internet based desktop video conferencing enables effective interaction between students and faculty. Asynchronous instruction, including on-demand lectures and electronic mail through list servers, is more flexible as it accommodates multiple learning levels and schedules. In addition, intensive residential contact classes are held for various programmes at the Institute campus as well as at the locations of various organizations. Thus, the BITS, Pilani model emphasizes on acquisition of knowledge and skills through mediated information and instruction, encompassing all technologies, in the work-integrated learning environment.

The Role of a Mentor: A Mentor is a senior officer of the student-employee who has been nominated by his employing organization or is a person in a senior position willing to undertake and discharge the academic responsibilities on his own volition. It is expected of the Mentor to possess adequate qualifications to guide the student. Typically for the B.Tech. programmes mentor is expected to have minimum educational qualification of the level of Integrated First Degree of BITS or its equivalent such as B.E. / BITS B.S./ B.Tech. / M.Sc. / A.M.I.E. etc. and for the M.B.A. / M.Tech. / M.S./ M.Phil. programmes of the level of Higher Degree of BITS or its equivalent such as M.E. / M.S. / M.Tech. / M.Phil. / M.D. etc.

The Mentors would assist the course instructors in terms of the following:

b) Achieving the set of academic objectives specified by the instructors;

c) Verifying if a student is indeed adhering to the plan of study given in the handout;

d) Monitoring involvement of the student in self-study, time planning, understanding of concepts and their use, developing self-reliant articulation, awareness of and enthusiasm for new pedagogy, responsibility to meet deadlines, develops familiarity with the library, etc.

e) Conducting certain evaluation components like Seminar, Assignment, Project, Case Study, etc.

Additional features include:

(a) Course Materials (Printed notes and standard textbooks) developed/identified especially for the work-integrated learning situation.

(b) ***It is the responsibility of each student to acquire textbooks and other reference materials recommended for each course.***

(c) Curricula designed on S&T approach for modernizing the workbench by purposeful acquisition of scientific methods and modern skills.

(d) Residential Terms for intensive contact classes (where required) conducted at BITS, Pilani or at its off-campus centres or at the collaborating organizations. The requirements of these Terms would include the following:

- Gap Lectures
- Field, Library and Laboratory work
- Projects
- Tutorials
- Informal discussions
- Seminars
- Social activities.

Evaluation Methodology

Evaluation for a given course is internal and continuous and has the following features:

- Assignments, Projects, Case-studies, spread over a semester for making the course relevant and meaningful to the work learning environment of the students;
- Written examinations – one at the mid-semester point and another comprehensive exam at the end of semester. These examinations are conducted at specified off-campus centres of

BITS in a centralized manner under the supervision of BITS faculty.

- For B.Tech. Engineering Technology, B.Tech. Information Systems, M.Sc. Information Systems, M.B.A. Consultancy Management, M.B.A. Manufacturing Management, M.B.A. Quality Management, M.Tech. Software Systems, M.Tech. Manufacturing Management, M.Tech. Quality Management, Integrated M.Tech. Software Systems, M.Phil. Hospital & Health Systems Management; the Institute presently has examination centre arrangements at Bangalore, Chennai, Delhi, Goa, Hosur, Hyderabad, Kolkata, Mumbai, Pilani, Pune in India and Dubai in UAE.
- Strict adherence to the evaluation schedule as announced through the course handout at the start of the semester.
- The Institute follows continuous system of internal evaluation and letter grades A, A-, B, B-, C, C-, D, E carrying grade points 10, 9, 8, 7, 6, 5, 4, 2 respectively are awarded for all courses other than Dissertation / Thesis-Seminar / Project Work for which only non-letter grades namely EXCELLENT, GOOD, FAIR, POOR are awarded. If a student does not offer adequate opportunity for evaluation in a course, reports such as RRA (Require to Register Again) may be awarded.
- The final grading in a course is done by tabulating in descending order (equivalently a histogram) the total marks of all students in a particular course. The performance of the course will be analysed in terms of average, highest and lowest marks and dividing lines between various clusters. Gaps between clusters and the nature of clusters will guide drawing the dividing lines between various grades. In a normal class of large size, the C-band will usually include the average mark. This is not a hard and fast rule and exceptions may arise in cases of small classes or a skewed histogram etc.
- The Cumulative Grade Point Average (CGPA) on a 10 Scale basis is used to describe the overall performance of a student in all courses for which LETTER GRADES are awarded.

$$CGPA = \frac{U_1G_1 + U_2G_2 + U_3G_3 + ... + U_nG_n}{U_1 + U_2 + U_3 + ... + U_n}$$

Where U_1, U_2, U_3, … U_n denote units associated with the courses taken by the student and G_1, G_2,G_3,…G_n denote grade points of the letter grades awarded in the respective courses. Non-Letter grades do not go into computation of CGPA.

- In the case of Integrated First Degree programmes the final division for the degree is decided on the basis of CGPA and there are three classifications, namely Distinction (CGPA 9.00 or more), First Division (CGPA 7.00 or more but less than 9.00) and Second Division (CGPA 4.50 or more but less than 7.00). However, no division will be awarded in diploma, higher degrees and Ph.D. programmes.
- Subject to fulfilling the Academic Regulations of the Institute, the student will be issued at the end of each semester a grade sheet and at the end of the programme a Transcript and Provisional Certificate followed by the Final Degree Certificate. The grade sheet / transcript – provisional certificate will be withheld when a student has not paid his dues or when there is a pending case of breach of discipline or a case of unfair means against him.
- The minimum academic requirements for the M.B.A., M.Tech. & M.Phil. programmes stipulate that a student obtains a CGPA of 5.50 and no E grade in any course. Similarly for the B.S., B.Tech. M.Sc. programmes, a student should obtain a CGPA of 4.50 and no E grade in any course. Students who fail to meet the minimum academic requirements are placed under the purview of Academic Monitoring Board (AMB), which monitors their progress, and gives guidance so that they are properly rehabilitated at the earliest.
- The Institute's Academic Regulations must be consulted for additional details.

Some Stipulations

(a) While the students who are admitted to on-campus degree programmes may be permitted to transfer to off-campus degree programmes, the reverse is normally not possible since the admission modalities for the two degrees are not the same. However, all off-campus degrees are equivalent to the corresponding degree of on-campus and for admissions to the Institute for any higher

degree programmes the off-campus degrees will not be distinguished from on-campus degrees.

(b) In any examination, as far as possible, the direct interactive process of the evaluation would be made at a place nearest the working place of the candidates. Wherever there is not adequate number of candidates, the Institute will be free to demand that all candidates come to Campus or other Off-Campus centers for this purpose.

(c) In case of organization specific collaborative programmes, a student who is admitted to the Institute because of sponsorship from an organization will cease to be a student if he discontinues employment from the organization. In case of other programmes, the student may be allowed to continue if the new organization in which he is employed agrees to sponsor him for the degree and if the work integrated learning environment is relevant to the degree programme. However, if the person becomes unemployed he may not be continued because of the requirement of work integrated learning environment for the degree, which may no longer be available to the student.

(d) Any student admitted to a programme may be allowed to transfer to another programme provided he is eligible for the same and is supported by his work environment and sponsorship of his employer.

(e) Since every student admitted to off-campus degree programme is treated as a full-time student and a full time employee, it is essential that such a student be not enrolled for any degree or diploma programme, part-time or otherwise, in any other university. If it is found that a student is admitted / registered in some other university for degree programme, then his admission / registration will be cancelled.

Operating Definitions of Certain Key Terms

1. A course is a component of knowledge, which serves as the irreducible minimum building block in the curriculum or syllabus.

2. A programme of studies is a set of courses constituting the requirements of a degree.

3. A regular student is one who is enrolled for a degree.

4. A collaborating organization is an organization that helps the Institute in setting up the necessary facilities and in the running of classes and laboratories for all students. Such an organization may simultaneously be also a sponsoring organization.

5. A sponsoring organization is an organization, which fulfills one or more of the following features:

   a) The organization is the employer of the student and pays fully / partly the fees/dues of the student and also provides facilities required for the learning process.

   b) The organization is an employer of the student but does not pay the fees/dues of the student. Nonetheless the organization agrees to encourage and actively participate in the special nature of the educational process for the mutual benefit of the organization and the employee.

6. An Associate Student is one who is allowed to register in any of the courses offered in each semester with an ultimate goal of obtaining a diploma/degree or without any such ambition. The treatment of these students will be different from that of the casual students in that these students will be registered on credit and not on audit basis and may be admitted for a degree or a diploma, if situation so warrants. Further, admission procedure and the fee structure may also differ in contrast to the casual students. Presently the Institute considers only sponsored candidates from structured collaborative programmes for admission as Associate Student.

Duration: This may vary from programme to programme depending upon the input qualification, experience, nature as well as the need of the collaborating organizations including the viability and feasibility of course offerings. The Semesterwise pattern given in the following pages indicate the currently operational details for various programmes, which are subject to change if the situation warrants.

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POST GRADUATE DIPLOMA (FINANCE)

Type of Input: Employed professionals working in finance and allied business domains, holding a three year undergraduate degree in relevant disciplines with adequate preparation in mathematics.

Duration: Two Semesters

Programme Structure

Core Courses

Course No.	Course Title	Units
FIN ZG514	Derivatives & Risk Management	4
FIN ZC415	Financial and Management Accounting	4
FIN ZG521	Financial Management	4
FIN ZG512	Global Financial Markets and Products	4
FIN ZG513	Management of Banks & Financial Institutions	4
FIN ZG518	Multinational Finance	4

Pool of Electives

Course No.	Course Title	Units
FIN ZG519	Business Analysis & Valuation	4
FIN ZG520	Security Analysis & Portfolio Management	4
FIN ZG528	Venture Capital & Private Equity	4
FIN ZG522	Mergers, Acquisitions, and Corporate Restructuring	4
FIN ZG523	Market Risk Management	4
FIN ZG524	Credit Risk Management	4
FIN ZG525	Operational Risk Management	4
FIN ZG526	Advanced Risk Models	4
FIN ZG527	International Regulatory Framework for Banks	4

Semester wise pattern

Year	First Semester		U	Second Semester		U
I	FIN ZG512	Global Financial Markets and Products	4	FIN ZG514	Derivatives & Risk Management	4
	FIN ZG513	Management of Banks & Financial Institutions	4	FIN ZG518	Multinational Finance	4
	FIN ZC415	Financial and Management Accounting	4		Elective 1	4
	FIN ZG521	Financial Management	4		Elective 2	4
		Total	16		Total	16

B. TECH. (ENGINEERING DESIGN)
Curriculum Structure

Normal Input: Employed professionals holding a Technical Diploma or B.Sc. degree with adequate preparation in Mathematics, and having adequate, relevant work experience.

Nominal duration: The nominal duration of a B.Tech. programme will be 7 semesters.

Curriculum Requirements:

Foundation Courses	:	9 courses	(32 units min.)
Discipline Core	:	11 courses	(40 units min.)
Discipline Electives	:	4 courses	(12 units min.)
Coursework sub total	:	24 courses	(84 units min.)
Project Work	:	16 units	

Category-wise Programme Structure:

Category	Course No.	Course Title	Units
Foundation Courses (9)			
Mathematics Foundation	ED* ZC233	Calculus	4
	ED* ZC235	Linear Algebra & Optimization	3
Technical Arts / Professional Courses	ED* ZC164	Computer Programming	4
	ED* ZC241	Technical Report Writing	3
	ED* ZC 231	Principles of Management	3
Engineering Foundation	ED* ZC232	Engineering Materials	3
	ED* ZC261	Mechanical Technology	4
	ED* ZC211	Electrical and Electronics Technology	4
	ED* ZC251	Engineering Measurements	4
Discipline Courses			
Core (11)	ED* ZC321	Mechanics of Solids	3
	ED* ZC245	Fluid Mechanics & Machines	4
	ED* ZC332	Mechanical Engineering Design-I	4
	ED* ZC322	Kinematics & Dynamics of Machines	3
	ED* ZC311	Manufacturing Processes	4
	ED* ZC453	Product Design & Development	4
	ED* ZC342	Mechanical Engineering Design-II	4
	ED* ZC434	Quality Control, Assurance & Reliability	4
	ED* ZC433	Mechanical Vibrations & Acoustics	3
	ED* ZC441	Automotive Vehicles	3
	ED* ZC436	Computer Aided Design	4
Electives (any 4)	ED* ZC471	Management Information Systems	3
	ED* ZC324	Mechatronics & Automation	4
	ED* ZC325	Fluid Power Systems	4
	ED* ZC452	Composite Materials and Design	4
	ED* ZC454	Reverse Engineering and Rapid Prototyping	4

B. TECH. ENGINEERING DESIGN (Eaton Technologies, Pune)

Normal Input: Employed professionals holding a Technical Diploma or B.Sc. degree with adequate preparation in Mathematics, and having adequate, relevant work experience.

Nominal duration: The nominal duration of a B.Tech. programme will be 7 semesters.

Year	First Semester		U	Second Semester		U
I	EDET ZC211	Electrical and Electronics Technology	3	EDET ZC164	Computer Programming	4
	EDET ZC232	Engineering Materials	3	EDET ZC235	Linear Algebra and Optimization	3
	EDET ZC233	Calculus	4	EDET ZC251	Engineering Measurements	3
	EDET ZC261	Mechanical Technology	3	EDET ZC321	Mechanics of Solids	3
		Total	13		Total	13
II	EDET ZC245	Fluid Mechanics and Machines	4	EDET ZC342	Mechanical Engineering Design-II	4
	EDET ZC311	Manufacturing Processes	3	EDET ZC436	Computer Aided Design	4
	EDET ZC322	Kinematics & Dynamics of Machines	3	EDET ZC453	Product Design & Development	4
	EDET ZC332	Mechanical Engineering Design-I	4		Discipline Elective	3(min.)
		Total	12		Total	12
III	EDET ZC433	Mechanical Vibrations & Acoustics	3	EDET ZC241	Technical Report Writing	3
	EDET ZC434	Quality Control, Assurance & Reliability	4	EDET ZC231	Principles of Management	3
	EDET ZC441	Automotive Vehicles	3		Discipline Elective	3(min.)
		Discipline Elective	3(min.)		Discipline Elective	3(min.)
		Total	12		Total	16
	EDET ZC425T	Project Work	16			

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

Pool of Electives

Course No.	Course Title	Units
EDET ZC471	Management Information Systems	3
EDET ZC324	Mechatronics & Automation	4
EDET ZC325	Fluid Power Systems	4
EDET ZC452	Composite Materials and Design	4
EDET ZC454	Reverse Engineering and Rapid Prototyping	4

B. TECH. (ENGINEERING TECHNOLOGY)
Curriculum Structure

Normal Input: Employed professionals holding a Technical Diploma or B.Sc. degree with adequate preparation in Mathematics, and having adequate, relevant work experience.

Nominal duration: The nominal duration of a B.Tech. programme will be 7 semesters.

Curriculum Requirements:

Foundation Courses	: 10 courses	(35 units min.)
Discipline Core	: 9 courses	(34 units min.)
Discipline Electives	: 5 courses	(15 units min.)
Coursework sub total	: 24	(84 units min.)
Project Work	: 16 units	

Category-wise Programme Structure:

Sub-Category	Course No.	Course Title	Units
Foundation Courses (10)			
Mathematics Foundation	MATH ZC233	Calculus	4
	MATH ZC234	Linear Algebra & Optimization	3
	AAOC ZC111	Probability and Statistics	3
Technical Arts / Professional Courses	TA ZC164	Computer Programming	4
	TA ZC312	Technical Report Writing	3
	MGTS ZC211	Principles of Management	3
Engineering Foundation	ENGG ZC232	Engineering Materials	3
	ENGG ZC241	Mechanical Technology	4
	ENGG ZC111	Electrical & Electronics Technology	4
	ENGG ZC232	Engineering Measurements	4
Discipline Courses			
Core (9)	ET ZC413	Engineering Design	4
	ET ZC423	Essentials of Project Management	3
	ET ZC344	Instrumentation & Control	4
	ENGG ZC242	Maintenance & Safety	3
	ET ZC234	Manufacturing Processes	4
	ET ZC342	Materials Management	4
	ET ZC412	Production Planning & Control	4
	ET ZC434	Quality Control, Assurance & Reliability	4
	ET ZC426	Plant Layout and Design	4
Electives (any 5)	ET ZC352	Energy Management	4
	ET ZC362	Environmental Pollution Control	3
	EA ZC412	Flexible Manufacturing Systems	4
	BITS ZC471	Management Information Systems	3
	ET ZC415	Manufacturing Excellence	4
	ET ZC323	Mechatronics & Automation	4
	ES ZC343	Microprocessors & Microcontollers	3

B. TECH. (ENGINEERING TECHNOLOGY)
Semesterwise Pattern

Normal Input: Employed professionals holding a Technical Diploma or B.Sc. degree with adequate preparation in Mathematics, and having adequate, relevant work experience.

Nominal duration: The nominal duration of a B.Tech. programme will be 7 semesters.

Year	First Semester		U	Second Semester		U
I	ENGG ZC111	Electrical & Electronics Technology	4	AAOC ZC111	Probability & Statistics	3
	ENGG ZC232	Engineering Materials	3	TA ZC232	Engineering Measurements	4
	MATH ZC233	Calculus	4	MATH ZC234	Linear Algebra & Optimization	3
	ENGG ZC241	Mechanical Technology	4	TA ZC164	Computer Programming	4
		Total	15		Total	14
II	ENGG ZC242	Maintenance & Safety	3	ET ZC344	Instrumentation & Control	4
	ET ZC234	Manufacturing Processes	4	ET ZC342	Materials Management	4
	ET ZC413	Engineering Design	4	ET ZC423	Essentials of Project Management	3
	ET ZC412	Production Planning & Control	4	ET ZC426	Plant Layout & Design	4
		Total	15		Total	15
III	ET ZC434	Quality Assurance & Reliability	4	MGTS ZC211	Principles of Management	3
		Discipline Elective	3(min.)	TA ZC312	Technical Report Writing	3
		Discipline Elective	3(min.)		Discipline Elective	3(min.)
		Discipline Elective	3(min.)		Discipline Elective	3(min.)
		Total	13		Total	12
	BITS ZC425T	Project Work	16			

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

Pool of Electives

Course No.	Course Title	Units
ET ZC352	Energy Management	4
ET ZC362	Environmental Pollution Control	3
EA ZC412	Flexible Manufacturing Systems	4
BITS ZC471	Management Information Systems	3
ET ZC415	Manufacturing Excellence	4
ET ZC323	Mechatronics & Automation	4
ES ZC343	Microprocessors & Microcontollers	3

B. TECH. (INFORMATION SYSTEMS)
Curriculum Structure

Normal Input: Employed professionals holding a Technical Diploma or B.Sc. degree with adequate preparation in Mathematics, and having adequate, relevant work experience.

Nominal duration: The nominal duration of a B.Tech. programme will be 7 semesters.

Curriculum Requirements:

Foundation Courses	: 8 courses	(27 units min.)
Discipline Core	: 10 courses	(39 units min.)
Discipline Electives	: 6 courses	(18 units min.)
Course work sub total	: 24	(84 units min.)
Project Work	: 16 units	

Category-wise Programme Structure:

Sub-category	Course No.	Course Title	Units
Foundation Courses (8)			
Mathematics Foundation	MATH ZC234	Linear Algebra & Optimization	3
	AAOC ZC111	Probability and Statistics	3
	MATH ZC222	Discrete Structures for Computer Science	3
	MATH ZC233	Calculus	4
Technical Arts / Professional Courses	TA ZC163	Computer Programming	4
	TA ZC312	Technical Report Writing	3
	MGTS ZC211	Principles of Management	3
Engineering Foundation	ES ZC264	Digital Electronics and Microprocessors	4
Discipline Courses			
Core (10)	IS ZC467	Computer Networks	4
	IS ZC353	Computer Organization & Architecture	4
	IS ZC363	Data Structures & Algorithms	4
	IS ZC337	Database Systems & Applications	4
	IS ZC372	Compiler Design	4
	IS ZC313	Object Oriented Programming & Design	4
	IS ZC364	Operating Systems	4
	IS ZC341	Software Engineering	4
	IS ZC327	Systems Programming	4
	IS ZC327	Software Testing	3
Electives (6)	BITS ZC471	Management Information Systems	3
	IS ZC423	Software Development for Portable Devices	3
	IS ZC415	Data Mining	3
	IS ZC472	Computer Graphics	3
	IS ZC446	Data Storage Technologies & Networks	3
	EA ZC473	Multimedia Computing	3
	IS ZC462	Network Programming	3
	IS ZC422	Parallel Computing	3
	IS ZC424	Software for Embedded Systems	3
	SS ZG511	Design & Analysis of Algorithms	5

B. TECH. (INFORMATION SYSTEMS)
Semesterwise Pattern

Normal Input: Employed professionals holding a Technical Diploma or B.Sc. degree with adequate preparation in Mathematics, and having adequate, relevant work experience.

Nominal duration: The nominal duration of a B.Tech. programme will be 7 semesters.

Year	First Semester		U	Second Semester		U
I	MATH ZC222	Discrete Structures for Computer Science	3	IS ZC313	Object Oriented Programming & Design	4
	MATH ZC233	Calculus	4	IS ZC327	Systems Programming	4
	TA ZC163	Computer Programming	4	MATH ZC234	Linear Algebra & Optimization	3
	ES ZC264	Digital Electronics and Microprocessors	4	IS ZC363	Data Structures and Algorithms	4
		Total	15		Total	15
II	IS ZC353	Computer Organization & Architecture	4	IS ZC372	Compiler Design	4
	IS ZC337	Database Systems & Applications	4	IS ZC344	Software Engineering	4
	IS ZC364	Operating Systems	4	IS ZC467	Computer Networks	4
	AAOC ZC111	Probability and Statistics	3	IS ZC472	Computer Graphics	3
		Total	15		Total	15
III		Discipline Elective	3(min.)	MGTS ZC211	Principles of Management	3
		Discipline Elective	3(min.)	TA ZC312	Technical Report Writing	3
		Discipline Elective	3(min.)		Discipline Elective	3(min.)
		Discipline Elective	3(min.)		Discipline Elective	3(min.)
		Total	12		Total	12
	BITS ZC425T	Project Work	16			

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

Pool of Electives

Course No.	Course Title	Units
BITS ZC471	Management Information Systems	3
IS ZC423	Software Development for Portable Devices	3
IS ZC415	Data Mining	3
IS ZC472	Computer Graphics	3
IS ZC446	Data Storage Technologies & Networks	3
EA ZC473	Multimedia Computing	3
IS ZC462	Network Programming	3
IS ZC422	Parallel Computing	3
IS ZC424	Software for Embedded Systems	3
SS ZG511	Design & Analysis of Algorithms	5

B. TECH. MANUFACTURING TECHNOLOGY
Curriculum Structure

Normal Input: Employed professionals holding a Technical Diploma or B.Sc. degree with adequate preparation in Mathematics, and having adequate, relevant work experience.

Nominal duration: The nominal duration of a B.Tech. programme will be 7 semesters.

Curriculum Requirements:

Foundation Courses	:	9 courses	(32 units min.)
Discipline Core	:	11 courses	(40 units min.)
Discipline Electives	:	4 courses	(12 units min.)
Coursework sub total	:	24 courses	(84 units min.)
Project Work	:	16 units (min.)	

Category-wise Programme Structure:

Category	Course No.	Course Title	Units
Foundation Courses (9)			
Mathematics Foundation	MT* ZC233	Calculus	4
	MT* ZC235	Linear Algebra & Optimization	3
Technical Arts / Professional Courses	MT* ZC164	Computer Programming	4
	MT* ZC241	Technical Report Writing	3
	MT* ZC 231	Principles of Management	3
Engineering Foundation	ME* ZC236	Engineering Materials	3
	MT* ZC251	Mechanical Technology	4
	MT* ZC112	Electrical and Electronics Technology	4
	MT* ZC213	Engineering Measurements	4
Discipline Courses			
Core (11)	MT* ZC261	Mechanics of Solids	3
	MT* ZC245	Fluid Mechanics and Machines	4
	MT* ZC342	Machine Design	4
	MT* ZC344	Metal Forming and Machining	4
	MT* ZC345	Casting and Welding	4
	MT* ZC331	Production Planning & Control	4
	MT* ZC418	Lean Manufacturing	4
	MT* ZC434	Quality Control, Assurance & Reliability	4
	MT* ZC433	Tool and Fixture Design	3
	MF* ZC421	Essentials of Project Management	3
	MT* ZC434	Computer Aided Manufacturing	3
Electives (any 4)	MT* ZC412	Flexible Manufacturing Systems	4
	MT* ZC324	Mechatronics & Automation	4
	MT* ZC343	Materials Management	4
	MT* ZC471	Manufacturing Excellence	4
	MT* ZC311	Automobile Technology-I	4
	MT* ZC312	Automobile Technology-II	4
	MT* ZC332	Operations Research	4
	MT* ZC234	Maintenance & Safety	3
	MT* ZC452	Composite Materials and Design	4

B. TECH. MANUFACTURING TECHNOLOGY
(Bharat Forge, TACO, Pune; Kirloskar Oil Engines, Kolhapur; Tata Motors, Jamshedpur)
Semesterwise Pattern

Normal Input: Employed professionals holding a Technical Diploma or B.Sc. degree with adequate preparation in Mathematics, and having adequate, relevant work experience.

Nominal duration: The nominal duration of a B.Tech. programme will be 7 semesters.

Year	First Semester		U	Second Semester		U
I	MT* ZC233	Calculus	4	MT* ZC235	Linear Algebra and Optimization	3
	MT* ZC261	Mechanics of Solids	3	MT* ZC245	Fluid Mechanics and Machines	4
	MT* ZC236	Engineering Materials	3	MT* ZC213	Engineering Measurements	3
	MT* ZC112	Electrical and Electronics Technology	4	MT* ZC221	Computer Programming	4
		Total	14		Total	14
II	MT* ZC241	Machine Design & Drawing	4	MT* ZC432	Computer Aided Manufacturing	3
	MT* ZC315	Casting and Welding	4	MT* ZC331	Production Planning and Control	4
	MT* ZC344	Metal Forming and Machining	4	MT* ZC312	Tool and Fixture Design	3
	MT* ZC342	Machine Design	4		Discipline Elective	3(min.)
		Total	16		Total	13
III	MT* ZC418	Lean Manufacturing	4	MT* ZC241	Technical Report Writing	3
	MT* ZC434	Quality Control Assurance and Reliability	4	MT* ZC231	Principles of Management	3
	MT* ZC421	Essentials of Project Management	3		Discipline Elective	3(min.)
		Discipline Elective	3(min.)		Discipline Elective	3(min.)
		Total	14		Total	12
	MT* ZC425T	Project Work	16			

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

Pool of Electives

Course No.	Course Title	Units
MT* ZC412	Flexible Manufacturing Systems	4
MT* ZC324	Mechatronics & Automation	4
MT* ZC343	Materials Management	4
MT* ZC471	Manufacturing Excellence	4
MT* ZC311	Automobile Technology-I	4
MT* ZC312	Automobile Technology-II	4
MT* ZC332	Operations Research	4
MT* ZC234	Maintenance & Safety	3
MT* ZC452	Composite Materials and Design	4

B. TECH. (POWER ENGINEERING)
Curriculum Structure

Normal Input: Employed professionals holding a Technical Diploma or B.Sc. degree with adequate preparation in Mathematics, and having adequate, relevant work experience.

Nominal duration: The nominal duration of a B.Tech. programme will be 7 semesters.

Curriculum Requirements:

Foundation Courses	:	9 courses (31 units min.)
Discipline Core	:	10 courses (36 units min.)
Discipline Electives	:	5 courses (17 units min.)
Coursework sub total	:	24 courses (84 units min.)
Project Work	:	16 units

Sub- Category	Course No	Course Title	Unit
Foundation Courses (9)			
Mathematics Foundation	POW* ZC233	Calculus	4
	POW* ZC234	Linear Algebra & Optimization	3
General Awareness / Technical Arts	POW* ZC164	Computer Programming	4
	POW* ZC232	Principles of Management	3
	POW* ZC321	Technical Report Writing	3
Engineering Foundation	POW* ZC112	Electrical & Electronics Technology	4
	POW* ZC343	Microprocessors & Microcontrollers	3
	POW* ZC231	Thermodynamics	3
	POW* ZC242	Engineering Measurements	4
Discipline Courses (10)			
Core (10)	POW* ZC434	Quality Control, Assurance & Reliability	4
	POW* ZC313	Power Plant Engineering	4
	POW* ZC314	Prime Movers & Fluid Machines	4
	POW* ZC342	Power System Engineering I	3
	POW* ZC344	Instrumentation & Control	4
	POW* ZC432	Essentials of Project Management	3
	POW* ZC431	Maintenance & Safety	3
	POW* ZC316	Power Electronics	4
	POW* ZC441	Power System Engineering II	3
	POW* ZC315	Transport Phenomena	4
Electives (any 5)	POW* ZC332	Energy Management	4
	POW* ZC411	Environmental Pollution Control	3
	POW* ZC412	Power System Operation and Control	3
	POW* ZC413	Process Control	3
	POW* ZC422	Power System Drawing & Design	3
	POW* ZC452	Renewable Energy	3
	POW* ZC471	Power Electronics & Drives	3
	POW* ZC481	Plant Layout & Design	4

B. TECH. (POWER ENGINEERING
(Aditya Birla Group, Tata Power, JSW Energy, Essar Power)
Semesterwise Pattern

Normal Input: Employed professionals holding a Technical Diploma or B.Sc. degree with adequate preparation in Mathematics, and having adequate, relevant work experience.

Nominal duration: The nominal duration of a B.Tech. programme will be 7 semesters.

Year	First Semester		U	Second Semester		U
I	POW* ZC112	Electrical & Electronics Technology	4	POW* ZC234	Linear Algebra & Optimization	3
	POW* ZC164	Computer Programming	4	POW* ZC242	Engineering Measurements	4
	POW* ZC231	Thermodynamics	3	POW* ZC343	Microprocessors & Microcontrollers	3
	POW* ZC233	Calculus	4	POW* ZC315	Transport Phenomena	4
		Total	15		Total	14
II	POW* ZC342	Power System Engineering I	3	POW* ZC434	Quality Control, Assurance & Reliability	3
	POW* ZC344	Instrumentation & Control	4	POW* ZC314	Prime Movers and Fluid Machines	4
	POW* ZC431	Maintenance & Safety	3	POW* ZC441	Power System Engineering	3
	POW* ZC313	Power Plant Engineering	4		Discipline Elective	3(min.)
		Total	14		Total	13
III	POW* ZC316	Power Electronics	4	POW* ZC232	Technical Report Writing	3
	POW* ZC421	Essentials of Project Management	4	POW* ZC321	Principles of Management	3
		Discipline Elective	3(min.)		Discipline Elective	3(min.)
		Discipline Elective	3(min.)		Discipline Elective	3(min.)
		Total	14		Total	12
	POW* ZC425T	Project Work	16			

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

Pool of Electives

Course No	Course Title	Unit
POW* ZC332	Energy Management	4
POW* ZC411	Environmental Pollution Control	3
POW* ZC412	Power System Operation and Control	3
POW* ZC413	Process Control	3
POW* ZC422	Power System Drawing & Design	3
POW* ZC452	Renewable Energy	3
POW* ZC471	Power Electronics & Drives	3
POW* ZC481	Plant Layout & Design	4

B. TECH. (PROCESS ENGINEERING)
Curriculum Structure

Normal Input: Employed professionals holding a Technical Diploma or B.Sc. degree with adequate preparation in Mathematics, and having adequate, relevant work experience.

Nominal duration: The nominal duration of a B.Tech. programme will be 7 semesters.

Curriculum Requirements:

Foundation Courses	:	8 courses	(28 units min.)
Discipline Core	:	9 courses	(35 units min.)
Discipline Electives	:	7 courses	(21 units min.)
Coursework sub total	:	24 courses	(84 units min.)
Project Work	:	16 units	

Category-wise Programme Structure:

Category	Course No.	Course Title	Units
Foundation Courses (8)			
Mathematics Foundation	PE* ZC233	Calculus #	4
	PE* ZC235	Linear Algebra & Optimization #	3
	PE* ZC113	Probability and Statistics	3
Technical Arts / Professional Courses	PE* ZC164	Computer Programming #	4
	PE* ZC211	Principles of Management #	3
	PE* ZC313	Technical Report Writing #	3
Engineering Foundation	PE* ZC231	Engineering Materials #	3
	PE* ZC213	Engineering Measurements #	4
	PE* ZC112	Electrical & Electronics Technology #	4
Discipline Courses			
Core	PE* ZC321	Chemical Process Calculations	3
	PE* ZC311	Chemical Engineering Thermodynamics	4
	PE* ZC318	Fundamentals of Transport Processes	4
	PE* ZC319	Unit Operations – I	4
	PE* ZC352	Energy Management	4
	PE* ZC452	Process Plant Safety and Environment	4
	PE* ZC453	Process Control & Instrumentation	4
	PE* ZC322	Process Design Principles	4
	PE* ZC412	Process Equipment Design	4
Elective Courses			
Electives	PE* ZC434	Quality Control Assurance & Reliability	4
	PE* ZC314	Power Plant Engineering	4
	PE* ZC234	Manufacturing Processes	4
	PE* ZC411	Production Planning and Control	4
	PE* ZC342	Materials Management	4
	PE* ZC353	Industrial Engineering	3
	PE* ZC423	Essentials of Project Management	4
	PE* ZC361	Environmental Pollution Control	3
	PE* ZC383	Extractive Metallurgy	3
	PE* ZC385	Fertilizer Technology	3
	PE* ZC382	Cement Technology	3
	PE* ZC384	Fibre & Cellulosic Technology	3
	PE* ZC214	Pharmaceutical Analysis	3
	PE* ZC221	Disinfection & Sterilization Processes	3
	PE* ZC342	Pharmaceutical Quality Control & Regulatory Affairs	3
	PE* ZC252	Mineral Beneficiation & Agglomeration	3
	PE* ZC262	Iron Making	3
	PE* ZC273	Advances in Material Science & Testing	3
	PE* ZC312	Steel Making & Casting	3
	PE* ZC362	Steel Processing	3
	PE* ZC320	Unit Operations – II	4
	PE* ZC323	Corrosion Engineering	3
	PE* ZC324	Chemical Reaction Engineering	3
	PE* ZC272	Furnace Technology	3
	PE* ZC442	Advances in Materials Science	3

Mandatory Foundation Course

B. TECH. (PROCESS ENGINEERING)

(Aditya Birla Group, Mumbai; Dr. Reddy's Labs, Hyderabad; Vedanta, Jharsuguda; JSW Steel, Toranagallu)

Semesterwise Pattern

Normal Input: Employed professionals holding a Technical Diploma or B.Sc. degree with adequate preparation in Mathematics, and having adequate, relevant work experience.

Nominal duration: The nominal duration of a B.Tech. programme will be 7 semesters.

Year	First Semester		U	Second Semester		U
I	PE* ZC112	Electrical & Electronics Technology	4	PE* ZC352	Energy Management	4
	PE* ZC231	Engineering Materials	3	PE* ZC213	Engineering Measurements	4
	PE* ZC233	Calculus	4	PE* ZC235	Linear Algebra & Optimization	3
	PE* ZC164	Computer Programming	4	PE* ZC321	Chemical Process Calculations	3
		Total	15		Total	14
II	PE* ZC311	Chemical Engineering Thermodynamics	4	PE* ZC322	Process Design Principles	4
	PE* ZC318	Fundamentals of Transport Processes	4	PE* ZC412	Process Equipment Design	4
	PE* ZC319	Unit Operations – I	4		Discipline Elective	3(min.)
		Discipline Elective	3(min.)		Discipline Elective	3(min.)
		Total	15		Total	15
III	PE* ZC452	Process Plant Safety & Environment	4	PE* ZC313	Technical Report Writing	3
	PE* ZC453	Process Control & Instrumentation	4	PE* ZC211	Principles of Management	3
		Discipline Elective	3(min.)		Discipline Elective	3(min.)
		Discipline Elective	3(min.)		Discipline Elective	3(min.)
		Total	14		Total	12
	PE* ZC425T	Project Work	16			

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

Pool of Electives

Course No.	Course Title	Units
PE* ZC434	Quality Control Assurance & Reliability	4
PE* ZC314	Power Plant Engineering	4
PE* ZC234	Manufacturing Processes	4
PE* ZC411	Production Planning and Control	4
PE* ZC342	Materials Management	4
PE* ZC353	Industrial Engineering	3
PE* ZC423	Essentials of Project Management	4
PE* ZC361	Environmental Pollution Control	3
PE* ZC383	Extractive Metallurgy	3
PE* ZC385	Fertilizer Technology	3
PE* ZC382	Cement Technology	3
PE* ZC384	Fibre & Cellulosic Technology	3
PE* ZC214	Pharmaceutical Analysis	3
PE* ZC221	Disinfection & Sterilization Processes	3
PE* ZC342	Pharmaceutical Quality Control & Regulatory Affairs	3
PE* ZC252	Mineral Beneficiation & Agglomeration	3
PE* ZC262	Iron Making	3
PE* ZC273	Advances in Material Science & Testing	3
PE* ZC312	Steel Making & Casting	3
PE* ZC362	Steel Processing	3
PE* ZC320	Unit Operations – II	4
PE* ZC323	Corrosion Engineering	3
PE* ZC324	Chemical Reaction Engineering	3
PE* ZC272	Furnace Technology	3
PE* ZC442	Advances in Materials Science	3

M.Sc. (BUSINESS ANALYTICS)
Curriculum Structure

Type of Input: Employed professionals working in a variety of business domains, holding a three year undergraduate degree in relevant disciplines with adequate preparation in mathematics, with minimum one year work experience in relevant domains.

Nominal Duration: Five Semesters

Curriculum Structure

Foundation courses

Course No.	Course Title	Units
BA* ZG522	Business Data Mining	4
BA* ZG521	Financial Management	4
BA* ZC413	Introduction to Statistical Methods	3
BA* ZC471	Management Information Systems	3
BA* ZC411	Marketing	4
BA* ZC412	Models and Applications in Operations Research	4
BA* ZG621	Supply Chain Management	4

Core courses

Course No.	Course Title	Units
BA* ZG524	Advanced Statistical Methods	4
BA* ZC415	Analytics for Competitive Advantage	4
BA* ZG525	Big Data Analytics	4
BA* ZG523	Introduction to Data Science	3
BA* ZC414	Optimization Methods for Analytics	4
BA* ZG512	Predictive Analytics	4

Pool of electives

Course No.	Course Title	Units
BA* ZC418	Advanced Financial Modeling	4
BA* ZC420	Data Visualization	3
BA* ZC417	Financial Risk Analytics	4
BA* ZC425	HR Analytics	4
BA* ZC416	Investment Banking Analytics	4
BA* ZC422	Marketing Analytics	4
BA* ZC421	Marketing Models	4
BA* ZC423	Retail Analytics	4
BA* ZC424	Supply Chain Analytics	4
BA* ZC426	Real-time Analytics	4
BA* ZG537	Text Analytics	4

Semesterwise pattern

Year	First Semester		U	Second Semester		U
	BA* ZC411	Marketing	4	BA* ZG521	Financial Management	4
	BA* ZC471	Management Information Systems	4	BA* ZG522	Business Data Mining	4
I	BA* ZC412	Models and Applications in Operational Research	4	BA* ZG621	Supply Chain Management	4
	BA* ZC413	Introduction to Statistical Methods	4	BA* ZG523	Introduction to Data Science	3
		Total	16		Total	15
	BA* ZG524	Advanced Statistical Methods	4	BA* ZC415	Analytics for Competitive Advantage	4
II	BA* ZG525	Big Data Analytics	4		Elective 1	
	BA* ZG512	Predictive Analytics	4		Elective 2	
	BA* ZC414	Optimization Methods for Analytics	4		Elective 3	
		Total	16		Total	
III	BA* ZG625T	Elective 4 Project	10			
		Total				

M.Sc. (INFORMATION SYSTEMS)
Curriculum Structure

Normal Input: Employed professionals holding a B.Sc. or BCA degree with adequate preparation in Mathematics, and having adequate, relevant work experience.

Nominal duration: 5 semesters.

Curriculum Requirements:

Foundation Courses	: 5 courses (17 units min.)
Discipline Core	: 9 courses (36 units min.)
Discipline Electives	: 4 courses (12 units min.)
Coursework sub total	: 18 courses (65 units min.)
Project	: 8 units

Category-wise Programme Structure:

Sub- Category	Course No	Course Title	Unit
Foundation Courses (5)			
Mathematics Foundation	MATH ZC234	Linear Algebra & Optimization	3
	AAOC ZC111	Probability and Statistics	3
	MATH ZC222	Discrete Structures for Computer Science	3
General Awareness / Technical Arts	TA ZC163	Computer Programming	4
Engineering Foundation	ES ZC264	Digital Electronics and Microprocessors	4
Discipline Courses			
Core	IS ZC372	Compiler Design	4
	IS ZC467	Computer Networks	4
	IS ZC351	Computer Organization & Architecture	4
	IS ZC363	Data Structures & Algorithms	4
	IS ZC337	Database Systems & Applications	4
	IS ZC313	Object Oriented Programming & Design	4
	IS ZC364	Operating Systems	4
	IS ZC341	Software Engineering	4
	IS ZC327	Systems Programming	4
Electives (4)	CS ZG551	Advanced Compilation Techniques	5
	CS ZG623	Advanced Operating Systems	5
	IS ZC444	Artificial Intelligence	3
	IS ZC472	Computer Graphics	3
	EA ZC473	Multimedia Computing	3
	IS ZC422	Parallel Computing	3

M.Sc. (INFORMATION SYSTEMS)

Semesterwise Pattern

Normal Input: Employed professionals holding a B.Sc. or BCA degree with adequate preparation in Mathematics, and having adequate, relevant work experience.

Nominal duration: 5 semesters.

Year	First Semester		U	Second Semester		U
I	MATH ZC222	Discrete Structures for Computer Science	3	IS ZC313	Object Oriented Programming & Design	4
	MATH ZC234	Linear Algebra & Optimization	3	IS ZC327	Systems Programming	4
	TA ZC163	Computer Programming	4	AAOC ZC111	Probability and Statistics	3
	ES ZC264	Digital Electronics and Microprocessors	4	IS ZC363	Data Structures and Algorithms	4
		Total	15		Total	14
II	IS ZC353	Computer Organization & Architecture	4	IS ZC372	Compiler Design	4
	IS ZC337	Database Systems & Applications	4	IS ZC344	Software Engineering	4
	IS ZC364	Operating Systems	4	IS ZC467	Computer Networks	4
		Discipline Elective	3(min.)		Discipline Elective	3(min.)
		Total	15		Total	15
III	BITS ZC426T	Project	8			
		Discipline Elective	3(min.)			
		Discipline Elective	3(min.)			
		Total	14			

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

Pool of Electives

Course No	Course Title	Unit
CS ZG551	Advanced Compilation Techniques	5
CS ZG623	Advanced Operating Systems	5
IS ZC444	Artificial Intelligence	3
IS ZC472	Computer Graphics	3
EA ZC473	Multimedia Computing	3
IS ZC422	Parallel Computing	3

MBA in Consultancy Management
Curriculum Structure

Type of Input: Employed professionals working in Consulting and allied business organizations, holding an Integrated First Degree of BITS or its equivalent such as B.E. / M.Sc. in relevant disciplines, with minimum one year work experience in relevant domains. Candidates holding other qualifications such as M.Com. / ACA / ACS may also be considered on a case by case basis.

Duration: Four Semesters

Curriculum Requirements

Completion of the programme would require:

(a) At least 13 courses (totaling at least 52 units) towards coursework, and

(b) Project (12 units).

Programme Structure

Management Core (7 Courses)

Course No.	Course Title	Units
MBA ZC415	Financial and Management Accounting	4
MBA ZC416	Managerial Economics	3
MBA ZC417	Quantitative Methods	4
MBA ZG511	Managing People & Organizations	4
MBA ZC411	Marketing	4
MBA ZG521	Financial Management	4
MBA ZG526	Operations Management	4

Consultancy Core (5 Courses)

Course No.	Course Title	Units
CM ZG511	Consultancy Practice	4
CM ZG512	Consulting and People Skills	4
CM ZG631	Strategic Change Management	4
CM ZG523	Project Management	4
CM ZG524	Business Process Analysis	4

Pool of Electives

Course No.	Course Title	Units
BITS ZC471	Management Information Systems	3
CM ZG621	Supply Chain Management	4
CM ZC489	Enterprise Resource Planning	3

Project

Course No.	Course Title	Units
MBA ZG623T	Project	12

MBA in Consultancy Management

Type of Input: Employed professionals working in Consulting and allied business organizations, holding an Integrated First Degree of BITS or its equivalent such as B.E. / M.Sc. in relevant disciplines, with minimum one year work experience in relevant domains. Candidates holding other qualifications such as M.Com. / ACA / ACS may also be considered on a case by case basis.

Duration: Four Semesters

Semesterwise pattern for students admitted in the First Semester of the academic year

Year	First Semester		U	Second Semester		U
I	MBA ZC415	Financial & Management Accounting	4	MBA ZC411	Marketing	4
	MBA ZC416	Managerial Economics	4	MBA ZG521	Financial Management	4
	MBA ZC417	Quantitative Methods	4	MBA ZG526	Operations Management	4
	MBA ZG511	Managing People & Organizations	4	MBA ZG541	Consultancy Practice	4
		Total	16		Total	16
II	MBA ZG515	Consulting & People Skills	4	MBA ZG623T	Project	12
	MBA ZG634	Strategic Change Management	4		Elective	4(min)
	MBA ZG523	Project Management	4			
	MBA ZG525	Business Process Analysis	4			
		Total	16		Total	16(min)

Semesterwise pattern for students admitted in the Second Semester of the academic year

Year	First Semester		U	Second Semester		U
I				MBA ZC415	Financial & Management Accounting	4
				MBA ZC416	Managerial Economics	4
				MBA ZC417	Quantitative Methods	4
				MBA ZG511	Managing People & Organizations	4
					Total	16
II	MBA ZC411	Marketing	4	MBA ZG515	Consulting & People Skills	4
	MBA ZG521	Financial Management	4	MBA ZG634	Strategic Change Management	4
	MBA ZG526	Operations Management	4	MBA ZG523	Project Management	4
	MBA ZG541	Consultancy Practice	4	MBA ZG525	Business Process Analysis	4
		Total	16		Total	16
III	MBA ZG623T	Project	12			
		Elective	4(min)			
		Total	16(min)			

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

Pool of Electives

Course No.	Course Title	Units
MBA ZG513	Enterprise Resource Planning	4
MBA ZG514	Leadership & Managing Change	4
MBA ZG621	Supply Chain Management	4
MBA ZG641	Management Information & Decision Support Systems	5

MBA in Finance

Type of Input: Employed professionals working in finance and allied business domains, holding a three year undergraduate degree in relevant disciplines with adequate preparation in mathematics, and minimum 2 years work experience in relevant domains.

Nominal Duration: Four Semesters

Curriculum Requirements

Completion of the programme would require:
(a) At least 14 courses (totaling at least 56 units) towards coursework, and
(b) Project (8 units).

Programme Structure

Management Core (7 Courses)

Course No.	Course Title	Units
MBA ZC415	Financial and Management Accounting	4
MBA ZG521	Financial Management	4
MBA ZC416	Managerial Economics	4
MBA ZG511	Managing People & Organizations	4
MBA ZC411	Marketing	4
MBA ZC417	Quantitative Methods	4
MBA ZG611	Strategic Management and Business Policy	4

Finance Core (4 Courses)

Course No.	Course Title	Units
FIN ZG514	Derivatives & Risk Management	4
FIN ZG512	Global Financial Markets and Products	4
FIN ZG513	Management of Banks & Financial Institutions	4
FIN ZG518	Multinational Finance	4

Pool of Electives

Course No.	Course Title	Units
FIN ZG526	Advanced Risk Models	4
FIN ZG519	Business Analysis & Valuation	4
FIN ZG524	Credit Risk Management	4
FIN ZG527	International Regulatory Framework for Banks	4
FIN ZG523	Market Risk Management	4
FIN ZG522	Mergers, Acquisitions, and Corporate Restructuring	4
FIN ZG525	Operational Risk Management	4
FIN ZG520	Security Analysis & Portfolio Management	4
FIN ZG528	Venture Capital & Private Equity	4

Project

Course No.	Course Title	Units
MBA ZG622T	Project	8

Semesterwise pattern

Year	First Semester		U	Second Semester		U
I	MBA ZC415	Financial and Management Accounting	4	MBA ZC411	Marketing	4
	MBA ZC416	Managerial Economics	4	MBA ZG521	Financial Management	4
	MBA ZC417	Quantitative Methods	4	MBA ZG611	Strategic Management and Business Policy	4
	MBA ZG511	Managing People & Organizations	4	FIN ZG512	Global Financial Markets and Products	4
		Total	16		Total	16
II	FIN ZG513	Management of Banks & Financial Institutions	4		Elective 2	
	FIN ZG514	Derivatives & Risk Management	4		Elective 3	
	FIN ZG518	Multinational Finance	4	MBA ZG622T	Project	8
		Elective 1				
		Total			Total	

MBA in Manufacturing Management
Curriculum Structure

Type of Input: Employed professionals working in Manufacturing and allied business organizations, holding an Integrated First Degree of BITS or its equivalent such as B.E. / M.Sc. in relevant disciplines, with minimum one year work experience.

Duration: Four Semesters

Curriculum Requirements

Completion of the programme would require:
(a) At least 13 courses (totaling at least 52 units) towards coursework, and
(b) Project (12 units).

Programme Structure

Management Core (7 Courses)

Course No.	Course Title	Units
MBA ZC415	Financial and Management Accounting	4
MBA ZC416	Managerial Economics	4
MBA ZC417	Quantitative Methods	4
MBA ZG511	Managing People & Organizations	4
MBA ZC411	Marketing	4
MBA ZG521	Financial Management	4
MBA ZG611	Strategic Management & Business Policy	4

Manufacturing Core (4 courses)

Course No.	Course Title	Units
MM ZG522	Total Quality Management	4
MM ZG621	Supply Chain Management	4
MM ZG521	World Class Manufacturing	4
MM ZG526	Operations Management	4

Pool of Electives

Course No.	Course Title	Units
MBA ZC489	Enterprise Resource Planning	3
MM ZG523	Project Management	4
MM ZG541	Product Design	5
MM ZG534	Sustainable Manufacturing	4

Project

Course No.	Course Title	Units
MBA ZG623T	Project	12

MBA in Manufacturing Management

Type of Input: Employed professionals working in Manufacturing and allied business organizations, holding an Integrated First Degree of BITS or its equivalent such as B.E. / M.Sc. in relevant disciplines, with minimum one year work experience.

Duration: Four Semesters

Semesterwise pattern for students admitted in the First Semester of the academic year

Year	First Semester		U	Second Semester		U
I	MBA ZC415	Financial and Management Accounting	4	MBA ZC411	Marketing	4
	MBA ZC416	Managerial Economics	4	MBA ZG521	Financial Management	4
	MBA ZC417	Quantitative Methods	4	MBA ZG611	Strategic Management & Business Policy	4
	MBA ZG511	Managing People & Organizations	4	MBA ZG526	Operations Management	4
		Total	16		Total	16
II	MBA ZG522	Total Quality Management	4	MBA ZG623T	Project	12
	MBA ZG621	Supply Chain Management	4		Elective	4(min)
	MBA ZG537	Lean Manufacturing	5			
		Elective	4(min)			
		Total	17(min)		Total	16(min)

Semesterwise pattern for students admitted in the Second Semester of the academic year

Year	First Semester		U	Second Semester		U
I				MBA ZC415	Financial and Management Accounting	4
				MBA ZC416	Managerial Economics	4
				MBA ZC417	Quantitative Methods	4
				MBA ZG511	Managing People & Organizations	4
					Total	16
II	MBA ZC411	Marketing	4	MBA ZG522	Total Quality Management	4
	MBA ZG521	Financial Management	4	MBA ZG621	Supply Chain Management	4
	MBA ZG611	Strategic Management & Business Policy	4	MBA ZG537	Lean Manufacturing	5
	MBA ZG526	Operations Management	4		Elective	4(min)
		Total	16		Total	17(min)
III	MBA ZG623T	Project	12			
		Elective	4(min)			
		Total	16(min)			

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

Pool of Electives

Course No.	Course Title	Units
MBA ZG513	Enterprise Resource Planning	4
MBA ZG514	Leadership & Managing Change	4
MBA ZG523	Project Management	4
MBA ZG641	Management Information & Decision Support Systems	5

MBA in Quality Management
Curriculum Structure

Type of Input: Employed professionals working in Quality and allied business domains, holding an Integrated First Degree of BITS or its equivalent such as B.E. / M.Sc. in relevant disciplines, with minimum one year work experience.

Duration: Four Semesters

Curriculum Requirements

Completion of the programme would require:
(a) At least 13 courses (totaling at least 52 units) towards coursework, and
(b) Project (12 units).

Programme Structure

Management Core (7 Courses)

Course No.	Course Title	Units
MBA ZC415	Financial and Management Accounting	4
MBA ZC416	Managerial Economics	4
MBA ZC417	Quantitative Methods	4
MBA ZG511	Managing People & Organizations	4
MBA ZC411	Marketing	4
MBA ZG521	Financial Management	4
MBA ZG611	Strategic Management & Business Policy	4

Quality Core (4)

Course No.	Course Title	Units
QM ZG522	Total Quality Management	4
QM ZG521	Quality Management Systems	5
QM ZG531	Statistical Quality Control	5
QM ZG526	Operations Management	4

Pool of Electives

Course No.	Course Title	Units
QM ZC471	Management Information Systems	3
QM ZG621	Supply Chain Management	4
QM ZG521	World Class Manufacturing	5
QM ZG523	Project Management	4
QM ZG661	Software Quality Management	4

Project

Course No.	Course Title	Units
MBA ZG623T	Project	12

MBA in Quality Management
Semesterwise pattern

Type of Input: Employed professionals working in Quality and allied business domains, holding an Integrated First Degree of BITS or its equivalent such as B.E. / M.Sc. in relevant disciplines, with minimum one year work experience.

Duration: Four Semesters

Year	First Semester		U	Second Semester		U
I	MBA ZC415	Financial & Management Accounting	4	MBA ZC411	Marketing	4
	MBA ZC416	Managerial Economics	4	MBA ZG521	Financial Management	4
	MBA ZC417	Quantitative Methods	4	MBA ZG611	Strategic Management & Business Policy	4
	MBA ZG511	Managing People & Organizations	4	MBA ZG526	Operations Management	4
		Total	16		Total	16
II	MBA ZG522	Total Quality Management	4	MBA ZG623T	Project	12
	MBA ZG524	Quality Management Systems	5		Elective	4(min)
	MBA ZG531	Statistical Quality Control	5			
		Elective	4(min)			
		Total	18(min)		Total	16(min)

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

Pool of Electives

Course No.	Course Title	Units
MBA ZG514	Leadership & Managing Change	4
MBA ZG523	Project Management	4
MBA ZG641	Management Information & Decision Support Systems	5
MBA ZG661	Software Quality Management	4

M. Tech. Automotive Engineering
Curriculum Structure

Input Requirements

Employed professionals in Engineering Industries and holding an Integrated First Degree of BITS in Mechanical Engineering or Electrical & Electronics Engineering or its equivalent, with minimum one year work experience in relevant domains.

Normal Duration: 4 Semesters

Curriculum Requirements:

Completion of the programme would require

a) At least 12 courses (totaling at least 48 units) towards coursework, and

b) Dissertation (16 units)

The coursework requirement for the program would consist of a set of core courses and elective courses. The core course requirement is mandatory for all students in a given programme. Rest of the coursework must be completed through elective courses.

Programme Structure

Core Courses (5)

Course No.	Course Title	Units
AE* ZG511	Mechatronics	5
AE* ZG514	Advanced Automotive Systems	4
AE* ZG516	Advances in Internal Combustion Engines	4
AE* ZG524	Vehicle Dynamics	4
AE* ZG532	Computer Aided Engineering	5

Pool of Electives (7)

Course No.	Course Title	Units
AE* ZG512	Embedded System Design	4
AE* ZG513	Maintenance Engineering	5
AE* ZG515	Non-Destructive Testing	5
AE* ZG521	World Class Manufacturing	5
AE* ZG523	Project Management	4
AE* ZG531	Product Design	5
AE* ZG535	Advanced Engineering Mathematics	5
AE* ZG542	Just-in-time Manufacturing	4
AE* ZG611	Computational Fluid Dynamics and Heat Transfer	4
AE* ZG612	Advances in Materials, Composites & Plastics	4
AE* ZG613	Tribology	5
AE* ZG614	Fracture Mechanics	5
AE* ZG621	Durability, Crash and Safety Engineering	4
AE* ZG622	Advanced Manufacturing Processes	4
AE* ZG633	Advances in Vehicle Body Structures	4

Note: In the above programme structure, the symbol * in the course numbers, can be substituted by the letters representing the collaborating organization

M. Tech. Automotive Engineering
(Tata Motors, Pune)
Semesterwise Pattern

Type of Input: Employed persons in Engineering Industries and holding an integrated First Degree of BITS in Mechanical Engineering or Electrical & Electronics Engineering or its equivalent, with adequate relevant work experience

Normal Duration: Four Semesters

Special Feature: This programme is specially designed for the HRD needs of Tata Motors, Pune

Year	First Semester		U	Second Semester		U
I	AETM ZG514	Advanced Automotive Systems	4	AETM ZG524	Vehicle Dynamics	4
	AETM ZG511	Mechatronics	5	AETM ZG532	Computer Aided Engineering	5
	AETM ZG516	Advances in Internal Combustion Engines	4	AETM ZG523	Project Management	4
	AETM ZG531	Product Design	5	AETM ZG611	Computational Fluid Dynamics and Heat Transfer	4
		Total	18		Total	17
II	AETM ZG612	Advances in Materials, Composites & Plastics	4	AETM ZG628T	Dissertation	16
	AETM ZG621	Durability, Crash and Safety Engineering	4			
	AETM ZG622	Advanced Manufacturing Processes	4			
	AETM ZG633	Advances in Vehicle Body Structures	4			
		Total	16		Total	16

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

Pool of Electives

Course No.	Course Title	Units
AETM ZG512	Embedded System Design	4
AETM ZG513	Maintenance Engineering	5
AETM ZG515	Non-Destructive Testing	5
AETM ZG521	World Class Manufacturing	5
AETM ZG523	Project Management	4
AETM ZG531	Product Design	5
AETM ZG535	Advanced Engineering Mathematics	5
AETM ZG542	Just-in-time Manufacturing	4
AETM ZG611	Computational Fluid Dynamics and Heat Transfer	4
AETM ZG612	Advances in Materials, Composites & Plastics	4
AETM ZG613	Tribology	5
AETM ZG614	Fracture Mechanics	5
AETM ZG621	Durability, Crash and Safety Engineering	4
AETM ZG622	Advanced Manufacturing Processes	4
AETM ZG633	Advances in Vehicle Body Structures	4

M. Tech. Automotive Engineering
(Tata Technologies, Pune)
Semesterwise Pattern

Type of Input: Employed persons in Engineering Industries and holding an integrated First Degree of BITS in Mechanical Engineering or Electrical & Electronics Engineering or its equivalent, with adequate relevant work experience

Normal Duration: Four Semesters

Special Feature: This programme is specially designed for the HRD needs of Tata Technologies, Pune

Year	First Semester		U	Second Semester		U
I	AETT ZG514	Advanced Automotive Systems	4	AETT ZG524	Vehicle Dynamics	4
	AETT ZG511	Mechatronics	5	AETT ZG532	Computer Aided Engineering	5
	AETT ZG516	Advances in Internal Combustion Engines	4	AETT ZG523	Project Management	4
	AETT ZG531	Product Design	5	AETT ZG611	Computational Fluid Dynamics and Heat Transfer	4
		Total	18		Total	17
II	AETT ZG612	Advances in Materials, Composites & Plastics	4	AETT ZG628T	Dissertation	16
	AETT ZG621	Durability, Crash and Safety Engineering	4			
	AETT ZG622	Advanced Manufacturing Processes	4			
	AETT ZG633	Advances in Vehicle Body Structures	4			
		Total	16		Total	16

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

Pool of Electives

Course No.	Course Title	Units
AETT ZG512	Embedded System Design	4
AETT ZG513	Maintenance Engineering	5
AETT ZG515	Non-Destructive Testing	5
AETT ZG521	World Class Manufacturing	5
AETT ZG523	Project Management	4
AETT ZG531	Product Design	5
AETT ZG535	Advanced Engineering Mathematics	5
AETT ZG542	Just-in-time Manufacturing	4
AETT ZG611	Computational Fluid Dynamics and Heat Transfer	4
AETT ZG612	Advances in Materials, Composites & Plastics	4
AETT ZG613	Tribology	5
AETT ZG614	Fracture Mechanics	5
AETT ZG621	Durability, Crash and Safety Engineering	4
AETT ZG622	Advanced Manufacturing Processes	4
AETT ZG633	Advances in Vehicle Body Structures	4

M. Tech. Design Engineering
Curriculum Structure

Input Requirements

The students admitted to the four-semester M.Tech. Design Engineering must:

(i) hold an Integrated First Degree of BITS or its equivalent such as B.E. / B.Tech. in relevant disciplines, and

(ii) be employed professionals with minimum one year work experience in relevant domains.

Normal Duration: 4 Semesters

Curriculum Requirements:

Completion of the programme would require

a) At least 12 courses (totaling at least 48 units) towards coursework, and

b) Dissertation (16 units)

The coursework requirement for the program would consist of a set of core courses and elective courses. The core course requirement is mandatory for all students in a given programme. Rest of the coursework must be completed through elective courses.

Programme Structure

Core Courses (5)

Course No.	Course Title	Units
DE* ZG512	Finite Element Methods	5
DE* ZG541	Product Design	5
DE* ZG561	Mechanisms and Robotics	5
DE* ZG611	Dynamics & Vibrations	5
DE* ZG631	Materials Technology & Testing	5

Pool of Electives (7)

Course No.	Course Title	Units
DE* ZC415	Introduction to MEMS	4
DE* ZG511	Mechatronics	5
DE* ZG514	Fracture Mechanics	5
DE* ZG515	Computational Fluid Dynamics	5
DE* ZG521	World-Class Manufacturing	5
DE* ZG522	Advanced Composites	5
DE* ZG523	Project Management	4
DE* ZG525	Mechanical System Design	5
DE* ZG531	Concurrent Engineering	5
DE* ZG532	Quality Assurance and Reliability	5
DE* ZG542	Machine Tool Engineering	5
DE* ZG535	Advanced Engineering Mathematics	5
DE* ZG621	Computer Aided Analysis & Design	5
DE* ZG641	Theory of Elasticity and Plasticity	5

Note: In the above programme structure, the symbol * in the course numbers, can be substituted by the letters representing the collaborating organization

M.Tech. Design Engineering (Cluster Programme, Pune)

Type of Input: Sponsored employees (with adequate relevant work experience) with an Integrated First Degree of BITS in Mechanical Engineering or its equivalent.

Duration: Four Semesters.

Special Feature: This is a specially designed Work-Integrated Learning Programme for the HRD requirements of a diverse spectrum of Engineering industries.

Year	First Semester	U	Second Semester	U
I	DECP ZG621 Computer Aided Analysis & Design	5	DECP ZG525 Mechanical System Design	5
	DECP ZG512 Finite Element Methods	5	DECP ZG521 World-Class Manufacturing	5
	DECP ZG611 Dynamics & Vibrations	5	DECP ZG541 Product Design	5
	DECP ZG631 Materials Technology & Testing	5	DECP ZG531 Mechanisms & Robotics	5
	Total	20	Total	20
II	DECP ZG515 Computational Fluid Dynamics	5	DECP ZG628T Dissertation	16
	DECP ZG523 Project Management	4		
	DECP ZG514 Fracture Mechanics	5		
	DECP ZG532 Quality Assurance and Reliability	5		
	Total	19	Total	16

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

M.Tech. Design Engineering (Eaton Technologies, Pune)

Type of Input: Sponsored employees (with adequate relevant work experience) with an Integrated First Degree of BITS in Mechanical Engineering or its equivalent.

Duration: Four Semesters.

Special Feature: This is a specially designed Work-Integrated Learning Programme for the HRD requirements of Eaton Technologies, Pune.

Year	First Semester	U	Second Semester	U
I	DEET ZG531 Mechanisms & Robotics	5	DEET ZC312 Industrial Instrumentation and Control	3
	DEET ZG512 Finite Element Methods	5	DEET ZG521 World-Class Manufacturing	5
	DEET ZG611 Dynamics & Vibrations	5	DEET ZG541 Product Design	5
	DEET ZG621 Computer Aided Analysis & Design	5	DEET ZG631 Materials Technology & Testing	5
	Total	20	Total	18
II	DEET ZG515 Computational Fluid Dynamics	5	DEET ZG628T Dissertation	16
	DEET ZG523 Project Management	4		
	DEET ZG525 Mechanical System Design	5		
	DEET ZG532 Quality Assurance and Reliability	5		
	Total	19	Total	16

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

M.Tech. Design Engineering (John Deere, Pune)

Type of Input: Sponsored employees (with adequate relevant work experience) with an Integrated First Degree of BITS in Mechanical Engineering or its equivalent.

Duration: Four Semesters.

Special Feature: This is a specially designed Work-Integrated Learning Programme for the HRD requirements of John Deere, Pune.

Year	First Semester		U	Second Semester		U
I	DEJD ZG621	Computer Aided Analysis & Design	5	DEJD ZG525	Mechanical System Design	5
	DEJD ZG512	Finite Element Methods	5	DEJD ZG521	World-Class Manufacturing	5
	DEJD ZG611	Dynamics & Vibrations	5	DEJD ZG541	Product Design	5
	DEJD ZG631	Materials Technology & Testing	5	DEJD ZG531	Mechanisms & Robotics	5
		Total	20		Total	20
II	DEJD ZG515	Computational Fluid Dynamics	5	DEJD ZG628T	Dissertation	16
	DEJD ZG523	Project Management	4			
	DEJD ZG514	Fracture Mechanics	5			
	DEJD ZG532	Quality Assurance and Reliability	5			
		Total	19		Total	16

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

M.Tech. Design Engineering (L&T IES, Vadodara)

Type of Input: Sponsored employees of L&T IES, Vadodara with an Integrated First Degree of BITS in Mechanical Engineering or its equivalent and adequate, relevant work experience.

Duration: Four Semesters

Special Feature: This is a specially designed Work-Integrated Learning Programme for the HRD requirements of sponsored employees of L&T, Vadodara.

Year	First Semester		U	Second Semester		U
I	DELT ZG512	Finite Element Analysis	5	DELT ZG532	Machine Tool Engineering	5
	DELT ZG535	Advanced Engineering Mathematics	5	DELT ZG511	Mechatronics	5
	DELT ZG541	Product Design	5	DELT ZG641	Theory of Elasticity and Plasticity	5
	DELT ZG631	Materials Technology & Testing	5	DELT ZG561	Mechanism and Robotics	5
		Total	20		Total	20
II	DELT ZG621	Computer Aided Anal & Design	5	EDLT ZG628T	Dissertation	16
	DELT ZG525	Mechanical System Design	5			
	DELT ZG531	Concurrent Engineering	5			
	DELT ZG611	Dynamics & Vibrations	5			
		Total	20		Total	16

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

M.Tech. Design Engineering (SKF India Ltd., Pune)

Type of Input: Sponsored employees (with adequate relevant work experience) with an Integrated First Degree of BITS in Mechanical Engineering or its equivalent.

Duration: Four Semesters.

Special Feature: This is a specially designed Work-Integrated Learning Programme for the HRD requirements of SKF India Ltd., Pune.

Year	First Semester		U	Second Semester		U
I	DESKF ZG621	Computer Aided Analysis & Design	5	DESKF ZG511	Mechatronics	5
	DESKF ZG512	Finite Element Methods	5	DESKF ZG521	World-Class Manufacturing	5
	DESKF ZG611	Dynamics & Vibrations	5	DESKF ZG541	Product Design	5
	DESKF ZG531	Mechanisms & Robotics	5	DESKF ZG631	Materials Technology & Testing	5
		Total	20		Total	20
II	DESKF ZG515	Computational Fluid Dynamics	5	DESKF ZG628T	Dissertation	16
	DESKF ZG523	Project Management	4			
	DESKF ZG525	Mechanical System Design	5			
	DESKF ZG532	Quality Assurance and Reliability	5			
		Total	19		Total	16

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

M.Tech. Embedded Systems
Curriculum Structure

Input Requirements

The students admitted to the four-semester M.Tech. Embedded Systems must:

(i) hold an Integrated First Degree of BITS or its equivalent such as B.E. / B.Tech. / M.Sc. in relevant disciplines, and

(ii) be employed professionals with minimum one year work experience in relevant domains.

Normal Duration: 4 Semesters

Curriculum Requirements:

Completion of the programme would require

a) At least 12 courses (totaling at least 48 units) towards coursework, and

b) Dissertation (16 units)

The coursework requirement for the program would consist of a set of core courses and elective courses. The core course requirement is mandatory for all students in a given programme. Rest of the coursework must be completed through elective courses.

Programme Structure

Core Courses (4)

Course No.	Course Title	Units
ES* ZC424	Software for Embedded Systems	3
ES* ZG512	Embedded System Design	4
ES* ZG553	Real Time Systems	5
ES* ZG641	Hardware Software Co-Design	5

Pool of Electives (21)

Course No.	Course Title	Units
ES* ZC441	Robotics	3
ES* ZC446	Data Storage Technologies & Networks	3
ES* ZC481	Computer Networks	3
ES* ZG511	Mechatronics	5
ES* ZG513	Network Security	4
ES* ZG514	Mechanisms & Robotics	5
ES* ZG520	Wireless & Mobile Communication	5
ES* ZG523	Project Management	4
ES* ZG524	Real Time Operating Systems	5
ES* ZG525	Avionics Systems	5
ES* ZG531	Pervasive Computing	4
ES* ZG545	Control & Instrumentation for Systems	5
ES* ZG554	Reconfigurable Computing	5
ES* ZG556	DSP Based Control of Electric Drives	3
ES* ZG573	Digital Signal Processing	3
ES* ZG611	Advanced Control Systems	5
ES* ZG612	Fault Tolerant System Design	5
ES* ZG625	Safety Critical Embedded System Design	4
ES* ZG642	VLSI Architecture	4
ES* ZG651	Networked Embedded Applications	4

Note: In the above programme structure, the symbol * in the course numbers, can be substituted by the letters representing the collaborating organization.

M.Tech. Embedded Systems (Cluster Programme 1, Bangalore)

Type of Input: Sponsored employees (with adequate relevant work experience) holding an Integrated First Degree of BITS in Electrical & Electronics or Electronics & Instrumentation or Computer Science or its equivalent.

Normal Duration: Four Semesters

Special Feature: This is a specially designed Work-Integrated Learning Programme for the HRD requirements of sponsored employees of IT industries in Bangalore.

Year	First Semester		U	Second Semester		U
I	ESCB ZG512	Embedded System Design	4	ESCB ZC341	Mechatronics	3
	ESCB ZG511	Mechatronics	5	ESCB ZC424	Software for Embedded System	3
	ESCB ZG553	Real Time Systems	5	ESCB ZG611	Advanced Control Systems	5
	ESCB ZG573	Digital Signal Processing	3	ESCB ZG523	Project Management	4
		Total	17		Total	15
II	ESCB ZG525	Avionics Systems	5	ESCB ZG628T	Dissertation	16
	ESCB ZG531	Pervasive Computing	4			
	ESCB ZG612	Fault Tolerant System Design	5			
	ESCB ZG651	Networked Embedded Applications	4			
		Total	18		Total	16

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

M.Tech. Embedded Systems (Cluster Programme 2, Bangalore)

Type of Input: Sponsored employees (with adequate relevant work experience) holding an Integrated First Degree of BITS in Electrical & Electronics or Electronics & Instrumentation or Computer Science or its equivalent.

Normal Duration: Four Semesters

Special Feature: This is a specially designed Work-Integrated Learning Programme for the HRD requirements of sponsored employees of IT industries in Bangalore.

Year	First Semester		U	Second Semester		U
I	ESCB ZG512	Embedded Systems Design	4	ESCB ZC424	Software for Embedded Systems	3
	ESCB ZG520	Wireless and Mobile Communication	5	ESCB ZG553	Real Time Systems	5
	ESCB ZG545	Control & Instrumentation Sys	5	ESCB ZG611	Advanced Control Systems	5
	ESCB ZG573	Digital Signal Processing	3	ESCB ZG641	Hardware Software Co-Design	5
		Total	17		Total	18
II	ESCB ZG531	Pervasive Computing	4	ESCB ZG628T	Dissertation	16
	ESCB ZG554	Reconfigurable Computing	5			
	ESCB ZG642	VLSI Architectures	4			
	ESCB ZG651	Network Embedded Applications	4			
		Total	17		Total	16

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

M.Tech. Embedded Systems (Cluster Programme, Pune)

Type of Input: Sponsored employees (with adequate relevant work experience) holding an Integrated First Degree of BITS in Electrical & Electronics or Electronics & Instrumentation or Computer Science or its equivalent.

Normal Duration: Four Semesters

Special Feature: This is a specially designed Work-Integrated Learning Programme for the HRD requirements of sponsored employees of IT industries in Pune.

Year	First Semester		U	Second Semester		U
I	ESCP ZG512	Embedded System Design	4	ESCP ZC341	Mechatronics	3
	ESCP ZG511	Mechatronics	5	ESCP ZC424	Software for Embedded System	3
	ESCP ZG553	Real Time Systems	5	ESCP ZG611	Advanced Control Systems	5
	ESCP ZG573	Digital Signal Processing	3	ESCP ZG523	Project Management	4
		Total	17		Total	15
II	ESCP ZG525	Avionics Systems	5	ESCP ZG628T	Dissertation	16
	ESCP ZG531	Pervasive Computing	4			
	ESCP ZG612	Fault Tolerant System Design	5			
	ESCP ZG651	Networked Embedded Applications	4			
		Total	18		Total	16

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

M.Tech. Embedded Systems (L&T, Vadodara)

Type of Input: Sponsored employees (with adequate relevant work experience) holding an Integrated First Degree of BITS in Electrical & Electronics or Electronics & Instrumentation or Computer Science or its equivalent.

Normal Duration: Four Semesters

Special Feature: This is a specially designed Work-Integrated Learning Programme for the HRD requirements of sponsored employees of L&T, Vadodara.

Year	First Semester		U	Second Semester		U
I	ESLT ZG512	Embedded System Design	4	ESLT ZC424	Software for Embedded Systems	3
	ESLT ZG523	Project Management	4	ESLT ZG511	Mechatronics	5
	ESLT ZG553	Real Time Systems	5	ESLT ZG611	Advanced Control Systems	5
	ESLT ZG573	Digital Signal Processing	3	ESLT ZG641	Hardware Software Co-Design	5
		Total	16		Total	18
II	ESLT ZG525	Avionics Systems	5	ESLT ZG628T	Dissertation	16
	ESLT ZG533	Reconfigurable Computing	5			
	ESLT ZG612	Fault Tolerant System Design	5			
	ESLT ZG651	Networked Embedded Applications	4			
		Total	19		Total	16

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

M.Tech. Embedded Systems (UTC Aerospace Systems, Bangalore)

Type of Input: Sponsored employees (with adequate relevant work experience) holding an Integrated First Degree of BITS in Electrical & Electronics or Electronics & Instrumentation or Computer Science or its equivalent.

Normal Duration: Four Semesters

Special Feature: This is a specially designed Work-Integrated Learning Programme for the HRD requirements of sponsored employees of UTC Aerospace Systems, Bangalore.

Year	First Semester		U	Second Semester		U
I	ESUTC ZG512	Embedded System Design	4	ESUTC ZC424	Software for Embedded Systems	3
	ESUTC ZG520	Wireless & Mobile Communication	5	ESUTC ZG553	Real Time Systems	5
	ESUTC ZG511	Mechatronics	5	ESUTC ZG545	Cont & Instru for Systems	5
	ESUTC ZG573	Digital Signal Processing	3	ESUTC ZG641	Hardware Software Co-Design	4
		Total	17		Total	17
II	ESUTC ZG525	Avionics Systems	5	ESUTC ZG628T	Dissertation	16
	ESUTC ZG523	Project Management	4			
	ESUTC ZG611	Advanced Control Systems	5			
	ESUTC ZG651	Networked Embedded Applications	4			
		Total	18		Total	16

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

M.Tech. Embedded Systems (UTC Fire and Security Systems, Hyderabad)

Type of Input: Sponsored employees (with adequate relevant work experience) holding an Integrated First Degree of BITS in Electrical & Electronics or Electronics & Instrumentation or Computer Science or its equivalent.

Normal Duration: Four Semesters

Special Feature: This is a specially designed Work-Integrated Learning Programme for the HRD requirements of sponsored employees of UTC Fire and Security Systems, Hyderabad.

Year	First Semester		U	Second Semester		U
I	ESUTC ZG512	Embedded System Design	4	ESUTC ZC424	Software for Embedded Systems	3
	ESUTC ZG520	Wireless & Mobile Communication	5	ESUTC ZG513	Network Security	4
	ESUTC ZC481	Computer Networks	3	ESUTC ZC446	Data Storage Technologies & Networks	3
	ESUTC ZG553	Real Time Systems	5	ESUTC ZG641	Hardware Software Co-Design	5
		Total	17		Total	15
II	ESUTC ZG531	Pervasive Computing	4	ESUTC ZG628T	Dissertation	16
	ESUTC ZG625	Safety Critical Embedded Systems Design	4			
	ESUTC ZG611	Advanced Control Systems	5			
	ESUTC ZG651	Networked Embedded Applications	4			
		Total	17		Total	16

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

M.Tech. Environmental Engineering
Curriculum Structure

Input requirements

Employed Professionals with background and minimum one year work experience in Environmental Science / Engineering and allied areas holding an Integrated First Degree of BITS or its equivalent such as B.E / B.Tech / or M.Sc. in relevant disciplines (Chemistry, Chemical Engineering, Civil Engineering, Biology, Microbiology, Biotechnology, Mechanical Engineering) with adequate preparation in Mathematics.

Normal Duration: 4 Semesters

Core Courses

Course No	Course Title	Units
EE* ZG511	Environmental Chemistry	5
EE* ZG512	Environmental Biotechnology	5
EE* ZG513	Applied Transport Phenomena	5
EE* ZG514	Environmental Sampling and Analytical Methods	5
EE* ZG515	Environmental Management Systems	5

Pool of Electives

Course No	Course Title	Units
EE* ZG521	Physico – Chemical Treatment Principles & Design for Wastewater systems	4
EE* ZG522	Biological Treatment Principles & Design for Wastewater systems	4
EE* ZG523	Environmental Statistics	4
EE* ZG611	Energy Generation and Management in Waste Treatment Plants	4
EE* ZG612	Environmental Remote Sensing and GIS	4
EE* ZG613	Environmental Systems Modelling	4
EE* ZG614	Air Pollution Control Technologies	4
EE* ZG621	Solid Waste Management	4
EE* ZG622	Environmental Process Engineering	4
EE* ZG623	Environmental Impact and Risk Assessment	4

M.Tech. Environmental Engineering (GSPCB, Goa)

Type of Input: Employed professionals holding an Integrated First Degree of BITS or its equivalent, with adequate, relevant work experience.

Normal Duration: Four Semesters.

Special Feature: This is a specially designed programme for Human Resource Development needs of GSPCB, Goa

Semester wise pattern for students admitted in First Semester of the Academic Session

Year	First Semester		U	Second Semester		U
I	EEGPC ZG511	Environmental Chemistry	5	EEGPC ZG512	Environmental Biotechnology	5
	EEGPC ZG515	Environmental Management Systems	5	EEGPC ZG611	Energy Generation and Management in Waste Treatment Plants	4
	EEGPC ZG521	Physico – Chemical Treatment Principles & Design for Wastewater systems	4	EEGPC ZG613	Environmental Systems Modelling	4
	EEGPC ZG523	Environmental Statistics	4	EEGPC ZG622	Environmental Process Engineering	4
		Total	18		Total	17
II	EEGPC ZG513	Applied Transport Phenomena	5	EEGPC ZG628T	Dissertation	16
	EEGPC ZG514	Environmental Sampling and Analytical Methods	5			
	EEGPC ZG612	Environmental Remote Sensing and GIS	4			
	EEGPC ZG614	Air Pollution Control Technologies	4			
		Total	18		Total	16

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

M.Tech. Microelectronics
Curriculum Structure

Input Requirements

The students admitted to the four-semester M.Tech. Microelectronics must:

(i) hold an Integrated First Degree of BITS or its equivalent such as B.E. / B.Tech. / M.Sc. in relevant disciplines, and

(ii) be employed professionals with minimum one year work experience in relevant domains.

Normal Duration: 4 Semesters

Curriculum Requirements:

Completion of the programme would require

a) At least 12 courses (totaling at least 48 units) towards coursework, and

b) Dissertation (16 units)

The coursework requirement for the program would consist of a set of core courses and elective courses. The core course requirement is mandatory for all students in a given programme. Rest of the coursework must be completed through elective courses.

Programme Structure

Core Courses (5)

Course No.	Course Title	Units
MEL* ZG611	IC Fabrication Technology	5
MEL* ZG621	VLSI Design	5
MEL* ZG631	Physics & Modelling of Microelectronic Devices	5
MEL* ZG632	Analog IC Design	5
MEL* ZG641	CAD for IC Design	5

Pool of Electives (7)

Course No.	Course Title	Units
MEL* ZC415	Introduction to MEMS	4
MEL* ZG510	RF Microelectronics	5
MEL* ZG511	Design & Analysis of Algorithms	5
MEL* ZG526	Optoelectronic Devices, Circuit & Systems	5
MEL* ZG520	Wireless & Mobile Communication	5
MEL* ZG524	Real Time Operating Systems	5
MEL* ZG512	Embedded System Design	4
MEL* ZG531	Testability for VLSI	5
MEL* ZG553	Real Time Systems	5
MEL* ZG554	Reconfigurable Computing	5
MEL* ZG573	Digital Signal Processing	3
MEL* ZG613	Advanced Digital Signal Processing	4
MEL* ZG623	Advanced VLSI Design	5
MEL* ZG625	Advanced Analog and Mixed Signal Design	5
MEL* ZG642	VLSI Architecture	4
MEL* ZG651	Hardware Software Co-Design	4
MEL* ZG652	Networked Embedded Applications	4

Note: In the above programme structure, the symbol * in the course numbers, can be substituted by the letters representing the collaborating organization

M.Tech. Microelectronics (Cypress, Qualcomm, Texas Instruments, Bangalore)

Type of Input: Employed professionals holding an Integrated First Degree of BITS or its equivalent, with adequate, relevant work experience.

Normal Duration: Four Semesters

Special Feature: This is a specially designed Work-Integrated Learning Programme for the HRD requirements of sponsored employees of Cypress Semiconductor Technology India Pvt. Ltd., Bangalore, Qualcomm India Pvt. Ltd., Bangalore, and IBM India Pvt. Ltd., Bangalore.

Year	First Semester		U	Second Semester		U
I	MEL* ZG512	Embedded System Design	4	MEL* ZG520	Wireless & Mobile communications	5
	MEL* ZG573	Digital Signal Processing	3	MEL* ZG611	IC Fabrication Technology	5
	MEL* ZG621	VLSI Design	5	MEL* ZG632	Analog IC Design	5
	MEL* ZG631	Physics & Modeling of Microelectronic Devices	5	MEL* ZG641	CAD for IC Design	5
		Total	17		Total	20
II	MEL* ZG531	Testability of VLSI	5	MEL* ZG628T	Dissertation	16
	MEL* ZG625	Advanced Analog and Mixed Signal Design	5			
	MEL* ZG642	VLSI Architecture	4			
	MEL* ZG651	Hardware Software Co-Design	4			
		Total	18		Total	16

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.
In the above programme structure, the symbol * in the course numbers can be substituted by the letters representing the collaborating organization.

M.Tech. Microelectronics (Cluster Programme -1, Bangalore)

Type of Input: Employed professionals holding an Integrated First Degree of BITS or its equivalent, with adequate, relevant work experience.

Normal Duration: Four Semesters

Year	First Semester		U	Second Semester		U
I	MELCA ZG520	Wireless & Mobile Communication	3	MELCA ZG641	CAD for IC Design	4
	MELCA ZG621	VLSI Design	5	MELCA ZG611	IC Fabrication Technology	5
	MELCA ZG632	Analog IC Design	5	MELCA ZG625	Advanced Analog and Mixed Signal Design	5
	MELCA ZG631	Physics & Modelling of Micro-electronic Devices	5	MELCA ZG651	Hardware Software Co-Design	5
		Total	18		Total	19
II	MELCA ZG415	Introduction to MEMS	4	MELCA ZG628T	Dissertation	16
	MELCA ZG531	Testability for VLSI	5			
	MELCA ZG623	Advanced VLSI Design	5			
	MELCA ZG510	RF Microelectronics	4			
		Total	18		Total	16

M.Tech. Microelectronics (Cluster Programme -2, Bangalore)

Type of Input: Employed professionals holding an Integrated First Degree of BITS or its equivalent, with adequate, relevant work experience.

Normal Duration: Four Semesters

Year	First Semester		U	Second Semester		U
I	MELWT ZG573	Digital Signal Processing	3	MELWT ZG520	Wireless & Mobile Communication	5
	MELWT ZG621	VLSI Design	5	MELWT ZG632	Analog IC Design	5
	MELWT ZG512	Embedded System Design	5	MELWT ZG641	CAD for IC Design	5
	MELWT ZG631	Physics & Modelling of Micro-electronic Devices	5	MELWT ZG611	IC Fabrication Technology	5
		Total	18		Total	20
II	MELWT ZG642	VLSI Architecture	4	MELWT ZG628T	Dissertation	16
	MELWT ZG531	Testability for VLSI	5			
	MELWT ZG625	Advanced Analog and Mixed Signal Design	5			
	MELWT ZG651	Hardware Software Co-Design	4			
		Total	18		Total	16

M.Tech. Manufacturing Management
Curriculum Structure

Input Qualification

The students admitted to the four-semester M.Tech. in Manufacturing Management must:

(i) hold an Integrated First Degree of BITS or its equivalent such as B.E. / B.Tech. / M.Sc. in relevant disciplines, and

(ii) be employed professionals with minimum one year work experience in relevant domains.

Normal Duration: 4 Semesters

Curriculum Requirements:

Completion of the programme would require

a) At least 12 courses (totaling at least 48 units) towards coursework, and

b) Dissertation (16 units)

The coursework requirement for the program would consist of a set of core courses and elective courses. The core course requirement is mandatory for all students in a given programme. Rest of the coursework must be completed through elective courses.

Programme Structure

Manufacturing Management Core (7)

Course No.	Course Title	Units
MM ZG533	Manufacturing Planning and Control	5
MM ZG621	Supply Chain Management	4
MM ZG522	Total Quality Management	4
MM ZG515	Quantitative Methods	4
MM ZG537	Lean Manufacturing	5
MM ZG523	Project Management	4
MM ZG541	Product Design	5

Pool of Electives

Course No.	Course Title	Units
MM ZG513	Maintenance Engineering	5
MM ZG527	Decision Engineering	4
MM ZG534	Sustainable Manufacturing	4
MM ZG611	Strategic Management & Business Policy *	4
MM ZC441	Human Resource Management *	4
MM ZG514	Leadership and Managing Change *	4
MM ZG627	Managerial Corporate Finance *	4

Note: A student may be allowed to take upto 3 courses from among the specified management domain electives which are indicated by an '*'.

M.Tech. Manufacturing Management

Type of Input: Employed professionals working in Manufacturing and allied business organizations, holding an Integrated First Degree of BITS or its equivalent such as B.E. / B.Tech. / M.Sc. in relevant disciplines, with minimum one year work experience in relevant domains.

Duration: Four Semesters

Special Feature: This Work Integrated Learning Programme is designed for the HRD requirements of a diverse spectrum of Engineering / Manufacturing Industries.

Semesterwise pattern for students admitted in the First Semester of the Academic Session

Year	First Semester		U	Second Semester		U
I	MM ZG533	Manufacturing Planning & Control	5	MM ZG621	Supply Chain Management	4
	MM ZG522	Total Quality Management	4	MM ZG537	Lean Manufacturing	5
	MM ZG515	Quantitative Methods	4	MM ZG523	Project Management	4
	MM ZG541	Product Design	5		Elective	4 (min)
		Total	18		Total	17(min)
II		Elective	4 (min)	MM ZG628T	Dissertation	16
		Elective	4 (min)			
		Elective	4 (min)			
		Elective	4 (min)			
		Total	16(min)		Total	16

Semesterwise pattern for students admitted in the Second Semester of the academic year

Year	First Semester		U	Second Semester		U
I				MM ZG533	Manufacturing Planning & Control	5
				MM ZG522	Total Quality Management	4
				MM ZG515	Quantitative Methods	4
				MM ZG541	Product Design	5
					Total	18
II	MM ZG621	Supply Chain Management	4		Elective	4 (min)
	MM ZG537	Lean Manufacturing	5		Elective	4 (min)
	MM ZG523	Project Management	4		Elective	4 (min)
		Elective	4 (min)		Elective	4 (min)
		Total	17(min)		Total	16(min)
III	MM ZG628T	Dissertation	16			
		Total	16			

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

Pool of Electives

Course No.	Course Title	Units
MM ZC412	Flexible Manufacturing Systems	4
MM ZC441	Human Resource Management	4
MM ZG512	Manufacturing Strategy	4
MM ZG513	Maintenance Engineering	5
MM ZG514	Leadership & Managing Change	4
MM ZG534	Sustainable Manufacturing	4
MM ZG535	Decision Analysis	4
MM ZG611	Strategic Management & Business Policy	4
MM ZG627	Managerial Corporate Finance	4

M.Tech. Manufacturing Management (Vedanta, Jharsuguda)

Type of Input: Employed professionals working in Manufacturing and allied business organizations, holding an Integrated First Degree of BITS or its equivalent such as B.E. / B.Tech. / M.Sc. in relevant disciplines, with minimum one year work experience in relevant domains.

Duration: Four Semesters

Special Feature: This Work Integrated Learning Programme is designed for the HRD requirements of Vedanta, Jharsuguda

Semesterwise pattern for students admitted in the First Semester of the Academic Session

Year	First Semester		U	Second Semester		U
I	MMVA ZG533	Manufacturing Planning & Control	5	MMVA ZG621	Supply Chain Management	4
	MMVA ZG522	Total Quality Management	4	MMVA ZG537	Lean Manufacturing	5
	MMVA ZG515	Quantitative Methods	4	MMVA ZG523	Project Management	4
	MMVA ZG541	Product Design	5	MMVA ZC441	Human Resource Management	4
		Total	18		Total	17
II	MMVA ZG512	Manufacturing Strategy	4	MMVA ZG628T	Dissertation	16
	MMVA ZG514	Leadership and Managing Change	4			
	MMVA ZG534	Sustainable Manufacturing	4			
	MMVA ZG627	Managerial Corporate Finance	4			
		Total	16		Total	16

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

M.Tech. Pharmaceutical Operations and Management

Curriculum Structure

Type of Input: Employed professionals holding an Integrated First Degree of BITS or its equivalent, with adequate relevant work experience.

Normal Duration: Four Semesters

Core Courses

Course No.	Course Title	Units
POM* ZG534	Advanced Pharmaceutical Technology	5
POM* ZG515	Pharmaceutical Administration and Management	5
POM* ZG525	Pharmaceutical Process Development and Scale-up	4
POM* ZG522	Quality Assurance and Regulatory Affairs	5

Pool of Electives

Course No.	Course Title	Units
POM* ZG551	Advanced Physical Pharmaceutics	5
POM* ZG511	Disinfection and Sterilization	4
POM* ZG512	Dosage Form Design	5
POM* ZG513	Financial Management	4
POM* ZC441	Human Resource Management	4
POM* ZG545	Intellectual Property Rights and Pharmaceuticals	3
POM* ZC471	Management Information Systems	3
POM* ZG531	Manufacturing Organization and Management	5
POM* ZG542	Production and Operations Management	4
POM* ZG523	Project Management	4
POM* ZG521	Statistical Process Control	5
POM* ZG611	Strategic Management & Business policy	5
POM* ZG532	Supply Chain Management	4
POM* ZG631	TQM Tools and Techniques	5

Dissertation

Course No.	Course Title	Units
POM* ZG628T	Dissertation	16

Note: In the above programme structure, the symbol '*' in the course numbers, shall be substituted by the letters representing the collaborating organization.

M.Tech. Pharmaceutical Operations and Management (Cipla Ltd., Mumbai)

Type of Input: Employed professionals holding an Integrated First Degree of BITS or its equivalent, with adequate relevant work experience.

Normal Duration: Four Semesters

Special Feature: This programme is specially designed for the HRD needs of Cipla Ltd., Mumbai.

Semesterwise Pattern

Year	First Semester		U	Second Semester		U
I	POMCL ZG512	Dosage Form Design	5	POMCL ZG523	Project Management	4
	POMCL ZG515	Pharmaceutical Administration and Management	5	POMCL ZG534	Advanced Pharmaceutical Technology	5
	POMCL ZG522	Quality Assurance & Regulatory Affairs	5	POMCL ZG542	Production and Operations Management	4
	POMCL ZG551	Advanced Physical Pharmaceutics	5	POMCL ZG545	Intellectual Property Rights and Pharmaceuticals	3
		Total	20		Total	16
II	POMCL ZC441	Human Resource Management	4	POMCL ZG628T	Dissertation	16
	POMCL ZG525	Pharmaceutical Process Development & Scale-up	4			
	POMCL ZG532	Supply Chain Management	4			
	POMCL ZG611	Strategic Management & Business policy	5			
		Total	17		Total	16

M.Tech. Pharmaceutical Operations and Management (Lupin, Mumbai)

Type of Input : Employed professionals holding an Integrated First Degree of BITS in Pharmacy or its equivalent, with adequate, relevant work experience.

Normal Duration: Four Semesters

Special Feature: This is a specially designed programme for the Human Resource Development needs of Lupin Ltd., Mumbai.

Year	First Semester		U	Second Semester		U
I	POMLM ZC471	Management Information Systems	3	POMLM ZG534	Advanced Pharmaceutical Technology	5
	POMLM ZG522	Quality Assurance & Regulatory Affairs	5	POMLM ZG525	Pharmaceutical Process Development & Scale-up	4
	POMLM ZG531	Manufacturing Organization and Management	5	POMLM ZG542	Production and Operations Management	4
	POMLM ZG523	Project Management	4	POMLM ZG631	TQM Tools and Techniques	5
		Total	17		Total	18
II	POMLM ZC441	Human Resource Management	4	POMLM ZG628T	Dissertation	16
	POMLM ZG513	Financial Management	4			
	POMLM ZG515	Pharmaceutical Administration & Management	5			
	POMLM ZG532	Supply Chain Management	4			
		Total	17		Total	16

Note: This is currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

M.Tech. in Quality Management
Curriculum Structure

Input Qualification

The students admitted to the four-semester M.Tech. in Quality Management must:

(i) hold an Integrated First Degree of BITS or its equivalent such as B.E. / B.Tech. / M.Sc. in relevant disciplines, and

(ii) be employed professionals with minimum one year work experience in relevant domains.

Normal Duration: 4 Semesters

Curriculum Requirements:

Completion of the programme would require

a) At least 12 courses (totaling at least 48 units) towards coursework, and

b) Dissertation (16 units)

The coursework requirement for the program would consist of a set of core courses and elective courses. The core course requirement is mandatory for all students in a given programme. Rest of the coursework must be completed through elective courses.

Programme Structure

Quality Management Core (7)

Course No.	Course Title	Units
QM ZG515	Quantitative Methods	4
QM ZG524	Quality Management Systems	5
QM ZG523	Project Management	4
QM ZG526	Operations Management	5
QM ZG528	Reliability Engineering	5
QM ZG531	Statistical Quality Control	5
QM ZG532	Total Quality Management	4

Pool of Electives (7)

Course No.	Course Title	Units
QM ZC441	Human Resource Management	4
QM ZG514	Leadership & Managing Change	4
QM ZG535	Decision Analysis	4
QM ZG536	Design of Experiments	4
QM ZG611	Strategic Management & Business Policy	4
QM ZG661	Software Quality Management	4
QM ZG663	Concurrent Engineering	5

Project

Course No.	Course Title	Units
BITS ZG628T	Dissertation	16

M.Tech. Quality Management

Type of Input: Employed professionals working in Quality and allied services, holding an Integrated First Degree of BITS or its equivalent such as B.E. / B.Tech. / M.Sc. in relevant disciplines, with minimum one year work experience in relevant domains.

Duration: Four Semesters

Special Feature: This Work Integrated Learning Programme is conducted in collaboration with Indian Institute of Quality Management (IIQM), Jaipur.

Semesterwise pattern for students admitted in the First Semester of the Academic Session

Year	First Semester		U	Second Semester		U
I	QM ZG521	Quality Management Systems	5	QM ZG531	Statistical Quality Control	5
	QM ZG532	Total Quality Management	4	QM ZG526	Operations Management	4
	QM ZG515	Quantitative Methods	4	QM ZG523	Project Management	4
	QM ZG528	Reliability Engineering	5	QM ZC441	Human Resource Methods	4
		Total	18		Total	17
II	QM ZG514	Leadership & Managing Change	4	QM ZG628T	Dissertation	16
	QM ZG611	Strategic Management & Business Policy	4			
	QM ZG661	Software Quality Management	4			
	QM ZG663	Concurrent Engineering	5			
		Total	17		Total	16

Semesterwise pattern for students admitted in the Second Semester of the academic year

Year	First Semester		U	Second Semester		U
I				QM ZG521	Quality Management Systems	5
				QM ZG532	Total Quality Management	4
				QM ZG515	Quantitative Methods	4
				QM ZG528	Reliability Engineering	5
					Total	17
II	QM ZG531	Statistical Quality Control	5	QM ZG514	Leadership & Managing Change	4
	QM ZG526	Operations Management	4	QM ZG611	Strategic Management & Business Policy	4
	QM ZG523	Project Management	4	QM ZG661	Software Quality Management	4
	QM ZC441	Human Resource Methods	4	QM ZG663	Concurrent Engineering	5
		Total	17		Total	17
III	QM ZG628T	Dissertation	16			
		Total	16			

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

Pool of Electives

Course No.	Course Title	Units
QM ZC441	Human Resource Management	4
QM ZG514	Leadership & Managing Change	4
QM ZG611	Strategic Management & Business Policy	4
QM ZG661	Software Quality Management	4
QM ZG663	Concurrent Engineering	5
QM ZG535	Decision Analysis	4
QM ZG536	Design of Experiments	4

M.Tech. Science Communication (NCSM, Kolkata)

Type of Input: Integrated First Degree of BITS or its equivalent

Normal Duration: Four Semesters

Special Feature: This is a specially designed programme for Human Resource Development needs of National Council of Science Museums (NCSM), Kolkata and other associated organizations

Year	First Semester	U	Second Semester	U
I	NCSM ZG511 History of Science & Technology	4	NCSM ZG522 Exhibits & Presentation	3
	NCSM ZG521 Concepts in Science Communication	3	NCSM ZG532 Science Communication & IT	4
	NCSM ZG531 Technical Communication	4	NCSM ZG542 Professional Skills & Techniques- II	4
	NCSM ZG541 Professional Skills & Techniques- I	4	NCSM ZG611 Museum Management & Operations	4
		15		15
II	NCSM ZG512 Museum Planning & Organization	4	NCSM ZG628T Dissertation	16
	NCSM ZG621 Science Learning in Non Formal Settings	4		
	NCSM ZG631 Science & Society	3		
	NCSM ZG641 Professional Skills & Techniques- III	4		
		15		16

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

M.Tech. Software Engineering (4-semester)
Curriculum Structure

Type of Input: Employed professionals holding an Integrated First Degree of BITS or its equivalent, with adequate work experience.

Normal Duration: Four Semesters

Core Courses

Course No.	Course Title	Units
SE* ZG512	Object Oriented Analysis & Design	4
SE* ZG651	Software Architectures	5
SE* ZG622	Software Project Management	4
SE* ZG552	Software Testing Methodologies	4

Pool of Electives

Course No.	Course Title	Units
SE* ZC424	Software Development for Portable Devices #	3
SE* ZC434	Software for Embedded Systems #	3
SE* ZG652	Software Maintenance Management #	4
SE* ZG661	Software Quality Management #	4
SE* ZG517	Usability Engineering #	5
SE* ZG566	Secure Software Engineering #	5
SE* ZG533	Service Oriented Computing #	4
SE* ZG544	Agile Software Processes #	4
SE* ZG623	Advanced Operating Systems	5
SE* ZG527	Cloud Computing	5
SE* ZC481	Computer Networks	3
SE* ZC425	Data Mining	3
SE* ZC446	Data Storage Technologies & Networks	3
SE* ZG519	Data Structures & Algorithms Design	5
SE* ZG515	Data Warehousing	5
SE* ZG518	Database Design & Applications	5
SE* ZG511	Design & Analysis of Algorithms	5
SE* ZG573	Digital Signal Processing	3
SE* ZG554	Distributed Data Systems	5
SE* ZG526	Embedded System Design	4
SE* ZG626	Hardware Software Co-Design	5
SE* ZC473	Multimedia Computing	3
SE* ZC462	Network Programming	3
SE* ZG513	Network Security	4
SE* ZG531	Pervasive Computing	4
SE* ZG524	Real Time Operating Systems	5
SE* ZG582	Telecom Network Management	5
SE* ZG520	Wireless & Mobile Communication	5

Note 1: Atleast two courses (minimum 7 units) from among those marked with a '#' must be chosen as electives.
Note 2: In the above programme, the symbol '*' in the course numbers, can be substituted by the letters representing the collaborating organization.

M.Tech. Software Engineering (Cognizant Technology Solutions, Chennai)

Type of Input & Duration : Sponsored employees (with adequate work experience) holding an Integrated First Degree of BITS or its equivalent

Normal Duration: Four Semesters

Special Feature: This is a specially designed programme for Human Resource Development needs of Cognizant Technology Solutions, Chennai.

Year	First Semester		U	Second Semester		U
I	SECT ZG512	Object Oriented Analysis & Design	4	SECT ZG517	Usability Engineering	5
	SECT ZG544	Agile Software Processes	4	SECT ZG552	Software Testing Methodologies	4
	SECT ZG519	Data Structures & Algorithm Design	5	SECT ZG622	Software Project Management	4
	SECT ZG518	Database Design & Applications	5	SECT ZG651	Software Architectures	5
		Total	18		Total	18
II	SECT ZG513	Network Security	4	SECT ZG628T	Dissertation	16
	SECT ZC425	Data Mining	3			
	SECT ZG527	Cloud Computing	5			
	SECT ZG652	Software Maintenance Management	4			
		Total	16		Total	16

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

M.Tech. Software Engineering (Cybage, Pune)

Type of Input: Employed professionals holding an Integrated First Degree of BITS or its equivalent, with adequate work experience.

Normal Duration: Four Semesters

Special Feature: This is a specially designed programme for the Human Resource Development needs of Cybage India Ltd., Pune

Year	First Semester		U	Second Semester		U
I	SECY ZG512	Object Oriented Analysis and Design	4	SECY ZG515	Data Warehousing	5
	SECY ZG518	Database Design and Applications	5	SECY ZG552	Software Testing Methodologies	4
	SECY ZC421	Computer Networks	3	SECY ZG520	Wireless and Mobile Communication	5
	SECY ZG516	Computer Organization and Software Systems	5	SECY ZG651	Software Architectures	5
		Total	16		Total	16
II	SECY ZG622	Software Project Management	4	SECY ZG628T	Dissertation	16
	SECY ZG527	Cloud Computing	5			
	SECY ZG 513	Network Security	4			
	SECY ZG528	Usability Engineering	5			
		Total	18		Total	16

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

M.Tech. Software Engineering (EMC Software and Services, Bangalore)

Type of Input: Employed professionals holding an Integrated First Degree of BITS or its equivalent, with adequate, relevant work experience.

Normal Duration: Four Semesters

Special Feature: This is a specially designed Work-Integrated Learning Programme for the HRD requirements of sponsored employees of EMC Software and Services, Bangalore.

Year	First Semester		U	Second Semester		U
I	SEEMC ZC446	Data Storage Technologies & Networks	3	SEEMC ZC462	Network Programming	3
	SEEMC ZG512	Object Oriented Analysis and Design	4	SEEMC ZG513	Network Security	4
	SEEMC ZG531	Pervasive Computing	4	SEEMC ZG622	Software Project Management	4
	SEEMC ZG562	Software Engineering and Management	5	SEEMC ZG651	Software Architectures	5
		Total	16		Total	16
II	SEEMC ZC444	Cloud Computing	4	SEEMC ZG628T	Dissertation	16
	SEEMC ZG554	Distributed Data Systems	5			
	SEEMC ZG552	Software Testing Methodologies	4			
	SEEMC ZG623	Advanced Operating Systems	5			
		Total	18		Total	16

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

M.Tech. Software Engineering (Hexaware Technologies, Mumbai)

Type of Input: Employed professionals holding an Integrated First Degree of BITS or its equivalent, with adequate, relevant work experience.

Normal Duration: Four Semesters

Special Feature: This is a specially designed Work-Integrated Learning Programme for the HRD requirements of sponsored employees of Hexaware Technologies, Mumbai.

Year	First Semester		U	Second Semester		U
I	SEHEX ZG552	Software Testing Methodologies	4	SEHEX ZG544	Agile Software Processes	4
	SEHEX ZG518	Database Design & Applications	5	SEHEX ZG515	Data Warehousing	5
	SEHEX ZG512	Object Oriented Analysis & Design	4	SEHEX ZG622	Software Project Management	4
	SEHEX ZC424	Software Development for Portable Devices	3	SEHEX ZG651	Software Architectures	5
		Total	16		Total	18
II	SEHEX ZG527	Cloud Computing	5	SEHEX ZG628T	Dissertation	16
	SEHEX ZG652	Software Maintenance Management	4			
	SEHEX ZC425	Data Mining	3			
	SEHEX ZG661	Software Quality Management	4			
		Total	16		Total	16

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

M.Tech. Software Engineering (iGate, Mumbai)

Type of Input: Sponsored employees of iGate holding an Integrated First Degree of BITS or its equivalent.

Normal Duration: Four Semesters

Special Feature: This is a specially designed programme for Human Resource Development needs of iGate, Mumbai

Year	First Semester		U	Second Semester		U
I	SEPC ZC481	Computer Networks	3	SEPC ZC462	Network Programming	3
	SEPC ZG512	Object Oriented Analysis and Design	4	SEPC ZG514	Data Warehousing	5
	SEPC ZG518	Database Design and Applications	5	SEPC ZG623	Advanced Operating Systems	5
	SEPC ZG519	Data Structures and Algorithm Design	5	SEPC ZG651	Software Architectures	5
		Total	17		Total	18
II	SEPC ZG513	Network Security	4	SEPC ZG628T	Dissertation	16
	SEPC ZC527	Cloud Computing	5			
	SEPC ZG552	Software Testing Methodologies	4			
	SEPC ZG622	Software Project Management	4			
		Total	17		Total	16

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

M.Tech. Software Engineering (Persistent Systems, Pune)

Type of Input: Sponsored employees of Persistent Systems Pvt. Ltd., Pune holding an Integrated first degree of BITS or its equivalent.

Normal Duration: Four Semesters

Special Feature: This is a specially designed programme for Human Resource Development needs of Persistent Systems Pvt. Ltd., Pune.

Year	First Semester		U	Second Semester		U
I	SEPS ZG512	Object Oriented Analysis and Design	4	SEPS ZG651	Software Architectures	5
	SEPS ZG519	Data Structures and Algorithm Analysis	5	SEPS ZG520	Wireless and Mobile Communication	5
	SEPS ZG518	Database Design and Applications	5	SEPS ZG514	Data Warehousing	5
	SEPS ZG622	Software Project Management	4	SEPS ZG552	Software Testing Methodologies	4
		Total	18		Total	19
II	SEPS ZC462	Network Programming	3	SEPS ZG628T	Dissertation	16
	SEPS ZG623	Advanced Operating Systems	5			
	SEPS ZG513	Network Security	4			
	SEPS ZC444	Cloud Computing	5			
		Total	17		Total	16

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

M.Tech. Software Engineering (Qualcomm, Hyderabad)

Type of Input: Sponsored employees of Qualcomm, Hyderabad holding an Integrated first degree of BITS or its equivalent, with adequate, relevant work experience.

Normal Duration: Four Semesters

Special Feature: This is a specially designed programme for Human Resource Development needs of Qualcomm, Hyderabad.

Year	First Semester		U	Second Semester		U
I	SEQC ZG512	Object Oriented Analysis & Design	4	SEQC ZG653	Software Architectures	5
	SEQC ZG516	Embedded System Design	4	SEQC ZG622	Software Project Management	4
	SEQC ZG519	Data Structures & Algorithms Design	5	SEQC ZC434	Software for Embedded Systems	3
	SEQC ZG552	Software Testing Methodologies	4	SEQC ZG520	Wireless and Mobile Communication	5
		Total	17		Total	17
II	SEQC ZC424	Software Development for Portable Devices	3	SEQC ZG628T	Dissertation	16
	SEQC ZG566	Secure Software Engineering	5			
	SEQC ZG623	Advanced Operating Systems	5			
	SEQC ZG525	Advanced Computer Networks	5			
		Total	18		Total	16

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

M.Tech. Software Engineering (SAP Labs, Bangalore)

Type of Input: Sponsored employees of Sap Labs, Bangalore holding an First Degree of BITS or its equivalent, with adequate, relevant work experience.

Normal Duration: Four Semesters.

Special Feature: This is a specially designed programme for Human Resource Development needs of SAP Labs, Bangalore.

Year	First Semester		U	Second Semester		U
I	SESAP ZG512	Object Oriented Analysis & Design	4	SESAP ZG514	Data Warehousing	5
	SESAP ZG519	Data Structures and Algorithm Design	5	SESAP ZG651	Software Architectures	5
	SESAP ZG518	Database Design and Applications	5	SESAP ZG513	Network Security	4
	SESAP ZG552	Software Testing Methodologies	4	SESAP ZG661	Software Quality Management	4
		Total	18		Total	18
II	SESAP ZC425	Data Mining	3	SESAP ZG628T	Dissertation	16
	SESAP ZG527	Cloud Computing	5			
	SESAP ZG622	Software Project Management	4			
	SESAP ZG528	Usability Engineering	5			
		Total	17		Total	16

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

M.Tech. Software Engineering (Sabre, Bangalore)

Type of Input: Sponsored employees of Sap Labs, Bangalore holding an First Degree of BITS or its equivalent, with adequate, relevant work experience.

Normal Duration: Four Semesters.

Special Feature: This is a specially designed programme for Human Resource Development needs of Sabre, Bangalore.

Year	First Semester		U	Second Semester		U
I	SEST ZG512	Object Oriented Analysis & Design	4	SEST ZG514	Data Warehousing	5
	SEST ZG519	Data Structures and Algorithm Design	5	SEST ZG651	Software Architectures	5
	SEST ZG518		5	SEST ZG517	Usability Engineering	5
	SEST ZG552	Database Design and Applications	4	SEST ZG662	Software Project Management	4
		Software Testing Methodologies				
		Total	18		Total	19
II	SEST ZG533	Service Oriented Computing	4	SEST ZG628T	Dissertation	16
	SEST ZG527	Cloud Computing	5			
	SEST ZG661	Software Quality Management	4			
	SEST ZG652	Software Maintenance Management	4			
		Total	17		Total	16

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

M.Tech. Software Engineering (TCS, Hyderabad)

Type of Input: Sponsored employees of Sap Labs, Bangalore holding an First Degree of BITS or its equivalent, with adequate, relevant work experience.

Normal Duration: Four Semesters.

Special Feature: This is a specially designed programme for Human Resource Development needs of TCS, Hyderabad

Year	First Semester		U	Second Semester		U
I	SETC ZC481	Computer Networks	3	SETC ZC462	Network Programming	3
	SETC ZG512	Object Oriented Analysis and Design	4	SETC ZG515	Data Warehousing	5
	SETC ZG518	Database Design & Applications	5	SETC ZG552	Software Testing Methodologies	4
	SETC ZG519	Data Structures & Algorithm Design	5	SETC ZG651	Software Architectures	5
		Total	17		Total	17
II	SETC ZC425	Data Mining	3	SETC ZG628T	Dissertation	16
	SETC ZG520	Wireless & Mobile Communication	5			
	SETC ZG527	Cloud Computing	5			
	SETC ZG622	Software Project Management	4			
		Total	17		Total	16

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

M.Tech. Software Engineering (Tech Mahindra, Hyderabad)

Type of Input: Sponsored employees of Satyam Computer Services holding an Integrated First Degree of BITS or its equivalent, with adequate, relevant work experience.

Normal Duration: Four Semesters

Special Feature: This is a specially designed programme for the Human Resource Development needs of Tech Mahindra, Hyderabad

Year	First Semester		U	Second Semester		U
I	SESL ZC421	Computer Networks	3	SESL ZG651	Software Architecture	5
	SESL ZG512	Object Oriented Analysis and Design	4	SESL ZG514	Data Warehousing	5
	SESL ZG518	Data Base Design and Applications	5	SESL ZG513	Network Security	4
	SESL ZG661	Software Quality Management	4	SESL ZG552	Software Testing Methodologies	4
		Total	16		Total	18
II	SESL ZG622	Software Project Management	4	SESL ZG628T	Dissertation	16
	SESL ZG527	Cloud Computing	5			
	SESL ZG552	Software Testing Methodologies	4			
	SESL ZC415	Data Mining	3			
		Total	16		Total	16

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

M.Tech. Software Engineering (Verizon, Chennai & Hyderabad)

Type of Input: Sponsored employees of Verizon holding an Integrated first degree of BITS or its equivalent.

Normal Duration: Four Semesters

Special Feature: This is a specially designed programme for Human Resource Development needs of Verizon, Chennai & Hyderabad.

Year	First Semester		U	Second Semester		U
I	SEVZ ZG512	Object Oriented Analysis and Design	4	SEVZ ZG622	Software Project Management	4
	SEVZ ZG511	Design and Analysis of Algorithms	5	SEVZ ZG520	Wireless and Mobile Communication	5
	SEVZ ZG518	Database Design and Applications	5	SEVZ ZG527	Cloud Computing	5
	SEVZ ZG517	Usability Engineering	5	SEVZ ZG552	Software Testing Methodologies	4
		Total	19		Total	18
II	SEVZ ZG651	Software Architectures	5	SEVZ ZG628T	Dissertation	16
	SEVZ ZG623	Advanced Operating Systems	5			
	SEVZ ZG513	Network Security	4			
	SEVZ ZC424	Software Development for Portable Devices	3			
		Total	17		Total	16

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

Integrated M.Tech. Software Engineering - Curriculum Structure

Input Qualification

The students admitted to the **Integrated M.Tech. Software Engineering** programme must:

(i) hold a B.Sc. / BCA degree or its equivalent in relevant disciplines with adequate background in Mathematics, and

(ii) be employed professionals with minimum one year work experience in relevant domains.

Normal Duration: Eight semesters

Programme Structure:

Foundation Courses

Mathematics Foundation	SE* ZC132	Linear Algebra & Optimization #	3
	SE* ZC213	Probability and Statistics #	3
	SE* ZC252	Discrete Structures for Computer Science #	3
Engineering Foundation	SE* ZC261	Digital Electronics and Microprocessors #	3
Technical Arts / Professional Courses	SE* ZC241	Principles of Management	3
	SE* ZC312	Technical Report Writing	3
	SE* ZC142	Computer Programming #	4

Mandatory Foundation Courses

Core Courses

Course No.	Course Title	Units
SE* ZC416	Compiler Design	3
SE* ZC421	Computer Networks	3
SE* ZC353	Computer Organization & Architecture	4
SE* ZC363	Data Structures & Algorithms	4
SE* ZC322	Database Systems & Applications	3
SE* ZG512	Object Oriented Analysis & Design	4
SE* ZC313	Object Oriented Programming & Design	4
SE* ZC422	Operating Systems	3
SE* ZG651	Software Architectures	5
SE* ZC461	Software Engineering	3
SE* ZG552	Software Testing Methodologies	4
SE* ZG622	Software Project Management	4
SE* ZC332	Systems Programming	3

Pool of Electives

Course No.	Course Title	Units
SE* ZC424	Software Development for Portable Devices #	3
SE* ZC434	Software for Embedded Systems #	3
SE* ZG652	Software Maintenance Management #	4
SE* ZG661	Software Quality Management #	4
SE* ZG517	Usability Engineering #	5
SE* ZG566	Secure Software Engineering #	5
SE* ZG533	Service Oriented Computing #	4
SE* ZG544	Agile Software Processes #	4
SE* ZG623	Advanced Operating Systems	5
SE* ZG527	Cloud Computing	5
SE* ZC481	Computer Networks	3
SE* ZC425	Data Mining	3
SE* ZC446	Data Storage Technologies & Networks	3
SE* ZG519	Data Structures & Algorithms Design	5
SE* ZG515	Data Warehousing	5
SE* ZG518	Database Design & Applications	5
SE* ZG511	Design & Analysis of Algorithms	5
SE* ZG573	Digital Signal Processing	3
SE* ZG554	Distributed Data Systems	5
SE* ZG526	Embedded System Design	4
SE* ZG626	Hardware Software Co-Design	5
SE* ZC473	Multimedia Computing	3
SE* ZC462	Network Programming	3
SE* ZG513	Network Security	4
SE* ZG531	Pervasive Computing	4
SE* ZG524	Real Time Operating Systems	5
SE* ZG582	Telecom Network Management	5
SE* ZG520	Wireless & Mobile Communication	5

Integrated M.Tech. Software Engineering

Semesterwise pattern for students admitted in the First Semester of the academic year

Year	First Semester		U	Second Semester		U
I	SE* ZC252	Discrete Structures for Computer Science	3	SE* ZC313	Object Oriented Programming & Design	4
	SE* ZC132	Linear Algebra & Optimization	3	SE* ZC332	Systems Programming	3
	SE* ZC142	Computer Programming	4	SE* ZC353	Computer Organization & Architecture	4
	SE* ZC261	Digital Electronics & Microprocessors	3	SE* ZC363	Data Structures & Algorithms	4
		Total	13		Total	15
II	SE* ZC213	Probability & Statistics	3	SE* ZC416	Complier Design	3
	SE* ZC322	Database Systems & Applications	3	SE* ZC461	Software Engineering	3
	SE* ZC422	Operating Systems	3	SE* ZC421	Computer Networks	3
		Elective	3 (min)		Elective	3 (min)
		Total	12 (min)		Total	12 (min)
III	SE* ZG512	Object Oriented Analysis & Design	4	SE* ZG651	Software Architectures	5
		Elective	3 (min)	SE* ZG552	Software Testing Methodologies	4
		Elective	4 (min)		Elective	4 (min)
		Elective	4 (min)		Elective	4 (min)
		Total	15 (min)		Total	14 (min)
IV	SE* ZG622	Software Project Management	4	SE* ZG628T	Dissertation	16
		Elective	3(min)			
		Elective	4 (min)			
		Elective	4 (min)			
		Total	15 (min)		Total	16

Semesterwise Pattern for Integrated M.Tech. Software Engineering

Semesterwise pattern for students admitted in the Second Semester of the academic year

Year	First Semester		U	Second Semester		U
I				SE* ZC252	Discrete Structures for Computer Science	3
				SE* ZC132	Linear Algebra & Optimization	3
				SE* ZC142	Computer Programming	4
				SE* ZC261	Digital Electronics & Microprocessors	3
					Total	13
II	SE* ZC313	Object Oriented Programming & Design	4	SE* ZC213	Probability & Statistics	3
	SE* ZC332	Systems Programming	3	SE* ZC322	Database Systems & Applications	3
	SE* ZC353	Computer Organization & Architecture	4	SE* ZC422	Operating Systems	3
	SE* ZC363	Data Structures & Algorithms	4		Elective	3 (min)
		Total	15		Total	12 (min)
III	SE* ZC416	Complier Design	3	SE* ZG512	Object Oriented Analysis & Design	4
	SE* ZC461	Software Engineering	3		Elective	3 (min)
	SE* ZC421	Computer Networks	3		Elective	4 (min)
		Elective	3 (min)		Elective	4 (min)
		Total	12 (min)		Total	15 (Min)
IV	SE* ZG651	Software Architectures	5	SE* ZG622	Software Project Management	4
	SE* ZG552	Software Testing Methologies	4		Elective	3 (min)
		Elective	4 (min)		Elective	4 (min)
		Elective	4 (min)		Elective	4 (min)
		Total	17 (min)		Total	15 (Min)
V	SE* ZG628T	Dissertation	16			
		Total	16			

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

Integrated M.Tech. Software Engineering (EMC, Bangalore)

Type of Input: Sponsored employees (with adequate, relevant work experience) with a B.Sc. Degree or its equivalent with adequate preparation in Mathematics & Physics

Normal Duration: Eight Semesters

Special Feature: This programme is specially designed for the Human Resource Development needs of EMC, Bangalore

Year	First Semester		U	Second Semester		U
I	SEEMC ZC132	Linear Algebra & Optimization	3	SEEMC ZC222	Advanced Programming Techniques	3
	SEEMC ZC142	Computer Programming	3	SEEMC ZC332	Systems Programming	3
	SEEMC ZC252	Discrete Structures for Computer Science	3	SEEMC ZC413	Computer Organization & Architectures	3
	SEEMC ZC261	Digital Electronics & Microprocessors	3	SEEMC ZC415	Data Structures & Algorithms	3
			12		Total	12
II	SEEMC ZC213	Probability & Statistics	3	SEEMC ZC416	Compiler Design	3
	SEEMC ZC422	Operating Systems	3	SEEMC ZC421	Computer Networks	3
	SEEMC ZC322	Database Management Systems	3	SEEMC ZC472	Computer Graphics	3
	SEEMC ZC461	Software Engineering	3	SEEMC ZC424	Software Development for Portable Devices	3
		Total	12		Total	12
III	SEEMC ZC446	Data Storage Tech & Networks	3	SEEMC ZC462	Network Programming	3
	SEEMC ZG512	Object Oriented Analysis & Design	4	SEEMC ZG554	Distributed Data Systems	5
	SEEMC ZG531	Pervasive Computing	4	SEEMC ZG622	Software Project Management	4
	SEEMC ZG562	Software Engineering & Management	5	SEEMC ZG651	Software Architectures	5
		Total	16		Total	17
IV	SEEMC ZG552	Software Testing Methodologies	4	SEEMC ZG628T	Dissertation	16
	SEEMC ZG623	Advanced Operating Systems	4			
	SEEMC ZG527	Cloud Computing	5			
	SEEMC ZG513	Network Security	4			
		Total	17		Total	16

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

Integrated M.Tech. Software Engineering (SAP Labs, Bangalore)

Type of Input: Sponsored employees (with adequate, relevant work experience) with a B.Sc. Degree or its equivalent with adequate preparation in Mathematics & Physics

Normal Duration: Eight Semesters

Special Feature: This programme is specially designed for the Human Resource Development needs of SAP Labs, Bangalore

Year	First Semester		U	Second Semester		U
I	SESAP ZC132	Linear Algebra & Optimization	3	SESAP ZC222	Advanced Programming Techniques	3
	SESAP ZC142	Computer Programming	3	SESAP ZC332	Systems Programming	3
	SESAP ZC252	Discrete Structures for Computer Science	3	SESAP ZC413	Computer Organization & Architectures	3
	SESAP ZC261	Digital Electronics & Microprocessors	3	SESAP ZC415	Data Structures & Algorithms	3
			12		Total	12
II	SESAP ZC213	Probability & Statistics	3	SESAP ZC416	Compiler Design	3
	SESAP ZC422	Operating Systems	3	SESAP ZC421	Computer Networks	3
	SESAP ZC322	Database Management Systems	3	SESAP ZC472	Computer Graphics	3
	SESAP ZC461	Software Engineering	3	SESAP ZC424	Software Development for Portable Devices	3
		Total	12		Total	12
III	SESAP ZG514	Data Warehousing	5	SESAP ZG622	Software Project Management	4
	SESAP ZG512	Object Oriented Analysis & Design	4	SESAP ZG552	Software Testing Methodologies	4
	SESAP ZG524	Real Time Operating Systems	5	SESAP ZC425	Data Mining	3
	SESAP ZC473	Multimedia Computing	3	SESAP ZG511	Design & Analysis of Algorithms	5
		Total	17		Total	16
IV	SESAP ZG651	Software Architectures	5	SESAP ZG628T	Dissertation	16
	SESAP ZC446	Data Storage Technologies & Networks	3			
	SESAP ZG527	Cloud Computing	5			
	SESAP ZG513	Network Security	4			
		Total	17		Total	16

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

Integrated M.Tech. Software Engineering (Tech Mahindra, Hyderabad)

Type of Input: Sponsored employees (with adequate, relevant work experience) with a B.Sc. Degree or its equivalent with adequate preparation in Mathematics & Physics

Normal Duration: Eight Semesters

Special Feature: This programme is specially designed for the Human Resource Development needs of Tech Mahindra, Hyderabad

Year	First Semester		U	Second Semester		U
I	SEMH ZC132	Linear Algebra & Optimization	3	SEMH ZC222	Advanced Programming Techniques	3
	SEMH ZC142	Computer Programming	3	SEMH ZC332	Systems Programming	3
	SEMH ZC252	Discrete Structures for Computer Science	3	SEMH ZC413	Computer Organization & Architectures	3
	SEMH ZC261	Digital Electronics & Microprocessors	3	SEMH ZC415	Data Structures & Algorithms	3
			12		Total	12
II	SEMH ZC213	Probability & Statistics	3	SEMH ZC416	Compiler Design	3
	SEMH ZC422	Operating Systems	3	SEMH ZC421	Computer Networks	3
	SEMH ZC322	Database Management Systems	3	SEMH ZC472	Computer Graphics	3
	SEMH ZC461	Software Engineering	3	SEMH ZC424	Software Development for Portable Devices	3
		Total	12		Total	12
III	SEMH ZG514	Data Warehousing	5	SEMH ZG622	Software Project Management	4
	SEMH ZG512	Object Oriented Analysis & Design	4	SEMH ZG552	Software Testing Methodologies	4
	SEMH ZG524	Real Time Operating Systems	5	SEMH ZC425	Data Mining	3
	SEMH ZC473	Multimedia Computing	3	SEMH ZG511	Design & Analysis of Algorithms	5
		Total	17		Total	16
IV	SEMH ZG651	Software Architectures	5	SEMH ZG628T	Dissertation	16
	SEMH ZC446	Data Storage Technologies & Networks	3			
	SEMH ZG527	Cloud Computing	5			
	SEMH ZG513	Network Security	4			
		Total	17		Total	16

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

Integrated M.Tech. Software Engineering (Virtusa, Chennai)

Type of Input: Sponsored employees (with adequate, relevant work experience) with a B.Sc. Degree or its equivalent with adequate preparation in Mathematics & Physics

Normal Duration: Eight Semesters

Special Feature: This programme is specially designed for the Human Resource Development needs of Virtusa, Chennai

Year	First Semester		U	Second Semester		U
I	SEVI ZC132	Linear Algebra & Optimization	3	SEVI ZC222	Advanced Programming Techniques	3
	SEVI ZC142	Computer Programming	3	SEVI ZC332	Systems Programming	3
	SEVI ZC252	Discrete Structures for Computer Science	3	SEVI ZC413	Computer Organization & Architectures	3
	SEVI ZC261	Digital Electronics & Microprocessors	3	SEVI ZC415	Data Structures & Algorithms	3
			12		Total	12
II	SEVI ZC213	Probability & Statistics	3	SEVI ZC416	Compiler Design	3
	SEVI ZC422	Operating Systems	3	SEVI ZC421	Computer Networks	3
	SEVI ZC322	Database Management Systems	3	SEVI ZC472	Computer Graphics	3
	SEVI ZC461	Software Engineering	3	SEVI ZC424	Software Development for Portable Devices	3
		Total	12		Total	12
III	SEVI ZG514	Data Warehousing	5	SEVI ZG622	Software Project Management	4
	SEVI ZG512	Object Oriented Analysis & Design	4	SEVI ZG552	Software Testing Methodologies	4
	SEVI ZG524	Real Time Operating Systems	5	SEVI ZC425	Data Mining	3
	SEVI ZC473	Multimedia Computing	3	SEVI ZG511	Design & Analysis of Algorithms	5
		Total	17		Total	16
IV	SEVI ZG651	Software Architectures	5	SEVI ZG628T	Dissertation	16
	SEVI ZC446	Data Storage Technologies & Networks	3			
	SEVI ZG527	Cloud Computing	5			
	SEVI ZG513	Network Security	4			
		Total	17		Total	16

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

M.Tech. Software Systems (4-semester) with specializations
Curriculum Structure

Input Requirements
Employed professionals holding an Integrated First Degree of BITS or its equivalent in relevant disciplines, with minimum one year work experience in relevant domains.

Normal duration: Four semesters
Programme Structure

Core Courses

Course No.	Course Title	Units
SS ZG519	Data Structures & Algorithms Design *	5
SS ZG518	Database Design & Applications *	5
SS ZG526	Distributed Computing	5
SS ZG514	Object Oriented Analysis & Design	4
SS ZG653	Software Architectures	5

* Dean, WILP may be permitted the operational flexibility of substituting these courses with others from the elective pool(s) based on certain input criteria.

General Pool of Electives

Course No.	Course Title	Units
CS ZG551	Advanced Compilation Techniques	5
CS ZG623	Advanced Operating Systems	5
IS ZC444	Artificial Intelligence	3
IS ZC472	Computer Graphics	3
SS ZG516	Computer Organization & Software Systems	5
IS ZC364	Human Computer Interaction	3
EA ZC473	Multimedia Computing	3
IS ZC422	Parallel Computing	3

Curriculum for 4-semester M.Tech. Software Systems with specializations

Specializations:

1. **Software Engineering:**
   a. **Requirements:**
      i. 4 courses / 16 units (min)
      ii. All courses are to be chosen from a designated pool of electives

   b. **List of electives:**

Course No.	Course Title	Units
SS ZG566	Secure Software Engineering	5
SS ZG562	Software Engineering & Management	5
IS ZC424	Software for Embedded Systems	3
SS ZG652	Software Maintenance Management	4
SS ZG622	Software Project Management	4
SS ZG661	Software Quality Management	4
SS ZG552	Software Testing Methodologies	4
SS ZG547	Usability Engineering	5

2. Data Analytics:

a. Requirements:

i. 4 courses / 16 units (min)
ii. All courses are to be chosen from a designated pool of electives

b. List of electives:

Course No.	Course Title	Units
SS ZG548	Advanced Data Mining	4
SS ZG536	Advanced Statistical Techniques for Analytics	4
IS ZC425	Data Mining	3
IS ZC446	Data Storage Technologies & Networks	3
SS ZG515	Data Warehousing	5
SS ZG554	Distributed Data Systems	5
SS ZG537	Information Retrieval	4
IS ZC464	Machine Learning	3

3. Networks and Networked Systems

a. Requirements:

i. 4 courses / 16 units (min)
ii. All courses are to be chosen from a designated pool of electives

b. List of electives:

Course No.	Course Title	Units
SS ZG525	Advanced Computer Networks	5
SS ZG527	Cloud Computing	5
IS ZC481	Computer Networks	3
BITS ZC463	Cryptography	3
IS ZC446	Data Storage Technologies & Networks	3
SS ZG538	Infrastructure Management	4
EA ZC451	Internetworking Technologies	3
IS ZC462	Network Programming	3
SS ZG513	Network Security	4
SS ZG582	Telecom Network Management	5
SS ZG520	Wireless & Mobile Communication	5

4. Embedded Systems

a. Requirements:

i. 4 courses / 16 units (min)

ii. All courses are to be chosen from a designated pool of electives

b. List of electives:

Course No.	Course Title	Units
EEE ZG512	Embedded System Design	4
SS ZG626	Hardware Software Co-Design	5
SS ZG656	Networked Embedded Applications	4
SS ZG531	Pervasive Computing	4
CS ZG524	Real Time Operating Systems	5
BITS ZG553	Real Time Systems	5
IS ZC314	Software Development for Portable Devices	3
IS ZC424	Software for Embedded Systems	3

5. Telecommunications

a. Requirements:

i. 4 courses / 16 units (min)

ii. All courses are to be chosen from a designated pool of electives

b. List of electives:

Course No.	Course Title	Units
SS ZG525	Advanced Computer Networks	5
EEE ZG573	Digital Signal Processing	5
EEE ZG512	Embedded System Design	4
EEE ZG571	Optical Communication	5
EEE ZG572	Satellite Communication	5
EEE ZG582	Telecom Network Management	5
SS ZG520	Wireless & Mobile Communication	5

M.Tech. Software Systems (4 semesters)

Type of Input: Employed professionals holding an Integrated First Degree of BITS or its equivalent such as B.E./ B.Tech../ M.Sc./ MCA in relevant disciplines, with minimum one year work experience in relevant domains.

Normal Duration: Four Semesters

Special Feature: This WILP is designed for the HRD requirements of a diverse spectrum of IT Industries.

Semesterwise pattern for students admitted in the First Semester of the academic year

Year	First Semester		U	Second Semester		U
I	SS ZG514	Object Oriented Analysis & Design	4	SS ZG653	Software Architectures	5
	SS ZG519	Data Structures & Algorithms Design	5		Elective 2	3(min)
	SS ZG518	Database Design & Applications	5		Elective 3	3(min)
		Elective 1	3 (min)		Elective 4	4(min)
		Total	17(min)		Total	15(min)
II	SS ZG526	Distributed Computing	5	BITS ZG628T	Dissertation	16
		Elective 5	3(min)			
		Elective 6	4(min)			
		Elective 7	4(min)			
		Total	16(min)		Total	16

Semesterwise pattern for students admitted in the Second Semester of the academic year

Year	First Semester		U	Second Semester		U
I				SS ZG514	Object Oriented Analysis & Design	4
				SS ZG519	Data Structures & Algorithms Design	5
				SS ZG518	Database Design & Applications	5
					Elective 1	3 (min)
					Total	17(min)
II	SS ZG653	Software Architectures	5	SS ZG526	Distributed Computing	5
		Elective 2	3(min)		Elective 5	3(min)
		Elective 3	3(min)		Elective 6	4(min)
		Elective 4	4(min)		Elective 7	4(min)
		Total	15(min)		Total	16(min)
III	BITS ZG628T	Dissertation	16			
		Total	16			

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

M.Tech. Software Systems (Wipro Technologies, Bangalore)

Type of Input: Employed professionals holding an Integrated First Degree of BITS or its equivalent such as B.E./ B.Tech../ M.Sc./ MCA in relevant disciplines, with minimum one year work experience in relevant domains.

Normal Duration: Four Semesters

Semesterwise pattern for students admitted in the First Semester of the academic year

Year	First Semester		U	Second Semester		U
I	SSWT ZG514	Object Oriented Analysis & Design	4	SSWT ZG653	Software Architectures	5
	SSWT ZG519	Data Structures & Algorithms Design	5	SSWT ZC314	Software Dev for Port Devices	3
	SSWT ZG518	Database Design & Applications	5	SSWT ZG548	Advanced Data Mining	4
	SSWT ZG527	Cloud Computing	5	SSWT ZG513	Network Security	3
		Total	19		Total	15
II	SSWT ZG526	Distributed Computing	5	BITS ZG628T	Dissertation	16
	SSWT ZG622	Software Project Management	4			
	SSWT ZC481	Computer Networks	3			
	SSWT ZG512	Embedded System Design	4			
		Total	16		Total	16

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

M.Tech. Software Systems (TCS, Hyderabad)

Type of Input: Employed professionals holding an Integrated First Degree of BITS or its equivalent such as B.E./ B.Tech../ M.Sc./ MCA in relevant disciplines, with minimum one year work experience in relevant domains.

Normal Duration: Four Semesters

Special Feature : This programme is designed for the HRD needs of Tata Consultancy Services, Hyderabad

Semesterwise pattern for students admitted in the First Semester of the academic year

Year	First Semester		U	Second Semester		U
I	SSTCS ZG519	Data Structures & Algorithms Design	5	SSTCS ZC444	Artificial Intelligence	3
	SSTCS ZG518	Database Design & Applications	5	SSTCS ZC425	Data Mining	3
	SSTCS ZG514	Object Oriented Analysis & Design	4	SSTCS ZG515	Data Warehousing	5
	SSTCS ZG562	Software Engineering & Management	5	SSTCS ZG526	Distributed Computing	5
		Total	19		Total	16
II	SSTCS ZG554	Distributed Data Systems	5	SSTCS ZG628T	Dissertation	16
	SSTCS ZG537	Information Retrieval	4			
	SSTCS ZC473	Multimedia Computing	3			
	SSTCS ZG653	Software Architectures	5			
		Total	17		Total	16

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

Integrated M.Tech. Software Systems

Curriculum Structure

Input Qualification

The students admitted to the **Integrated M.Tech. Software Systems** programme must:

(i) hold a B.Sc. / BCA degree or its equivalent in relevant disciplines with adequate background in Mathematics, and

(ii) be employed professionals with minimum one year work experience in relevant domains.

Normal Duration: Eight semesters

Curriculum Structure

Completion of the programme would require, completion of:

Foundation Courses	: 5 courses	(16 units min.)
Discipline Core	: 12 courses	(44 units min.)
Discipline Electives	: 11 courses	(36 units min.)
Course work sub total	: 28 courses	(96 units min.)
Dissertation	: 16 units	

Programme Structure:

Foundation Courses

Mathematics Foundation	MATH ZC234	Linear Algebra & Optimization *	3
	AAOC ZC111	Probability and Statistics *	3
	MATH ZC222	Discrete Structures for Computer Science *	3
Engineering Foundation	ES ZC261	Digital Electronics and Microprocessors *	3
Technical Arts / Professional Courses	MGTS ZC211	Principles of Management	3
	TA ZC312	Technical Report Writing	3
	TA ZC163	Computer Programming *	4

***** Mandatory Foundation Courses

Core Courses

Course No.	Course Title	Units
IS ZC372	Compiler Design	3
IS ZC461	Computer Networks	3
IS ZC351	Computer Organization & Architecture	4
IS ZC363	Data Structures & Algorithms	4
IS ZC332	Database Systems & Applications	3
SS ZG526	Distributed Computing	5
SS ZG514	Object Oriented Analysis & Design	4
IS ZC313	Object Oriented Programming & Design	4
IS ZC362	Operating Systems	3
SS ZG653	Software Architectures	5
IS ZC341	Software Engineering	3
IS ZC323	Systems Programming	3

General Pool of Electives

Course No.	Course Title	Units
CS ZG551	Advanced Compilation Techniques	5
CS ZG623	Advanced Operating Systems	5
IS ZC444	Artificial Intelligence	3
IS ZC472	Computer Graphics	3
EA ZC473	Multimedia Computing	3
IS ZC422	Parallel Computing	3

Specializations:

1. **Software Engineering**
   a. **Requirements:**
      i. 4 courses / 16 units (min)
      ii. All courses are to be chosen from a designated pool of electives
   b. **List of electives:**

Course No.	Course Title	Units
SS ZG566	Secure Software Engineering	5
IS ZC424	Software for Embedded Systems	3
SS ZG652	Software Maintenance Management	4
SS ZG622	Software Project Management	4
SS ZG661	Software Quality Management	4
SS ZG552	Software Testing Methodologies	4
SS ZG547	Usability Engineering	5

2. **Data Analytics**
   a. **Requirements:**
      i. 4 courses / 16 units (min)
      ii. All courses are to be chosen from a designated pool of electives
   b. **List of electives:**

Course No.	Course Title	Units
SS ZG548	Advanced Data Mining	4
IS ZC425	Data Mining	3
IS ZC446	Data Storage Technologies & Networks	3
SS ZG515	Data Warehousing	5
SS ZG554	Distributed Data Systems	5
SS ZG537	Information Retrieval	4
IS ZC464	Machine Learning	3

3. **Networks and Networked Systems**
   a. **Requirements:**
      i. 4 courses / 16 units (min)
      ii. All courses are to be chosen from a designated pool of electives
   b. **List of electives:**

Course No.	Course Title	Units
SS ZG525	Advanced Computer Networks	5
SS ZG527	Cloud Computing	5
BITS ZC463	Cryptography	3
IS ZC446	Data Storage Technologies & Networks	3
SS ZG538	Infrastructure Management	4
IS ZC462	Network Programming	3
SS ZG513	Network Security	4
SS ZG582	Telecom Network Management	5
SS ZG520	Wireless & Mobile Communication	5

4. Embedded Systems

a. Requirements:

i. 4 courses / 16 units (min)

ii. All courses are to be chosen from a designated pool of electives

b. List of electives:

Course No.	Course Title	Units
EEE ZG512	Embedded System Design	4
SS ZG626	Hardware Software Co-Design	5
SS ZG656	Networked Embedded Applications	4
SS ZG531	Pervasive Computing	4
CS ZG524	Real Time Operating Systems	5
BITS ZG553	Real Time Systems	5
IS ZC314	Software Development for Portable Devices	3
IS ZC424	Software for Embedded Systems	3

5. Telecommunications

a. Requirements:

i. 4 courses / 16 units (min)

ii. All courses are to be chosen from a designated pool of electives

b. List of electives:

Course No.	Course Title	Units
SS ZG525	Advanced Computer Networks	5
EEE ZG573	Digital Signal Processing	5
EEE ZG512	Embedded System Design	4
EEE ZG571	Optical Communication	5
EEE ZG572	Satellite Communication	5
EEE ZG582	Telecom Network Management	5
SS ZG520	Wireless & Mobile Communication	5

Integrated M.Tech. Software Systems

Semesterwise pattern for students admitted in the First Semester of the academic year

Year	First Semester		U	Second Semester		U
I	MATH ZC222	Discrete Structures for Computer Science	3	IS ZC313	Object Oriented Programming & Design	4
	MATH ZC234	Linear Algebra & Optimization	3	IS ZC323	Systems Programming	3
	TA ZC163	Computer Programming	4	IS ZC353	Computer Organization & Architecture	4
	ES ZC261	Digital Electronics & Microprocessors	3	IS ZC363	Data Structures & Algorithms	4
		Total	13		Total	15
II	AAOC ZC111	Probability & Statistics	3	IS ZC372	Complier Design	3
	IS ZC332	Database Systems & Applications	3	IS ZC341	Software Engineering	3
	IS ZC362	Operating Systems	3	IS ZC461	Computer Networks	3
		Elective	3 (min)		Elective	3 (min)
		Total	12 (min)		Total	12 (min)
III	SS ZG514	Object Oriented Analysis & Design	4	SS ZG653	Software Architectures	5
		Elective	3 (min)		Elective	3 (min)
		Elective	4 (min)		Elective	4 (min)
		Elective	4 (min)		Elective	4 (min)
		Total	15 (min)		Total	16 (min)
IV	SS ZG526	Distributed Computing	5	BITS ZG628T	Dissertation	16
		Elective	3(min)			
		Elective	4 (min)			
		Elective	4 (min)			
		Total	16 (min)		Total	16

Semesterwise pattern for students admitted in the Second Semester of the academic year

Year	First Semester		U	Second Semester		U
I				MATH ZC222	Discrete Structures for Computer Science	3
				MATH ZC234	Linear Algebra & Optimization	3
				TA ZC163	Computer Programming	4
				ES ZC261	Digital Electronics & Microprocessors	3
					Total	13
II	IS ZC313	Object Oriented Programming & Design	4	AAOC ZC111	Probability & Statistics	3
	IS ZC323	Systems Programming	3	IS ZC332	Database Systems & Applications	3
	IS ZC353	Computer Organization & Architecture	4	IS ZC362	Operating Systems	3
	IS ZC363	Data Structures & Algorithms	4		Elective	3 (min)
		Total	15		Total	12 (min)
III	IS ZC372	Complier Design	3	SS ZG514	Object Oriented Analysis & Design	4
	IS ZC341	Software Engineering	3		Elective	3 (min)
	IS ZC461	Computer Networks	3		Elective	4 (min)
		Elective	3 (min)		Elective	4 (min)
		Total	12 (min)		Total	15 (Min)
IV	SS ZG653	Software Architectures	5	SS ZG526	Distributed Computing	5
		Elective	3 (min)		Elective	3 (min)
		Elective	4 (min)		Elective	4 (min)
		Elective	4 (min)		Elective	4 (min)
		Total	16 (min)		Total	16 (Min)
V	BITS ZG628T	Dissertation	16			
		Total	16			

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

M.Tech. Structural Engineering

Type of Input: Employed professionals in engineering industries and holding an Integrated First Degree of BITS in Civil Engineering or its equivalent, with minimum one year work experience in relevant domains.

Nominal Duration: Four Semesters

Programme Structure

Core Courses

Course No	Course Title	Units
ST* ZG617	Advanced Structural Analysis	4
ST* ZG552	Advanced Structural Mechanics and Stability	4
ST* ZG551	Dynamics of Structures	4
ST* ZG615	Earthquake Engineering	4
ST* ZG619	Finite Element Analysis	5

Pool of Electives (any seven)

Course No	Course Title	Units
ST* ZG533	Advanced Composite Materials for Structures	4
ST* ZG513	Advanced Computational Techniques	4
ST* ZG524	Advanced Concrete Structural Design	5
ST* ZG613	Advanced Concrete Structures	4
ST* ZG523	Advanced Concrete Technology	4
ST* ZG620	Advanced Foundation Engineering	4
ST* ZG532	Advanced Soil Mechanics	4
ST* ZG612	Advanced Steel Structures	4
ST* ZG554	Advanced Structural Design	4
ST* ZG616	Bridge Engineering	4
ST* ZG610	Computer Aided Analysis and Design in Civil Engineering	5
ST* ZG618	Design of Multi-storey Structures	4
ST* ZG621	Fluid Dynamics	5
ST* ZG623	Ground Improvement Techniques	4
ST* ZG511	Matrix methods in Civil Engineering	5
ST* ZG614	Prestressed Concrete Structures	4
ST* ZG631	Selected Topics in Soil Mechanics and Geotechnical Engineering	4
ST* ZG622	Soil-Structure-Interaction	4
ST* ZG522	Structural Health Assessment and Rehabilitation	4
ST* ZG514	Structural Optimization	4
ST* ZG641	Theory of Elasticity and Plasticity	5
ST* ZG553	Theory of Plates and Shells	4
ST* ZG521	Topics in Structural Engineering	5

M.Tech. Structural Engineering (PWD, Goa)

Type of Input: Employed professionals in engineering industries and holding an Integrated First Degree of BITS in Civil Engineering or its equivalent, with minimum one year work experience in relevant domains.

Nominal Duration: Four Semesters

Special Feature : This programme is designed for the HRD needs of PWD, Goa

Year	First Semester		U	Second Semester		U
I	STPWG ZG551	Dynamics of Structures	4	STPWG ZG617	Advanced Structural Analysis	4
	STPWG ZG552	Advanced Structural Mechanics and Stability	4	STPWG ZG615	Earthquake Engineering	4
	STPWG ZG619	Finite Element Analysis	5	STPWG ZG610	Computer Aided Analysis and Design in Civil Engineering	5
	STPWG ZG612	Advanced Steel Structures	4	STPWG ZG523	Advanced Concrete Technology	4
		Total	17		Total	17
II	STPWG ZG620	Advanced Foundation Engineering	4	STPWG ZG628T	Dissertation	16
	STPWG ZG524	Advanced Concrete Structural Design	5			
	STPWG ZG618	Design of Multi-storey Structures	4			
	STPWG ZG522	Structural Health Assessment and Rehabilitation	4			
		Total	17		Total	16

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

M.Tech. Systems Engineering (4-semester)
Curriculum Structure

Input Requirements

Employed professionals holding an Integrated First Degree of BITS or its equivalent in relevant disciplines, with minimum one year work experience in relevant domains.

Normal duration: Four semesters

Programme Structure

Core Courses : None.

Pool of Electives

Course No.	Course Title	Units
SE* ZG527	Cloud Computing	5
SE* ZC425	Data Mining	3
SE* ZC446	Data Storage Technologies & Networks	3
SE* ZG515	Data Warehousing	5
SE* ZC451	Internetworking Technologies	3
SE* ZC473	Multimedia Computing	3
SE* ZC462	Network Programming	3
SE* ZG513	Network Security	4
SE* ZG512	Object Oriented Analysis & Design	4
SE* ZG531	Pervasive Computing	4
SE* ZG524	Real Time Operating Systems	5
SE* ZG553	Real Time Systems	5
SE* ZG622	Software Project Management	4
SE* ZG661	Software Quality Management	4
SE* ZG552	Software Testing Methodologies	4
SE* ZG582	Telecom Network Management	5
SE* ZG520	Wireless & Mobile Communication	5

Note: In the above programme, the symbol '*' in the course numbers, can be substituted by the letters representing the collaborating organization.

M.Tech. Systems Engineering (Wipro Infotech, Bangalore)

Type of Input: Sponsored employees (with adequate relevant work experience) with First Degree of BITS or its equivalent

Normal Duration: Four Semesters

Special Feature This is a specially designed Work-Integrated Learning Programme for the HRD requirements of sponsored employees of Wipro Technologies and Wipro Infotech, Bangalore.

Year	First Semester		U	Second Semester		U
I	SEWI ZG514	Data Warehousing	5	SEWI ZG661	Software Quality Management	4
	SEWI ZG512	Object Oriented Analysis & Design	4	SEWI ZG531	Pervasive Computing	4
	SEWI ZG524	Real Time Operating Systems	5	SEWI ZC425	Data Mining	3
	SEWI ZG520	Wireless & Mobile Communication	5	SEWI ZG552	Software Testing Methodologies	4
		Total	19		Total	15
II	SEWI ZG622	Software Project Management	4	SEWI ZG628T	Dissertation	16
	SEWI ZG527	Cloud Computing	5			
	SEWI ZG582	Telecom Network Management	5			
	SEWI ZG513	Network Security	4			
		Total	18		Total	16

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

M.Tech. Telecommunications and Software Engineering

Curriculum Structure

Input Requirements

Employed professionals holding an Integrated First Degree of BITS or its equivalent in relevant disciplines, with minimum one year work experience in relevant domains.

Normal duration: Four semesters

Programme Structure

Core Courses : None.

Pool of Electives

Course No	Course Title	Units
SE* ZG525	Advanced Computer Networks	5
SE* ZC421	Computer Networks	3
SE* ZG515	Data Warehousing	5
SE* ZG518	Database Design & Applications	5
SE* ZG516	Embedded System Design	4
SE* ZC452	Mobile Telecom Networks	3
SE* ZC473	Multimedia Computing	3
SE* ZG513	Network Security	4
SE* ZG512	Object Oriented Analysis & Design	4
SE* ZG591	Optical Communication	5
SE* ZC482	Satellite Communication	3
SE* ZG651	Software Architectures	5
SE* ZG622	Software Project Management	4
SE* ZG552	Software Testing Methodologies	4
SE* ZG659	Technical Communication	4
SE* ZG582	Telecom Network Management	5
SE* ZG520	Wireless & Mobile Communication	5

Note: In the above programme, the symbol '*' in the course numbers, can be substituted by the letters representing the collaborating organization.

M.Tech. Telecommunications and Software Engineering (Avaya, Pune)

Type of Input: Sponsored employees (with adequate work experience in Telecommunications area) holding an Integrated First Degree of BITS or its equivalent.

Normal Duration: Four Semesters

Special Feature: This is a specially designed programme for Human Resource Development needs of Avaya, Pune.

Year	First Semester		U	Second Semester		U
I	SEAY ZC421	Computer Networks	3	SEAY ZC473	Multimedia Computing	3
	SEAY ZG512	Object Oriented Analysis & Design	4	SEAY ZG520	Wireless and Mobile Communication	5
	SEAY ZG516	Embedded System Design	4	SEAY ZG651	Software Architectures	5
	SEAY ZG622	Software Project Management	4	SEAY ZG552	Software Testing Methodologies	4
		Total	15		Total	14
II	SEAY ZG513	Network Security	4	SEAY ZG628T	Dissertation	16
	SEAY ZG518	Database Design and Applications	5			
	SEAY ZG525	Advanced Computer Networks	5			
	SEAY ZG582	Telecom Network Management	5			
		Total	19		Total	16

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

M.Tech. Transportation Engineering

Type of Input: Employed professionals in engineering industries and holding an Integrated First Degree of BITS in Civil Engineering or its equivalent, with minimum one year work experience in relevant domains.

Nominal Duration: Four Semesters

Programme Structure

Core Courses

Course No	Course Title	Units
TE* ZG535	Highway Geometric Design	4
TE* ZG518	Pavement Analysis and Design	4
TE* ZG534	Pavement Material Characterization	4
TE* ZG536	Traffic Engineering and Safety	4
TE* ZG523	Transportation Systems Planning and Management	4
TE* ZG524	Urban Mass Transit Planning, Operations and Management	4

Pool of Electives (any six)

Course No	Course Title	Units
TE* ZG511	Soil Mechanics for Highway Engineering	4
TE* ZG512	Soil Exploration and Field Techniques	4
TE* ZG513	Reinforced Soil Structures for Transportation Engineering	4
TE* ZG514	Advanced Concrete Technology in Transportation Engineering	4
TE* ZG515	GIS Applications in Transportation Engineering	4
TE* ZG516	CAD Laboratory in Transportation Engineering	4
TE* ZG517	Road Safety and Audit	4
TE* ZG519	Pavement Evaluation Field Project	4
TE* ZG521	Environmental Impact Assessment	4
TE* ZG520	Infrastructure Planning and Management	4
TE* ZG528	Selection of Construction Equipment and Modeling	4
TE* ZG537	Transportation Economics and Finance	4
TE* ZG539	Introduction to Discrete Choice Theory	4
TE* ZG543	Traffic Flow Theory	4
TE* ZG545	Airport Planning and Design	4
TE* ZG546	Highway Construction Practices	4
TE* ZG547	Pavement Failures, Evaluation and Rehabilitation	4
TE* ZG548	Pavement Management Systems	4
TE* ZG549	Rural Road Technology	4
TE* ZG616	Bridge Engineering	4
TE* ZG619	Finite Element Analysis	5
TE* ZG623	Ground Improvement Techniques	4

M.Tech. Transportation Engineering (PWD, Goa)

Type of Input: Employed professionals in engineering industries and holding an Integrated First Degree of BITS in Civil Engineering or its equivalent, with minimum one year work experience in relevant domains.
Normal Duration: Four Semesters
Special Feature: This programme is specially designed for the HRD needs of PWD, Goa.

Year	First Semester		U	Second Semester		U
I	TEPWG ZG534	Pavement Material Characterization	4	TEPWG ZG513	Reinforced Soil Structures for Transportation Engineering	4
	TEPWG ZG535	Highway Geometric Design	4			
	TEPWG ZG616	Bridge Engineering	4	TEPWG ZG518	Pavement Analysis and Design	4
	TEPWG ZG623	Ground Improvement Techniques	4	TEPWG ZG521	Environmental Impact Assessment	4
				TEPWG ZG536	Traffic Engineering and Safety	4
		Total	16		Total	16
II	TEPWG ZG519	Pavement Evaluation Field Project	4	TEPWG ZG628T	Dissertation	16
	TEPWG ZG523	Transportation Systems Planning and Management	4			
	TEPWG ZG524	Urban Mass Transit Planning, Operations and Management	4			
	TEPWG ZG546	Highway Construction Practices	4			
		Total	16		Total	16

M.Phil. Consciousness Studies

Type of Input: Integrated First Degree of BITS or its equivalent.
Normal Duration: Four Semesters
Special Feature: This programme is specially designed for being conducted for eligible candidates in collaboration with Bhaktivedanta Institute, Mumbai. Structured classes would be held in Mumbai regularly.

Year	First Semester		U	Second Semester		U
I	CONS ZG511	Philosophy and Consciousness	4	CONS ZG512	Philosophy and Consciousness – Advanced Topics	4
	CONS ZG656	Technical Writing	4	CONS ZG551	Artificial Intelligence and Consciousness	4
	CONS ZG573	Study in Advanced Topics I	5	CONS ZG574	Study in Advanced Topics II	5
		Elective	4	CONS ZG541	Biology and Consciousness	4
		Total	17		Total	17
II	CONS ZG542	Consciousness Studies – Advanced Topics	4	CONS ZG629T	Dissertation	20
	CONS ZG572	Matter and Consciousness in Bhagavata Sankhya	4			
	CONS ZG591	Selected Topics in Consciousness Studies	4			
		Elective	4			
		Total	16		Total	20

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

Pool of other Courses

Course No.	Course Title	U
CONS ZG531	Physics and Consciousness	4
CONS ZG532	Neuroscience and Consciousness	4
CONS ZG552	Foundations of Physics	4
CONS ZG561	Vedanta and Consciousness	4
CONS ZG562	Physics and Consciousness – Advanced Topics	4
CONS ZG571	Mind, Body, Medicine-Current Trends	4
CONS ZG581	Medicine and Consciousness – Advanced Topics	4
CONS ZG582	Psychology and Consciousness	4

* Any course from this pool may be used to substitute a course from the Semesterwise pattern, if the situation warrants.

M.Phil. Hospital & Health Systems Management

Type of Input: Employed professionals in the healthcare industry, having an M.B.B.S. degree or any Integrated First Degree of BITS or its equivalent, with at least one year post-qualification work experience and sponsored by their employers.

Normal Duration: Four Semesters

Special Feature: This programme is conducted in collaboration with Christian Medical College, Vellore and Bombay Hospital, Mumbai. Contact classes for four weeks are held at Vellore / Mumbai during the first semester, and at Pilani, during the second semester. The viva-voce for dissertation in the final semester would be held at BITS, Pilani.

Year	First Semester		U	Second Semester		U
I	HHSM ZG631	Introduction to Health Systems & Environmental Health	4	HHSM ZG514	Health Care Marketing & Strategic Management	4
	HHSM ZG665	Hospital Operations Management	3	HHSM ZG515	Quantitative Methods	3
	HHSM ZG513	Biostatistics & Epidemiology	4	HHSM ZG516	Epidemic & Disaster Management	4
	HHSM ZG531	Health Economics & Financial Management	4	HHSM ZG517	Health Care Management	4
		Total	15		Total	15
II	HHSM ZG518	Total Quality Management	4	HHSM ZG629T	Dissertation	20
	HHSM ZC471	Management Information Systems	3			
	HHSM ZC417	Managerial Communication	4			
	HHSM ZG519	Project Management	4			
		Total	15		Total	20

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

B. S. Engineering Design
Curriculum Structure

Generic curriculum requirements:

Foundation Courses	:	8-10 courses	(24 units min.)
Discipline Core	:	8 courses	(24 units min.)
Discipline Electives	:	4-6 courses	(12 units min.)
Coursework sub total	:	22 courses	(70 units min.)
Project Work	:	10 units (min.)	

Category	Course No.	Course Title	Units
Foundation Courses			
Mathematics Foundation	ED* ZC233	Calculus #	4
	ED* ZC235	Linear Algebra & Optimization #	3
	ED* ZC113	Probability and Statistics #	3
Technical Arts / Professional Courses	ED* ZC164	Computer Programming #	4
	ED* ZC241	Technical Report Writing #	3
	ED* ZC231	Principles of Management #	3
Engineering Foundation	ED* ZC232	Engineering Materials #	3
	ED* ZC211	Electrical and Electronics Technology #	3
	ED* ZC321	Mechanics of Solids #	3
	ED* ZC251	Engineering Measurements #	3
	ED* ZC261	Mechanical Technology	3
Discipline Courses			
Core	ED* ZC245	Fluid Mechanics and Machines	4
	ED* ZC341	Thermal Engineering I	3
	ED* ZC342	Thermal Engineering-II	3
	ED* ZC322	Kinematics & Dynamics of Machines	3
	ED* ZC332	Mechanical Engineering Design I	3
	ED* ZC431	Mechanical Engineering Design II	3
	ED* ZC453	Product Design & Development	4
	ED* ZC311	Manufacturing Processes	3
Electives	ED* ZC471	Management Information Systems	3
	ED* ZC324	Mechatronics & Automation	4
	ED* ZC421	Fluid Power Engineering	3
	ED* ZC441	Automotive Vehicles	3
	ED* ZC423	Polymer Science & Engineering	3
	ED* ZC452	Composite Materials and Design	3

*** The symbol * in the course numbers, can be substituted by letters representing the collaborating organization.**
 # Mandatory Foundation Course

B. S. Engineering Design (Eaton Technologies, Pune)

Type of Input: Sponsored employees of Eaton Technologies, Pune with Technical Diploma / B.Sc. or its equivalent for a six semesters programme.

Normal Duration: Six Semesters

Special Feature: This is a specially designed programme for the Human Resource Development needs of Eaton Technologies, Pune.

Year	First Semester		U	Second Semester		U
I	EDET ZC161	Engineering Mathematics I	3	EDET ZC162	Engineering Mathematics II	3
	EDET ZC211	Electrical & Electronics Technology	3	EDET ZC232	Engineering Materials	3
	EDET ZC231	Principles of Management	3	EDET ZC241	Technical Report Writing	3
	EDET ZC242	Fluid Mechanics and Machines	3	EDET ZC251	Engineering Measurements	3
		Total	12		Total	12
II	EDET ZC311	Manufacturing Process	3	EDET ZC322	Kinematics & Dynamics of Machines	3
	EDET ZC312	Computer Programming	3	EDET ZC331	Optimization	3
	EDET ZC321	Mechanics of Solids	3	EDET ZC332	Mechanical Engineering Design I	3
	EDET ZC341	Thermal Engineering I	3	EDET ZC342	Thermal Engineering II	3
		Total	12		Total	12
III	EDET ZC431	Mechanical Engineering Design II	3	EDET ZC423T	Project Work	20
	EDET ZC432	Quality Control Assurance and Reliability	3			
	EDET ZC451	Product Design & Development	3			
		Elective	3			
		Total	12		Total	20

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

Pool of Elective Courses		
EDET ZC421	Fluid Power Engineering	3
EDET ZC422	Polymer Science and Engineering	3
EDET ZC441	Automotive Vehicles	3

B. S. Engineering Technology

Type of Input: Employed persons in Engineering Industries holding a Technical Diploma / B.Sc. or its equivalent with adequate background in Mathematics and having minimum 2 years work experience. Employer consent with suitable mentor availability will be additional requirements.

Normal Duration: Six Semesters

Special Feature: This is a specially designed Work-Integrated Learning Programme for catering to the HRD requirements of a diverse spectrum of Engineering Industries.

Semesterwise pattern for students admitted in the First Semester of the Academic year

Year	First Semester		U	Second Semester		U
I	ENGG ZC232	Engineering Materials	3	AAOC ZC111	Probability & Statistics	3
	MATH ZC233	Calculus	3	TA ZC232	Engineering Measurements	3
	TA ZC164	Computer Programming	4	MATH ZC234	Linear Algebra & Optimization	3
	ENGG ZC111	Electrical & Electronics Technology	3	ENGG ZC241	Mechanical Technology	3
		Total	13		Total	12
II	ET ZC342	Materials Management	3	ET ZC432	Quality Control Assurance & Reliability	3
	ET ZC234	Manufacturing Processes	3	ET ZC344	Instrumentation & Control	4
	ET ZC412	Production Planning & Control	3	ET ZC423	Essentials of Project Management	3
	ET ZC413	Engineering Design	4	ENGG ZC242	Maintenance & Safety	3
		Total	13		Total	13
III		Elective	3	BITS ZC424T	Project Work	10
		Elective	3	MGTS ZC211	Principles of Management	3
		Elective	3	TA ZC312	Technical Report Writing	3
		Elective	3			
		Total	12		Total	16

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semesterwise pattern for students admitted in the Second Semester of the Academic year

Year	First Semester		U	Second Semester		U
I				ENGG ZC232	Engineering Materials	3
				MATH ZC233	Calculus	3
				TA ZC164	Computer Programming	4
				ENGG ZC111	Electrical & Electronics Technology	3
					Total	13
II	AAOC ZC111	Probability & Statistics	3	ET ZC342	Materials Management	3
	TA ZC232	Engineering Measurements	3	ET ZC234	Manufacturing Processes	3
	MATH ZC234	Linear Algebra & Optimization	3	ET ZC412	Production Planning & Control	3
	ENGG ZC241	Mechanical Technology	3	ET ZC413	Engineering Design	4
		Total	12		Total	13
III	ET ZC432	Quality Control Assurance & Reliability	3		Elective	3
	ET ZC344	Instrumentation & Control	4		Elective	3
	ET ZC423	Essentials of Project Management	3		Elective	3
	ENGG ZC242	Maintenance & Safety	3		Elective	3
		Total	12		Total	12
IV	BITS ZC424T	Project Work	10			
	MGTS ZC211	Principles of Management	3			
	TA ZC312	Technical Report Writing	3			
		Total	16			

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

Pool of Electives

S.No.	Course No.	Course Title	Units
1.	ET ZC352	Energy Management	3
2.	ET ZC362	Environmental Pollution Control	3
3.	EA ZC412	Flexible Manufacturing Systems	4
4.	BITS ZC471	Management Information Systems	3
5.	ET ZC415	Manufacturing Excellence	3
6.	ET ZC323	Mechatronics & Automation	3
7.	ES ZC343	Microprocessors & Microcontrollers	3
8.	ET ZC426	Plant Layout & Design	3

B. S. Information Systems

Type of Input: Employed professionals in Information Technology industries, holding (1) a Technical Diploma or its equivalent with adequate preparation in Mathematics, and minimum two years relevant work experience OR (2) a B.Sc. / BCA degree or its equivalent with adequate preparation in Mathematics, and minimum one year relevant work experience. Employer consent with suitable mentor availability will be additional requirements.

Normal Duration: Six Semesters

Special Feature: This is a specially designed Work-Integrated Learning Programme for catering to the HRD requirements of a diverse spectrum of IT Industries.

Semesterwise pattern for students admitted in the First Semester of the Academic Year

Year	First Semester		U	Second Semester		U
I	MATH ZC222	Discrete Structure for Computer Science	3	IS ZC313	Object Oriented Programming & Design	4
				IS ZC323	Systems Programming	3
	MATH ZC234	Linear Algebra & Optimization	3	IS ZC353	Computer Organization & Architecture	4
	TA ZC163	Computer Programming	4	IS ZC363	Data Structures & Algorithms	4
	ES ZC261	Digital Electronics & Microprocessors	3			
		Total	13		Total	15
II	AAOC ZC111	Probability & Statistics	3	IS ZC372	Complier Design	3
	IS ZC332	Database Systems & Applications	3	BITS ZC461	Software Engineering	3
	IS ZC362	Operating Systems	3	BITS ZC481	Computer Networks	3
		Elective	3		Elective	3
		Total	12		Total	12
III		Elective	3	BITS ZC424T	Project Work	10
		Elective	3	MGTS ZC211	Principles of Management	3
		Elective	3	TA ZC312	Technical Report Writing	3
		Elective	3			
		Total	12		Total	16

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

Semesterwise pattern for students admitted in the Second Semester of the Academic Session

Year	First Semester		U	Second Semester		U
I				MATH ZC222	Discrete Structure for Computer Science	3
				MATH ZC234	Linear Algebra & Optimization	3
				TA ZC163	Computer Programming	4
				ES ZC261	Digital Electronics & Microprocessors	3
					Total	13
II	IS ZC313	Object Oriented Programming & Design	4	AAOC ZC111	Probability & Statistics	3
	IS ZC323	Systems Programming	3	IS ZC332	Database Systems & Applications	3
	IS ZC353	Computer Organization & Architecture	4	IS ZC362	Operating Systems	3
	IS ZC363	Data Structures & Algorithms	4		Elective	3
		Total	15		Total	12
III	IS ZC372	Complier Design	3		Elective	3
	IS ZC341	Software Engineering	3		Elective	3
	IS ZC481	Computer Networks	3		Elective	3
		Elective	3		Elective	3
		Total	12		Total	12
IV	BITS ZC424T	Project Work	10			
	MGTS ZC211	Principles of Management	3			
	TA ZC312	Technical Report Writing	3			
		Total	16			

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

Pool of Electives

S.No.	Course No.	Course Title	Units
1.	BITS ZC471	Management Information Systems	3
2.	EA ZC473	Multimedia Computing	3
3.	IS ZC415	Data Mining	3
4.	IS ZC423	Software Development for Portable Devices	3
5.	IS ZC424	Software for Embedded Systems	3
6.	IS ZC446	Data Storage Technologies & Networks	3
7.	IS ZC462	Network Programming	3
8.	IS ZC472	Computer Graphics	3

B. S. Information Systems (Wipro Infotech, Bangalore)

Type of Input: Sponsored employees (with adequate work experience) with a Technical Diploma / B.Sc. or its equivalent with adequate background in Mathematics, for a six semester programme.

Normal Duration: Six Semesters

Special Feature: This is a specially designed Programme for the Human Resource Development needs of Wipro Infotech, Bangalore.

Year	First Semester		U	Second Semester	U
I	SEWI ZC132	Linear Algebra & Optimization	3	SEWI ZC222 Advanced Programming Techniques	3
	SEWI ZC142	Computer Programming	3	SEWI ZC332 Systems Programming	3
	SEWI ZC252	Discrete Structures for Computer Science	3	SEWI ZC413 Computer Organization & Architecture	3
	SEWI ZC261	Digital Electronics & Microprocessors	3	SEWI ZC415 Data Structures & Algorithms	3
		Total	12	Total	12
II	SEWI ZC213	Probability & Statistics	3	SEWI ZC416 Compiler Design	3
	SEWI ZC422	Operating Systems	3	SEWI ZC421 Computer Networks	3
	SEWI ZC322	Database Management Systems	3	SEWI ZC312 Technical Report Writing	3
	SEWI ZC461	Software Engineering	3	SEWI ZC472 Computer Graphics	3
		Total	12	Total	12
III	SEWI ZC446	Data Storage Technologies and Networks	3	SEWI ZC423 Project work	20
	SEWI ZG511		5		
	SEWI ZC471	Design and Analysis of Algorithms	3		
	SEWI ZC473	Management Information Systems	3		
		Multimedia Computing			
		Total	14	Total	20

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

B. S. Manufacturing Engineering
Curriculum Structure

Generic curriculum requirements:

Foundation Courses	:	8-10 courses	(24 units min.)
Discipline Core	:	8 courses	(24 units min.)
Discipline Electives	:	4-6 courses	(12 units min.)
Coursework sub total	:	22 courses	(70 units min.)
Project Work	:	10 units (min.)	

Category	Course No.	Course Title	Units
Foundation Courses			
Mathematics Foundation	ME* ZC233	Calculus #	4
	ME* ZC235	Linear Algebra & Optimization #	3
	ME* ZC113	Probability & Statistics	3
Technical Arts / Professional Courses	ME* ZC164	Computer Programming #	4
	ME* ZC241	Technical Report Writing #	3
	ME* ZC231	Principles of Management #	3
Engineering Foundation	ME* ZC236	Engineering Materials #	3
	ME* ZC251	Mechanical Technology #	3
	ME* ZC261	Mechanics of Solids #	3
	ME* ZC112	Electrical and Electronics Technology #	3
	ME* ZC213	Engineering Measurements #	3
Discipline Courses			
Core	ME* ZC323	Design of Machine Elements	4
	ME* ZC421	Essentials of Project Management	3
	ME* ZC324	Mechatronics & Automation	4
	ME* ZC234	Maintenance & Safety	3
	ME* ZC242	Manufacturing Processes	3
	ME* ZC343	Materials Management	3
	ME* ZC331	Production Planning & Control	3
	ME* ZC432	Quality Control, Assurance & Reliability	3
Electives	ME* ZC412	Flexible Manufacturing Systems	3
	ME* ZC418	Lean Manufacturing	3
	ME* ZC471	Management Information Systems	3
	ME* ZC271	Manufacturing Excellence	3
	ME* ZC311	Automobile Technology-I	3
	ME* ZC312	Automobile Technology-II	3
	ME* ZC332	Operations Research	3
	ME* ZC454	Foundry Engineering	3

*** The symbol * in the course numbers, can be substituted by letters representing the collaborating organization.**

 # Mandatory Foundation Course

BS Manufacturing Engineering (Bharat Forge, Pune)

Type of Input: Sponsored employees of Bharat Forge Ltd., Pune with Technical Diploma / B.Sc. or its equivalent.

Normal Duration Six Semesters

Special Feature: This is a specially designed programme for the Human Resource Development needs of Bharat Forge Ltd., Pune.

Year	First Semester	U	Second Semester	U
I	MEBF ZC211 Engineering Mathematics-I	3	MEBF ZC212 Engineering Mathematics-II	3
	MEBF ZC221 Computer Programming	3	MEBF ZC222 Engineering Materials	3
	MEBF ZC231 Principles of Management	3	MEBF ZC232 Engineering Measurements and Techniques	3
	MEBF ZC241 Technical Report Writing	3	MEBF ZC251 Mechanical Technology	3
	Total	12	Total	12
II	MEBF ZC242 Manufacturing Process	3	MEBF ZC312 Automobile Technology-II	3
	MEBF ZC311 Automobile Technology –I	3	MEBF ZC341 Mechatronics	3
	MEBF ZC321 Quality Assurance and Reliability	3	MEBF ZC261 Mechanics of Solids	3
	MEBF ZC331 Production Planning & Control	3	MEBF ZC271 Manufacturing Excellence	3
	Total	12	Total	12
III	MEBF ZC322 Materials Management	3	MEBF ZC423T Project Work	20
	MEBF ZC332 Operations Research	3		
	MEBF ZC342 Machine Design	3		
	MEBF ZC352 Maintenance Engineering and Safety	3		
	Total	12	Total	20

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

BS Manufacturing Engineering (TACO, Pune)

Type of Input: Sponsored employees of TACO, Pune with Technical Diploma / B.Sc. or its equivalent.

Normal Duration: Six Semesters

Special Feature: This is a specially designed programme for the Human Resource Development needs of TACO, Pune.

Year	First Semester	U	Second Semester	U
I	META ZC211 Engineering Mathematics-I	3	META ZC251 Mechanical Technology	3
	META ZC221 Computer Programming	3	META ZC212 Engineering Mathematics-II	3
	META ZC231 Principles of Management	3	META ZC222 Engineering Materials	3
	META ZC241 Technical Report Writing	3	META ZC232 Engineering Measurements and Techniques	3
	Total	12	Total	12
II	META ZC242 Manufacturing Process	3	META ZC331 Production Planning & Control	3
	META ZC252 Production and Operations Management	3	META ZC341 Mechatronics	3
	META ZC311 Automobile Technology –I	3	META ZC351 Industrial Engineering	3
	META ZC321 Quality Assurance and Reliability	3	META ZC312 Automobile Technology-II	3
	Total	12	Total	12
III	META ZC322 Materials Management	3	META ZC423T Project Work	20
	META ZC332 Operations Research	3		
	META ZC342 Machine Design	3		
	META ZC352 Maintenance Engineering and Safety	3		
	Total	12	Total	20

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

BS Manufacturing Engineering (Kirloskar Oil Engines, Pune)

Type of Input: Sponsored employees of Kirloskar Oil Engines, Pune with Technical Diploma / B.Sc. or its equivalent.

Normal Duration: Six Semesters

Special Feature: This is a specially designed programme for the Human Resource Development needs of Kirloskar Oil Engines, Pune.

Year	First Semester		U	Second Semester		U
I	MEKE ZC211	Engineering Mathematics-I	3	MEKE ZC251	Mechanical Technology	3
	MEKE ZC221	Computer Programming	3	MEKE ZC212	Engineering Mathematics-II	3
	MEKE ZC231	Principles of Management	3	MEKE ZC222	Engineering Materials	3
	MEKE ZC241	Technical Report Writing	3	MEKE ZC232	Engineering Measurements and Techniques	3
		Total	12		Total	12
II	MEKE ZC242	Manufacturing Process	3	MEKE ZC331	Production Planning & Control	3
	MEKE ZC252	Production and Operations Management	3	MEKE ZC341	Mechatronics	3
	MEKE ZC311	Automobile Technology –I	3	MEKE ZC351	Industrial Engineering	3
	MEKE ZC321	Quality Assurance and Reliability	3	MEKE ZC312	Automobile Technology-II	3
		Total	12		Total	12
III	MEKE ZC322	Materials Management	3	MEKE ZC423T	Project Work	20
	MEKE ZC332	Operations Research	3			
	MEKE ZC342	Machine Design	3			
	MEKE ZC352	Maintenance Engineering and Safety	3			
		Total	12		Total	20

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

B.S. Physician Assistant (MMM, Chennai)

Type of Input: 10+2 from Central / State Board or its equivalent with Physics, Chemistry & Mathematics / Biology along with adequate proficiency in English. Short-listed candidates will be required to take a Written Test and Interview at their own expense for getting admission.

Normal Duration: Eight Semesters

Special Feature: This is a specially designed four year integrated programme with classes and laboratory work conducted entirely at Madras Medical Mission (MMM), Chennai

Year	First Semester		U	Second Semester		U
I	PAT ZC121	Mathematics I	3	PAT ZC122	Mathematics II	3
	PAT ZC131	Introduction to Computers	3	PAT ZC132	Scientific Measurements	3
	PAT ZC141	Biological Chemistry	3	PAT ZC142	Nutrition & Dietetics	4
	PAT ZC151	General Anatomy	3	PAT ZC152	Clinical Biochemistry	5
	PAT ZC161	General Physiology	3	PAT ZC162	Pediatrics & Geriatrics	2
	PAT ZC171	Cell Biology	3			
		Total	18		Total	17
II	PAT ZC251	Principles of Management	3	PAT ZC212	Introduction to Surgery	2
	PAT ZC231	Microbiology	3	PAT ZC222	Introduction to Medicine	2
	PAT ZC262	Introduction to Psychology	3	PAT ZC282	Molecular Genetics	3
	PAT ZC261	Technical Report Writing	3	PAT ZC382	Data Processing	3
	PAT ZC411	Inservice Training - I	10	PAT ZC412	Inservice Training - II	10
		Total	22		Total	20
III	PAT ZC311	Cardiology & Cardiac Surgery.	4	PAT ZC332	Principles of Emergency Medicine	1
	PAT ZC381	Anesthesiology	1	PAT ZC342	Medical Instrumentation	2
	PAT ZC341	Cardiac Nursing	2	PAT ZC312	Advances in Cardiology	2
	PAT ZC423	Pharmacology & Toxicity	3	PAT ZC322	Advances in Cardiac Surgery	2
	PAT ZC431	Biostatistics	3	PAT ZC482	Management Information Systems	3
	PAT ZC421	Inservice Training - III	10	PAT ZC422	Inservice Training - IV	10
		Total	23		Total	20
IV	PAT ZC442	Internship - I	20	PAT ZC443	Internship - II	20
		Total	20		Total	20

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

B. S. Power Engineering
Curriculum Structure

Curriculum requirements:

Foundation Courses	:	8-10 courses	(24 units min.)
Discipline Core	:	8 courses	(24 units min.)
Discipline Electives	:	4-6 courses	(12 units min.)
Coursework sub-total	:	22 courses	(70 units min.)
Project Work	:	10 units (min.)	

Category	Course No.	Course Title	Units
Foundation Courses			
Mathematics Foundation	POW* ZC233	Calculus #	3
	POW* ZC234	Linear Algebra & Optimization #	3
	POW* ZC113	Probability & Statistics $	3
General Awareness / Technical Arts	POW* ZC164	Computer Programming #	4
	POW* ZC232	Principles of Management #	3
	POW* ZC321	Technical Report Writing #	3
Engineering Foundation	POW* ZC112	Electrical & Electronics Technology #	3
	POW* ZC343	Microprocessors & Microcontrollers #	3
	POW* ZC231	Thermodynamics #	3
	POW* ZC242	Engineering Measurements #	3
Discipline Courses			
Core	POW* ZC312	Quality Control, Assurance & Reliability	3
	POW* ZC313	Power Generation	4
	POW* ZC314	Prime Movers & Fluid Machines	4
	POW* ZC342	Power System Engineering I	3
	POW* ZC344	Instrumentation & Control	4
	POW* ZC421	Essentials of Project Management	3
	POW* ZC431	Maintenance & Safety	3
	POW* ZC441	Power System Engineering II	3
Electives	POW* ZC332	Energy Management	3
	POW* ZC411	Environmental Pollution Control	3
	POW* ZC412	Power System Operation and Control	3
	POW* ZC413	Process Control	3
	POW* ZC422	Power System Drawing & Design	3
	POW* ZC452	Renewable Energy	3
	POW* ZC461	Power Plant Engineering	3
	POW* ZC471	Power Electronics & Drives	3
	POW* ZC481	Plant Layout & Design	3

Mandatory Foundation Course
$ May be included depending on the HRD needs of the collaborating organization.
* The symbol * in the course numbers, can be substituted by letters representing the collaborating organization.

B.S. Power Engineering (Programme Chart as per curriculum)

Type of Input: Sponsored employees with Technical Diploma/ B.Sc. or its equivalent.

Normal Duration: Six Semesters

Year	First Semester		U	Second Semester		U
I	POW* ZC112	Electrical & Electronics Technology	3	POW* ZC234	Linear Algebra & Optimization	3
	POW* ZC164	Computer Programming	4	POW* ZC242	Engineering Measurements	3
	POW* ZC231	Thermodynamics	3	POW* ZC313	Power Generation	4
	POW* ZC233	Calculus	3	POW* ZC343	Microprocessors & Microcontrollers	3
		Total	13		Total	13
II	POW* ZC314	Prime Movers & Fluid Machines	4	POW* ZC312	Quality Control, Assurance & Reliability	3
	POW* ZC342	Power System Engineering I	3	POW* ZC421	Essentials of Project Management	3
	POW* ZC344	Instrumentation & Control	4	POW* ZC441	Power System Engineering II	3
	POW* ZC431	Maintenance & Safety	3		Elective	
		Total	12		Total	
III		Elective		POW* ZC232	Principles of Management	3
		Elective		POW* ZC321	Technical Report Writing	3
		Elective		POW* ZC423T	Project Work	10
		Elective				
		Total			Total	16

Note 1: This is currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

Note 2: In the above chart**,** the symbol * in the course numbers, can be substituted by letters representing the collaborating organization.

List of Elective Courses

Course No.	Course Title	Units
POW* ZC332	Energy Management	3
POW* ZC411	Environmental Pollution Control	3
POW* ZC412	Power System Operation and Control	3
POW* ZC413	Process Control	3
POW* ZC422	Power System Drawing & Design	3
POW* ZC452	Renewable Energy	3
POW* ZC461	Power Plant Engineering	3
POW* ZC471	Power Electronics & Drives	3
POW* ZC481	Plant Layout & Design	3

B.S. Power Engineering (Aditya Birla Group, Tata Power, JSW Energy - Mumbai; Essar Power, Hazira)

Type of Input: Sponsored employees with Technical Diploma/ B.Sc. or its equivalent.

Normal Duration: Six Semesters

Special Feature: This is a specially designed programme for Human Resource Development needs of Aditya Birla Group, Tata Power, JSW Energy - Mumbai; Essar Power, Hazira.

Year	First Semester		U	Second Semester		U
I	POW** ZC211	Computer Programming	3	POW** ZC212	Engineering Mathematics II	3
	POW** ZC221	Engineering Mathematics I	3	POW** ZC222	Electronics & Microprocessor	3
	POW** ZC231	Thermodynamics	3	POW** ZC232	Principles of Management	3
	POW** ZC251	Electrical Technology	3	POW** ZC242	Engineering Measurements	3
		Total	12		Total	12
II	POW** ZC311	Prime Movers & Fluid Machines	3	POW** ZC312	Quality Control, Assurance and Reliability	3
	POW** ZC321	Technical Report Writing	3			
	POW** ZC322	Power Generation	3	POW** ZC332	Energy Management	3
	POW** ZC331	Instrumentation & Control	3	POW** ZC342	Power Systems Engineering I	3
				POW** ZC481	Plant Layout & Design	3
		Total	12		Total	12
III	POW** ZC411	Environmental Pollution Control	3	POW** ZC423T	Project Work	20
	POW** ZC421	Essentials of Project Management	3			
	POW** ZC431	Maintenance & Safety	3			
	POW** ZC441	Power Systems Engineering II	3			
		Total	12		Total	20

Note 1: This is currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

Note 2: In the above chart**,** the symbol ** in the course numbers, can be substituted by letters representing the collaborating organization. For example, we can have AB for Aditya Birla Group, TP for Tata Power, ES for Essar Power, and JS for JSW Energy.

Pool of other Courses*		
Course No.	**Course Title**	**U**
POW** ZC412	Power System Operation and Control	3
POW** ZC422	Power System Drawing and Design	3
POW** ZC451	Alternative Energy Sources	3
POW** ZC461	Power Plant Engineering	3
POW** ZC471	Power Electronics & Drives	3

* Any course from this pool may be used to substitute a course from the Semesterwise pattern, if the situation warrants.

B. S. Process Engineering
Curriculum Structure

Generic curriculum requirements:

Foundation Courses	:	8-10 courses	(24 units min.)
Discipline Core	:	8 courses	(24 units min.)
Discipline Electives	:	4-6 courses	(12 units min.)
Coursework sub total	:	22 courses	(70 units min.)
Project Work	:	10 units (min.)	

Category	Course No.	Course Title	Units
Foundation Courses			
Mathematics Foundation	PE* ZC233	Calculus #	4
	PE* ZC235	Linear Algebra & Optimization #	3
	PE* ZC113	Probability and Statistics	3
Technical Arts / Professional Courses	PE* ZC164	Computer Programming #	4
	PE* ZC211	Principles of Management #	3
	PE* ZC313	Technical Report Writing #	3
Engineering Foundation	PE* ZC231	Engineering Materials #	3
	PE* ZC213	Engineering Measurements #	3
	PE* ZC241	Mechanical Technology	3
	PE* ZC112	Electrical & Electronics Technology #	3
Discipline Courses			
Core	PE* ZC331	Quality Control Assurance & Reliability $	3
	PE* ZC321	Chemical Process Calculations	3
	PE* ZC316	Transport Phenomena I	4
	PE* ZC311	Chemical Engineering Thermodynamics	3
	PE* ZC317	Transport Phenomena II	4
	PE* ZC352	Energy Management	3
	PE* ZC452	Process Plant Safety and Environment	4
	PE* ZC453	Process Control & Instrumentation	4
Electives	PE* ZC322	Kinetics & Reactor Design	3
	PE* ZC412	Process Equipment Design	3
	PE* ZC314	Power Plant Engineering	3
	PE* ZC234	Manufacturing Processes	3
	PE* ZC411	Production Planning and Control	3
	PE* ZC315	Materials Management	3
	PE* ZC353	Industrial Engineering	3
	PE* ZC423	Essentials of Project Management	3
	PE* ZC361	Environmental Pollution Control	3
	PE* ZC383	Extractive Metallurgy	3
	PE* ZC385	Fertilizer Technology	3
	PE* ZC382	Cement Technology	3
	PE* ZC384	Fibre & Cellulosic Technology	3
	PE* ZC214	Pharmaceutical Analysis	3
	PE* ZC221	Disinfection & Sterilization Processes	3

Mandatory Foundation Course
$ Will be replaced by PE* ZC342 Pharmaceutical Quality Control & Regulatory Affairs 3 Units for Pharmaceutical Industries

B.S. Process Engineering (Birla Copper, Dahej and Indogulf Fertilizers, Jagdishpur)

Type of Input: Sponsored employees with Technical Diploma / B.Sc. or its equivalent

Normal Duration: Six Semesters

Special Feature: This is a specially designed programme for the Human Resource Development needs of Birla Copper, Dahej and Indogulf Fertilizers, Jagdishpur.

Year	First Semester		U	Second Semester		U
I	PEHC ZC121	Electrical & Electronics Engineering	3	PEHC ZC111	Computer Programming	3
	PEHC ZC131	Engineering Mathematics- I	3	PEHC ZC212	Engineering Mathematics – II	3
	PEHC ZC221	Principles of Management	3	PEHC ZC222	Fluid Mechanics	3
	PEHC ZC313	Technical Report Writing	3	PEHC ZC232	Engineering Materials	3
		Total	12		Total	12
II	PEHC ZC311	Chemical Engineering Thermodynamics	3	PEHC ZC322	Kinetics & Reactor Design	3
	PEHC ZC321	Chemical Process Calculations	3	PEHC ZC352	Energy Management	3
	PEHC ZC341	Heat Transfer	3	PEHC ZC412	Process Equipment Design	3
	PEHC ZC351	Mass Transfer	3	PEHC ZC441	Process Control & Instrumentation	3
		Total	12		Total	12
III	PEHC ZC314	Power Plant Engineering	3	PEHC ZC423T	Project Work	20
	PEHC ZC331	Quality Control Assurance & Reliability	3			
	PEHC ZC413	Process Plant Safety and Environment	3			
		Elective	3			
		Total	12		Total	20

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

Pool of Elective Courses		
PEHC ZC382	Fertilizer Technology	3
PEHC ZC383	Extractive Metallurgy	3

B.S. Process Engineering (Aditya Birla Group – Cement Business)

Type of Input: Sponsored employees of Aditya Birla Group with Technical Diploma / B.Sc. or its equivalent

Normal Duration: Six Semesters

Special Feature: This is a specially designed programme for the Human Resource Development needs of Aditya Birla Group.

Year	First Semester		U	Second Semester		U
I	PEAB ZC121	Electrical & Electronics Engineering	3	PEAB ZC111	Computer Programming	3
	PEAB ZC131	Engineering Mathematics- I	3	PEAB ZC212	Engineering Mathematics – II	3
	PEAB ZC221	Principles of Management	3	PEAB ZC222	Fluid Mechanics	3
	PEAB ZC313	Technical Report Writing	3	PEAB ZC232	Engineering Materials	3
		Total	12		Total	12
II	PEAB ZC311	Chemical Engineering Thermodynamics	3	PEAB ZC322	Kinetics & Reactor Design	3
	PEAB ZC321	Chemical Process Calculations	3	PEAB ZC352	Energy Management	3
	PEAB ZC341	Heat Transfer	3	PEAB ZC412	Process Equipment Design	3
	PEAB ZC351	Mass Transfer	3	PEAB ZC441	Process Control & Instrumentation	3
		Total	12		Total	12
III	PEAB ZC314	Power Plant Engineering	3	PEAB ZC423T	Project Work	20
	PEAB ZC331	Quality Control Assurance & Reliability	3			
	PEAB ZC382	Cement Technology	3			
	PEAB ZC413	Process Plant Safety and Environment	3			
		Total	12		Total	20

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

B.S. Process Engineering (Dr. Reddy's Laboratories, Hyderabad)

Type of Input: Sponsored employees of Dr. Reddy's Laboratories, Hyderabad with Technical Diploma / B.Sc. or its equivalent

Normal Duration: Six Semesters

Special Feature: This is a specially designed programme for Human Resource Development needs of Dr. Reddy's Laboratories, Hyderabad.

Year	First Semester	U	Second Semester	U
I	PERL ZC233 Calculus	4	PERL ZC235 Linear Algebra & Optimization	3
	PERL ZC231 Engineering Materials	3	PERL ZC164 Computer Programming	4
	PERL ZC112 Electrical and Electronics Technology	3	PERL ZC221 Disinfection & Sterilization Processes	3
	PERL ZC213 Engineering Measurements	3	PERL ZC321 Chemical Process Calculations	3
	Total	13	Total	13
II	PERL ZC316 Transport Phenomena I	4	PERL ZC317 Transport Phenomena II	4
	PERL ZC214 Pharmaceutical Analysis	3	PERL ZC342 Pharmaceutical Quality Control & Regulatory Affairs	3
	PERL ZC113 Probability & Statistics	3	PERL ZC412 Process Equipment Design	3
	PERL ZC311 Chemical Engineering Thermodynamics	3	PERL ZC411 Production Planning and Control	3
	Total	13	Total	13
III	PERL ZC453 Process Control & Instrumentation	4	PERL ZC423T Project Work	10
	PERL ZC361 Environmental Pollution Control	3	PERL ZC313 Technical Report Writing	3
	PERL ZC352 Energy Management	3	PERL ZC211 Principles of Management	3
	PERL ZC452 Process Plant Safety & Environment	4		
	Total	14	Total	16

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

B.S. Process Engineering (JSW Steel, Toranagallu)

Type of Input: Sponsored employees of JSW Steel Ltd. with Technical Diploma / B.Sc. or its equivalent

Normal Duration: Six Semesters

Special Feature: This is a specially designed programme for Human Resource Development needs of JSW Steel Ltd, Toranagallu.

Year	First Semester	U	Second Semester	U
I	PEJS ZC233 Calculus	4	PEJS ZC235 Linear Algebra & Optimization	3
	PEJS ZC313 Technical Report Writing	3	PEJS ZC164 Computer Programming	4
	PEJS ZC112 Electrical and Electronics Technology	3	PEJS ZC231 Engineering Materials	3
	PEJS ZC213 Engineering Measurements	3	PEJS ZC252 Mineral Beneficiations and Agglomeration	3
	Total	13	Total	13
II	PEJS ZC316 Transport Phenomena I	4	PEJS ZC317 Transport Phenomena II	4
	PEJS ZC311 Chemical Engineering Thermodynamics	3	PEJS ZC312 Steel Making & Casting	3
	PEJS ZC262 Iron Making	3	PEJS ZC272 Furnace Technology	3
	PEJS ZC321 Chemical Process Calculations	3	PEJS ZC442 Advances in Materials Science	3
	Total	13	Total	13
III	PEJS ZC331 Quality Control, Assurance & Reliability	3	PEJS ZC423T Project Work	10
	PEJS ZC452 Process Plant Safety and Environment	4	PEJS ZC211 Principles of Management	3
	PEJS ZC352 Energy Management	3	PEJS ZC453 Process Control & Instrumentation	4
	PEJS ZC362 Steel Processing	3		
	Total	13	Total	17

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

B.S. Process Engineering (Vedanta, Jharsuguda)

Type of Input: Sponsored employees with Technical Diploma / B.Sc. or its equivalent.

Normal Duration: Six Semesters.

Special Feature: This programme is designed for the HRD needs of Sesa Sterlite.

Year	First Semester		U	Second Semester		U
I	PEVA ZC233	Calculus	4	PEVA ZC235	Linear Algebra & Optimization	3
	PEVA ZC231	Engineering Materials	3	PEVA ZC164	Computer Programming	4
	PEVA ZC112	Electrical and Electronics Technology	3	PEVA ZC234	Manufacturing Processes	3
	PEVA ZC213	Engineering Measurements	3	PEVA ZC311	Chemical Engineering Thermodynamics	3
		Total	13		Total	13
II	PEVA ZC316	Transport Phenomena I	4	PEVA ZC317	Transport Phenomena II	4
	PEVA ZC314	Power Plant Engineering	3	PEVA ZC331	Quality Control Assurance & Reliability	3
	PEVA ZC353	Industrial Engineering	3	PEVA ZC412	Process Equipment Design	3
	PEVA ZC321	Chemical Process Calculations	3	PEVA ZC411	Production Planning and Control	3
		Total	13		Total	13
III	PEVA ZC453	Process Control & Instrumentation	4			
	PEVA ZC452	Process Plant Safety and Environment	4	PEVA ZC423T	Project Work	10
	PEVA ZC352	Energy Management	3	PEVA ZC313	Technical Report Writing	3
	PEVA ZC383	Extractive Metallurgy	3	PEVA ZC211	Principles of Management	3
		Total	14		Total	16

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

B.Tech. Marine Engineering (TMI, Induri / RLINS, Madurai)

Type of Input: 10+2 from Central / State Board or its equivalent with Physics, Chemistry and Mathematics along with adequate proficiency in English. Short-listed candidates will be required to take an entrance examination and interview at their own expense at Induri / Madurai for getting admission

Normal Duration: Eight Semesters

Special Feature: This is specially designed 4-year integrated programme with classes and laboratory work conducted entirely at Tolani Maritime Institute (TMI), Induri, Pune and at R.L. Institute of Nautical Sciences (RLINS), Madurai .

Year	First Semester		U	Second Semester		U
I	ME** ZC111	English Language Skills	2	ME** ZC112	Thermodynamics	3
	ME** ZC121	Engineering Mathematics I	3	ME** ZC122	Engineering Mathematics II	3
	ME** ZC131	Applied Mechanics I	3	ME** ZC132	Applied Mechanics II	3
	ME** ZC141	Geometrical Drawing	2	ME** ZC142	Engineering Drawing	2
	ME** ZC151	Workshop Technology	4	ME** ZC152	Workshop Practice I	2
	ME** ZC161	Applied Electricity	4	ME** ZC162	Electrical Measurements	2
	ME** ZC171	Maritime Geography	2	ME** ZC172	Strength of Materials	3
	ME** ZC183/192	Computer Programming / Social Studies	3/2	ME** ZC183 /192	Computer Programming / Social Studies	3/2
		Total	23/2 2		Total	21/ 20
II	ME** ZC213	Electronics I	2	ME** ZC211	Probability & Statistics	3
	ME** ZC242	Seamanship & Survival at Sea	2	ME** ZC214	Electronics II	2
	ME** ZC233	Marine Machinery Drawing	3	ME** ZC222	Marine Boilers & Steam Engineering	3
	ME** ZC263	Fluid Mechanics	3	ME** ZC224	Internal Combustion Engines	3
	ME** ZC271	Applied Thermodynamics	3	ME** ZC231	Fuels & Lubricants	2
	ME** ZC281	Workshop Practice II	2	ME** ZC223	Engineering Materials	3
	ME** ZC282	Electrical Machines	3	ME** ZC272	Mechanics of Materials	3
	ME** ZC291	Ship Structure & Construction	3	ME** ZC361	Alternators & Motors	2
				ME** ZC372	Ship Fire Prevention & Control	3
		Total	21		Total	24
III	ME** ZC311	Marine Auxiliary Machines I	2	ME** ZC312	Marine Auxiliary Machines II	2
	ME** ZC313	Naval Architecture	3	ME** ZC314	Advanced Naval Architecture	3
	ME** ZC323	Marine Electro Technology	2	ME** ZC324	Advanced Marine Electro Technology	2
	ME** ZC333	Machine Design	3	ME** ZC334	Marine Machinery Design	3
	ME** ZC371	Mechanics of Machines	3	ME** ZC382	Refrigeration & Air-conditioning	3
	ME** ZC381	Pumps of Pumping Systems	2	ME** ZC352	Technical Report Writing	3
	ME** ZC342	Marine Environment Protection	2	ME** ZC362	Dynamics of Vibrations	2
	ME** ZC391	Marine Internal Combustion Engines	3	ME** ZC431	Marine Control Engineering	4
		Total	20		Total	22
IV	ME** ZC351	Principles of Management	3	ME** ZC412	Internship	20
	ME** ZC421	Ship Operation & Management	3			
	ME** ZC441	International Conventions & IMO	3			
	ME** ZC471	Operations Research	3			
	ME** ZC481	Marine Cost Engineering	2			
	ME** ZC491	Power Plant Operation & Watchkeeping Elective	3			
		Total	-		Total	20

Note 1: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

Note 2: For the course numbers in the above chart, the symbol ****** can be substituted by **TI** for TMI and **RI** for RLINS.

Pool of other Courses*		
Course No.	**Course Title**	**U**
ME** ZC413	Oceanography	3
ME** ZC423	Emergency Management & Damage Control	3
ME** ZC433	Quality Management	3
ME** ZC443	CAD/CAM	3
ME** ZC453	Project	3
ME** ZC463	Maritime Law	3
ME** ZC473	Switchgear & Protection	3
ME** ZC483	Dredgers & Dredging	3
ME** ZC492	Organizational Behaviour	3

* Any course from this pool may be used to substitute a course from the Semesterwise pattern, if the situation warrants.

B.Tech. Nautical Technology

Type of Input: 10+2 from Central / State Board or its equivalent with Physics, Chemistry and Mathematics along with adequate proficiency in English. Short-listed candidates will be required to take a Written Test and Interview at their own expense at Induri / Madurai for getting admission.

Normal Duration: Eight Semesters

Special Feature: This is specially designed 4-year integrated programme with classes and laboratory work conducted entirely at Tolani Maritime Institute (TMI), Induri, Pune , and at R.L. Institute of Nautical Sciences (RLINS), Madurai

Year	First Semester		U	Second Semester		U
I	NT** ZC111	English Language Skills	2	NT** ZC112	Workshop Practical	2
	NT** ZC121	Engineering Mathematics –I	3	NT** ZC122	Engineering Mathematics – II	3
	NT** ZC131	Applied Mechanics –I	3	NT** ZC132	Applied Mechanics-II	3
	NT** ZC141	Geometrical Drawing	2	NT** ZC242	Seamanship & Survival at sea	2
	NT** ZC151	Workshop Technology	4	NT** ZC152	Nautical Physics	2
	NT** ZC161	Applied Electricity	4	NT** ZC162	General Cargo Handling & Stowage	3
	NT** ZC171	Maritime Geography	2	NT** ZC172	Strength of Materials	3
	NT** ZC183/192	Computer Programming / Social Studies	3/2	NT** ZC183/192	Computer Programming / Social Studies	3/2
		Total	23/22		Total	21/20
II	NT** ZC213	Electronics – I	2	NT** ZC211	Probability & Statistics	3
	NT** ZC221	Chart Work – I	3	NT** ZC212	Celestial Navigation – I	3
	NT** ZC241	Marine Signalling	3	NT** ZC214	Electronics –II	2
	NT** ZC231	Collision Prevention	2	NT** ZC222	Chart Work – II	3
	NT** ZC252	Meteorology – I	3	NT** ZC232	Bridge Equipment & Watchkeeping – I	3
	NT** ZC251	Principles of Navigation	3	NT** ZC223	Engineering Materials	3
	NT** ZC261	Hydraulics	3	NT** ZC243	Hazardous Cargo Handling & Stowage - I	3
	NT** ZC291	Ship Structure & Construction	3	NT** ZC372	Ship Fire Prevention & Control	3
		Total	22		Total	23
III	NT** ZC311	Celestial Navigation – II	3	NT** ZC312	Chart Work – III	3
	NT** ZC314	Ship Stability	3	NT** ZC322	Marine Machinery systems	3
	NT** ZC321	Meteorology - II	3	NT** ZC352	Technical Report Writing	3
	NT** ZC331	Ship Routine & Maintenance	2	NT** ZC351	Principles of Management	3
	NTTIZC341	Bridge Equipment & Watchkeeping - II	3	NT** ZC421	Ship Operation & Management	3
	NT** ZC332	Hazardous Cargo Handling & Stowage II	3	NT** ZC441	International Conventions & IMO	3
	NT** ZC342	Marine Environment Protection	2	NT** ZC362	Ship Manoeuvring & Emergencies	3
	NT** ZC471	Operations Research	3	NT** ZC373	Advanced Ship Construction & Stability	3
		Total	22		Total	24
IV	NT** ZC442	Internship - I	20	NT** ZC443	Internship - II	20
		Total	20		Total	20

Note 1: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

Note 2: For the course numbers in the above chart, the symbol ****** can be substituted by **TI** for TMI and **RI** for RLINS.

Pool of Electives for B.Tech. Nautical Technology

SNo	Course No.	Course Title	Units
1.	NT** ZC411	Supply Chain Management	3
2.	NT** ZC412	Shipping Finance & Insurance	3
3.	NT** ZC413	Ship Agency Management	3
4.	NT** ZC414	Ports & Terminals Management	3
5.	NT** ZC415	Maritime Economics	3
6.	NT** ZC416	Logistics & Multimodal Transport	3
7.	NT** ZC417	Liner Shipping Business	3
8.	NT** ZC418	Legal Aspects of Maritime Business	3

Note: In the course numbers above, the symbol ****** can be substituted by **TI** for TMI and **RI** for RLINS.

B.Optom. (Sankara Nethralaya, Chennai)

Type of Input: 10+2 from Central / State Board or its equivalent with Physics, Chemistry & Mathematics / Biology along with adequate proficiency in English. Short-listed candidates will be required to take a Written Test and Interview at their own expense for getting admission.

Normal Duration: Eight Semesters

Special Feature: This is a specially designed four-year integrated programme with classes and laboratory work conducted entirely at Elite School of Optometry, Sankara Nethralaya, Chennai.

Year	First Semester		U	Second Semester		U
I	OPTO ZC111	Functional English & Communication	3	OPTO ZC131	Physical Optics	4
	OPTO ZC211	Computer Programming	3	OPTO ZC142	Ocular Anatomy	2
	OPTO ZC141	Basic Biochemistry I	3	OPTO ZC152	Ocular Physiology	3
	OPTO ZC151	General Anatomy	2	OPTO ZC162	Basic Biochemistry II	3
	OPTO ZC161	General Physiology	5	OPTO ZC121	Mathematics I	2
	OPTO ZC112	Basic Accountancy	2	OPTO ZC182	Principles of Lighting	1
	OPTO ZC172	Nutrition	1	OPTO ZC122	Public Relations	1
	OPTO ZC133	Hospital Procedures	1	OPTO ZC171	Geometric Optics I	4
		Total	20		Total	20
II	OPTO ZC192	Mathematics II	2	OPTO ZC132	Pharmacology	2
	OPTO ZC221	Optometric Optics I	3	OPTO ZC212	Medical Psychology	1
	OPTO ZC231	Optometric Instruments	3	OPTO ZC222	Pathology & Microbiology	3
	OPTO ZC241	Clinical Exam of Visual System	2	OPTO ZC232	Optometric Optics II	3
	OPTO ZC251	Ocular Diseases I	3	OPTO ZC242	Ocular Diseases II	3
	OPTO ZC261	Visual Optics I	2	OPTO ZC252	Visual Optics II	3
	OPTO ZC123	Geometric Optics II	3	OPTO ZC272	Clinics II	5
	OPTO ZC281	Clinics I	4	OPTO ZC292	Monocular Sensory Perception	2
		Total	22		Total	22
III	OPTO ZC282	Dispensing Optics	3	OPTO ZC312	Binocular Vision II	1
	OPTO ZC311	Binocular Vision I	1	OPTO ZC322	Law & Optometry	1
	OPTO ZC323	Contact Lens I	1	OPTO ZC324	Contact Lens II	1
	OPTO ZC331	Systemic Disease	1	OPTO ZC332	Public Health & Community Optometry	1
	OPTO ZC341	Glaucoma	1	OPTO ZC342	Pediatric Optometry	1
	OPTO ZC371	Clinics & Special Clinics I	8	OPTO ZC352	Occupational Optometry	2
	OPTO ZC381	Low Vision Aids	1	OPTO ZC372	Clinics & Special Clinics II	8
	OPTO ZC421	Epidemiology	3	OPTO ZC382	Geriatric Optometry	1
	OPTO ZC431	Biostatistics	3	OPTO ZC422	Project	5
		Total	22		Total	21
IV	OPTO ZC411	Internship I	20	OPTO ZC412	Internship II	20
		Total	20		Total	20

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants. Students with marginal deficiency in Mathematics or Biology would be additionally required to register in OPTO ZC181 Remedial Mathematics (2 units) or OPTO ZC191 Remedial Biology (2 units) in the first year first semester.

B.Optom. (LVPEI, Hyderabad)

Type of Input: 10+2 from Central / State Board or its equivalent with Physics, Chemistry & Mathematics / Biology along with adequate proficiency in English. Short-listed candidates will be required to take a Written Test and Interview at their own expense for getting admission.

Normal Duration: Eight Semesters

Special Feature: This is a specially designed four year integrated programme with classes and laboratory work conducted entirely at Bausch & Lomb School of Optometry, L.V. Prasad Eye Institute (LVPEI), Hyderabad.

Semesterwise Pattern

Year	First Semester			Second Semester		
	Course No	**Course Title**	**U**	**Course No**	**Course Title**	**U**
I	OPLVP ZC161	Functional English & Communication	3	OPLVP ZC141	Physical Optics	4
	OPLVP ZC272	Computer Programming	3	OPLVP ZC121	Ocular Anatomy	2
	OPLVP ZC151	Basic Biochemistry I	3	OPLVP ZC131	Ocular Physiology	3
	OPLVP ZC112	General Anatomy	2	OPLVP ZC142	Basic Biochemistry II	3
	OPLVP ZC122	General Physiology	5	OPLVP ZC171	Mathematics I	2
	OPLVP ZC111	Introductory Optometry	2	OPLVP ZC332	Principles of Lighting	1
	OPLVP ZC371	Basic Accountancy	2	OPLVP ZC381	Public Relations	1
	OPLVP ZC232	Nutrition	1	OPLVP ZC181	Geometric Optics I	4
	OPLVP ZC182	Hospital Procedures	1			
		Total	22		Total	20
II	OPLVP ZC171	Mathematics II	2	OPLVP ZC132	Pharmacology	2
	OPLVP ZC221	Optometric Optics I	3	OPLVP ZC342	Medical Psychology	1
	OPLVP ZC231	Optometric Instruments	3	OPLVP ZC152	Pathology & Microbiology	3
	OPLVP ZC241	Clinical Exam of Visual System	2	OPLVP ZC222	Optometric Optics II	3
	OPLVP ZC271	Ocular Diseases I	3	OPLVP ZC242	Ocular Diseases II	3
	OPLVP ZC192	Visual Optics I	2	OPLVP ZC261	Visual Optics II	3
	OPLVP ZC172	Geometric Optics II	3	OPLVP ZC282	Clinics II	5
	OPLVP ZC251	Clinics I	4			
		Total	22		Total	20
III	OPLVP ZC212	Dispensing Optics	3	OPLVP ZC361	Binocular vision II	1
	OPLVP ZC262	Binocular Vision I	1	OPLVP ZC362	Law and Optometry	1
	OPLVP ZC252	Contact Lens I	1	OPLVP ZC351	Contact Lens II	1
	OPLVP ZC321	Systemic Disease	1	OPLVP ZC281	Public Health & Community Optometry	1
	OPLVP ZC341	Clinics & Special Clinics I	8	OPLVP ZC322	Pediatric Optometry	1
	OPLVP ZC211	Low Vision Aids	1	OPLVP ZC352	Occupational Optometry	2
	OPLVP ZC331	Epidemiology	3	OPLVP ZC372	Clinics & Special Clinics II	8
	OPLVP ZC311	Biostatistics	3	OPLVP ZC312	Geriatric Optometry	1
	OPLVP ZC333	Glaucoma	1	OPLVP ZC382	Project	5
		Total	22		Total	21
IV	OPLVP ZC411	Internship I	20	OPLVP ZC412	Internship II	20
		Total	20		Total	20

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants. Student with marginal deficiency in Mathematics or Biology would be additionally required to register in OPLVP ZC113 Remedial Mathematics (2 units) or OPLVP ZC114 Remedial Biology (2 units) in the first year first semester.

B.Optom. (The Tun Hussein Onn National Eye Hospital, Malaysia)

Type of Input: 10+2 from Central / State Board or its equivalent with Physics, Chemistry & Mathematics / Biology along with adequate proficiency in English.

Normal Duration: Eight Semesters

Special feature: This is a specially designed four-year integrated programme with classes and laboratory work conducted entirely at National Institute of Ophthalmic Studies, The Tun Hussein Onn National Eye Hospital, Malaysia.

Semesterwise Pattern

Year	First Semester	U	Second Semester	U
I	OPTOM ZC111 Functional English and Communicatio	3	OPTOM ZC112 Basic Accountancy	2
	OPTOM ZC121 Mathematics I	2	OPTOM ZC142 Ocular Anatomy	4
	OPTOM ZC131 Physical Optics	4	OPTOM ZC152 Ocular Physiology	3
	OPTOM ZC141 Basic Biochemistry I	3	OPTOM ZC162 Basic Biochemistry II	3
	OPTOM ZC151 General Anatomy	3	OPTOM ZC171 Geometric Optics I	3
	OPTOM ZC161 General Physiology	4	OPTOM ZC172 Nutrition	1
			OPTOM ZC182 Principles of Lighting	1
			OPTOM ZC192 Mathematics II	2
			OPTOM ZC211 Computer Programming	2
	Total	19	Total	21
II	OPTOM ZC122 Public Relations	1	OPTOM ZC132 Pharmacology	2
	OPTOM ZC123 Geometric Optics II	3	OPTOM ZC212 Medical Psychology	1
	OPTOM ZC221 Optometric Optics I	3	OPTOM ZC222 Pathology/Microbiology	3
	OPTOM ZC231 Optometric Instruments	3	OPTOM ZC232 Optometric Optics II	3
	OPTOM ZC241 Clinical Exam for Visual Systems	2	OPTOM ZC242 Ocular Diseases II	3
	OPTOM ZC251 Ocular Diseases I	3	OPTOM ZC252 Visual Optics II	3
	OPTOM ZC261 Visual Optics I	2	OPTOM ZC272 Clinics II	5
	OPTOM ZC281 Clinic I	4		
	Total	21	Total	20
III	OPTOM ZC282 Dispensing Optics	2	OPTOM ZC312 Binocular Vision II	2
	OPTOM ZC311 Binocular Vision I	1	OPTOM ZC322 Law Optometry	1
	OPTOM ZC323 Contact Lens I	2	OPTOM ZC324 Contact Lens II	2
	OPTOM ZC331 Systemic Diseases	1	OPTOM ZC332 Public Health Community Optometry	1
	OPTOM ZC341 Glaucoma	1	OPTOM ZC342 Pediatric Optometry	1
	OPTOM ZC371 Clinic & Special Clinics I	6	OPTOM ZC352 Occupational Optometry	2
	OPTOM ZC381 Low Vision Aids	1	OPTOM ZC372 Clinics & Special Clinics II	6
	OPTOM ZC421 Epidemiology	1	OPTOM ZC382 Geriatric Optometry	1
	OPTOM ZC431 Biostatistics	2	OPTOM ZC422 Project	5
	Total	17	Total	21
IV	OPTOM ZC411 Internship I	10	OPTOM ZC412 Internship II	10
	Total	10	Total	10

Note: This is the currently operative pattern as approved by the Senate appointed committee, subject to change if the situation warrants. Students with marginal deficiency in Mathematics or Biology would be additionally required to register in OPTOM ZC181 Remedial Mathematics (2 units) or OPTOM ZC191 Remedial Biology (2 units) in the first year first semester. Students may also be required to register in OPTOM ZC101T Bahasa Kebangsaan (3 units), OPTOM ZC102T Pendidikan Moral (3 units) or OPTOM ZC103T Pendidikan Islam (3 units), and OPTOM ZC104T Malaysian Studies (3 units) to satisfy requirements as prescribed by the Malaysian Qualification Agency, during the first three semesters.

M. S. Automotive Engineering
Curriculum Structure

Input Requirements

Employed professionals in Engineering Industries and holding an Integrated First Degree of BITS in Mechanical Engineering or Electrical & Electronics Engineering or its equivalent, with minimum one year work experience in relevant domains.

Programme Structure

Core Courses (5)

Course No.	Course Title	Units
AE* ZG511	Mechatronics	5
AE* ZG514	Advanced Automotive Systems	4
AE* ZG516	Advances in Internal Combustion Engines	4
AE* ZG524	Vehicle Dynamics	4
AE* ZG532	Computer Aided Engineering	5

Pool of Electives (7)

Course No.	Course Title	Units
AE* ZG512	Embedded System Design	4
AE* ZG513	Maintenance Engineering	5
AE* ZG515	Non-Destructive Testing	5
AE* ZG521	World Class Manufacturing	5
AE* ZG523	Project Management	4
AE* ZG531	Product Design	5
AE* ZG535	Advanced Engineering Mathematics	5
AE* ZG542	Just-in-time Manufacturing	4
AE* ZG611	Computational Fluid Dynamics and Heat Transfer	4
AE* ZG612	Advances in Materials, Composites & Plastics	4
AE* ZG613	Tribology	5
AE* ZG614	Fracture Mechanics	5
AE* ZG621	Durability, Crash and Safety Engineering	4
AE* ZG622	Advanced Manufacturing Processes	4
AE* ZG633	Advances in Vehicle Body Structures	4

Note: In the above programme structure, the symbol * in the course numbers, can be substituted by the letters representing the collaborating organization

M. S. Automotive Engineering

Type of Input: Employed persons in Engineering Industries and holding an integrated First Degree of BITS in Mechanical Engineering or Electrical & Electronics Engineering or its equivalent, with adequate relevant work experience

Normal Duration: Four Semesters

Special Feature: This programme is specially designed for the HRD needs of Tata Technologies, Pune

Year	First Semester		U	Second Semester		U
I	AETT ZG514	Advanced Automotive Systems	4	AETT ZG524	Vehicle Dynamics	4
	AETT ZG511	Mechatronics	5	AETT ZG532	Computer Aided Engineering	5
	AETT ZG516	Advances in Internal Combustion Engines	4		Elective	
		Elective			Elective	
Total				Total		
II		Elective		AETT ZG629T	Dissertation	16
		Elective				
		Elective				
		Elective				
Total				Total		16

Pool of Electives

Course No.	Course Title	Units
AETT ZG512	Embedded System Design	4
AETT ZG513	Maintenance Engineering	5
AETT ZG515	Non-Destructive Testing	5
AETT ZG521	World Class Manufacturing	5
AETT ZG523	Project Management	4
AETT ZG531	Product Design	5
AETT ZG535	Advanced Engineering Mathematics	5
AETT ZG542	Just-in-time Manufacturing	4
AETT ZG611	Computational Fluid Dynamics and Heat Transfer	4
AETT ZG612	Advances in Materials, Composites & Plastics	4
AETT ZG613	Tribology	5
AETT ZG614	Fracture Mechanics	5
AETT ZG621	Durability, Crash and Safety Engineering	4
AETT ZG622	Advanced Manufacturing Processes	4
AETT ZG633	Advances in Vehicle Body Structures	4

M.S. Consultancy Management

Type of Input: Employed professionals working in consulting and business organizations, with an Integrated First Degree of BITS or its equivalent.

Normal Duration: Four Semesters

Special Feature: This is a specially designed Work-Integrated Learning programme for eligible candidates, conducted in collaboration with Consultancy Development Centre (CDC) New Delhi.

Year	First Semester		U	Second Semester		U
I	CM ZG511	Consultancy Practice	4	CM ZG542	Knowledge Management	3
	CM ZG513	Financial Management	4	CM ZC483	Marketing Research	3
	CM ZG515	Quantitative Methods	4	CM ZG561	Management of Technology	4
	CM ZC473	International Business	3	CM ZG619	Professional Practice	4
		Total	15		Total	14
II	CM ZC471	Management Information Systems	3	CM ZG629T	Dissertation	20
	CM ZG523	Project Management	4			
	CM ZG532	Total Quality Management	4			
	CM ZG611	Strategic Management & Business Policy	4			
		Total	15		Total	20

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

M.S. Design Engineering (Eaton Technologies, Pune)

Type of Input: Sponsored employees (with adequate relevant work experience) with an Integrated First Degree of BITS in Mechanical Engineering or its equivalent.

Duration: Four Semesters.

Special Feature: This is a specially designed Work-Integrated Learning Programme for the HRD requirements of Eaton Technologies, Pune.

Year	First Semester		U	Second Semester		U
I	DEET ZG531	Mechanisms & Robotics	5	DEET ZC312	Industrial Instrumentation and Control	3
	DEET ZG512	Finite Element Methods	5	DEET ZG521	World-Class Manufacturing	5
	DEET ZG611	Dynamics & Vibrations	5	DEET ZG541	Product Design	5
	DEET ZG621	Computer Aided Analysis & Design	5	DEET ZG631	Materials Technology & Testing	5
		Total	20		Total	18
II	DEET ZG515	Computational Fluid Dynamics	5	DEET ZG629T	Dissertation	20
	DEET ZG523	Project Management	4			
	DEET ZG525	Mechanical System Design	5			
	DEET ZG532	Quality Assurance and Reliability	5			
		Total	19		Total	20

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

M.S. Design Engineering (L&T, Vadodara)

Type of Input: Sponsored employees of L&T, Vadodara with an Integrated First Degree of BITS in Mechanical Engineering or its equivalent and adequate, relevant work experience.

Duration: Four Semesters

Special Feature: This is a specially designed Work-Integrated Learning Programme for the HRD requirements of sponsored employees of L&T, Vadodara.

Year	First Semester		U	Second Semester		U
I	DELT ZG512	Finite Element Analysis	5	DELT ZG532	Machine Tool Engineering	5
	DELT ZG535	Advanced Engineering Mathematics	5	DELT ZG511	Mechatronics	5
	DELT ZG541	Product Design	5	DELT ZG641	Theory of Elasticity and Plasticity	5
	DELT ZG631	Materials Technology & Testing	5	DELT ZG561	Mechanism and Robotics	5
		Total	20		Total	20
II	DELT ZG621	Computer Aided Anal & Design	5	EDLT ZG629T	Dissertation	20
	DELT ZG525	Mechanical System Design	5			
	DELT ZG531	Concurrent Engineering	5			
	DELT ZG611	Dynamics & Vibrations	5			
		Total	20		Total	20

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

M.S. Design Engineering (SKF India Ltd., Pune)

Type of Input: Sponsored employees (with adequate relevant work experience) with an Integrated First Degree of BITS in Mechanical Engineering or its equivalent.

Duration: Four Semesters.

Special Feature: This is a specially designed Work-Integrated Learning Programme for the HRD requirements of SKF India Ltd., Pune.

Year	First Semester		U	Second Semester		U
I	DESKF ZG621	Computer Aided Analysis & Design	5	DESKF ZG511	Mechatronics	5
	DESKF ZG512	Finite Element Methods	5	DESKF ZG521	World-Class Manufacturing	5
	DESKF ZG611	Dynamics & Vibrations	5	DESKF ZG541	Product Design	5
	DESKF ZG531	Mechanisms & Robotics	5	DESKF ZG631	Materials Technology & Testing	5
		Total	20		Total	20
II	DESKF ZG515	Computational Fluid Dynamics	5	DESKF ZG629T	Dissertation	20
	DESKF ZG523	Project Management	4			
	DESKF ZG525	Mechanical System Design	5			
	DESKF ZG532	Quality Assurance and Reliability	5			
		Total	19		Total	20

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

M.S. Embedded Systems
Curriculum Structure

For students admitted to four-semester M.S. Embedded Systems programme during the academic year 2012-13, the programme structure and requirements will be as follows:

Requirements

1. Type of Input: Employed professionals holding an Integrated First Degree of BITS in Electrical & Electronics or Electronics & Instrumentation or Computer Science or its equivalent, with adequate relevant work experience.
2. Completion of the programme would require

   (a) At least 12 courses (totaling at least 48 credit units) towards coursework, and

   (b) Dissertation (20 credit units).
3. The coursework requirement for the program would consist of a set of core courses and elective courses. The core course requirement is mandatory for all students in a given programme. Rest of the coursework must be completed through elective courses.

Programme Structure

Core Courses (4)

Course No.	Course Title	Units
ES* ZC424	Software for Embedded Systems	3
ES* ZG512	Embedded System Design	4
ES* ZG553	Real Time Systems	5
ES* ZG641	Hardware Software Co-Design	5

Pool of Electives

Course No.	Course Title	Units
BITS ZG659	Technical Communication	4
ES* ZC441	Robotics	3
ES* ZC446	Data Storage Technologies & Networks	3
ES* ZC481	Computer Networks	3
ES* ZG511	Mechatronics	5
ES* ZG513	Network Security	4
ES* ZG514	Mechanisms & Robotics	5
ES* ZG520	Wireless & Mobile Communication	5
ES* ZG523	Project Management	4
ES* ZG524	Real Time Operating Systems	5
ES* ZG525	Avionics Systems	5
ES* ZG531	Pervasive Computing	4
ES* ZG545	Control & Instrumentation for Systems	5
ES* ZG554	Reconfigurable Computing	5
ES* ZG556	DSP Based Control of Electric Drives	3
ES* ZG573	Digital Signal Processing	3
ES* ZG611	Advanced Control Systems	5
ES* ZG612	Fault Tolerant System Design	5
ES* ZG625	Safety Critical Embedded System Design	4
ES* ZG642	VLSI Architecture	4
ES* ZG651	Networked Embedded Applications	4

Note: In the above programme structure, the symbol * in the course numbers, can be substituted by the letters representing the collaborating organization.

M.S. Embedded Systems (John Deere, Pune)

Type of Input: Sponsored employees (with adequate relevant work experience) holding an Integrated First Degree of BITS in Electrical & Electronics or Electronics & Instrumentation or Computer Science or its equivalent.

Normal Duration: Four Semesters

Special Feature: This is a specially designed Work-Integrated Learning Programme for the HRD requirements of sponsored employees of John Deere, Pune.

Year	First Semester		U	Second Semester		U
I	ESJD ZG512	Embedded System Design	4	ESJD ZC424	Software for Embedded System	3
	ESJD ZG523	Project Management	4	ESJD ZC441	Robotics	3
	ESJD ZG553	Real Time Systems	5	ESJD ZG511	Mechatronics	5
	ESJD ZG573	Digital Signal Processing	3	ESJD ZG611	Advanced Control Systems	5
		Total	16		Total	16
II	ESJD ZG545	Control and Instrumentation for Systems	5	ESJD ZG629T	Dissertation	20
	ESJD ZG556	DSP Based Control of Electric Drives	3			
	ESJD ZG641	Hardware Software Co-Design	4			
	ESJD ZG651	Networked Embedded Applications	4			
		Total	16		Total	20

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

M.S. Embedded Systems (L&T, Vadodara)

Type of Input: Sponsored employees (with adequate relevant work experience) holding an Integrated First Degree of BITS in Electrical & Electronics or Electronics & Instrumentation or Computer Science or its equivalent.

Normal Duration: Four Semesters

Special Feature: This is a specially designed Work-Integrated Learning Programme for the HRD requirements of sponsored employees of L&T, Vadodara.

Year	First Semester		U	Second Semester		U
I	ESLT ZG512	Embedded System Design	4	ESLT ZC424	Software for Embedded Systems	3
	ESLT ZG523	Project Management	4	ESLT ZG511	Mechatronics	5
	ESLT ZG553	Real Time Systems	5	ESLT ZG611	Advanced Control Systems	5
	ESLT ZG573	Digital Signal Processing	3	ESLT ZG641	Hardware Software Co-Design	4
		Total	16		Total	17
II	ESLT ZG525	Avionics Systems	5	ESLT ZG629T	Dissertation	20
	ESLT ZG533	Reconfigurable Computing	5			
	ESLT ZG612	Fault Tolerant System Design	5			
	ESLT ZG651	Networked Embedded Applications	4			
		Total	19		Total	20

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

M.S. Manufacturing Management

Type of Input: Employed professionals holding an Integrated First Degree of BITS or its equivalent, with adequate work experience.

Normal Duration: Four Semesters

Special Feature: This Work Integrated Learning Programme is specially designed for the HRD requirements of a diverse spectrum of Engineering Industries.

Semesterwise pattern for students admitted in the First Semester of the academic year

Year	First Semester		U	Second Semester		U
I	MM ZG511	Manufacturing Organization & Management	5	MM ZG534	Sustainable Manufacturing	4
	MM ZG522	Total Quality Management	4		Elective 1	
	MM ZG538	Toyota Production System	5		Elective 2	
	MM ZG541	Product Design	5		Elective 3	
II	MM ZG523	Project Management	4	BITS ZG629T	Dissertation	20
	MM ZG621	Supply Chain Management	4			
		Elective 4				
		Elective 5				

Semesterwise pattern for students admitted in the Second Semester of the academic year

Year	First Semester		U	Second Semester		U
I				MM ZG511	Manufacturing Organization & Management	5
				MM ZG522	Total Quality Management	4
				MM ZG538	Toyota Production System	5
				MM ZG541	Product Design	5
II	MM ZG523	Project Management	4	MM ZG534	Sustainable Manufacturing	4
	MM ZG621	Supply Chain Management	4		Elective 3	
		Elective 1			Elective 4	
		Elective 2			Elective 5	
III	BITS ZG629T	Dissertation	20			

Pool of Electives

Course No.	Course Title	Units
BITS ZG659	Technical Communication	4
MM ZC411	Marketing	4
MM ZC441	Human Resource Management	4
MM ZG513	Maintenance Engineering	5
MM ZG514	Leadership and Managing Change	4
MM ZG521	Financial Management	4
MM ZG611	Strategic Management & Business Policy	4

M.S. Microelectronics

Curriculum Structure

For students admitted to four-semester M.S. Microelectronics programme during the academic year 2012-13, the programme structure and requirements will be as follows:

Requirements

1. Type of Input: Employed professionals holding an Integrated First Degree of BITS or its equivalent, with adequate relevant work experience.
2. Completion of the programme would require

   (a) At least 12 courses (totaling at least 48 credit units) towards coursework, and

   (b) Dissertation (20 credit units).
3. The coursework requirement for the program would consist of a set of core courses and elective courses. The core course requirement is mandatory for all students in a given programme. Rest of the coursework must be completed through elective courses.

Programme Structure

Core Courses (5)

Course No.	Course Title	Units
MEL* ZG611	IC Fabrication Technology	5
MEL* ZG621	VLSI Design	5
MEL* ZG631	Physics & Modelling of Microelectronic Devices	5
MEL* ZG632	Analog IC Design	5
MEL* ZG641	CAD for IC Design	5

Pool of Electives

Course No.	Course Title	Units
MEL* ZC415	Introduction to MEMS	4
MEL* ZG510	RF Microelectronics	5
MEL* ZG511	Design & Analysis of Algorithms	5
MEL* ZG512	Optoelectronic Devices, Circuit & Systems	5
MEL* ZG520	Wireless & Mobile Communication	5
MEL* ZG524	Real Time Operating Systems	5
MEL* ZG526	Embedded System Design	4
MEL* ZG531	Testability for VLSI	5
MEL* ZG553	Real Time Systems	5
MEL* ZG554	Reconfigurable Computing	5
MEL* ZG573	Digital Signal Processing	3
MEL* ZG613	Advanced Digital Signal Processing	4
MEL* ZG623	Advanced VLSI Design	5
MEL* ZG625	Advanced Analog and Mixed Signal Design	5
MEL* ZG642	VLSI Architecture	4
MEL* ZG651	Hardware Software Co-Design	4
MEL* ZG652	Networked Embedded Applications	4

Note: In the above programme structure, the symbol * in the course numbers, can be substituted by the letters representing the collaborating organization

M.S. Microelectronics (Wipro Technologies, Bangalore)

Type of Input: Sponsored employees (with adequate work experience in Microelectronics area) holding a First Degree of BITS or its equivalent.

Normal Duration: Four Semesters

Special Feature: This is a specially designed programme to meet the Human Resource Development requirements of Wipro Technologies, Bangalore.

Year	First Semester		U	Second Semester		U
I	MELWT ZG573	Digital Signal Processing	3	MELWT ZG512	Embedded System Design	4
	MELWT ZG621	VLSI Design	5	MELWT ZG632	Analog IC Design	5
	MELWT ZG511	Design & Analysis of Algorithms	5	MELWT ZG641	CAD for IC Design	5
	MELWT ZG631	Physics & Modelling of Micro-electronic Devices	5	MELWT ZG611	IC Fabrication Technology	5
		Total	18		Total	19
II	MELWT ZG642	VLSI Architecture	4	MELWT ZG629T	Dissertation	20
	MELWT ZG531	Testability for VLSI	5			
	MELWT ZG625	Advanced Analog and Mixed Signal Design	5			
	MELWT ZG651	Hardware Software Co-Design	4			
		Total	18		Total	20

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

M.S. Microelectronics (Cypress, Qualcomm, and Texas Instruments, Bangalore)

Type of Input: Employed professionals holding an Integrated First Degree of BITS or its equivalent, with adequate, relevant work experience.

Normal Duration: Four Semesters

Special Feature: This is a specially designed Work-Integrated Learning Programme for the HRD requirements of sponsored employees of Cypress Semiconductor Technology India Pvt. Ltd., Bangalore, Qualcomm India Pvt. Ltd., Bangalore, and Texas Instruments, Bangalore.

Year	First Semester		U	Second Semester		U
I	MEL* ZG511	Design & Analysis of Algorithms	5	MEL* ZG520	Wireless & Mobile communications	5
	MEL* ZG573	Digital Signal Processing	3	MEL* ZG611	IC Fabrication Technology	5
	MEL* ZG621	VLSI Design	5	MEL* ZG632	Analog IC Design	5
	MEL* ZG631	Physics & Modeling of Microelectronic Devices	5	MEL* ZG641	CAD for IC Design	5
		Total	16		Total	17
II	MEL* ZG531	Testability of VLSI	5	MEL* ZG629T	Dissertation	20
	MEL* ZG625	Advanced Analog and Mixed Signal Design	5			
	MEL* ZG642	VLSI Architecture	4			
	MEL* ZG651	Hardware Software Co-Design	4			
		Total	17		Total	20

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.
In the above programme structure, the symbol * in the course numbers can be substituted by the letters representing the collaborating organization.

M.S. Pharmaceutical Operations and Management
Curriculum Structure

Type of Input : Employed professionals holding an Integrated First Degree of BITS or its equivalent, with adequate work experience.

Normal Duration : Four Semesters

Special Feature : This Work Integrated Learning Programme is specially designed for the HRD requirements of a diverse spectrum of Pharmaceutical Industries.

Core Courses (4)

Course No.	Course Title	Units
POM* ZC471	Management Information Systems	3
POM* ZG522	Quality Assurance and Regulatory Affairs	5
POM* ZG532	Supply Chain Management	4
POM* ZG534	Advanced Pharmaceutical Technology	5

Pool of Electives (14)

Course No.	Course Title	Units
POM* ZC441	Human Resource Management	4
POM* ZC473	International Business	3
POM* ZG511	Disinfection and Sterilization	4
POM* ZG512	Dosage Form Design	5
POM* ZG513	Financial Management	4
POM* ZG515	Pharmaceutical Administration and Management	5
POM* ZG521	Statistical Process Control	5
POM* ZG523	Project Management	4
POM* ZG525	Pharmaceutical Process Development and Scale Up	4
POM* ZG531	Manufacturing Organization and Management	5
POM* ZG541	Modern Analytical Techniques	4
POM* ZG542	Production and Operations Management	4
POM* ZG611	Advanced Pharmacology	5
POM* ZG631	TQM Tools and Techniques	5

Note: In the above programme structure, the symbol * in the course numbers, can be substituted by the letters representing the collaborating organization

M.S. Pharmaceutical Operations and Management (Lupin, Mumbai)

Type of Input : Employed professionals holding an Integrated First Degree of BITS in Pharmacy or its equivalent, with adequate, relevant work experience.

Normal Duration: Four Semesters

Special Feature: This is a specially designed programme for the Human Resource Development needs of Lupin Ltd., Mumbai.

Year	First Semester		U	Second Semester		U
I	POMLM ZC471	Management Information Systems	3	POMLM ZG534	Advanced Pharmaceutical Technology	5
	POMLM ZG522	Quality Assurance & Regulatory Affairs	5	POMLM ZG525	Pharmaceutical Process Development & Scale-up	4
	POMLM ZG531	Manufacturing Organization and Management	5	POMLM ZG542	Production and Operations Management	4
	POMLM ZG523	Project Management	4	POMLM ZG631	TQM Tools and Techniques	5
		Total	17		Total	18
II	POMLM ZC441	Human Resource Management	4	POMLM ZG629T	Dissertation	20
	POMLM ZG513	Financial Management	4			
	POMLM ZG515	Pharmaceutical Administration & Management	5			
	POMLM ZG532	Supply Chain Management	4			
		Total	17		Total	20

Note: This is currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

M.S. Software Engineering (4 Semester)
Curriculum Structure

For students admitted to four-semester M.S. Software Engineering programme during the academic year 2012-13, the programme structure and requirements will be as follows:

Requirements

1. Type of Input: Employed professionals holding an Integrated First Degree of BITS or its equivalent, with adequate, relevant work experience.
2. Completion of the programme would require
   (a) At least 12 courses (totaling at least 48 credit units) towards coursework, and
   (b) Dissertation (20 credit units).
3. The coursework requirement for the program would consist of a set of core courses and elective courses. The core course requirement is mandatory for all students in a given programme. Rest of the coursework must be completed through elective courses.

Programme Structure

Core Courses (4)

Course No.	Course Title	Units
SE* ZG512	Object Oriented Analysis & Design	4
SE* ZG552	Software Testing Methodologies	4
SE* ZG622	Software Project Management	4
SE* ZG651	Software Architectures	5

Pool of Electives

Course No.	Course Title	Units
SE* ZC415	Data Mining	3
SE* ZC422	Parallel Computing	3
SE* ZC424	Software for Embedded Systems	3
SE* ZC446	Data Storage Technologies & Networks	3
SE* ZC462	Network Programming	3
SE* ZC463	Cryptography	3
SE* ZC473	Multimedia Computing	3
SE* ZC481	Computer Networks	3
SE* ZG513	Network Security	4
SE* ZG515	Data Warehousing	5
SE* ZG516	Computer Organization & Software Systems	5
SE* ZG517	Usability Engineering	5
SE* ZG518	Database Design & Applications	5
SE* ZG519	Data Structures & Algorithms Design	5
SE* ZG520	Wireless & Mobile Communication	5
SE* ZG521	Advanced Data Mining	4
SE* ZG524	Real Time Operating Systems	5
SE* ZG525	Advanced Computer Networks	5
SE* ZG526	Embedded System Design	4
SE* ZG527	Cloud Computing	5
SE* ZG531	Pervasive Computing	4
SE* ZG551	Advanced Compilation Techniques	5
SE* ZG553	Real Time Systems	5
SE* ZG562	Software Engineering & Management	5
SE* ZG573	Digital Signal Processing	3
SE* ZG582	Telecom Network Management	5
SE* ZG623	Advanced Operating Systems	5
SE* ZG626	Hardware Software Co-Design	5
SE* ZG641	Management Information & Decision Support Systems	5
SE* ZG652	Software Maintenance Management	4
SE* ZG659	Technical Communication	4
SE* ZG661	Software Quality Management	4

Note: In the above programme structure, the symbol * in the course numbers, can be substituted by the letters representing the collaborating organization

M.S. Software Engineering (Cognizant Technology Solutions, Chennai)

Type of Input & Duration : Sponsored employees (with adequate work experience) holding an Integrated First Degree of BITS or its equivalent

Normal Duration: Four Semesters

Special Feature: This is a specially designed programme for Human Resource Development needs of Cognizant Technology Solutions, Chennai.

Year	First Semester		U	Second Semester		U
I	SECT ZG512	Object Oriented Analysis & Design	4	SECT ZG517	Usability Engineering	5
	SECT ZG544	Agile Software Processes	4	SECT ZG552	Software Testing Methodologies	4
	SECT ZG519	Data Structures & Algorithm Design	5	SECT ZG622	Software Project Management	4
	SECT ZG518	Database Design & Applications	5	SECT ZG651	Software Architectures	5
		Total	18		Total	18
II	SECT ZG513	Network Security	4	SECT ZG629T	Dissertation	20
	SECT ZC425	Data Mining	3			
	SECT ZG527	Cloud Computing	5			
	SECT ZG652	Software Maintenance Management	4			
		Total	16		Total	20

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

M.S. Software Engineering (Cybage, Pune)

Type of Input: Employed professionals holding an Integrated First Degree of BITS or its equivalent, with adequate work experience.

Normal Duration: Four Semesters

Special Feature: This is a specially designed programme for the Human Resource Development needs of Cybage India Ltd., Pune

Year	First Semester		U	Second Semester		U
I	SECY ZG512	Object Oriented Analysis and Design	4	SECY ZG515	Data Warehousing	5
	SECY ZG518	Database Design and Applications	5	SECY ZG552	Software Testing Methodologies	4
	SECY ZC421	Computer Networks	3	SECY ZG520	Wireless and Mobile Communication	5
	SECY ZG516	Computer Organization and Software Systems	5	SECY ZG651	Software Architectures	5
		Total	16		Total	16
II	SECY ZG622	Software Project Management	4	SECY ZG629T	Dissertation	20
	SECY ZG527	Cloud Computing	5			
	SECY ZG 513	Network Security	4			
	SECY ZG528	Usability Engineering	5			
		Total	18		Total	20

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

M.S. Software Engineering (EMC Software and Services, Bangalore)

Type of Input: Employed professionals holding an Integrated First Degree of BITS or its equivalent, with adequate, relevant work experience.

Normal Duration: Four Semesters

Special Feature: This is a specially designed Work-Integrated Learning Programme for the HRD requirements of sponsored employees of EMC Software and Services, Bangalore.

Year	First Semester		U	Second Semester		U
I	SEEMC ZC446	Data Storage Technologies & Networks	3	SEEMC ZC462	Network Programming	3
	SEEMC ZG512	Object Oriented Analysis and Design	4	SEEMC ZG513	Network Security	4
	SEEMC ZG531	Pervasive Computing	4	SEEMC ZG622	Software Project Management	4
	SEEMC ZG562	Software Engineering and Management	5	SEEMC ZG651	Software Architectures	5
		Total	16		Total	16
II	SEEMC ZC444	Cloud Computing	4	SEEMC ZG629T	Dissertation	20
	SEEMC ZG554	Distributed Data Systems	5			
	SEEMC ZG552	Software Testing Methodologies	4			
	SEEMC ZG623	Advanced Operating Systems	5			
		Total	18		Total	20

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

M.S. Software Engineering (iGate, Mumbai)

Type of Input: Sponsored employees of iGate-Patni holding an Integrated First Degree of BITS or its equivalent.

Normal Duration: Four Semesters

Special Feature: This is a specially designed programme for Human Resource Development needs of iGate, Mumbai

Year	First Semester		U	Second Semester		U
I	SEPC ZC421	Computer Networks	3	SEPC ZC462	Network Programming	3
	SEPC ZG512	Object Oriented Analysis and Design	4	SEPC ZG514	Data Warehousing	5
	SEPC ZG518	Database Design and Applications	5	SEPC ZG623	Advanced Operating Systems	5
	SEPC ZG519	Data Structures and Algorithm Design	5	SEPC ZG651	Software Architectures	5
		Total	17		Total	18
II	SEPC ZG513	Network Security	4	SEPC ZG629T	Dissertation	20
	SEPC ZC527	Cloud Computing	5			
	SEPC ZG552	Software Testing Methodologies	4			
	SEPC ZG622	Software Project Management	4			
		Total	17		Total	20

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

M.S. Software Engineering (Persistent Systems, Pune)

Type of Input: Sponsored employees of Persistent Systems Pvt. Ltd., Pune holding an Integrated first degree of BITS or its equivalent.

Normal Duration: Four Semesters

Special Feature: This is a specially designed programme for Human Resource Development needs of Persistent Systems Pvt. Ltd., Pune.

Year	First Semester		U	Second Semester		U
I	SEPS ZG512	Object Oriented Analysis and Design	4	SEPS ZG651	Software Architectures	5
	SEPS ZG519	Data Structures and Algorithm Analysis	5	SEPS ZG520	Wireless and Mobile Communication	5
	SEPS ZG518	Database Design and Applications	5	SEPS ZG514	Data Warehousing	5
	SEPS ZG622	Software Project Management	4	SEPS ZG552	Software Testing Methodologies	4
		Total	18		Total	19
II	SEPS ZC462	Network Programming	3	SEPS ZG629T	Dissertation	20
	SEPS ZG623	Advanced Operating Systems	5			
	SEPS ZG513	Network Security	4			
	SEPS ZC444	Cloud Computing	5			
		Total	17		Total	20

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

M.S. Software Engineering (Qualcomm, Hyderabad)

Type of Input: Sponsored employees of Qualcomm, Hyderabad holding an Integrated first degree of BITS or its equivalent, with adequate, relevant work experience.

Normal Duration: Four Semesters

Special Feature: This is a specially designed programme for Human Resource Development needs of Qualcomm, Hyderabad.

Year	First Semester		U	Second Semester		U
I	SEQC ZG512	Object Oriented Analysis & Design	4	SEQC ZG552	Software Testing Methodologies	4
	SEQC ZG562	Software Engineering & Management	5	SEQC ZG622	Software Project Management	4
	SEQC ZG511	Design & Analysis of Algorithms	5	SEQC ZG516	Embedded Systems Design	4
	SEQC ZG573	Digital Signal Processing	3	SEQC ZG520	Wireless and Mobile Communication	5
		Total	17		Total	17
II	SEQC ZG653	Software Architectures	5	SEQC ZG629T	Dissertation	20
	SEQC ZG651	Hardware Software Co-Design	4			
	SEQC ZG531	Pervasive Computing	4			
	SEQC ZC473	Multimedia Computing	3			
		Total	16		Total	20

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

M.S. Software Engineering (SAP Labs, Bangalore)

Type of Input: Sponsored employees of Sap Labs, Bangalore holding an First Degree of BITS or its equivalent, with adequate, relevant work experience.

Normal Duration: Four Semesters.

Special Feature: This is a specially designed programme for Human Resource Development needs of SAP Labs, Bangalore.

Year	First Semester		U	Second Semester		U
I	SESAP ZG512	Object Oriented Analysis & Design	4	SESAP ZG514	Data Warehousing	5
	SESAP ZG519	Data Structures and Algorithm Design	5	SESAP ZG651	Software Architectures	5
	SESAP ZG518	Database Design and Applications	5	SESAP ZG513	Network Security	4
	SESAP ZG552	Software Testing Methodologies	4	SESAP ZG661	Software Quality Management	4
		Total	18		Total	18
II	SESAP ZC425	Data Mining	3	SESAP ZG629T	Dissertation	20
	SESAP ZG527	Cloud Computing	5			
	SESAP ZG622	Software Project Management	4			
	SESAP ZG528	Usability Engineering	5			
		Total	17		Total	20

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

M.S. Software Engineering (TCS, Hyderabad)

Type of Input: Sponsored employees of Sap Labs, Bangalore holding an First Degree of BITS or its equivalent, with adequate, relevant work experience.

Normal Duration: Four Semesters.

Special Feature: This is a specially designed programme for Human Resource Development needs of TCS, Delhi, Hyderabad & Mumbai.

Year	First Semester		U	Second Semester		U
I	SETC ZC481	Computer Networks	3	SETC ZC462	Network Programming	3
	SETC ZG512	Object Oriented Analysis and Design	4	SETC ZG515	Data Warehousing	5
	SETC ZG518	Database Design & Applications	5	SETC ZG552	Software Testing Methodologies	4
	SETC ZG519	Data Structures & Algorithm Design	5	SETC ZG651	Software Architectures	5
		Total	17		Total	17
II	SETC ZC425	Data Mining	3	SETC ZG629T	Dissertation	20
	SETC ZG520	Wireless & Mobile Communication	5			
	SETC ZG527	Cloud Computing	5			
	SETC ZG622	Software Project Management	4			
		Total	17		Total	20

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

M.S. Software Engineering (Tech Mahindra, Hyderabad)

Type of Input: Sponsored employees of Satyam Computer Services holding an Integrated First Degree of BITS or its equivalent, with adequate, relevant work experience.

Normal Duration: Four Semesters

Special Feature: This is a specially designed programme for the Human Resource Development needs of Tech Mahindra, Hyderabad

Year	First Semester		U	Second Semester		U
I	SESL ZC421	Computer Networks	3	SESL ZG651	Software Architecture	5
	SESL ZG512	Object Oriented Analysis and Design	4	SESL ZG514	Data Warehousing	5
	SESL ZG518	Data Base Design and Applications	5	SESL ZG513	Network Security	4
	SESL ZG661	Software Quality Management	4	SESL ZG552	Software Testing Methodologies	4
		Total	16		Total	18
II	SESL ZG622	Software Project Management	4	SESL ZG629T	Dissertation	20
	SESL ZG527	Cloud Computing	5			
	SESL ZG552	Software Testing Methodologies	4			
	SESL ZC415	Data Mining	3			
		Total	16		Total	20

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

M.S. Software Engineering (CTS, Chennai)

Type of Input: Sponsored employees (with adequate, relevant work experience) with a B.Sc. Degree or its equivalent with adequate preparation in Mathematics & Physics

Normal Duration : Eight Semesters

Special Feature: This is a specially designed programme for Human Resource Development needs of Cognizant Technology Solutions, Chennai.

Year	First Semester		U	Second Semester		U
I	SECT ZC271	Mathematics I	3	SECT ZC272	Mathematics II	3
	SECT ZC221	Structured Programming	3	SECT ZC213	Probability & Statistics	3
	SECT ZC241	Principles of Management	3	SECT ZC413	Computer Organization & Architecture	3
	SECT ZC261	Digital Electronics & Microprocessors	3	SECT ZC461	Software Engineering	3
		Total	12		Total	12
II	SECT ZC415	Data Structures & Algorithms	3	SECT ZC421	Computer Networks	3
	SECT ZC432	Object Oriented Programming	3	SECT ZC362	Programming Languages & Compiler Construction	3
	SECT ZC222	Advanced Programming Techniques	3	SECT ZC322	Database Management Systems	3
	SECT ZC252	Discrete Structures for Computer Science	3	SECT ZC422	Operating Systems	3
						3
		Total	12		Total	12
III	SECT ZG659	Technical Communication	4	SECT ZG651	Software Architectures	5
	SECT ZG512	Object Oriented Analysis & Design	4	SECT ZG552	Software Testing Methodologies	4
	SECT ZG511	Design & Analysis of Algorithms	5	SECT ZG641	Management Information & Decision Support Systems	5
	EBCT ZG511	Overview of e-Business	3			
				SECT ZG517	Usability Engineering	5
		Total	16		Total	19
IV	SECT ZG661	Software Quality Management	4	SECT ZG629T	Dissertation	20
	SECT ZG622	Software Project Management	4			
	SECT ZG513	Network Security	4			
	SECT ZG652	Software Maintenance Management	4			
		Total	16		Total	20

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

M.S. Software Engineering (EMC, Bangalore)

Type of Input: Sponsored employees (with adequate, relevant work experience) with a B.Sc. Degree or its equivalent with adequate preparation in Mathematics & Physics

Normal Duration: Eight Semesters

Special Feature: This programme is specially designed for the Human Resource Development needs of SAP Labs, Bangalore

Year	First Semester	U	Second Semester	U
I	SEEMC ZC132 Linear Algebra & Optimization	3	SEEMC ZC222 Advanced Programming Techniques	3
	SEEMC ZC142 Computer Programming	3	SEEMC ZC332 Systems Programming	3
	SEEMC ZC252 Discrete Structures for Computer Science	3	SEEMC ZC413 Computer Organization & Architectures	3
	SEEMC ZC261 Digital Electronics & Microprocessors	3	SEEMC ZC415 Data Structures & Algorithms	3
		12	Total	12
II	SEEMC ZC213 Probability & Statistics	3	SEEMC ZC416 Compiler Design	3
	SEEMC ZC422 Operating Systems	3	SEEMC ZC421 Computer Networks	3
	SEEMC ZC322 Database Management Systems	3	SEEMC ZC472 Computer Graphics	3
	SEEMC ZC461 Software Engineering	3	SEEMC ZC424 Software Development for Portable Devices	3
	Total	12	Total	12
III	SEEMC ZC446 Data Storage Tech & Networks	3	SEEMC ZC462 Network Programming	3
	SEEMC ZG512 Object Oriented Analysis & Design	4	SEEMC ZG554 Distributed Data Systems	5
	SEEMC ZG531 Pervasive Computing	4	SEEMC ZG622 Software Project Management	4
	SEEMC ZG562 Software Engineering & Management	5	SEEMC ZG651 Software Architectures	5
	Total	16	Total	17
IV	SEEMC ZG552 Software Testing Methodologies	4	SEEMC ZG629T Dissertation	20
	SEEMC ZG623 Advanced Operating Systems	4		
	SEEMC ZG527 Cloud Computing	5		
	SEEMC ZG513 Network Security	4		
	Total	17	Total	20

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

M.S. Software Engineering (SAP Labs, Bangalore)

Type of Input: Sponsored employees (with adequate, relevant work experience) with a B.Sc. Degree or its equivalent with adequate preparation in Mathematics & Physics

Normal Duration: Eight Semesters

Special Feature: This programme is specially designed for the Human Resource Development needs of SAP Labs, Bangalore

Year	First Semester	U	Second Semester	U
I	SESAP ZC132 Linear Algebra & Optimization	3	SESAP ZC222 Advanced Programming Techniques	3
	SESAP ZC142 Computer Programming	3	SESAP ZC332 Systems Programming	3
	SESAP ZC252 Discrete Structures for Computer Science	3	SESAP ZC413 Computer Organization & Architectures	3
	SESAP ZC261 Digital Electronics & Microprocessors	3	SESAP ZC415 Data Structures & Algorithms	3
		12	Total	12
II	SESAP ZC213 Probability & Statistics	3	SESAP ZC416 Compiler Design	3
	SESAP ZC422 Operating Systems	3	SESAP ZC421 Computer Networks	3
	SESAP ZC322 Database Management Systems	3	SESAP ZC472 Computer Graphics	3
	SESAP ZC461 Software Engineering	3	SESAP ZC424 Software Development for Portable Devices	3
	Total	12	Total	12
III	SESAP ZG514 Data Warehousing	5	SESAP ZG622 Software Project Management	4
	SESAP ZG512 Object Oriented Analysis & Design	4	SESAP ZG552 Software Testing Methodologies	4
	SESAP ZG524 Real Time Operating Systems	5	SESAP ZC425 Data Mining	3
	SESAP ZC473 Multimedia Computing	3	SESAP ZG511 Design & Analysis of Algorithms	5
	Total	17	Total	16
IV	SESAP ZG651 Software Architectures	5	SESAP ZG629T Dissertation	20
	SESAP ZC446 Data Storage Technologies & Networks	3		
	SESAP ZG527 Cloud Computing	5		
	SESAP ZG513 Network Security	4		
	Total	17	Total	20

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

M.S. Software Engineering (Virtusa, Chennai)

Type of Input: Sponsored employees (with adequate, relevant work experience) with a B.Sc. Degree or its equivalent with adequate preparation in Mathematics & Physics

Normal Duration: Eight Semesters

Special Feature: This programme is specially designed for the Human Resource Development needs of Virtusa, Chennai

Year	First Semester	U	Second Semester	U
I	SEVI ZC132 Linear Algebra & Optimization	3	SEVI ZC222 Advanced Programming Techniques	3
	SEVI ZC142 Computer Programming	3	SEVI ZC332 Systems Programming	3
	SEVI ZC252 Discrete Structures for Computer Science	3	SEVI ZC413 Computer Organization & Architectures	3
	SEVI ZC261 Digital Electronics & Microprocessors	3	SEVI ZC415 Data Structures & Algorithms	3
		12	Total	12
II	SEVI ZC213 Probability & Statistics	3	SEVI ZC416 Compiler Design	3
	SEVI ZC422 Operating Systems	3	SEVI ZC421 Computer Networks	3
	SEVI ZC322 Database Management Systems	3	SEVI ZC472 Computer Graphics	3
	SEVI ZC461 Software Engineering	3	SEVI ZC424 Software Development for Portable Devices	3
	Total	12	Total	12
III	SEVI ZG514 Data Warehousing	5	SEVI ZG622 Software Project Management	4
	SEVI ZG512 Object Oriented Analysis & Design	4	SEVI ZG552 Software Testing Methodologies	4
	SEVI ZG524 Real Time Operating Systems	5	SEVI ZC425 Data Mining	3
	SEVI ZC473 Multimedia Computing	3	SEVI ZG511 Design & Analysis of Algorithms	5
	Total	17	Total	16
IV	SEVI ZG651 Software Architectures	5	SEVI ZG629T Dissertation	20
	SEVI ZC446 Data Storage Technologies & Networks	3		
	SEVI ZG527 Cloud Computing	5		
	SEVI ZG513 Network Security	4		
	Total	17	Total	20

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

M.S. Software Engineering (Tech Mahindra, Hyderabad)

Type of Input: Sponsored employees (with adequate work experience) with a B.Sc. Degree or its equivalent with adequate preparation in Mathematics & Physics, for an Eight Semester programme

Normal Duration: Eight Semesters

Special Feature: This is a specially designed programme for Human Resource Development needs of Tech Mahindra, Hyderabad.

Year	First Semester	U	Second Semester	U
I	SEMH ZC132 Linear Algebra & Optimization	3	SEMH ZC222 Advanced Programming Techniques	3
	SEMH ZC142 Computer Programming	3	SEMH ZC332 Systems Programming	3
	SEMH ZC252 Discrete Structures for Computer Science	3	SEMH ZC413 Computer Organization & Architectures	3
	SEMH ZC261 Digital Electronics & Microprocessors	3	SEMH ZC415 Data Structures & Algorithms	3
		12	Total	12
II	SEMH ZC213 Probability & Statistics	3	SEMH ZC416 Compiler Design	3
	SEMH ZC422 Operating Systems	3	SEMH ZC421 Computer Networks	3
	SEMH ZC322 Database Management Systems	3	SEMH ZC472 Computer Graphics	3
	SEMH ZC461 Software Engineering	3	SEMH ZC424 Software Development for Portable Devices	3
	Total	12	Total	12
III	SEMH ZG514 Data Warehousing	5	SEMH ZG622 Software Project Management	4
	SEMH ZG512 Object Oriented Analysis & Design	4	SEMH ZG552 Software Testing Methodologies	4
	SEMH ZG524 Real Time Operating Systems	5	SEMH ZC425 Data Mining	3
	SEMH ZC473 Multimedia Computing	3	SEMH ZG511 Design & Analysis of Algorithms	5
	Total	17	Total	16
IV	SEMH ZG651 Software Architectures	5	SEMH ZG629T Dissertation	20
	SEMH ZC446 Data Storage Technologies & Networks	3		
	SEMH ZG527 Cloud Computing	5		
	SEMH ZG513 Network Security	4		
	Total	17	Total	20

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

M.S. Software Engineering (Teh Mahindra, Pune)

Type of Input: Sponsored employees (with adequate work experience) with a B.Sc. Degree or its equivalent with adequate preparation in Mathematics & Physics, for an Eight Semester programme

Normal Duration: Eight Semesters

Special Feature: This is a specially designed programme for Human Resource Development needs of Tech Mahindra, Pune.

Year	First Semester		U	Second Semester		U
I	SEMB ZC211	Mathematics I	3	SEMB ZC212	Mathematics –II	3
	SEMB ZC223	Advanced Programming Techniques	3	SEMB ZC461	Software Engineering	3
	SEMB ZC241	Principles of Management	3	SEMB ZC213	Probability and Statistics	3
	SEMB ZC261	Digital Electronics & Microprocessors	3	SEMB ZC252	Discrete Structures for Computer Science	3
		Total	12		Total	12
II	SEMB ZC413	Computer Organization and Architecture	3	SEMB ZC421	Computer Networks	3
	SEMB ZC415	Data Structure and Algorithms	3	SEMB ZG659	Technical Communication	4
	SEMB ZC432	Object Oriented Programming	3	SEMB ZC351	Organizational Behaviour	3
	SEMB ZC322	Database Management Systems	3	SEMB ZC422	Operating Systems	3
		Total	12		Total	12
III	SEMB ZG651	Software Architectures	5	SEMB ZG514	Data Warehousing	5
	SEMB ZG512	Object Oriented Analysis and Design	4	SEMB ZG513	Network Security	4
	SEMB ZG511	Design and Analysis of Algorithms	5	SEMB ZG582	Telecom Network Management	5
	SEMB ZC473	Multimedia Computing	3	SEMB ZC462	Network programming	3
		Total	17		Total	17
IV	SEMB ZG661	Software Quality Management	4	SEMB ZG629T	Dissertation	20
	SEMB ZG552	Software Testing Methodologies	4			
	SEMB ZG622	Software Project Management	4			
	SEMB ZC451	Internetworking Technologies	3			
		Total	15		Total	20

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

M.S. Software Engineering (Wipro Technologies, Bangalore)

Type of Input: Sponsored employees (with adequate work experience) with a B.Sc. Degree or its equivalent with adequate preparation in Mathematics & Physics, for an Eight Semester programme

Normal Duration: Eight Semesters

Special Feature: This is a specially designed programme for Human Resource Development needs of Wipro Technologies, Bangalore.

Year	First Semester		U	Second Semester		U
I	SEWP ZC132	Linear Algebra & Optimization	3	SEWP ZC222	Advanced Programming Techniques	3
	SEWP ZC142	Computer Programming	3			
	SEWP ZC252	Discrete Structures for Computer Science	3	SEWP ZC332	Systems Programming	3
				SEWP ZC413	Computer Organization & Architectures	3
	SEWP ZC261	Digital Electronics & Microprocessors	3	SEWP ZC415	Data Structures & Algorithms	3
			12	Total		12
II	SEWP ZC213	Probability & Statistics	3	SEWP ZC416	Compiler Design	3
	SEWP ZC422	Operating Systems	3	SEWP ZC421	Computer Networks	3
	SEWP ZC322	Database Management Systems	3	SEWP ZC472	Computer Graphics	3
	SEWP ZC461	Software Engineering	3	SEWP ZC424	Software Development for Portable Devices	3
	Total		12	Total		12
III	SEWP ZG514	Data Warehousing	5	SEWP ZG622	Software Project Management	4
	SEWP ZG512	Object Oriented Analysis & Design	4	SEWP ZG552	Software Testing Methodologies	4
	SEWP ZG524	Real time Operating Systems	5	SEWP ZC425	Data Mining	3
	SEWP ZC473	Multimedia Computing	3	SEWP ZG511	Design & Analysis of Algorithms	5
	Total		17	Total		16
IV	SEWP ZG651	Software Architectures	5	SEWP ZG629T	Dissertation	20
	SEWP ZC446	Data Storage Technologies & Networks	3			
	SEWP ZC444	Cloud Computing	4			
	SEWP ZG513	Network Security	4			
	Total		16	Total		20

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

M.S. Software Systems

Type of Input: Employed professionals holding an Integrated First Degree of BITS or its equivalent, with adequate, relevant work experience.

Normal Duration: Four Semesters

Special Feature: This Work Integrated Learning Programme is designed for the HRD requirements of a diverse spectrum of IT Industries.

Semesterwise pattern for students admitted in the First Semester of the academic year

Year	First Semester		U	Second Semester		U
I	SS ZG514	Object Oriented Analysis & Design	4	SS ZG653	Software Architectures	5
	SS ZG562	Software Engineering & Management	5		Elective 1	4(min)
	SS ZG519	Data Structures & Algorithms Design	5		Elective 2	4(min)
	SS ZG518	Database Design & Applications	5		Elective 3	4(min)
		Total	19		Total	17(min)
II	SS ZG526	Distributed Computing	5	BITS ZG628T	Dissertation	16
		Elective 4	4(min)			
		Elective 5	4(min)			
		Elective 6	4(min)			
		Total	17(min)		Total	16

Semesterwise pattern for students admitted in the Second Semester of the academic year

Year	First Semester		U	Second Semester		U
I				SS ZG514	Object Oriented Analysis & Design	4
				SS ZG562	Software Engineering & Management	5
				SS ZG519	Data Structures & Algorithms Design	5
				SS ZG518	Database Design & Applications	5
					Total	19
II	SS ZG653	Software Architectures	5	SS ZG526	Distributed Computing	5
		Elective 1	4(min)		Elective 4	4(min)
		Elective 2	4(min)		Elective 5	4(min)
		Elective 3	4(min)		Elective 6	4(min)
		Total	17(min)		Total	17(min)
III	BITS ZG628T	Dissertation	16			

Pool of Electives

Course No.	Course Title	Units
BITS ZC481	Computer Networks	3
BITS ZG553	Real Time Systems	5
BITS ZG659	Technical Communication	4
CS ZG525	Advanced Computer Networks	5
CS ZG623	Advanced Operating Systems	5
EA ZC473	Multimedia Computing	3
EEE ZG512	Embedded System Design	4
IS ZC424	Software for Embedded Systems	3
IS ZC462	Network Programming	3
SS ZG513	Network Security	4
SS ZG516	Computer Organization & Software Systems	5
SS ZG527	Cloud Computing	5
SS ZG531	Pervasive Computing	4
SS ZG552	Software Testing Methodologies	4
SS ZG622	Software Project Management	4

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

Integrated M.S. Software Systems

Type of Input: Employed persons holding a B.Sc. / BCA degree or its equivalent in relevant disciplines with adequate background in Mathematics, with minimum one year work experience in relevant domains.

Normal Duration: Eight Semesters

Special Feature: This Work Integrated Learning Programme is designed for the HRD requirements of diverse spectrum of IT Industries.

Semesterwise pattern for students admitted in the First Semester of the Academic Session

Year	First Semester		U	Second Semester		U
I	MATH ZC222	Discrete Structures for Computer Science	3	IS ZC313	Object Oriented Programming & Design	4
	MATH ZC234	Linear Algebra & Optimization	3	IS ZC323	Systems Programming	3
	TA ZC163	Computer Programming	4	IS ZC353	Computer Organization & Architecture	4
	ES ZC261	Digital Electronics & Microprocessors	3	IS ZC363	Data Structures & Algorithms	4
		Total	13		Total	15
II	AAOC ZC111	Probability & Statistics	3	IS ZC372	Complier Design	3
	IS ZC332	Database Systems & Applications	3	IS ZC341	Software Engineering	3
	IS ZC362	Operating Systems	3	IS ZC461	Computer Networks	3
		Elective	4 (min)		Elective	4 (min)
		Total	13(min)		Total	13(min)
III	SS ZG514	Object Oriented Analysis & Design	4	SS ZG526	Distributed Computing	5
		Elective	4 (min)		Elective	4 (min)
		Elective	4 (min)		Elective	4 (min)
		Elective	4 (min)		Elective	4 (min)
		Total	16(min)		Total	17(min)
IV	SS ZG653	Software Architectures	5	BITS ZG628T	Dissertation	16
		Elective	4 (min)			
		Elective	4 (min)			
		Elective	4 (min)			
		Total	17(min)		Total	16

Semesterwise pattern for students admitted in the Second Semester of the academic year

Year	First Semester		U	Second Semester		U
I				MATH ZC222	Discrete Structures for Computer Science	3
				MATH ZC234	Linear Algebra & Optimization	3
				TA ZC163	Computer Programming	4
				ES ZC261	Digital Electronics & Microprocessors	3
					Total	13
II	IS ZC313	Object Oriented Programming & Design	4	AAOC ZC111	Probability & Statistics	3
	IS ZC323	Systems Programming	3	IS ZC332	Database Systems & Applications	3
	IS ZC353	Computer Organization & Architecture	4	IS ZC362	Operating Systems	3
	IS ZC363	Data Structures & Algorithms	4		Elective	4(min)
		Total	15		Total	13(min)
III	IS ZC372	Complier Design	3	SS ZG514	Object Oriented Analysis & Design	4
	IS ZC341	Software Engineering	3		Elective	4 (min)
	IS ZC461	Computer Networks	3		Elective	4 (min)
		Elective	4 (min)		Elective	4 (min)
		Total	13(min)		Total	16(min)
IV	SS ZG526	Distributed Computing	5	SS ZG653	Software Architectures	5
		Elective	4 (min)		Elective	4 (min)
		Elective	4 (min)		Elective	4 (min)
		Elective	4 (min)		Elective	4 (min)
		Total	17(min)		Total	17(min)
V	BITS ZG628T	Dissertation	16			
		Total	16			

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

Pool of Electives

General Pool of Electives:

Course No.	Course Title	Units
EA ZC473	Multimedia Computing	3
IS ZC472	Computer Graphics	3
IS ZC422	Parallel Computing	3
IS ZC444	Artificial Intelligence	3
CS ZG551	Advanced Compilation Techniques	5
CS ZG623	Advanced Operating Systems	5

Specializations:

2. Software Engineering

Requirements: 4 courses / 16 units (min) and all courses are to be chosen from a designated pool of electives

Course No.	Course Title	Units
IS ZC424	Software for Embedded Systems	3
SS ZG547	Usability Engineering	5
SS ZG552	Software Testing Methodologies	4
SS ZG566	Secure Software Engineering	5
SS ZG622	Software Project Management	4
SS ZG652	Software Maintenance Management	4
SS ZG661	Software Quality Management	4

3. Data Analytics

Requirements: 4 courses / 16 units (min) and all courses are to be chosen from a designated pool of electives

Course No.	Course Title	Units
IS ZC425	Data Mining	3
IS ZC446	Data Storage Technologies & Networks	3
IS ZC464	Machine Learning	3

SS ZG515	Data Warehousing	5
SS ZG548	Advanced Data Mining	4
SS ZG537	Information Retrieval	4
SS ZG554	Distributed Data Systems	5

4. Networks and Networked Systems

Requirements: 4 courses / 16 units (min) and all courses are to be chosen from a designated pool of electives

Course No.	Course Title	Units
BITS ZC463	Cryptography	3
IS ZC462	Network Programming	3
SS ZC446	Data Storage Technologies & Networks	3
SS ZG513	Network Security	4
SS ZG520	Wireless & Mobile Communication	5
SS ZG525	Advanced Computer Networks	5
SS ZG527	Cloud Computing	5
SS ZG538	Infrastructure Management	4
SS ZG582	Telecom Network Management	5

5. Embedded Systems

Requirements: 4 courses / 16 units (min) and all courses are to be chosen from a designated pool of electives

Course No.	Course Title	Units
BITS ZG553	Real Time Systems	5
CS ZG524	Real Time Operating Systems	5
EEE ZG512	Embedded System Design	4
IS ZC424	Software for Embedded Systems	3
SS ZG531	Pervasive Computing	4
SS ZG626	Hardware Software Co-Design	5
SS ZG656	Networked Embedded Applications	4

M.S. Systems Engineering (Wipro Infotech, Bangalore)

Type of Input: Sponsored employees (with adequate relevant work experience) with First Degree of BITS or its equivalent

Normal Duration: Four Semesters

Special Feature This is a specially designed Work-Integrated Learning Programme for the HRD requirements of sponsored employees of Wipro Technologies and Wipro Infotech, Bangalore.

Year	First Semester		U	Second Semester		U
I	SEWI ZG514	Data Warehousing	5	SEWI ZG661	Software Quality Management	4
	SEWI ZG512	Object Oriented Analysis & Design	4	SEWI ZG531	Pervasive Computing	4
	SEWI ZG524	Real Time Operating Systems	5	SEWI ZC425	Data Mining	3
	SEWI ZG520	Wireless & Mobile Communication	5	SEWI ZG552	Software Testing Methodologies	4
		Total	19		Total	15
II	SEWI ZG622	Software Project Management	4	SEWI ZG629T	Dissertation	20
	SEWI ZG527	Cloud Computing	5			
	SEWI ZG582	Telecom Network Management	5			
	SEWI ZG513	Network Security	4			
		Total	18		Total	20

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

M.S. Systems Engineering (Wipro Infotech, Bangalore)

Type of Input: Sponsored employees (with adequate work experience) with a B.Sc. Degree or its equivalent with adequate preparation in Mathematics & Physics, for an Eight-Semester programme

Normal Duration: Eight Semesters

Special Feature: This is a specially designed programme for Human Resource Development needs of Wipro Infotech, Bangalore.

Year	First Semester		U	Second Semester		U
I	SEWI ZC132	Linear Algebra & Optimization	3	SEWI ZC222	Advanced Programming Techniques	3
	SEWI ZC142	Computer Programming	3	SEWI ZC332	Systems Programming	3
	SEWI ZC252	Discrete Structures for Computer Science	3	SEWI ZC413	Computer Organization & Architecture	3
	SEWI ZC261	Digital Electronics & Microprocessors	3	SEWI ZC415	Data Structures & Algorithms	3
			12		Total	12
II	SEWI ZC213	Probability & Statistics	3	SEWI ZC416	Compiler Design	3
	SEWI ZC422	Operating Systems	3	SEWI ZC421	Computer Networks	3
	SEWI ZC322	Database Management Systems	3	SEWI ZC472	Computer Graphics	3
	SEWI ZC461	Software Engineering	3	SEWI ZC424	Software Development for Portable Devices	3
		Total	12		Total	12
III	SEWI ZG514	Data Warehousing	5	SEWI ZG661	Software Quality Management	4
	SEWI ZG512	Object Oriented Analysis & Design	4	SEWI ZG531	Pervasive Computing	4
	SEWI ZG524	Real Time Operating Systems	5	SEWI ZC425	Data Mining	3
	SEWI ZG520	Wireless & Mobile Communication	5	SEWI ZG552	Software Testing Methodologies	4
		Total	19		Total	15
IV	SEWI ZG622	Software Project Management	4	SEWI ZG629T	Dissertation	20
	SEWI ZC446	Data Storage Technologies & Networks	3			
	SEWI ZG582	Telecom Network Management	5			
	SEWI ZG513	Network Security	4			
		Total	16		Total	20

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

M.S. Telecommunications and Software Engineering (Avaya, Pune)

Type of Input: Sponsored employees (with adequate work experience in Telecommunications area) holding an Integrated First Degree of BITS or its equivalent.

Normal Duration: Four Semesters

Special Feature: This is a specially designed programme for Human Resource Development needs of Avaya, Pune.

Year	First Semester		U	Second Semester		U
I	SEAY ZC421	Computer Networks	3	SEAY ZC473	Multimedia Computing	3
	SEAY ZG512	Object Oriented Analysis & Design	4	SEAY ZG520	Wireless and Mobile Communication	5
	SEAY ZG516	Embedded System Design	4	SEAY ZG651	Software Architectures	5
	SEAY ZG622	Software Project Management	4	SEAY ZG552	Software Testing Methodologies	4
		Total	15		Total	14
II	SEAY ZG513	Network Security	4	SEAY ZG629T	Dissertation	20
	SEAY ZG518	Database Design and Applications	5			
	SEAY ZG525	Advanced Computer Networks	5			
	SEAY ZG582	Telecom Network Management	5			
		Total	19		Total	20

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

M.S. Telecommunications and Software Engineering (Tech Mahindra, Pune)

Type of Input: Sponsored employees (with adequate work experience in Telecommunications area) holding an Integrated First Degree of BITS or its equivalent.

Normal Duration: Four Semesters

Special Feature: This is a specially designed programme for Human Resource Development needs of Tech Mahindra, Pune.

Year	First Semester		U	Second Semester		U
I	SEMB ZC421	Computer Networks	3	SEMB ZC452	Mobile Telecom Networks	3
	SEMB ZG512	Object Oriented Analysis & Desigr	4	SEMB ZC473	Multimedia Computing	3
	SEMB ZG516	Embedded System Design	4	SEMB ZC482	Satellite Communication	3
	SEMB ZG659	Technical Communication	4	SEMB ZG651	Software Architectures	5
		Total	15		Total	14
II	SEMB ZG513	Network Security	4	SEMB ZG629T	Dissertation	20
	SEMB ZG514	Data Warehousing	5			
	SEMB ZG582	Telecom Network Management	5			
	SEMB ZG591	Optical Communication	5			
		Total	19		Total	20

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

M.Phil. Optometry (Sankara Nethralaya, Chennai)

Type of Input: B.S. Optometry of BITS or its equivalent. Short-listed candidates will be required to take a Written Test and Interview at their own expense for getting admission.

Normal Duration: Four semesters

Special Feature: This is a specially designed two-year higher degree programme with classes and laboratory work conducted entirely at Elite School of Optometry, Sankara Nethralaya, Chennai.

Year	First Semester		U	Second Semester		U
I	OPTO ZG642	Computers & Information Systems	3	OPTO ZG653	Visual Perception	4
	OPTO ZG623	Research Methodology I	3	OPTO ZG663	Research Methodology II	3
	OPTO ZG511	Special Clinics I	4	OPTO ZG512	Special Clinics II	4
		Elective 1	4		Elective 2	4
		Total	14		Total	15
II	OPTO ZG659	Technical Communication	4	OPTO ZG629T	Dissertation	20
	OPTO ZG513	Special Clinics III	4			
	OPTO ZG644	Recent Advances in Optometry	4			
		Elective 3				
		Total		Total		20

Note: This is the currently operative pattern as approved by the Senate-appointed committee, subject to change if the situation warrants.

Pool of Elective Pairs		
Course No.	**Course Title**	**U**
OPTO ZG673	Clinical Optometry I	4
OPTO ZG683	Clinical Optometry II	4
OPTO ZG631	Advanced Glaucoma I	4
OPTO ZG682	Advanced Glaucoma II	4
OPTO ZG612	Advanced Contact Lens I	4
OPTO ZG611	Advanced Contact Lens II	4
OPTO ZG614	Neurological Basis and Electrophysiology of Vision – I	4
OPTO ZG615	Neurological Basis and Electrophysiology of Vision – I	4
OPTO ZG616	Low Vision Care and Vision Enhancement Techniques – I	4
OPTO ZG617	Low Vision Care and Vision Enhancement Techniques – I	4
OPTO ZG696	Advanced Occupational Optometry I	4
OPTO ZG697	Advanced Occupational Optometry II	4
OPTO ZG698	Advanced Binocular Vision I	4
OPTO ZG699	Advanced Binocular Vision II	4
Pool of other electives		
OPTO ZG613	Ophthalmic Photography	3
OPTO ZG681	Medical Records	2

PART VI

COURSE DESCRIPTIONS (On-Campus)

See enclosed CD for Contents.

LEGEND

The numbers that appear at the end of each course title like 3 0 3, 0 9 3, 2 3 3 etc. indicate the lecture hours per week, the practical/seminar/project hours per week and the number of units in that order. Wherever a single number (with or without*) appears, it indicates only total units and its break up in terms of lectures and practicals/seminar/project may be announced from time to time through the timetable whenever it is needed.

PART VI: COURSE DESCRIPTIONS *(On-Campus)*

See enclosed CD for Contents

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This part gives a detailed description of all the courses.

Offering of courses: The academic calendar consists of two regular semesters. The summer term is not part of the academic calendar except where specifically stated. The offering of courses shall always depend on the normal unfolding of these courses for regular students who should be able to negotiate all the courses required as compulsory or electives as they proceed within the stated number of years in the programme. Very often any departure from this practice is subject to the overall facilities available. It will be invariably taxing of facilities to help the largest number of students when possible. For instance, same course is offered in both the semesters where only one is necessary, in the pattern described above. Depending upon the need and the facilities, Dean Instruction decides the courses that will be offered in any particular semester and this information will be made available through a course-wise timetable at the beginning of every semester.

It will be clear from the above discussion that a student who wishes to exercise his choice of electives can do so only through courses available in the timetable and not courses which are mentioned in the bulletin. Nonetheless, students can easily guess, on the basis of previous timetables, which courses are likely to be offered in what semester and make an advance planning to the extent it is possible. Similarly, a student who has backlog will find that he is already out of phase with the pattern that has been described earlier and therefore has to work out a strategy for himself by which he reduces fouling up as much as it is possible for him to do so.

While registration in a particular course or set of courses is governed by Academic Regulations, for easy reference the following general guidelines together with specific points are listed.

1. The Dean, Instruction may introduce or withdraw courses in categories which are taken on the basis of electives or options.
2. Registration in any course can be made only with the prior permission of the Dean, ARC.
3. Although the detailed break-up of the units in terms of hours for lecture and practical classes are presented without designating tutorial hours, every student will be required to attend these tutorial classes as and when required by the Dean, Instruction.
4. In the structure of a programme a block of courses follow in a particular sequence semester after semester. The mere fact that no specific restriction has been put does not permit unwarranted jumbling of this sequence. This sequence is presented in semesterwise pattern for each programme.
5. The lists of courses to be followed invariably have numbers attached to each course. These numbers generally determine the level at which the course is to be normally registered. However on the same plane there are courses which are specially designed for group C programmes and are not available to students of groups A&B programmes. Appropriate sections of the Bulletin may be consulted.
6. Sometimes a particular course has a prerequisite condition which has to be fulfilled before one can register in that course, or has to be waived with the consent of the Dean, Instruction.
7. For registration in certain specific courses like Specialized Discipline Courses, Higher Degree Courses, apart from the prerequisite, there will also be requirement of prior preparation. Academic regulations must be consulted for this.
8. For students registered in courses of Off-Campus Work Integrated Learning and Collaborative Programmes corresponding instructions have been detailed in PART V.

Note: The items mentioned above are not exhaustive. For precise rules reference should be made to Academic Regulations.

Course Description for all On-campus Programmes

Analysis & Application Oriented Courses

AAOC C111 Probability and Statistics **3 0 3**

Probability spaces; conditional probability and independence; random variables and probability distributions; marginal and conditional distributions; independent random variables; mathematical expectation; mean and variance; binomial, Poisson and normal distributions; sum of independent random variables; law of large numbers; central limit theorem (without proof); sampling distribution and test for mean using normal and student's t-distribution; test of hypothesis; correlation and linear regression.

AAOC C221 Graphs and Networks **3 0 3**

Basic concepts of graphs and digraphs behind electrical communication and other networks behind social, economic and empirical structures; connectivity, reachability and vulnerability; trees, tournaments and matroids; planarity; routing and matching problems; representations; various algorithms; applications.

AAOC C222 Optimization **3 0 3**

Prerequisite: MATH C191 and MATH C192

Introduction to optimization; linear programming; simplex methods; duality and sensitivity analysis; transportation model and its variants; integer linear programming nonlinear programming; multi-objective optimization; evolutionary computation techniques.

AAOC C311 Data Processing **3 0 3**

Prerequisite: TA C162

Introduction to Data Processing; Files and File Structures; Indexing Techniques; Sorting, Searching and Merging Techniques; Introduction to Database Management Systems; Design of Information Systems; Emerging trends in Data Processing.

AAOC C312 Operations Research **3 0 3**

Prerequisite: AAOC C111

Introduction to operations research; dynamic programming; network models - including CPM and PERT; probability distributions; inventory models; queuing systems; decision making- under certainty, risk, and uncertainty; game theory; simulation techniques, systems reliability.

AAOC C321 Control Systems **0 3 3**

Prerequisites: (ES C241 or ENGG C111) and (MATH C191)

Mathematical models of physical systems, feedback characteristics of control systems, control system components, time response analysis, stability, frequency response, state-space analysis, compensation.

AAOC C322 Systems **3 0 3**

Prerequisite: ES C241 or ENGG C111

Systems and systems approach; signals and systems; modelling of physical systems and modelling of non-physical systems; continuous and discrete systems; time domain analysis; systems stability.

AAOC C341 Numerical Analysis **3 0 3**

Prerequisite : MATH C191 and MATH C192

Solution of non-linear algebraic equation; interpolation and approximation; numerical differentiation and quadrature; solution of ordinary differential equations; systems of linear equations; matrix inversion; eigenvalue and eigenvector problems; round off and conditioning.

Bioengineering

BENG C411 Anatomy, Physiology and Hygiene **2 3 3**

Course description is same as given underPHA C321.

BENG G511 Biomaterials **3 2 5**

Introduction to biomaterials, structure and characterizations of materials, metallic implant materials, ceramic implant materials, polymeric implant materials, composites as biomaterials, structure property relationship, tissue response to implants, certain aspects of different kinds of prostheses.

BENG G512 Biomechanics **3 2 5**

Introduction to biomechanics, kinematics, kinetics, anthropometry, muscle and joint biomechanics, electromyography, synthesis of human movement, muscle mechanics, kinesiology, biomechanics in sports.

BENG G521 Bioinformatics **3 2 5**

General search methods, means-ends analysis, problem reduction, goal tree, optimal search, dynamic programming principle, minimax procedure, alpha-beta pruning. Stastical preliminaries, sampling and sampling distribution, estimation, hypothes's testing. Scoring systems and comparison of two sequences. Global multiple alignment. Construction of polygenetic trees. Search in biological database, pattern discovery in set of sequences. Sequences and structure of macromolecules. Transcription and translation.

BENG G522 Biotransport Processes **3 2 5**

Introduction to basic principles of fluid mechanics and of energy and mass transport, with emphasis on applications to living systems. Mass, momentum and energy conservation, mass diffusion, convection and diffusion. Modelling of momentum, energy and mass transport processes in physiological systems. Boundary layer, Penetration, and compartment models; interphase transport. Applications to respiratory, circulatory and other systems.

BENG G531 Telemetry **3 2 5**

Major components and concerns of telemetry systems, including : sensors, signal conditioning and calibration, analogue-to-digital conversion, frame and packet construction, time and position determination, multiplexing,

modulators, power amplifiers, channel distortion, link budgets, communication link reliability.

BENG G532 Biomedical Imaging **3 2 5**

The physics and engineering of the data acquistion, mathematics of the image reconstruction. Multi-dimensional linear systems, x-ray radiography, radioisotopes, ultrasound imaging, computed tomography, nuclear medicine, nuclear magnetic resonance (NMR) imaging, magnetic resonance imaging (MRI), volumetric rendering, confocal computed tomography (CT) in radiological sciences and confocal fluorescence microscopy in the biological sciences.

BENG G591 Selected Topics in Bioengineering **3 2 5**

Course description for the above course is to be developed.

Biological Sciences

BIO C111 General Biology **3 0 3**

Living systems and their properties; major biological compounds; basic physiological processes; introduction to genetics; environment and evolution.

BIO C211 Biological Chemistry **3 0 3**

Chemistry and functions of constituents of cells and tissues; introduction to enzymes; metabolism of carbohydrates, lipids, aminoacids; nucleic acids and protein synthesis; vitamins and hormones.

BIO C231 Biology Project Laboratory **3***

The course includes projects involving laboratory investigation or laboratory development in Biology. The course is normally available to students of second or higher level. The course must coterminate with a project report.

BIO C241 Microbiology **2 3 3**

Introduction and classification of microbes; structure and physiology of microbial cell; infection and immunity; host parasite relationship; microbiology of milk, air, water and food; physical and chemical methods of controlling microbes; experiments for isolation, cultivation, physiological and biochemical characterization of microbes.

BIO C312 Developmental Biology **3 0 3**

Scope and problems in developmental processes in biology, role of different animal and plant models, cell division and differentiation, cell interaction, genetic control of morphogenesis in vertebrate and invertebrates, tissue specific gene expression, organogenesis, germ cells and fertilization, apoptosis, genomic imprinting, sex determination, regeneration, teratology, post embryonic development, aging and senescence.

BIO C321 Cell Biology **3 0 3**

Fundamental processes of life at cellular and subcellular levels, cell environments, membrane transport, cell movements, division and control mechanisms.

BIO C322 Ecology **3 0 3**

Ecosystem productivity and trophism; environmental complex; limiting factors; population and community; ecological regulation; biogeographic regions; applied ecology.

BIO C331 Biophysics **3 0 3**

A study of molecules and their interaction forces; bioenergetics and physical techniques as applied to biological phenomena.

BIO C332 Genetics **3 0 3**

Facts and theories of heredity, their relation to the present state of biological theory in general; elements of population genetics; genetics and species concept.

BIO C342 General Physiology **3 0 3**

Basic functional processes in plants and animals; nutrition, photosynthesis, circulation, respiration, excretion, reproduction, hormonal mechanisms and irritability.

BIO C352 Cell and Tissue Culture Technology **3 0 3**

Theories and practices on *in vitro* techniques for plants and animals, development of normal and tumor cell lines, somatic hybridization, monoclonal antibody production, hairy root cultures, secondary metabolite production, scale-up strategies for large scale production of biomass.

BIO C391 Instrumental Methods of Analysis **4**

Principles, configuration, applications of instruments like mass spectrophotometer, NMR, UV, IR, X-ray apparatus, atomic spectrophotometer, gas chromatography, liquid scintillation spectrophotometer, laser device, high voltage electrophoresis, ultracentrifuge, DTA, TGA, etc.

The course is specially designed for students in the first degree majoring in experimental sciences and would require groups of students to work with the above instruments in order to appreciate the potentiality of such modern instrumental methods of analysis.

BIO C411 Laboratory **0 9 3**

Specially designed for M.Sc. (Hons). Biological Sciences; cannot be taken by others under any circumstances.

This laboratory course is designed only for M.Sc.(Hons) Biological Sciences students and aims to expose the students to and build competence in selected techniques of modern biology.

BIO C412 Introduction to Bioinformatics **3 0 3**

Introduction to genomics and proteomics, Human genome and other sequencing projects; Biological database and data mining; Similarity search and sequence alignment; Protein structure prediction and structure analysis; Use of software package in bioinformatics.

BIO C413 Molecular Biology of Cell **3 0 3**

Introduction of eukaryotic cell cycle, genetic regulation of cell cycle and differential gene expression during developmental process. In addition, the postulated functions of hitherto accepted non-essential DNA and the functioning of higher eukaryotic genes with unexpected structures in eukaryotic genomes would also be covered.

BIO C416 Immunology **3 0 3**

Introduction to immune system, cell mediated and humoral immunity, allergy, mechanisms of hypersensitivity reactions, immunity to infectious diseases, immune mechanisms involved in cancer and transplantation immunology.

BIO C417 Biomolecular Modelling **3 0 3**

Biomolecular Conformation, Structural genomics and proteomics, protein folding, Forecefield, Simulation, Conformational analysis, ab initio structure prediction, comparative modeling, lattice models, usage of modeling packages.

BIO C418 Genetic Engineering Techniques **1 9 4**

Experiments on the common molecular biology techniques used in gene manipulation in bacteria and plants; gene cloning procedure in bacteria – from isolation of plasmids to screening of recombinant clones; polymerase chain reaction (PCR) and its applications; gene and protein expression analysis; DNA sequencing; Agrobacterium-mediated gene transfer in plants and introduction to plant cell culture techniques; Use of software for molecular biology.

BIO C419 Molecular Evolution **3 0 3**

Introduction of evolution of macromolecules, reconstruction of evolutionary history of genes and organisms, evolutionary adaptation to temperature, water solute adaptation, dynamics of genes in populations, rates and pattern of nucleotide substitution, evolution of gene duplication and domain shuffling, concreted evolution of multigene family, genome organization and evolution, roles of mutation and selection in molecular evolution.

BIO C421 Enzymology **3 0 3**

Prerequisite : BIO C211

Enzyme nomenclature and classification; isolation and purification; structures; kinetics; regulation of enzymatic reactions; evaluation of enzymes and other proteins.

BIO C431 Reproductive Physiology **3 0 3**

Prerequisite: BIO C211

Study of sexual cycles; biochemistry of fertilisation; control of ovarian functions; gonadotropins; pheromones and mammalian reproduction.

BIO C441 Biochemical Engineering **3 0 3**

Principles of Chemical Engineering applied to Bioprocesses; Kinetic Models for growth, substrate utilization and product formation; Biological reaction kinetics and applied enzyme catalysis; immobilized biocatalysts; Bioreactor Design and Operation; Fermentation, Upstream & Downstream processing; Novel Bioreactor Configurations; Transport phenomena in Bioprocesses; Instrumentation and control; Bioprocess Optimization and Scale up; Industrial Protein Purification Techniques; Commercial Enzymes & Biopharmaceuticals; Bioprocess Patenting, Economics & Feasibility Studies.

BIO C451 Bioprocess Technology **3***

Bioprocess Principles; Kinetics of Biomass production, substrate utilization and product formation; Kinetics of enzyme catalyzed reactions and applied enzyme catalysis; Fermentation process parameters and controls, Upstream & Downstream processing; Bioreactor Design & Operation; Transport processes in Bioreactors; Novel Bioreactor Configurations; Immobilized biocatalysts; Bioconversion; Protein Purification; Industrial applications of Bioprocesses; Bioprocess Patenting & Economics.

BIO C461 Recombinant DNA Technology **3 0 3**

The course deals with theoretical aspects of recombinant DNA manipulation. Emphasis will be placed on procedures to create chemeric molecules using examples from actual experimental work. Vector designing, polymerase chain reaction, invitro mutagenesis and cloning in prokaryotic and eukaryotic vectors will be covered.

BIO C491 Special Projects **3**

This is an unstructured open-ended course where under the overall supervision of an instructor-in-charge, batches of students will be attached to different instructors. Each batch will work on a specific time-bound project which is of basic or peripheral concern of his discipline. Each student must submit a project report as a culmination of his endeavour and investigation. The instructor- in-charge will determine the choice of the project and also whether or not the project report is to be submitted jointly by a group or individually by a student. The course will aim to evaluate student's actual ability to use the fundamentals of knowledge and to meet new unknown situations as demonstrated by the students' interaction with the instructors and instructor-in- charge and aggregated in the project report. The instructor-in- charge may assign specific hours for formal brain-storming sessions.

BIO F110 Biology laboratory **0 2 1**

An introductory level course where students would perform selected experiments of biology in the laboratory so that they appreciate the concepts learnt in theory course. Experiments related to Microscopy and micrometry, quantification of biological macromolecules, chlorophyll estimation, measurement of solvent potential of plant tissue, measurement of parameters related

to cell cycle, Experiments related to hematology, DNA quantification from the plant organs; Water analysis.

BIO F111 General Biology 3 0 3

Course description is same as given under BIO C111**.**

BIO F201 Introductory Biology 3 1 4

Living systems and their properties; classification of organisms; biochemical pathways operative in organisms; introductory genetics, Introductory recombinant DNA technology, ecology and environmental scienes and related basic labs.

BIO F211 Biological Chemistry 3 0 3

The molecular process of life presents us with a seemingly never ending succession of chemical mechanisms of almost incredible fascination. This course is introduced at the cellular and molecular level and focus upon bio -macromolecules, biosynthesis of macromolecules, energy yielding and requiring processes, genetic information etc. This would help going for higher level activities, appreciation of biochemical problems, evaluation and problem solving. It also includes theory of techniques used in biochemistry and related experiments.

BIO F212 Microbiology 3 1 4

Introduction and classification of microbes; structure, physiology and genetics of microbial cell; isolation, cultivation, physiological and biochemical characterization of microbes; host parasite relationship; microbiology of soil, water and food; physical chemical methods of controlling microbes; antimicrobial drugs; clinical microbiology; and related lab components.

BIO F213 Cell Biology 3 0 3

Types and properties of cells; microscopy; membrane structure, function and transport; endomembrane system and its functions; nuclear organization and functions; ribosomes and protein synthesis; cytoskeleton; cell communication; cell cycle, cell growth and cancer; apoptosis; techniques, related experiments and applications of cell biology.

BIO F214 Integrated Biology 3 0 3

The Integrative Biology course is a course which bridges as well as opens new vistas to a student taking up bioogy. The course covers two tracks, essentially. The first track introduces the student to the ordering that helps biologists to actually study the vast diversity of the living world. This track would encompass questions related to the origin and evolutionary pathways followed in Nature, as well as the methods followed by biologists to systematically categorize and document them. The second track highlights the uses and applications of biology in everyday life – whether in the economic or in the social realms. Together, the course projects the subject in a way from which the student can choose and implement his biological knowledge vis-à-vis his/her interests.

BIO F215 Biophysics 3 0 3

A study of molecules and their interaction forces; bioenergetics and physical techniques as applied to biological phenomena and related labs.

BIO F231 Biology Project Laboratory 3

Course description is same as given under BIO C231.

BIO F241 Ecology and Environmental Sciences 3 0 3

Biotic and abiotic components of environment; limiting factors; regional ecology; ecosystem productivity and trophism; population and community ecology; succession and evolution; pollution; environmental biotechnology; Indian environmental movement. Associated with related labs.

BIO F242 Introduction to Bioinformatics 3 0 3

Introduction to genomic & Proteomics, Biological databases and data mining, sequence similarity search and sequence alignment algorithms, Phylogenetic tree construction algorithms, Protein structure predication and structure analysis, use of software package in Bioinformatics; Related lab components.

BIO F243 Genetics 3 0 3

Facts and theories of heredity, their relation to the present state of biological theory in general; elements of population genetics; genetics and species concept and related labs.

BIO F244 Instrumental Methods of Analysis 1 3 4

Principles, configuration, applications of instruments like mass spectrophotometer, NMR,UV, IR, X-ray apparatus, atomic spectrophotometer, Fluorescence Spectroscopy, gas chromatography, liquid scintillation spectrophotometer, laser device, high voltage electrophoresis, ultracentrifuge, DTA,TGA, Thermo Cycler-PCR, SDS-PAGE, ELISA etc. The course is specially designed for students in the first degree majoring in experimental sciences and would require groups of students to work with the above instruments in order to appreciate the potentiality of such modern instrumental methods of analysis.

BIO F266 Study Project 3

These courses include projects which are oriented towards readings from published literature or books about new frontiers of development or analysis of available database. These courses are normally available to students in second or higher levels. These courses must coterminate with project reports.

BIO F311 Recombinant DNA Technology 3 0 3

The course deals with theoretical aspects and lab exposure to selected experiments of recombinant DNA manipulation. Emphasis will be placed on procedures to create chimeric molecules using examples from actual experimental work. Vector designing, PCR, qPCR, DNA sequencing, in-vitro mutagenesis, cloning in prokaryotic and eukaryotic systems and whole genome

approaches will be covered with related lab components.

BIO F312 Plant Physiology 3 0 3

Basic functional processes in plants; Plant tissue system, Plant-water relations, Gaseous exchange, Stomatal regulations, Mineral nutrition and absorption, Transport of material, Growth and development, Hormones and PGRs, Photoperiodism, Vernalization, Plant defense mechanisms, Stress Physiology and related lab components.

BIO F313 Animal Physiology 3 0 3

Principles and concepts underlying the function of tissues and organ systems in animals, with emphasis on mammalian systems and integration of systems at the level of the whole organism. Several biological systems are considered, including respiratory, circulatory, nervous, endocrine, immune, excretory, muscles, skeletal and reproductive systems. Laboratory session will help to study function of any organ system; Related lab components.

BIO F314 Conservation Biology 2 1 3

Biological diversity: its measurement, value and crisis; conservation at ecosystem, population and species levels; protection, management and res-toration of ecosystems; sustainable development and community-based conservation; conservation legislation. Course practicum will be effected through classroom and field activities.

(This course is introduced in the pool of discipline electives for M.Sc. (Hons.) Biological Sciences programme).

BIO F341 Developmental Biology 3 0 3

Scope and problems in developmental biology; major model organisms (vertebrates, invertebrates and plants) and their life cycles; patterning and axis formation; morphogenesis; organogenesis; nervous system; germ cells and sex; cell differentiation and stem cells; growth, ageing and regeneration; applications of developmental biology. The course will emphasize universal principles that govern the process of development; Related lab components.

BIO F342 Immunology 3 0 3

Introduction to immune system, cell mediated and humoral immunity, immune system in health and disease immunity to infectious diseases, immune mechanisms involved in cancer, immunodeficiency and autoimmunity. Vaccination and transplantation Immunology; Related lab components.

BIO F352 Cell and Tissue Culture Technology 3 1 4

Theories and practices on *in vitro* techniques for plants and animals, development of normal and tumor cell lines, somatic hybridization, monoclonal antibody production, hairy root cultures, secondary metabolite production, scale-up strategies for large scale production of biomass.

BIO F366 Lab Project 3

BIO F367 Lab Project 3

These courses include projects involving laboratory investigation or laboratory development in the students discipline or interdisciplinary areas. These courses are normally available to students in third or higher levels. These courses must coterminate with project reports.

BIO F376 Design Project 3

BIO F377 Design Project 3

These courses are intended to impart training in design of product/ process or other artifact to the students in the discipline or interdisciplinary areas. These courses are normally available to students in third or higher levels. These courses must coterminate with project reports.

BIO F411 Laboratory 0 9 3

Specially designed for M.Sc. (Hons). Biological Sciences; cannot be taken by others under any circumstances.

This laboratory course is designed only for M.Sc.(Hons) Biological Sciences students and aims to expose the students to and build competence in selected techniques of modern biology.

BIO F413 Molecular Biology of Cell 3 0 3

Course description is same as given under BIO C413.

BIO F417 Biomolecular Modelling 3 0 3

Course description is same as given under BIO C417.

BIO F418 Genetic Engineering Techniques 1 3 4

Course description is same as given under BIO C418.

BIO F419 Molecular Evolution 3 0 3

Course description is same as given under BIO C419.

BIO F421 Enzymology 3 0 3

Course description is same as given under BIO C421.

BIO F431 Reproductive Physiology 3 0 3

Course description is same as given under BIO C431.

BIO F441 Biochemical Engineering 3 0 3

Course description is same as given under BIO C441.

BIO F451 Bioprocess Technology 3 0 3

Course description is same as given under BIO C451.

BIO F491 Special Projects 3

This is an unstructured open-ended course where under the overall supervision of an instructor-in-charge, batches of students will be attached to different instructors. Each batch will work on a specific time-bound project which is of basic or peripheral concern of his discipline. Each student must submit a project

report as a culmination of his endeavour and investigation. The instructor- in-charge will determine the choice of the project and also whether or not the project report is to be submitted jointly by a group or individually by a student. The course will aim to evaluate student's actual ability to use the fundamentals of knowledge and to meet new unknown situations as demonstrated by the students' interaction with the instructors and instructor-in- charge and aggregated in the project report. The instructor-in- charge may assign specific hours for formal brain-storming sessions.

BIO G510 Application of Computers and Statis- 5 tics in Biology

to data classification, analysis and probability; statistical inference – estimation and hypothesis testing; linear regression and correlation; design of experiments; analysis of variance; non parametric procedures & tests; statistical quality control; experimental design in clinical trials and validation; basic techniques in optimization. Introduction to computer and its components; operating systems; principles and use of standard software packages having application in drug design, development, analysis, etc.; principles of software creation; processing concepts, flow charting and algorithms, programming constructs, programming languages, program development sequence; information systems: need, significance concepts, their analysis, design and implementation; software life cycle with special reference to software planning and maintenance.

BIO G511 Population and Quantitative Genetics 5

Gene pool, allele frequency, genotype frequency, Hardy-Weinberg equilibrium & its complications, nonrandom breeding, genetic drift, genetic load, gene flow, selection, intensity of selection pressure, inbreeding & artificial selection, natural selection & polymorphism, neutral theory & evolution speciation.

BIO G512 Molecular Mechanism of Gene Ex- 3 2 5 pression

Prokaryotic and eukaryotic genomes and their topology: DNA - protein interactions; RNA transcription and transcriptional control; DNA replication; transcription in yeast; RNA processing; translation; mechanism of gene expression in pro and eukaryotes.

BIO G513 Microbial and Fermentation Technol- 3 2 5 ogy

Metabolic Stoichiometry- energetics, fundamentals of microbes and their morphology, Stoichiometry of cell growth and product formation, fermentation kinetics, phases of growth in batch culture, continuous culture and fed-batch cultures, kinetics of cell growth, product formation and substrate utilization-substrate and product inhibition kinetics, enzyme technology. Industrial Biotechnology- strain selection and improvement, media formulation and sterilization strategies, industrial applications, fermentation and product recovery, preparation of alcohols, antibiotics, organic acids, enzymes, bakery and dairy products, biopharmaceuticals, vaccine production.

BIO G514 Molecular Immunology 3 2 5

This course will deal extensively with topics like molecular basis of T and B cell antigen recognition and activation. Immunity to microbes and diseases caused by humoral and cell mediated immune responses will be covered and emphasis placed on congenital and acquired immunodeficiencies. Advanced topics like antibody engineering will be discussed with the help of review articles.

BIO G515 Stem Cell and Regenerative Biology 3 1 4

Introduction to stem cells and regenerative biology; embryonic stem cells, adult stem cells, manipulation of stem cells for replacing cells in diseased tissues; transplantation of embryonic and adult stem cells, replacing congenitally defective organs and damaged organs, tissue engineering, biodegradable and biocompatible materials, nano-devices, and regulatory perspectives.

BIO G516 Fermentation Processes (5*)

Introduction to Fermentation, fermentation processes, microbial organisms in fermentation, strain isolation, improvement and preservation, media formulation, sterilization, metabolic pathways and engineering, metabolite overproduction, detailed case studies on food fermentation including cheese, dairy products, bakery foods, wine, brandy, beer, and food related fermentation including single cell protein, baker's yeast, enzymes, organic acids, antibiotics, amino acids, bio-fuel, industrial alcohol. Preparation of vaccine, insecticides, alkaloids. Microbial transformation, Bioleaching, Fermentation economics.

BIO G517 Recombinant DNA Technology (3*)

The course deals with theoretical aspects of recombinant DNA manipulation. Emphasis will be placed on procedures to create chemeric molecules using examples from actual experimental work. Vector designing, polymerase chain reaction, invitro mutagenesis and cloning in prokaryotic and eukaryotic vectors will be covered.

BIO G522 Interferon Technology 3 1 4

Characterization, Functional activity, broad pleiotropic agents, antiviral, anti-angiogenic, antitumor, antiproliferative, immunomodulatory effect, specific receptor binding, mechanisms, sequencing, classification, Dosage formulation Therapeutic study, side effects, molecular manipulation and activity profile.

BIO G523 Advanced and Applied Microbiology 3 2 5

Molecular taxonomy, Systematic Microbiology; Study of molecular diversity of microorganisms, clinical microbiology, human-microbe interaction, molecular plant-microbe interaction, applied microbiology and synthetic microbiology.

BIO G524 Animal Cell Technology 3 2 5

Animal cell and tissue culture from various organisms, types of cell lines, development and maintenance of cell lines, manipulation and applications of cell culture technology for Biotechnological research and therapeutics implication**.**

BIO G525 Environmental Biotechnology and Waste Management 3 2 5

Applications of biotechnology to the management of environmental problems, role of biotechnology in increasing plant and animal production through biological insecticides, herbicide resistance, mineral cycling, conservation of genetic resources and biological nitrogen-fixation. Use of biotechnological processes in pollution control, bioremediation of toxicants, treatment of domestic and industrial waste will be emphasized. Ethical issues related with the release of genetically modified organisms would also be covered.

BIO G526 Cancer Biology 3 2 5

Basic concepts and molecular basis of cancer, Growth, Regulation and Metastasis, Cancer Immune system Interaction, Cancer therapy, Cancer and Environment, Cancer and society.

BIO G532 Biostatistics and Biomodelling 3 1 4

Probability analysis variables in biology; standard deviation and standard errors; correlation and correlation coefficient; regression analysis; significance test; chi-square and goodness of fit; applications of computers in statistics; handling of software on enzyme kinetics and protein sequence analysis; computer analysis of nucleic acid structure.

BIO G541 Neural Network Analysis 5

Basic concepts, Characteristics of nerve cells and neurons, Definition of artificial neurons, Algorithms, network topology and functions, Neural network application for learning, expert systems, knowledge representation, speech recognitions and synthesis, visual perception and pattern recognition and language processing: Emphasis will be on a comparative study with biological systems.

BIO G542 Advanced Cell and Molecular Biology 5

Eukaryotic cell cycle: restriction point, G1 phase progression, role of cyclins, cancer cell cycles; growth factors and their interaction with receptors: PDGF, EGF, VEGF, FGF, TGF; stress responses: mechanisms molecular biology with special reference to hypoxia; extracelular matrix and adhesion molecules; cytokines: sources, molecular structure, targets and mechanisms of action; apoptosis, caspases and necrosis.

BIO G544 Bioremediation and Bio-metallurgy 5

Applications of microbial metabolism for removal of toxic material from environmental sample and recovery of metals from low grade ore; metal- microbe interaction, comparison of conventional and microbe based processes of treating toxic waste material; steps in bioremediation processes such as preparation of biomass through genetic manipulations, immobilization, batch or continuous processes; applications of microbes in bioleaching process and recovery of copper, gold and nickel with case studies.

BIO G545 Molecular Parasitology & Vector Biology 5

Biology of parasitic diseases and their transmission in human and animal population by vectors/carriers. molecular aspects of parasite and vector biology, modes of infection, life cycles of parasite and vector, host - parasite interactions, infectivity pattern, mechanisms of drug resistance and immune evasion, methods of diagnosis, prophylaxis, treatments to parasitic diseases and vector control measures.

BIO G551 Membrane Biology 5

Concepts of biological membrane, Membrane constituents phospholipids, glycolipids and cholesterol; Membrane bilayers, amphipathic molecules, Self-assembly process; Membrane proteins, lateral and transverse diffusion, fluid mosaic model, Membrane permeability; Organization and dynamics of membrane, Signal transduction, role of carbohydrate components of membrane, Red-cell membrane proteins, Tools and techniques in membrane study: electron microscope, X-ray study, autoradiography and spectrometry. Immune response, Surface properties, Kinetics of membrane-bound processes.

BIO G561 Advances in Recombinant DNA Technology 3 2 5

Recent advances in high--- throughput genomics, proteomics and large--- scale mutagenesis; genomics techniques like transcriptome arrays and arrays for whole genome analysis; proteomics analysis techniques like 2D PAGE and MS; understanding genome and protein structures and protein interactions through yeast/bacterial two--- hybrid systems; large scale mutagenesis and interference.

Pre-requisite: **BIO F311** Recombinant DNA Technology

BIO G570 Recent Developments in Biology 1 0 1

The students will be exposed to recent advances / research in the area including but not restricted to animal, plants or microbial systems. There will be emphasis placed on understanding the applications and benefits of the in silico and/or wet lab approaches to the selected topics.

BIO G612 Human Genetics 3 2 5

Epigenetic and Chromosomal Control of Gene Expression**:** DNA methylation, Genomic imprinting and mammalian development. DNA damage & repair: Damage control during replication and mitosis, Genome stability and checkpoint control, Disorders related to aberrant

DNA repair. Molecular genetics of inherited disorders. Cancer genetics: Genetic analysis of various cancers, tumor suppressor genes, metabolic polymorphisms and cancer susceptibility. Genomics & Proteomics: Human genome project and its applications in Gene therapy, novel drug design approaches.

BIO G631 Membrane and Liposome Tech. 3 1 4

Membrane structure and biogenesis: techniques for the study of membrane structure and properties; model of membranes; molecular transport mechanisms; techniques of artificial membrane productions; liposomes - structure and characteristics; carrier mechanisms for targeting therapeutic agents; industrial applications of liposomes.

BIO G632 Transgenic Technology 3 2 5

Transgenic techniques as replacements of traditional breeding practices; understanding faulty gene pool; development of commercial and economically viable tissue culture and their genetic improvement through r-DNA strategies; development of recombinant transplants for improved genomic system.

BIO G641 Cell & Tissue Culture Technology 2 2 4

Plant and animal cell culture from various organism; types of cell lines; development and maintenance of cell lines; tissue culture for viral growth, hybridization and gene manipulation; hybridoma technology and protoplast fusion.

BIO G642 Experimental Techniques 4

Specially designed laboratory course which aims to impart training in selected range of techniques such as, salt fractionation, dialysis, PAGE with discontinuous buffer solution, Western Blotting, Ion-exchange chromatography and Gel filtration, Genomic DNA extraction from Human Blood, bacteria, purification of DNA and analysis, polymerase chain reaction, single, double and partial restriction digestion, construction of genomic DNA library, Southern Blotting, Karyotyping, short term lymphocyte culture, RNA extraction and quantification.

BIO G643 Plant Biotechnology 3 2 5

Plant cell and tissue culture, media constituents, micro propagation and other culture techniques, their applications and limitations, germplasm storage, secondary metabolite production, therapeutic protein and antibody production through plants, promoter designing and inducible promoters, molecular markers and their applications, approaches to influence metabolite partitioning and quality and quantity of plant storage products.

BIO G651 Protein and Enzyme Bioengineering 3 2 5

Sources, isolation, purification and storage of protein and/or enzymes; kinetics of enzyme catalyzed reactions; biocatalyst reaction engineering; techniques of production and recovery of enzymes; protein and enzyme modification; clinical and industrial applications of free and immobilized enzymes.

BIO G661 Gene Toxicology 3 1 4

Origin and fundamentals of Gene Toxicity; genotoxic effects in plants and mammalian systems; screening and measurements of genetoxicants; techniques in gene toxicology and their application to human, agricultural and environmental monitoring.

BIO G671 Bioconversion Technology 3 2 5

Waste and by-product utilization; downstream processing; biogas production; principles of biodegradation process parameters; bioreactor design and operation; exploitation of waste streams enzyme-based bioconversions of high value products.

Biotechnology

BIOT C216 Introductory Molecular Biology 3 0 3

Basic aspects of molecular biology, DNA replication, transcription, translation and control mechanisms of protein synthesis. DNA-protein interactions, post transcriptional modifications, regulation of gene expression, DNA repair. Current advances.

BIOT C332 Genetics 3 0 3

Course description is same as given under BIO C332.

BIOT C336 Cell Physiology 3 0 3

Fundamentals of structure and functioning of cells and organelles; cytoskeleton, cellular membrane, ultrastructural studies of bacterial, plant and animal cells and viruses; cellular homeostasis, respiration, bioenergetics, carbon and nitrogen fixation. Synthesis of biomolecules and homeostasis.

BIOT C337 Industrial Microbiology and Bioprocess Engineering 2 3 4

Principles and application of fermentation technology with respect to production of value added biotechnological products and strategies of improving production; development of biological processes associated with raw materials preparation to product recovery, relevant to industries as diverse as medical, food and environmental protection.

BIOT C338 Introduction to Environmental Biotechnology 3 0 3

Industrial processes, incorporating design and monitoring of waste treatment technologies; microbial removal and degradation of organics pollutants, phytoremediation of soil and water contaminated with toxic metals and radionuclides, wetlands as treatment processes, biofilms, biofilters for vapor-phase wastes, and composting; biosensors in environmental analysis, molecular biology applications in environmental engineering and genetic engineering of organisms for bioremediation.

BIOT C339 Biophysical Chemistry **3 0 3**

Course description is same as given under CHEM C341.

BIOT C343 Genomics **3 0 3**

Introduction to the field of genomics, structure of the human genome, and the strategies that are used to map and sequence the genome, how genomic sequence information is utilized for pharmacogenomics, drug discovery and diagnostics; post-genomics technologies such as bioinformatics, functional genomics and comparative genomics.

BIOT C344 Proteomics **3 0 3**

Introduction to proteome, significance and analysis of post-translational modification of proteins, protein-protein interaction; functions of all protein in light of the standard prokaryotic and eukaryotic models; methods of proteomic research, proteome analysis, resolution and identification of proteins.

BIOT C345 Immunotechnology **3 0 3**

Biotechnological aspects of immunological mechanisms, hybridoma technology and production of monoclonal antibodies, antibody engineering using genetic manipulations, alternatives to hybridoma technology for monoclonal antibodies, designing and building of mAb genes, primary and secondary libraries for antibody genes including production of humanized antibodies; monoclonal antibodies in diagnosis, therapy of allergic diseases, vaccine production, abzyme, purification, quantification and cytogenetic analysis.

BIOT C346 Experiments in Biotechnology **0 9 3**

Advanced molecular biology techniques such as genomic DNA isolation, plasmid DNA, single, double & partial digestion, construction of genomic DNA library, PCR, polymorphism in studies, southern blotting, RNA isolation, Real Time PCR, protein expression and analysis and immuno-histochemical techniques.

BIOT C413 Molecular Biology of Cell **3 0 3**

Course description is same as given under BIO C413.

BIOT C416 Immunology **3 0 3**

Course description is same as given under BIO C416.

BIOT C417 Biomolecular Modeling **3 0 3**

Course description is same as given under BIO C417.

BIOT C418 Genetic Engineering Techniques **3 0 3**

Course description is same as given under BIO C418.

BIOT C461 Recombinant DNA Technology **3 0 3**

Course description is same as given under BIO C461.

BIOT C463 Introduction to Immunology & Immunotechnology **3 0 3**

Types of immunity & immune response, Cells & ogans of immune system; Antigens, antibodies & complement, cellular responses, autoimmunity, autoimmune disorders & diagnosis; tumor immunoloy, immunity to infections, viral pathogenesis & immunity; monoclonal & polyclonal antibody prduction, antibody engineering; Use of monoclonal antibodies in diagnosis (antibodies & immunodiagnosis), therapy of diseases, vaccine production & immunological techniques.

BIOT C491 Special Projects **3**

Course description is same as given under BIO C491.

BIOT F211 Biological Chemistry **3 0 3**

Course description is same as given under BIO C211.

BIOT F212 Microbiology **3 1 4**

Course description is same as given under BIO C241.

BIOT F213 Cell Biology **3 0 3**

Course description is same as given under BIO C321.

BIOT F215 Biophysics **3 0 3**

Course description is same as given under BIO C331.

BIOT F241 Genetic Engineering Techniques **1 3 4**

Course description is same as given under BIO C418.

BIOT F242 Introduction to Bioinformatics **3 0 3**

Introduction to genomics and proteomics, human genome and other sequencing projects, biological databases and data mining, sequence similarity search and sequence alignment, protein structure prediction and structure analysis, use of software packages in Bioinformatics.

BIOT F243 Genetics **3 0 3**

Course description is same as given under BIO C332.

BIOT F244 Instrumental Methods of Analysis **1 3 4**

Course description is same as given under BIO C391.

BIOT F245 Introduction to Environmental Biotechnology **3 0 3**

Course description is same as given under BIOT C338.

BIOT F266 Study Project **3**

Course description is same as given under BIO F266.

BIOT F311 Recombinant DNA Technology **3 0 3**

Course description is same as given under BIO C461.

BIOT F314 Industrial Microbiology and Bio process Engineering **2 2 4**

Course description is same as given under BIOT C337.

BIOT F342 Immunology **3 0 3**

Course description is same as given under BIO C416.

BIOT F343 Experiments in Biotechnology 0 3 3

Course description is same as given under BIOT C346.

BIOT F344 Downstream Processing 2 1 3

Recovery and purification of biologically – produced products including biomass itself, extracellular and intracellular components; Strategies to recover and purify products, separation of insoluble products, cell disruption, separation of soluble products, finishing steps for purification, integration of reaction and separation.

BIOT F345 Proteomics 3 0 3

This course deals with the introduction to proteome, significance and analysis of post-translational modification of proteins, protein-protein interaction. Functions of all protein will be discussed in light of the standard prokaryotic and eukaryotic models. Emphasis will be given on methods of proteomic research, proteome analysis, resolution and identification of proteins.

BIOT F346 Genomics 3 0 3

This course provides an introduction to the field of genomics. It also covers the structure of the human genome, and the strategies that were used to map and sequence the genome, and details how genomic sequence information is utilized for pharmacogenomics, drug discovery and diagnostics. The course also introduces post-genomics technologies such as bioinformatics, functional genomics and comparative genomics.

BIOT F347 Immunotechnology 3 0 3

Immunotechnology is a specialised course, which deals with biotechnological aspects of immunological mechanisms Hybridoma technology and production of monoclonal antibodies, antibody engineering using genetic manipulations, alternatives to hybridoma technology for monoclonal antibodies, designing and building of mAb genes, primary and secondary libraries for antibody genes. Emphasis will be given on the production of humanized and human antibodies. Uses of monoclonal antibodies in diagnosis, therapy of allergic diseases, vaccine production, abzyme, purification, quantification and cytogenetic analysis.

BIOT F352 Cell and Tissue Culture Technology 3 0 3

This course will provide an introduction to theory and application of tissue culture technologies. The details of animal and plant tissue culture will be covered including design of media and large scale production of the animal and plant cells. The course also covers the various techniques of preserving the animal cell lines.

BIOT F366 Lab Project 3

BIOT F367 Lab Project 3

Course description is same as given under BIO F366 and BIO F367.

BIOT F376 Design Project 3

BIOT F377 Design Project 3

Course description is same as given under BIO F376 and BIO F377.

BIOT F413 Molecular Biology of the Cell 3 0 3

This course is designed to impart knowledge of molecular biology of the cell. Students will understand the various concepts related to cell structure and function at molecular level. : Molecular biology and nucleus, ultrastructure and cytochemical studies, membrane structure and function. Organelle involved in intracellular transport and cell signaling , cell sorting Cell junctions and adhesion molecules, Cell division and the Cell Cycle.

BIOT F416 Introduction to Pharmaceutical Bio- technology 3 0 3

The course is designed to provide advances in drug development, drug delivery systems and pharmaceutical specialties including polypeptides, proteins, viruses, DNA and antibiotics. It covers relevant aspects for the development of new bi technology based drugs, target identification, downstream processing and formulation. Special emphasis is given on understanding the mechanisms and process involved in diseases.

BIOT F417 Biomolecular Modeling 3 0 3

The course is designed to provide students the first hand experience of potential utility of biomolecular modeling especially in concurrent pharmaceutical research, and in cell and structural biology. It describes the functionality, advantages, and limitations of standard computing strategies for the simulation of biomolecules. Biomolecular Conformation, Structural genomics and Proteomics, Protein folding, Forecefield, simulation, Conformational analysis ,abinitio structure predictioncomparative modeling, lattice models , usage of modeling packages.

BIOT F420 Introduction to Plant Biotechnology 3 0 3

Introduction to plant tissue culture, Micropropagation, Somaclonal variation, meristem culture, Anther culture, Cell suspension culture, Secondary metabolite production, Protoplast isolation and Fusion, cryopreservation, Techniques for Plant Transformation – Agrobacterium and Biolistics, Transgenics in crop Improvement.

BIOT F422 Nanobiotechnology 3 0 3

The course deals with the principles and application of nano- and micro-fabrication methods to build tools for exploring the biological systems. The course includes interdisciplinary aspects of biology and nanotechnology on the principles of microfabrication techniques with a focus on nanoparticles, drug delivery systems, and interations with molecular and cellular level for biomedical and biological research applications.

BIOT F423 Drug design and delivery **3 0 3**

The objective of this course is to give insight into the principles of drug discovery and molecular mechanism of drug action. The course is designed for applications in the pharmaceutical and biotechnology related to identifying and optimizing a drug candidate for clinical development. Special emphasis is given on rational and systematic approaches to the development of novel classes of drugs against diseases and effective treatment.

BIOT F424 Food Biotechnology **3 0 3**

The course gives an overview on presence of microorganisms, their activity and control in food. It explores the scientific methods for measuring microorganisms and their products. Preservation techniques of foods, food safety, quality controls and food borne diseases are also discussed. The course also covers food fermentation and use of various microorganisms in preparation of fermented foods at industrial level.

BITS

BITS C211 Introduction to IPR **1**

Importance & relevance of IPR's in the globalised era; legislation covering IPR's in India; patents, copyrights, trademarks, industrial designs, trade secrets, geographical indications; procedures for filing IPR's in India, WTO, TRIPS agreement and their relevance to agriculture, industry education and service sector and others.

BITS C212 Introduction to Human Rights **1**

Relevance of human rights education in India: evolution of human rights and duties, human rights: international norms, human rights and duties in India, redressal mechanisms for human rights violations, deprivation of human rights: core issues; women and human rights and duties, good governance, science and technology and human rights.

BITS C213 Introduction to Environmental Studies **1**

Ecosystems, evolution and biodiversity; impact of population and economic growth on the environment; sustainable development and use of resources such as water, food, and energy; environmental quality – waste management, air and water pollution, hazards such as global warming, ozone layer depletion, acid rain, and nuclear accidents; sustaining environmental quality-economic, social, political and ethical issues.

BITS C214 Introduction to Mass Communication **3 0 3**

Mass communication: an overview, history of media and media plan, cinema, radio, television, theatre, advertising, audience and media, public relations, writing for media, new information technology: software revolution, internet, social media, video conferencing.

BITS C215 Applications of Bio-Medical Instrument tion Techniques in Healthcare **2 0 2**

Introduction to biomechanics, neuro-prosthetics based on function- sensory, motor, neuro prosthetics; based on regulation- person, auto regulated as adjuncts or alternates to therapy, implants, prosthetics for vision, audition, pain relief, pharmako-kinetic studies, brain-machine interface –methods, rapid prototyping technique in developing artificial bones, tissues, tendons, cartilages, and various applications of these techniques in improvement of health-care.

BITS C216 Selected Readings **3 0 3**

The course is intended to nurture the students' critical thinking and to enhance their skills at information gathering and expressing. Selected readings from books in the areas of History, Science & Technology, Culture, Literature, Art, Philosophy, Psychology, Religion, Development Concepts and Trends etc. will be assigned to the students. A set of books will be identified in at least two broad areas for study and analysis. This course is designed only for students of M.Sc.(Tech.) General Studies Programme.

BITS C217 Environment, Development and Climate Change **3 0 3**

Specific topics on environment, development and climate change; regional, national and international climate debates; review of international climate negotiations such as Kyoto, Copenhagen and other declarations; environment problems: causes, sustainability and policies; population, resources and sustainability; population dynamics, capacity and conservation; food security, poverty, impact and global solutions; energy resources: renewable, wind, oil, natural gas, nuclear energy; growth, technology and greenhouse gas emissions, carbon credit; regional impacts of climate change and adaptation strategies; techniques in modeling; water resources and pollution: monsoon, drought, rainwater harvesting, traditional practices in water conservation; case studies.

BITS C218 Public Policy **3 0 3**

Public Policy-meaning nature and types; approaches and models of public policy; nature of public process-process in the executive; parliamentary processes; processes to manage the ruling party-government interfaces; strategic thinking on the process of policy-making, judicial policy making.

BITS C221 Practice School I **5**

BITS C231 Practice School I **5**

BITS C241 Practice School I **5**

All the above courses are run during the summer term only. The operation of all these three courses will be identical in nature. However, BITS C221 will be a required course for all integrated First Degree students with Practice School option.

This course is also a prerequisite for BITS C412 Practice School II. BITS C231 may be available only to those students who have successfully cleared BITS C221 and BITS C241 is available only to those students who have successfully completed BITS C231. Thus BITS C231 and BITS C241 can be taken only as electives and are available only to highly motivated students if facilities are available after satisfying the needs of students who have to compulsorily register in BITS C221

BITS C224 Corporate Taxation 3 0 3

Corporation tax; assessing income from business; receipts less deductions: actual business expenses, scientific research; insurance premium, bonus, etc., interest, bad debts and other expenses for business; amortization of certain expenses, capital expenditure, allowances, carry forward losses and allowances; income from other heads, interest, dividends house property, deductions from gross total income, total income, taxable income, capital gains, mode of computation and deduction, personal income tax laws and provisions.

BITS C313 Lab Oriented Projects 3

BITS C314 Lab Oriented Projects 3

These courses include projects involving laboratory investigation or laboratory development in the students' discipline or interdisciplinary areas. These courses are normally available to students in third or higher levels. These courses must coterminate with project reports.

BITS C315 Multicriterion Decision Making in Engineering and Management 3 0 3

Introduction, Single Objective Optimization, Estimation of weights, Multiobjective optimization, Classification Methods, Discrete Multicriterion Decision Making, Fuzzy Logic based discrete MCDM, Correlation coefficients and group decision making, Advanced topics of decision making, Case studies.

BITS C318 Workshop on Film Production 1*

Introduction and Concept of Film-making, Script Writing, Screenplay, Equipment and Facilities, Film Shooting, Sound Recording, Dubbing and Voice Over, Film Editing, Finishing.

BITS C319 Negotiation Skills and Techniques 2 0 2

Overview, Negotiation styles, Negotiation process, Tactics in Negotiation, Handling conflicts in negotiation, Best Alternative to a Negotiated Agreement, Communication - Key to Effective Negotiating, Non-verbal communication in Negotiations, Emotions: dealing with others and ourselves, International negotiations, Cross Cultural Issues in Negotiations, Power in negotiation, Workplace Negotiations, Turning Negotiation into a Corporate Capability, Do's and Don'ts of Negotiations, Negotiating over the telephone/ Electronic media, Ethics in negotiation, Negotiation-Exercise.

BITS C320 Managerial Skills 2*

(= MBA C320)

The role of manager, team building and goal setting, basics of supervision, leadership, decision making, negotiation skills and techniques, how managers communicate, how to interview, process of induction, training and development, delegation, how to appraise employees, how to manage time, use of committees, how to handle meetings, how to handle complaints.

BITS C321 Legal and Economic Environment of Business 4*

Indian contracts act, sale of goods act, negotiable instruments act, companies act, corporate tax laws, consumer protection and unfair trade practices act, FEMA, Industrial policy, macroeconomic environment, fiscal and monetary policy, overview of Indian economy, economic indicators.

BITS C323 Study Oriented Project 3

BITS C324 Study Oriented Project 3

These courses include projects which are oriented towards readings from published literature or books about new frontiers of development or analysis of available data base. These courses

are normally available to students in third or higher levels. These courses must coterminate with project reports.

BITS C331 Computer Projects 3

BITS C335 Computer Projects 3

Prerequisite: Prior preparation for one's own CDC or for CDC of first degree for dual degree students.

These courses are intended to impart practical training to the students in the areas of computer software and hardware through specifically assigned one-semester projects. The projects would be person-oriented, individually supervised by a project guide and demand attainments of different dimensions and complexity depending on the student's earlier background and the objectives of the projects.

BITS C332 Culture and Significance of Modern Mathematics 3 0 3

Prerequisite: Prior preparation for one's own CDC or for CDC of first degree for dual degree students.

This course intends to give a guided tour of mathematics of the 20th century. Topics will be treated not for coverage of content but for giving the culture, excitement, flavour and relevance of modern branches of mathematics like topology, algebra, geometry, homology homotopy, undecidable problems, non-euclidean geometries, functional analysis, discrete areas of mathematics etc. The topics will be dealt with, in an expository manner with an attempt to show that mathematics is a challenging series of abstractions of concrete situation. Students may be required to do pro-

jects in one or more areas touched upon in class. The treatment will assume the mathematics already built in the core BITS courses of mathematics. The standard of treatment will be as in Bell's Development of mathematics, Courant and Robbins "What is Mathematics?"

BITS C333 Projects on Organisational Aspects 3

BITS C334 Projects on Organisational Aspects 3

These courses involve projects related to thrust areas where students are expected to get involved with planning, organisation and execution of new ideas and concepts. These courses are normally available to students in third or higher levels. These courses must coterminate with project reports.

BITS C341 Selected Computer Languages 3*

Prerequisite: TA C252

This course aims at inculcating programming and problem-solving skills using one or more of the higher level languages like C++, LISP and 4GLs; The choice of languages and the treatment may vary from semester to semester depending on various factors like emerging technologies and feedback from the industry.

BITS C342 Object Oriented Programming 3 0 3

Prerequisite: TA C162

Object orientation concepts and principles: abstraction, encapsulation, modularity, inheritance, and polymorphism; classes and objects; static and dynamic binding; class utilities; metaclasses; object oriented software engineering; programming and problem-solving using one or more of the popular object-oriented programming languages like C++ or Java.

BITS C364 Human Computer Interaction 3 0 3

Principles of human-computer interaction; Evaluation of user interfaces; Usability engineering; Task analysis, user-centered design, and prototyping; Conceptual models and metaphors; Software design rationale; Design of windows, menus, and commands. Voice and natural language I/O; Response time and feedback; Color, icons, and sound; Internationalization and localization; User interface architectures and APIs.

BITS C372 Data Communications and Networks 3 0 3

Communication Concepts; Data and Voice Communications; Hardware Systems and Configurations; Network Topologies and Design Aspects; Protocols; Networking Software; Local Area Networks; Network Security and Management; Emerging Trends in Communications.

BITS C381 TIC Projects 3

BITS C383 TIC Projects 3

These courses provide an avenue for first degree students who are normally in third year or in a higher class, to earn a letter grade credit for doing projects under the Technology Innovation Centre. These projects are sponsored by the industries which come to the Institute under the scheme for participating in Technology Innovation Centre. The projects are also supervised and monitored by the personnel from industry who visit as Associate Faculty. These courses are unstructured and would require all the rigor which the industry would demand.

BITS C382 Reading Course 3

BITS C385 Introduction to Gender Studies 0 3 3

Introduction to gender studies, Sociological theories about gender, Women's access to education, interest, access and role in science and technology from gender perspective, Gender bias, work place, women and employment opportunities, Women and Politics, women in *Panchayati Raj* Institutions, women and family, women and violence, dowry, women and law, women's movements, feminism, women and human rights, women and media, gender equity-policy issues, women and development.

BITS C386 Quantum Information and Computation 3 0 3

History and scope, introduction to quantum information, quantum bits (qubits), quantum parallelism, teleportation etc. Basic ideas of quantum systems, two-state systems, evolution of states, superposition, entanglement, quantum measurement, decoherence. Basic ideas of computation theories and models, computational resources, complexity. Quantum Gates: single qubit, multiple qubit gates, controlled gates, universal gates, measurement. Quantum algorithms, Deutsch', Shor's and Grover's Algorithms, quantum circuits. Quantum Fourier Transform and applications, Quantum Search Algorithm. Physical Implementation of quantum computation. Compression and transmission of quantum information, quantum noise, error-correction, coding and cryptography, complexity, fault-tolerant computation.

BITS C393 Current Affairs 3 0 3

Introduction, importance and scope; domains: political, social, religious, scientific, developmental, etc.; categories: controversial, non controversial, neutral; sources of information: newspapers, magazines, posters, pamphlets, manifestoes, etc.; reading skills: skimming, scanning, extensive and intensive reading; understanding, interpreting and analysing news, events and information; forming, balancing and expressing opinion.

BITS C394 Mass Media Content and Design 3 0 3

Types of Corporate Communication documents; Importance of corporate communication documents for stakeholders; Data collection for docments- Sources, types, methods; Analyzing and Organizing the content – preparing the drafts; Design Concepts; Design Technologies – Overview; Specific Design tools –

Dreamweaver, Macromedia Director, Adobe Premier, Photoshop, Flash; Integrating Content and Design.

BITS C395 Short Film and Video Production 3 0 3

Introduction; communication media formats like audio, film, video, audio recording and editing; image composting; script writing : screenplay; equipment: video cameras, film cameras, the lens, the camera; the film stock: negatives, prints, aspect ratio, grain, gauge, speed, colour contrast, tone; handling the camera; image technology, sound technology; basic filming techniques: lights and lighting, shooting, sound recording, sound track, dubbing, voice over; visual effects, editing: familiarization with editing software, mixing and looping; Final production.

BITS C396 Reporting and Writing for Media 3 0 3

Reporters and their functions; What makes news; Analysing the components; Getting the information and putting it together; Organizing a news story; Building colour into news stories; Fighting the formula story ; Writing Leads; Message molecules (Vocabulary, grammar, Spelling), Human Interest and Depth Report; Finding and using news sources; Basics of ethics in Journalism.

BITS C397 Techniques in Social Research 3 0 3

Principles of social research, research process, stages of social research, choosing the research problem, objectivity and subjectivity in social research, ethics in social research, ethical codes of practice, confidentiality and anonymity, privacy, Effects of Value in social research, constructing social explanations, descriptive studies, explanatory studies, designing a social research proposal, quantitative research, survey, sampling, SPSS, various statistical tests, qualitative research, observation: participant and non-participant, issues in conducting qualitative research studies, case studies of socio-economic, political, health, gender and developmental issues, interview as social interaction, ethnographic research, field study, hypothesis testing, analysis of data, report preparation and documentation, factors limiting application of social research, evaluation research and development of social indicators.

BITS C398 Creative Multimedia 2 2 3

Imaginative and creative communication skills, interactive multimedia applications incorporating various aspects of rich media; digital screen design, typography, non linear editing, animation techniques, sound design and editing, testing and managing multimedia products, post production techniques.

BITS C412 Practice School II 20

BITS C413 Practice School II 20

The above two courses will be operated identically with stipulated prior preparation conditions as per the Academic Regulations. BITS C412 is a required course for all students with practice school option either for a single degree or for one of the degrees under dual degree scheme. BITS C413 has been created as a required course if a dual degree student is allowed a practice school option for a second degree after he has completed a practice school option for one degree.

BITS C428 Essentials of Strategic Management 3 0 3

Difference between Strategy and Organizational effectiveness; Tools for internal and external strategic analyses; Environmental Scanning and Industry Analysis; Market opportunities and internal sources of competitive advantage; Value chain analysis; Corporate level, Business level and Functional strategies; Strategy implementation.

BITS C432 Entrepreneurship 3 0 3

Meant for senior students who are close to completing their graduation requirements Small scale industry; growth and structure of Indian economy; identification of specific industry and product; market evaluation; description of the manufacturing processes; machinery and equipment requirements; building and site requirements; recurring cost; management; human relationship; product distribution; finance management and accounting; projects; system design of a small scale industry.

BITS C421T Thesis 15

BITS C441T Seminar 1

BITS C422T Thesis 15

BITS C442T Seminar 1

The above two pairs of courses BITS C422T and BITS C442T and BITS C421T and BITS C441T will be operated identically with stipulated prior preparation conditions as per the Academic Regulations. BITS C422T and BITS C442T are required courses for all students with Theses and Seminar option either for a single degree of for one of the degrees under dual degree scheme. BITS C421T and BITS C441T have been created as required courses if a dual degree student is permitted Thesis and Seminar option for a second degree after he has completed Thesis and Seminar option for one degree.

BITS C452T Independent Study 1

BITS C461 Software Engineering 3*

Prerequisite: TA C252

Software engineering concepts and methodology; formal requirements specification; estimation; software project planning; detailed design; techniques of design; productivity; documentation; programming languages styles, code review; tool, integration and validation; software quality assurance; software maintenance; metrics, automated tools in software engineering.

BITS C462 Renewable Energy 3 0 3

Introduction of renewable energy, advantages, poten-

tial, status of development, broad details of different renewable energy systems such as solar, wind, biomass, microhydel, geothermal etc; Renewable energy development policy, Renewable energy industries, international co-operation, HRD and career growth opportunities, consultancy areas and future thrust areas in renewable energy development.

BITS C463 Cryptography **3 0 3**

Objectives of cryptography; ciphers – block and stream; mathematical foundations – modular arithmetic, finite fields, discrete logarithm, primality algorithms; RSA; digital signatures; interactive proofs; zero–knowledge proofs; probabilistic algorithms; pseudo-randomness.

BITS C464 Machine Learning **3 0 3**

Neural networks; neuro-computing theory and applications, knowledge representation; computational learning theory; statistical/probabilistic methods, genetic algorithms; in ductive/analytic/reinforcement learning and bayesian networks; selected topics such as alpha-beta pruning in game trees, computer models of mathematical reasoning, natural language understanding and philosophical implications.

BITS C465 Enterprise Computing **3 1 4**

Overview of enterprise applications and their architecture-Building distributed multi tier applications using enterprise java–Packaging and deploying enterprise applications into application servers- Development of web applications using java servlets -java server pages and java server faces - Usage of JDBC for database driven enterprise applications -Enterprise java support for building soap and Rest enabled web services-Enterprise application integration using software components -Enterprise java beans-Message based communication between enterprise application components using JMS-Need for handling data persistence in database driven applications in an object-oriented manner –Usage of java persistence API for handling data persistence-Need for security of enterprise applications-Securing enterprise java applications using java based Glassfish application server-Configuring glassfish server for SSL security-Working with Realms, Users, Groups, and Role for client authentication-Overview of dot net framework for building distributed enterprise applications-Dot net framework: windows presentation foundation windows communication foundation-asp.net and ado.net

BITS C466 Service Oriented Computing **3 1 4**

Introduction to Web Services: Distributed computing using software component technologies like DCOM and EJBs-overview about Service Oriented Architecture- RPC and Document centric SOAP enabled web services-Describing information using XML -SAX and DOM based XML parsers-XSLT-XPath. SOAP Protocol for web services- Describing Web Services using WSDL-Publishing and Finding web services using UDDI Registry-UDDI SOAP APIs-Inquiry APIs-Publisher APIs. Web Services security –Need for secured web service-confidentiality of web service invocation using XML encryption and its advantages over SSL security -Integrity of soap message using xml digital signing-Maintaining confidentiality and integration together for soap messages -Authentication mechanisms for Web service client – Security Assertion Markup Language- Incorporating saml assertions for web service client authentication- IP layer security for web service- Need for work flow of web services-Usage of Business Process Execution Language for describing workflow of web services-Rest web service, its protocol and usage-Usage of Ajax in invoking Rest web service-Role played by web services in cloud computing.

BITS C467 Bioethics and Biosafety **3 0 3**

Introduction to the need and issues governing biosafety, legal, ethical and social implications of human gene manipulation, guidelines for research in transgenic organisms and plants, socio-economic impacts of biotechnological experiments, GLP and MGP and CPCSEA guidelines, patent processing, ethics in stem cell research, animal cloning and organ transplants, environmental pollution-hazards and control, public education and participation in biosafety.

BITS C468 New Venture Creation **3 0 3**

Entrepreneurship as career option, idea to opportunity – market analysis and segmentation, presenting a pitch deck, building the startup team, competition analysis, lean startups, product development, intellectual property, sales and marketing, business models, financing, launching a business, growth and exit strategy, social entrepreneurship, business plan presentation skills.

BITS C469 Financing Infrastructure Projects **3 0 3**

Investment decisions in infrastructural projects: benefit cost analysis, measurement problems, indirect estimation methods of benefits; Cost of capital: private and public money, different schools of thought on social capital- cases; Multiple projects and constraints: linear and integer programming models, goal programming formulation; Financing infrastructure projects: venture capital, sources of capital–private and public participation, modes of cooperation such as BOOT and BOT national and international sources, international agencies, borrowing terms and conditionalities; Public policy issues, leasing and mortgaging, evaluation issues, infrastructural mutual funds, valuation aspects; Real options, value of option for delay, abandonment and vacant land – judgmental assessment of options; post review and administrative issues in project management, international (cross country) projects, implementation issues.

BITS C471 Management Information Systems **3 0 3**

Introduction to Information Systems; Concepts of

management, concepts of information, systems concepts; Information Systems and Organizations; decision making process; database systems; data communications; planning, designing, developing and implementing information systems; quality assurance and evaluation of information systems; future developments and their organizational and social implications; decision support system and expert systems.

BITS C472 e-Business 3 0 3

e-business evolution & opportunities; categories of e-business; e-business models; network infrastructure & web based tools for e-business; e-business risks & risks management; network security and firewall; cryptography and authentication; billing/payment systems; regulatory environment of e-business; ERP/SCM/CRM and web based marketing; business intelligence & intelligent systems; data warehousing and data mining; implementing e-business systems & change management. Case studies and projects in e-business areas; emerging e-business scenarios.

BITS C473 Nonlinear Dynamics and Chaos 3 0 3

Chaos – definitions, characteristics, and measures; Examples of chaotic systems; Nonlinear dynamics and chaos – state space, Poincare sections, Iterated maps, Period-doubling; Quasi-periodicity, Intermittency, fractals; computer simulations of chaotic systems; Selected topics and applications of chaos theory; Examples will be drawn from different disciplines in science, engineering, and social sciences.

BITS C474 Rural Infrastructure Planning 3 0 3

Local level government structure; planning methodology and budgeting; regional economics; link of rural infrastructure with poverty alleviation and employment creation; sustainable livelihood approach; participatory planning; Integrated Rural Accessibility Planning (IRAP): need based approach, planning objectives, access needs, questionnaire preparation and data collection, quantification of accessibility, identification of problems and their prioritization, identification, screening and ranking of projects, selection of project and its location, action plan for implementation; Introduction to software such as: HDM (Highway Development and Management System) and RED (Road Economic Decision Model) etc.

BITS C481 Computer Networks 3 0 3

Introduction, history and development of computer networks; Reference models; Physical Layer: theoretical basis, transmission media, types of transmission; MAC sub-layer: local area networks, FDDI; Data Link Layer: Sliding Window protocols, design aspects; Network Layer: routing algorithms, congestion control algorithms, internetworking: Transport Layer: Integrated Services Digital Network (ISDN). Asynchronous Transfer Mode (ATM) - reference models, service classes, switch design, LAN emulation; Application Layer protocols.

BITS C482 Creating and Leading Entrepreneurial Organizations 3 0 3

Fundamentals of entrepreneurship; elements of leadership; identifying business opportunities; market study and research; business plans; finance, issues in raising finance; venture capitalist evaluation of business plans, technical aspects for the project, corporate strategies for growth; legal aspect to entrepreneurship, people skills, marketing and branding; creativity and communication.

BITS C483 Indian Wisdom for Modern Management 3 0 3

The blind management; the identity crisis – family business; the mistaken judgment; the management of man, mind, methods, and materials; the management methods for man management; the management methods for mind (individual); the management methods for mind (total); the basic quality of an efficient manager; the commonsense factor of an efficient manager, clarity about goals and priority fixations; duty-oriented life style vs. right-oriented life style; inner equipoise leading to inner strength; a portrait of a balance manager; secrets of a Karmayogi; the cardinal principles supporting excellence in life.

BITS C484 Introduction to Conflict Management 3 0 3

Characteristics and dynamics of conflict, reasons for conflict; the value of conflict in social change; the different approaches to addressing and managing conflict; Examining the history and impacts of a conflict; exploring stakeholder power and relationship; assessment of options to address conflict; tools for determining the best strategy; incentive sand methods in getting stakeholders to collaborate; active listening; skills in mediation and facilitation; roles of mediator and facilitator in conflict management; dealing with emotions and difficult situations; planning and preparing for negotiations; improving negotiation skills; joint problem solving approaches; building agreements; building conflict management mechanisms and consensus-building strategies.

BITS C485 Marketing Audit 3 0 3

Prerequisite: FIN C431/MGTS C322

The marketing process, marketing planning, the customer audit, the product audit, the service business, the competitive climate, setting objectives and strategies, advertising and sales promotion, the buying process, the sales plan, sales force management, the pricing plan, the distribution plan, marketing information and forecasting, implementing marketing plan, diagnosing problems in marketing.

BITS C486 Product and Brand Management 3 0 3

Scope of product Policy Decisions; Product-Market strategy; Product Life Cycle and Strategy; Managing Product Deletion; Product Associations; Branding including aspects of brand name selection; Brand Equity

and its utilization for marketing decision making; Brand Extension: use for brand names for launching new products; New product development process; Idea Generation and Screening; Concept Development and Evaluation; Product Design and Testing; Market planning; Testing the market plan; Marketing research process; Adoption and Diffusion of products; Organizing for new and existing product.

BITS C487 Global Business, Technology and Knowledge Sharing **3 0 3**

Changing corporate landscape, New knowledge industries, networking and interdependence, Technology: a fundamental driving force, WTO. Global Business Environment, Intellectual Property Rights (IPR), FDI, trends in India and comparison with China. Technology import and export, Technology transfer and adaptation. Need for technology intermediation, newly emerging techno-business opportunities, technology forecasting, technology assessment, technical actions. The role of small and medium enterprise's and the changing roles of enterprises. Leadership for the inter-networked business, Employment and Jobs, access and equity, quality of life, global knowledge innovation infrastructure.

BITS C488 Services Management System **3 0 3**

Understanding Services, the Service Sector today, Designing the Service Enterprise, Technological Issues, Structuring Service Operations, Processes Management, Staffing for Services, Functions of Services Management System, Client Relationships, Measuring and Reporting Services.

BITS C489 Enterprise Resource Planning **3 0 3**

Introduction to ERP; Re-engineering and ERP systems; ERP planning, design, and implementation; ERP systems – sales and marketing; ERP systems – accounting and finance; ERP systems – production and materials management; ERP systems – human resources; Managing and ERP project; Supply chain management and e-Market place.

BITS C493 Business Analysis and Valuation **3 0 3**

(= MBA C493)

Theory of finance, value maximization, stakeholder theory, and corporate objective function: value creation – ways and means, business analysis: The techniques of strategy and competitive analysis, value chain analysis for competitive advantages, business valuation – approaches and methods, the dark side of valuation: strategic investment decisions.

BITS C494 Environmental Impact Assessment **3 1 4**

Environment and global problems; Framing Environmental issues; effects of infrastructure development on environment; prediction and assessment of environmental impacts of infrastructure projects: technical and procedural aspects, guidelines and legal aspects of environmental protection, impacts on air, water, soil and noise environment, valuation, strategic assessment, mathematical modeling for environmental processes; social impact assessment (SIA), dislocation/disruption impact of Infrastructure projects; Life Cycle Assessments (LCA) and risk analysis methodologies; mitigation of environmental impacts; case studies; environmental management plan (EMP), national and international certification and guidelines including ISO.

BITS C790T Independent study **2**

BITS C791T Teaching Practice I **1**

BITS C792T Teaching Practice II **1**

BITS C797T Ph.D. Seminar **2**

BITS C799T Ph.D. Thesis **40 (Max)**

The registration in this course will be for a minimum of 10 units in any semester.

BITS E511 Computer Applications I **4**

BITS E512 Computer Applications II **4**

This is a package of two courses in sequence, the second reinforcing the content of the first in scope or depth. Each one ends with a project report. These two courses would aim at training student in skills of computer applications through examples as well as through requirement of project work. In the process, the courses are expected to create an awareness in the student's mind of computer usage in his own work setting.

Recognizing that input to the programme is unlikely to be in a narrow band, it is visualized that students for these courses will come with different levels of computer competence in their previous training, formal or informal. Understandably, these courses will therefore aim to take that background for each student and come out with admissible and acceptable outputs in the areas of computer application.

BITS E521 Technical Communication I **4**

BITS E522 Technical Communication II **4**

This is a package of two courses in sequence, the second reinforcing the content of the first in scope or depth. Each one ends with a project report. These two courses will attempt, through examples and through project-work, to build up improved communication skills with the present technology as well as exposure to new communication technology for the student in the broad areas of his own professional orientation and aptitude.

BITS E531 Social, Behavioral and Economic Sciences I **4**

BITS E532 Social, Behavioral and Economic Sciences II **4**

This is a package of two courses in sequence, the second reinforcing the content of the first in scope or

depth. Each one ends with a project report. These two courses will deal with methods and techniques through which social, behavioral and economic situations under professional settings are focussed, analyzed and used for application conditions. Various aspects thus covered would be organizational behavior, group dynamics, personnel, legal functions, government and business, managerial economics, finance, accounting and budgeting, corporate planning, project appraisals, etc. While course No. I will aim at an integrated exposure (in the context) through examples as well as through requirement of project work as drawn against the student's professional backdrop, course No. II will consist of a deeper investigation undertaken by the student in relation to the above vis-a-vis a defined problem-solving situation.

BITS E533 Modern Experimental Techniques I 4

BITS E534 Modern Experimental Techniques II 4

This is a package of two courses in sequence, the second reinforcing the content of the first in scope or depth. Each one ends with a project report. These courses will deal with modern experimental techniques and measurement techniques. Students will be encouraged to use instrumental methods of analysis dealing with advanced analytical instruments in conducting their experimental work.

BITS E535 Management Methods and Techniques I 4

BITS E536 Management Methods and Techniques II 4

This is a package of two courses in sequence the second reinforcing the content of the first in scope or depth. Each one ends with a project report. These two courses will attempt through examples and through requirement of project work, to bring to the attention of the student certain basic management concepts which are manifest in the professional setting in which the student functions. Various concepts thus covered will be planning, organizing, directing and control, production, marketing, etc. While course No. I will aim at providing an integrated exposure in the above context, course No. II will require student to undertake deeper investigation(s) in the context against well-defined situation(s).

BITS E537 Systems Science and Engineering I 4

BITS E538 Systems Science and Engineering II 4

This is a package of two courses in sequence, the second reinforcing the content of the first in scope or depth. Each one ends with a project report. The attempt through these courses would be to create an awareness in the student's mind of the systems approach the aspects of micro as well as macro design in the setting of his own professional operation through examples as well as through requirement of project report(s). Thus, these courses would introduce students to methods and techniques from areas of information processing, systems analysis, systems planning and operation and systems optimization. While course No. I will introduce the student to an integrated view of the above methods and techniques constituting elements of systems science, course No. II will require him to carry out an intense investigation in the context against a defined professional situation identified in terms of his own work setting.

BITS E541 Chemical and Life Science I 4

BITS E542 Chemical and Life Science II 4

This is a package of two courses in sequence, the second reinforcing the content of the first in scope or depth. Each one ends with a project report. These two courses, will cover areas of Modern Biology together with Structural Chemistry and expose students to recent developments in organic and biochemistry and to certain extent developments in molecular biology. Some part of the training and exposure will deal with modern experimental techniques and measurement techniques.

BITS E543 Instrumentation Engineering I 4

BITS E544 Instrumentation Engineering II 4

This is a package of two courses in sequence, the second reinforcing the content of the first in scope or depth. Each one ends with a project report. These two courses will attempt through short and long projects to bring to the student's attention certain basic design and implementation concepts relating to instrumentation for better plant efficiency and modern engineering operations. The

aspects, which would thus be covered, would pertain to planning and executing modernization of instrumentation in defined situations.

BITS E545 Projects and Consultancy I 4

BITS E546 Projects and Consultancy II 4

This is a package of two courses in sequence, the second reinforcing the content of the first in scope or depth. Each one ends with a project report. These courses would attempt to give the experience to the students in handling various types of projects and get involved in the process of consultancy. The work will encompass all factors starting with organizing the details and the scope of the project, planning of manpower and other resources, financial estimates, etc. which are to be matched with Institutional goals. The student will go through the experience of various stages of implementation of the projects including the drafting of its final report. While the course No. I will introduce the student to individual components of project/consultancy work, course No. II will aim to integrate the above knowledge for the fulfillment of ultimate objectives.

BITS E547 Public Administration I **4**

BITS E548 Public Administration II **4**

This is a package of two courses in sequence, the second reinforcing the contents of the first in scope or depth. Each one ends with a project report. These courses will introduce the students to the various aspects in which an administrator plays a vital role, whether it is personnel policies or financial administration or an implementation of law and this will be done through participation in a work associated with these aspects. Further, the student learns the role of an administrator in a society where planning, management and social aspirations have to be finally achieved with or without the help of a legislative/statutory solution.

Thus, the student has to involve himself in situations where decision making, coordination and supervision of various functions are the issues in an organization. While course No. I will provide the students the elements of administrative methodologies, course No. II will require him to pursue a deeper investigation in the context against defined situation(s) consistent with his professional background.

BITS E551 Physical and Mathematical Sciences I **4**

BITS E552 Physical and Mathematical Sciences II **4**

This is a package of two courses in sequence, the second reinforcing the content of the first in scope or depth. Each one ends with a project report. These will be analysis-oriented courses, where one has to draw heavily upon background of physics and modern mathematics. Some part of the training and exposure will deal with modern experimental and measurement techniques.

BITS E561 Use of English for Professional Purposes I **4**

BITS E562 Use of English for Professional Purposes II **4**

This is a package of two courses in sequence, the second reinforcing the content of the first in scope or depth. Each one ends with a project report. These courses will revolve around professional involvement of a student in the skill areas of handling English language and communication as defined in terms of technological, professional, scientific and social science situations. This package is specially designed for students who apply their training in English language in the above-defined situations to the production of technical outputs along with a group of technologists.

BITS E571 Methods of Planning and Development I **4**

BITS E572 Methods of Planning and Development II **4**

This is a package of two courses in sequence, the second reinforcing the content of the first in scope or depth. Each one ends with a project report. These courses would attempt to introduce the student to planning and development methods in terms of development definitions, strategies of development, mobilization of internal and external inputs for development, planning methods, factors affecting statutory administrative and financial decisions, project implementation, etc. The student, depending on his professional setting would be expected to study the above aspects of planning and development in situations of R&D, production, maintenance, social science, university development, planning & implementing new institutions and organizations, etc. While course No. I will provide the student an integrated understanding of planning and development methods, Course No. II will require him to pursue a deeper investigation in the context against defined situation(s) consistent with his professional background.

BITS E573 Study in Advanced Topics I **5**

BITS E574 Study in Advanced Topics II **5**

In these courses students will be assigned study work in advanced areas of professional interest. Each student will work under the overall supervision and guidance of a faculty member and will in the end submit a project report encompassing critical review of the material studied. The organization and evaluation of the course would be achieved through seminars, group discussions, project report etc. The course will be conducted by the team of teachers who provide guidance for study work.

BITS E583 Case Studies I **4**

BITS E584 Case Studies II **4**

This is a package of two courses in sequence, the second reinforcing the content of the first in scope or depth. Each one ends with a project report. These courses using case methods of education, will introduce students to issues relating to modern technology application(s) as drawn from broad spectrum of activities. Consistent with the professional background of the student and his operational setting, these activities would be identified in terms of process plants, engineering and design organization, pharmaceutical units, science centers, R&D activities, social & service sectors, university environment; etc. Various Technological issues thus covered would range from Techno-Economic Decision to Design, Commissioning & Production to operations & Maintenance to Resource Management to Planning of Management Information System etc. While Course No. I will introduce the student to an integrated view on decision making in respect of complete cycle mentioned above, course No. II will require him to pursue a deeper investigation in the context against a defined industrial behavioral social problem.

BITS E591 Science and Technology Development I **4**

BITS E592 Science and Technology Development II **4**

This is a package of two courses in sequence, the second reinforcing the content of the first in scope or depth. Each one ends with a project report. These two courses will deal with issues relating to science and technology development. Towards this end, the method of teaching will heavily draw upon the examples as well as the requirement of project work consistent with the student's professional background. Thus, depending on the professional setting, the courses will cover various aspects of science and technology development in respect of science policy, R&D management, technology forecasting, science communication, science centres, rise of technological order, etc. While course No. I will aim at providing an integrated exposure to the student in the above context, course No. II will end up with analysis of a specific science and technology application situation for development.

BITS E593 Reading Course I **5**

BITS E594 Reading Course II **5**

BITS E611 Internship I **20**

BITS E612 Internship II **20**

Each of these courses will span a period of five and half months. Consistent with the student's Professional background and operational setting,the student will be required to carry out work-oriented projects. In their operation these courses will imitate internship under M.E.(Collaborative) programme, thus enabling the student to play the role of an understudy.

BITS E661 Research Methodology I **5**

BITS E662 Research Methodology II **5**

These two courses, to be offered in two consecutive semesters, are designed to impart training in methodology of research such as analysis of research problems, mathematical and statistical analysis of data, computer simulation methods, experimental techniques etc. The actual contents of these course will depend upon the needs and research goals of a particular student. A project report has to be submitted by each student at the end of each course.

The organization and evaluation of these courses would be achieved through seminars, group discussions, project reports etc. The courses will be conducted by a team of teachers.

BITS E793T Practice Lecture Series I **1**

BITS E794T Practice Lecture Series II **1**

BITS F110 Engineering Graphics **1 2 2**

Introduction to AutoCAD basic commands; theory of projections; orthographic projections; isometric projections; projection of points, lines, planes and solids; section of solids; developments of surfaces; interpenetration of solids.

BITS F111 Thermodynamics **3 0 3**

Course Description is same as given under ES C112

BITS F112 Technical Report Writing **2 0 2**

Overview of communication, elements of effective writing, formal reports, types of reports, preparatory steps for writing reports, methods and sources of data, use of illustrations, oral presentation.

BITS F113 General Mathematics I **3 0 3**

I. Review of coordinate geometry, Theory of equations, Progression and series, permutations and combinations, Binomial theorem, Functions: Trigonometric (with identities), Transcendental.

II. One Dimensional Calculus: Limit and continuity, Differentiation, Integration. Applications of derivatives and definite integration.

BITS F114 General Mathematics II **3 0 3**

I. Polar coordinates, Function of several variables, Multiple integrals, Vector valued functions.

II. Complex functions and their analyticity.

III. First order and second order ordinary differential equations, Laplace transformations and its applications to ordinary differential equations.

BITS F201 Material Science and Engineering **3 0 3**

Introduction on materials for engineering, structures of metals, ceramics and polymers; crystalline structure imperfections; amorphous and semi-crystalline materials (includes glasses, introduction to polymers); Correlation of structure to properties and engineering functions (mechanical, chemical, electrical, magnetic and optical); phase diagrams; Improving properties by controlled solidification, diffusion or heat treatment; Failure analysis and non-destructive testing; Types of materials (includes synthesis, Fabrication and processing of materials): Polymers and composites, Environmental degradation of materials (corrosion); Evolution of materials (functional materials, Biomimetic materials, energy saving materials etc); Criteria for material selection.

BITS F211 Introduction to IPR **1**

Course description is same as given under BITS C211.

BITS F212 Introduction to Human Rights **1**

Course description is same as given under BITS C212.

BITS F213 Introduction to Environmental Studies **1**

Course description is same as given under BITS C213.

BITS F214 Science, Technology and Modernity **3 0 3**

Interrelationship between science, technology and modern society; forms in which beliefs and values of a modern society shape sciences and technologies; forms in which scientific discoveries and technological developments influence and shape modern societies. Scientific Revolution and the emergence of modernity as a social condition; Enlightenment promise of progress within the economic system of capitalism. Some critiques of the received view; recent phase of capitalism and the role of technology in globalization.

BITS F215 Applications of Bio-Medical Instrumentation Techniques in Healthcare **2 0 2**

Introduction to biomechanics, neuro-prosthetics based on function- sensory, motor, neuro prosthetics; based on regulation- person, auto regulated as adjuncts or alternates to therapy, implants, prosthetics for vision, audition, pain relief, pharmako-kinetic studies, brain-machine interface –methods, rapid prototyping technique in developing artificial bones, tissues, tendons, cartilages, and various applications of these techniques in improvement of health-care.

BITS F217 Environment, Development and Climate Change **3 0 3**

Course description is same as given under BITS C217.

BITS F218 General Mathematics III **3 0 3**

Linear equations and matrices, Determinants, Basis of R^n, Eigen Value, Eigen Vector, Linear transformations on R^n.

Linear Programming: Geometric Solutions, Simplex Method, Duality, Post optimal Analysis, Transportation and Assignment Problem. Nonlinear Programming (Unconstrained optimization).

BITS F219 Process Engineering **2 1 3**

Processes and equipment's involved in extraction and clarification; mixing and granulation; preparations such as aromatic waters, spirits, syrups, elixirs, lotions, liniments, official solutions, etc.; galenical products like infusions, decoctions, tinctures, extracts, etc.

BITS F221 Practice School I **5**

BITS F231 Practice School I **5**

BITS F241 Practice School I **5**

All the above courses are run during the summer term only. The operation of all these three courses will be identical in nature. However, BITS F221 will be a required course for all integrated First Degree students with Practice School option. This course is also a prerequisite for BITS F412 Practice School II. BITS F231 may be available only to those students who have successfully cleared BITS F221 and BITS F241 may be available only to those students who have successfully cleared BITS F231. Thus BITS F231 and BITS F241 can be taken by highly motivated students if facilities are available after satisfying the needs of students who have to compulsorily register in BITS F221.

BITS F311 Image Processing **3 0 3**

Course description is same as given under EA C443.

BITS F312 Neural Networks and Fuzzy Logic **3 0 3**

Introduction to neural networks, neural dynamics; activations and signals; activation models; unsupervised and supervised learning rules and their domain of applications; architectures of neural systems; Fuzzy sets, fuzzy binary relations; fuzzy logic, fuzzy reasoning; applications in decision making, control theory, adaptive fuzzy and neural control systems and their comparison; Concepts in control systems : stability, state variable, controllability, regression and optimization; mathematical models in control; conventional controllers : design, tuning; Relations, design of fuzzy control systems; control using ANN; Hybrid control, Neuro-fuzzy, GA and bio-inspired optimized control; Case studies on applications of neural, fuzzy and hybrid techniques.

BITS F313 Multicriterion Decision Making in Engineering and Management **3 0 3**

Introduction, Single Objective Optimization, Estimation of weights, Multiobjective optimization, Classification Methods, Discrete Multicriterion Decision Making, Fuzzy Logic based discrete MCDM, Correlation coefficients and group decision making, Advanced topics of decision making, Case studies.

BITS F316 Nonlinear Dynamics and Chaos **3 0 3**

Course description is same as given under BITS C473.

BITS F319 Negotiation Skills and Techniques **2 0 2**

Course description is same as given under BITS C319.

BITS F320 Managerial Skills **2***

Course description is same as given under BITS C320.

BITS F321 Legal and Economic Environment of Business **4***

Course description is same as given under BITS C321.

BITS F331 Quantum Computation and nformation I **3 0 3**

History and scope, introduction to quantum information, quantum bits (qubits), quantum parallelism, teleportation etc; Basic ideas of quantum systems - two-state systems, evolution of states, superposition, entanglement, quantum measurement, decoherence; Basic ideas of computation theories and models : computational resources, complexity; Quantum Gates - single qubit and multiple qubit gates, controlled gates, universal gates, measurement; Quantum algorithms - Deutsch', Shor's and Grover's Algorithms; quantum circuits, quantum Fourier Transform and applications, quantum search algorithm; Physical Imple-

mentation of quantum computation Compression and transmission of quantum information, quantum noise, error-correction, coding and cryptography, complexity, fault-tolerant computation.

BITS F333 Project on Organisational Aspects 3

Course description is same as given under BITS C333.

BITS F334 Project on Organisational Aspects 3

Course description is same as given under BITS C334.

BITS F343 Fuzzy Logic and Applications 3 0 3

Course description is same as given under EA C482.

BITS F345 Information Law and Cyber Law 3 0 3

Information related crimes and Cyber-crimes and methods to contain them; National and International laws and IT acts. Economic considerations related to the use and management of digital data; Legal and policy issues, rights, responsibilities, and potential liabilities of parties in information exchange and digital transactions; Cyber laws; Introduction to intellectual property, IPR, legal and technical aspects; Digital rights management: Tools, Standards and Techniques.

BITS F351 Nonlinear Dynamics and Chaos 3 0 3

Dissipative systems; Bifurcations in maps & differential equations (1-d, 2-d, 3-d) – saddle node, transcritical, pitchfork, Hopf, etc.; Application of bifurcation analysis to various systems in natural & engineering sciences; Chaos; Routes to chaos; Quasiperiodicity; Intermittency; Fractals & strange attractors; Conservative systems.

BITS F364 Human Computer Interaction 3 0 3

Course description is same as given under BITS C364.

BITS F372 Data Communications and Networks 3 0 3

Course description is same as given under BITS C372.

BITS F381 TIC Projects 3

Course description is same as given under BITS C381.

BITS F382 Reading Course 3

Course description is same as given under BITS C382.

BITS F383 TIC Projects 3

Course description is same as given under BITS C383

BITS F385 Introduction to Gender Studies 3 0 3

Course description is same as given under BITS C385.

BITS F386 Quantum Information and Computation 3 0 3

Course description is same as given under BITS C386.

BITS F398 Creative Multimedia 2 2 3

Course description is same as given under BITS C398.

BITS F399 Humanistic Theories of Science and Technology 3 0 3

Ways of considering the interrelationship among three of the major dimensions of our culture: its science, its technology and its humanistic orientation. Alternative ways of thinking about science and technology, diverse approaches of humanistic scholarship to studying science and technology, along with their historical sources. Approaches by social scientists to analyze technical fields of science and technology.

BITS F407 Selected Readings 2 0 3

The course is intended to nurture the students critical thinking and to enhance their skills at information gathering and expressing. Selected readings from books in the areas of History, Science & Technology, Culture, Literature, Art, Philosophy, Psychology, Religion, Development Concepts and Trends etc. will be assigned to the students. A set of books will be identified in at least two broad areas for study and analysis.

BITS F412 Practice School II 20

BITS F413 Practice School II 20

The above two courses will be operated identically with stipulated prior preparation conditions as per the Academic Regulations. BITS F412 is a required course for all students with Practice School option either for a single degree or for one of the degrees under dual degree scheme. BITS C413 has been created as a required course if a dual degree student is permitted a Practice School option for a second degree after he has completed Thesis option for one degree.

BITS F414 Introduction to Bioinformatics 3 0 3

Course description is same as given under EA C414.

BITS F415 Introduction to MEMS 3 1 4

Course description is same as given under EA C415.

BITS F416 Introduction to Nanoscience 3 0 3

Course description is same as given under EA C416.

BITS F417 Microfluidics and Its Application 4*

Course description is same as given under EA C417.

BITS F418 Introduction to Biomedical Engineering 3 1 4

Introduction; Engineering principals applied for physiological phenomena; Bio implant materials:Metallic, ceramics; Polymeric materials for bio applications; Protein-biomaterial surface Interactions;Modification of surface of the biomaterials; Tissue engineering;Drug delivery systems, principals,and applications; Biomedical sensors; Modeling and simulation.

(This course is introduced in the pool of discipline electives for B.E. (Hons.) Chemical programme.The course is also included in the list of pool of elective courses for M.E. Chemical and M.E.Chemical with

specialization in Petroleum Engineering programmes).

BITS F419 Management of Cross-cultural Engineering Teams **3 0 3**

[Course Description is same as University of Southern California, ISE499 by mutual agreement.

Course Description of University of Southern California, ISE499 is reproduced below:

Characteristics of open technological innovation in competitive global market. The dynamic interaction between technological innovation and market competition – the S-curves. Standard battles to shape the dominant design of a new technology – Cross-the-Chasm and timing of entry. Competitive strategy of companies in different market segments – the Segment-Zero Principle.Commoditization of technology and product on global market – out-sourcing and off-shoring. Blueocean strategy to innovate new breakthrough products.

BITS F421T Thesis **16**

BITS F422T Thesis **16**

The above two courses will be operated identically with stipulated prior preparation conditions as per the Academic Regulations. BITS F421 is a required course for all students with Thesis option either for a single degree or for one of the degrees under dual degree scheme. BITS F421 and BITS F422 have been created as required courses if a dual degree student is permitted Thesis option for a second degree after he has completed Thesis option for one degree.

BITS F423T Thesis **9**

BITS F424T Thesis **9**

Course description of the above two courses is same as given under BITS F421T/BITS F422T. However Thesis with this course number will be available with concurrent coursework for at most 9 Units over a full semester duration.

BITS F428 Essentials of Strategic Management **3 0 3**

Course description is same as given under BITS C428.

BITS F429 Nanotechnology for Renewable Energy and Environment **3 1 4**

Basics of nano physics, macro vs. nano. Solar cells: Organic solar cell, quantum dot solar cell, dye sensitized solar cell. Self cleaning in solar panel. Fuel cell: Nano electrode and catalysts. Batteries: Nano electrode based batteries. Catalysts: H2 production and H2 storage. Carbon nano tube for energy. wind energy: Nanocomposites, nanocoating, and nanolubricants. Nanotechnology as tool for sustainability. Environmental fate & transport of nanomaterials. Nanomaterials for ground water remediation. Nanomaterials as adsorbents. Toxicity of nanomaterials, Ecotoxicological impacts of nanomaterials, Societal implications of nanotechnology.

Prerequisites:

BITS F201 Material Science & Engineering (or equivalent) OR CHEM F333 Chemistry of Materials OR PHY F414 Physics of Advanced Materials.

BITS F430 Renewable Energy Laboratory **0 2 2**

Experiments on generation of photovoltaic power, wind energy, geothermal energy, fuel cell energy, piezoelectric energy harvesting, smart grid, micro grid, etc.

BITS F431 Flexible Manufacturing Systems **3 2 4**

Course description is same as given under EA C412.

BITS F437 Technical Communication **3 0 3**

Overview of technical communication, verbal and non-verbal communication, elements of effective writing, technical report, technical proposal, research paper, dissertation, thesis, presentations and group discussions.

BITS F441 Robotics **3**

Course description is same as given under EA C441.

BITS F442 Remote Sensing and Image Processing **3**

Course description is same as given under EA C442.

BITS F444 Artificial Intelligence **3**

Course description is same as given under EA C461.

BITS F445Neural Networks and Applications **3 0 3**

Course description is same as given under EA C463.

BITS F446 Pattern Recognition **3**

Course description is same as given under EA C471.

BITS F447 Multimedia Computing **3 0 3**

Course description is same as given under EA C473.

BITS F448 Retail Management Systems **3 0 3**

Course description is same as given under EA C474.

BITS F449 Financial Engineering **3 0 3**

Course description is same as given under EA C475

BITS F461 Software Engineering **3**

Course description is same as given under BITS C461.

BITS F462 Renewable Energy **3 0 3**

Course description is same as given under BITS C462.

BITS F463 Cryptography **3 0 3**

Course description is same as given under BITS C463.

BITS F464 Machine Learning **3 0 3**

Course description is same as given under BITS C464.

BITS F465 Enterprise Computing **3 1 4**

Course description is same as given under BITS C465.

BITS F466 Service Oriented Computing 3 1 4

Course description is same as given under BITS C466.

BITS F467 Bioethics and Biosafety 3 0 3

Course description is same as given under BITS C467.

BITS F468 New Venture Creation 3 0 3

Course description is same as given under BITS C468.

BITS F469 Financing Infrastructure Projects 3 0 3

Course description is same as given under BITS C469.

BITS F482 Creating and Leading Entrepreneurial Organizations 3 0 3

Course description is same as given under BITS C482.

BITS F488 Services Management Systems 3 0 3

Course description is same as given under BITS C488.

BITS F489 Enterprise Resource Planning 3 0 3

Course description is same as given under BITS C489.

BITS F493 Business Analysis and Valuation 3 0 3

Course description is same as given under BITS C493.

BITS F494 Environmental Impact Assessment 3 1 4

Course description is same as given under BITS C494.

BITS G501 Biostatistics 5

Methods of collection and presentation of statistical data; calculation and interpretation of various measures like mean, median, mode, standard deviation, kurtosis, correlation coefficient; probability distributions; sampling and estimation of parameters; tests of hypothesis; data analysis. Introduction to data classification, analysis and probability; statistical inference – estimation and hypothesis testing; linear regression and correlation; design of experiments; analysis of variance; non parametric procedures & tests; experimental design in clinical trials and validation; basic techniques in optimization.

BITS G511 Advanced Project 5

This course is designed to permit treatment of an advanced area in a discipline or interdisciplinary pursuit to meet the objectives of acquisition of additional competence by the student and also development of new areas of study or lab. The course will be characterized by minimum formal contact and maximum self- study under immediate supervision by the teacher.

BITS G512 Object Oriented Programming 2 2 4

Basics of object oriented programming: objects, classes, instances; inheritance; polymorphism; operator overloading; static and dynamic binding; small talk, C++, cases from other object oriented languages like Ada, Loop, Flavors, Objective-C, etc.; object oriented software engineering.

BITS G513 Study in Advanced Topics 5

In this course students will be assigned study work in advanced areas of professional interest. Each student will work under the overall supervision and guidance of a faculty member and will in the end submit a project report encompassing critical review of the material studied.

The organisation and evaluation of the course would be achieved through seminars, group discussions, project report etc. The course will be conducted by the team of teachers who provide guidance for study work.

BITS G514 Environmental Health 3 0 3

Environmental Health and its importance, water pollution, air pollution, automobile pollution, pollution due to chemicals used in agricultural sector, handling and disposal of domestic and industrial refuse, incineration of waste materials, techniques for studying, monitoring and controlling pollution, effect on health, vector control, effect of high frequency electromagnetic radiation, nuclear radiation, hazardous wastes, occupational health.

BITS G515 Management Principles and Practices 4*

Management concepts and functions; Decision process; Marketing variables, analysis and research; Services marketing; Financial transactions and statements; Financial planning and control; Manpower planning and development; Personnel appraisal, General administration.

BITS G521 Fourth Generation Languages and Applications 1 3 4

Nature of 4GLs; application generators; RDBMS and 4GLs; SQL based 4GLs; 4GLs and development of information systems and decision support systems; other types of 4GLs; case studies.

BITS G522 Software Development Standards 1 3 4

Standards and their role in software development; Institutions involved in formulating and promoting standards; operating environment standards; POSIX; software design standards; diagramming standards; coding standards; language design, code generation and usage standards; software portability and standards; standards in software development tools; standards in compilers and interpreters; open systems; OSI; user interface standards.

BITS G529 Research Project I 6

BITS G539 Research Project II 6

This is a package of two courses dealing with an advanced pursuit in terms of a study project or a lab project in assigned areas of professional interest. Each student will work under the overall supervision and guidance of an assigned teacher. The second course may be a continuation of the task engaged in the first course; or the two courses may be independent of each other. Each course must end with a well-defined

project report outlining all the investigative efforts and conclusions.

BITS G540 Research Practice 4*

This course is designed to train the students towards acquiring competence in research methodologies. The course will be conducted in terms of actual participation in Research and Development Work. Each student will be assigned to a faculty member to work on specified projects. The student will be required to present a number of seminars in his research area in a structured manner.

BITS G541 User Interfaces 1 3 4

Emerging importance of user interfaces; user interface management systems; designing UIMS toolkits; hardware and OS aids in user interface development; human & psychological factors in user interface design; theories, principles and guidelines; emerging interaction styles; menu selection systems, command languages, direct manipulation; interaction device; hypertext; standards in user interface design and implementation; case studies from Domain Dialog; Apple's user interface; Open Look; OSF/Motif.

BITS G553 Real Time Systems 3 1 4

Real time software, Real time operating systems-scheduling, virtual memory issues and file systems, real time data bases, fault tolerance and exception handling techniques, reliability evaluation, data structures and algorithms for real time/embedded systems, programming languages, compilers and run time environment for real time/embedded systems, real time system design, real time communication and security, real time constraints and multi processing and distributed systems.

BITS G554 Data Compression 3 1 4

Introduction: the need for data compression. Information theory and data compression; Entropy, Relative entropy and mutual information. Fano's inquality. Types of information sources, and source extension. Asymptotic equipartition property and data compression. Entropy rates of stochastic processes. Kraft inequality, Prefix codes, Huffman codes and Arithmetic coding. Quantization and Rate distortion theory. Lossy image compression techniques based on DCT, VQ and Fractals. Introduction to wavelets: continuous and discrete wavelet transforms. Filter banks and wavelets. Frames and tight frames. Wavelet packets. Wavelet based signal processing. Joint source and channel coding.

BITS G560 Practice School 20

BITS G561T Dissertation 25 (Max)

BITS G612 Methods and Techniques of Sys- 2 3 5 tems Engineering

This course would cover various systems engineering methods and techniques in the context of their application to the design, implementation and operation of large, humanly-contrived soft systems. The techniques would be chosen from amongst linear programming, integer programming, queuing theory, inventory control, simulation, maintenance models sampling techniques, forecasting techniques, decision models, network scheduling methods etc. These would be applied in the context of resource planning, facility location, manpower planning, financial management, decision-making, maintenance issues, construction and operation scheduling; planning research issues; social assessment of technology; issues of technology-economy nexus etc.

BITS G613 Systems Analysis for Large Systems 2 3 5

System thinking and approach; concepts of systems with special reference to large, humanly-contrived soft systems; review of mathematical techniques and principles of economics and management required for systems engineering of such systems; modelling and systems engineering methodology for large soft systems.

BITS G619 Professional Practice 4

This course will aim to achieve a professional development of the student in the context of the overall goal of his/her programme. Depending upon the profession, this course will be conducted in terms of actual participation in professional activities such as teaching, laboratory organization, course development, organizational development, R&D work, design, production, data organization, data preparation or management of institutions/ hospitals/voluntary organizations, etc. The course will also deal with communication aspects such as teaching a course, presenting a paper in the seminar/conference, articulating ideas and concepts to professional audience/customers, etc. This course will also deal with the laws and ethics concerned with the profession of an individual.

BITS G620 Professional Practice I 3

BITS G621 Professional Practice II 3

These two courses, to be offered in two consecutive semesters, are designed to train the students towards acquiring competence in teaching as well as in research methodologies. The course will be conducted in terms of actual participation in professional activities such as teaching, laboratory organization, course development, R & D work, etc. Each student will be assigned under a faculty member to work on specified projects, and to assist the faculty in teaching and research activities. The student will be required to present a number of seminars in a group in a structured manner.

BITS G624 Computer Based Simulation and 2 3 5 Modelling

Discrete event simulation on computers; Systems simulation & simulation languages; GASP & GPSS; Continuous simulation - languages and modelling techniques; Forrester's models; case studies.

BITS G629T Dissertation 25 (Max)

This is a required component for all higher degree students except for those who opt and are selected for practice school programme. The unit requirements will vary from 12 to 25 units. It may be registered for one full semester (12 to 25 units) after completing all courses or may be registered for varied units (4 to 10 units) along with other courses.

BITS G630T Dissertation 25 (Max)

Course description is same as given under BITS G629T.

BITS G639 Practice School 20

A higher degree student if permitted can register in this course in lieu of Dissertation only after the completion of all course work. Concurrent registration of other courses with this course is not permitted. All clauses of Academic Regulations applicable to First Degree Practice School courses will govern the operation of this course.

BITS G640 Practice School 20

Course description is same as given under BITS G639.

BITS G641 Management Information and Decision Support Systems 2 3 5

Data & information; characteristics of information; components of management information systems; information flows; design and maintenance of management information systems; decision support systems.

BITS G644 Development and Use of Computer Software 5

Concepts and operations of processors; concept, capabilities and types of software; review and case studies of computer applications. Principles and use of standard software packages. Principles of software creation: processing concepts, flowcharting and algorithms, programming constructs, programming languages, program development sequence. Concepts of data and information: files and databases, logical data storage structures. Information Systems: need, significance, concepts, their Analysis, Design and Implementation. Software Engineering: software life cycle, with special reference to software planning, software requirements and software maintenance. The course would terminate with a term paper on a specialised area of the development and use of computer software.

BITS G649 Reading Course 5

BITS G651 Project Formulation and Preparation 2 3 5

This course is designed to inculcate principles of technical documentation as required within S&T organizations. Through this course, students are expected to acquire familiarity with several of the following: Proposals, feasibility reports, formal project reports, short reports, memos, negotiations, contracts, etc. In the process principles of project formulation and evaluation, such as technical considerations; performance specifications; preliminary block diagrams, types and analysis of contracts; cost estimation concepts, work breakdown structure; project data preparation, scheduling facilities etc., would be introduced. The course would invariably include the preparation of a detailed report embodying as many of the above concepts as appropriate.

BITS G654 Advanced Instrumentation Tecniques 5

Generalized approach to measuring systems; performance characteristics of instruments; primary sensing elements and transducers; analog and digital signal conditioning operations; microprocessors in instrumentation; applied process control instrumentation; General purpose and analytical instruments covering spectroscopic, separation, atomic absorption instruments UV-VIS-IR,GLC, HPLC, etc; Instrumentation practices in typical R&D laboratories; instrumentation case studies covering selection, quality assurance, system design, etc; Hands on experience in operation of sophisticated instrumentation systems.

BITS G659 Technical Communication 3 1 4

Role and importance of communication; effectiveness in oral and written communication; technical reports; technical proposals; technical descriptions; definitions and classifications; business correspondence; précis writing; memorandum; notices, agenda and minutes; oral communication related to meetings, seminars, conferences, group discussions, etc.; use of modern communication aids.

BITS N101T Physical Fitness, Health and Wellness 1

Basic Exercise - warm-up and warm-down exercise, Calisthenics and its importance, Cardio-respiratory or endurance exercises - various forms of endurance exercise, exercise with intensity and duration for physical wellness; strength training exercise; various strength exercises and their importance, free hand weight training; flexibility exercise and wellness and relaxation exercise including stretching & yoga. This course can be taken only on audit.

Courses on Development Process

CDP C211 Agricultural Growth of India 3 0 3

Planning and policy problems-agricultural policy in India since independence, planning for agriculture, growth and inequality in agriculture; production modes and Institutions-technical relations in agriculture, farm mechanisation; agricultural labour market, land reforms and the changing agrarian structure; resources for production-fertilizer in India's agricultural development, motive power and energy use in agriculture, education and agricultural growth, technological change, extension, and innovation - new technology,

problems & potentialities, dry farming technology, integrated rural development; role of agriculture looking ahead - India's crop output trends, past and present; forecasting agricultural production.

CDP C212 Industrial Growth of India 3 0 3

Concept and problems of industrialization; industrialization in developing countries; industrial growth and planning in India since 1947, emerging industrial structure in India; problems and prospects of some industries namely: steel, foundry, iron ore, aluminium, machine tool industry, cement, chemicals petrochemicals, fertilizer, oil industry, coal industry, power generation, textile, handloom, jute, sugar, vanaspati, plantations, paper, rubber, drug and pharmaceuticals; issues bearing on industrial growth in the 1980s.

CDP C221 Growth of Social Health in India 3 0 3

Planning and development of public health in India; public health administration at centre and in the states; environmental sanitation; prerequisites of healthy life-water, air and ventilation, food and housing; family planning and population control; school health, rural sanitation; sanitation of camps, fairs and festivals; social security and health services; comprehensive health care; social medicine, health education, health statistics and statistical methods.

CDP C231 Transport and Communication 3 0 3

Review of transport development in India, transport under the five year plans, growth of transport, trends in traffic, imbalances in the transport system, a new evidence on traffic flow; machinery for coordination of transport policy at the centre and state levels; transport planning and data base; transport research training; railways; road development; road transport; urban transport; air transport; coastal shipping; inland water transport; ports and harbours; ropeways and pipelines.

CDP C313 Security Analysis & Portfolio Management 3 0 3

Introduction to investment and securities; profile of financial assets; new issue market or primary market, initial public offerings (IPO); secondary market; framework of risk & return; fundamental analysis- economy, industry; company analysis; stock evaluation models; multiple holding period and multiple growth rate; bond analysis and bond management strategies; technical analysis; efficient market theory; portfolio management; Markowitz model; Sharpe's Single Index model; capital asset pricing model; financial derivatives-options & futures.

CDP C323 Functions and Working of Stock Echanges 3 0 3

Stock exchanges in India: regulations governing formation and working; trading and settlement procedures; review of the working of stock exchanges in India. National stock market system; OTCEI; listing requirements. requirements for membership of stock exchange; responsibilities of stock brokers in regard to contracts and accounts, duties and responsibilities to stock exchange, public and members interset; securitiescontracts act, by-laws and regulations; SEBI guidelines; trading in stock exchanges; insider trading: SEBI guidelines; dealings in debentures; rating of debentures; trading in government securities; potential for trading in derivatives.

CDP C332 Contemporary India 3 0 3

Topics will include some or all of the following: economic process; contemporary Indian planning and industry; political processes; Contemporary Indian political scene and Indian administration: India and the contemporary world; social processes: contemporary Indian educational scene; religion and caste system; Indian science; Indian women; cultural processes; contemporary Indian art, music, dance, theatre, cinema and literature.

CDP C364 Industrial Relations 3 0 3

Introduction to human resources management; planning and organising human resources; leadership and motivation; job satisfaction and morale; employee communication; audit and control; procurement of personnel; performance appraisal; human resource development; wage and salary administration; job change; discipline; labour welfare; trade unions and collective bargaining; industrial disputes; worker participation in management.

CDP C371 Development Economics 3 0 3

Concept of development; statistical foundation of decisions; nutrition, disease and climate as influences on growth; critical importance of population; importance of agriculture, international trade and industry; cost-benefit analysis and planning process.

Civil Engineering

CE C212 Transport Phenomena I 3 0 3

Concepts and definitions, Fluid pressure and measurement, Hydrostatics, Buoyancy, Fundamentals of fluid flow, equations of motion and energy equation, impulse momentum equation, applications, flow through pipes, Laminar flow, Dimensional analysis.

CE C241 Analysis of Structures 3 0 3

Determinacy and indeterminacy, work and energy principles, fixed beams, continuous beams, frames and trusses, slope deflection and moment distribution methods, maxwell's reciprocal theorems, rolling loads and influence lines, Muller Breslau's principles, arches, multistory frames, stiffness and flexibility methods, introduction to plastic theory.

CE C322 Construction Planning and Technology 3 0 3

Development of model-based planning; control and reviewing Civil Engineering construction; network based methodology; cost- duration studies and resources allocation, case studies, major construction problems;

principal building system as affected by environmental, legal, material and industrial constraints; interrelationships among the components of the systems; fundamental systems of enclosure-load distribution and environmental control; assembly line process.

CE C342 Water and Waste Water Treatment 3 2 4

Water supply and waste water systems; capacity requirements; analysis of water and waste water; treatment requirements; unit operations and processes of treatment, design of treatment units; disposal waste water and sludge; design of sewers and water distribution networks; rural sanitation, effluent repurification and reuse.

CE C361 Soil Mechanics and Foundation Engineering 3 2 4

Origin and classification of soils; physicochemical properties; effective stress concept; steady state flow-Darcy's law, permeability; one-dimensional consolidation; shear strength under different drainage conditions, Mohr-Coulomb theory; slope stability; earth pressures; stress distribution in soils; bearing capacity; shear failure and settlement; design of footings; pile foundations, group of piles; well foundations; machine foundations; foundations on black cotton soil; soil stabilization.

CE C371 Hydraulics and Fluid Mechanics 3 2 4

Turbulent flow through conduits; lift and drag; pipe networks; boundary layer theory; open channel flow; uniform and varied flow; hydraulic jump; elements of sediment transport; introduction to hydrology and hydrological cycle; elements of meteorology; precipitation; mean depth of rainfall over area; evaporation, transpiration and evapotranspiration; interception and infiltration;run off and factors affecting run- off; unit hydrograph; methods of determination of run-off.

CE C381 Design of Steel Structures 3 0 3

Structural steels loads and stresses, design of tension, compression and flexural members of steel; riveted, bolted and welded connections, trusses, gantry girders, beam columns, plate girder, column bases and footings. Industrial buildings, Plastic designs.

CE C383 Design of Concrete Structures 3 2 4

Materials for concrete, design of concrete mix, design philosophies, singly and doubly reinforced beams, flanged beams, shear and development length, slabs, columns, footings and walls, foundations, water tanks, introduction to prestressed concrete, yield line theory.

CE C391 Transportation Engineering 3 2 4

Basic characteristics of transportation systems, social factors and strategic consideration; demand forecasting and economic analysis; planning and design of transport facilities; design standards-geometric design of highways railways and airports; design of highway and airport pavements; flexible and rigid pavement; materials and tests; design of grades and grade separated intersections; traffic accidents; traffic management.

CE C392 Geodesy 3 2 4

Field measurements and mapping; theory of measurements and error analysis; astronomical observation; triangulation; photogrammetry; laying out works.

CE C394 Green Buildings and Energy Conservation 3 0 3

Climate zones and sun path diagram, thermal comfort, heat flow through building materials, energy efficient building design factors like site planning, plan form and orientation, construction techniques, materials and finishes, natural day lighting and ventilation strategies, thermal performance of building elements, simple techniques to recycle and reuse water, harvest rainwater, green building rating system, case studies and poster presentation of traditional architecture and contemporary buildings, building design using AUTOCAD.

CE C412 Disaster Management 3 0 3

Definitions, types of hazards, natural and man-made disasters, impact, causes and effects, damages, coping mechanism and relief assistance, disaster continuum, preparedness, prevention, mitigation, warning and management, vulnerability assessment, rehabilitation and reconstruction after disasters, pre disaster planning for earthquakes, cyclones, floods, draught and famine, disaster resistant constructions, non-structural and structural mitigation measures, guiding principles of mitigation, education and training for disasters, disaster case studies, computer use in disaster scenario development.

CE C414 Introduction to Environmental Engineering 3 0 3

Environmental pollution; essentials of solid waste management; environmental noise pollution and its control; water quality significance; air quality management; industrial site selection criteria environmental impact assessment-case studies-computer applications.

CE C415 Design of Prestressed Concrete Structures 3 0 3

Introduction to basic concepts of prestressing; prestressing systems; analysis of prestress & bending stress; losses in prestress; deflection; design for flexure, shear and torsion; transfer of prestress; composite construction of prestresses and in situ concrete; load balancing technique, statically indeterminate structures; introduction to optimum design.

CE C416 Computer Application in Civil Engineering 3 2 4

Programming techniques, review of programming languages useful to civil engineering works, structural analysis concepts, modeling of problems, relation be-

tween elements and systems, programming with and flexibility and stiffness matrix displacement plain stress/strain problems, eigen value problems, programming for pre and post processor, civil engineering computer projects.

CE C417 Applications of Artificial Intelligence in Civil Engineering 3 0 3

Genetic algorithm and its applications in problem solving and optimization; neural network and itsapplication in functional mapping, flood forecasting, remote sensing; fuzzy logic and its application in decision making, clustering and linear programming.

CE C418 Introduction to Water Resources Engineering 3 0 3

Introduction to hydrology, Methods of Irrigation, Water requirement of crops and Estimation methods, Detailed analysis of runoff and Hydrograph, Ground water hydrology, definitions, Discharge computations for confined and unconfined aquifers, pumping tests, Reservoir planning, types of reservoirs, Selection of site, mass curve, life of reservoir, Cost aspects, Flood routing, Introduction to dams, Systems analysis techniques in planning and practical applications.

CE C419 Geotechnical Earthquake Engineering and Machine Foundation 3 0 3

Seismic hazard, Engineering seismology, Wave propagation, Dynamic Soil Properties, Dynamic bearing capacity, Seismic design of foundation, Seismic slope stability, Dynamic earth pressure, Seismic design of retaining structure, Liquefaction, Design of machine foundation, Soil improvement techniques, Seismic design codes.

CE C422 Design of Bridge Structures 3 0 3

Investigations for bridges, types of bridges and loading standards, selection of bridge, analysis and design of bridges, pier and abutments, different types of bridge foundations.

CE C432 Structural Dynamics 3 0 3

Free and forced vibrations, single and multidegree systems, continuous systems, response of various systems to different excitations, damping; numerical evaluation of dynamic response, frequency domain analysis, mode superposition, direct integration for dynamic response.

CE C441 Design of Water Resources Systems 3 0 3

Aspects of water resources system planning; storage dams; estimation of flood; flood routing through reservoir; spillways; weirs on permeable foundation; canal masonry works; ground water exploration; well hydraulics, construction and development; pumping tests under boundary conditions.

CE C461 Refrigeration and Air Conditioning 3 0 3

Principles, thermodynamic analysis, load estimates and design of various refrigeration and air conditioning systems for comfort and industrial applications. Theoretical or experimental investigation of refrigeration and air-conditioning problems.

CE C471 Introduction to Finite Element Methods 3 0 3

Element properties; Isoparametric elements; Finite element method; analysis of framed structures; plane stress and plane strain axisymmetric and 3D analysis; analysis of plate bending, shell finite element. Application of FEM in Civil Engineering & Mechanical Engineering, FEM programming.

CE C491 Special Projects 3

Course description is same as given under BIO C491.

CE F211 Mechanics of Solids 3 0 3

Introduction to mechanics of rigid bodies and deformable bodies; Thermal stresses; Equilibrium of forces; Bending moment and shear force diagrams for determinate beams and frames; Analysis of statically determinate trusses; Flexural and shear Stresses in beams; Stresses and strains on inclined planes; Torsion in shafts; Combined bending and torsion stresses in shafts; Slope and deflection in beams due to bending using double Integration, moment area method and conjugate beam method; Energy principles and their application in structural analysis; Hoop stresses in thin cylindrical shells; Suspension cables; Failure theories.

CE F212 Transport Phenomena 3 0 3

Concepts and definitions, Fluid pressure and measurement, Hydrostatics, Buoyancy, Fundamentals of fluid flow and Kinematics of Fluid in Motion, Flow Analysis using Control Volume Approach and its applications in conservation of mass, momentum and energy, Analysis of flow through pipes, Differential forms of the fundamental laws, Viscous fluid flow Analysis, Navier-Stokes Equations, Study of Flow pattern through Orifices and Mouthpieces, Notches and Weirs and Dimensional analysis and similitude.

CE F213 Surveying 3 1 4

Chain, Compass, Theodolite and Plane table surveying fundamentals, Traverse computations and adjustments, leveling, contouring, computation of area and volumes, Curve setting, Trigonometric leveling, Tachometry, Introduction to advanced surveying techniques viz. GPS, Total Station, EDM, etc.

CE F214 Construction Materials 3 0 3

Different types of cements, chemical composition, properties and tests, coarse and fine aggregate for concrete, tests on aggregates, grading of aggregates and its effect on concrete properties, chemical and mineral admixtures, properties and tests on fresh and hardened concrete; transportation and placing of concrete, nondestructive testing of concrete, durability of concrete, quality control and acceptance criteria of concrete, Factors in the choice of mix proportions,

Proportioning of concrete mixes by various methods – BIS method of mix design.; Special Concretes such as fibre reinforced concrete, high performance concrete, self consolidating concrete etc., Manufacturing/ sources, classification, applications, properties and testing of bricks, blocks, tiles, stones, aggregates, puzzolanas, flyash, lime, wood, timber, paints, tar, bitumen, cutback, emulsion, modified bitumen, steel, non-ferrous metals, polymeric material, geosynthetics, etc. Low cost and waste material in construction. Latest, BIS, IRC & ASTM specifications and guidelines of all above mentioned material, Construction equipments, classification, selection and economics.

CE F241 Analysis of Structures 3 0 3

Static and kinematic Indeterminacy, Displacement Methods of analysis: Slope-deflection method, Moment distribution method and Kani's method; Force Methods of analysis: strain energy method, consistent deformation method, three moment equation method and column analogy method; Influence Line Diagrams; Analysis of Moving/Rolling loads; Substitute frame method; Approximate analysis of frames subjected to lateral loads; Analysis of Three-hinged, two-hinged and fixed Arches; Analysis of indeterminate trusses; Introduction to Matrix Methods of structural analysis.

CE F242 Construction Planning and Technology 3 0 3

Development of model based planning, control and reviewing civil engineering construction, network techniques, CPM, PERT, LOB, network crashing and time-cost trade off, resources allocations, valuation, engineering economy and cost benefit analysis of project; principal building system as affected by environmental, legal, material, and industrial constraints; interrelationship among the components of the systems, functional requirement, development control rules, National building code 2005, planning and selection of foundation systems, foundation construction, piling system, construction procedures, pile construction problems, causes and remediation, construction of masonry work, floors, roofs, stairs, dam proofing and other components of buildings and relevant code of practices, earthquake resistant construction of buildings, computer applications in construction management, construction safety & health acts and management, contracts, tender, estimating and costing.

CE F243 Soil Mechanics 3 1 4

Preview of Geotechnical Problems in Civil Engineering and Infrastructure development, Origin and classification of soils; physicochemical properties, index properties of soil, Stresses within a soil, effective stress principle, Soil - water systems - capillarity, flow, Darcy's law, permeability, and tests for its determination, different heads, piping, quicksand condition, seepage, flow nets, flow through dams, filters, Compressibility and consolidation characteristics, over consolidation ratio, determination of coefficients of consolidation and secondary compression (creep), consolidation under construction loading, 3-D consolidation, Shear Strength and Mohr-Coulomb strength criterion, direct and triaxial shear tests, drained, consolidated undrained and undrained tests, strength of loose and dense sands, NC and OC soils, dilation, pore pressures, Skempton's coefficients. Compaction characteristics, water content - dry unit weight relationships, OMC, maximum dry unit weight, field compaction, quality control, etc. Characterization of ground, site investigations, methods of drilling, sampling, in situ test - SPT, CPT, plate load and dynamic tests, insitu perme ability and groundwater level, etc. Stress in soils due to different applied loading conditions, Settlements, tilt and rotation of foundations, immediate settlement, elastic theories, consolidation and creep settlements, methods based on in situ tests.

CE F244 Highway Engineering 3 1 4

Basic characteristics of Transportation systems, social factors and strategic consideration; Demand Forecasting and Economic Analysis; Planning and Design of Transportation Facilities; Design of Geometric Standards: Cross section elements, sight distances, horizontal and vertical alignments; Pavement Materials and testing: Soil, Aggregate, Bitumen and Bituminous Concrete; Design of Highway Pavements: Flexible and Rigid Highways: IRC method; Design of flexible overlays over flexible pavements; Traffic Engineering: Traffic Characteristics; Highway capacity and level of service concepts; traffic measurement and analysis; Traffic signals; parking studies and analysis; design of at-grade and grade separated intersections; analysis of traffic accidents; Introduction to Intelligent Transportation Systems (ITS).

CE F266 Study Project 3

Course description is same as given under BIO F266.

CE F311 Design of Concrete Structures 3 1 4

Engineering properties of different concreting materials; Design Philosophies; Concepts of Limit State Method; Limit State Design for flexure of Singly and doubly reinforced rectangular and flanged section beams, one-way and two-way slabs; Design for Bond, anchorage and development length; Design of beams with rectangular and Flanged sections for Shear; Limit state of serviceability for beams and slabs; Limit State Design for collapse of columns subjected to axial, axial plus uni-axial bending and axial and bi-axial bending; Design of Footings; Design of Stair Cases.

CE F312 Hydraulics Engineering 3 1 4

Behavior of real fluids: boundary layer theory, flow past immersed bodies, turbulent flow through conduits; analysis of closed-conduit hydraulic systems including pipes, valves, fittings, and pumps, pipe networks analysis: Hardy cross method and linear graph method; Open channel hydraulics: uniform and non-uniform

flow; analysis and design of hydraulic systems; Analysis of Impact of jets; fluid machinery: theory, performance and application.

CE F313 Foundation Engineering 3 0 3

General requirement for satisfactory performance of shallow foundations, Bearing capacity, general, local and punching shear failures, corrections for size, shape, depth, water table, compressibility, etc., methods based on in situ tests, footings subjected to eccentric-inclined loads, footings on layered soils and slopes, contact pressure distributions, proportioning of shallow foundations - isolated, combined, circular, annular, raft, etc., Deep foundations, piles, pile groups, under-reamed piles, pre-cast, driven cast in situ and bored piles, shaft and base resistances, down drag, pile load tests, settlement of piles, pile group, various methods for laterally loaded pile analysis, Pier and well foundations, Indian case histories, soil stabilization and ground improvement techniques, methods for difficult or problematic ground conditions - soft soils, loose sands, seismic conditions, expansive or collapsible soils, etc., preloading, vertical drains, stone columns, heavy tamping, grouting, etc. repair and strengthening measures for foundations. Earth Pressure theories, Coulomb and Rankine approaches, smooth and rough walls, inclined backfill, depth of tension crack, Retaining structures: gravity, cantilever, counter fort, reinforced earth walls, etc., design and checks for stability, Stability of slopes, limit equilibrium methods, methods of slices and simplified Bishop, factors of safety, machine foundations for different type of machines, introduction to designing with geosynthetics, for various applications, introduction to geotechnical earthquake engineering and liquefaction of soils, computer applications in foundation design.

CE F323 Introduction to Environmental Engineering 3 0 3

Environmental pollution; essentials of solid waste management; environmental noise pollution and its control; water quality significance; air quality management; industrial site selection criteria – environmental impact assessment; computer applications.

CE F324 Numerical Analysis 3 0 3

Solution of Linear Algebraic System of Equations, Storage Schemes and techniques to a System of Large number of Equation, Numerical Solutions by Interpolation, Integration of Functions containing Singularities, Finite Element Method, Solutions of Initial and Boundary Value Problems, Boundary Integral Element Method, Solution of Non Linear System of Equations.

CE F341 Hydrology & Water Resources Engineering 3 0 3

Hydrological Cycle and Budget; Precipitation Measurement and Analysis; Hydrologic Abstractions; Stream Flow analysis and concepts of hydrograph; Hydrologic measurements; Statistical analysis in hydrology; Ground Water hydrology; Flood Routing; Water withdrawals and uses, Introduction to dams, spillways, diversion head-works and distribution systems, River basin management, Reservoir planning and multi-purpose reservoirs, hydropower engineering, Systems analysis techniques in planning and practical applications.

CE F342 Water & Waste Water Treatment 3 1 4

Water supply and waste water systems; capacity requirements; analysis of water and waste water; treatment requirements; unit operations and processes of treatment, design of treatment units; disposal of waste water and sludge; design of sewers and water distribution networks; rural sanitation; effluent re-purification and reuse.

CE F343 Design of Steel Structures 3 0 3

Introduction to Limit State Design and Plastic design; Limit state design of bolted and welded connections; Eccentric connection; Design of Tension Members; Design of Compression Members; Design of Beams; Design of plate girders ,Design of Beam-Columns, Column bases.

CE F366 Lab Project 3

CE F367 Lab Project 3

Course description is same as given under BIO F366 and BIO F367.

CE F376 Design Project 3

CE F377 Design Project 3

Course description is same as given under BIO F376 and BIO F377.

CE F411 Operation Research for Engineers 3 0 3

Linear programming, Simplex method, Duality and sensitivity analysis, Transportation model and its variants, Integer linear programming, Nonlinear programming, Multi-objective optimization, Evolutionary computation, Inventory models, Queuing system, Decision making under certainty, risk, and uncertainty.

CE F412 Disaster Management 3 0 3

Course description is same as given under CE C412.

CE F413 Advanced Structural Design 3 0 3

Design of concrete chimneys, water tanks, retaining walls, bunkers and silos; Design of steel tanks, towers, Roof trusses and Gantry Girder design.

CE F414 Introduction to Environmental Engineering 3 0 3

Course description is same as in CE C414.

CE F415 Design of Prestressed Concrete Structure 3 0 3

Introduction to basic concepts of prestressing; prestressing systems; analysis of prestress& bending stress; losses in prestress; deflection; design for flex-

ure, shear and torsion; transfer of prestress; composite construction of prestresses and in situ concrete; load balancing technique, statically indeterminate structures; introduction to optimum design.

CE F416 Computer Applications in Civil Engi- 3 1 4 neering

Course description is same as given under CE C416.

CE F417 Applications of Artificial Intelligence in 3 0 3 Civil Engineering

Course description is same as given under CE C417.

CE F419 Geotechnical Earthquake Engineering 3 0 3 and Machine Foundation

Course description is same as given under CE C419.

CE F420 Introduction to Bridge Engineering 3 0 3

Course description is to be developed.

CE F421 Analysis and Design of FRP Rein- 3 0 3 forced Concrete Structures

Course description is to be developed.

CE F422 Urban Hydrology 2 1 3

Background of urban hydrology; urban flooding; description of hydrological and planning models such as SWMM, HEC-HMS, HEC-RAS, EPANET, WEAP, SWAT; urban flood forecasting and mitigation strategies; Urban flood planning in changing climate;description of general circulation models and downscaling approaches; Management of Syphonic rainwater systems and detention facilities; sustainable urban drainage systems (SUDS);case studies.

Prerequisite:

CE F341 (Hydrology and Water Resources Engineering)

CE F423 Green Buildings and Energy Conser- 3 0 3 vation

Course description is same as given under CE C394.

CE F425 Airport, Railways and Waterways 3 0 3

Airports: Characteristics of aircrafts related to airport design; runway orientation, length, capacity, configuration and number, taxiway layout, high-speed exit taxiway, terminal building functional areas, visual aids; grading and drainage; Railways: component of railway tracks, train resistance and tractive power, curves and super elevation, switches and crossing, signalling and interlocking, high speed tracks, track stresses. Tunnelling: necessity of tunnels, ventilation, lighting and drainage; Water transportation: nature of water transportation, classes of harbours, desirable features of harbour site, planning and design of port faculties; Pipeline transportation systems: need and planning.

CE F426 Geosynthetics and Reinforced Soil 3 0 3 Structure

Geo-synthetics: classification, functions, applications, properties & testing, Applications and advantages of reinforced soil structure. Principles, concepts and mechanism of reinforced soil. Soil-reinforcement interface friction. Behaviour of Reinforced earth walls, basis of wall design, internal and external stability condition, Codal provisions; Seismic design consideration. Bearing capacity improvement and design of foundations resting on reinforced soil; embankments on soft soils; Design of reinforced soil slopes, Indian experiences. Use of geosynthetics for separations, drainage and filtration. Use of geosynthetics in roads, airports and railways, India Road Congress, AASHTO and other relevant guidelines; randomly distributed fiber reinforced soil. Soil nailing. Geocell, PVD, Geosynthetics in Environmental Control: Liners for ponds and canals; covers and liners for landfills – material aspects and stability considerations; Use of jute, coir, natural Geotextiles, waste products such as scrap tire, LDPE and HDPE strips, as reinforcing material.

CE F427 System Modeling and Analysis 3 0 3

Systems and system's approach, Modelling of physical system and non-physical system, Continuous and discrete systems, Time domain analysis, Frequency response, Steady-space analysis.

CE F428 Earthquake Resistant Design and 3 0 3 Construction

Earthquake resistant design philosophy. Ground motion characterization, response spectra and design earthquake. Evaluation of dynamic properties of soil. Free and forced vibration analysis of single and multiple degree of freedom system. Seismic analysis of buildings as per IS: 1893 (Part-I). Analysis and design of shallow and deep foundations under seismic loads; liquefaction of soil; seismic design of bridges, retaining walls, tanks, chimney, towers, embankments and dams as per IS1893-Part1,2,3,4 & 5. Earthquake resistant construction and ductile detailing for RCC & steel structure as per IS 13920 and IS 800. Seismic strengthening and retrofitting of building. International code of practice for earthquake resistant design and construction of various structure such as Eurocode 8, NEHRP 2009, FHWA, FEMA, ASC7-2010, ACI318-2010, IBC 2009, etc.

CE F429 Design of Foundation Systems 3 0 3

Evaluation and interpretation of soil properties, dynamic properties of soil, geophysical and seismic methods, Stress in soil mass due to applied load, various methods of settlement analysis, static and dynamic bearing capacity of footings, bearing capacity of footings resting on layered soils and footing on or near slopes, tilt, rotation and horizontal displacement of foundations subjected to eccentric-inclined loads, foundations on rocks, seismic design of shallow foundations, analysis of raft foundations, circular and annular rafts, structural design of shallow foundations, pile foundations load capacity and settlements, various methods of analysis of laterally loaded Pile Foundations, uplift capacity,

piles subjected to dynamic loads, seismic design of pile foundations, structural design of pile foundations, static and dynamic earth pressure theories, stability analysis of retaining walls, reinforced earth wall design, machine foundations for reciprocating machines, impact type, rotary machines such as turbines, turbogenerator, IS code provisions on foundations, codal provisions on structural and earthquake resistant design of foundations.

CE F430 Design of Advanced Concrete Structures **3 0 3**

Determination of deflection and crack width in beams and slabs; Design of flat slabs, Design of slabs of irregular shape by yield-line theory; Design of beam-column joints; Design of circular Slabs; Design of building frames; Design of Retaining walls; Design of beams curved in plan; Design of water Tanks; Design of Folded plates and cylindrical shell roofs.

CE F431 Principles of Geographical Information Systems **3 1 4**

Introduction to Geographical Information Systems(GIS), Databases and database management systems, Spatial databases, Coordinate systems and georeferencing, Interpolation methods: Deterministic and Statistical. Digital elevation models and their applications, Strategies for development, implementation and management of GIS, Case studies on use of GIS from various fields such as water and land resources, environment, transportation, etc. Next generation GIS systems.

CE F432 Structural Dynamics **3 0 3**

Free and forced vibrations, single and multi-degree systems, continuous systems, response of various systems to different excitations, damping; numerical evaluation of dynamic response, frequency domain analysis, mode superposition, direct integration for dynamic response.

CE F433 Remote Sensing and Image Processing **3 1 4**

Introduction to the principles and fundamental concepts of remote sensing, platforms and sensors, visual and digital image processing of satellite images, aerial photographs, various data products and their uses, Case studies on use of remote sensing data from various fields of engineering such as water and land resources, environment, transportation, agriculture, forestry, etc.

CE F434 Environmental Impact Assessment **3 0 3**

Course description is same as given under BITS C494.

CE F435 Introduction to Finite Element Methods **3 0 3**

Course description is same as given under CE C471.

CE F491 Special Projects **3**

Course description is same as given under BIO F491.

CE G511 Matrix Methods in Civil Engineering **3 2 5**

Matrix techniques; basic equations of solid mechanics; variational methods; finite difference and finite element methods; applications to structural mechanics, soil and rock mechanics, fluid mechanics, and hydraulic structures.

CE G512 Topics in Environmental Engineering **3 1 4**

Collection and disposal of solid wastes; air pollution and control; stream sanitation; rural water supply and sanitation.

CE G513 Advanced Computational Techniques **3 1 4**

Interpolation, Polynomial Interpolation, Lagrange, Newton's Interpolation, Numerical integration, Wilson θ Method, Newmark's Method, Gauss and Hermitian Quadrature, Quadrature rules for multiple integrals, Large system of linear simultaneous equations, Direct and iterative algorithms based on Gauss elimination, Gauss Seidel method and symmetric banded equations, storage schemes – skyline, band solver, frontal solver, Cholesky decomposition, Non-linear system of equations, Eigen value problems, Forward iteration, Inverse iteration, Jacobi, Given's method, Transformation of generalized Eigen value problem to standard form, Vector iteration method, Initial and boundary value problems, Solution of first and second order differential equations using Euler, modified Euler, and Runge-Kutta methods, Finite difference operators.

CE G514 Structural Optimization **3 1 4**

Introduction, Engineering Optimization Problems, Optimal problem formulation, Single-variable optimization algorithms, Bracketing methods, Region Elimination methods, Gradient-based methods, Multivariable optimization algorithms, Evolutionary optimization methods, Simplex Search method, Hooke-Jeeves pattern search method, Powell's conjugate direction method, Cauchy's method, Newton's method, Conjugate Gradient method, Constrained Optimization algorithms, Kuhun-Tucker conditions, Transformation methods, Direct search for constrained minimization, Feasible Direction Method, Specialized algorithms, Integer Programming, Geometric Programming, Nontraditional optimization Algorithms, Genetic algorithms, Simulated Annealing, Structural Optimization, Methods of optimal design of structural elements, minimum weight design of truss members, optimum reinforced design of R.C. C. Slabs and beams, Optimization to the design of structures such as multi-storey buildings, water tank, shell roofs, folded plates.

CE G515 Fundamentals of Systems Engineering **3 1 4**

Linear Programming, Queuing Theory, Inventory Control, Simulation, Maintenance models sampling techniques, Forecasting techniques, Decision models, Network scheduling, application to Resources plan-

ning, financial Management, facility location, decision making Maintenance issues, construction & operational issues for Civil Engg. System

CE G516 Multicriteria Analysis in Engineering 3 1 4

Introduction, Conventional optimization, Multi-objective Optimization, Fuzzy logic and its extensions, in multi-objective optimization, Multicriterion Decision Making, Deterministic analysis, Stochastic analysis, Fuzzy analysis, Classification problems, Hybrid approaches in Decision Making, Genetic Algorithms, Artificial Intelligence, Artifical Neural networks, Practical applications in Engineering.

CE G517 Waste Management Systems 3 1 4

Introduction, Wastewater and Solid Wastes, Collection and Transportation, Waste Disposal Systems, Land Treatment, Wastewater Management Methods, Wetland and Aquatic Treatment, Landfilling, Incineration, Energy from Wastes, Recycling, Composting, Reduction, Reuse and Recovery, Risk management, Case studies.

CE G518 Pavement Analysis and Design 3 1 4

Types of pavements, flexible, rigid and semi-rigid; components of pavement structure; stresses and strains in flexible and rigid pavements: layered systems, visco-elastic solutions; stresses and deflections in rigid pavements; computer programmes for analysis of stresses and deflections in rigid pavements; traffic loadings, load equivalency factors, traffic projections and analysis; material characterization as input to pavement design; flexible pavement design and rigid pavement design using IRC, AASHTO, PCA methods; design of overlays; pavement deterioration, pavement performance and use of HDM-4; pavement drainage design.

CE G520 Infrastructure Planning and Manage- 3 1 4 ment

The goals and perspectives of planning; forecasting and design of alternatives; plan testing: economic, financial and environmental evaluation; the challenges of managing infrastructure; Information management and decision support system; Concepts of total quality management; Economics: life-cycle analysis and maintenance, Rehabilitation and Reconstruction (M.R & R) programming; Infrastructure management system (IMS) development and implementation; Rural Infrastructure Planning.

CE G521 Topics in Structural Engineering 3 2 5

Introduction to structural optimization, application to simple structures such as trusses, and simple frames; Theory of plates and its applications in Civil Engineering; folded plate design; theory and design of shell structures specifically with application in structures covering large area.

CE G522 Pavement Design, Maintenance and 3 2 5 Management

Materials for road construction: specifications and tests on binder, aggregate and soil; Asphalt mix design; Pavement structure; Stresses in flexible and rigid pavements; Design of flexible and rigid pavements; Pavement Management System (PMS) implementation and operation; Data base requirements; Road condition surveys; Data management; Pavement condition analysis; Determination of maintenance and rehabilitation needs at network level; Panel inspection; Prioritization and optimization; Budgets, programmes and plans of action.

CE G523 Transportation Systems Planning and 3 1 4 Management

System and environment; sequential transportation systems planning: trip generation, trip distribution, modal split and traffic assignment. Transportation Systems Management (TSM) actions: traffic management techniques for improving vehicular flow, preferential treatment for high occupancy modes, demand management technique for reduced traffic demand, staggered hours, vehicle restrictions; planning for pedestrians, parking planning; Methods of accident data collection and analysis.

CE G524 Urban Mass Transit Planning, Opera- 3 1 4 tions and Management

Modes of public transportation and application pf each to urban travel needs; Comparison of transit modes and selection of technology and transit service; Estimating demand in transit planning studies and functional design of transit routes; Terminal design; Management and operation of transit systems, Model for operational management; Fleet and crew management; Terminal management; Fiscal management.

CE G525 Water Resources Planning and Man- 3 1 4 agement

Introduction; Quantitative and qualitative assessment of water resources; Engineering principles applied to the management of water resources; Hydrographic and project surveys; Watershed management; Measurement techniques in water resources engineering; Gains of water resources planning to the society; Water economics; Computer utilization areas; Project discussions; Laboratory experiments.

CE G526 Systems Approach to Water Re- 3 1 4 sources Modeling

Introduction to system analysis; Water management models: types and significance; Fundamentals of model development; Model solution techniques (computational methods) such as computer aided optimization, simulation, statistical analysis and reliability con-

siderations; Model calibration and verification; Modeling of water quality subsystems and water quantity subsystems in various water bodies and its methods of analysis.

CE G527 Construction Management 3 1 4

Industry profile, parties involved, contracts, bonds, bidding, changes, pre-planning, construction management approach and partnering; Planning and scheduling, net-work based scheduling systems (CPM), Resource management, Network acceleration, PERT probabilistic approach.

CE G528 Selection of Construction Equipment and Modeling 3 1 4

Selection and application of construction and earth moving equipment; Productivity analysis of equipment operations; mathematical models for construction operations; Quality issues in construction process modeling.

CE G529 Construction Project Control Systems 3 1 4

Concepts, planning and organization; bar charts and schedule networks; CPM computer software, Resource management; Optimal project duration; Project estimates; Budgeting and cash flow; Project control; PERT and line of balance; Project simulation; Materials management and information systems; Claims; Corrective actions; Total quality management; Equipment economics; Nature of design projects: (1) design of project scheduling networks, (2) design of construction operations, (3) development of project breakdown structure, and (4) development of project cash flow design.

CE G530 Design of Construction Operations 3 1 4

Techniques for the design and analysis of construction operations to maximize productivity and minimize resource idleness; Queuing theory, line of balance, simulation, probabilistic and statistical methods applied to construction; An actual construction operation will be modeled and analyzed as part of the course in the context of a term project.

CE G531 Environmental Conservation 3 1 4

Environmental management; impact of development schemes; essentials of an environmental policy and an environmental act; environmental issues and priorities, ecological effects of current development process; energy resources and water resources planning; Economics of pollution control; National conservation strategy; Organisations dealing with environmental conservations.

CE G532 Advanced Soil Mechanics 3 1 4

Modern concept of soil structure and its application in explaining its behaviour; effects of seepage on equilibrium of ideal soil; mechanics of drainage; theories of elastic subgrade reaction; theories of semi infinite elastic soils; vibration problems.

CE G533 Advanced Composite Materials for Structures 3 1 4

Introduction and History of FRP, Overview of Composite materials, Physical and Mechanical Properties and Test methods, Design of RC Structures reinforced with FRP Bars, Flexural Strengthening of RC Beams, Shear Strengthening of Beams, Flexural Strengthening of Slabs, Strengthening of Axially and Eccentrically Loaded Columns, Seismic Retrofit of Columns.

CE G534 Pavement Material Characterization 3 1 4

Soils: Origin, properties of soils, tests on soils; aggregates: origin, classification, requirements, properties, importance of aggregate gradation; bituminous materials: origin, preparation, properties and tests, criterion for selection of different binders, modified binders; bituminous emulsions and cutbacks: preparation, characteristics, uses and tests; bitumen mix design: marshall method and superpave procedure; mechanical properties of bituminous mixes: resilient modulus, dynamic modulus, visco-elastic and fatigue characteristics. cement concrete pavement materials: requirements and design of mix for CC pavement, IRC and IS specifications and tests, joint filler and sealer materials.

CE G535 Highway Geometric Design 3 1 4

Highway functional classification; route layout and selection, design controls and criteria: turning paths, driver performance, traffic characteristics; highway capacity; access control; safety; environment; Elements of design: sight distance, horizontal alignment, transition curves, super elevation and side friction; vertical alignment: - grades, crest and sag curves; highway cross-sectional elements and their design; at-grade Inter-sections – sight distance consideration and principles of design, canalization, mini roundabouts, layout of roundabouts, inter-changes: major and minor interchanges, entrance and exit ramps, acceleration and deceleration lanes, bicycle and pedestrian facility design; parking layout and design; terminal layout and design.

CE G536 Traffic Engineering and Safety 3 1 4

Road users and their characteristics; traffic studies-volume, speed, origin-destination (O-D) and delay studies; analysis and interpretations of traffic studies; traffic forecasting; capacity and level of service analysis; traffic characteristics at un-signalized and signalized intersections; design of signalized intersections, capacity and LOS of signalized intersections, actuated signal control, signal coordination; traffic controls: signs, markings, street furniture; traffic regulations; parking studies; nature of traffic problems and their so-

lutions; traffic safety: accidents- data collection and analysis; causes and prevention.

CE G537 Transportation Economics and Finance **3 1 4**

Need for economic evaluation; concept of total transport cost; fixed and variable costs, elasticity of demand, marginal costs; value of travel time, accident costs; methods of economic evaluation; taxation in road transport, user charges: fees and tolls; highway legislation; investment policies and pricing, issues in financing and subsidy policy, public private partnership (PPP) options in transport sector: BOT, BOOT, BOLT; feasibility studies, identification and sharing of risks in PPP projects, operation and management agreements.

CE G538 Project Planning and Management **3 1 4**

Foundations of project management: project life cycle, environment, selection, proposal, scope, ToR standardization; work break down structure; network scheduling: critical path method (CPM), programme evaluation and review technique (PERT), planning and scheduling of activity networks; resource planning: allocation, schedule compression, precedence diagram, generalized activity network; estimation of project cost, earned value analysis, monitoring project progress; quality assurance; contract administration and management; mechanization and advanced process control; quality audit; milestones, bonus and penalties; dispute resolution; capacity building and skill development.

CE G539 Introduction to Discrete Choice Theory **4***

Introduction, element of choice process, individual preferences, behavioral choice rule, utility based choice theory; data collection techniques, stated preference (SP) survey, revealed preference (RP) survey, paradigms of choice data; discrete choice models, property of discrete choice models, Multinomial logit model; overview and structure, Nested logit model formulation; discriminant analysis, Naive Bayes classification, classification trees, classification using nearest neighbors; application of fuzzy logic and artificial neural network in discrete choice modeling.

CE G542 Water Resources and Management **3 1 4**

Water resources system for different utilization; theory and analytical methods for minimum cost and optimum development; analysis and design of multi-purpose water resources system; engineering and economic principles applied to the management of water resources.

CE G543 Traffic Flow Theory **3 1 4**

Traffic flow elements: speed, volume and density and their relationships; time-space diagrams, controlled access concept, freeway concept, system performances, measures of effectiveness; mathematical modeling; probabilistic & stochastic models of traffic flow process, discrete and continuous modeling: headways, gaps and gap acceptance; macroscopic models; car-following model; queuing models; fundamentals & development of queuing processes; traffic simulation; intelligent transportation systems (ITS).

CE G544 Fracture Mechanics of Concrete Structures **3 1 4**

Types of failure, Types of fracture, Modes of fracture, Fracture criteria, Energy release rate, Stress intensity factor (SIF), SIF of more complex cases, , Elastic plastic analysis through J-integral, Crack tip opening displacement, Test methods, Fatigue failure, Fracture mechanics of concrete: Need for fracture in concrete, Linear Elastic fracture models, Elasto-plastic fracture models, Nonlinear fracture models, RILEM fracture energy, softening of concrete, fracture process zone, size effect, Interface fracture, Fracture behaviour of special concretes, Numerical analysis.

CE G545 Airport Planning and Design **3 1 4**

Air Transport-structure and organization; forecasting air travel demand: trend forecasts and analytical methods; air freight demand; airport system; characteristics of the aircraft; airport planning: site selection, layout plan, orientation and length of runway; airport capacity and configuration; geometric design of runway, taxiway and aprons; passenger terminal function, passenger and baggage flow, design concepts, analysis of flow through terminals, parking configurations and apron facilities; air cargo facilities-flow through cargo terminals, airport lighting; airport drainage; pavement design; airport access problem; environmental impact of airports.

CE G546 Highway Construction Practices **3 1 4**

Road planning and reconnaissance; right of way selection; fixing of alignment; road construction techniques: construction staking, clearing and grubbing of the road construction area; subgrade construction: excavation and filling, compaction, preparation of sub grade, quality control tests as per MORTH specifications; granular subbase and base course construction: gravel courses, WBM, WMM, stabilized soil subbases, use of geotextiles and geo-grids; construction of bituminous layers; concrete pavement construction; field quality control ; road making machinery.

CE G547 Pavement Failures, Evaluation and Rehabilitation **3 1 4**

Pavement deterioration, distress and different types of failures, pavement surface condition deterioration such as slipperiness, unevenness, rutting, cracking; pot holes, etc., causes, effects, methods of measurement and treatment, use of modern equipment for pavement surface condition measurements, Analysis of data, interpretation. Structural deterioration of pavements: causes, effects, methods of treatment. Structural evaluation of flexible pavements by rebound deflection method, analysis of data, design of overlay, use of

FWD and other methods for evaluation of flexible and rigid pavements and their application. Evaluation of new pavement materials, model studies, pavement testing under controlled conditions, accelerated testing and evaluation methods, Test track studies. Instrumentation for pavement testing.

CE G548 Pavement Management Systems 3 1 4

Components of pavement management systems, pavement maintenance measures; pavement performance evaluation: general concepts, serviceability, pavement distress survey systems, performance evaluation and data collection using different equipment; evaluation of pavement distress modeling and safety; pavement performance prediction: concepts, modeling techniques, structural condition deterioration models, mechanistic and empirical models, HDM-IV models, comparison of different deterioration models, functional and structural condition deterioration models; ranking and optimization methodologies: Recent developments, economic optimization of pavement maintenance and rehabilitation.

CE G549 Rural Road Technology 3 1 4

Network planning, accessibility and mobility; road alignment and survey; geometric design: cross-sectional elements, sight distance, horizontal and vertical alignments; road materials and use of marginal materials; pavement design, drainage, culverts and small bridges; construction and specifications; quality control in construction; pavement failures; maintenance; preparation of detailed project report (DPR); community participation in planning, design, construction and management.

CE G551 Dynamics of structures 3 1 4

Free and forced Vibration Analysis of SDOF system, Response to general dynamic loadings, Numerical evaluation of dynamic response, Effect of damping; Free and forced vibration of undamped and damped multi degree of freedom systems; Modeling for multi degree of freedom systems; Equation of motions, Evaluation of natural frequencies and mode shapes, orthogonality conditions, Modal analysis and modal combination rules, Numerical evaluation of dynamic response for multi degree of freedom, time history analysis; support excited vibration, analysis of non-linear systems, Free and forced vibration analysis of continuous systems, Random vibrations, Stochastic response; Vibration isolation, vibration absorber and tuned mass damper; Evaluation of wind, blast, wave loading and other dynamic forces on structure; Modeling and dynamic analysis of buildings, bridges, water tank, liquid storage tanks, stack like structure, machine foundations etc.

CE G552 Advanced Structural Mechanics and Stability 3 1 4

Analysis of stress and strain in three dimension domain, deviatoric stress and strain; stress and strain invariants, compatibility conditions, equilibrium equations; stress-strain relations for anisotropic, orthotropic and isotropic elastic materials; yield criterion; plastic potential and flow rules. Problems on plane stress and plain strain conditions, Airy stress function; Axi-symmetric problems; torsion of prismatic bars, circular and non-circular sections; thin-walled sections, membrane and sand-heap analogies, concept of stability of structures and examples of instability. Stability of structures with one and two degree of freedom, buckling of columns; beam-columns and simple frames, lateral torsion buckling of beams; and introduction to postbuckling of plates.

CE G553 Theory of Plates and Shells 3 1 4

Analysis procedure and the basic theory of plates and shells; Different kinds of plates such as rectangular, circular, and elliptical; Different kinds of shell structures such as shell of revolution: spherical shells, cylindrical shells and special shell structures; Principles and applications of bending of plates, membrane theory, bending of shells, and stability of plates and shells; Kirchoff theory, Reissner-Mindlin-Naghadi type theories, rectangular plates-solution by double Fourier series, membrane theory of shells, and case study on plates and shells using numerical tools.

CE G554 Advanced Structural Design 3 1 4

Practical design problems on analysis and design of multistoried and industrial buildings, chimney, retaining wall, water tank, towers, etc using both the steel and concrete materials. Modeling of structures subjected to various load (DL, LL, WL, EQ etc.) combinations, structural analysis, design, and detailing of specific advanced concrete and steel structures.

CE G555 Remote Sensing and GIS in Water Resources 4*

Basic concepts of Remote Sensing (RS) and image processing; photogrammetry; global positioning system and its application in water resources; fundamentals of GIS; map projection; spatial data modeling and analysis; integration of hydrologic models and RS & GIS with relevance to surface and ground water resources. advanced aspects of RS & GIS; case studies.

CE G556 Advanced Computational Hydraulics 4*

Ordinary and partial differential equations; finite difference schemes and their variations, finite element methods and their variations; implicit and explicit types; accuracy, convergence and stability; applications to steady and unsteady flows in various fields in hydraulics; one-, two- and three-dimensional flows; Case Studies.

CE G557 Stochastic Hydrology 4*

Basics of statistics in hydrology, discrete and continuous distributions and their applications to hydrological variables; parameter estimation; hypothesis testing; regression analysis; classification and characteristics

of time series; autocorrelation analysis; univariate and multivariate stochastic models; spectral analysis; case studies.

CE G558 Advanced Groundwater Hydrology 4*

Aquifers - hydraulic characteristics of aquifers (confined and unconfined). Basic principles of ground water flow; Techniques of artificial recharge; Well design; groundwater recharge basins and injection wells; flow into aquifer with different boundaries and special cases; ground water models (digital and analog models): groundwater pollution, contaminant transport, remediation and legislation.

CE G559 Soft Computing in Water Resources 4*

Introduction and role of soft computing techniques such as fuzzy logic, expert systems, evolutionary algorithms in water resources engineering; classical sets and fuzzy sets; membership functions; defuzzification; basics of expert systems and relevant terminology; Procedure for development of knowledge base and handling of uncertainty; fundamentals of evolutionary algorithms; case Studies.

CE G560 Hydrologic Simulation Laboratory 4*

Role of simulation and optimization modeling in water resources; data mining techniques in hydrology; database management; applicability of hydraulic and hydrologic related simulation models and softwares; applicability of optimization based models and softwares.

CE G561 Impact of Climate Change on Water Resources Systems

Introduction to anthropogenic climate change; impact of climate change on hydrology and water resources; global climate teleconnections; various modeling approaches including general circulation models and downscaling approaches; selection criteria; climate predictability and forecasting; limitations and uncertainties; adaptability to climate change; Case Studies.

CE G610 Computer Aided Analysis and Design in Civil Engineering 3 2 5

Computer languages; CAD, graphics; database management system; knowledge base expert system; development of preprocessor and post processor with graphic interface; analysis and design, optimization techniques, genetic algorithms, software development for analysis and design, interfacing.

CE G611 Computer Aided Analysis and Design 3 2 5

The course aims at developing complete self reliance in solving analysis & design problems of engineering with the aid of computers. It stresses upon the use of more powerful tools including system planning, simulation and modelling. The student will take up a design project and will work independently on the project guided by the instructor or resource person as and when required. The effort must culminate with a CAAD program and a project report.

CE G612 Advanced steel Structures 3 1 4

Steel properties; high strength steels, structural behaviour, analysis and design; loads and environmental effects; load and resistant factor design (LRFD); column and beams; connections; member under combined loads; bracing requirements; composite members; plastic analysis and design; tall steel buildings, detailing in steel structures.

CE G613 Advanced concrete Structures 3 1 4

Materials; high strength concrete, flexure analysis and design; shear and diagonal tension; bond and anchorage; serviceability; torsion; columns; joints; indeterminate beams and frames; yield line analysis; strip method for slabs; composite construction; footing and foundations; concrete building system; concrete tall buildings, detailing in concrete structures.

CE G614 Prestressed Concrete Structures 3 1 4

Effect of prestressing; source of prestress, prestressing steel; concrete for construction; elastic flexure analysis, flexural strength; partial prestressing; flexural design based on concrete stress limits; tension profile; flexural design based on load balancing; losses due to prestress; shear diagonal tension and web reinforcement; bond stress, transfer and development length, anchorage zone design, deflections.

CE G615 Earthquake Engineering 3 1 4

Single and multi degree freedom system; seismic risk, causes and effects of earthquakes; seismicity, determination of site characteristics; design earthquakes; earthquake resistant design philosophy; seismic response; earthquake resistant design of structures; detailing for earthquake resistance in concrete and steel structures.

CE G616 Bridge Engineering 3 1 4

Purpose of bridge; classification of bridges; characteristics of each bridge; loads stresses and combinations; design of RC bridges; design of non-composite and composite bridges; prestressed bridge; continuous spans, box girders, long span bridges; substructure design for bridges.

CE G617 Advanced Structural Analysis 3 1 4

Flexibility Method; stiffness method; beam curved in plan; two dimensional and three dimensional analysis of structures; shear deformations, shear wall analysis; interactive software development for analysis of structures.

CE G618 Design of Multi-Storey Structures 3 1 4

Loads and stresses; building frames; framing systems, bracing of multistorey building frames; diaphragms; shear walls and cover; tube structure, approximate

analysis and preliminary design; frame analysis; design loading, wind effects and response, earthquake response of structures.

CE G619 Finite element analysis 3 2 5

Fundamentals of Finite Element Method (FEM); basic formulations of FEM; assembly of elements, solution techniques; 2D and 3D problems; review of the isoparametric elements; thin and thick plate elements; introduction to shell formulations; use of newly developed elements; mixed finite element method; material and geometric nonlinear problems; application of FEM to civil engineering problems, programming FEM.

CE G620 Advanced Foundation Engineering 3 1 4

Types of foundations, capacity and settlement of foundations, soil properties, design considerations, discrete method for analysis, design of shallow and deep foundations, failure in foundations, remedial measures, case studies of foundations.

CE G621 Fluid Dynamics 3 2 5

Mechanics of turbulent flow; semi-empirical expressions; statistical concepts; stability theory;flow of non-Newtonian fluids; stationary and moving shock waves; Prandtl-Mayer expressions; two and three dimensional subsonic and supersonic flow; methods of characteristics; small perturbation theory and similarity rules.

CE G622 Soil-Structure-Interaction 3 1 4

Importance of soil-structure interaction, basic theories, types of interaction problems, numerical modelling, experimental and field investigations, prediction of failure mechanism, economic considerations.

CE G623 Ground Improvement Techniques 3 1 4

Requirements for ground improvement, various techniques of improvement, water table lowering, ground freezing, electro-osmosis, compaction, tamping, use of explosives, vibratory probes, thermal treatment, addition of lime, cement and bitumen, gravel and sand columns, preloading techniques, reinforced earth, soil replacement techniques.

CE G631 Selected Topics in Soil Mechanics and Geotechnical Engineering 3 1 4

Formation of soil & soil deposits, subsurface exploration, collapsible soils identification treatment & design consideration, review of casting expansion models in soil, treatment of weak soil, numerical modelling, fracture propagation & fracture energy, fluid infiltered materials, modern trends.

CE G632 Design of Foundations for Dynamic Loads 3 1 4

Evaluation and interpretation of geotechnical reports, selecting foundation design parameters from laboratory and field tests, Selection of foundation, Analysis and design of strip, isolated & combined footing, circular and ring foundation, Design of raft foundation using conventional rigid method, Coefficient of subgrade reaction, Winkler model for footings and mat on elastic foundations, Proportioning and structural design of footings subjected to combined vertical, moment and horizontal loads, Seismic design of shallow foundations, ductile detailing, Analysis and design of different type of pile foundations, piles subjected lateral load, moment and uplift, piles subjected to dynamic loads, design of pile group and pile cap, Seismic design of pile foundations and ductile detailing, Analysis and design of retaining walls, reinforced earth wall design, seismic design of retaining structure, Analysis and design of machine foundations for reciprocating machines, impact type, rotary machines such as turbines, turbo-generator, Computing static and dynamic stiffness of foundations, soil-structure interaction, Optimization and computer aided design of foundation, BIS, IRC, ACI, ASCE, AASTHO and Euro code provisions on structural and earthquake resistant design of foundations.

CE G641 Theory of Elasticity and Plasticity 3 2 5

Basic equations of theory of elasticity; elementary elasticity problems in two and three dimensions; theories of plastic flow; problems in plastic flow of ideally plastic and strain hardening materials; theory of metal forming processes.

Chemical Engineering

CHE C213 Fluid Flow Operations 3 0 3

Fundamental concepts; fluid statics; integral and differential analyses for fluid motion; dimensional analysis; internal and external fluid flow; fluid machinery; flow through packed bed; agitation; introduction to compressible flow.

CHE C221 Chemical Process Calculations 3 0 3

Properties of gases, liquids and solids; material and energy balances; elementary process analysis involving phase equilibria and chemical reactions; recycling and unsteady state processes; combustion calculations and typical industrial applications.

CHE C311 Chemical Engineering Thermodynamics 3 0 3

Development and applications of the combined first and second laws; relations between state properties; chemical equilibria in reacting and nonreacting systems; statistical concepts, and brief exposure to irreversible thermodynamics; extensive problem assignments throughout.

CHE C312 Kinetics and Reactor Design 3 0 3

Kinetics of homogeneous, heterogeneous reactions; ideal reactors, nonideal flow; selectivity; analysis and design of chemical reactors.

CHE C322 Chemical Process Technology 3 0 3

Process synthesis concepts for flow sheet generation;

selected technologies for chemicals from inorganic chemical industries, natural product industries, synthetic organic chemical industries, polymerization industries, etc.

CHE C332 Process Design Decisions 3 0 3

Strategic design decisions in process synthesis & analysis; cost models; profitability measures & analysis; depreciation; engineering economics; hierarchy of levels of design decision making; batch vs. continuous; input-output structure of flow sheet; recycle structure of flow sheet; general structure of separation systems; energy integration analysis; pinch technology; cost diagrams & screening of process alternatives; preliminary process optimization; process retrofitting; case studies.

CHE C351 Heat Transfer Operations 3 3 4

Steady and unsteady state heat conduction; forced and natural convection; radiation; condensation and boiling heat transfer; evaporation; heat exchanger; associated laboratory.

CHE C361 Mass Transfer Operations 3 0 3

Introduction to molecular diffusion and mass transfer coefficients; interphase mass transfer; design of absorption, distillation, extraction and leaching processes.

CHE C411 Environmental Pollution Control 3 0 3

Air & water pollutants; sampling and analysis; control methods for air & water pollutants; modeling of different control techniques; advanced wastewater treatment processes; solid waste management, noise pollution; case studies; associated laboratory.

CHE C412 Process Equipment Design 3 0 3

Application of principles of Chem. Engg. to the selection and design of equipment for Chemical industries; design, cost estimation and selection of process equipment; piping, pressure vessels, heat exchangers, distillation columns etc. Use of computer software packages in the design; plant safety practices; use of codes.

CHE C413 Process Plant Safety 3 0 3

Role of safety in society. Engineering aspects of process plant safety. Chemical hazards and worker safety. Hazardous properties of chemicals. Safety aspects in site selection and plant layout. Design and inspection of pressure vessels. Storage, handling and transportation of hazardous chemicals. Risk assessment methods. Toxic release, fire and explosions. Boiling liquid expanding vapor explosions. Safety audit. Emergency planning and disaster management. Case studies.

CHE C414 Transport Phenomena 3 0 3

Prerequisite : CHE C213, CHE C351, CHE C361

Analogy for momentum, heat and mass transport; shell balance approach for analysis of individual and simultaneous momentum, heat and mass transport; hydrodynamic and thermal boundary layers; velocity, temperature and concentration distributions in turbulent flow; interphase transport for isothermal and non-isothermal systems.

CHE C421 Biochemical Engineering 3 0 3

Course description is same as given under BIO C441.

CHE C422 Combustion Engineering 3 0 3

Fundamentals; theory of combustion and its application to problems of design and operation of equipment for efficient use of fuel; burning of coal in boilers and furnaces; radiation from fires, fly ash and fusion; ignition and flame propagation in fires; industrial explosion and fire hazards; study of design and construction of furnaces.

CHE C431 Selected Chemical Engineering Operations 3 3 4

Chemical engineering operations such as size reduction, mechanical separation, filtration, crystallization, drying, adsorption, membrane separation processes etc; associated laboratory.

CHE C432 Computer Aided Process Plant Design 3 0 3

Introduction to chemical engineering, process plant and methodology for computer aided process design, and analysis. It further undertakes computer aided design of process equipment viz. distillation column, absorption column, heat exchanger, evaporator, condenser, pressure vessel, piping, etc; and plant safety practices. The course contains a project work on computer aided design of the specific plant or equipment.

CHE C433 Corrosion Engineering 3 0 3

(Prerequisite: ES C242)

Corrosion principles: electrochemical aspects, environmental effects, metallurgical & other aspects; various forms of corrosion. Materials: metals and alloys, non-metallics (polymers and ceramics). Corrosion prevention: materials selection, alternation of environment, design, cathodic and anodic protection, coatings.

(This course is introduced as SDC category of B.E. (Hons.) Chemical Engineering Programme).

CHE C441 Process Control 3 0 3

Prerequisite: AAOC C321

Dynamic modeling and simulation of momentum, energy and mass transfer and reacting systems; analysis of the dynamic behaviour of lumped and distributed parameter systems; analysis and design of simple feedback and advanced control systems; design of

control systems with multiple input and multiple output; introduction to computer control.

CHE C471 Refrigeration and Air Conditioning 3 0 3

Course description is same as given under CE C461.

CHE C473 Advanced Process Control 3 1 4

(Prerequisite: CHE C441 Process Control or

INSTR C451 Process Control)

Process identification and adaptive control; Model predictive control structures; Model-based control structures; State estimation; Synthesis of control systems-some case studies; intelligent control.

CHE C491 Special Projects 3

Course description is same as given under BIO C491.

CHE F211 Chemical Process Calculations 3 0 3

Historical overview of Chemical Engineering, Principles of balancing with examples to illustrate differential and integral balances lumped and distributed balances, Material balances in simple systems involving physical changes and chemical reactions, Systems involving recycle, purge and bypass, Properties of substances: single component & multicomponent, single and multiphase systems. Ideal liquid and gaseous mixtures, Energy balance calculations in simple systems, Introduction to Computer aided calculations-steady state material and energy balances for chemical plants

CHE F212 Fluid Mechanics 3 0 3

Dimensions and Units, Velocity and Stress Fields, Viscosity and surface tension, Non-Newtonian flow, Introduction to Fluid Statics, Dimensional Analysis (Buckingham PI theorem), Types of flows, Fluid Statics, Bernoulli equation, Differential and Integral analysis methods of analysis, Navier Stokes equation, Potential flows, Stream functions and velocity potential, Boundary Layer Theory, Flow measurement, Pipe flow analysis, Flow past immersed objects, Packed beds, Fluidized beds, Sedimentation, Pumps and compressors Agitation and Mixing, (Power consumption, mixing times, scale up), Introduction to Turbulent Flows (Reynolds equations), Compressible flows.

CHE F213 Chemical Engineering Thermodynamics 3 0 3

Review of work, heat, reversible and irreversible processes, First Law applications to closed and open systems, Second law, Entropy, and applications related to power and refrigeration, Heat effects, Availability and Exergy analyses Equations of state and generalized correlations for PVT behaviour, Maxwell relations and fluid properties estimation; Residual and excess properties, Partial molar quantities; Gibbs-Duhem Equation, Fugacity and Activity Coefficient models, Vapour-liquid equilibria, Chemical Reaction Equilibrium.

CHE F214 Engineering Chemistry 3 0 3

Organic chemistry – Important functional groups, their reactions and named reactions, Physical chemistry – thermo-physical and thermodynamic properties determination, phase rule, Adsorption equilibria, Electrochemistry, Chemical methods of analysis, Instrumental methods of analysis, Water and waste water chemistry and analysis, Corrosion, Engineering materials and inorganic chemicals, Metals and alloys, Polymers, Fuels and fuel analysis.

CHE F241 Heat Transfer 3 0 3

Steady state and unsteady state conduction, Fourier's law, Concepts of resistance to heat transfer and the heat transfer coefficient. Heat transfer in Cartesian, cylindrical and spherical coordinate systems, Insulation, critical radius, Convective heat transfer in laminar and turbulent boundary layers, Theories of heat transfer and analogy between momentum and heat transfer, Heat transfer by natural convection, Boiling and condensation, Radiation, Heat exchangers: LMTD, epsilon-NTU method, Co-current counter-current and cross flows, NTU – epsilon method for exchanger evaluation.

CHE F242 Numerical Methods for Chemical Engineers 3 0 3

Introduction to mathematical modelling and engineering problem solving, Use of software packages and programming, Errors and approximations including error propagation and Numerical error, Roots of equations: Linear algebraic equations, 1-D and multidimensional unconstrained optimization including gradient methods, Linear programming, Non-linear constrained Optimization, Optimization with packages, Least Squares Regression including quantification of error, Polynomial regression, Lagrange, inverse and spline interpolation and Fourier approximation, Engineering applications, Numerical differentiation and integration, Ordinary differential equations, Partial differential equations, Engineering applications

CHE F243 Material Science and Engineering 3 0 3

Introduction on materials for engineering, structures of metals, ceramics and polymers; crystalline structure imperfections; amorphous and semi-crystalline materials (includes glasses, introduction to polymers); Correlation of structure to properties and engineering functions (mechanical, chemical, electrical, magnetic and optical); phase diagrams; Improving properties by controlled solidification, diffusion or heat treatment; Failure analysis and non-destructive testing; Types of materials (includes synthesis, Fabrication and processing of materials): Polymers and composites, Environmental degradation of materials (corrosion); Evolution of materials (functional materials, Biomimetic materials, energy saving materials etc); Criteria for material selection.

CHE F244 Separation Processes I 3 0 3

Molecular diffusion in fluids, Interphase mass transfer, mass transfer coefficient, Theories for interphase mass transfer, overall mass transfer coefficient and correlations, mass transfer with chemical reaction, analogy between momentum, heat and mass transfer, Absorption, Distillation including azeotropic and extractive distillation, Liquid-Liquid extraction, Leaching, Equipment for absorption, distillation, extraction and leaching.

CHE F266 Study Project 3

Course description is same as given under BIO F266.

CHE F311 Kinetics and Reactor Design 3 0 3

Kinetics Reaction rate, order, rate constant; Batch reactors Design + basics; Kinetic constants from batch reactor data; Ideal flow reactors Mass and Energy balances; Isothermal, adiabatic and non-isothermal operation; Catalysts, Catalytic rates, Reaction mechanisms; Internal/External transport in catalysts; Non-catalytic solid-gas reactions; Reactor design for ideal flow reactors; Kinetics of Solid Catalyzed Reactions; Yield and Selectivity; Concept of RTD; Segregation and Maximum Mixedness models.

CHE F312 Chemical Engineering Lab I 0 3 3

This course aims to help students gain practical experience using laboratory-scale experiments to supplement theory courses taught in classroom with major focus on chosen experiments from Fluid Mechanics, Engineering Chemistry, Heat transfer and Separation Processes – 1. Students will collect and analyze experimental data using theoretical principles related to relevant courses already covered in previous Semesters.

CHE F313 Separation Processes II 3 0 3

Special equilibrium based separations like humidification and water cooling, Drying of wet solids, adsorption, crystallization etc., Mechanical separations like filtration, centrifugation, froth floatation etc., Solid separations based on size reduction including sieving operations and related equipment like crushers, mills, pulverizers etc., special separation processes like ion-exchange, membranes, chromatography etc.

CHE F314 Process Design Principles I 3 0 3

Process invention using heuristics and analysis (The Design process, Process creation and heuristics for process synthesis, Molecular structure design, Role of process simulators Like Aspen, Chemcad, Hysys etc. in process creation), Detailed process synthesis using algorithmic methods with emphasis on reactor networks, separation trains, batch processes, heat integration etc.

CHE F341 Chemical Engineering Laboratory II 0 3 3

This course aims to help students gain practical experience using laboratory-scale experiments to supplement theory courses taught in classroom with major focus on chosen experiments from Kinetics and Reactor Design, Process Dynamics and Control and Separation Processes – 2. Students will collect and analyze experimental data using theoretical principles related to relevant courses already covered in previous Semesters.

CHE F342 Process Dynamics and Control 3 0 3

Introduction to process control, Theoretical models of chemical process, Laplace Transforms, Transfer functions and state space models, Dynamic response of first and second order processes, Effect of dead time, Dynamics response of more complicated systems, Development of empirical models from empirical data, Feedback control, Control system instrumentation, Overview of Control system design, Dynamic behavior and stability of closed loop system using root locus, frequency response using Bode and Nyquist plots, PID controller design and tuning, Control system design based on frequency response analysis, Feed forward, cascade and ratio control, Introduction to multivariable control system, identification of interaction, design of controllers in interactions, elimination of interactions, Control strategies for common industrial processes such distillation, heat exchangers, etc. Control strategies for Batch processes.

CHE F343 Process Design Principles II 3 0 3

Review of process synthesis, Design and sizing of equipment of heat exchangers, separation towers, pumps etc. Cost accounting and capital cost estimation, Annual costs, earnings and profitability analysis, optimization of process flow sheets, Steps involved in designing configured industrial systems like solar desalinators, fuel cells, hand warmers etc.

CHE F366 Lab Project 3

CHE F367 Lab Project 3

Course description is same as given under BIO F366 and BIO F367.

CHE F376 Design Project 3

CHE F377 Design Project 3

Course description is same as given under BIO F376 and BIO F377.

CHE F411 Environmental Pollution Control 3 0 3

Course description is same as given under CHE C411.

CHE F412 Process Equipment Design 3 0 3

Course description is same as given under CHE C412.

CHE F413 Process Plant Safety 3 0 3

Course description is same as given under CHE C413.

CHE F414 Transport Phenomena 3 0 3

Course description is same as given under CHE C414.

CHE F415 Molecular and Statistical Thermodynamics **3 0 3**

Fundamental of Statistical Mechanics, Quantum Mechanics, Postulates, Concept of Ensembles, Intermolecular Potential Energy functions; Distribution functions: Radial Distribution Function (RDF); Applications of Statistical Mechanics: Thermo-physical property calculations in ensembles; Cooperative Phenomenon: Phase Equilibria: Ising model, Gibbs Ensemble (VLE), Thermodynamic Integration, Gibbs-Duhem Integration, Free Energy calculation; Virial EOS: second virial coefficient; Special Applications: From Surface Adsorption: Adsorption Isotherm. Molecular Simulation Techniques: Molecular Dynamics and Monte Carlo Simulation, Monte Carlo Simulation in various Ensemble.

CHE F416 Process Plant Design Project I **3**

This course aims to train the student on various aspects involved in design of a process plant. It may be for a Battery limit (B/L) plant or for a Grass roots project. The design will have to be submitted in the form of a standard report. There would be two major submissions: (i) Process selection and PFD, (ii) Material and Energy Balance. This part of the project in conjunction with Process Plant Design Project 2 is a Basic Process Package Report for a complete process plant.

CHE F417 Process Plant Design Project II **3**

This course is an extension of Process Plant Design Project 1 and aims to train the student on various aspects involved in design of a process plant. It may be for a Battery limit (B/L) plant or for a Grass roots project. The design will have to be submitted in the form of a standard report. There would be three major submissions in relation to the process selected in Process Plant Design Project 1: (i) Process Design, (ii) Mechanical design, (iii) Costing. This part of the project in conjunction with Process Plant Design Project 1 is part of detailed engineering and economics for a complete process plant.

CHE F418 Modelling and Simulation in Chemical Engineering **3 0 3**

Mathematical model and necessity, Introduction to modeling, Physical and Mathematical models, Modelling in Chemical Engineering, Formulation of dynamic models with case studies based on mass, component, momentum and energy balances, Modeling of selected fluid flow, heat transfer, mass transfer and reaction engineering phenomena, Role of Simulation and simulators, Sequential and modular approaches to Process Simulation, Equation solving approach, Decomposition of networks, Convergence promotion, Specific purpose simulation, Introduction to role of evolutionary computation in simulation.

Pre-requisite : 1. CHE F242 Numerical Methods for Chemical Engineers 2. CHE F311 Kinetics and Reactor Design

CHE F419 Chemical Process Technology **3 0 3**

Process synthesis concepts for flow sheet generation - Unit operations and unit processes, General principles applied in studying a chemical industry; Chemical processes based on agricultural and sylvi-cultural raw materials - Sugar, starch, alcohol, cellulose, etc; Selected technologies for chemicals from inorganic chemical industry covering contact process, fertilizer, chloral-alkali, cement and lime; Natural product industry covering manufacture of oils, soaps, detergents, paper and pulp, Coal and various coal-chemicals, Petroleum and petrochemical products, Raw materials and principles involved in the production of olefins and aromatics, Acetylene, Butadiene and typical intermediates from olefins and aromatics such as ethylene glycol, ethyl benzene, phenol, cumene and DMT/PTA, Dyes and pharmaceuticals.

CHE F421 Bio-chemical Engineering **3 0 3**

Basics of Microbiology and Biochemistry; Introduction to Biochemical engineering, Mass and energy balance in microbial processes; Microbial growth, Substrate utilization and product formation kinetics; Medium and air sterilization; Enzyme kinetics and immobilized enzyme systems; Design of batch, continuous and fed-batch bioreactors; Transport Phenomena in biological reactors; Scale-up principles for biochemical processes; Instrumentation and control of bioprocesses, Bio-separations.

CHE F422 Petroleum Refining Technology **3 0 3**

Current world oil and gas scenario; History and development of refining; Petroleum industry in India; Origin, formation, and composition of petroleum; Classification and evaluation of crude oils; Petroleum products and test methods; Crude oil distillation; Thermal, catalytic and finishing processes; Product blending; Lube oil and bitumen (asphalt) manufacturing processes.

Pre-requisite: CHE F244 Separation Processes I

CHE F433 Corrosion Engineering **3 0 3**

Corrosion principles: electrochemical aspects, environmental effects, metallurgical & other aspects; various forms of corrosion. Materials: metals and alloys, non-metallics (polymers and ceramics). Corrosion prevention: materials selection, alternation of environment, design, cathodic and anodic protection, coatings.

Pre-requisite: CHE F243 / ME F213 / MF F213 (Material Science and Engineering)

CHE F471 Advanced Process Control **3 0 3**

Course description is same as given under CHE C473.

CHE F491 Special Projects **3**

Course description is same as given under BIO F491.

CHE G511 Fluidisation Engineering 3 1 4

Fundamentals, industrial applications; study, design and operation of fluidisation units.

CHE G512 Petroleum Refining and Petro-Chemicals 3 1 4

Origin, formation and composition of petroleum; history and development of refining; refinery products and test methods; classification and evaluation of oil stocks, fractionation of petroleum; thermal and catalytic processes; properties & production of petrochemicals.

CHE G513 Environmental Management Systems 3 2 5

Introduction to air & water pollutants & solid wastes; sampling & analysis techniques; impact of these on environment; national & international regulations; ISO series; conventional & non-conventional energy resources; life cycle analysis; environmental audit; sustainable developments; case studies.

CHE G514 Evolutionary Computation 5

Non-traditional optimization techniques; population based search algorithms; evolutionary strategies; evolutionary programming; simulated annealing; genetic algorithms; differential evolution; different strategies of differential evolution; Memetic algorithms; scatter search; ant colony optimization; self-organizing migrating algorithm; other emerging hybrid evolutionary computation techniques; engineering applications involving highly non-linear processes with many constraints and multi-objective optimization problems.

CHE G521 Chemical Engineering Analysis 2 2 4

Mathematical analysis of chemical engineering problems; introduction to modelling and simulation techniques in the analysis of systems; emphasis on applying mathematical techniques to real Chemical Engineering processes and on physical and mathematical interpretation of results; use of computer software for analysis and solution of mass and energy balances problems for complex processes.

CHE G522 Polymer Technology 3 1 4

Polymerisation techniques; classification of polymers; mechanism and kinetics of formation of polymers; different techniques for determination of different types of molecular weights; polymer structure; definition and measurement of glass transition and crystalline melting temperatures; viscoelasticity and rubber elasticity behaviour; degradation and stability; polymer processing; rheology and applications. The course will terminate with several design projects on real life problems.

CHE G523 Mathematical Methods in Chemical Engineering 3 2 5

An introduction to mathematical modelling and simulation, Fundamentals of functional analysis, Linear algebraic equations and related numerical schemes, ODE's IVP and related numerical schemes, Partial differential equations and related numerical schemes, Optimization and related numerical schemes, Application of the above principles to solving problems in Chemical Engineering, Role of computer programming and packages in problem solving.

CHE G524 Introduction to Multiphase Flow 3 1 4

Introduction to multiphase flow, Single particle motion, Bubble and droplet transition, Marangoni effects, Bubble growth and collapse, Cavitation, Flow patterns, Internal flow energy conversions, Homogenous flows, Flows with bubble and gas dynamics, Sprays, Granular flows, Drift flux models, System instabilities.

CHE G525 Chemical Process and Equipment Design 3 1 4

The nature and function of process design, Flow sheet preparation and drawing, Process Planning Scheduling and Flow Sheet Design, P and I diagrams, Piping Design, Pump size selection. Design information and data, Specification and design of process equipment, Rules of THUMB for design of equipment, Software use in process design, Process design of equipment in heat and mass transfer, reactors, pumps, etc., Mechanical design of selected equipment.

CHE G526 Nuclear Engineering 3 1 4

Review of Nuclear Physics, Mechanism of nuclear fission, Fission cross section, Fission products, Reactor Physics, Types of nuclear reactors, Construction and control of nuclear reactors, Heat transfer in nuclear reactors, Design and operation, Reactor shielding, Nuclear fuels, Moderators, Coolants, Reflectors and structural materials, Nuclear fuel cycle, Spent fuel characteristics, Reprocessing techniques role of solvent extraction in reprocessing, Reactor control and safety.

CHE G527 Energy Conservation and Management 3 1 4

Energy conservation, Growth and demand of energy, Energy availability, Comparison of specific energy use in select industry, Potential and status of energy in India, Energy saving potential in industries, Potential of energy efficiency in India, Energy available for industrial use and the role of conservation, Energy management and policy, Comprehensive energy conservation planning (CECP), Definition and principles of energy conservation, Energy conservation technologies, Cogeneration concept and scope, Energy audit and management. Energy conservation in utilities.

CHE G528 Introduction to Nano Science and Technology 3 1 4

Introduction to nano-science, Basic idea of solid state physics and quantum mechanics, Quantum wells, Wires and dots, Properties of nanomaterials, Carbon nanotubes, Nanosynthesis, Characterisation methods, Application of nano-materials to various fields like elec-

tronics, medical, MEMS, photonics, molecular switches and others, Special reference to Chemical Engineering as in catalysis, heat transfer and special additive and performance materials (nanofluids, nanocomposites), Future of nano science and technology, Large scale manufacture and technological issues.

CHE G529 Pulp and Paper Technology 3 1 4

Selection of pulp and paper making raw materials, Wood Anatomy- identification, Preparation of wood chips, Chip screening, Storage and chip conveying, Chemical composition of fibrous raw materials, Chemical Pulping, Mechanical Pulping, Chemical thermomechanical (CTP) processes, Waste Paper Pulping, Bleaching and washing, Chemical Recovery, Description of various grades of pulp & paper, Mechanical and chemical properties of pulp, Paper making, cellulose derivatives- preparation & end use, Environmental aspects in pulp and paper industry.

CHE G531 Project Engineering 2 2 4

Project feasibility studies and report; Project appraisal; Project solution and evaluation; Project planning; Economic decision making; Project preparation and management.

CHE G532 Alternate Energy Resources 3 1 4

The scope and present day technology in utilization of solar energy, wind power, tidal power, geothermal power, M.H.D. and fuel cells.

CHE G533 Petroleum Product Characterization 3 2 5

Methods of estimation of characterization parameters for pure hydrocarbons; methods of characterization of petroleum fractions and products; experimental methods on measurement of basic properties obtained from laboratory testing; methods of prediction of properties for defined mixtures from pure-component properties (normal boiling point, density, molecular weight, critical properties, etc.); methods of prediction of properties for undefined mixtures based on certain bulk properties; characterization methods for light and heavy as well as narrow and wide boiling range mixtures; predictive methods for some characteristics specifically applicable to petroleum fractions that affect the quality of a fuel; standard test methods recommended by ASTM for various properties; minimum laboratory data needed to characterize various fractions as well as analysis of laboratory data and criteria for development of a predictive method; introduction to characterization of crude oils and reservoir fluids; associated Petroleum Laboratory experiments.

CHE G541 Process Plant Simulation 2 2 4

Computer aided analysis of chemical process systems; classification and development of mathematical models to various chemical engineering systems; decomposition of networks; tearing algorithms; numerical methods for convergence promotion and solving chemical engineering problems; traditional & non-traditional optimization techniques; specific purpose simulation; dynamic process plant simulation; case study problems using professional software packages.

CHE G542 Computational Transport Phenomena 3 2 5

Concepts; partial differential equations: types, boundary conditions, finite difference scheme, error analysis, grid generation, stability criteria; conduction and convection : two-dimensional steady state problem, methods for solving coupled algebraic equations, finite element method; fluid flow : governing equations, various approach of simulation (stream-vorticity, primitive variable), staggered grid, similarity solution, Newton-Raphson method, explicit and implicit formulation; solution of Navier-Stokes equations : solution of full and parabolized equations, unsteady flow, MAC, SIMPLE algorithm, RNS method; Mass Transfer : dynamic model, mass transfer with simultaneous convection and diffusion, transient multicomponent diffusion; short projects on development of codes for various real life problems involving transport processes.

CHE G551 Advanced Separation Technology 3 2 5

A brief overview of the existing separation technologies such as adsorption-based separation, membrane separation, cryogenic separation, and biotechnology-based separation. Recent advancements on the above areas and the new concepts such as simulated moving bed adsorption, thermally coupled pressure swing adsorption, reactive distillation, bio-filtration, supercriticalfluid extraction etc. This course will terminate with several design projects on real life problems.

CHE G552 Advanced Transport Phenomena 5

Viscosity, thermal conductivity and diffusivity, Shell momentum and energy balance, equations of change for isothermal and non-isothermal systems, Concentration distribution in solids and laminar flows, momentum, thermal and concentration boundary layers near walls, origin of turbulence, length scales in turbulent flows, Reynolds (RANS) equations, estimates of Reynolds stress (k-epsilon and k-omega type models), turbulent shear flow near a wall, turbulent flow in pipes and channels, turbulent heat transfer, Introduction to large eddy simulations models, rheology and material functions, non-Newtonian viscosity and generalized Newtonian models, Linear and non-linear viscoelasticity, radiation heat transfer, multi-component systems, Coupled heat and mass transfer, evaporation, boiling and condensation, chemical reactions, **Special topics**: Flow through porous media, compressible flows, multiphase flow, Transport phenomena in biochemical systems.

CHE G553 Statistical Thermodynamics 4

Review: Classical thermodynamic and elementary Statistical Mechanics, Macroscopic and microscopic descriptions of the state of a system, Equilibrium ensembles, the partition function and thermodynamic properties; System of independent particles; Fluctuations and

the compressibility equation; Chemical equilibrium in ideal gas mixtures; Molecular based equations of state, SAFT, Lattice statistics; Real gases, Virial equation; The liquid state: lattice models, distribution functions theories, perturbation theories; Liquid mixtures: solution theories and local composition models, Statistical thermodynamics of electrolytes

CHE G554 Computational Fluid Dynamics 4

Introduction to CFD, Equations of change for momentum, energy and mass transport, introduction to partial differential equations, Numerical analysis and discretization techniques, Managing uncertainties in CFD, grid generation, application of CFD to solve Chemical Engineering problems, Introduction to COMSOL, data analysis, validation and post processing.

CHE G556 Electrochemical Engineering 4

Basic physics of galvanic cells, Electrochemical Energy conversion, Electrochemical Energy storage, Equivalent circuit dynamics, Impedance spectroscopy, Impedance of electrodes, Nernst equation, Fuel cells and batteries, Faradic equations in dilute solutions, Butler Volmer equation, Reactions in concentrated solutions, Ion absorption and intercalation, Concentration polarization, forced convection in fuel cells, Transient diffusion, Warburg impedance, Diffusion in concentrated solutions, Transport in bulk electrolytes, Ion concentration polarization, Double layer structure, Transport on porous media, Porous electrodes, Super capacitors, Electrostatic correlations.

CHE G557 Energy Systems Engineering 4

Cradle to grave overview of major current and future energy conversion processes. Energy sources such as coal, natural gas, petroleum, biomass, uranium, wind, and solar. Fuel processing techniques such as Fischer-Tropsch synthesis, gasification, methane reforming, and CO_2 reforming. Power generation technologies including steam turbines, gas turbines, wind turbines, fuel cells, and solar panels. Sustainability impact factors including water consumption, smog formation, and CO_2 emissions. Advanced processing techniques such as combined cycles, turbine/fuel cell hybrids, and CO_2 capture technologies. Real world use and application.

CHE G558 Chemical Process Optimization 4

Introduction to Process Modelling and simulation, Fundamentals of analytical optimization. Survey of one dimensional line-search methods, and multi-dimensional unconstrained and constrained numerical optimization algorithms. Applications of linear programming, nonlinear programming, mixed integer linear/ nonlinear programming, and parameter estimation in chemical engineering. Feasible-path and infeasible-path techniques for chemical process flowsheet optimization, Evolutionary computation in Chemical Engineering.

CHE G559 Reactor Physics and Engineering 5

Nuclear Reactions, Binding Energy, Fission Reactions, Fissile and Fertile Materials, Radioactive Decay; Neutron Cross Sections, Nuclear Fuel Properties, Moderators, Energy Spectra, Infinite Medium Multiplication, Power Reactor Core & Kinetics, Neutron Balance & Diffusion Equation, Four-factor formula, Two-group analysis, criticality equation, Electrical power generation from nuclear fission, fundamental aspects of fission chain reaction, and reactor design. Reactor concepts & types, their static and dynamic characteristics Reactor operation and control, Startup and shut down of systems.

CHE G560 Nuclear Fuel Cycle and Waste Management 5

Processing of nuclear fuel with descriptions of mining, milling, conversion, enrichment, fabrication, irradiation & properties of irradiated fuel, reprocessing, and waste disposal. In-core and out-of-core nuclear fuel management design, Nuclear power plant and fuel cycle economics, Management of spent fuel, high-level waste, uranium mill tailings, low-level waste and decommissioning wastes. Fundamental processes and governing equations for waste management systems, safety assessment of waste disposal facilities, Chemical Engineering operations in Nuclear fuel manufacture, waste reprocessing operations and waste management, Process Engineering for Nuclear Industry.

CHE G561 Nuclear Reactor Control and Instrumentation 4

Fundamentals of process instrumentation and control, Open and closed loops, SCADA and DDC, PLC, Alarms and Safety interlocks for shutdown and emergency shutdown, special sensors and sensor specifications for Nuclear Industry, Nuclear reactor safety, Special control logic for Nuclear safety, reliability and redundancy, Nucleonics: application of Nuclear materials and radiation in measurement techniques, Nucleonics based instruments for analysis, Design, maintenance and operation of such instruments. Calorimetry, detection of alpha, beta and gamma rays including spectrometry, liquid scintillation counting.

CHE G562 Thermal Hydraulics and Heat Transfer 4

Thermal-hydraulic core design and analysis of nuclear systems, Single and two-phase flow, Flow regimes, pressure drops, frictional losses, pumping power modeling of fluid systems. Design constraints imposed by thermal-hydraulics heat generation, temperature distribution, heat removal, reactor heat sources & coolants, departure from nucleate boiling, boiling heat transfer, critical heat flux conduction in reactor components and fuel elements, heat transfer in reactor fuel bundles and heat exchangers, application of CFD in thermo-hydraulics of core.

CHE G563 Nuclear Chemical Engineering 4

Solvent Extraction, Ion Exchange, Decontamination, Isotope Separation, Unit operations and processes used in the Production of Heavy Water, Desalination, Thermo-chemical Cycle for Hydrogen Production, district heating, nuclear propulsion, waste processing including vitrification.

CHE G564 Nuclear Materials and Radiation Damage 4

Nuclear Materials; fabrication and quality control, non – destructive evaluation and irradiation behavior of uranium, plutonium and thorium based ceramic, metallic and composite fuels; fuel failure, post irradiation examination and mitigation of fuel failure; fabrication, heat treatment, property evaluation and irradiation behavior of fuel cladding and core structural materials e.g. aluminum & alloys for research reactors, zirconium alloys for water cooled nuclear power reactors and stainless steels and oxide dispersion strengthened (ODS) steel for fast reactors; physical, chemical and instrumental methods of analysis of nuclear materials and real time accounting of nuclear materials, radiation damage of nuclear fuels, pressure vessel, pressure tubes and other structural materials including radiation-embrittlement, void swelling, irradiation growth and creep, fracture toughness etc.

CHE G565 Radiation and Radio Isotopes Applications 4

Nuclear non-power research reactors, measurement of radiation and use of neutron radiography, neutron diffraction and activation analysis for materials characterization; Production of Radioisotopes and their applications in medicine and healthcare, food and agriculture including food irradiation & preservation, radiation induced mutation for seed and crop, sterilization and application of radioactive tracers in basic and applied research.

CHE G566 Nuclear Safety, Security and Safeguards 4

Radiation interaction & safety, environmental aspects, internal and external dose evaluation, reactor effluents and release of radioactivity, Operational and maintenance safety, Hazop and Hazan analysis, HSE issues and systems management in Nuclear installations and Nuclear industry and Nuclear Laboratories, Design basis threat (DBT) and threat analysis and evaluation, Detection, delay and response technologies and evaluation, Incorporating insider threat/wrong operation in DBT, Security and safety in Nuclear Materials Transportation, Nuclear forensics and consequence management, Nuclear systems safety and security analysis, Technologies and techniques for securing nuclear materials, Nuclear materials safeguard systems from theft, spillage and other unforeseen incidents, Fuel facility safeguard systems, Design of safeguard systems, Intrinsic and Extrinsic safeguard and proliferation resistance of fissile and fertile materials, Technical issues associated with Nuclear Non Proliferation, Facility inspection, safety, security and safeguard audit, Elements of non-proliferation policies, treaties and enforcement technologies.

CHE G567 Natural Gas Processing 4

Overview of Natural Gas industry; Overview of Gas Plant processing; Field operation and inlet receiving; Compression; Gas treating; Gas dehydration; Hydrocarbon recovery; Nitrogen rejection; Trace component recovery or removal; Liquids processing; Sulfur recovery; Transportation and storage; Liquefied Natural Gas; Capital cost of Gas processing facilities; Natural gas processing plants.

CHE G568 Modeling and Simulation in Petroleum Refining 4

Introduction to modeling and simulation; Numerical methods and software; Modeling and simulation of multi-component distillation columns; Reactor modeling in the petroleum refining industry; Modeling of catalytic hydro-treating; Modeling of catalytic reforming; Modeling and simulation of fluidized-bed catalytic cracking converters.

CHE G569 Petroleum Production Economics 4

Cash flow analysis in the petroleum industry (definition of cash flow, deriving net cash flow under tax/royalty systems and production sharing contracts, depreciation methods, inflation, sunk costs). Economic indicators (net present value, rate of return and other indicators). Fiscal analysis (the nature of petroleum fiscal regimes, the effects of fiscal regimes on exploration and field development decision making, economic analysis of fiscal regimes in India & abroad).

CHE G611 Computer Aided Analysis and Design 2 3 5

Course description is same as given under CE G611.

CHE G613 Advanced Mass Transfer 3 2 5

Use of stage and differential contact concepts in design of mass transfer equipment; methods of determining and interpretation of rate data; multicomponent distillation, absorption and extraction.

CHE G614 Advanced Heat Transfer 3 2 5

(= ME G631)

Heat conduction with unsteady boundary conditions; recent advances in natural and forced convection; condensation and boiling phenomena; heat transfer in high speed flows; liquid metal heat transfer, radioactive metal heat-transfer between surfaces in absorbing media; complex problems involving simultaneous conduction, convection and radiation.

CHE G615 Advanced Separation Processes 3 2 5

Shortcut and rigorous methods of conventional separa-

tion processes such as multicomponent distillation, absorption, stripping and extraction; Azeotropic and Extractive distillation; adsorption based separation, simulated moving bed adsorption, thermally coupled pressure swing adsorption; cryogenic separation, gas liquefaction; membrane based separation, pervaporation, liquid membrane; biotechnology based separation, modeling approach, design considerations, biofiltration; reactive distillation; super critical fluid extraction.

CHE G616 Petroleum Reservoir Engineering 3 2 5

Origin and composition of petroleum; Geographic distribution of oil; Petroleum geology; Exploration, drilling and recovery; Drilling methods and drilling fluids; Lubricants and spotting fluids; Corrosion control; Analytical and test methods; Enhanced oil recovery; Injection fluids; Polymer and caustic flooding; Use of surfactants; Improvement of oil displacement efficiency; Environmental and economic aspects.

CHE G617 Petroleum Refinery Engineering 3 2 5

History and development of refining; Indian petroleum industry; Composition of petroleum, laboratory tests, refinery products; Classification, characterization and evaluation of crude oil; Trends of petroleum products; Atmospheric and vacuum distillation; Design of crude distillation column; Catalytic cracking; Hydrotreating and Hydrocracking; Catalytic reforming; Delayed coking and visbreaking; Furnace design; Isomerization, alkylation and polymerization; Lube oil manufacturing; Energy conservation in petroleum refineries; Environmental aspects of refining.

CHE G618 Petroleum Downstream Processing 3 2 5

Petrochemical feedstock; Pyrolysis of Naptha and light hydrocarbons; First generation petrochemicals: Ethylene, Propylene, Butylenes, Acetylene, Butadienes, Chloroprene, cyclohexane, BTX, Polymethyl Benzenes; Second generation petrochemicals: synthesis gas, methanol, ethanol, ethylene oxide, propylene oxide, acetone, allyl alcohol, glycerol, acrylonitrile, Acrylic acid and derivatives, phenol, aniline, nylon monomers, polyester monomers, styrene and other monomers; Third generation petrochemicals: plastics, rubbers, fibres, resins, detergents, pesticides, dyes, protein, explosives, petroleum coke and carbon black; Catalysts in petroleum refining and petrochemicals processes; Transportation of dangerous goods; Health and safety in petrochemical industries; Pollution and toxicity; Future of petrochemicals.

CHE G619 Process Intensification 3 2 5

A brief review of the process intensification (PI), includes philosophy and principles of PI; equipments and methods for PI; few examples of their application on the commercial scale, such as multifunctional reactors, hybrid processes, monolithic reactors, high gravity reactors etc., industrial practice of PI- methodology and applications; PI by process synthesis; PI by plant safety. This course will terminate with several design projects on real life problems.

CHE G620 Energy Integration Analysis 3 2 5

Importance and scope of application of Energy Integration; Pinch technology tools, targeting, design, synthesis and optimization of heat exchanger networks (HEN); Interfacing HEN synthesis with heat exchanger design, Retrofitting, energy integration of distillation and evaporation processes, mathematical programming approach, Artificial intelligence based approaches.

CHE G621 Fluid Dynamics 2 3 5

Course description is same as given under CE G621.

CHE G622 Advanced Chemical Engineering Thermodynamics 3 2 5

Review of fundamental principles; statistical foundations; thermodynamic properties of pure substances and mixtures, their estimation and correlation; stability and equilibrium criteria for homogeneous and heterogeneous systems; thermodynamics of irreversible processes.

CHE G641 Reaction Engineering 3 2 5

Design of multi-phase reactors; analyses of gas-liquid and gas-liquid-solid reactions; intrinsic kinetics of catalytic reactions; residence time distribution models for micro-and macro-mixing; mathematical models for gas-liquid-solid reactors; laboratory reactors; dynamics and design of various multi-phase reactors such as trickle bed reactors, bubble column reactors, segmented-bed reactors, slurry reactors, spouted bed reactors, pulsating reactors, fluidized bed reactors, etc.; optimization of chemical reactors.

Chemistry

CHEM C141 Chemistry I 3 0 3

This is the first of a sequence of two courses aimed at providing an integrated overview of chemistry. Topics to be discussed will include: nuclear chemistry: electronic structure of atoms; molecular structure and chemical bonding; chemical thermodynamics; phase and chemical equilibrium; electrochemistry; chemical kinetics.

CHEM C142 Chemistry II 3 0 3

Pre-requisite: CHEM C141

Representative topics from inorganic and organic chemistry will be discussed to expose the student to the logic and systematics of these areas, keeping in view the general principles introduced in the first course. Topics will include: stereoisomerism; important classes of organic reactions such as nucleophilic aliphatic substitution, elimination, electrophilic addition, free radical addition; organic synthesis; chemistry of selected main group elements; coordination chemistry.

CHEM C211 Atomic and Molecular Structure 3 0 3

Elements of quantum theory; the Schrodinger equation; some exactly solvable models; angular momentum; hydrogen-like atoms; approximation methods; electronic structure of many-electron atoms; molecules-Valence Bond and molecular orbital theories; semi-empirical treatments-huckel theory; molecular spectroscopy.

CHEM C212 Colloid and Surface Chemistry 3 0 3

Surface phenomena; intermolecular forces relevant to colloidal systems; forces in colloidal systems; experimental and theoretical studies of the structure, dynamics and phase transitions in micelles, membranes, monolayers, bilayers, vesicles and related systems; technical applications**.**

CHEM C221 General Chemistry 3 0 3

Atomic structure; chemical bonding; gaseous, liquid and solid states; thermodynamics: phase and chemical equilibrium; electrochemistry; chemical kinetics; organic compounds: functional groups,structure and isomerism; stereochemistry; organic reactions: substitution, addition and elimination; chemistry of some representative elements; nucleus and radioactivity.

CHEM C222 Modern Analytical Chemistry 3 0 3

Data handling and analysis; sample preparation; unit operations; volumetric and gravimetric analysis; oxidation-reduction and complexometric titrations; electroanalytical methods: potentiometry, ion selective electrodes, conductometry, polarography; separation techniques: chromatography, solvent extraction; introduction to spectroscopic methods; radiochemical methods; specific applications to problems in air and water quality analysis, toxic and trace metal estimation in biological and environmental samples.

CHEM C231 Chemistry Project Laboratory 3*

The course includes projects involving laboratory investigation or laboratory development in chemistry. The course is normally available to students of second or higher level. The course must coterminate with a project report.

CHEM C232 Chemistry of Organic Compounds 3 0 3

Electrophilic and nucleophilic aromatic substitution; nucleophilic additions to carbonyl compounds, aldol and related condensations; amines, malonic ester and acetoacetic ester synthesis; carbohydrates; orbital symmetry and chemical reactions; hetrocyclic compounds.

CHEM C311 Chemical Kinetics 3 0 3

Discussion of reaction rate theory, kinetics and mechanism of various types of reactions, effect of temperature on reaction rates, energy of activation, theories of reaction rates and photochemistry.

CHEM C312 Chemistry of Nontransitional Ele- 3 0 3 ments

Basic principles of inorganic chemistry; abnormal and general properties; methods of preparation; industrial uses of derivatives of non-transitional elements.

CHEM C321 Chemical Thermodynamics 3 0 3

Review of classical thermodynamics and an introduction to statistical mechanics with applications to chemical systems.

CHEM C322 Quantum Chemistry 3 0 3

Review of the postulates of quantum mechanics and some exactly solvable potential problems; angular momentum; variation method; stationary state and time dependent perturbation theory; atomic structure: antisymmetry, determinantal wave functions, SCF method, coupling of angular momenta, spectra; symmetry: point groups, representations, direct product, projection operators; molecules – Born-Oppenheimer approximation, molecular Hartree Fock calculations, VB and MO theories: ab initio and semi empirical methods; symmetry and molecular spectra.

CHEM C331 Structure and Reactivity of Organic 3 0 3 Compounds

Structure & reactivity; oxidation and reduction, aliphatic nucleophilic substitution; aromatic substitution reactions; eliminations, addition to carbon heteromultiple bonds and rearrangements; stereo chemistry of cyclic compounds.

CHEM C332 Synthetic Organic Chemistry 3 0 3

Retrosynthetic analysis, synthetic strategies, protecting groups, carbon-carbon bond forming reactions, functional group disconnection, carbon-carbon bond disconnection, ring annelation, multistep synthesis, synthetic equivalents, asymmetric synthesis.

CHEM C341 Biophysical Chemistry 3 0 3

The principles governing the molecular shapes, structures, structural transitions and dynamics in some important classes of biomolecules and biomolecular aggregates will be discussed. The topics will include: structure, conformational analysis, conformational transitions and equilibria in proteins and nucleic acids; protein folding; lipids - monolayers, bilayers and micelles; lipid-protein interactions in membranes.

CHEM C342 Coordination Chemistry 3 0 3

Crystal field, ligand field and molecular orbital theories; chemistry of transitional metals; organometallic compounds; lanthanides and actinides.

CHEM C351 Computational Chemistry 3 3 4

Selected problems in computational chemistry from diverse areas such as chemical kinetics and dynamics, quantum mechanics, electronic structure of molecules,

spectroscopy, molecular mechanics and conformational analysis, thermodynamics, and structure and properties of condensed phases will be discussed. The problems chosen will illustrate the application of various mathematical and numerical methods such as those used in the solution of systems of algebraic equations, differential equations, and minimization of multidimensional functions, Fourier transform and Monte Carlo methods.

CHEM C352 Bonding in Inorganic Compounds 3 0 3

Point groups and molecular symmetry; uses of point group symmetry; ionic bonding; covalent bonding; valence bond and molecular orbital theories of simple compounds; electronegativity; VSEPR model; fluxional molecules; ionic and covalent solids; band theory; dipole related forces; hydrogen bonding; coordination compounds: VB, crystal field and MO theories, electronic spectra and magnetic properties.

CHEM C361 Polymer Chemistry 3 0 3

Types of polymers; structures of polymers; molecular weight and molecular weight distributions; kinetics and mechanisms of major classes of polymerization reactions such as step growth, radical, ionic, heterogeneous, and copolymerization methods; polymer solutions- solubility, lattice model and the Flory-Huggins theory, solution viscosity; bulk properties- thermal and mechanical properties such as the melting and glass transitions, rubber elasticity, and viscous flow; polymerization reactions used in industry.

CHEM C362 Chemistry of Inorganic Compounds 3 0 3

Periodicity; periodic anomalies; p orbitals in pi bonding; d orbitals in non-metal chemistry: similarities and contrasts within a group, e.g., C-Si, N-P; chemistry of boron hydrides, aluminosilicates; hydrogen; acid-base concepts; hard and soft acids and bases; chemistry in aqueous and nonaqueous media; halogens and noble gases; coordination chemistry: different coordination numbers, chelation, isometrism and reactivity; chemistry of metals; introduction to bioinorganic and organometallic chemistry.

CHEM C391 Instrumental Methods of Analysis 1 6 4

Principles and practice of modern instrumental methods of chemical analysis. Emphasis on spectroscopic techniques such as UV-Visible, infrared, NMR (^{1}H, ^{13}C and other elements, NOE, correlation spectroscopies), ESR, atomic absorption and emission, photoelectron, Mossbauer, and fluorescence. Other topics will include mass spectrometry, separation techniques, light scattering, electroanalytical methods, thermal analysis, and diffraction methods.

CHEM C411 Chemical Experimentation 0 9 3

Specially designed for M.Sc. (Hons.) Chemistry; cannot be taken by others under any circumstances.

This laboratory course is designed only for M.Sc. (Hons.) Chemistry students in order to develop competence in selected techniques of modern analytical chemistry.

CHEM C412 Photochemistry and Laser pectroscopy 3 0 3

Photochemical events : absorption, fluorescence and phosphorescence; Jablonski diagrams; physical properties of molecules after photoexcitation; photochemical tools and techniques : spectrophotometers, fluorescence decay time measurement and analysis, flash photolysis; fundamental properties of laser light; principles of laser operation ; description of some specific laser systems : Helium-Neon, Argon ion, CO_2, Nd-YAG and ultrafast Titanium : Sapphire lasers.

CHEM C421 Theoretical Inorganic Chemistry 3 0 3

Stereochemistry of inorganic compounds; acids and bases; nonaqueous solvents; chemistry of the elements of the first period.

CHEM C422 Statistical Thermodynamics 3 0 3

Review of classical thermodynamics, principles of statistical thermodynamics, ensemble averages; Boltzmann distribution; partition functions and thermodynamic quantities; ideal gases and crystals; thermodynamic properties from spectroscopic and structural data; dense gases and the second virial coefficient; statistical mechanics of solutions; Bose-Einstein and Fermi-Dirac statistics.

CHEM C431 Stereochemistry and Reaction Mechanisms 3 0 3

Relative and absolute configuration; stereochemistry of organic compounds including those containing nitrogen atoms, allenes, and biphenyls; stereochemical implications of various organic reactions; conformational analysis of cyclohexanes and substituted cyclohexanes; mechanism of addition, elimination and substitution reactions.

CHEM C441 Biochemical Engineering 3 0 3

Course description is same as given under BIO C441.

CHEM C451 Physical Pharmacy 2 3 3

This course is designed to make the students conversant with the applications of physico-chemical principles to the study of the drug stability behaviour of drug powers and of other pharmaceutical systems; it includes the discussion of drug degradation, micromeritics, rheology and interactions of drugs.

CHEM C453 Mathematics for Chemists 4

This course is meant for higher degree students of chemistry having no mathematics in their first degree curriculum. The following topics will be covered along with suitable examples in chemistry or other physical sciences. Functions and graphs; Polynomials; Rational Functions; Binomial Theorem; Trigonometric Func-

tions; Complex numbers; Limits and Continuity; Differentiation; Matrices and Linear Equations; Three dimensional geometry; Vectors and Vector Products; Integration; Logarithms and Exponentials; Differential Equations; Sequences and Series; Simple Numerical Methods; Probability and Statistics; Regression Analysis.

CHEM C461 Nuclear and Radiochemistry 3 0 3

Nuclear and radiochemistry; transuranic elements; nucleus; nuclear reactions and radiation chemistry.

CHEM C491 Special Projects 3

Course description is same as given under BIO C491.

CHEM F110 Chemistry Laboratory 0 2 1

This laboratory course consists of experiments based on fundamental principles and techniques of chemistry emphasizing on physical-chemical measurements, quantitative & qualitative analysis and preparations.

CHEM F111 General Chemistry 3 0 3

Principles of thermodynamics, phase and chemical equilibrium, electrochemistry, kinetics; Atomic structure, chemical bonding, solid state and structural chemistry, molecular spectroscopy; organic compounds, functional groups, structure and isomerism, stereochemistry, reactions and mechanisms, aromaticity, coordination chemistry, chemistry of representative elements.

CHEM F211 Physical Chemistry I 3 0 3

Kinetic - molecular theory of gases; perfect gas; pressure and temperature; Maxwell distribution; collisions, effusion, mean free path; Boltzmann distribution law and heat capacities; first law of thermodynamics; p-V work , internal energy, enthalpy; Joule-Thomson experiment; second law; heat engines, cycles; entropy; thermodynamic temperature scale; material equilibrium; Gibbs energy; chemical potential; phase equilibrium; reaction equilibrium; standard states, enthalpies; Temperature dependence of reaction heats; third law; estimation of thermodynamic properties; perfect gas reaction equilibrium; temperature dependence; one component phase equilibrium, Clapeyron equation; real gases, critical state, corresponding states; solutions, partial molar quantities, ideal and non-ideal solutions, activity coefficients, Debye-Huckel theory; standard state properties of solution components; Reaction equilibrium in non-ideal solutions, weak acids-buffers, coupled reactions; multi component phase equilibrium-colligative properties, two and three component systems, solubility; electrochemical systems- thermodynamics of electrochemical systems and galvanic cells, standard electrode potentials, concentration cells, liquid junction, ion selective electrodes, double layer, dipole moments and polarizations, applications in biology, concept of overvoltage.

CHEM F212 Organic Chemistry I 3 0 3

Basic terminology and representation of organic reactions; thermodynamics and kinetics of reactions; reactive intermediates (carbocations, carbanions, free radicals, nitrenes carbenes); aromatic chemistry; properties, preparation and reactions of alkyl halides, alcohols, ethers, amines and nitro compounds; carbonyl compounds; carboxylic acid and derivatives; carbohydrates.

CHEM F213 Physical Chemistry II 3 0 3

Origin of quantum theory - black body radiation, line spectra, photoelectric effect; wave particle duality; wave equation: normal modes, superposition; postulates of quantum mechanics, time dependence, Hermitian operators, commutator; Schrödinger equation - operators, observables, solution for particle in a box, normalization, variance, momentum; harmonic oscillator, vibrational spectroscopy; rigid rotor, angular momentum, rotational spectroscopy; Hydrogen atom - orbitals, effect of magnetic field; Variation method - variation theorem, secular determinants; Many electron atoms and molecules; Born Oppenheimer approximation, VB Theory, H_2 in VB, Coulomb, exchange, overlap integrals states of H_2; antisymmetric wavefunctions – two electron systems, Slater determinants, HF method; SCF method; term symbols and spectra - configuration, state, Hund's rules, atomic spectra, spin orbit interaction; basic MO theory, homonuclear diatomics - N_2, O_2, SCF-LCAO-MO, molecular term symbols; HMO theory - π electron approximation, conjugated, cyclic systems.

CHEM F214 Inorganic Chemistry I 3 0 3

Structure of molecules: VSEPR model; ionic crystal structure, structure of complex solids; concepts of inorganic chemistry: electronegativity, acid-base chemistry, chemistry of aqueous and non-aqueous solvents; descriptive chemistry of some elements: periodicity, chemistry of transition metals, halogens and noble gases; inorganic chains, rings, cages and clusters.

CHEM F223 Colloid and Surface Chemistry 3 0 3

Surface phenomena; intermolecular forces relevant to colloidal systems; forces in colloidal systems; experimental and theoretical studies of the structure, dynamics and phase transitions in micelles, membranes, monolayers, bilayers, vesicles and related systems; technical applications.

CHEM F241 Inorganic Chemistry II 3 0 3

Coordination Chemistry: Bonding - Valence Bond, Crystal Field, and Molecular Orbital theories; Complexes - nomenclature, isomerism, coordination numbers, structure, electronic spectra, magnetic properties, chelate effect; Reactions - nucleophilic substitution reactions, kinetics, mechanisms; descriptive chemistry of Lanthanides and Actinides; Organometallic Chemistry: structure and reaction of metal carbon-

yls, nitrosyls, dinitrogens, alkyls, carbenes, carbynes, carbides, alkenes, alkynes, and metallocenes; catalysis by organometallic compounds; stereochemically non-rigid molecules.

CHEM F242 Chemical Experimentation I 0 3 3

This course is based on laboratory experiments in the field of organic chemistry. Qualitative organic analysis including preliminary examination, detection of functional groups, preparation and recrystallization of derivatives, separation and identification of the two component mixtures using chemical and physical methods; quantitative analysis such as determination of the percentage/ number of hydroxyl groups in organic compounds by acetylation method, estimation of amines/ phenols using bromate-bromide solution/ acetylation method, determination of iodine and saponification values of an oil sample; single step synthesis such as benzaldehyde to cinnamic acid; multistep synthesis such as phthallic anhydride – phthallimide – anthranillic acid ; extraction of organic compounds from natural sources: isolation of caffeine from tea leaves, casein from milk, lactose from milk, lycopene from tomatoes, β- carotene from carrots etc.; demonstration on the use of software such as Chem Draw, Chem-Sketch or ISI-Draw.

CHEM F243 Organic Chemistry II 3 0 3

Introduction to stereoisomers; symmetry elements; configuration; chirality in molecules devoid of chiral centers (allenes, alkylidenecycloalkanes, spiranes, biphenyl); atropisomerism; stereochemistry of alkenes; conformation of acyclic molecules; conformations of cyclic molecules; reaction mechanisms; asymmetric synthesis; photochemistry and pericyclic reactions.

CHEM F244 Physical Chemistry III 3 0 3

Symmetry: symmetry operations, point groups, reducible and irreducible representations, character tables, SALC, degeneracy, vibrational modes IR-Raman activity identification; matrix evaluation of operators; stationary state perturbation theory; time dependent perturbation theory; virial and Hellmann-Feynmann theorems; polyatomic molecules: SCF MO treatment, basis sets, population analysis, molecular electrostatic potentials, localized MOs; VB method; configuration interaction, Moller Plesset perturbation theory; semi empirical methods-all valence electron methods: CNDO,INDO, NDDO; Density Functional Theory: Hohenberg-Kohn theorems, Kohn-Sham self consistent field approach, exchange correlation functional; molecular mechanics.

CHEM F266 Study Project 3

Course description is same as given under BIO F266.

CHEM F311 Organic Chemistry III 3 0 3

Applications of important reagents and reactions in organic synthesis and disconnection or synthon approach will be emphasized in this course. Basic principles of disconnection, order of events, chemioselectivity, regioselectivity etc. Common organic reagents, Organometallic reagents, Transition metal catalyzed reactions, introduction to reterosynthetic analysis using one group C-X and C-C disconnections, two group C-X and C-C disconnections, ring synthesis (saturated heterocycles), synthesis of heterocyclic compounds and complex molecules.

CHEM F312 Physical Chemistry IV 3 0 3

Weak forces; surface chemistry: interphase region, thermodynamics, surface films on liquids, adsorption of gases on solids, colloids, micelles, and reverse micellar structures; transport processes: kinetics, thermal conductivity, viscosity, diffusion, sedimentation; electrical conductivity in metals and in solutions; reaction kinetics, measurement of rates; integrated rate laws; rate laws and equilibrium constants for elementary reactions; reaction mechanisms; temperature dependence of rate constants; rate constants and equilibrium constants; rate law in non ideal systems; uni, bi and tri molecular reactions, chain reactions, free-radical polymerizations; fast reactions; reactions in solutions; heterogeneous and enzyme catalysis; introduction to statistical thermodynamics; theories of reaction rates; molecular reaction dynamics.

CHEM F313 Instrumental Methods of Analysis 3 1 4

Principles and practice of modern instrumental methods of chemical analysis. Emphasis on spectroscopic techniques such as UV-Visible, infrared, NMR (1H, 13C and other elements, NOE, correlation spectroscopies), ESR, atomic absorption and emission, photoelectron, Mössbauer, and fluorescence. Other topics will include mass spectrometry, separation techniques, light scattering, electroanalytical methods, thermal analysis, and diffraction methods.

CHEM F323 Biophysical Chemistry 3 0 3

The principles governing the molecular shapes, structures, structural transitions and dynamics in some important classes of biomolecules and biomolecular aggregates will be discussed. The topics will include: structure, conformational analysis, conformational transitions and equilibria in proteins and nucleic acids; protein folding; lipids - monolayers,bilayers and micelles; lipid-protein interactions in membranes.

CHEM F324 Numerical Methods in Chemistry 3 3 4

Selected problems in chemistry from diverse areas such as chemical kinetics and dynamics, quantum mechanics, electronic structure of molecules, spectroscopy, molecular mechanics and conformational analysis, thermodynamics, and structure and properties of condensed phases will be discussed. The problems chosen will illustrate the application of various mathematical and numerical methods such as those used in the solution of systems of algebraic equations, differential equations, and minimization of multidimensional functions, Fourier transform and Monte Carlo methods.

CHEM F325 Polymer Chemistry **3 0 3**

Types of polymers; structures of polymers; molecular weight and molecular weight distributions; kinetics and mechanisms of major classes of polymerization reactions such as step growth, radical, ionic, heterogeneous, and copolymerization methods; polymer solutions- solubility, lattice model and the Flory- Huggins theory, solution viscosity; bulk properties- thermal and mechanical properties such as the melting and glass transitions, rubber elasticity, and viscous flow; polymerization reactions used in industry.

CHEM F326 Solid State Chemistry **3 0 3**

X-ray diffraction; point groups, space groups and crystal structure; descriptive crystal chemistry; factors which influence crystal structure; crystal defects and non-stoichiometry; solid solutions; interpretation of the phase diagrams; phase transitions; ionic conductivity and solid electrolytes; electronic properties and band theory; magnetic properties; optical properties; analysis of single crystal XRD data; preparation of solid state materials and the chemistry of device fabrication.

HEM F327 Electrochemistry: Fundamentals and Applications **3 0 3**

Electrode Processes: Overpotential, Faradaic and non-Faradaic processes, the ideal polarized electrode, capacitance and charge of an electrode, electrical double layer; primary and secondary cells, variables in electrochemical cells, factors affecting electrode reaction, cell resistance; Mass transfer: steady-state mass transfer, semiempirical treatment of the transient response, coupled reversible and irreversible reactions, reference electrodes; Kinetics of electrode reactions: Arrhenius equation and potential energy surfaces, equilibrium conditions, Tafel Plots; rate determining electron transfer, Nernstian, quasireversible, and irreversible multistep processes; Marcus Theory; mass transfer by migration and diffusion; basic potential step methods; Ultramicroelectrodes (UME) potential sweep methods; polarography and pulse voltammetry; controlled current techniques; impedance; bulk and flow electrolysis; electrochemical instrumentation; scanning probe techniques, STM, AFM, Scanning Electrochemical Microscopy, approach curves, imaging surface topography and reactivity, potentiometric tips, applications.

CHEM F328 Supramolecular Chemistry **3 0 3**

Non-covalent interactions and their role in "supermolecules" and organized polymolecular systems; concepts of molecular recognition, information and complementarity; molecular receptors: design principles, binding and recognition of neutral molecules and anionic substrates, coreceptor molecules and multiple recognition, linear recognition of molecular lengths by ditopic coreceptors, heterotopic coreceptors, amphiphilic receptors, large molecular cages; supramolecular dynamics; supramolecular catalysis: reactive macrocyclic cation and anion receptor molecules, cyclophane type receptor, metallocatalysis, catalysis of synthetic reactions, biomolecular and abiotic catalysis, heterogeneous catalysis; transport processes and carrier design: cation and anion carriers, electron, proton and light coupled transport processes, transfer via transmembrane channels; supramolecular assemblies: heterogeneous molecular recognition, supramolecular solids, molecular recognition at surfaces, molecular and supramolecular morphogenesis; supramolecular photochemistry: photonic devices, light conversion and energy transfer devices, photosensitive molecular receptors, photoinduced electron transfer and reactions, non-linear optical properties; supramolecular electrochemistry: electronic devices, molecular wires, polarized molecular wires, switchable molecular wires, molecular magnetic devices; ionic devices, tubular mesophases, ion-responsive monolayers, molecular protonics, ion and molecular sensors, switching devices and signals, photoswitching and electroswitching devices, switching of ionic and molecular processes, mechanical switching processes; self-assembly: inorganic architectures, organic structures by hydrogen bonding; helical metal complexes, supramolecular arrays of metal ions – racks, ladders and grids, molecular recognition directed self-assembly of organized phases; supramolecular polymers; ordered solid-state structures; supramolecular synthesis, assistance, replication; supramolecular chirality; supramolecular materials.

CHEM F329 Analytical Chemistry **3 1 4**

Data handling; sample preparation; unit operations; volumetric and gravimetric analysis; chromatography; solvent and solid phase extraction; absorption and emission techniques; potentiometry, voltammetry; trace metal separation and estimation in biological and environmental samples with emphasis on green chemistry, sensors; laboratory training in some of these techniques.

CHEM F330 Photophysical Chemistry **3 1 4**

Absorption of the electromagnetic radiation; photophysical processes such as fluorescence, phosphorescence, non-radiative transitions, and delayed luminescence, excimer and exciplex formation; triplet state: radiative and non-radiative transitions; energy transfer, fluorescence resonance energy transfer (FRET), quenching of fluorescence; fluorescence decay; protein and DNA fluorescence; time-resolved emission spectra (TRES); time-dependent anisotropy decays; application of photophysics for the characterization of biological and bio-mimicking systems. In addition to the theory, through simple experiments, laboratory training will be imparted.

CHEM F333 Chemistry of Materials **3 0 3**

Solid state structure : unit cells, metallic crystal structures, polymorphism and allotropy, crystallographic direction and planes, closed packed crystal structures,

polycrystalline materials, anisotropy; meso and micro porous materials: zeolites, composites, synthesis, characterization (XRD, SEM, TEM, AFM, FTIR, NMR, TGA, and DTA) and applications; ceramics and glass materials: crystalline and non-crystalline nature, glass-ceramics, processing; polymers: synthesis, structure, properties, inorganic polymers; mechanical properties: stress and strain, elastic and tensile properties, hardness, phase transformations, microstructure, alteration of mechanical properties; magnetic properties: atomic magnetism in solids, the exchange interaction, classification of magnetic materials, diamagnetism, pauli paramagnetism, ferromagnetism, antiferromagnetism, ferrimagnetism, superparamagnetism, ferromagnetic domains, hysteresis loop, hard and soft ferrites, applications; electrical properties: conductivity, band theory, types of semiconductors, time dependence of conductivity, mobility of charge carriers, metal-metal junction, metal–semiconductor junction, n-type and p-type semiconductors; optical properties: refraction, reflection, absorption, transmission, luminescence, photoconductivity, opacity and translucency in insulators, optical fibers; thermal properties: heat capacity, thermal expansion, conductivity, thermal stresses; corrosion: electrochemistry of corrosion of metals, different forms, environmental effects, prevention.

CHEM F334 Magnetic Resonance 3 0 3

Classical treatment of motion of isolated spins; quantum mechanical description of spin in static and alternating magnetic fields; Bloch equations; spin echoes; transient and steady state responses; absorption and dispersion; magnetic dipolar broadening; formal theory of chemical shifts; Knight shift; second order spin effects; spin-lattice relaxation; spin temperature; density matrix; Bloch-Wangsness-Redfield theory; adiabatic and sudden changes; saturation; spin locking; double resonance; Overhauser effect; ENDOR; pulsed magnetic resonance: Carr-Purcell sequence, phase alternation, spin-flip narrowing, real pulses; electric quadrupole effects; spin-spin coupling; 2D correlation spectroscopies: COSY, DQF, INADEQUATE experiments; CIDNP; electron paramagnetic resonance (EPR); nuclear quadrupolar resonance; muon spin resonance; magnetic resonance imaging.

CHEM F335 Organic Chemistry and Drug Design 3 0 3

An introduction to organic chemistry principles and reactivities vital to drug design, drug development and drug action; the role of molecular size, shape, and charge, and in drug action; proteins and nucleic acids as drug targets; bioisosterism; ADME, QSAR and drug design; applied molecular modeling and combinatorial synthesis; Synthesis of some selected chemotherapeutic agents (e.g antifungal, antibacterial, antimalarial, anticancer etc.)

CHEM F336 Nanochemistry 3 1 4

Nano and nature, importance of nanoscience, chemistry behind nano; instruments for characterizing nanomaterials; diversity in nanosystems: chemical aspects of metallic, magnetic and semiconducting nanomaterials, carbon nanotubes and fullerenes, self-assembled monolayers, monolayer protected metal nanomaterials, core-shell nanomaterials; applications of nano materials in nanobiology, nanosensors and nanomedicine; hands on experience in laboratory.

CHEM F337 Green Chemistry and Catalysis 3 0 3

Definition and overview of the twelve principles of Green Chemistry, alternative starting materials; alternative synthesis and reagents; E factor and the concept of atom economy; the role of catalysis, alternate energy sources (microwave & ultrasound), catalysis by solid acids and bases, bio-catalysis, catalytic reduction, catalytic oxidation, catalytic C–C bond formation, cascade catalysis, enantioselective catalysis, alternative reaction media, renewable raw materials, industrial applications of catalysis.

CHEM F341 Chemical Experimentation II 0 4 4

This course is based on laboratory experiments in the fields of inorganic, physical and analytical chemistry. Quantitative separation and determination of pairs of metal ions using gravimetric and volumetric methods; Ion exchange chromatography; Separation & estimation of metal ions using ion exchangers and solvent extraction techniques; Determination of Keq of M – L systems by colorimetry; Preparation, purification and structural studies (magnetic, electronic and IR) of inorganic complex compounds; Physical property measurements such as conductance, pH, viscosity, surface tension, refractive index, specific rotation etc. Experiments to illustrate the principles of thermodynamics, kinetics, chemical equilibrium, phase equilibrium, electrochemistry, adsorption, etc.

CHEM F342 Organic Chemistry IV 3 0 3

The fundamental structural characteristics, synthesis and reaction of various heterocyclic compounds, natural products and biomolecules will be emphasized in this course. Structure, nomenclature and common reactions of heterocyclic compounds; synthesis, properties and reactions of three-, four-, five-, and six membered ring systems; condensed five and six membered ring systems, introduction to natural products; terpenoids, steroids, lipids, alkaloids, amino acids, peptides, proteins and vitamins.

CHEM F343 Inorganic Chemistry III 3 0 3

Inorganic elements in biological systems: role of alkali and alkaline earth metal ions, iron, copper and molybdenum; metalloenzymes. Metals in medicine: metal deficiency and disease; toxicity of mercury, cadmium, lead, beryllium, selenium and arsenic; biological defence mechanisms and chelation therapy. Molecular magnetic materials: trinuclear and high nuclearity compounds; magnetic chain compounds; magnetic long-range ordering in molecular compounds; design

of molecular magnets. Other emerging topics in inorganic chemistry.

CHEM F366 Lab Project **3**

CHEM F367 Lab Project **3**

Course description is same as given under BIO F366 and BIO F367.

CHEM F376 Design Project **3**

CHEM F377 Design Project **3**

Course description is same as given under BIO F376 and BIO F377.

CHEM F412 Photochemistry and Laser Spectroscopy **3 0 3**

Photochemical events : absorption, fluorescence and phosphorescence; Jablonski diagrams; physical properties of molecules after photoexcitation; photochemical tools and techniques: spectrophotometers, fluorescence decay time measurement and analysis, flash photolysis; fundamental properties of laser light; principles of laser operation ; description of some specific laser systems : Helium-Neon, Argon ion, CO2, Nd-YAG and ultrafast Titanium : Sapphire lasers.

CHEM F413 Electron Correlation in Atoms and Molecules **3 1 4**

Matrix algebra, Matrix representation of operators; mean-field approach: the Hartree-Fock method- formulation, coulomb and exchange integrals, Fock-operator, second quantization, Slater rules, self-consistency, correlation energy; Brillouin's theorem, Koopmans' theorem; basis-sets, restricted Hartree-Fock, Roothan-Hall equations; unrestricted Hartree-Fock method, spin-contamination; restricted open-shell Hartree-Fock method; Recovery of correlation energy time independent perturbation approach: Brillouin-Wigner and Rayleigh-Schrodinger perturbation theories; Møller Plesset and Epstein-Nesbeth partitioning of molecular Hamiltonion, many-body perturbation theory; Feynman diagrams, connected and disconnected terms, size-consistency; Recovery of correlation energy: configuration interaction and other non-perturbative approaches, variational and projection approaches for obtaining CI anasatz, truncated CI and size-consistency problem, Davidson correction, pair-coupled-pair theory, coupled-electron-pair method and coupled-cluster approach; Density functional theory, N-representability, V-representability, Kohn-Sham approach, natural orbitals, exchange-correlation functionals, Levy functional.

CHEM F414 Bio and Chemical Sensors **3 0 3**

Biological and chemical recognition: reaction kinetics, signals and noise, sensitivity, specificity, selectivity; IUPAC definition of biosensors, their classification based on receptors and transducers; analytical characteristics of various types of bio and chemical sensors, performance criteria of biosensors; electrochemical, optical, thermal, piezoelectric transducer selections for immunosensors and enzyme sensors; sufrace functionaliazaiton of transducers, novel self assembly techniques, coupling of biomolecules on different surfaces and their characterization; thermal biosensors, enzyme thermistor; miniaturization of sensors and flow injection techniques; applications in analysis such as urea, penicillin, pesticides, cholesterol; optical biosensor mechanisms: fluorescence and chemiluminescence techniques; electrochemical biosensors: impedimetric and amperometric biosensors; electrochemical quartz crystal micro balance, applications in chemical and biological analysis; flow injection systems vs. static measurements, protein-protein interaction and quantification; principle of inhibition based biosensor for enzyme and immunoassay, pretreatment techniques in bio-analysis.

CHEM F415 Frontiers in Organic Synthesis **3 0 3**

Traditional and classic organic synthesis; modern synthetic strategies; systematic approach in terms of progress in reaction methodologies in synthesizing complex natural molecules; metal-catalyzed C-C and C-X couplings; direct functionalization via C-H and C-C activation; development of organocatalysis: metal-free catalysis; direct functionalization of olefins including hydroamination, hydrogenation, hydrosilylation, hydroformylation and other C-C bond forming reactions; the potential of radical chemistry for C-C and C-X bond formation; metal-catalyzed carbocyclization: from Ru and Rh-mediated cycloadditions to Pt and Au chemistry; one-pot multi-steps reactions: avoiding time and resource-consuming isolation procedures; tracing the development from the first total synthesis to the state of the art for some complex molecules.

CHEM F422 Statistical Thermodynamics **3 0 3**

Review of classical thermodynamics, principles of statistical thermodynamics, ensemble averages; Boltzmann distribution; partition functions and thermodynamic quantities; ideal gases and crystals; thermodynamic properties from spectroscopic and structural data; dense gases and the second virial coefficient; statistical mechanics of solutions; Bose-Einstein and Fermi-Dirac statistics.

CHEM F491 Special Projects **3**

Course description is same as given under BIO F491.

CHEM G511 Nuclear and Radio Chemistry **5**

Course description is to be developed.

CHEM G513 Advanced Nuclear and Radiochemistry **5**

Nuclear stability, binding energy, properties of nucleons; Nuclear models (Shell Model, Liquid drop model), Radioactive decay characteristics, decay kinetics, α, β and γ decay, nuclear reactions, types, radiative capture, reaction cross section, theory of fission; Nuclear reactors – classification, Reactor power, Breeder reac-

tors, Nuclear reactors in India, Reprocessing of spent fuel, Nuclear waste management (HLW, LLW and ILW); Detection and measurement of activity, GM counters, Gamma counters, Liquid Scintillation counting; Application of radioactivity, Szilard Chalmers reaction, Isotope dilution analysis, Neutron activation analysis, Diagnostic and therapeutic applications of radionucleides, interaction of radiation with matter.

CHEM G521 Environmental Chemistry 5

Energy-flows and supplies, fossil fuels, nuclear energy, nuclear waste disposal, renewable energy, industrial ecology, green chemistry, ozone chemistry, effect of SO_x, NO_x as pollutants, reformulated gasoline, water pollution and treatment, organochlorine and organophosphate pesticides, eco-system effects, Toxic chemicals – Effect of dioxins, polychlorinated biphenyls (PCBs) and species of metals such as lead, mercury, cadmium etc.

CHEM G531 Recent Advances in Chemistry 5

The course is aimed at providing an overview of recent developments in selected areas of chemistry. Topics to be covered may be drawn from: modern theories of structure, bonding and reactivity, spectroscopy, chemical dynamics, phase transitions, surface phenomena, solid state materials, and synthetic and mechanistic organic and inorganic chemistry, or such other topics as may emerge in the development of the subject.

CHEM G541 Chemical Applications of Group Theory 5

Groups, subgroups and classes : definitions and theorems; molecular symmetry and symmetry groups; representation of groups; character tables; wave functions as bases for irreducible representations; direct product; symmetry adapted linear combinations; symmetry in molecular orbital theory; hybrid orbitals; molecular orbitals of metal sandwich compounds; ligand field theory; molecular vibrations; space groups.

CHEM G551 Advanced Organic Chemistry 5

Recent advances in aromatic electrophilic and nucleophilic substitution reactions and nucleophilic addition reactions; oxidation and reduction; enolates in organic synthesis; retro synthetic analysis; multiple step synthesis; protecting groups.

CHEM G552 Advanced Inorganic Chemistry 5

Advanced coordination chemistry, reactions, kinetics and mechanism; advanced organometalic chemistry, bonding models in inorganic chemistry, inorganic chains, rings, cages and clusters; group theory and its applications to crystal field theory, molecular orbital theory and spectroscopy (electronic and vibrational); inorganic chemistry in biological systems.

CHEM G553 Advanced Physical Chemistry 5

Equilibrium: The laws of Thermodynamics, applications to phase equilibrium, reaction equilibrium, and electrochemistry; Structure: Principles and techniques of quantum mechanics, applications to atomic and molecular structure and spectroscopy, statistical thermodynamics, molecular interactions, macromolecules, solid state; Dynamics: Molecular motion in gases and liquids, reaction rate laws, mechanisms and rate theories of complex reactions, molecular reaction dynamics, surface processes, electron transfer dynamics.

CHEM G554 Physical Methods in Chemistry 5

Advanced spectroscopic and non-spectroscopic techniques used in chemistry; Topics will include electronic absorption spectroscopy of organic and inorganic compounds, ORD, CD; vibrational rotational spectroscopy symmetry aspects; Dynamic and Fourier transform NMR, NOE, Multipulse methods, Two-Dimensional NMR; EPR; NQR; Mossbauer spectroscopy; Magnetism; Ionization Methods: Mass spectrometry, Ion Cyclotron Resonance; Photoelectron Spectroscopy; Microscopic techniques: TEM, STM, AFM; EXAFS, XANES; X-ray Crystallography.

CHEM G555 Chemistry of Life Processes 4

Synthesis and structures of biopolymers such as proteins and nucleic acids; nucleic acid replication, transcription and translation; lipids and biomembranes; transport across membranes; neurotransmission; enzyme and enzyme inhibitors; citric acid cycle, pentose phosphate pathway and nucleic acid metabolisms; photosynthesis; electron transport systems in respiration and oxidative phosphorylation.

CHEM G556 Catalysis 4

A comprehensive survey of the catalytic processes along with the fundamental aspects of the catalyst design and evaluation; several classes of heterogeneous industrial catalysts; their preparation, characterization and applications, recent developments in catalysis, application of nanomaterials in catalysis.

CHEM G557 Solid Phase Synthesis and Combinatorial Chemistry 4

A comprehensive understanding of solid phase synthesis and combinatorial chemistry, basic principles of solid phase organic synthesis; solid phase organic synthesis strategies; introduction to combinatorial chemistry; analytical techniques in combinatorial chemistry; applications of the combinatorial approach in chemistry, drug development and biotechnology.

CHEM G558 Electronic Structure Theory 5

Advanced methods in theoretical and computational chemistry based on Quantum Mechanics: Review of mathematical background, N-Dimension complex vector spaces, linear variational problem, many electron wave functions and operators, operators and matrix elements; Ab-initio methods: Hartree-Fock (H-F), Configuration Interaction (CI), Many Body Perturbation Theory (MBPT); Density Functional Theory: Thomas-Fermi model, Hohenberg-Kohn theorems, derivation of

Kohn-Sham equations; Development and use of software for such models.

CHEM G559 Bioinorganic Chemistry 4

Fundamentals of inorganic biochemistry; essential and non-essential elements in bio-systems, metalloproteins and metalloenzymes; role of metal ions in oxygen carriers, synthetic oxygen carriers, bioinorganic chips and biosensors; fixation of dinitrogen, environmental bioinorganic chemistry; transport and storage of metal ions *in vivo*, metal complexes as probes of structure and reactivity with metal substitution; fundamentals of toxicity and detoxification, chelating agents and metal chelates as medicines, nuclear medicines.

CHEM G561 Heterocyclic Chemistry 5

The fundamental structural characteristics; synthesis and reactions of various heterocycles with nitrogen, oxygen and sulphur heteroatom in the ring; heterocyles such as pyrrole, thiophene, furan, imidazole, thiazole, oxazole, indole, benzofuran, pyridine and quinoline; advanced synthesis and reaction mechanism of heterocyclic compound.

CHEM G562 Solid State Chemistry 4

Basics of solid state chemistry, comprehensive survey of different synthesis techniques, properties and their structural-property relationship of solid materials; introduction to special nanomaterials, ceramics, polymers, biopolymers and nanocomposites; thermal and mechanical properties of nanomaterials; nanocomposites in hydrophobic applications; recent advances in material science and technology.

CHEM G563 Advanced Statistical Mechanics 5

Review of ensembles, fluctuations, Boltzmann statistics, quantum statistics, ideal gases and chemical equilibrium; imperfect gases; distribution function theories and perturbation theories of classical liquids; electrolyte solutions; kinetic theory of gases; continuum mechanics; Boltzmann equation; transport processes in gases and Brownian motion; introduction to time-correlation function formalism.

Chinese

CHI N101T Beginning Chinese 3 0 3

Basic grammar; sentence construction; vocabulary building; conversations; dialogues; listening; translation of simple passages.

Computer Science

CS C311 Data Structures 3 0 3

Basic concepts of data, linear lists, strings, arrays and orthogonal lists; representation of trees and graphs; storage systems and structures; symbol table and searching techniques, sorting techniques; data structures in programming languages; data management systems.

CS C313 Object Oriented Programming and Design 3 2 4

Object oriented concepts and design, abstraction, architecture and design patterns, GUI programming and frameworks, design of object oriented solutions using UML, design for concurrency, implementation of solutions using object oriented languages like C++ or Java; Language level mapping and realization of object oriented constructs, realization and performance issues versus abstraction and usability.

CS C314 Software Development for Portable Devices, 2 2 3

(= IS C314)

Introduction to mobile computing and emerging mobile application and hardware platforms; Developing and assessing mobile applications; Software lifecycle for mobile application – design and architecture, development – tools, techniques, frameworks, deployment; Human factors and emerging human computer interfaces (tangible, immersive, attentive, gesture, zero-input); Select application domains such as pervasive health care, m-Health; Mobile web browsing, gaming and social networking.

CS C321 Computers and Programming 3 2 4

Computer structures; instruction execution, addressing techniques; computer system organization, microprogramming and interpreters; symbolic coding; programme segmentation and linkage; laboratory work as several computer projects to illustrate basic machine structure and programming techniques.

CS C332 Systems Programming 3 0 3

Prerequisite: CS C311 & CS C321 & (CS C391 or

EEE C391 or INSTR C391)

Batch processing Systems programs; operatingcharacteristics and limitations; parallel processing of I/O and interrupt handling, multiprogramming; multiprocessing systems; design of system modules and interfaces; other selected topics.

CS C342 Advanced Computer Organization 3 0 3

Prerequisite: CS C391 or EEE C391 or INSTR C391

Memories and memory module design; sample CPU design - instruction set, addressing modes, instruction formats, instruction fetching and execution; instruction and execution cycles, timing, realization and documentation; floating point arithmetic operations, FPAU design; I/O devices and interrupt processing; special topics such as microprogramming & bus structures, simple design examples.

CS C351 Theory of Computation **3 0 3**

Finite automata and regular languages – equivalences, closure properties. context free languages & push-down automata – equivalences, closure properties, concepts in parsing; turing machines; computability & decidability – universal turing machine, recursive functions, church-turing hypothesis; complexity classes – P, NP, reducibility and NP-completeness.

CS C352 Data Base Systems **3 0 3**

Introduction to data bases and management; data files and structures; hierarchical, relational, network models; distributed data bases; query processing and query optimization, query languages; concepts of security and protection; case study of a data base system.

CS C362 Programming Languages & Compiler Construction **3 0 3**

Overview of programming languages concepts and constructs, programming paradigms; Introduction to compiler process, phases and passes, bootstrapping of compilers; Formal languages, grammars and abstract machines; Lexical analysis, regular expressions and finite automata; Context-free grammar and push-down automata; Recursive-descent, LL and LR parsers; Semantic analysis, attribute grammar, type checking, intermediate representation; Run-time environments; Code optimization and code generation.

CS C363 Data Structures and Algorithms **3 2 4**

Introduction to software design principles, modularity, abstract data types, data structures and algorithms; Analysis of algorithms; Linear data structures – stacks, arrays, lists, queues and linked representations; Pre-fix, in-fix and post-fix expressions; Recursion; Set operations; Hashing and hash functions; Binary and other trees, traversal algorithms, Huffman codes; Search trees, priority queues, heaps and balanced trees; Sorting techniques; Graphs and digraphs; Algorithmic design techniques; Data structures for external storage, multi-way search and B-trees; Implementation techniques for different data structures including trees, graphs and search structures; Performance evaluation of data structures and algorithms; Implementation issues in large data structures.

CS C372 Operating Systems **3 0 3**

Introduction to operating systems; Various approaches to design of operating systems; Overview of hardware support for operating systems; Process management: process synchronization and mutual exclusion, interprocess communication, process scheduling; CPU scheduling approaches; Memory management: paging, segmentation, virtual memory, page replacement algorithms; File systems: design and implementation of file systems; Input/Output systems; device controllers and device drivers; Security and protection; Case studies on design and implementation of operating system modules.

CS C391 Digital Electronics and Computer Organisation **3 3 4**

Number systems and machine representation, Boolean algebra, combinational and sychronous sequential circuits, logic minimisation, programmable logic devices, state table and state diagrams, digital integrated circuits, asynchronous circuits, arithmetic operations and algorithms, introduction to computer organisation and architecture, speed considerations, memory organisation, I/O design, implementation issues. The course will also consist of laboratory practice.

CS C414 Telecommunication Switching Systems and Networks **3 0 3**

Intoduction, electromechanical switching, pulse dialing and DTMF dialing, stored program control, space division switching, speech digitization and transmission, time division switching, fundamentals of traffic engineering, telephone networks, signaling, data networks, layered architecture and protocols, LANs, packet switching networks, TCP/IP, ISDN, ATM networks.

CS C415 Data Mining **3 0 3**

Data Mining – introduction, fundamental concepts; motivation and applications; role of data warehousing in data mining; challenges and issues in data mining; Knowledge Discovery in Databases (KDD); role of data mining in KDD; algorithms for data mining; tasks like decision-tree construction, finding association rules, sequencing, classification, and clustering; applications of neural networks and machine learning for tasks of classification and clustering.

CS C422 Parallel Computing **3 0 3**

Introduction to parallel computing; Models of parallel computers; Interconnection networks, basic communication operations; Introduction to parallel algorithms; Parallel programming paradigms; issues in implementing algorithms on parallel computers; Parallel programming with message passing interface; Performance analysis; Scalability analysis; Basic design techniques for parallel algorithms; Parallel algorithms for selected topics like sorting, searching and merging, matrix algebra, graphs, discrete optimization problems and computational geometry.

CS C424 Software for Embedded System **3 0 3**

Real-time and embedded system; software issues in embedded system; software development process; requirements analysis: use Cases, identification and analysis of use cases, use case diagrams; design: architectural design, design patterns and detailed de-

sign; implementation: languages, compilers, runtime environments and operating systems for embedded software; testing: methodologies, tests cases.

CS C441 Selected Topics from Computer Science **3 0 3**

This course is primarily intended to introduce the students of computer science to topics, either in recent advances or of special interest. Topics may be taken from one or more of the areas like artificial intelligence, theory of computing, networking and distributed processing, digital control, information theory, super computers, special purpose architectures and language processors.

The course will be unstructured and operationally polarized depending upon the interests and pursuits of the professional in the discipline. Actual structuring will be announced from time to time.

CS C442 Advanced Algorithms and Complexity **3 0 3**

Randomized algorithms (Las Vegas & Monte Carlo); basic tools from probability theory and probabilistic analysis required in algorithmic applications: game theoretic techniques; occupancy problems & tail inequalities; data structures for randomized algorithms: skip list & hash tables; randomized geometric & linear programming algorithms: convex hull, duality & diameter of a set; randomized graph algorithms: all-pairs shortest paths & minimum spanning trees; optimization problems: simplex algorithm & duality; primal-dual algorithm for shortest paths; NP-Completeness; the Classes P & NP, NP – hard problems, approximation algorithms.

CS C444 Real–Time Systems **3 0 3**

Introduction to real-time systems, clock synchronization, task assignment and scheduling, programming language with real-time support, ADA, real-time communication protocols, real-time databases, fault tolerant techniques, reliability evaluation methods; case studies in real-time operating systems, simulation of real-time systems, embedded system programming.

CS C446 Data Storage Technologies and Networks **3 0 3**

Storage Media and Technologies – Magnetic, Optical and Semiconductor media, techniques for read/write operations, issues and limitations. Usage and Access – Positioning in the memory hierarchy, Hardware and Software Design for access, Performance issues. Large Storages – Hard Disks, Networked Attached Storage, Scalability issues, Networking issues. Storage Architecture. - Storage Partitioning, Storage System Design, Caching, Legacy Systems. Storage Area Networks – Hardware and Software Components, Storage Clusters/Grids. Storage QoS – Performance, Reliability, and Security issues**.**

CS C451 Combinatorial Mathematics **3 0 3**

Advanced theory of permutations and combinations; elementary counting functions; theory of partitions; theorems on choice including Ramsey's theorem; the mobius function; permutation groups; Polya's theorem and Debrauijn's generalisation; graphical enumeration problems.

CS C453 Discrete Mathematical Structures **3 0 3**

One or more of the interrelated topics will be covered from the following: graphs, designs, codes, shift register sequences, groups, fields, Boolean algebras, analysis of algorithms, Fast Fourier Transform etc. providing a fertile ground for interaction between mathematics and modern areas of computer science. The selection of the topics will depend upon the circumstance and current interest of faculty.

CS C461 Computer Networks **3 0 3**

(Prerequisite: CS C372 Conc.)

Evolution of communication and computer networks, protocol layering, network reference models, multiple access protocols, local area networks, packet and circuit switching, switching fabrics, network performance analysis and simulation techniques; addressing, routing, flow and congestion control, IP protocol; Broadband Integrated Services Digital Network (B-ISDN); Asynchronous Transfer Mode (ATM) reference models; network interoperability, traffic management and quality of service in integrated network protocol design and implementation strategies.

CS C471 Computer Graphics **2 2 3**

Generation of dots, lines, arcs and polygons; color graphics, shades and levels; image transformation, windowing and clipping; 2-D and 3-D graphics; data structures, algorithms and optimization methods; case studies using GKS, CORE, etc; graphic languages and compilers.

CS C481 Graphical User Interfaces **3 0 3**

Concept of an User Interface; User Interface Management Systems; Interaction Styles; Event-driven programming; graphical user interface components and examples; emphasis will be on programming in GUI environments like MS Windows.

CS C491 Special Projects **3**

Course description is same as given under BIO C491.

CS F111 Computer Programming **3 1 4**

Basic Model of a Computer; Problem Solving-Basic Computing Steps and Flow Charting (Assignment, Sequencing, Conditionals, Iteration). Programming Constructs – Expressions, Statements, Conditionals, Iterators/Loops, Functions/Procedures; Data Types – Primitive Types, Tuples, Choices (Unions or Enumerations), Lists/Arrays, Pointers and Dynamically Allocated Data. Input output and Files.

Laboratory Component: Programming Exercises involving development and testing of iterative and procedural programs using bounded and unbounded it-

erations, function composition, random access lists, sequential access lists, dynamically allocated lists, and file access.

CS F211 Data Structures & Algorithms 3 1 4

Introduction to Abstract Data Types, Data structures and Algorithms; Analysis of Algorithms – Time and Space Complexity, Complexity Notation, Solving Recurrence Relations.; Divide-and-Conquer as a Design Technique; Recursion – Recursive Data Types, Design of Recursive Functions / Procedures, Tail Recursion, Conversion of Recursive Functions to Iterative Form. Linear data structures – Lists, Access Restricted Lists (Stacks and Queues); Searching and Order Queries. Sorting – Sorting Algorithms (Online vs. Offline, In-memory vs. External, In-space vs. Out-of-space, Quick Sort and Randomization), Lower Bound on Complexity of Sorting Algorithms. Unordered Collections: Hash tables (Separate Chaining vs. Open Addressing, Probing, Rehashing). Binary Trees – Tree Traversals. Partially Ordered Collections: Search Trees and Height Balanced Search Trees, Heaps and Priority Queues. Probabilistic/Randomized Data Structures (such as Bloom Filters and Splay Trees). Generalized Trees – Traversals and applications. Text Processing – Basic Algorithms and Data Structures (e.g. Tries, Huffman Coding, String search / pattern matching). External Memory Data structures (B-Trees and variants). Graphs and Graph Algorithms: Representation schemes, Problems on Directed Graphs (Reachability and Strong Connectivity, Traversals, Transitive Closure. Directed Acyclic Graphs - Topological Sorting), Problems on Weighted Graphs (Shortest Paths. Spanning Trees).

CS F212 Database Systems 3 1 4

Data modeling, database design theory, data definition and manipulation languages, relational data model, relational algebra and relational calculus, SQL, functional dependencies and normalization, storage and indexing techniques, query processing and optimization, transaction management - concurrency control and crash recovery; distributed databases.

CS F213 Object Oriented Programming 3 1 4

Object orientation concepts, theories and principles; fundamental concepts of the object model: classes, objects, methods and messages, encapsulation and inheritance, interface and implementation, reuse and extension of classes, inheritance and polymorphism; overloading and overriding; static and dynamic binding; multithreaded programming; event handling and exception handling; process of object oriented requirements specification, analysis and design; notations for object-oriented analysis and design; case studies and applications using some object oriented programming languages. Object Oriented Design Patterns: Behavioral, Structural and Creational.

CS F214 Logic in Computer Science 3 0 3

propositional logic – syntax, semantics, satisfiability & validity, predicate or first order logic – syntax, semantics, satisfiability & validity, completeness & compactness, Undecidability & incompleteness; Godel's incompleteness theorem; SAT solvers; verification by model checking, linear-time temporal logic (LTL), & computational tree logic (CTL). Program verification using Hoare logic & proofs of correctness; Modal logic & logic programming paradigm.

CS F215 Digital Design 3 1 4

Boolean Algebra & logic minimization; combinational logic circuits : arithmetic circuit design , Design using MSI components; Sequential Logic Circuits : flip flops & latches, registers and counters, Finite state machine ; HDL Implementation of Digital circuits; Digital Integrated Circuits ; Programmable logic devices; Memory organization ; Algorithmic State machine; Introduction to computer organization; The course will also have laboratory component on digital design.

CS F222 Discrete structures for Computer Science 3 0 3

Sets & operation on sets; relations & equivalence relations; number theory; weak & strong form of mathematical induction; principle of inclusion & exclusion, pigeonhole principle; recurrence relations & generating functions; digraphs & graphs, graph isomorphism & sub-graphs, spanning trees, Euler & Hamiltonian graphs, planar graphs, chromatic numbers & graph coloring; groups; Lagrange theorem finite groups; Rings & Fields.

CS F241 Microprocessors & Interfacing 3 1 4

Programmers model of processor, processor architecture; Instruction set, modular assembly programming using subroutines, macros etc.; Timing diagrams ; Concept of interrupts: hardware & software interrupts, Interrupt handling techniques, Interrupt controllers; Types of Memory & memory interfacing; Programmable Peripheral devices and I/O Interfacing ; DMA controller and its interfacing: Design of processor based system . This course will have laboratory component.

CS F266 Study Project 3

Course description is same as given under BIO F266.

CS F301 Principles of Programming Languages 2 0 2

The course covers features of programming languages and introduces the main programming paradigms. It covers, in detail, the semantics of the features of programming languages –Control Abstraction, Data Types and Data Abstraction, Scope and Parameter passing and Concurrency related features. It covers various aspects of runtime environments like global and local data, code, function call stacks, dynamically allocated data, runtime features for exceptions and threads. In-

troduction to programming paradigms. Functional paradigm – formal elements of lambda calculus, introduction to syntax of common functional programming languages and programming exercises that explore the functional paradigm. Logic programming paradigm - formal elements of logic programming and programming tasks that explore the logic paradigm. Scripting as a paradigm. Domain specific languages. Applications of the principles of programming languages – program verification, software testing and security.

CS F303 Computer Networks 3 1 4

Introduction; Need for Computer Networks; Top-down vs. Bottom-up approaches; Network Services, and Protocols; Network Reference Models and Architectures, Architecture of the Internet, Types and Applications of contemporary and emerging Networks, Application-Layer Requirements, Concepts, Services and Protocols: Protocols for Web, Email, File transfer, Name Resolution, Address Assignment / Discovery, Remote Access Services, Voice/Video over IP, Webcasting, Video-Conferencing and Telepresence, Network Management Protocols and Overlay Networks; Transport Layer Requirements, Services, Concepts and Protocols; Network Layer Requirements, Concepts, Services and Protocols, Routing vs. Layer-3 Switching; QoS; Link Layer and Physical Layer Requirements, Concepts, Services and Protocols, Logical Link and Medium Access Control concepts, Physical medium dependent function, Modes of Signaling and Communication at the lower layer; IEEE 802 architecture, Bridging versus Layer-2 Switching; VLANs, VPNs, Performance vs. Security, Emerging Trends and Best Practices related to design of computer networks and internetworks.

CS F314 Software Development for Portable Devices 2 1 3

Course description is same as given under CS C314.

CS F342 Computer Architecture 3 1 4

Processor performance criteria, performance benchmarks, arithmetic circuits, CPU design - instruction set architecture, instruction execution, Single and Multicycle implementation, Pipeline design, Hazards, methods of overcoming hazards, Branch prediction, Memory subsystems including cache optimization, Instruction level Parallelism.

CS F351 Theory of Computation 3 0 3

Review of Set Theory - Cardinality, Countable and Uncountable Infinite Sets, Relations and Functions, Equivalence Relations. Introduction to Languages and Operations Applicable to Languages. Regular Expressions. Finite State Automata - Deterministic and Non-Deterministic – Equivalence, FSAs and Regular Expressions – Closure Properties of Regular Languages – Equivalence Classes of a Language and Minimal Automata. Non-Regular Languages. Context Free Grammars and Push Down Automata – Equivalence and Closure Properties – Normal forms and Concepts in Parsing – Languages that are not Context Free. Turing Machines – Unrestricted Grammars – Equivalence – Various Forms of TMs and their Equivalence. Recursive functions. Universal Turing machine – Reductions – Decidability – Undecidable Languages. Complexity Classes – P, NP and NP-Completeness.

CS F363 Compiler Construction 2 1 3

Introduction - Compilation and Execution Environments -Compilers and Interpreters – Requirements and Motivation; Front-end and Back-end of compilers/interpreters; Intermediate Representation and Intermediate Languages; Compile Time vs. Execution Time; Translators, and Assemblers; Virtual Machine - Just-in-Time Compilers. Structure of a Compiler – Phases and Passes. In-memory data - intermediate versions of code, symbol table. Lexical Analysis: error handling & tool construction, DFA, Defining tokens using regular expressions, Designing and implementing scanners / lexical analyzers. Parsers: Context Free Languages (introduction where needed)and Recognizing CFLs. Parsing techniques – LL , LR - LR (0),LR(1), LALR) . Intermediate Representation: Parse Trees and Abstract Syntax Trees; 3-address code. Semantic Analysis. Back End Phases: Machine Independent optimizations: Loop Optimization Techniques - Loop Unrolling, Induction variable based optimization, Loop-Invariant code elimination. Procedure Call Optimization, and Dead Code Elimination. Target Code Generation : Data Flow Analysis, Register Allocation, Instruction Selection & Scheduling. Memory Management : Memory allocation support, Memory- deallocation – Garbage Collection Techniques. Advanced Topics :Issues in compiling Object Oriented Languages, Functional Languages, Concurrent Languages, Script & Query Languages.

CS F364 Design and Analysis of Algorithms 3 0 3

Basic Design Techniques – Divide-and-Conquer, Greedy, Dynamic Programming (Examples, Analysis, General Structure of Solutions, Limitations and Applicability). Specialized Design Techniques: Network Flow, Randomization (Examples, Analysis, Limitations). Complexity Classes and Hardness of Problems – P, NP, Reductions, NP-hardness and NP-Completeness, Reduction Techniques, Basic NP-complete problems. Design Techniques for Hard Problems – Backtracking, Branch-and-Bound, and Approximation (General approaches and structure of solution, Analysis, and Limitations). Linear Programming – LP Problem and Simplex Algorithm, Approach for using LP for modeling and solving problems. Introduction to Design and Analysis of Parallel and Multi-threaded Algorithms.

CS F366 Lab Project **3**

CS F367 Lab Project **3**

Course description is same as given under BIO F366 and BIO F367.

CS F372 Operating Systems **3 0 3**

Introduction to operating systems; Various approaches to design of operating systems ; Overview of hardware support for 0perating systems; Process/thread management: synchronization and mutual exclusion, inter process communication, CPU scheduling approaches ;Memory management: paging, segmentation ,virtual memory, page replacement algorithms ; File systems: design and implementation of file systems; Input/Output systems; device controllers and device drivers; Security and protection ; Case studies on design and implementation of operating system modules.

CS F376 Design Project **3**

CS F377 Design Project **3**

Course description is same as given under BIO F376 and BIO F377.

CS F401 Multimedia Computing **3 0 3**

Course description is same as given under EA C473.

CS F404 Computer Crime and Forensics **2 0 2**

Introduction to Computer Forensics: collection, preservation, analysis, preparation and presentation of computer based evidence for the purposes of criminal law enforcement or civil litigation. Structure of Storage Media: Study of different file systems (FAT12, FAT16, FAT32, NTFS, EXT2/EXT3, etc). Study of digital forensic techniques: Disk forensics, Network forensics and Device forensics. Understanding Computer Crime, Data Acquisition, Forensic Analysis (Internet History files, Email files and major operating system files for different OS's). Study of Steganography: information hiding and retrieval. Live versus Dead forensics. Use of Forensic Tools for file system analysis, registry analysis, network analysis, etc. Introduction to computer crimes in India and abroad.

CS F406 Ethical Hacking **2 2 3**

Techniques and tools for ethical hacking and countermeasures; exploit approaches – social engineering, scanning, foot-printing, enumeration, sniffers, buffer overflows, web-hacking including cross scripting, SQL injection, privilege escalation, root kits, search engine highjack, covert channel, binary auditing, services specific hacking like DNS, Email, Web servers, Proxy; techniques of bypassing security mechanisms and hardening systems and networks for countermeasures of security analysis, monitoring and analysis tools including network traffic and system logs.

CS F407 Artificial Intelligence **3 0 3**

Course description is same as given under EA C461.

CS F413 Internetworking Technologies **3 0 3**

Course description is same as given under EA C451.

CS F415 Data Mining **3 0 3**

Course description is same as given under CS C415.

CS F422 Parallel Computing **3 0 3**

Course description is same as given under CS C422.

CS F424 Software for Embedded Systems **3 1 4**

Real-time and Embedded Systems; Software issues in Embedded Systems; Software Development Process; Requirements Analysis – Use Cases, Identification and Analysis of use cases, Use Case Diagrams. Design – Architectural Design, Design Patterns, Detailed Design. Implementation – Languages, Compilers, Runtime Environments and Operating Systems for embedded software. Testing – Methodologies, Test Cases.

CS F441 Selected Topics from Computer Science **3**

Course description is same as given under CS C441.

CS F446 Data Storage Technologies and Networks **3 0 3**

Course description is same as given under CS C446.

CS F451 Combinatorial Mathematics **3 0 3**

Course description is to be developed.

CS F468 Information Security Project **0 3 3**

Malware and Malware Identification, Terminate-and-Stay-Resident programs, Identification of signatures/patterns of viruses, Developing Antivirus tools, Single system firewalls and rules, Rootkits and identification of rootkits, Virtual machines, Sandboxes and run-time monitors.

CS F469 Information Retrieval **3 0 3**

Organization, representation, and access to information; categorization, indexing, and content analysis; data structures for unstructured data; design and maintenance of such data structures, indexing and indexes, retrieval and classification schemes; use of codes, formats, and standards; analysis, construction and evaluation of search and navigation techniques; search engines and how they relate to the above. Multimedia data and their representation and search.

CS F491 Special Projects **3**

Course description is same as given under BIO F491.

CS G501 Mobile Computing **5***

Course description to be developed.

CS G511 Design and Analysis of Algorithms **3 2 5**

Design techniques such as divide-and-conquer, recursion, backtracking, branch-and-bound, simulation; Analysis in terms of average level and worst level effi-

ciency; Relationship to appropriate data structures; Illustrations dealing with problems in computer science, graph theory and mathematics; Computational complexity and bounds; NP-hard and NP-complete problems.

CS G512 Introduction to Authoring Systems 4

Characteristics and principles of expert systems; construction and transfer of expertise; meta-knowledge; tools and formalisms for expert systems; application through programs in prolog; state of art characteristics and principles of authoring systems; implementation techniques.

CS G513 Network Security 3 1 4

This course examines issues related to network and information security. Topics include security concepts, security attacks and risks, security architectures, security policy management, security mechanisms, cryptography algorithms, securitystandards, security system interoperation and case studies of the current major security systems.

CS G514 Object Oriented Analysis and Design 2 2 4

Object orientation concepts, theories and principles; fundamental concepts of the object model: classes, objects, methods and messages, encapsulation and inheritance, interface and implementation, reuse and extension of classes, inheritance and polymorphism; process of object-oriented requirements specification, analysis and design; notations for object-oriented analysis and design; case studies and applications using some object oriented programming languages.

CS G515 Queueing Systems Theory 3 2 5

Resource sharing issues and theory of queueing systems; Review of Markov chains and baby queueing theory; Method of stages. M/Er/1. Er/M/1. Bulk arrival and bulk service systems. Series-parallel stages. Fundamentals of open and closed queueing networks. Intermediate queueing theory: M/G/1; G/M/m. Collective marks. Advanced queueing theory: G/G/1; Lindley integral equation; spectral solution. Inequalities, bounds, approximations.

CS G517 Network and System Security 4*

Course description is to be developed.

CS G520 Advanced Data Mining 3 1 4

Prerequisite: CS C415/ IS C415 Data Mining

(=SS G520)

Topics beyond conventional record data mining. Mining complex data structures. Tree/graph mining, sequence mining, web/text data mining, stream data mining, spatiotemporal data mining, mining multi-variate time series data, high-dimensional data clustering, and mining social networking sites. Mining data from multiple relations (Multi-relational Data Mining). Privacy preserving Data Mining. Distributed computing solutions for data intensive data mining.

CS G521 Object Oriented Programming 2 2 4

Course description is same as given under BITS G512.

CS G523 Software for Embedded Systems 3 2 5

Real-time and embedded systems; software issues in embedded system; software development process; requirement analysis: use cases, identification and analysis of use cases, use case diagrams; design: architectural design, design patterns and detailed design; implementation: languages, compilers, runtime environments and operating systems for embedded software; testing: methodologies, test cases. The course will also consist of laboratory practices and development of software for embedded systems.

CS G524 Advanced Computer Architecture 3 0 5

Basics of Parallelism, Instruction Level Parallelism, Simultaneous Multi-Threading, Design and Optimization Techniques for Cache and DRAM; Pipelining and Super-scalar Techniques, Multiprocessor and Multicore architecture, Shared Memory and Cache Coherence Issues; Multi-vector and SIMD computers, Performance evaluation methods, Interconnect Design Techniques.

CS G525 Advanced Computer Networks 3 2 5

Topics in advanced networking – Quality of Service in IP networks, IPv6, Wireless and Mobile Networks, Carrier Technologies (Frame Relay, FDDI, ISDN, ATM), Peer-to-Peer Networks and Overlays, Routing and QoS Issues in Optical Networks.

CS G526 Advanced Algorithms & Complexity 3 2 5

Advanced Algorithm Design Strategies such as Randomization, Approximation and Game-Theoretic Techniques. Design of Parallel and Distributed Algorithms. Design of algorithms for application domains such as Internet / Web, and Computational Biology.

CS G527 Cloud Computing 5

Review of Distributed computing - Concurrency, message passing, connectivity and failure models, replication. Computing Infrastructure - Processing Power, Storage aggregation, I/O & Communication, Clusters and Data Centers. Resource modeling and virtualization - CPU virtualization, memory and storage virtualization, virtualized networks. Services - Service models and service contracts; Programming on the cloud. Cloud Applications - Software on the Cloud and Infrastructure Services. Cloud infrastructure - Private vs. Public Clouds, Resource scaling and Resource provisioning. Quality of Service - Performance models, scalability, Performance measurement and enhancement techniques. Security issues - Data/ Storage Security, Resource Access Control, Process Isolation and Control, Service Policies and Privacy Issues.

CS G531 Testable Design & Fault Tolerant Computing 3 2 5

Fault: types, modelling and simulation; testing methodologies, coverage, economics and quality; test vector generation: design for testability, built-in self tests; fault tolerant computing; fault tolerant software.

CS G541 Pervasive Computing 4*

Select application architectures; hardware aspects; human-machine interfacing; device technology: hardware, operating system issues; software aspects, java; device connectivity issues and protocols; security issues; device management issues and mechanisms; role of web; wap devices and architectures; voice-enabling techniques; PDAs and their operating systems; web application architectures; architectural issues and choices; smart card-based authentication mechanisms; applications; issues and mechanisms in WAP-enabling; access architectures; wearable computing architectures.

CS G551 Advanced Compilation Techniques 5

Generic Code Optimization Techniques - loop optimization, inlining, and other transformations. Impact of architectures on code generation and optimization: RISC architectures, VLIW architectures, special-purpose architectures. Architecture-specific code optimizations – register allocation, instruction scheduling. Code Optimizations under real-time / embedded constraints - cacheless / diskless memory models, bounded time responses. Garbage Collection Techniques. Virtual Machines and Just-in-Time Compilation techniques - HotSpot-like optimizations. Implementation of exception handling, concurrency, and generic jumps (like call/cc).

CS G553 Reconfigurable Computing 5

Overview of Programmable Logics. FPGA fabric architectures. Logic Elements and Switch Networks. Design and Synthesis of Combinational and Sequential Elements. Placement and Routing. Pipelining and other Design Methodologies. Fine-grained and Coarse-Grained FPGAs. Static and Dynamic Reconfiguration. Partitioning. Hardware/Software Portioning and Partial Evaluation. Systolic Architectures.

CS G554 Distributed Data Systems 3 2 5

Distributed File Systems - File System Models; Replication and Synchronization - Caching; Failure & Recovery; File System Security. Distributed Databases - Distributed Data Sources and Updates; Database Connectivity; Concurrency Control and Distribution mechanism; Distributed indexing schemes. Database security. Data on the Web - Web as a distributed data repository. Data Collection and Use Crawlers, Search Engines, and Indexing Schemes. Information Retrieval Techniques.

Data Exchange - Hierarchical Data Models, XML, and query languages. Semi-structured / Unstructured data -querying and synchronization.

Pervasive Data - Data distribution and access for non-computing devices, small computing devices, embedded computing devices and sensory devices.

CS G555 System Specifications and Modelling 3 3 4

Requirement analysis, specification formalisms, system modeling issues, system modeling languages, Hardware Specification and verification languages, EDA tools and its applications.

CS G557 Distributed Computing 5*

Course description is to be developed.

CS G559 Database Security 5*

Course description is to be developed.

CS G562 Advanced Architecture and Performance Evaluation 3 2 5

Introduction to advanced architectures; parallel processing; pipelining and vector processing; array processing; SIMD computers and processor enhancement; performance evaluation methods, statistics and discrete math applications; modelling for evaluation of virtual memory; time sharing environments.

CS G564 Advanced Cryptography 5*

Course description is to be developed.

CS G566 Secure Software Engineering 5*

Best practices for designing secure systems, software engineering principles for designing secure systems, criteria for designing secure systems; analysis of system properties and verification of program correctness; use of formal methods and verification for security; tools for verification of security properties; techniques for software protection (such as code obfuscation, tamper-proofing and watermarking) and their limitations; analysis of software based attacks (and defenses), timing attacks and leakage of information, and type safety.

CS G568 Network Security Project 0 3 3

Network Intrusion and Intrusion Detection Techniques and Tools; Denial-of-Service attacks and Techniques/Tools for handling them; Network Firewalls and Firewall policies/mechanisms; Network-wide authentication schemes for users/clients/servers; Network-wide storage and storage security models and implementations.

CS G611 Distributed Processing Systems 2 2 4

Concepts of distributed processing, networkable architectures, inter process and processor communication algorithms, process migration and porting techniques etc.

CS G612 Fault Tolerant System Design 2 3 5

Principles of fault tolerant systems, redundancy, parallel and shared resources, spatial systems, configura-

tions, design aspects etc.

CS G622 Local Area Networks: Design and Implementation **2 3 5**

Introduction to Local Networks; carrier sense networks; shared memory and device systems; protocol and token passing techniques & algorithms; security and integrity problems; algorithms and implementation; and selected current topics.

CS G623 Advanced Operating Systems **3 2 5**

Overview of advanced operating systems: motivation for their design, and various types of advanced operating systems; Distributed operating systems: architecture of distributed systems, theoretical foundation of distributed systems, deadlock detection/resolution, aggrement protocols, file systems, distributed shared memory, scheduling, fault tolerance and recovery; Multiprocessor operating systems: multiprocessor system architectures, multiprocessor operating system design issues, thereads, process synchronization, process scheduling and memory management; Data base operating systems: introduction, concurrency control: theoretical and algorithmic aspects; Case Study: Amoeba and Mach.

CS G631 Devices, Data Communications and Control **3 2 5**

Principles of operations of I/O devices; device handlers; master- slave control & controllers; Intelligent mode of operation; device handlers; most popular data communication methods; synchronisation and handshaking; design of controllers for selected devices.

CS G632 Application Driven System Design **0 4 4**

General principles of application driven systems, examples from space and high speed digital imaging systems, Bandwidth considerations, design aspects etc

CS G641 Microprocessor-Based Systems Design **3 5**

Small systems organisation; bus architectures; building blocks around a microprocessor; memory techniques; RAM disks; paged memory modules; communications and data transfers; monitors and operating systems; engineering applications of microprocessors as device controllers; concept of local and central control.

CS G642 Recent Advances in Computing **2 2 4**

Introduction to transputing and transputers, minimization algorithms, design aspects. Neural networks modelling, simulation and design. Optical computing and recent advances.

CS G651 Symbolic Computing & Computer Algebra **2 2 4**

Course description is to be developed.

CS G652 Digital Communications and Message Switching **3 2 5**

Signals & transmission types; noise; coding & decoding; modulation techniques; filters; time and frequency multiplexing; message switching; protocols; packet switching systems; remote networks; satellite linking communications.

CS G653 Software Architectures **3 2 5**

Systems engineering and software architectures; Hatley-Pirbhai architectural template; architecture flow diagrams; requirements engineering and software architecture; architectural design processes; design post-processing; real-time architectures; architectural design patterns; software architecture and maintenance management; object oriented architectures; client-server architectures; forward engineering for object oriented and client-server architectures; emerging software architectures.

CS G671 Advanced Computer Graphics **3 2 5**

Overview of computer graphics and graphic devices; two dimensional & three dimensional curve representations, rotations and transformations; surfaces, generation, representation, rotation and transformations; modelling techniques; concepts in geometric design.

Design Engineering

DE G511 Advanced Methods in Applied Mathematics **A 5**

Suitable topics from amongst the following: linear algebra; vector analysis; numerical methods to solve different types of equations; approximate numerical solutions of ordinary and partial differential equations; integral transform; linear and nonlinear optimization techniques; mathematical programming; mathematical modelling; calculus of variations; random variates and statistical techniques; decision models and analysis.

DE G512 Finite Element Analysis **5**

Element properties, Isoparametric elements, Finite element methods and analysis, Applications in design including continuum mechanics, Dynamic systems, Heat conduction and Electrical potentials, etc. will be taken up.

DE G513 Tribiology **3 2 5**

Introduction, lubricants and lubrication, surface texture, bearing materials, fundamentals of viscous flow, reynolds equation and applications, thrust bearings, journal bearings, squeeze-film bearings, hydrostatic bearings, gas bearings, dry and starved bearings, selecting bearing type and size, principles and operating limits, friction, wear and lubrication.

DE G514 Fracture Mechanics **3 2 5**

Introduction, energy release rate, stress intensity factor and complex cases, anelastic deformation at the crack tip, elastic plastic analysis through J-integral, crack tip opening displacement, test methods, fatigue failure, numerical analysis, mixed mode crack initiation and growth.

DE G521 Instrumentation and Applied Electronics **5**

Generalized instrumentation system for measurement and control; performance characteristics of instruments; analytical techniques - time and frequency domain analysis, Laplace and Fourier transform techniques; sensors and transducers; Feedback measurement system, ynalmg and digital signal conditioning and conversion techniques, telemetry techniques, improvement of signal-to-noise ratio, statistical instrumentation techniques; transducers interfacing; computer control instrumentation, electronic bench instruments, etc.

DE G522 Design Projects **3 2 5**

Practice in engineering design through projects emphasizing creative solutions to engineering design problem. Illustrative case studies of design will be taken up. The course will be conducted through selected group/individual projects.

DE G531 Product Design **3 2 5**

Introduction to creative design; user research and requirements analysis, product specifications, Computer Aided Design; standardization, variety reduction, preferred numbers and other techniques; modular design; design economics, cost analysis, cost reduction and value analysis techniques, design for production; human factors in design: anthropometric, ergonomic, psychological, physiological considerations in design decision making; legal factors, engineering ethics and society.

DE G532 Quality Assurance & Reliability **5**

Quality planning and control, economics of quality control, Specifications, tolerances and process capability studies, total quality control concepts in quality circles, quality incentives. Fundamental concepts of reliability engineering, Failure analysis, Reliability versus quality control, Systems reliability evaluation, reliability allocation, maintainability, and designing for reliability. Illustrative examples of design ensuring reliability to be taken up.

DE G611 Dynamics & Vibrations **3 2 5**

Steady and transient Vibration of single and multi degree freedom systems. Systems with distributed mass and elasticity. Non-linear and self-excited vibrations, structural damping, Random vibrations, vibration analysis, vibration control - reduction, isolation and vibration absorbers.

DE G621 Digital & Microprocessor Based Systems **5**

Digital system design using combinational and sequential circuits; processor architecture, assembly programming and system design using peripheral devices such as PPI, Interrupt controller, DMA controller, etc. Microcontroller architecture and typical applications; concept of bus based system design and PC based system design.

DE G631 Materials Technology & Testing **5**

Study of characteristics and technology of metals, plastics, rubbers, ceramics, polymers, composites, optical fibres and other modern engineering materials and their application with particular reference to Railways. Destructive and non-destructive testing techniques and their applications in Railways.

Emerging Area

EA C342 Computer Aided Design **3***

Computer Aided Drafting and tools for graphics; mathematical tools; convergence criteria; design tools like modelling, simulation, spread sheets and use of specialised packages etc.; students will be required to do projects, specialised works for which a pool of guides will be drawn from several disciplines.

EA C412 Flexible Manufacturing Systems **3 2 4**

Introduction CAD/CAM systems, overview of FMS, system hardware and general functions, material handling system, work holding systems, cutting tools and tool management, physical planning of system, software structure functions and description, cleaning and automated inspection, communications and computer networks for manufacturing, quantification of flexibility, human factors in manufacturing, FMS and CIM in action (case studies), justification of FMS, modelling for design, planning and operation of FMS.

EA C413 Intelligent Manufacturing Systems **3 0 3**

Introduction of manufacturing systems and intelligent manufacturing systems, intelligent systems architecture: design techniques, knowledge-based systems, artificial neural networks, fuzzy systems, genetic algorithms in process planning, scheduling, fault diagnosis, automated assembly, manufacturing feature identification, visionbased inspection, process monitoring & control.

EA C414 Introduction to Bioinformatics 3 0 3

Course description is same as given under BIO C412.

EA C415 Introduction to MEMS **3 1 4**

Overview, history and industry perspective; working principles; mechanics and dynamics, thermofluid engineering; scaling law; microactuators, microsensors and microelectromechanical systems; microsystem design, modeling and simulation; materials; packaging; microfabrication: bulk, surface, LIGA etc; micromanufacturing; microfludidics; microrobotics; case studies.

EA C416 Introduction to Nanoscience **3 0 3**

Introduction; nanoscience in nature; fundamental science behind nanomaterials; synthesis and properties of nanomaterials; tools to study the properties, size and shape determinations, application of

nanomaterials in science, engineering and biomedical field; future trends.

EA C417 Micro-fluidics and its Applications 4*

Introduction to microfluidics, scaling in microfluidics, theoretical microfluidics, Philosophy of Computational Fluid Dynamics, Concepts of discretization, fabrication techniques for microfluidic devices, microvalves, micropumps, microflow sensors, microfluidics for life sciences: micromixers, microneedles, microfilters, microseparators, microreactors, modeling and simulation on CAD tool.

EA C422 Fibre Optics and Optoelectronics 3 0 3

Theory of optical fibres; image transmission by fibres; technology of fibre production; fibre testing; characterization of optical fibres; detectors and sources for fibre optic systems; active fibres; applications of optical fibres; optoelectronic devices and applications.

EA C441 Robotics 3 0 3

The objective of this course is to make the students familiar with Robotics, the main components of kinematics, sensors, transmission and drives, control systems, intelligence and vision, geometric modelling and reasoning, assembly planning, grasping, collision avoidance, mobile robots, force strategies, uncertainty analysis, and representation of visual world.

EA C442 Remote Sensing and Image Processing 3 0 3

Introduction to remote sensing; types of sensors; earth resource sensors; Landsat; IRS; SPOT; microwave remote sensing; SAR; SLAR; thermal infrared remote sensing; data analysis; image processing; smoothing; filtering; image averaging;enhancement techniques; transforms; FFT; PCA; segmentation; gradient operators; pattern recognition; ML classifier; minimum distance classifier; other classifiers; ISODATA clustering; feature selection; divergence; canonical analysis; recent developments in remote sensing; LIDAR; imaging spectroscopy etc.

EA C443 Image Processing 3 0 3

Introduction to Image Processing and Imaging systems, Image sampling, Transforms, Enhancement and Restoration, Coding and Communications, Image Compression, Image understanding, Neural network and PR Approaches.

EA C451 Internetworking Technologies 3 0 3

Introduction to internetworking concepts; the internet architecture; goals and key issues related to internetworking technologies; design aspects; HTTP and other relevant protocols; agent technology and tools relevant to the internet; techniques of data compression; voice, video, and interactive video-on-demand over the internet; multimedia operating systems and their impact; multimedia networking; mobile computing; internet security; case studies.

EA C452 Mobile Telecommunication Networks 3 0 3

Fundamentals of mobile telecommunications, with an overview of first generation (analog) systems and more detailed coverage of second generation (digital) technologies; technology basics including descriptions of wireless network elements, spectrum allocation, frequency re-use, characteristics of the transmission medium; over the-air (OTA) interface characteristics; capacity, coverage, speech coding, channel coding and modulation techniques of TDMA and CDMA technologies; network characteristics; architecture, signaling, element management of IS-41 and GSM networks; call processing; call setup and release, handoff, roaming, advanced services; mobile data communications; circuit and packet switched data services, third generation (wideband data) mobile communications system requirements/ architecture.

EA C461 Artificial Intelligence 3

The object of this course is to give an introduction to the problems and techniques of A.I. along with the applications of A.I. techniques to the fields like natural language understanding, image processing, game theory and problem solving.

The course also aims at understanding its implementation using LISP and PROLOG languages.

EA C462 Superconductivity Theory and Applications 3 0 3

Phenomenological theory involving concepts of critical temperature, critical current; Meissner effect, London equation, GL theory, BCS theory, superconductors in magnetic field, high Tc superconductors, Josephson junction; superconducting devices SQUIDS, uses in biomagnetic fields, Josephson arrays for submillimeter source; LSI technology and circuits.

EA C463 Neural Networks and Applications 3 0 3

Introduction to neural networks and fuzzy systems' neural dynamics; activations and signals; activation models; unsupervised and suprvised learning rules and their domain of applications; architectures of neural systems; adaptive fuzzy and neural control systems and their comparison; case studies on fuzzy and neural control systems.

EA C471 Pattern Recognition 3*

The object of this course is to study the principles and available techniques for the analysis and design of pattern recognition system, introduction to pattern classification by distance functions, and likelihood functions, trainable pattern classifiers: deterministic and statistical approach.

EA C472 Photovoltaic Devices 3 0 3

Introduction to photovoltaic energy conversion: physics of semiconductors, p-n junction band diagram, fermi energy, surface states and types of defects; photovoltaic solar cells; p-n junction, metal - schottky junction,

electrolyte - semiconductor junction, and other types of photovoltaic devices; characterisations of solar cells and photovoltaic modules, and applications in various systems: storage battery, DC drives, water pumps, space applications and power plants.

EA C473 Multimedia Computing 3 0 3

Introduction to multimedia; media & data streams; image, video & audio file formats; image & video processing, synthesis of sound signal; image coding & compression, video & audio codecs, low bit rate video telephony; audio-visual integration, lip reading, face animation; augmented reality; multimedia search services, content based image & video indexing; access to multimedia, human-machine interfaces, spoken language interface; algorithm vs. architecture based approaches, multimedia processors, performance quantification; case studies, vision 2010.

EA C474 Retail Management Systems 3 0 3

Retailing history and theories, basic retail management process, retail industry in Indian and abroad, shopper behavior in retailing, retailing formats and location related issues, category management, supply chain management in retail, retail buying, store layout and design, point of purchase communication, retail pricing strategy, building store loyalty and technology in retailing. Case studies and projects in retailing, specially focusing on Indian scenarios.

EA C475 Financial Engineering 3 0 3

Introduction; Review of Markets, Players, and Conventions; Cash Flow Engineering with Forward Contracts; Engineering Simple Interest Rate Derivatives; Swap Engineering; Report Market Strategies; Dynamic Replication Methods and Synthetics; Mechanics of Options; Options Engineering with Applications; Pricing Tools; Applications of Fundamental Theorem of Finance; Fixed Income Engineering; Tools for Volatility Engineering: Volatility Swaps and Volatility Trading; Engineering of Equity Instruments: Pricing and Replication, computational methods such as Monte Carlo Simulation.

EA C476 Power Apparatus & Networks 3 2 4

Essential fundamentals of power networks: overview of power systems and changing landscape; sources of electrical energy and environmental consequences; the Indian power industry; fundamental principles of power networks; magnetic prerequisites. Apparatus in power networks: transformers; synchronous generators; transmission lines, cables, HVDC; loads and power quality. Analysis and operation: power flow; rotor angle and voltage stability; control of large interconnected power networks. Protection: fault calculations, relay co-ordination and circuit breakers; transient overvoltages, protection by surge arrestors, and insulation co-ordination. Management of vertical utilities, utility deregulation and open access: operational economics of the power industry, privatization; deregulation and energy markets.

EA C477 Foundations of Nanomechanics 3 0 3

Introduction to nano-mechanics; mechanics at molecular level; stress, strain and elastic relations; system equations for a static deformable solid; dynamic behavior at molecule level ; equation of motion in an isotropic solid; Micro cantilever, General components of nano-mechanics device; high resolution force spectroscopy; measuring intermolecular adhesion, lateral force microscopy, experimental nanostructures; nano tribology; adhesion and stiction; nano-magneto-rhehology; nanoindentation.

EA C481 Expert Systems 3*

The object of this course is to study in details the features of expert systems and their role in the scientific world of today and tomorrow. It concentrates on the tools available to the knowledge engineer, expert systems, building techniques, and the difficulties which may be encountered during the development of an expert system.

EA C482 Fuzzy Logic and Applications 3 0 3

Fuzzy sets, fuzzy binary relations; fuzzy logic, fuzzy reasoning; applications in decision making, control theory, expert systems, artificial intelligence etc.

EA C485 Sustainable Manufacturing 3 0 3

Course description is to be developed.

Electronics and Communication Engineering

ECE C272 Circuits and Signals 3 0 3

Course description is same as given under EEE C272.

ECE C313 Microelectronic Circuits 3 0 3

Course description is same as given under EEE C424.

ECE C364 Analog Electronics 3 3 4

Course description is same as given under EEE C364.

ECE C383 Communication Systems 3 3 4

Course description is same as given under EEE C383.

ECE C391 Digital Electronics and Computer Organization 3 3 4

Course description is same as given under CS C391.

ECE C392 Modern Communication Technologies 3 0 3

Modern communication systems overview, Digital modulation techniques, Channel capacity and coding, Digital link improve techniques, Digital receiver design and performance analysis, Wireless communication systems: wireless channel models and link improvement techniques, multiple access schemes. Basic concept of mobile network, Optical Communication Systems: Transmitters, receivers and other optical Communication subsystem, Optical wireless systems.

ECE C393 Information Theory & Coding **3 0 3**

Random variables and random processes; Information sources and source coding theorem, Kraft inequality, Shannon-Fano codes, Huffman codes, Arithmatic Codes, Lempel-Ziv-Welch algorithm, universal source codes; channel capacity: channel capacity; noisy channel coding theorem for discrete memoryless channels; channel capacity with feedback; continuous and Gaussian channels; error control coding: linear block codes and their properties, hard-decision decoding, convolution codes and the Viterbi decoding algorithm, iterative decoding; turbo codes and lowdensity-parity-check codes; rate distortion theory: rate distortion function, random source codes; joint source-channel coding and the separation theorem; cryptography: basic concepts on cryptography and cryptoanalysis, security issues; private-key encryption algorithms- stream ciphers, block ciphers, Shannon's theory; introduction to number theory - modular arithmetic, exponentiation and discrete logarithms in Galois field; public-key encryption algorithms- Diffie-Hellman public-key distribution scheme, RSA public-key cryptosystem; Message authentication, hashing functions, digital signatures.

ECE C394 Communication Networks **3 0 3**

Packet switching and circuit switching; layered network architecture (OSI model), point-to-point protocols and links: physical layer, error detection and correction, ARQ retransmission strategy, framing, X.25 standard, queueing theory and delay analysis: Little's theorem, analytical treatment of M/M/1 and M/M/m queuing systems, simulation of queueing systems, delay analysis for ARQ system, multi-access protocols and techniques: Aloha systems, CSMA, IEEE-802 standards, routing and flow control. TCP/ IP protocols, ISDN, ATM, network security, design of a LAN system with commercially available functional units. Wireless LAN: adhoc network, security issues.

ECE C452 Electromagnetic Fields & Microwave Engineering **3 0 3**

Course description is same as given under EEE C452.

ECE C491 Special Projects **3**

Course description is same as given under BIO C491.

ECE F211 Electrical Machines **3 1 4**

Course description is same as given under EEE F211.

ECE F212 Electromagnetic Theory **3 0 3**

Course description is same as given under PHY F212 Electromagnetic Theory I.

ECE F214 Electronic Devices **3 0 3**

Course description is same as given under EEE F214.

ECE F215 Digital Design **3 1 4**

Course description is same as given under EEE F215.

ECE F241 Microprocessors and interfacing **3 1 4**

Course description is same as given under EEE F241.

ECE F242 Control Systems **3 0 3**

Course description is same as given under EEE F242.

ECE F243 Signals and Systems **3 0 3**

Course description is same as given under EEE F243.

ECE F244 Microelectronic Circuits **3 0 3**

Course description is same as given under EEE F244.

ECE F266 Study Project **3**

Course description is same as given under BIO F266.

ECE F311 Communication Systems **3 1 4**

Course description is same as given under EEE F311.

ECE F312 EM Fields and Microwave Engineering Laboratory **0 1 1**

Experiments in Microwaves and antennas using Microwave benches and simulation softwares.

Prerequisite:

EEE/ECE/INSTR F212 Electromagnetic Theory

ECE F314 Electromagnetic Fields and Microwave Engineering **3 0 3**

Course description is same as given under EEE C452.

ECE F341 Analog Electronics **3 1 4**

Course description is same as given under EEE F341.

ECE F343 Communication Networks **3 1 4**

Course description is same as given under ECE C394.

ECE F344 Information Theory and Coding **3 0 3**

Course description is same as given under ECE C393.

ECE F366 Lab Project **3**

ECE F367 Lab Project **3**

Course description is same as given under BIO F366 and BIO F367.

ECE F376 Design Project **3**

ECE F377 Design Project **3**

Course description is same as given under BIO F376 and BIO F377.

ECE F414 Telecommunication Switching Systems and Networks **3 0 3**

Course description is same as given under CS C414.

ECE F416 Digital Communication **3 0 3**

Course description is same as given under EEE C416.

ECE F418 Modern Communication Technologies **3 0 3**

Course description is same as given under ECE C392.

ECEF431 Mobile Telecommunication Networks 3 0 3

Course description is same as given under EA C452.

ECE F434 Digital Signal Processing 3 1 4

Course description is same as given under EEE C415.

ECE F472 Satellite Communication 3 0 3

Course description is same as given under EEE C472.

ECE F491 Special Projects 3

Course description is same as given under BIO F491.

Economics

ECON C211 Principles of Economics 3 0 3

Nature and scope of economic science, its relationship with other social sciences; quantification of economic variables, theories of consumer behaviour and of the firm: linear economic models; market structures; social accounting and basic elements of economic planning.

ECON C212 Fundamentals of Finance and Accounting 3 0 3

This course is a broad introduction to finance and related areas. An introduction to basic accounting principles for measuring and communicating financial data about a business enterprise to external parties, single and double entry, ledgers, journal, trading, profit and loss and appropriation accounts, trial balance and balance sheet; cash flow statements; capital budgeting and risk management using risk return trade-off notions; introduction to working capital management; structure of capital market; primary and secondary markets; financial market reforms, source of investment information; portfolio selection.

ECON C311 Microeconomics 3 0 3

Consumer behaviour under risk; production functions and linear programming applications; derivation of cost and supply functions; commodity pricing under imperfect markets; factor pricing; multimarket equilibrium; optimization over time; welfare optimization.

ECON C321 Macroeconomics 3 0 3

Systems of national accounts; input-output system; flow of funds system; monetary circulation and exchange; basic model of income determination; classical model; obstacles to full employment; Keynes' model, derivation of IS and LM functions; three sector model; four sector model; inflation and Philips curve.

ECON C322 Public Finance: Theory and Practice 3 0 3

Theories of taxation; the effects of taxation on consumption, production and distribution; theories of public expenditure; effects of public expenditure on the economy; deficit-financing; the economics of public debt; federal finance system in India; role of fiscal policy in India.

ECON C341 Economic Growth and Planning 3 0 3

Economic growth and development; models of economic growth: Harrod-Domar, Solow-Swan, the neoclassical model of growth, the Fel'dman model, Cambridge models, models of technical progress; the problem of economic development; the theories of economic development: the classical model, Rostow stages theory, balanced and unbalanced growth, the Lewis theory, dualistic models; the physical quality of life and human development indexes; economic planning; strategies of planning; planning in India; plan models: Mahalanobis model, long-term planning models, multisectoral models.

ECON C342 Econometrics 3 0 3

Specification of models; estimation of single equation economic models and related problems; autocorrelation; heteroscedasticity; multi-collinearity; interpretation; forecasting and verification; estimation methods and problems in simultaneous equation systems.

ECON C362 Money, Banking and Financial Markets 3 0 3

Money and its functions; money markets; foreign exchange markets; financial markets; financial derivatives; the banking firm; non-banking financial institutions; Indian banking; monetary transmission mechanisms; money and inflation; theory of rational expectations; central banking: determinants of the money supply; tools, goals and targets of monetary policy; international monetary and financial system.

ECON C372 International Trade and Balance of Payments 3 0 3

The international economy; early trade theories; comparative advantage model; neo-classical trade theories: gains from trade, offer curves, terms of trade; edgeworth box, factor endowments and the Heckscher-Ohlin model; alternative models of trade and intra-industry trade: the imitation-lag hypothesis; product cycle theory; international trade and economic growth; international factor movements; foreign direct investment and multinational corporations; protection; economic integration; GATT & WTO; the balance of payments accounts; balance of payments equilibrium; economic policy in the open economy.

ECON C411 Project Appraisal 3 0 3

Prerequisite: ECON C212

Criteria for selection of a project; factor intensity; commercial profitability; national economic-profitability; limitations of market prices; estimation of shadow prices; linkup project appraisal to national objectives; McGaughey and Thorbeck approach; Little-Mirrlees method; UNIDO guidelines approach; limitations of the conventional project appraisal; towards a new framework for project appraisal.

ECON C412 Security Analysis and Portfolio Management 3 0 3

Course description is same as given under CDP C313.

ECON C421 Issues in Indian Economy 3 0 3

Problems of Indian agriculture; land reforms; input

management; pricing of agricultural output; rural infrastructure; rural credit and commercial banking; underemployment and rural-urban migration; agriculture v/s industry; small scale v/s large scale; public sector v/s private sector; joint sector; size of the plan and budgetary resources; inflation and income growth; taxation and black money; sharing of resources between centre and states; regulations and black market; import substitutions and export promotion; expansion of money supply and monetary controls.

ECON C422 Functions & Working of Stock Exchanges **3 0 3**

Course description is same as given under CDP C323.

ECON C431 Regional Economics **3 0 3**

Concept of a region; scope and method of regional economics; criteria for location of economic activities; regional economic structure; measurement of regional economic activity; interregional theory of income and trade; regional economic growth and its impact on regional structure; public policy.

ECON C436 Strategic Financial Management **3 0 3**

(Prerequisite: ECON C481= FIN C342= MGTS C382 Financial Management or MBA C416 Corporate Finance and Taxation)

Company Value and the Manager's Mission: Introduction to Valuation, Why Value Value? The Value Manager, Cash Is King and Value-Based Management. Approach to Valuation - A Practitioner's Guide: Frameworks for Valuation. Valuation Methods: Discounted, Relative and Contingent Claim. Analyzing Historical Performance. Forecasting Performance. Estimation of Discount Rates. Estimation of Cash Flows. Estimation of Growth Rates. Valuation Models: Dividend-Discount Models, Free-Cash-Flow-To-Equity Discount Models, Free-Cash-Flow-to-firm Approach, Price / Earnings Ratio, Price/Book Value Ratio and Price/Sales Ratio. Measuring and Managing the Company Value: Company Value vs. Shareholders Wealth Maximization - TSR. Economic Value Added, Market Value Added and Cash Value Added. Wealth Creator by the Indian Corporates. Analyzing the Company Performance - Application of Balanced Scorecard (BSC). Applying Valuation: Multibusiness Valuation. Mergers, Acquisition , and Joint Ventures.

ECON C451 Technology Forecasting **3 0 3**

Importance of technology forecasting (TF) as a useful tool in planning and decision making in management, economic planning and planning of R&D; TF techniques like Delphi, extrapolation, normative techniques, morphological analysis, correlation methods and modelling techniques; applications in decision making; development planning and business.

ECON C461 Analysis of Indian Economy **3 0 3**

The course attempts to analyse, based on statistical data, different significant aspect of the Indian economy. Among the topics to be covered are: agriculture, population; infrastructure; public sector; industries; administrative price policy & subsidies, external aid; public debt; etc.

ECON C471 Resources and Environmental Economics **3 0 3**

This course is intended as a response to the recent explosion of interest in resource and environmental issues. Among the topics to be covered are: exhaustible resources; renewable resources; resource scarcity; natural environment; pollution; environmental control and regulation; etc.

ECON C481 Financial Management **3 0 3**

Concepts and techniques of financial management decision; concepts in valuation - time value of money; valuation of a firm's stock, capital asset pricing model; investment in assets and required returns; risk analysis; financing and dividend policies, capital structure decision; working capital management, management of cash, management of accounts receivable; inventory management, short and intermediate term financing, long term financial tools of financial analysis, financial ratio analysis, funds analysis and financial forecasting, operating and financial leverages.

ECON C491 Special Projects **3**

Course description is same as given under BIO C491.

ECON F211 Principles of Economics **3 0 3**

Course description is same as given under ECON C211.

ECON F212 Fundamentals of Finance and Accounts **3 0 3**

Introduction to basic accounting principles for measuring and communicating financial data, single and double entry, ledgers, journals, trading, profit and loss and appropriation accounts, trial balance and balance sheet; cash flow statements, risk-return trade off notions, security analysis, structure of capital market, primary and secondary market, introduction to financial system and its components, financial market reforms.

ECON F213 Mathematical & Statistical Methods **3 0 3**

Methods of collection and presentation of statistical data; calculation and interpretation of various measures like standard deviation, variance, Kurtosis, correlation coefficient; Sampling Methods - Simple random sampling, with and without replacement, stratified random sampling. Statistic and sample moments, Sampling Distributions - Properties of Student's – t, Chi-square and F-distributions. Theory of Estimation - Point estimation, method of moments; maximum likelihood; interval estimation. Testing of Hypothesis - Statistical hypothesis, simple and composite hypothesis,critical region, types and size of error, test of simple hypothesis versus simple alternative. Analysis of Variance - Analysis of one-way classified data, application in the study of relationships. Theory of Index Numbers - Calculation of Laspeyre's, Paasche's, Fisher's and Chain

index numbers, criteria of a good index number, cost of living index numbers, base shifting, splicing and deflating of index numbers. Introduction to Regression Analysis - Specification of simple linear regression model, least square method of estimation, classical assumptions, general and confidence approach to hypothesis testing.

ECON F214 Economic Environment of Business 3 0 3

Business and Economics, Government and business; market an the role of the Government, market failure, Government and the market, government and the firm, Fiscal policy and the environment, Macroeconomic environment; macroeconomic environment of business, Business activity, employment and inflation, monetary policy and economic environment, balance of payment accounting, Business in the international environment; World trade and international monetary system; international investing; investment decisions in multinational markets; country risk; multinational corporate strategy; multinational treasury management; currency risk; globalization and multinational business, FDI, FII, pricing strategy and business.

ECON F241 Econometric Methods 3 0 3

Business environment and economy, industrial policy, industrial licensing, role of industry in economic development, monetary and fiscal policy, inflation, foreign trade and balance of payment, MRTP, FERA and FEMA Acts, business ethics and corporate governance, IPR, technology issues, liberalization, privatization and disinvestment, globalization, FDI, MNCs, international business environment.

ECON F242 Microeconomics 3 0 3

Consumer behavior under risk, production function and linear programming applications, derivation of cost and supply functions, commodity pricing under imperfect market structures, factor pricing, multimarket equilibrium, optimization over time, welfare optimization, game theory applications.

ECON F243 Macroeconomics 3 0 3

Systems of national accounts; input-output systems; flow of fund systems; monetary circulation and exchange; basic model of income determination; classical macroeconomic models; obstacles of full employment; Keynes model, derivation of IS-LM functions; three sector model; four sector model; inflation and Phillips curve; real business cycles and new Keynesian economics; monetary policy, fiscal stabilization policy; consumption hypothesis; absolute income hypothesis, permanent income hypothesis, life-cycle income hypothesis, relative income hypothesis, investment models; money supply and money demand.

ECON F244 Economics of Growth and Development 3 0 3

Economic growth and development; models of economic growth; harrod domar model, solow model, neoclassical models of economic growth, the Feldman model, Cambridge model of growth,models of technical progress, the problem of economic development; causes of underdevelopment, human development index, theories of economic development, classical and neoclassical theory of economic development, Rostow stages theory, balanced and unbalanced growth, the lewis theory of economic development, Big-push theory, Critical Minimum effort Hypothesis theory.

ECON F266 Study Project 3

Course description is same as given under BIO F266.

ECON F311 International Economics 3 0 3

The international economy; early trade theories; comparative advantage model; neo-classical trade theories; gains from trade; offer curves, terms of trade; Edge-worth box, factor endowments and the Heckscher-Ohlin model; alternative models of trade and intra-industry trade; the imitation-lag hypothesis; product cycle theory; international trade and economic growth; international trade policy; tariff, non-tariff trade barriers, economic integration, international trade and economic development, balance of payment accounting, foreign exchange markets and exchange rates, exchange rate determination, open economy macroeconomics; income and price adjustment mechanisms, adjustment policies, macroeconomic policy in open economy.

ECON F312 Money, Banking and Financial Markets 3 0 3

Overview of the financial system, interest rate and their role in valuation, fluctuation in interest rate, risk and term structure of interest rate, rational expectation and efficient market hypothesis, central banking and the conduct of monetary policy, money supply and credit creation, monetary transmission mechanisms, fundamentals of financial institutions, banking and management of financial institutions, commercial banking industry, risk management in financial institutions, credit risk, analysis of various financial and economic crisis.

ECON F313 Issues in Economic Development 3 0 3

Income and Growth; Facets of Underdevelopment; Structural Features; contemporary models of development and underdevelopment, poverty, inequality and development, population and economic development, urbanization and rural-urban migration, education and health in economic development, environment and economic development, trade and economic development, FDI and economic development, infrastructure and economic development. Sustainable development.

ECON F314 Industrial Economics 3 0 3

Economic analysis of the theory and practice of organization of firms and industries. Nature of competition among firms and their behaviour in various markets, with specific emphasis on imperfectly competitive markets. Tools for empirical and theoretical approaches to the analysis of industries. Issues related to price dis-

crimination, vertical integration, advertising, research and development activities and entry and exit of firms. Government regulation of industries.

ECON F341 Public Finance Theory and Policy 3 0 3

Role of Government in modern economy, Theory of Public good and public choice; public goods and externalities, equity in distribution, Public Expenditure and Macro-economy: Determining optimal size of government, financing of public expenditure, debt versus tax financing, impact of public expenditure on the level and composition of output and employment, Government budget and cost benefit analysis, Taxation; Direct and Indirect taxes, efficiency and equity, tax incidence, models of taxation incidence, theory of optimal taxation, recent developments in theory of taxation, evolution of tax structures, tax evasion and avoidance, designing of modern tax system, reforms in direct and indirect taxes, value added tax, fiscal federalism, designing optimal government expenditure policy; Fiscal Policy Issues: Budget deficit and public debt, interdependence of fiscal and monetary policies, theory of intergovernmental transfers, theory and policy of subsidies, theory of fiscal federalism, issues of equity and efficiency, role of planning and finance commission, goods and services tax in India, new direct tax code, role of central and state FRBMs.

ECON F342 Applied Econometrics 3 0 3

This course provides a introduction to advanced estimation and econometric techniques of analysis, with particular emphasis on how these techniques can be used for the empirical testing of economic theories and/or policy prescriptions. Topics to be studied include specification, estimation, and inference in the context of models that include then extend beyond the standard linear multiple regression framework. Multiple regression analysis; analysis of generalized linear and nonlinear models; instrumental variables; maximum likelihood, generalized method of moments (GMM), and two step estimation methods; simultaneous equation models; time series processes; identification and estimation of time series models; techniques for assessing model fit; forecasting; time series analysis and models of expectations; univariate time series analysis, stationary vs. non-stationary series; ARIMA, GARCH, VAR, cointegration, granger causality, error correction and limited dependent variable models; auto regressive distributed lagged variable models multivariate time series analysis; dynamic models; analysis of panel data, balanced and unbalanced panel data, mixed, fixed and random effect models.

ECON F343 Economic Analysis of Public Policy 3 0 3

This course deals with the contributions of economic analysis to public policy and governance. It focuses on evaluating the rationale for government intervention in the economy and evaluating the efficiency, incentive, and distributional effects of social and economic policies. Introduction to of economic analysis; economic tools in valuing outcomes; measuring outcomes in policies and programme; policy making; the market and the public policy, policy framework and regulation, market and government issues, distribution and policy analysis; applications in tax policies, welfare policies, government policies relating to contracting, health, education, labour and employment, energy policy, competition policy, gender, rural-urban development, food security, climate change, infrastructure policy, financial and trade policy.

ECON F344 Models in Operations Management 3 0 3

Project Management Tools and Techniques, Forecasting Techniques, Quality Management Tools, Facility layout and location models, inventory management, aggregate planning, and scheduling.

ECON F345 Behavioral Economics 3 0 3

Behavioral decision theory; perspective on psychology and economics; heuristics and biases; bounded rationality; classical expected utility model; choice under uncertainty (and certainty); probabilistic judgment; and inter-temporal choice; responses to games; analogous games.

ECON F351 Indian Economic Development 3 0 3

Indian Economic Development; Understanding the Indian Economy, Growth of GDP and Per Capita Income, Planning for the economy; plan models, Five Year Plans, Sectoral Aspects; Regional Variations, Economic Reforms, Monetary Policy, Nationalization of Banks, Financial Sector Reforms; Role of Central Banking in India. External Sector; Growth and structure of India's international trade; Balance of Payments, Import and Export Policies, India ,World Bank and IMF. Agricultural Policy; Land Reform, Agricultural Growth and Productivity, Irrigation; Green Revolution and After, Price Policy; Subsidies; Impact of WTO. Industrial Policy; Industrial Controls and Licensing, Productivity and Growth, Industrial Credit Industrial Sickness-Foreign Investment, Industrial Reforms, Investment, Regional Variations, Impact of WTO, Social Sectors, Health and Education, Poverty and Inequality in India, Human Development Indicators.

ECON F352 Management of Banks and Financial Institutions 3 0 3

Overview Of Banking Industry And Regulations; Critical Analysis Of Bank's Balance Sheet, Cost Of Funds Evaluation Of Bank Performance; Management Of Profit & Loss Accounts Of A Bank; Management Of Non-Interest & Non-Fund Income and Expenses; Assessment & Management of Risks; Interest Rate Risk, Credit Risk, Market Risk, Operational Risk, Liquidity Risk Etc., Basel Accords, Correspondent Banking; Mortgage And Asset-Backed Securities; Securitization, Innovation In Banking.

ECON F353 Energy Economics and Policy 3 0 3

Global Energy and Climate Policy; population and en-

ergy, energy intensity, energy crisis and alternate sources; understanding cost-benefit analysis, life-cycle cost analysis and pricing developments, analysing and managing risks; energy and environment, energy security and governance ; economics of changing role of crude oil, natural gas, coal, nuclear power and renewable power; global energy markets and the challenge of mitigating global climate change. Geopolitical dimensions of energy supply and demand, regulatory approaches to cutting greenhouse gases and building a low-carbon economy; future of energy scenario.

ECON F354 Derivatives and Risk Management 3 0 3

Overview of Financial Markets. Introduction to derivatives. Definition of future, forward, option and swap. Difference between various players of derivative market, their motives and types of position they can hold. Mechanics of future, option & swap markets. Hedging strategies. Option Pricing and understanding of various factors affecting option price. Calculations of Greeks. Introduction to interest rates, yield, term structure and forward rates. Mechanics of Bond Market. Review of concept of compounding and time value of money. Difference between floating rate and fixed income bonds. Price quotes and accrued interest. Pricing of Bonds. Computation of yield. Bond Price volatility. Duration, Modified Duration and convexity. Factors affecting Bond Yields and the Term Structure. Concept of Risk. Perspective of Risk from view point of individuals, companies & financial institutions. Commercial Banks and risks faced by them. Different types of Insurance and risk faced insurance companies. Introduction to various risks: Market Risk, Credit Risk, Operational Risk, Liquidity risk & Model Risk. Concept of Value at Risk.

ECON F355 Business Analysis and Valuation 3 0 3

Course description is same as given under BITS C493.

ECON F356 Strategic Financial Management 3 0 3

Course description is same as given under ECON C436.

ECON F357 Management Control System 3 0 3

The nature of management control system, management control environment; understanding strategies, revenue and expense centers, profit centers, transfer pricing, measuring and controlling assets employed, The management control process; strategic planning, budget preparation, analyzing financial performance, performance measurement, management compensation, Variation in management control; controls for differentiated strategies, service organizations, multinational organizations, management control projects.

ECON F366 Lab Project 3

ECON F367 Lab Project

Course description is same as given under BIO F366 and BIO F367.

ECON F376 Design Project 3

ECON F377 Design Project 3

Course description is same as given under BIO F376 and BIO F377.

ECON F411 Project Appraisal 3 0 3

Course description is same as given under ECON C411.

ECON F412 Security Analysis and Portfolio Management 3 0 3

Course description is same as given under CDP C313.

ECON F413 Financial Engineering 3 0 3

Course description is same as given under EA C475.

ECON F414 Creating and Leading Entrepreneurial Organizations 3 0 3

Fundamentals of entrepreneurship; entrepreneurship development in emerging markets; entrepreneurial leadership; creativity and business ideas; identifying business opportunities; legal aspects of business; entrepreneurship and intellectual property rights; business plans; marketing plan; operation and production plan; venture team and organizational plan; insights from financial statements; issues in raising finance; venture capitalist evaluation of business plans; launching a venture; corporate strategies for growth; people skills, Public issue; revival, exit and end to a venture.

ECON F415 New Venture Creation 3 0 3

Entrepreneurship as career option, idea to opportunity – market analysis and segmentation, presenting a pitch deck, building the startup team, industry and competition analysis, lean startups, product development, protection of intellectual property, sales and marketing, business models, financing options and strategies, launching a business, growth and exit strategy, social entrepreneurship, business plan presentation skills.

ECON F416 Regional Economics 3 0 3

Course description is same as given under ECON C431.

ECON F418 Quantitative Analysis of International Trade 3 0 3

Global trade and empirical facts of International trade, Nature of Globalization process and benefits and costs associated with it, Theory and empirical testing of trade theories, Alternative trade theories and their empirical tests, Gains from trade and the impact of trade on income distribution, Instruments of trade policy and welfare effects, International factor movements and the impact and spillover effects of FDI and portfolio investments, Different forms of Economic integration and their benefits and costs, Technology and growth, International Technology Transfer, Exchange rate and balance of payments, Trade policy simulation using software, WTP Negotiations

ECON F422 Functions and Working of Stock Exchanges 3 0 3

Overview of financial markets and instruments; stock exchanges in India; trading and settlement procedures; listing; risk management; primary markets; debt markets; indices; mutual funds; derivatives; exchange traded funds; corporate governance; SEBI and regulation of the markets; important events in the stock markets; market microstructure; empirical studies on the Indian markets.

ECON F471 Resources and Environmental Economics 3 0 3

Introduction to Environmental Economics; Economy-Environment interaction; Environment vs. Development, Environmental Kuznet's curve, Economics of Exhaustible Resources; Solow-Harwick's Rule; Market structure and optimal extraction policy; Uncertainty and the rate of resource extraction; Resource scarcity, Economics of Renewable Resources ; Economics of Biodiversity, The Theory of Externality and Public Goods ; Concepts; Market Failure; Pigouvian Solution; Buchanan's Theory; Coase's theorem and its critique; Pigouvian vs. Coasian solution; Detrimental externality and non convexities in the production set; Property rights; Collective action, Techniques of Valuation; Physical linkage methods; Abatement cost methods; Behavior linkage methods; Social cost benefit analysis, Environmental impact assessment.

ECON F491 Special Projects 3

Course description is same as given under BIO F491.

ECON G511 Dynamic Modeling and Control of National Economies 5

ECON G521 Modern Cost Engineering 5

Course description for the above courses are to be developed.

ECON G531 Theory of Macroeconomic Policy 5

This course focuses on macroeconomic policy as the major application of the theoretical material and also considers the implications of macroeconomic events for asset price determination, management, decisions, social problems and personal employment and retirement planning.

Topics to be covered are: the foundations of aggregate supply and demand: use of AD-AS model; the business cycle; applications in the areas of asset market, management decisions, social problems, etc.

ECON G541 Economic Systems Analysis 5

Course description is to be developed.

Electrical and Electronics Engineering

EEE C272 Circuits and Signals 3 0 3

Two port parameters; passive network synthesis; modern filter theory; active RC filters; representation of deterministic signals; fourier integral; modulation; sampling; convolution; correlation; DFT & FFT; Z transform; network realization; direct form I & II; cascaded form; parallel form; digital filter design; IIR; FIR & window functions; bilinear transformation; signal coding algorithms; digital signal processors.

EEE C364 Analog Electronics 3 3 4

This course deals with the introduction and applications of various analog and mixed signal ICs. It includes discrete and IC amplifier basics; low and high frequency amplifiers; linear and non linear Op-amp circuits; non linear ICs; precision circuits; comparators; Schmitt triggers; non-sinusoidal and sinusoidal waveform generators; phase-locked-loops; analog switches; IC power amplifiers; RF/IF amplifiers; switched capacitor circuits; data converters; IC sensors and systems. Laboratory and computer simulation experiments in analysis, design and characterization of electronic circuits also form part of the course.

EEE C371 Electromechanical Energy Conversion 3 3 4

Theory; performance; testing; applications and control of d.c. machines; induction machines; synchronous machines and transformers; experiments on testing and control of machines and transformers; fractional hp motors; miniature motors.

EEE C374 Power Systems 3 0 3

Transmission line parameters and calculations, circle diagram; Incidence and network matrices, algorithm for network matrices, load flow studies; optimum generating strategies; load frequency control; insulators, cables; corona. Power system protection-generators, transformers and lines.

EEE C381 Electronic Devices & Integrated Circuits 3 0 3

Single pn junction devices - rectifier diodes, switching diodes, zener diodes, varactor diodes, UJTs, LEDs, etc; bipolar junction transistors - current gain mechanism, high frequency and switching behaviour; pnpn devices; JFET; MOSFET; other MOS & CMOS devices; optoelectronic devices; device fabrication techniques; introduction to ICs; microwave semiconductor devices.

EEE C383 Communication Systems 3 3 4

Principles of modern analog and digital communication with more emphasis on digital communication. Amplitude and angle modulation, sampling, PCM, DM, ADPCM, pulse shaping, digital modulation: FSK, PSK, DPSK, QPSK etc.; information theory, source coding & channel coding, Shannon capacity theorems; emerging trends in communication systems. Experiments in analog and digital communication.

EEE C391 Digital Electronics and Computer Organization **3 3 4**

Course description is same as given under CS C391.

EEE C414 Telecommunication Switching Systems and Networks **3 0 3**

Course description is same as given under CS C414.

EEE C415 Digital Signal Processing **3 0 3**

Introduction; design of analog filters; design of digital filters (IIR and FIR); structures for the realization of digital filters; random signals and random processes; linear estimation and prediction; Wiener filters; DSP processor architecture; DSP algorithms for different applications.

EEE C416 Digital Communication **3 0 3**

Introduction, the modeling and characterization of information sources, algorithms for source coding and encoding of analog output sources; Information transmission through AWGN channels using digital modulation methods and BER estimation; Digital communication through band limited Gaussian noise channels; channel coding and decoding; Wireless communication channels: its characterization and modulation schemes for such channels; emerging trends in the above field.

EEE C417 Computer Based Control Systems **3 0 3**

Prerequisite: AAOC C321 and CS C391 or EEE C391 or INSTR C391

Introduction to process control and Computer based control, elements of computer based control loop, digital sensors and their applications, field buses and specifications, types of digital and intelligent controllers, types of industrial control valves and their selections, PID vs Fuzzy and Neural Techniques of control, programmable logic controllers, SCADA and its applications, distributed control systems comparison between PLC, DCS, Fuzzy. ANN, industrial network hierarchy, industrial standards for networking, application of PLC in power system and process industries.

EEE C422 Modern Control Systems **3 0 3**

State variable characterization of linear continuous - time and discrete - time systems, controllability, observability, stability; sampled data systems; Z transforms; non-linear systems; phase plane and describing function methods; calculus of variations; optimal control.

EEE C423 Combinatorial Mathematics **3 0 3**

Course description is same as given under CS C451.

EEE C424 Microelectronic Circuits **3 0 3**

Basic single and two transistor amplifier configurations; current mirrors & current sources; active loads; biasing in discrete and integrated circuit amplifiers; voltage sources and voltage references; differential and multistage amplifiers; frequency response of amplifiers; frequency compensation; output stages and power amplifiers; filters and tuned amplifiers; signal sources and communication circuits etc, illustrative example of analog integrated circuits. The course will emphasize MOS/CMOS and bipolar transistor circuits. Computer simulation exercises using SPICE and other software packages will be prescribed.

EEE C432 Medical Instrumentation **3 0 3**

Basic components of bio-medical instruments, bioelectric signals & recording electrodes, transducers, recording and display devices. Patient care and monitoring systems, cardiovascular measurements-blood pressure, blood flow, cardiac output, heart sounds etc.; instrumentation for respiratory and nervous systems, analysis of EEG, ECG, EMG, EOG and action potentials, non- invasive diagnostic measurements - temperature, ultrasonic diagnosis, CAT scan techniques, sensory measurements-motor response, analysis of behaviour etc. biotelemetry, biofeedback, clinical laboratory instruments, X-ray diagnosis. Recent advances in biomedical instrumentation- microprocessor based systems, lasers & optical fiber based systems.

EEE C433 Electromagnetic Fields and Waves **3 0 3**

Maxwell's equations; application of circuit theory and field theory; Maxwell's equations in free space and time varying fields; plane waves in dielectric and conducting media; solution of wave equations; the poynting vector; the poynting theorem; poynting vector in conducting media and circuit application; wave polarization; linear, elliptical and circular polarization; wave reflection, refraction and diffraction; transmission lines and resonators; Smith chart, and its applications in stub matching and impedance matching; discontinuties; antennas and radiation; halfwave dipole antenna; loop antenna; helical antenna; directive arrays; frequency independent antennas; reflector and lens antennas; horn antennas; antenna arrays; Friis formula; antenna practices and antenna measurements.

EEE C441 Television Engineering **3 0 3**

Monochrome TV-nature of the composite video signal; camera tubes, generation of special waveforms, transmitters, antenna, receivers, picture tubes, receiving antenna elements of colour TV and industrial TV.

EEE C443 Analog & Digital VLSI Design **3 0 3**

Prerequisite: EEE C424 / ECE C313 / INSTR C313 Microelectronics Circuits

Physics and models of MOS transistors; basic IC building blocks; MOS operational amplifiers; Analog system design applications; Digital circuits - MOS & CMOS inverters, logic gates, PLA and storage circuits, etc.. Introduction to analog and digital VLSI design; CAD for IC design and CAD applications in circuit simulation and layout generation.

EEE C444 Real–Time Systems **3 0 3**

Course description is same as given under CS C444.

EEE C452 Electromagnetic Fields & Microwave Engineering **3 0 3**

Electromagnetic waves; Maxwell's equations; Poynting theorem and wave equations; propagation of EM waves; transmission lines; microstrip lines; wave guides; cavities and antennas; microwave generators, microwave amplifiers; measurement at microwave frequencies.

EEE C453 Discrete Mathematical Structures **3 0 3**

Course description is same as given under CS C453.

EEE C461 Power Electronics **3 0 3**

PNPN devices, power transistor characteristics, rating and specifications; triggering mechanism and commutation circuits; controlled power rectifiers, Inverters (DC to AC converters), choppers (DC to DC Converters); speed control of DC motors, speed control of AC motors; other industrial applications of thyristors and power transistors; voltage regulation and starting of electrical drives; logic modules for static converters; introduction to application of microprocessors for electrical drives.

EEE C462 Advanced Power Systems **3 0 3**

Prerequisite: EEE C371 or INSTR C371

Symmetrical components, sequence impedances; fault calculations; short circuit studies; circuit breakers and their selections; power system stability, power system protection--generators, transformers and lines; waves on transmission lines, protective devices -- grounded and ungrounded systems.

EEE C471 Electronic Measurements and Instrumentation **3 0 3**

Elements of electronic measurement and instrumentation; signal sources; voltage and current measuring instruments; waveform analysis instruments; display and recording instruments; device testers, DC power supplies and IC regulators; bridge instruments; basic digital instruments, industrial electronic practices.

EEE C472 Satellite Communication **3 0 3**

Review of microwave communications and LOS systems; the various satellite orbits like GEO, MEO, LEO; the satellite link analysis and design; the communication transponder system like INSAT, INELSAT etc; the earth segment and earth station engineering; the transmission of analog and digital signals through satellite and various modulation techniques employed; the multiple access techniques like FDMA, TDMA, CDMA, DAMA, etc; the INSAT program; salient features of INSAT – systems and services offered; satellite services offered by INTELSAT, INMARSAT and future satellites like IRIDIUM etc; future trends in satellite communications.

EEE C491 Special Projects **3**

Course description is same as given under BIO C491.

EEE F111 Electrical Sciences **3 0 3**

Course covers basic passive circuit elements, dependent and independent sources, network theorems, circuit analysis techniques and response of first and second order circuits. Introduction to three - phase circuits, magnetic circuits, transformers, basics of rotating machines. Semiconductors - operation of diodes, zener diodes, bipolar junction transistors and field effect transistors. Biasing techniques and applications of diodes and transistors. Introduction to operational amplifiers and applications. Introduction to Digital Electronics.

EEE F211 Electrical Machines **3 1 4**

Transformer: Constructional features, equivalent circuit and phasor diagram - regulation and efficiency, parallel operation. Three phase transformer connections; Harmonic in transformers; Testing; Phase conversion; Autotransformer. D.C Machines: Construction, armature windings, armature voltage and torque equations, classification. D.C generators, performance characteristics; D.C motors - torque/speed characteristics, speed control and braking. Testing and efficiency. Induction machines: Constructional features and rotating magnetic field. Circuit model and phasor diagram.

Steady state characteristics. Testing, starting and speed control. Time harmonics and space harmonics. Wound rotor induction motors, Single phase induction motors - classification and equivalent circuit. Synchronous machines: Constructional features; synchronous generators and motors; equivalent circuit and phasor diagram; power and torque characteristics and capability curves. Parallel operation. Salient pole synchronous machine - phasor diagram and determination of synchronous reactances; starting and speed control of synchronous motors. Special machines- universal motors, Induction generators.

EEE F212 Electromagnetic Theory **3 0 3**

Course description is same as given under PHY F212 Electromagnetic Theory I.

EEE F214 Electronic Devices **3 0 3**

Crystal structure and growth of semiconductor, electrical conduction in solids, Elementary quantum physics (Photoelectric effect, uncertainty principle, Schrodinger wave equation and tunneling), energy bands in solids, charge carriers in semiconductors, excess carriers in semiconductors, Fabrication of p-n junctions, equilibrium conditions, forward and reverse biased junctions, metal-semiconductor junctions Bipolar junction transistors, field effect transistors (JFET, HEMT, MOSFET), Special diodes (varactor diode, solar cell, LEDs, Tunnel diode and HBT), dielectric materials and insulation (Polarization mechanisms, frequency dependence, dielectric strength and insulation breakdown).

EEE F215 Digital Design **3 1 4**

Boolean Algebra & logic minimization; combinational logic circuits : arithmetic circuit design , Design using MSI components; Sequential Logic Circuits : flip flops & latches, registers and counters, Finite state machine ; HDL Implementation of Digital circuits; Digital Integrated Circuits ; Programmable logic devices; Memory organization ; Algorithmic State machine; Introduction to computer organization; The course will also have laboratory component on digital design.

EEE F241 Microprocessors and Interfacing **3 1 4**

Programmers model of processor, processor architecture; Instruction set, modular assembly programming using subroutines, macros etc.; Timing diagrams ; Concept of interrupts: hardware & software interrupts, Interrupt handling techniques, Interrupt controllers; Types of Memory & memory interfacing; Programmable Peripheral devices and I/O Interfacing ; DMA controller and its interfacing: Design of processor based system. This course will have laboratory component.

EEE F242 Control Systems **3 0 3**

Modeling and classification of dynamical systems, Properties and advantages of feedback systems, time-domain analysis, frequency-domain analysis, stability and performance analysis, State space analysis, controller design.

EEE F243 Signals & Systems **3 0 3**

This course is intended to provide a comprehensive coverage of Signals and Systems, a fundamental subject of Electrical Engineering. The topics covered are: Continuous-time and discrete time signals and systems, convolution, properties of linear time-invariant (LTI) systems, Fourier series, Fourier transform, Z transform, Laplace transform; System analysis, frequency response, analog filters, Sampling and reconstruction.

EEE F244 Microelectronic Circuits **3 0 3**

Basic microelectronic circuit analysis and design, biasing in discrete and integrated circuit amplifiers, an overview of modeling of microelectronic devices single and two transistor amplifier configurations with passive and active loads; current mirrors & current sources; single-ended and differential linear amplifiers , differential and multistage amplifiers; 2 stage CMOS OPAMP, frequency response of amplifiers; negative feedback in amplifiers, R-C frequency compensation.

EEE F245 Control System Laboratory **0 1 1**

Experiments and simulations on concepts related to conventional and advanced control systems.

Prerequisite:

EEE/ECE/INSTR F242 Control Systems

EEE F246 Electrical and Electronic Circuits Laboratory **0 2 2**

Experiments in Electrical sciences, Electronic devices, motors, transformer windings, machine windings, electronic circuits and signals, systems etc.

Prerequisites:

EEE/ECE/INSTR F243 Signals and Systems and

EEE/ECE/INSTR F244 Microelectronic Circuits

EEE F266 Study Project **3**

Course description is same as given under BIO F266.

EEE F311 Communication Systems **3 1 4**

Analysis and design of communication systems; analog and digital modulation and demodulation, frequency conversion, multiplexing, noise and distortion; spectral and signal-to-noise ratio analysis, probability of error in digital systems, spread spectrum.Introduction to the basic principles of the design and analysis of modern digital communication systems. Topics include source coding, channel coding, baseband and passband modulation techniques, receiver design, and channel equalization.

EEE F312 Power Systems **3 0 3**

Review and importance of power system, Present power system scenario, Transmission line parameters and modeling, Characteristics and performance of lines, Load flow studies, Optimal system operation, Automatic Generation and voltage Control, Power system fault analysis, Power Systems stability, Introduction of power system protection, Introduction of HVDC Transmission.

EEE F313 Analog & Digital VLSI Design **3 0 3**

Moore's Law, Y chart, MOS device models including Deep Sub-Micron effects; an overview of fabrication of CMOS circuits, parasitic capacitances, MOS scaling techniques, latch up, matching issues, common centroid geometries in layout. Digital circuit design styles for logic, arithmetic and sequential blocks design; device sizing using logical effort; timing issues (clock skew and jitter) and clock distribution techniques; estimation and minimization of energy consumption; Power delay trade-off, interconnect modelling; memory architectures, memory circuits design, sense amplifiers; an overview of testing of integrated circuits. Basic and cascaded NMOS/PMOS/CMOS gain stages, Differential amplifier and advanced OPAMP design , matching of devices, mismatch analysis, CMRR, PSRR and slew rate issues, offset voltage , advanced current mirrors; current and voltage references design, common mode feedback circuits, Frequency response, stabilty and noise issues in amplifiers; frequency compensation techniques.

EEE F341 Analog Electronics **3 1 4**

Introduction to operational amplifiers: The difference amplifier and the ideal operational amplifier models, concept of negative feedback and virtual short; Analysis of simple operational amplifier circuits; Effects of real operational amplifier parameters on circuit

performance . Linear applications of operational amplifiers: Instrumentation and Isolation amplifiers; Current and voltage sources; Active filters. Non-linear applications of operational amplifiers: Comparators,; Linearization amplifiers; Logarithmic amplifiers, multifunction modules & circuits, true rms convertors, Precision and signal conditioning circuits, Waveform Generation: sinusoidal and non-sinusoidal signal generation; Wave shape converters. Timer 555 based circuits, Phase lock loop circuits & applications, IC regulators, Output stage and large signal amplifiers, Power amplifiers, Tuned amplifiers, Analog and Digital interface circuits: A/D, D/A Converters.

EEE F342 Power Electronics 3 1 4

Need for power conversion; Power electronic converters: classifications and scope; Power semiconductor switches: diodes, SCR , GTO and transistors (BJT, MOSFET and IGBT): Ratings, static and dynamic characteristics, drive and switching aid circuits and cooling; DC to DC conversion: Buck, Boost and Buck-Boost converters: circuit configuration and analysis with different kinds of loads; Choppers: single quadrant and two quadrant operation with DC motor load and steady state analysis; Rectifiers: single phase and three phase operation, power factor, harmonics and effect of source inductance; Dual converters; Drive concept: Four quadrant drive and load characteristics, selection of motor, control and stability of electric drives, feed back control of drives; DC motor drive; Inverters: single phase and three phase bridge inverters and PWM inverters; Single phase AC voltage regulators and cycloconverter; Induction motor drive - Variable frequency operation of 3-phase induction motor, stator voltage control and V/f control methods; Non-drive application of power electronic converters: UPS, active power line conditioner, electronic ballast and induction.

EEE F345 Power Apparatus & Networks 3 0 3

Course description is same as given under EA C476.

EEE F346 Data Communication Networks 2 0 2

Communication Concepts; Data and Voice Communications; Hardware Systems and Configurations; Network Topologies and Design Aspects; Protocols; Networking Software; Local Area Networks; Network Security and Management; Emerging Trends in Communications.

EEE F347 Communication Networks Laboratory 0 2 2

Experiments on analytical studies of communication networks through network simulation, analysis of network performance, LANs, Cellular or Satellite networks, Wireless Adhoc or Sensor Networks, Wi-Fi and WIMAX networks, information theory and coding etc.

EEE F348 FPGA Based System Design Laboratory 0 2 2

Introduction to Field Programmable Gate Arrays, Overview of FPGA design tools, Implementation of Data Flow Graph in FPGA, Analysis of performance tradeoffs (Pipelining, Retiming, Unfolding), Bus protocols (SPI, I2C), FPGA based DSP System Design , ADC/DAC interface, Real time signal processing system design.

Prerequisites:

EEE/INSTR F215 DIGITAL DESIGN and EEE/INSTR F243 SIGNALS & SYSTEM

EEE F366 Lab Project 3

EEE F367 Lab Project 3

Course description is same as given under BIO F366 and BIO F367.

EEE F376 Design Project 3

EEE F377 Design Project 3

Course description is same as given under BIO F376 and BIO F377.

EEE F414 Telecommunication Switching Systems & Networks 3 0 3

Course description is same as given under CS C414.

EEE F416 Digital Communication 3 0 3

Course description is same as given under EEE C416.

EEE F417 Computer Based Control Systems 3 0 3

Prerequisite: AAOC C321 and CS C391 or EEE C391 or INSTR C391

Introduction to process control and Computer based control, elements of computer based control loop, digital sensors and their applications, field buses and specifications, types of digital and intelligent controllers, types of industrial control valves and their selections, PID vs Fuzzy and Neural Techniques of control, programmable logic controllers, SCADA and its applications, distributed ontrol systems comparison between PLC, DCS, Fuzzy. ANN, industrial network hierarchy, industrial standards for networking, application of PLC in power system and process industries.

EEE F418 Modern Communication Technologies 3 0 3

Course description is same as given under ECE C392.

EEE F422 Modern Control Systems 3 0 3

Course description is same as given under EEE C422.

EEE F425 Power System Analysis and Control 3 0 3

Course description is to be developed.

EEE F426 Fiber Optics & Optoelectronics 3 0 3

Course description is same as given under EA C422.

EEE F427 Electric Power Utilization and Illumination 3 0 3

Introduction to industrial utilization of electric power, types of drives, its characteristics, insulation materials

used, Industrial applications such as electric heating, welding etc.., traction systems, DC and AC systems of railway electrification, Train movement and factors effecting Energy Consumption, Speed-time curve, Tractive effort, Power of traction motors. Braking systems, Regenerative braking, Mechanical braking, control equipments. Illumination, laws of illumination, lighting calculation, interior and exterior illumination systems, design of various lighting schemes, types of lamps, high or low pressure lamps and discharge tubes.

EEE F431 Mobile Telecommunication Networks 3 0 3

Course description is same as given under EA C452.

EEE F432 Medical Instrumentation 3 0 3

Course description is same as given under EEE C432.

EEE F433 Electromagnetic Fields & Waves 3 0 3

Course description is same as given under EEE C433.

EEE F434 Digital Signal Processing 3 1 4

Course description is same as given under EEE C415.

EEE F435 Digital Image Processing 3 0 3

Introduction to multidimensional signal processing-- 2-D convolution and filtering, discrete-time Fourier , filter design 2-D sampling and reconstruction transform, human visual system, Brightness perception , Temporal properties of vision, 2-D Block transforms-- Walsh-Hadamard, Karhunen Loeve, Discrete Hartley, Filter Banks and Wavelets etc. , Image Compression , Image Enhancement , Medical Image Processing , 3D techniques.

EEE F472 Satellite Communication 3 0 3

Course description is same as given under EEE C472.

EEE F473 Wind Electrical Systems 3 0 3

Thermodynamics of wind energy, Types of Wind energy conversion devices, Aerodynamics of wind rotors, design of wind turbine rotor, Power -speed characteristics, torque-speed characteristics, Wind turbine control systems, Wind speed measurements , Wind speed statistics, Site and turbine selection, Induction Generators, Wound field synchronous Generator, Permanent Magnet synchronous machine, Doubly fed induction generator, Power Flow equations, Power Semiconductor devices, Converters, Inverters, power quality, Reactive power compensation, Wind diesel hybrid systems, Wind photovoltaic systems, Role of Govt. and policies for market development.

EEE F474 Antenna Theory and Design 3 1 4

Introduction into antenna theory and practice, Radiation integrals and auxiliary potential functions; basic EM theorems in antenna problems, Antenna characteristics, Infinitesimal dipole; wire and loop radiating elements, Wire antennas – dipoles, monopoles, Arrays – analysis and design, Reflector antennas, Broadband antennas, Micro-strip patch antennas , Smith Chart Review in line with antenna theory and Design , Antenna measurements, Antenna design using commercial software, study of radiation pattern of various antennas.

EEE F475 Special Electrical Machines 3 1 4

Construction, principle of operation and performance of synchronous reluctance motors, stepping motors, switched reluctance motors, permanent magnet brushless D.C. motors, permanent magnet synchronous motors.

EEE F476 Switchgear and Protection 3 1 4

Working applications of various switchgears and protective elements. Switches and fuses, Elementary principles of Circuit Breakers, Description and Operation of different types of circuit breakers, Electromagnetic and Static Relays, operation, construction and characteristics, Generator Protection, Transformer Protection, Feeder and Bus-Bar Protection, Neutral Grounding, Protection against over voltages.

EEE F477 Modeling of Field-Effect NanoDevices 3 0 3

Physical principles and MOS transistor phenomena, developing models including effective mobility, temperatures effects, and source/drain resistances. small-dimensional effects, impact ionization, velocity saturation drain-induced barrier lowering (DIBL), ballistic operation, polysilicon depletion, quantum effects, gate-tunneling currents, gate-induced drain leakage (GIDL) , fundamentals of low-power (low-voltage) CMOS design issues; the threshold voltage shift (due to SCE) , increased leakage power, sources of power , SOI MOS, (PDSOI, FDSOI) , multigate (MG) MOSFET, electrostatic integrity and short channel control, quantum mechanical origin, basics of BSIM CMG, compact models for multigate MOSFETs , mobility in multiple gate devices, improvement of the mobility ,crystallographic orientations, strained Si channels.

EEE F478 Power Systems Laboratory 0 2 2

Experiments on relays, circuit breakers, transmission lines, switch gear and protection , energy generation methods, and application of artificial intelligence techniques, electric energy utilization including illumination, electrical drives etc.

Prerequisite:

EEE F312 Power Systems

EEE F491 Special Projects 3

Course description is same as given under BIO F491.

EEE G510 RF Microelectronics 5

Introduction; application of RF electronics in modern systems; basic concepts in RF circuit design, active RF components: various RF diodes and transistors

and their circuit models, matching and biasing networks, RF amplifier design: low power, low noise and broadband amplifiers, RF oscillator design; negative resistance oscillator; dielectric resonator oscillators, phase noise. RF Mixers: Balanced mixers; low noise mixers; noise in RF circuits, microwave transmitters and receivers.

EEE G511 Integrated Electronics 3 2 5

Review of basic semiconductor devices and ICs, fabrication and design of integrated circuits, comparison of current bipolar and MOS technologies, VLSI design methodology and layout examples, etc. The main objective of this course is to enable the students to keep pace with the rapidly changing semiconductor technology.

EEE G512 Embedded System Design 3 1 4

Introduction to embedded systems; embedded architectures: Architectures and programming of microcontrollers and DSPs. Embedded applications and technologies; power issues in system design; introduction to software and hardware co-design.

EEE G520 Wireless and Mobile Communication 3 2 5

Signal propagation in a mobile environment, modulation, coding, equalization; first generation generation systems; multiple access techniques like FDMA, TDMA, CDMA, spread spectrum systems; second & third generation systems, UMTS, IMT-2000; Wireless LAN, Wireless ATM and Mobile IP; emerging trends in Wireless & Mobile Communication.

EEE G521 Optoelectronic Devices, Circuits & Systems 3 2 5

Physics of optical radiation and principles of calculation in radiation physics & optics, fundamental laws of photometry. Interaction between optical radiation and matter. Radiation sources. Parameters of IR detectors and junction photodetectors, parameters common to emitters and receiver, radiation measurements, optoelectronic components, optoelectronic integrated devices, photodetector circuits, methods of modulation and optoelectronic system design and applications.

EEE G522 Advanced Satellite Communication 5*

Radio wave propagation effects, low, medium and geo-synchronous earth orbits and their main characteristics. Various sub-systems of the satellite , the outer space and its impact on the design of spacecraft subsystems, LEO satellite network and its routing calls; Battery technology , propagation loss models, modulation and error correction techniques, Digital Video Applications, Satellite Mobile including NGEO, satellite access techniques, third generation satellite communication, remote sensing, bandwidth utilization and throughput capability, the Indian National Satellite System (INSAT), INTELSAT and other international satellite programs, VSAT, Mobile and Personal Satellite communication, principles of Global Positioning System (GPS), GPS receivers and its applications, regulatory and interference issues. Study and design of uplink transmitter, down link receiver, spacecraft transponder, satellite communication links.

EEE G531 Testable Design and Fault Tolerant Computing 3 2 5

Course description is same as given under CS G531.

EEE G541 Distribution Apparatus and Configurations 3 2 5

Basic configuration of a distribution set-up at the consumer end. Transformer types, specifications, performance, protection, and sizing. Types of cables and insulation, cable parameters, ampacity and protection. Ratings of LV switchgear and their use in selection, switching transients and clearing time. Properties of fuses with reference to ampacity. Meters, instrument transformers, and their application. Voltage control at distribution levels. Elementary concepts of power quality: power factor, frequency, and harmonic content.

EEE G542 Power Electronic Converters 3 2 5

The importance of the converter as an interface between source and load. DC-DC converters: Buck, boost, and buck-boost configurations. AC-DC converters: Diode and thyristor converters in single and three phase. Inversion in thyristorised converters and applications of line commutated inverters. DC-AC converters: Switch mode voltage source inverters in single and three phase, PWM operation of different types, VSI's operating in multi-levels, space vector modulation techniques. AC-AC converters: Thyristor fed AC loads, the cycloconverter. Matrix converter arrays and their operation as DC-DC and DC-AC converters.

EEE G543 Power Device Microelectronics and Selection 3 0 3

Thermal features of power device packaging, the issues of $R_{\theta JC}$ and $R_{\theta CS}$, heat flow and effect on device temperature, heat sink design and selection. The two-layer junction behaviour, the concept of drift region, characterisation of power diodes. The base operation in a thick film BJT, steady state characteristics, turn ON and turn OFF times, the multistage power Darlington. The four-layer junction behaviour, two transistor model of a thyristor, dynamic model for a four layer junction device. GTO thyristors, the turn OFF mechanism in four layer junction devices, current technological problems. MOS operation and characteristics, characterisation and structure of the power MOSFET. Development of the MOSFET to IGBT, technological advantages, characterisation, and dynamic behaviour. Current technological problems in insulated gate technologies. Introduction to matrix converters.

EEE G544 Steady State and Dynamics of Electric Motors 3 2 5

Direct current machines, dynamic characteristics of PM and shunt DC motors. The Reference Frame theory, balanced steady state phasor relations and voltage equations. Symmetrical induction machines: commonly used reference frames and per-unit system, analysis of steady state and dynamic operation and free acceleration characteristics from different reference frames. Synchronous machines: equations in different reference frames, per-unit system, steady state analysis, dynamic analysis for load changes and faults. Brushless DC machines: voltage and torque equations in machine variables, and rotor reference frame variables, analysis of steady state and dynamic performance. Operational impedances and time constants for synchronous machines. Linearised machine equations, and reduced order machine equations. Symmetrical and asymmetrical two-phase induction machines: conversion to stationary reference frame, analysis of steady state operation of the asymmetrical machine, single phase induction machine.

EEE G545 Control and Instrumentation for Power Electronic Systems 3 0 3

The regulation and control problem with reference to power electronic converters. Converter models for feedback: basic converter dynamics, fast switching, piece-wise linear models, discrete-time models. Voltage mode and current mode controls for DC-DC converters, comparator based control for rectifier systems, proportional and proportional-integral control applications. Control design based on linearisation: transfer functions, compensation and filtering, compensated feedback control systems. Hysteresis control basics, and application to DC-DC converters and inverters. General boundary control: behaviour near a boundary, and choice of suitable boundaries. Basic ideas of fuzzy control techniques, and performance issues. Sensors for power electronic circuits, speed and torque transducers.

EEE G546 Systems Simulation Lab. 4

Simulation tutorial problems on single- and three-phase AC-DC converters, DC-DC buck-, boost-, and buck-boost converters, DC-AC inverters in single and three phase with different levels of control complexity. Simulation of practical applications from utility and drives. May also include a small project.

EEE G547 Device Drivers 3 2 5

Introduction to operating system, Introduction to Linux Basics, commands, file system , kernel and introduction to Android, Process Synchronization ,Semaphores, Message Passing, Mailboxes and debugging, Module programming/ Shell programming / Character Device Driver, Timing and Interrupts--, Device Driver Programming as applicable to Linux/ Android/ Windows, Parallel/ Serial Port Driver/ Block /USB /NETWORK/ PCI/ Drivers, tty Subsystem

Prerequisite: EEE G512 Embedded system design

EEE G552 Solid State Drives 3 2 5

Introduction to the drive system: requirements, components and benchmarks; Review of motor theory; Power electronic control of motors: requirements and operational issues; Static speed control of induction motors: the AC power controller, slip energy recovery, VSI and CSI controlled induction motors; Speed control of synchronous motors and associated machines; The problem of DC motor speed control: rectifier and chopper controllers; Advanced induction motor drive control: vector control, current modulation, importance of microcontroller based systems; Organisation of microcontrollers: sensing and actuation of signals, interrupt handling and timing, priority of tasks in a microcontrolled drive system.

EEE G553 Utility Applications of Power Electronics 3 0 3

Static excitation systems: converters as used in SES, control and the IEEE types, enhancement of stability. HVDC transmission: configurations of line-commutated converters, constant current and constant extinction angle control at device terminal level, individual phase and equidistant pulse firing control at device level, active and reactive power considerations. FACTS: impedance type and inverter type FACTS devices, the static var compensator, the thyristor controlled series reactor, the STATCOM and its developments in the form of UPFC and SSSC. Active filters: the power quality problems at distribution level, inverter control by transient p-q theory, configuration of active filters and their control, existing bottlenecks.

EEE G554 Soft Switching Converter Technologies 3 0 3

Series, parallel, series-parallel resonant DC-DC converters, half and full bridge topologies, analysis and design. Sinusoidal analysis of resonant converters, soft switching, load resonant properties, exact characteristics. Soft switching mechanisms of semiconductor devices, zero current and zero voltage switching quasi resonant converters, resonant switch topologies, soft switching in PWM converters and inverters, multi resonant converters, control of resonant and soft switching converters, EMI suppression, snubbers, load resonant converters, passive components at high frequencies.

EEE G555 Transformer and Motor Design 3 0 3

Course description for the above course is to be developed.

EEE G556 DSP Based Control of Electric Drives 3 0 3

State space and transfer matrix representations, representation of nonlinear systems by update of parameters, output feedback and state feedback control, basic notion of state estimation. Sampling of signals, discrete representation of signals, *z*-transforms. Nature of discrete time poles and zeros. A/D and D/A converters as system elements. FIR and IIR behaviour, noise and its nature. AR, MA, and ARMA models of systems. The Fourier transform and what it conveys. Processing requirements of a DSP, floating point DSP's: the TMS320C3x family. Memory organisation, interrupt systems, and I/O interface with the TMS320C3x family. The TMS320C31 as an embedded controller, drive control features. Applica tions in vector and direct torque control of synchronous motors, vector and direct torque control of induction motors, torque control of SRM's.

EEE G557 Drives for Electronic Transaction 3 0 3

Course description is to be developed.

EEE G558 DSP Based Implementation Drivers 3 0 3

Course description is to be developed.

EEE G559 Advanced Power Electronics 5

Qualitative, Quantitative, and Simulation studies of Power electronic circuits like AC to DC, DC to DC, DC to AC and AC to AC converter circuits for their theory, performance, design, testing and applications. Use of these circuits for industrial, motor control, FACTS, HVDC, PF improvement and energy conservation applications.

EEE G581 RF & Microwave Engineering 3 2 5

Introduction to radio frequency engineering; advantages; various frequency bands; propagation; transmission lines; microwave waveguides and components; their characterizations; s-parameters and their use; microwave transistor; FETs, Gunn diode, IMPATT diodes; microwave tubes; Klystron; two cavity Klystron amplifier analysis; reflex Klystron; TWTs; high power tubes; cross field tubes; microstriplines; MMICs; microwave measurements; microwave antennas and microwave communication system; microwave applications; ISM applications; introduction to EMI and EMC; microwave hazards.

EEE G582 Telecom Network Management 5

Network architecture and protocols; LAN, MAN and WANs; internetworking; network planning; network management concepts and standards; administrative, operational and fault management; security issues; remote network management.

EEE G591 Optical Communication 3 2 5

Optical communication systems and components; optical sources and transmitters (basic concept, design and applications); modulators (electro-optic, acousto-optic and laser modulation techniques); beam forming; focussing and coupling schemes to optical repeators; optical amlifiers; optical field reception; coherent and non-coherent lightwave systems; fibre optic communication system design and performance; multichannel lightwave systems; long haul communications; fibre optic networks.

EEE G592 Mobile & Personal Communication 3 2 5

History of mobile radio; the mobile radio signal environment; review of statistical techniques; pathover flat as well as hilly terrain; effects of RF system design on propagation; received signal envelope and phase characteristics; modulation schemes employed; functional design of mobile radio systems, diversity schemes-space; frequency and polarization diversity; mobile radio system functional design; signal error analysis versus performance criteria; multiple access schemes; classification of the concepts of sensitive topics; new concepts data transmission via cellular; spectrum and technology of WLL.

EEE G593 Power Quality 5

Power Quality Introduction and terms and definitions, Voltage sags and interruptions, Transient Over Voltages, Fundamentals of harmonics, Harmonic Solutions, Long duration voltage variations, Distributed generation and power quality, Wiring and grounding, Power quality monitoring.

EEE G594 Advanced VLSI Devices 5

Device physics of and engineering of advanced transistors, review of metal oxide semiconductor (MOS) with quasi-ballistic and ballistic transport, Short-channel effects (SCEs) in nanometer regime, scaled MOSFETs, Device physics and engineering of sub-100nm MOSFETs , Limits of the state-of-the-art silicon device technology, issues in the miniaturization, Alternative device structures ,non-conventional MOSFETs, and transport in novel nanodevices. Analytical expression (supported by TCAD simulation) for the one-dimensional transport and interpretation of novel device characteristics.

EEE G595 Nanoelectronics and Nanophotonics Technology 5

Semiconductor Fundamentals, Band Theory, Quantum Structures and Quantum Mechanics, Transport in Quantum Structures, Optical Properties of Semiconductor Quantum Structures, Strain Engineering, Electro- Optic Effects, Photonic / electronic Devices based on Nano structures.

EEE G611 Computer Aided Analysis and Design 3 2 5

Course description is same as given under CE G611.

EEE G612 Coding Theory & Practice 3 2 5

Codes for data-compression: instantaneous codes; Kraft inequality; Mcmillan theorem; Huffman codes;

codes for error-detection and correction; binary symmetric channel; channel capacity, Shannon's fundamental theorem; linear codes; Macwilliam's identity; Reed-muller codes; cyclic codes; BCH codes; codes for secrecy and security; private-key cryptosystems; affine codes; twisted codes; one-time-pads; public-key cryptosystems based on large primes and discrete logarithms.

EEE G613 Advanced Digital Signal Processing 5

Review of stochastic processes, models and model classification, the identification problem, some field of applications, classical methods of identification of impulse response and transfer function models, model learning techniques, linear least square estimator, minimum variance algorithm, stochastic approximation method and maximum likelihood method, simultaneous state and parameter estimation of extended kalman-filter, non-linear identification, quasi linearization, numerical identification methods.

EEE G621 Advanced Electronic Circuits 3 2 5

Linear and non-linear operational circuitry, controlled sources, Active filters, power amplifiers, Power supplies, Analog switches and comparators, combinational and sequential logic circuitry. Data transmission and display, Electronic Controllers, Transducer interfacing and measurement circuits, etc.

EEE G622 Advanced Digital Communication 3 2 5

Introduction to Digital communication, review of probability and statistic processes; review of source coding and characterization of signals; optimum receivers for additive white gaussian noise channel; carrier & symbol synchronization; channel capacity & coding; block & convolutional codes; communication through band – limited linear filter channels; adaptive equalization multicarrier systems; digital communication through fading multipath channel; future trends in digital communication.

EEE G625 Safety Critical Embedded Systems Design 4

Course description is same as given under HTSL ZG631.

EEE G626 Hardware Software Co-Design 4

Course description is same as given under HTSL ZG641.

EEE G627 Network Embedded Applications 3 1 4

This course deals with the three main application areas of Network Embedded Systems – Wireless Sensor Networks, Automotive Networks, and Industrial Networks– Network Architecture , Deployment Issues, Network Protocol stack: Modular and Cross Layer Design. Network Node: Architectures, Operating System and Applications. Middleware Issues and Design. Security and Encryption

Engineering

ENGG C111 Electrical and Electronics Technology 3 0 3

Electric circuit, electromagnetism, magnetic circuit, electrostatics, AC voltage and current, single phase circuits, semiconductor devices, amplifiers, digital systems, microprocessors, DC machines, polyphase circuits, transformers, synchronous machines, induction motors, power electronics, measurements, illumination.

ENGG C212 Introduction to Systems 3 0 3

Systems approach; systems concepts; general systems theory; fuzzy sets; systems planning and control; block diagrams; signal flow graphs; graph theory; systems methodology-measurement and evaluation, model building, suboptimisation, implementation; Forrester's systems dynamics; decision making conflict resolution; management information theory. Development of the above concepts will be taken through various cases reflecting social problems, e.g., education, ecology, energy facility, location, integrated area development, etc.

ENGG C232 Engineering Materials 3 0 3

Mechanical, electrical, electronic and chemical properties and applications of common engineering materials; ferrous and non- ferrous metals and alloys; thermosetting and thermoplastic plastics; natural and synthetic resins; rubber; glass; abrasives and ceramics; common building materials, namely, timber, stone, lime and cement; corrosion of metals and methods of preventing corrosion; protective and decorative coatings; insulating materials; testing of materials.

ENGG C241 Mechanical Technology 3 0 3

Fundamental concepts of heat, work and energy; second law of thermodynamics; properties of gases and vapours; basic cycles; flow of liquids; steam boilers; steam engines and pumps; steam turbines and condensers; hydraulic pumps and turbines; internal combustion engine.

ENGG C242 Maintenance and Safety 3 0 3

Objectives, functions, and types of maintenance; defects due to wear; lubrication and surfacing techniques to reduce wear; maintenance of different equipments and their elements; spares planning; overhauling; TPM; safety and safety management; environmental safety; chemical safety; occupational health management; control of major industrial hazards; managing emergencies; employee participation in safety; HRD for maintenance and safety.

ENGG C264 Fluid and Solid Mechanics 3 0 3

Fluid; fluid properties; fundamental laws; flow of fluid through orifices, notches, and weirs; flow through pipes and channels; mechanical properties of materials; stress; strain; elasticity; bending moment and

shear force; bending stresses; shearing stresses; deflection of beams; columns and struts; torsion.

ENGG C272 Process Technology **3 0 3**

Manufacturing process of acids, chlor-alkali, fertilizers, coal, chemicals, pulp and paper, polymers, petroleum and extractive metallurgy; waste management.

ENGG C282 Industrial Engineering Techniques **3 0 3**

Industrial systems and organization; engineering economy; work measurement techniques; motivation and time studies; factory planning and materials handling; industrial standardization; critical path methods; quality assurance and statistical quality control; reliability; maintenance and management planning; scheduling; job analysis (evaluation); value engineering.

ENGG C291 Electronics and Instrumentation Technology **3 0 3**

Binary logic gates, logic circuits, Boolean algebra and K-map simplification, number systems and codes, arithmatic logic units, flipflops, registers and counters; introduction to microprocessors, architecture, instruction set and programming, memory and I/O interface devices, examples of digital system design.

English

ENGL C121 English Language Skills I **2 1 3**

ENGL C122 English Language Skills II **2 1 3**

The above two unstructured courses are designed to raise progressively the level of proficiency of the normal input to a stage where they can embark on English language and literature. They are intended to develop the language skills of listening, speaking, reading and writing. No student will be permitted to register in more than one course at a time. The presentation of the skills courses in the present break-up is not intended to indicate any sequence. It simply indicates the total number of units and the related number of hours spent in the course through formal contact or self-study only. Thus a student can begin at any one of the courses with the requirement that for the normal input only one (or two) of these courses would be needed. From the description presented above it would be clear that students may register in any one (or both) of these courses with the proviso that registration can be done in only one course per semester.

ENGL C123 English Language Skills **3 0 3**

Sounds of English; word structure; word order and effective sentences; listening comprehension; vocabulary extension; phrasal verbs; paragraph writing; reading comprehension; précis writing, letter writing; dicto composition; writing research papers; writing book reviews.

ENGL C221 Readings from Popular Science Writings **3 0 3**

JBS Haldane, Julian Huxley, J. Bronowski, George Gamow, Issac Asimov, Alan Issacs.

ENGL C222 Readings from Drama **3 0 3**

Oliver Goldsmith, John Galsworthy, T.S. Eliot, John Osborne.

ENGL C231 Readings from Prose and Poetry **3 0 3**

Thomas Gray, P.B. Shelley, Dylan Thomas, E.V. Lucas, Robert Lynd, J.B. Priestley.

ENGL C251 Linguistics **3 0 3**

Linguistics as a field of study and its relationship with other disciplines; nature of language; its varieties and role in society; concepts of structure, system, unit and class; theories of linguistic analysis.

ENGL C252 Phonetics and Spoken English **3 0 3**

Speech mechanism; the English phonemes; word accent; features of connected speech; phonetic transcriptions; varieties of spoken English; spoken English in India; problems of Indian speakers; oral reading of passages including conversation; speech training.

ENGL C261 Creative Writing **3**

Principles of creative writing; stimulating creative activity; techniques of creating images; constructing events and creating characters, writing short stories, plays and poems, writing critical essays on works of art.

The course will require from the student a comprehensive report on the techniques learnt and include samples of his creative writings.

ENGL C262 Effective Speaking **2 1 3**

Nature of spoken language, voice and speech improvement, art of delivery and platform manners, use of body language, principles of public speaking, choosing a subject and purpose, organisation and outlining, forms of explanation and support, introduction and conclusions, style of speech, speeches for special occasions, parliamentary procedures. This will be a heavily practice- oriented course where students will be helped to develop skills of speech making through actual practice.

ENGL C312 Semantics **3 0 3**

Introduction; nature of words; meaning, different approaches; sources of ambiguity, semantic changes; measurement of meaning.

ENGL C321 Prose **3 0 3**

Bacon, Addison, Swift, Lamb, Hazlitt, Orwell, Russell.

ENGL C331 Literary Criticism **3 0 3**

Aristotle, Dryden, Johnson, Coleridge, Arnold, Eliot.

ENGL C341 Fiction **3 0 3**

Fielding, Austen, Dickens, Hardy.

3 0 3

ENGL C342 Science Writings

A selection containing contribution by eminent scientists written with a view to popularising science amongst intelligent laymen. The treatment of the course would be to train a student in writing and comprehension of the English language except that the subject matter will deal with science. Through the offering of the course and attempt will be made to interface an arts student to the culture of science.

ENGL C353 Effective Public Speaking 2 1 3

Principles of public speaking; importance of effective listening; use of body language; characteristics of voice; ways to control stage fright; measures to develop confidence; audience analysis; modes of delivery; organization of speech; speeches for special occasion: welcome, introduction, felicitation, farewell, valedictory, inaugural; impromptu and extemporaneous speeches; meetings, group discussions, professional presentations, interviews.

(This course is extensively practice-oriented. Theoretical guidelines also will be given to the students for achieving effectiveness in public speaking. Students would be asked to prepare and deliver a number of talks and presentations. Comments and discussions will follow each presentation so as to provide the students opportunity to correct themselves. Group discussions and presentations will be recorded and projected for them to observe their organization, body language and understand the nuances of the characteristics of their voice. Evaluation components will be designed to assess the students' ability to listen actively and speak effectively. The new language laboratory will be used to enable the students to listen to speeches by eminent leaders and renowned personalities who were/are able to attract the masses with their powerful speeches. The lab would also be used to conduct group discussions through computers).

ENGL C361 Drama I 3 0 3

William Shakespeare, Christopher Marlowe, G.B. Shaw.

ENGL C362 Drama II 3 0 3

T.S. Eliot, John Osborne, Eugene Ionesco, Arthur Miller.

ENGL C371 Poetry I 3 0 3

Edmund Spenser, John Milton, John Donne, John Dryden, Alexander Pope, William Wordsworth, S.T. Coleridge, P.B. Shelley, John Keats.

ENGL C372 Poetry II 3 0 3

Alfred Tennyson, Robert Browning, W.B. Yeats, T.S. Eliot, W.H. Auden, Dylan Thomas.

ENGL C441 Modern Fiction 3 0 3

E.M. Forster, Virginia Woolf, Joseph Conrad, Aldous Huxley, D.H. Lawrence.

ENGL C451 American Literature I 3 0 3

Faulkner, Hawthorne, Henry James, Hemingway, Steinback.

ENGL C452 American Literature II 3 0 3

Edward Albee, Emily Dickinson, Frost, O'Neill, Whitman.

ENGL C461 English Literary Forms and Movements 3 0 3

This course is designed to provide a historical perspective on major forms and movements in English Literature and to develop an insight into various social, religious and other influences on their birth and growth. The course will cover the entire range of literature from renaissance and reformation to modern times.

ENGL C491 Special Projects 3

Course description is same as given under BIO C491.

ENGL G511 Growth of the English Language 5

The Origin and development; old English, middle English and modern English; foreign influences; changes in grammar and phonology; rise of standard English; English in the international context.

ENGL G512 Language and S & T 5

Historical development of communication in science; communicative process in science and technology; language of science & technology; scientific literature; growth and role of scientific journals.

ENGL G513 Social Impact of S&T 5

Elements of scientific thinking; role of science and technology in social change; impact of science on environment; technology and social growth; impact of science & technology in terms of developments in transportation and communication and innovations in sources of energy; impact on the quality of life.

ENGL G521 Principles of Language Teaching 5

Teaching different language skills; grading; sequencing and presentation; teaching at different levels; remedial teaching; techniques of teaching comprehension, grammar, composition; lesson planning; syllabus design; testing.

ENGL G522 Aesthetics and Technology 5

Aspects of aestheticism; emergence of aestheticism; influence of aesthetics on technology; impact of technological explosion on human sensibility and its expression in selected art forms.

ENGL G531 Applied Linguistics 5

Linguistics and language teaching; contrastive linguistics and its applications; error analysis; a linguistic theory of translation; linguistic approach to literature.

ENGL G541 Interpretation of Literature 5

Literary forms and conventions and their development;

different critical approaches; practical criticism.

ENGL G551 Information Technology Lab I 5

(This course is specially designed to prepare the stream of input, viz. traditional English graduates, in the use of technology in communication).

This course is built around the theme of use of modern technology for the purpose of presentation and processing of information for effective communication within an organisation. Consistent with this theme, assignments would be drawn from the student's work environment and from one or more areas of the following: Computerized text processing; use of utility software packages for information processing and production; desk top graphics; desk top video; computerized graphics packages; office automation equipment such as electric typewriters; photography; equipment for projection and preparation of projection material; reprography equipment; duplication equipment; audio visual technology involving equipment such as video systems, audio systems and audio-visual recording equipment; techniques for display and exhibition of formatted information, etc. The course will be unstructured in nature and assignments may require study of the principles of the above areas, or the actual use of equipment and techniques.

ENGL G561 Information Technology Lab II 5

(This course is specially designed to prepare the stream of input, viz. traditional English graduates in the use of technology in communication)

This is a sequal to the first course of the same name. The theme of use of modern technology for the purpose of presentation and processing of information for effective communication within an organization would be further developed. However, assignments would invariably emphasize the integration between various technologies for totality of communication.

ENGL G571 Applied Communication I 5

(This course is specially designed to prepare the stream of input, viz. engineering and hard science graduates in communication methods)

Process of communication; elements of speech; role of body language; dyadic communication; participation in different types of discussion groups, audio-visual aids.

ENGL G581 Applied Communication II 5

(This course is specially designed to prepare the stream of input viz. engineering and hard science graduates, in communication methods)

Elements of effective writing; methods of written exposition; art of condensation; writing technical articles, research papers, proposals, reports, manuals and letters, preparation and use of graphic aids; mechanics of writing; technical editing.

ENGL G591 Project Formulation and Preparation 5

Course description is same as given under BITS G651.

ENGL G611 Twentieth Century English Literature 5

Margret Atwood, Tony Morrison, Samuel Beckett, Harold Pinter, Philip Larkin,Ted Hughes.

Engineering Science

ES C112 Thermodynamics 3 0 3

Concepts and laws of thermodynamics; macroscopic thermodynamic properties; application to closed and open system; microscopic approach to entropy; equations of state; thermodynamics of nonreacting mixtures.

ES C221 Mechanics of Solids 3 0 3

Fundamental principles of mechanics; introduction of mechanics of deformable bodies; forces and moments transmitted by slender members; stress and strain; stress-strain-temperature relations; torsion; stresses and defections due to bending; stability of equilibrium.

ES C222 Energy Conversion 3 0 3

Prerequisite: ES C231

Study of the technical and economic problems in energy conversion; electromechanical conversion principles and devices; present technology including technical and economic comparison of thermal, hydro, and nuclear methods; future energy technology including analysis of breeder concepts, fusion devices, MHD; solar energy; and fuel cells.

ES C231 Circuit Theory 3 0 3

Electrical circuits as analogous of nonelectrical systems-examples drawn from various disciplines; circuit models, equilibrium equations and their solutions; independent sources; exponential signals; steady-state of electrical circuits; linear dependence; mesh and nodal analysis, network theorems; energy and power.

ES C233 Logic in Computer Science 3 0 3

Role of logic in computer science. Propositional logic – syntax and well-formedness, semantics, satisfiability and validity, decision procedures. Predicate logic or first order logic – syntax, and semantics, satisfiability and validity, completeness and compactness, undecidability and incompleteness – Godel's incompleteness theorem. Verification – model checking, linear-time temporal logic and computational tree logic. Program verification – Hoare logic, proofs of correctness. Modal logic, logic programming.

ES C241 Electrical Sciences I 3 0 3

Introduction; basic circuit elements; sources (dependent and independent); Kirchoff's current and voltage law, source representation and conversion; Network theorems; response of RL, RC and RLC circuits; diodes and its applications; transistors - BJT & FETs; amplifiers: biasing and small signal analysis; OPAMPS; Digital Logic gates; Basics of Combinational and Sequential circuits.

ES C242 Structure and Properties of Materials 3 0 3

Study of the basic properties of materials in relation to their molecular structure; emphasis on the structure of metallic, polymeric and ceramic materials in relation to their mechanical, electrical, electronic and chemical properties, methods of imparting desirable properties to materials by inducing changes in molecular structure; property requirements and material selection, criteria for widely ranging service conditions.

ES C252 Electronics 3 0 3

Prerequisite: ES C231

Ideal diodes, rectifier and filters; ideal amplifiers; physical mechanism of devices; small signal models, amplifiers-their evaluation, biasing, frequency response, cascading and signal feed-back; classes of operation of large signal amplifiers; oscillators; modulation; detection.

ES C261 Digital Electronics and Microprocessors 3 0 3

(Only for group C programmes, and not available for groups A & B programmes)

Binary logic gates; logic circuits; Boolean algebra and K-map simplification; number systems and codes; arithmetic logic units; flipflops; registers and counters; introduction to microprocessors; architecture; instruction set and programming; memory and I/O interfacing; examples of system design.

ES C263 Microprocessor Programming & Interfacing 3 2 4

Elements of digital electronics; PC organization; 80X86 as CPU: Instruction set register set, timing diagrams, modular assembly programming using procedures & macros, assembler, linker & loader concepts; concept of interrupts: hardware interrupts, software interrupts, BIOS and DOS interrupts; disk organization: boot sector, boot partition, root directory & FAT; memory interfacing & timing diagrams; I/O interfacing; programmable I/O devices such as 8255, 8253, 8259, etc.

ES C272 Electrical Sciences II 3 0 3

Introduction; sinusoidal steady state analysis of circuits; three phase circuits; magnetic circuits; transformers; basics of rotating machines; DC machines; synchronous machine; induction machine.

Engineering Technology

ET C311 Selected Technologies 3

This course will aim basically at a qualitative coverage in a broader sweep with necessary details of certain technological operations which are not generally covered in the standard engineering diploma course. The themes taken up would, among others, include technologies of transportation, communication, information material processing etc. In its operation the course will have restricted formal contact and a large number of hours to be used (unstructured) by the student himself under teacher's supervision.

ET C312 Technology and Energy Assessment 3 0 3

Energy demand and consumption in Indian Industries; contribution of energy cost to production cost; concepts and benefits of energy audit, energy conservation, energy efficiency and DSM; potential for energy efficiency in Indian Industry, and other sectors; key economic and market issues for energy efficiency in India; DSM design concepts; energy audit and energy efficiency case studies; role of ESCO, government's role in energy conservation and energy efficiency; renewable energy applications for energy efficiency.

ET C322 Technology and Environmental Impact 3 0 3

Water pollution: origin, effects and testing, treatment of various Industrial wastes, recycle and reuse; Air pollution: origin, effect and control; Noise pollution; Environmental Impact Analysis.

ET C331 Raw Materials and Process Selection 3 0 3

Choice of location, site and equipment with the raw materials available, raw materials processing, methods of process selection and optimization.

ET C332 Project Preparation 3 0 3

Overview of project and project phases; project formulation aspects in terms of market studies, technical studies, financial studies, economic studies, environmental studies, etc.; project evaluation aspects in terms of commercial profitability prospects, national economic profitability prospects; issues of project preparation in project implementation.

ET C341 Instrumentation & Control 3 0 3

Measurement systems, transducers, feedback control, components: electrical, hydraulic,pneumatic; Signal conditioning and processing, controllers, display, recording, direct digital control, programmable logic controllers, PC based instrumentation.

ET C342 Materials Management 3 0 3

Integrating materials management; policy aspects; purchasing management; warehousing and storage of inventory control systems; appraisal and control; just in time (JIT); automation in materials management.

ET C351 Chemical Process Technology 3 0 3

Course description is same as given under CHE C322.

ET C352 Energy Management 3 0 3

Energy management principles; energy conservation; energy auditing; analysis; formulation of energy management options; economic evaluation, implementation & control; energy conservation techniques – conservation in energy intensive industries; steam generation, distribution systems, and electrical systems; integrated resource planning; demand-side management;

cogeneration; total energy schemes; thermal insulation; energy storage; economic evaluation of conservation technologies; analysis of typical applications.

ET C362 Environmental Pollution Control 3 0 3

Course description is same as given under CHE C411.

ET C411 Concepts of Engineering Design 3

Course description to be developed.

ET C412 Production Planning & Control 3 0 3

Generalized model of production systems; types of production flows; life cycle concepts; facilities location and layout planning; aggregate and batch production planning; inventory systems; materials requirements planning; elements of monitoring & production control.

ET C413 Advances in Materials Science 3 0 3

Course description is same as given under ME C442.

ET C414 Project Appraisal 3 0 3

Course description is same as given under ECON C411.

ET C421 Computer Aided Project Planning and Monitoring 3

Course description is to be developed.

ET C422 Computer Aided Manufacturing 3 0 3

Introduction, features of NC machine tools, NC part programming, CAM system devices, interpolators for manufacturing systems, control loops of NC systems, computerized numerical control, adaptive control systems, CAD to CAM, CAPP, industrial robots, computer aided production planning & control, computer aided inspection and quality control, CIM systems.

ET C431 Technology Forecasting 3 0 3

Course description is same as given under ECON C451.

ET C432 Quality Control, Assurance & Reliability 3 0 3

Basic concepts of probability and probability distributions, standard probability distribution, sampling and sampling distributions, confidence intervals, testing significance, statistical tolerance, various types of control charts, statistical process control techniques, value analysis, defect diagnosis and prevention, basic concepts of reliability, reliability design evaluation and control, methods of applying total quality management, production process.

ET C441 Technology Management 3 0 3

Course description is same as given under MGTS C414.

ET C491 Special projects 3

Course description is same as given under BIO C491.

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ET G511 Science and Technology Dynamics

ET G521 Hi-Tech Management 5

ET G531 Systems Engineering 5

ET G541 Overview of Technology 5

Course description for the above courses are to be developed.

Finance

FIN C312 International Financial Markets & Services 3 0 3

Currency futures, options and swaps; interest rate determination and asset pricing in face of volatile nominal and real exchange rates; international portfolio management; treasury risk management and performance measurement; major international stock exchanges: New York; ISE London; Tokyo; trading and settlement practices; listing of Indian derivatives on Brussles stock exchange; arranging foreign collaboration; floating India funds; syndication of Euro-dollar loans.

FIN C321 Theory of Finance 3 0 3

Functions and operations of capital market, analysis of consumption-investment decisions of investors, diversification and portfolio selection, valuation theory and equilibrium pricing of risky assets, theory of efficient markets and investment and financing decisions of the firm.

Expected utility theory; stochastic dominance; portfolio frontiers; mutual fund separation; asset pricing model; arbitrage pricing theory; Arrow-Debreu theory; dynamic spanning; options; rational expectations; financial signaling.

FIN C322 Project Finance 3 0 3

Project identification, feasibility; appraisal of projects from technical, financial and economic view points; design of capital structure; factors influencing form of capital; instruments; shares, preference shares, debentures, convertible debentures; borrowing from development finance institutions.

Lease or buy decisions; leasing capital equipment; impact on investment; features of leasing companies in India; legislation regulating leasing; role of leasing companies in industrial countries.

FIN C331 Management Accounting 3 0 3

Accounting as a language for management decisions; Accounting principles, conventions and concepts; concepts relating to financial statements, analysis of financial statements; inventory pricing and valuation; inflation accounting; cost accounting and budgetary control systems - cost determination, standard costs, differential cost and direct costing; profit budgeting and analysis; capital investment analysis; disinvestment decisions.

FIN C332 Econometrics **3 0 3**

Course description is same as given under ECON C342.

FIN C341 Investment Banking and Financial Services **3 0 3**

Merchant banking function- perspectives; organization of merchant banking function; managing new issues; negotiating terms with financial institutions, brokers, investors and under writers; pricing of further issues-SEBI guidelines; syndication of loans from banks; preparation of loan dossiers and application for financial assistance; negotiations; public deposits to finance working capital; agencies mobilizing public deposits; regulations governing raising of public deposits; cost of public deposits, factoring, forfeiting , structured finance, securitization and personal finance like house loan, personal loan and other individual loans, non-fund based services -credit rating, business advisory services, mergers, de-mergers and acquisition, asset management and insurance commodities services and wealth management.

FIN C342 Financial Management **3 0 3**

Course description is same as given under ECON C481.

FIN C411 Project Appraisal **3 0 3**

Prerequisite: ECON C212

Course description is same as given under ECON C411.

FIN C413 Risk Management and Insurance **3 0 3**

Introduction to risk; types of risk; risk measurement; risk management techniques; risk avoidance, loss control, loss financing, risk retention, risk transfer, internal risk reduction through diversification etc.; insurance business and operations; insurance pricing; insurance v/s hedging; life, health and income risk; property and liability risk – commercial and personal; social insurance; insurance regulation.

FIN C421 Financing International Trade **3 0 3**

Export: financial needs - terms of payment, documentary credit, different types of letters of credit, procedure, types and uses; DP, DA arrangement; packing credit; short term finance; medium and long term financing; deferred payment terms; foreign exchange cover; financing for deferred payments; IDBI scheme; buyers credit; export credit and guarantee corporation; financial guarantees; export factoring imports: review current policy provisions; import compression; linking imports exports; classification of imports: OGL specific licenses; negative list, import of capital goods against free foreign exchange; suppliers credit; foreign equity, foreign commercial borrowing; borrowing by export oriented units, opening letters of credit and remittances against imports; import factoring.

FIN C422 Public Finance: Theory and Practice **3 0 3**

Course description is same as given under ECON C322.

FIN C424 Money, Banking and Financial Markets **3 0 3**

Course description is same as given under ECON C362.

FIN C431 Marketing **3 0 3**

Definition and scope; marketing research; channels of distribution; sales promotion; regulation of marketing and public policy.

FIN C432 Issues in Indian Economy **3 0 3**

Course description is same as given under ECON C421.

FIN C433 Advertising and Sales Promotion **3 0 3**

The communication process and models of persuasive communication; advertising research; advertising campaign components; advertising campaign planning; advertising/media scene; media concepts; media planning & strategy; advertising campaign planning, execution and evaluation; advertising agencies; sales promotion types and techniques; sales promotion strategy; measuring the effectiveness of the promotional program; regulations of advertising and promotion; Extending marketing communication to social communication, personal selling, international advertising, interactive advertising, advertising laws, social, ethical and moral issues.

FIN C436 Strategic Financial Management **3 0 3**

(Pre-requisite: ECON C481= FIN C342= MGTS C382 Financial Management or MBA C416 Corporate Finance and Taxation)

Course description is same as given under ECON C436.

FIN C441 Organisational Behaviour **3 0 3**

A new perspective of management; conceptual model of organization behavior; the individualprocesses- personality, work attitude, perception, attribution, motivation, learning and reinforcement, work stress and stress management; the dynamics of organizational behavior- group dynamics, power & politics, conflict & negotiation, leadership process & styles, communication; the organizational processes- decision making, job design; organizational theory and design, organizational culture, managing cultural diversity; organizational change & development.

FIN C442 Corporate Planning **3 0 3**

Assessment of corporate strengths, weaknesses and opportunities; planning and deployment of capital assets; profit planning and control; functions, problems, pressures, responsibilities, limits of the chief executive; evaluation of one's own business undertaking; formu-

lating objectives, strategies, policies and programmes for improving company's present situation; personnel strength and implementation of the policies and programmes.

FIN C451 International Business 3 0 3

Global Trade Protection, Cultural Environment, Legal Aspects, International Monetary System, Overseas Business Options, MNCs, Regional Analysis, Screening and Segmentation, International Marketing Research, International Marketing Strategy, Export Policy and Institutional Infrastructure, Export Finance, Export Payments, Exchange Transactions, Product Planning; Positioning and Management, Distribution Policy; Management and Agreements, International Pricing and Promotion, Organizing for Overseas Markets.

FIN C462 Services Marketing 3 0 3

Distinctive elements, system: relationships with customers; positioning; managing customer portfolio, demand management, service delivery process, pricing; promotion; operating strategy; quality, productivity, human resource management; internationalization of services; services marketing in future.

FIN C491 Special Project 3 0 3

Course description is same as given under BIO C491.

FIN F212 Fundamentals of Finance and Accounts 3 0 3

Course description is same as given under ECON C212.

FIN F213 Mathematical and Statistical Methods 3 0 3

Course description is same as given under ECON F213.

FIN F214 Economic Environment of Business 3 0 3

Course description is same as given under ECON F214.

FIN F242 Introduction to Financial Mathematics 3 0 3

Basic financial calculations; financial securities, time value of money, Annuties and equation of values; discounting and accumulations, flat rate and APRs, Capital Budgeting Techniques and compound interest problems; NPV, IRR, payback period. Arbitrage, Forward contracts, and term structure of interest; rationale of arbitrage assumptions; forward contracts, calculating the forward price, hedging, fixed cash income, spot rate and forward rate, term structure of interest rate, yield curves, yield to maturity, interest rate risk calculation, Stochastic interest models and investments; simple stochastic interest rate models, fixed and varying interest model, log normal distribution, fixed interest government borrowings, government bonds, tax, government bills, convertibles, property, derivatives, future, clearing house, margin, bond futures, short interest futures, stock index futures etc.

FIN F243 Functions and Working of Stock Exchanges 3 0 3

Overview of financial markets and instruments; stock exchanges in India; trading and settlement procedures; listing; risk management; primary markets; debt markets; indices; mutual funds; derivatives; exchange traded funds; corporate governance; SEBI and regulation of the markets; important events in the stock markets; market microstructure; empirical studies on the Indian markets.

FIN F244 Indian Financial System 3 0 3

Indian Financial System, financial markets, financial intermediaries and financial instruments. Components and structure of the financial system. Financial Assets & Financial Markets: Meaning of financial assets & types, role and structure of money market and capital market – Call money market, Treasury bill market, Commercial bill market including commercial paper and certificate of deposits, Discount market – Government securities market – Debt Market – Industrial Securities Market. Markets for derivatives; futures and options, and other derivatives. Definition and types of non-bank financial institutions, LIC, UTI, Mutual Funds, Venture Capital, bankassurance; their growth and impact on India's economic development. Organisational set up & functions of regulators: Reserve bank of India, SEBI, IRDA, Financial sector reforms.

FIN F266 Study Project 3

Course description is same as given under BIO F266.

FIN F311 Derivatives & Risk Management 3 0 3

Overview of Financial Markets. Introduction to derivatives. Definition of future, forward, option and swap. Difference between various players of derivative market, their motives and types of position they can hold. Mechanics of future, option & swap markets. Hedging strategies. Option Pricing and understanding of various factors affecting option price. Calculations of Greeks. Introduction to interest rates, yield, term structure and forward rates. Mechanics of Bond Market. Review of concept of compounding and time value of money. Difference between floating rate and fixed income bonds. Price quotes and accrued interest. Pricing of Bonds. Computation of yield. Bond Price volatility. Duration, Modified Duration and convexity. Factors affecting Bond Yields and the Term Structure. Concept of Risk. Perspective of Risk from view point of individuals, companies & financial institutions. Commercial Banks and risks faced by them. Different types of Insurance and risk faced insurance companies. Introduction to various risks: Market Risk, Credit Risk, Operational Risk, Liquidity risk & Model Risk. Concept of Value at Risk

FIN F312 Fundamental of Taxation & Audit 3 0 3

Legal business entities and tax assessments; profit and gains of business or profession; capital gains; Tax

planning for business entities; tax accounting principles; VAT , excise duty, custom duty etc.; computation of tax liability; appeal procedure; auditing procedure and taxation principles; auditing concepts; generally accepted auditing standards; audit documentation and evidence; role of internal N-131 control and concurrent audit; audit mechanism, valuation of assets, and auditing of depreciation, provisions, reserves, profits and dividends, etc.

FIN F313 Security Analysis and Portfolio Management **3 0 3**

Course description is same as given under CDP C313.

FIN F314 Investment Banking and Financial Services **3 0 3**

Course description is same as given under FIN C341.

FIN F315 Financial Management **3 0 3**

Course description is same as given under ECON C481.

FIN F341 International Financial Markets and Services **3 0 3**

Course description is same as given under FIN C312.

FIN F342 Project Finance **3 0 3**

Course description is same as given under FIN C322.

FIN F366 Lab Project **3**

FIN F367 Lab Project **3**

Course description is same as given under BIO F366 and BIO F367.

FIN F491 Special Projects **3**

Course description is same as given under BIO F491.

French

FRE N101T Beginning French **3**

Basic grammar; vocabulary; reading practice; translation of simple passages.

Not available for meeting the requirements of any programme except as prerequisite for another French course. Can be taken only on audit.

FRE N102T Technical French **3 0 3**

Prerequisite : FRE N101T

Phrases and sentence patterns in technical literature; special technical vocabulary; reading and translation of current technical literature from French to English with the help of a dictionary.

This course is designed to meet the foreign language requirement of the Ph.D. Programme and is not available for meeting the requirement of any other programme. Can be taken only on audit.

German

GER N101T Beginning German **3 0 3**

Basic grammar; vocabulary; reading practice; translation of simple passages.

Not available for meeting the requirements of any programme except as prerequisite for another German course. Can be taken only on audit.

GER N102T Technical German **3 0 3**

Prerequisite : GER N101T

Phrases and sentence patterns in technical literature; special technical vocabulary; reading and translation of current technical literature from German to English with the help of a dictionary.

This course is designed to meet the foreign language requirements of the Ph.D. programme and is not available for meeting the requirements of any other programme. Can be taken only on audit.

General Studies

GS F211 Modern Political Concepts **3 0 3**

Course description is same as given under POL C212.

GS F212 Environment, Development & Climate Change **3 0 3**

Course description is same as given under POL C217.

GS F213 Development Theories **3 0 3**

Course description is to be developed.

GS F221 Business Communication **3 0 3**

Managerial communication – national and international contexts, Interpersonal Communication, persuasive communication, communication technology, effective listening group communication, professional presentation.

GS F222 Language Lab Practice **0 3 3**

Writing: Grammar and usage, sentence completion, jumbled sentences, emphatic word order, vocabulary building, message organization, paragraph development techniques and note taking. Reading: Skimming, scanning, rapid reading, analytical reading, factual reading, and aesthetic reading. Listening: Content listening, critical listening, aesthetic listening, empathetic listening, listening to short conversations, stories, lectures.

GS F223 Introduction to Mass Communication **3 0 3**

Mass communication: an overview, history of media and media plan, cinema, radio, television, theatre, advertising, audience and media, public relations, writing for media, new information technology: software revolution, internet, social media, video conferencing.

GS F224 Print and Audio-Visual Advertising **3 0 3**

The Dimensions of Advertising; Advertising and Marketing; Creative strategy and Creative process; Crea-

tive Execution: Art and copy; Media strategy; Advertising research; Relationship Building: Public relation and Corporate advertising; Ethical issues.

GS F231 Dynamics of Social Change **3 0 3**

Course description is same as given under SOC C211.

GS F232 Introductory Psychology **3 0 3**

Course description is same as given under PSY C211.

GS F233 Public Policy **3 0 3**

Course description is same as given under BITS C218.

GS F234 Development Economics **3 0 3**

Course description is same as given under CDP C371.

GS F241 Creative Writing **2 1 3**

Course description is same as given under ENGL C261.

GS F242 Cultural Studies **3 0 3**

Introduction to Cultural studies, Importance of cultural studies, types of cultural studies, relation to Critical theory, relation to Literary Criticism. Introduction to theories such as Communication studies, Film studies, Feminist theory, Art history/Criticism, Societal impact, business relevance, introduction to myriad practices, institutions, beliefs and varied social structures within a given culture.

GS F243 Current Affairs **3 0 3**

Course description is same as given under BITS C393.

GS F244 Reporting and Writing for Media **3 0 3**

Reporters and their functions; What makes news; Analysing the components; Getting the information and putting it together; Organizing a news story; Building colour into news stories; Fighting the formula story ; Writing Leads; Message molecules (Vocabulary, grammar, Spelling), Human Interest and Depth Report; Finding and using news sources; Basics of ethics in Journalism.

GS F245 Effective Public Speaking **2 1 3**

Course description is same as given under ENGL C353.

GS F266 Study Project **3**

Course description is same as given under BIO F266.

GS F311 Introduction to Conflict Management **3 0 3**

Course description is same as given under BITS C484.

GS F312 Applied Philosophy **3 0 3**

Content of Philosophical Perspectives – Ethical, Logical, Epistemological and Metaphysical; Ethics and Social Dilemmas; Social Justice and Equality; Freedom of Expression; Social and Value Dimensions of Technology; Impact of Information Technology on the Quality of Life; Computer and Inter net Crime; Democratic Values and the Internet.

GS F313 Marxian Thoughts **3 0 3**

Marx and his times; basic tenets; dialectical materialism; economic determinism; doctrine of surplus value; doctrine of class struggle; different schools of Marxism; Leninism; Stalinism; Maoism; future of Marxism.

GS F321 Mass Media Content & Design **3 0 3**

Types of Corporate Communication documents; Importance of corporate communication; communication documents for stakeholders; Data collection for documents- Sources, types, methods; Analyzing and Organizing the content – preparing the drafts; Design Concepts; Design Technologies – Overview; Specific Design tools – Dreamweaver, Macromedia Director, Adobe Premier, Photoshop, Flash; Integrating Content and Design.

GS F322 Critical Analysis of Literature and Cinema **3 0 3**

Creativity and Aesthetics; An overview of Major Movements in Literature and Cinema; Interpretation of Selected Works; Cinema & Art; Understanding Drama: Theme, Character, Plot, form; Understanding Poetry: Diction, Imagery, Symbolism, Structure and Form, Personification, Apostrophe, Sound and Rhythm; Understanding fiction: Setting, Point of View, Plot and Character; Understanding Short Fiction: Meaning and message, Style and Coherence; Understanding Cinema: Plot; Character; Screenplay; Linguistic, Social, Musical codes; Cinematic Codes; Camera Work.

GS F325 Journalism **3 0 3**

Principles of reporting; the news media and public relations; ground rules for reporters; investigative reporting; specialised reporting of events, trends and activities; creating headlines; editing, copyediting; newspaper style; proof reading; the press and the law.

GS F326 Creative Thinking **2 1 3**

Creative thinking & its importance, Process of creative thinking, Road blocks to creative thinking, Developing creative thinking, Brainstorming, Bloom's Taxanomy, Assessment of creative thinking, Conceptual framework for Critical thinking, Aspects of critical thinking, Stages of critical thinking; Reasoning: Fountain head of critical thinking, Need & benefit of critical thinking, Critical thinking in decision making, Developing critical thinking in classroom, Assessment of critical thinking skills.

GS F327 Selected Reading **3 0 3**

Course description is same as given under BITS C216.

GS F331 Techniques in Social Research **3 0 3**

Course description is same as given under BITS C397.

GS F332 Contemporary India **3 0 3**

Course description is same as given under CDP C332.

GS F333 Public Administration **3 0 3**

Course description is same as given under HUM C351.

GS F334 Global Business, Technology and Knowledge Sharing **3 0 3**

Course description is same as given under BITS C487.

GS F342 Computer Mediated Communication **3 0 3**

Course description is to be developed.

GS F343 Short Film and Video Production **2 1 3**

Introduction; communication media formats like audio, film, video, audio recording and editing; image composting; script writing : screenplay; equipment: video cameras, film cameras, the lens, the camera; the film stock: negatives, prints, aspect ratio, grain, gauge, speed, colour contrast, tone; handling the camera; image technology, sound technology; basic filming techniques: lights and lighting, shooting, sound recording, sound track, dubbing, voice over; visual effects, editing: familiarization with editing software, mixing and looping; final production.

GS F344 Copywriting **2 0 2**

Concept of Copywriter, Setting up as a Copywriter, Copywriting Audience, Copy Writing Process, Marriage of Visual and Copy, Copy Types-Email Marketing, Direct Mail Press Release, Press Ads, Writing Leaflets and Brochures, Newsworthy Newsletters, Radio Copy, Online Copywriting, Other Types of Copy.

GS F366 Lab Project **3**

GS F367 Lab Project **3**

Course description is same as given under BIO F366 and BIO F367.

GS F491 Special Projects **3**

Course description is same as given under BIO F491.

Hindi

HINDI C201 Elementary Hindi **3 0 3**

This course is open only for a student whose mother-tongue is not Hindi and who has not studied Hindi in his school curriculum.

An elementary prose selection, comprehension, composition and usage.

HINDI C211 Novel and Short Stories **3 0 3**

Origin and development of Hindi short stories and novels.

HINDI C212 One Act Play and Drama **3 0 3**

Origin and development of Hindi drama.

History

HIST C112 Main Trends in Indian History **3 0 3**

A panoramic view of the development of Indian thought and society; evaluation of Indian life and quality from earliest times through the so-called Hindu, Muslim and British periods; the present day analysis and discussion on the basic features of Indian society, its strength and its weakness; a glimpse into future in terms of the transformation of the Indian society.

HIST C211 Main Currents of Modern History **3 0 3**

Renaissance, the major revolutions of the world; rise of nationalism; growth of imperialism; world between the two world wars; super powers and the contemporary world; resurgence of Asia, protest movements in Africa and Latin America; problem of world peace.

HIST C213 Gulf History and Culture **3 0 3**

Introduction to the Arab Gulf, Prophet Muhammad and appearance of Islam, Arab Caliphates and expansion of Islam, Ottoman Empire, Islam and its basic tenets, Islamic culture and society, Islamic contribution to civilization, modern history: Age of nation states, oil and the Arab world, years of turmoil, Arab world in the twenty first century.

Humanities and Social Sciences

HSS C221 Economic Legislation I **3 0 3**

Indian contract act; sale of goods act; negotiable; instruments act.

HSS C222 Economic Legislation II **3 0 3**

Industries and development regulation act; monopolies and restrictive trade practice act; foreign exchange regulation act; Indian companies act.

HSS C231 Economic Legislation **3 0 3**

Indian contract act; sale of goods and hire purchase acts; the negotiable instruments act; company law; industries and development regulation act; consumer protection and unfair trade practices act; monopolies and restrictive trade practices act; foreign exchange regulation act; securities and exchange board of India act, etc.

HSS C232 Indian Financial System **3 0 3**

Capital formation and capital markets; savings; financial savings, structure of capital market; primary and secondary markets; developmental financial institutions; linkages between money and capital markets; financial intermedieries and regulation of the financial system; commercial banks; unit trust; mutual funds; call money market; regulation of banking and money markets by reserve bank.

HSS C241 Legal Environment of Business 3 0 3

It provides broad knowledge of various legal aspects within which the business operates. Indian contract act, sale of goods and hirepurchase act, negotiable instruments act, companies act, corporate Tax laws, SEBI, BIFR and others, consumer protection and unfair trade practices act, monopolies and restrictive trade practices act, & FERA.

HSS C311 Taxation 3 0 3

Principles of taxation; economic effects of taxation; tax structure; taxation in practice with special reference to the Indian Income Tax Act 1961.

HSS C312 Bureaucracy 3 0 3

An introduction to the theory of governmental decision making and bureaucratic behaviour. Organisational structure; the role of the bureaucracy in policy making; sources of bureaucratic power; agency interaction; personnel management; differences in agency and bureaucratic power, and decision-making topologies. Company administration and meetings.

HSS C313 Critical Analysis of Literature and Cinema 3 0 3

Creativity and Aesthetics; An overview of Major Movements in Literature and Cinema; Interpretation of Selected Works; Cinema & Art; Understanding Drama: Theme, Character, Plot, form; Understanding Poetry: Diction, Imagery, Symbolism, Structure and Form, Personification, Apostrophe, Sound and Rhythm; Understanding fiction: Setting, Point of View, Plot and Character; Understanding Short Fiction: Meaning and message, Style and Coherence; Understanding Cinema: Plot; Character; Screenplay; Linguistic, Social, Musical codes; Cinematic Codes; Camera Work.

HSS C314 Print and Audio Visual Advertising 3 0 3

The Dimensions of Advertising; Advertising and Marketing; Creative strategy and Creative process; Creative Execution: Art and copy; Media strategy; Advertising research; Relationship Building: Public relation and Corporate advertising; Ethical issues.

HSS C316 Popular Literature and Culture of South Asia 3 0 3

South Asia as a region; culture and its representation through literature and cinema; politics of representation, breaking the stereotypes; bringing in the marginalized voices; writings of women; identity formation; concept of majority and minority; commonality in spite of all the differences, violence, migration and dislocation.

HSS C317 Introduction to Globalization 3 0 3

Main themes and concepts: Globalization, Globalism, Localization, Glocalization; Dimensions of Globalization: Social, cultural, economic, political and ideological; Processes related to Globalization: Internationalization, Westernization, Americanization, Neo-Colonialization; Relationship with issues of environment, city, consumption, media, inequality; Development; Impact and consequences of Globalization in India; Challenges and future of Globalization: Anti-Americanization and Anti-Globalization Movements.

HSS C318 Introduction to Anthropology 3 0 3

Introduction to Social and Biological Anthropology: Human Nature, Race, Evolution; Sex, Gender, Family; Archaeology: Domestication, Agriculture, and Civilization; Cultural Anthropology: Nature of Culture, and Cultural Relativism; Nature of Language and Languages.

HSS C319 Lighting for Theatre and Films 2*

Design principles and elements of design; lighting instruments; lighting mechanics, rigging and focusing lights; color and color theory, psychology of color, color mixing; lighting paper works, lighting for play, opera, thrust, musical, proscenium, arena and films.

HSS C321 Commercial Law 3 0 3

Elements of economic legislation including general principles of law, monopolies and restrictive trade practices act, securities and contracts, company's act, forms of business organisation and consumer protection.

HSS F221 Readings from Drama 3 0 3

Course description is same as given under ENGL C222.

HSS F222 Linguistics 3 0 3

Course description is same as given under ENGL C251.

HSS F223 Appreciation of Indian Music 3 0 3

Course description is same as given under HUM C321.

HSS F226 Postmodernism 3 0 3

Postmodernism, The Postmodern Condition, History of Postmodernism in brief, Pluralism, Eclecticism, Polysemy, Intertextuality, Metanarratives, Language Games, Parody, Pastiche, Simulation, Postcolonialism, Commodification, Deconstruction

and New Historicism, Creativity, Critical Judgment, Ethical and Social Understanding, analysis of postmodern cultural artifacts and practices from fine art, music, theology, literature, and film alongside primary texts by the leading theorists of postmodernism.

HSS F227 Cross Cultural Skills 3 0 3

Overview of Intercultural Communication, Intercultural Communication in the Global Workplace, Technology as cultural Power and Its Social Impact, Critical Issues and challenges in Intercultural Communication, Understanding interrelatedness among Religion, Family, Culture, Gender and Race.

HSS F228 Phonetics and Spoken English 3 0 3

Course description is same as given under ENGL C252.

HSS F229 Introduction to Western Music 3 0 3

A historical and cultural examination of music in Western culture from the Middle Ages to the 21st century; Listening to and understanding different genres of music; Fundamentals of Music: Rhythm, Meter and Measure; Melody and Harmony; Pitch names; Intervals; Key signatures; Chord progressions; Score reading; In-tune singing; Ear training; Making music on the electronic keyboard.

HSS F232 Introduction to Development Studies 3 0 3

History of development; meanings of development; Key development thinkers: Smith, Marx, Liszt, Keynes, Prebisch, Friedman; 20th century perspectives on development: dependency, modernization, human development, post- and anti-development theories; Models of development: ISI and neoliberalism; Themes in comparative international development: environment, health, gender, foreign aid, social and human rights.

HSS F233 Main Trends in Indian History 3 0 3

Course description is same as given under HIST C112.

HSS F234 Main Currents of Modern History 3 0 3

Course description is same as given under HIST C211.

HSS F235 Introductory Philosophy 3 0 3

Course description is same as given under PHIL C211.

HSS F236 Symbolic Logic 3 0 3

Course description is same as given under PHIL C221.

HSS F237 Contemporary Indian English Fiction 3 0 3

Indian novel in English as a global phenomenon; pioneering publications; new approaches to the art of storytelling and reworking of language introduced in Indian English fiction. Developments in contemporary Indian fiction in English from the 2000 to the present; Analysis of selected novels set in their historical, political, social and cultural contexts, and alternate viewpoints on contemporary India.

HSS F238 Sports and Society 3 0 3

The Sociology of Sport; Theories; Sports and Socialization; Sports and Culture; Deviance and Violence; Class, Gender, Race and Ethnicity; Sports and Education; Sports and Economy; Sports and Politics; Sports and Media; Sports and Globalization.

HSS F266 Study Project 3

Course description is same as given under BIO F266.

HSS F312 Bureaucracy 3 0 3

Course description is to be developed.

HSS F315 Society, Business and Politics 3 0 3

Course description is to be developed.

HSS F316 Popular Literature and Culture of South Asia 3 0 3

Course description is same as given under HSS C31

HSS F317 Introduction to Globalization 3 0 3

Course description is same as given under HSS C317.

HSS F318 Introduction to Anthropology 3 0 3

Course description is same as given under HSS C318.

HSS F319 Lighting for Theatre and Films 2*

Course description is same as given under HSS C319.

HSS F323 Organizational Psychology 3 0 3

Industrial/Organizational Psychology, Hawthorne Studies, Leadership-Theories, Motivation-Concepts, Personality & Values: Strengths & Weaknesses, Employee Issues: Recruitment, Training & Development, Organizational Change & Development- Psychosocial Aspects, Organizational Culture & Climate, Work-Family Balance, Stress and its Management, Positive Organizational Psychology.

HSS F325 Cinematic Adaptation 3 0 3

Course description is to be developed.

HSS F326 Humanities and Design 2 2 3

Ideas and Designs, Thinking about New Designs, Perspectives to Design: Historical, Social, Technical and Creative Dimensions; Engineering Design and Problem Solving; Basic Concepts in Engineering Design; Design Skills, Abstraction, Identification of Patterns in Processes and Products, Application of Systematic Techniques to Problem Solving, Application and Adaptation of tools and technologies to new problems; Core Principles of Design; Elements of Design, Form and Functionality, Central Activity of Engineering Designs; Language and Interface Design, Design Thinking: Influence of Context Vs. Conflict with Context.

HSS F327 Contemporary Drama 3 0 3

Course description is to be developed.

HSS F328 Human Resource Development 3 0 3

Course description is same as given under MGTS C362.

HSS F329 Musicology – An Introduction 3 0 3

Course description is same as given under HUM C381.

HSS F330 Appreciation of Art 3 0 3

Visual perception and basic techniques used in art, compositional balance, space, movement form, light colour, texture, tensions, expressions lines; mainstreams of art; influence of Indian art abroad; various schools of art-Greecian, Medieval, Christian Renais-

sance, Baroque and Romanticism, impressionism and post impressionism, fauvism, futurism, expressionism, Dadaism and surrealism, metaphysical art, non-representational and abstract art; analysis of work of art and their evaluation.

HSS F331 Sankara's Thoughts 3 0 3

Course description is same as given under HUM C382.

HSS F332 Cinematic Art 3

Course description is same as given under HUM C332.

HSS F333 Comparative Religion 3 0 3

Course description is same as given under HUM C421.

HSS F334 Srimad Bhagavad Gita 3 0 3

Course description is same as given under HUM C383

HSS F335 Literary Criticism 3 0 3

Course description is same as given under ENGL C331.

HSS F336 Modern Fiction 3 0 3

Course description is same as given under ENGL C441.

HSS F337 English Literary Forms and Movements 3 0 3

Course description is same as given under ENGL C461.

HSS F338 Comparative Indian Literature 3 0 3

Course description is same as given under HUM C341.

HSS F339 Theatre Art-Acting and Production 3 0 3

Course description is same as given under HUM C431.

HSS F340 Post Colonial Literature 3 0 3

Introduction to Post colonial discourses; Post Co-lonial Concepts: Colonization, De-colonization,Linguistic colonization, Politics of representation, Orientalism, Eurocentrism, Hybridization, Select Literary Texts.

(This course is introduced in the pool of humanities electives for all A, B, and C group programmes).

HSS F341 Performance Design 3 0 3

Study of a dramatic text and its genre, structure; plot, time, theme and its development, character;music and spectacles; conceiving scenography: basic principles of design; reading the hidden image in the text; performance and show; organizing performing space, conceiving light, music, and sound;staging the show: final production.

(This course is introduced in the pool of humanities electives for all A, B, and C group programmes).

HSS F342 Advanced Communicative English 3 0 3

Pronunciation, Accent, Intonation, Vocabulary, Active Listening, Conversation, Group Discussion,Dynamics of Writing, Art of condensation, Dictogloss, Critical Essays, Academic Essays, Term Paper, Book Review.

(This course is introduced in the pool of humanities electives for all A, B, and C group programmes).

HSS F343 Professional Ethics 3 0 3

Course description is same as given under HUM C411.

HSS F344 Heritage of India 3 0 3

Course description is same as given under HUM C412.

HSS F345 Gandhian Thoughts 3 0 3

Course description is same as given under POL C311.

HSS F346 International Relations 3 0 3

Course description is same as given under POL C321.

HSS F347 Introduction to Carnatic Music 3 0 3

Origins and History of Carnatic music; Basic concepts of svara, svaravalis, svarasthanas, aarohana, avarohana, sthayis; Concept of laya, tala, gati, nadai, different jaati's of taalams; Concept of raaga, Melakarta and janya; Ragalakshanam for some specific raagas; Notation of svaras, taalam; Brief biography of the Trinity, Purandaradasa, and other major composers; Concert formats and styles; Vocal or instrumental exercises including varisais, Saptataala alankaaras, Geetams, svarajati, keertanams; Listening practice.

HSS F348 Introduction to Hindustani Music 3 0 3

Origins of Hindustani music and evolution of the style; Basic concepts of melody and rhythm: Naad, Dhwani, Sangeet, Swar, Laya, Raag, Taal, Shuddh- Vikrit, Chal-Achal, Mandra-Madhya-Taar, Poorvang – Uttarang, Saptak - Ashtak, Sthayee – Antara, Aroha-Avaroha, Raag-Jati, Tal Jati, Alap-Tan, Varn, Alankar, Pakad, Bandish, Vilambit-Madhya-Drut, Matra, Theka, Vibhag, Tali, Khali, Sam. Raaga, Thaat, raag vivara; Compositions: khayals, dhrupad, taraana etc; Vocal or instrumental exercises including ten alankars, Identification of svaras, Aroh, avaroh and pakad of simple raags viz. Yaman, Bhoop, Khamaj, Des, Kafi, Bhimpalasi, Bageshri, Durga; Sargam geets, lakshan geets and madhyalay khayals; Taals including Trital, kaharva, daadra; Listening, identification of raaga from simple phrases.

HSS F349 Ecocriticism **3 0 3**

Defining Ecocriticism; Interdisciplinarity; Ecosystem and Biodiversity; Ecology and Environment; Developmental Ecology; Ecocritical Concepts; Literary Ecocriticism; Application of Ecocritical Principles in Literature - tinai Criticism; Deep Ecology; Bioregionalism - Cultural Ecocriticism; Ecocinema - Debates on Anthropocentrism and Biocentrism/Ecocentrism; Food documentaries; Animal Studies; Ecophobia; Gaia Theory; Ecocriticism and Society; Ecopolitics and Activism; Ecospirituality and Ecosophy; Practical Ecocriticism.

HSS F350 Human Rights: History, Theory & Practice **3 0 3**

The meaning and history of human rights; Human rights debates and controversies; Political, civil, social and economic rights; Culture and human rights; Themes - Democracy, dictatorship, and human rights; Science, technology, and human rights; Ethnicity; Gender; Children's rights and others;Evaluating the progress made and challenges in practice of human rights.

(This course is introduced in the pool of humanities electives for all A, B, and C group programmes).

HSS F351 Social and Political Ecology **3 0 3**

Environmental History and Social construction of nature; Theoretical perspectives on Natural Resource use; Ecological Development; Natural Resource Governance; Ecological Identity and Social Movement-Gender-based dimensions; Degradation and Marginalization; Conservation and Control; Ecotourism; Urban Ecology; Regional case studies.

HSS F352 Technology, Work and Society **3 0 3**

Work during and after Industrial Revolution; Major theoretical contributions to the study of Work; Technology and its impact on work in the 21st century; Work and self in the service industry; Work and self among professionals and managers; Changes in Culture of Work; Domestic labor and the politics of household work; Modern distinction between work and family.

HSS F353 Philosophy of Aesthetics **3 0 3**

Fundamental questions related to art, its purpose and manifestations as well as foundational problems such as, ideology, ontology, values attached, implicit/explicit meanings, connections with other disciplines, social manifestations and implications, historical contexts, mediums and representations. Important Indian and Western perspectives on aesthetics through music, literature, painting and cinema, contextualizing them in history.

HSS F354 Introduction to Islamic Economy **3 0 3**

Islamic Finance and Islamic digital economy, Halal industries, Halal tourism, Islamic art and design, Islamic economy standards and certification, and Islamic information and education.

HSS F355 Dictatorship, Democracy & Development **3 0 3**

Overview of the relationship between political regimes and development; how regimes matter: top-down interventions and bottom-up pressures; key concepts: democracy, dictatorship, civil society, social movements, social capital, human development; survey of academic literature to understand "democracy advantage"; country studies: Brazil, China, India; relevance and limitations of the relationship between political regime type and development.

HSS F356 Social Movements and Protest Politics **3 0 3**

Need for studying social movements ; origins, forms, trajectory, outcomes of social movements ; key participants; protestors objectives, their achievements / failures ; the Civil Rights Movement ; women's movements in the US and Europe; pro-democracy movements in Brazil; Islamic movements in the Middle East; The Christian Right in the US; the Hindu nationalist movement in India ; Maoism in India; anti-corruption protests.

HSS F399 Introduction to American Literature **3 0 3**

Socio-cultural and literary history of the United States since the landing of the Pilgrims from *The Mayflower* to the decisive American victory over the Axis powers in World War II. (1500-1700) Etablishment of Plymouth Plantation and the establishment of early Puritanism. (1700-1800) Influence of Enlightenment thought on American life and letters and Consequences of the Revolutionary War on literature. (1800-1865): American Literary Nationalism, the westward expansion, and the American Civil War. (1865-1914): Reconstruction period, Mexican War, imperial expansion to the Southwest, building of transcontinental railroads, the American frontier issue, industrialization and transformation of American life and their effects on the literary marketplace. (1914-1945): the two world wars, the Great Depression, Modernism and Modernity in American life and letters, Harlem Renaissance, increasing presence of science and technology in everyday American life.

HSS N301T Elements of Dance **1 1 2**

Introduction to elements of dance; dance sense; dance pathway; relationship of dance with culture, society, geography and arts; dance workout, salsa, ballet, folk, classical, contemporary, musical theatre

Humanities

HUM C121 Islamic Studies **3 0 3**

Course description is to be developed.

HUM C232 Indian Financial Systems **3 0 3**

Course description is same as given under HSS C232.

HUM C233 Music of the World: An Introduction 3*

Origin of Music, Music as a Cultural Activity, Experimenting with Music Understanding Rhythm, Rhythm Across Cultures, Introducing Melody, Evolution of Musical Instruments, Music of Asia, Music of Africa, Music of Central, South American and Carribean, Music of Europe, Music of Middle East and Arabian Countries, Music of Russian and Neighbouring Countries, Music of North America, Island Music.

HUM C311 Journalism 3 0 3

Principles of reporting; the news media and public relations; ground rules for reporters; investigative reporting; specialised reporting of events, trends and activities; creating headlines; editing, copy editing; newspaper style; proof reading; the press and the law.

HUM C312 Contemporary India 3 0 3

Course description is same as given under CDP C332.

HUM C321 Appreciation of Indian Music 3 0 3

The course is intended as an appreciation of Indian music; the emphasis will be upon exposing the students to musical performances, records, tapes, both vocal and instrumental; through these illustrations the consciousness in terms of the distinction between Raag and Taal etc., is expected to be derived; the course will pick up a certain number of Raags from the basic thaats and demonstrate the delineation of the Raag through Alap, through various improvisations based upon compositions; the appreciation of concepts both vocal and instrumental (Sitar and Violin) is expected to be obtained; Karnatik music will also be touched upon particularly in terms of Raags common to Hindustani Music.

HUM C322 Commercial Art 3

Course description is to be developed.

HUM C331 Appreciation of Art 3 0 3

Visual perception and basic techniques used in art, compositional balance, space, movement form, light colour, texture, tensions, expressions lines; mainstreams of art; influence of Indian art abroad; various schools of art-Greecian, Medieval, Christian Renaissance, Baroque and Romanticism, impressionism and post impressionism, fauvism, futurism, expressionism, Dadaism and surrealism, metaphysical art, non-representational and abstract art; analysis of work of art and their evaluation.

HUM C332 Cinematic Art 3

Cinema as an art form; elements of cinema; defining form, style types, rhyme as adopted in global cinema; new idiom in Indian cinema; experimental techniques; evolution of the language of cinema; analysis of Japanese, Swedish, American, French and Indian cinema ; theatre and cinema.

HUM C341 Comparative Indian Literature 3 0 3

This course is intended to acquaint the students with literary achievements in Indian Languages and their home-environment and to give integrated view of Indian literature, literary selections from the best writers in the Indian languages will be studied.

HUM C342 Graphic Art 3

Field of graphic arts; aims; graphic elements; basic principles; subject matter and picture surface; vocabulary of expression; techniques of composing and drawing; graphic products; typography; hand and mechanical printing processes; reproduction of monochromatic and coloured pictures.

HUM C351 Public Administration 3 0 3

Definition, nature and scope of public administration; the chief executive; leadership qualities of an administrator; principles of organization; organization of Ministries of Home and Finance; personnel administration-bureaucracy; recruitment, promotion, conduct and discipline, employer-employee relations; administration at work-planning, policy formulation, decision making, supervision, coordination; integrity in administration; public corporations in India; financial administration in India; local administration in India.

HUM C352 Painting 3

Introduction to the art of painting; styles of painting; techniques for various styles of painting; study of materials used; sketches of dynamic and still life; painting projects.

HUM C361 Accounting in Management 3 0 3

Use of accounting information for management decisions; Basic concepts and mechanics; Balance Sheet and Income & Expenditure statement; Valuation of Inventory and Assets; Depreciation; Capital Surplus and other liabilities; Cost determination; Standard costs; Differential costs and direct costing; overhead budgets; Control of programmed expenses.

HUM C362 History of Mathematics 3 0 3

Early periods of mathematical thought in Greece, China, India, Arabia and Egypt. Growth of early development in geometry and algebra and their impact on architecture and social values. The renaissance period and the advent of calculus and analytic geometry. The growth of differential geometry and its application to relativity and mechanics, their continuation into twentieth century. Axiomatic mathematics of the last two centuries and their impact on physics and computer science. Culture and development of mathematical ideas as contributions by fields medalist in the present day set up. Application of mathematical ideas to social sciences. The work of J.Von Neumam, K. Arrow and G. Debru.

HUM C371 Linguistics **3 0 3**

Course description is same as given under ENGL C251.

HUM C372 Phonetics and Spoken English **3 0 3**

Course description is same as given under ENGL C252.

HUM C381 Musicology - An Introduction **3 0 3**

Music and it's philosophy, history of music, different theories regarding the development of music, music as an exact science (mathematics), musical terminology, musical forms and their background, composers, artistes and their contributions, music of different cultures, music and film world, music therapy. Emphasis would be laid on research and knowledge gained through self-experience.

HUM C382 Sankara's Thoughts **3 0 3**

Life and achievements of Adi Sankara; pre-Sankara Vedanta; basic concepts and theories of Advaita: Atman and Jeeva, nature, sources and validity of knowledge, Brahman and Isvara, Maya and World, Avidya, bondage and liberation; Sankara's contribution to Indian heritage.

HUM C383 Srimad Bhagavad Gita **3 0 3**

The science of Soul; Reincarnation; Karma; Karma Yoga; Transcendental Knowledge; Action in Krishna consciousness; Dhyana Yoga; Knowledge of the Ablolute; Attaining the Supreme; The process of Transmigration; the most confidential knowledge; Bhakti Yoga – The process to go back home, back to Godhead.

(This course is introduced as an elective course in the pool of HSS courses for all A, B and C group programmes).

HUM C411 Professional Ethics **3 0 3**

Ethics, nature and purpose; ethical theories; ethics in business and management; ethics in engineering, global ethical issues.

HUM C412 Heritage of India **3 0 3**

Foundations of India; India and her ancient culture; life of the people; systems of Indian philosophy; art and archaeology; languages and literature; impact on world civilization; Western influence.

HUM C413 Indian Traditions of Science and Technology **3 0 3**

Science and technology in Indus-Sarasvati civilization; theories of ancient Indian technologies including shipping, agriculture, metallurgy, textiles, sculpture and architecture; theories of ancient Indian sciences including asronomy, ayurveda, sulbasutra geometry, alchemy and chemistry, physiology and biology; statististics on Indian industry in pre-colonial and colonial India; creativity in continuity with Indian tradition : the work of Ramanujam, Raman, P.C. Ray and J.C. Bose; challenging directions of pursuit in present day world in consonance with Indian tradition.

HUM C421 Comparative Religion **3 0 3**

A clear objective description of the great religions and their appeal to the spiritual aspirations of the different people of the world; a comparative non-sectarian approach to the understanding of Hinduism, Buddhism, Islam and Christianity; a final summing up bringing the unity of all religions of the world.

HUM C422 Aesthetics **3 0 3**

Form and scope of aesthetics, historical background, perceptual sense of beauty and its expression, ideas of Eastern and Western scholars about aesthetics, various arts and aesthetics.

HUM C431 Theatre Art-Acting and Production **3 0 3**

General historical background of theatre; general knowledge of acting; its tools and exercises; voice training and practice; a study of stage; various systems of theatres; rehearsal techniques and stage management.

HUM G511 Introduction to Health Systems **3 0 3**

Health facilities for SC/ST; Health Systems; Evolution of Medicine; Sociology, health and medicine; Primary health care; Health Development; Health education; Health policy in India; Issueslike euthanasia, consumer forums, child labor; Female infanticide; women's health; Role of hospitals; Advances in Public Health; Communications; Evaluation of National Health Systems; Demography; Family Planning; Psycho-social issues.

Instrumentation

INSTR C272 Circuits and Signals

3 0 3

Course description is same as given under EEE C272.

INSTR C312 Industrial Instrumentation and Control **3 0 3**

Prerequisite: AAOC C321

Importance of process control, elements of process loop, mathematical modeling, dynamic closed loop characteristics, controller principles & tuning, direct digital loop, hydraulic controllers, pneumatic controllers, electronic controllers, complex & multivariable control schemes, final control elements, P& I diagrams, PLCs, Distributed Control Systems (DCS), AI techniques: expert systems, neural networks, fuzzy logic, genetic algorithms & applications.

INSTR C313 Microelectronic Circuits **3 0 3**

Course description is same as given under EEE C424.

INSTR C355 Electronic Instruments and Instrumentation Technology 3 3 4

Electronic indicating, display, recording and analysis instruments, signal generators, frequency synthesizer, counters, elements of design, grounding and shielding, electronic circuits manufacturing technology, metrology, standards in quality management, instrumentation in hazardous area, industrial communication techniques.

INSTR C364 Analog Electronics 3 3 4

Course description is same as given under EEE C364.

INSTR C371 Electromechanical Energy Conversion 3 3 4

Course description is same as given under EEE C371.

INSTR C381 Transducers & Measurement Systems 3 0 3

Importance and types of measurement, generalized measurement system, functional elements, static & dynamic characteristics, primary sensing elements, passive transducers, active transducers, inverse transducers, fiber optic transducers, MEMS based transducers, measurement techniques for motion, seismic, pressure, flow, temperature, level, humidity, pH, viscosity; signal conditioning techniques using bridge, op-amp, instrumentation amplifier, carrier, chopper, charge, isolation amplifier, data converters, filters, modulators; data acquisition systems.

INSTR C391 Digital Electronics and Computer Organization 3 3 4

Course description is same as given under CS C391.

INSTR C392 Analysis Instrumentation 3 0 3

Generalized configuration of an analysis instrument. Off-line analysis instruments: emission spectrometers, UV/VIS/IR absorption spectrophotometers, flame emission and atomic absorption spectrophotometers, X-ray fluorescence spectrometer and diffractometer, NMR and mass spectrometers, pH-meters, gas chromatographs, electrochemical instruments, analytical electron microscopes. On line analyzers: Sampling systems for gases and liquids, fluid density monitors, consistency and viscosity analysers, thermal conductivity gas analysers, paramagnetic oxygen analysers, chemical composition analysers, on-line instruments for measuring standard parameters, e.g. vapour pressure, distillation characteristics, cloudpoint, pour point, flash point etc. Recent developments.

INSTR C411 Opto-Electronic Instruments 3 0 3

Optical radiation-its emission, control and detection; optical signal processing; amplifiers and associated electronic equipments. Opto-electronic system design-calorimeters, spectrophotometers, flame photometers, fluorimeter and turbidimeters; project equipments; introduction to laser-based instruments.

INSTR C414 Telecommunication Switching Systems and Networks 3 0 3

Course description is same as given under CS C414.

INSTR C421 Digital Systems 3 0 3

Prerequisite: EEE C391 or INSTR C391

Analysis and design of combinational and sequential digital circuits; data converters - A/D, D/A, V/F and F/V converters; special semiconductor devices, displays, ROM, RAM and their applications in instrumentation, digital instruments; programmable digital testing systems; electronic programmers; introduction to microprocessors, microprocessor based instruments and systems for measurement and control.

INSTR C444 Real-Time Systems 3 0 3

Course description is same as given under CS C444.

INSTR C451 Process Control 3 0 3

Prerequisite : AAOC C321

Course description is same as given under CHE C441.

INSTR C461 Power Electronics 3 0 3

Course description is same as given under EEE C461.

INSTR C471 Electronic Measurements and Instrumentation 3 0 3

Course description is same as given under EEE C471.

INSTR C481 Medical Instrumentation 3 0 3

Course description is same as given under EEE C432.

INSTR C491 Special Projects 3

Course description is same as given under BIO C491.

INSTR F211 Electrical Machines 3 1 4

Transformer: Constructional features, equivalent circuit and phasor diagram - regulation and efficiency, parallel operation. Three phase transformer connections; Harmonic in transformers; Testing; Phase conversion; Autotransformer. D.C Machines: Construction, armature windings, armature voltage and torque equations, classification. D.C generators, performance characteristics; D.C motors - torque/speed characteristics, speed control and braking. Testing and efficiency. Induction machines: Constructional features and rotating magnetic field. Circuit model and phasor diagram. Steady state characteristics. Testing, starting and speed control. Time harmonics and space harmonics. Wound rotor induction motors, Single phase induction motors - classification and equivalent circuit. Synchronous machines: Constructional features; synchronous generators and motors; equivalent circuit and phasor diagram; power and torque characteristics and capability curves. Parallel operation. Salient pole synchronous machine - phasor diagram and determination of synchronous reactances; starting and speed control of

synchronous motors. Special machinesuniversal motors, Induction generators.

INSTR F212 Electromagnetic Theory 3 0 3

Course description is same as given under PHY F212 Electromagnetic Theory I.

INSTR F214 Electronic Devices 3 0 3

Crystal structure and growth of semiconductor, electrical conduction in solids, Elementary quantum physics (Photoelectric effect, uncertainty principle, Schrodinger wave equation and tunneling), energy bands in solids, charge carriers in semiconductors, excess carriers in semiconductors, Fabrication of p-n junctions, equilibrium conditions, forward and reverse biased junctions, metal semiconductor junctions Bipolar junction transistors, field effect transistors (JFET, HEMT, MOSFET),Special diodes (varactor diode, solar cell, LEDs, Tunnel diode and HBT), dielectric materials and insulation (Polarization mechanisms, frequency dependence, dielectric strength and insulation breakdown).

INSTR F215 Digital Design 3 1 4

Boolean Algebra & logic minimization; combinational logic circuits : arithmetic circuit design , Design using MSI components; Sequential Logic Circuits : flip flops & latches, registers and counters, Finite state machine ; HDL Implementation of Digital circuits; Digital Integrated Circuits; Programmable logic devices; Memory organization ; Algorithmic State machine; Introduction to computer organization; The course will also have laboratory component on digital design.

INSTR F241 Microprocessors and Interfacing 3 1 4

Programmers model of processor, processor architecture; Instruction set, modular assembly programming using subroutines, macros etc.; Timing diagrams; Concept of interrupts: hardware & software interrupts, Interrupt handling techniques, Interrupt controllers; Types of Memory & memory interfacing; Programmable Peripheral devices and I/O Interfacing ; DMA controller and its interfacing: Design of processor based system. This course will have laboratory component.

INSTR F242 Control Systems 3 0 3

Modeling and classification of dynamical systems, Properties and advantages of feedback systems, time-domain analysis, frequency-domain analysis, stability and performance analysis, State space analysis, controller design.

INSTR F243 Signals & Systems 3 0 3

This course is intended to provide a comprehensive coverage of Signals and Systems, a fundamental subject of Electrical Engineering. The topics covered are: Continuous-time and discrete time signals and systems, convolution, properties of linear time-invariant (LTI) systems, Fourier series, Fourier transform, Z transform, Laplace transform; System analysis, frequency response, analog filters, Sampling and reconstruction.

INSTR F244 Microelectronic Circuits 3 0 3

Basic microelectronic circuit analysis and design, biasing in discrete and integrated circuit amplifiers, an overview of modeling of microelectronic devices single and two transistor amplifier configurations with passive and active loads; current mirrors & current sources; single-ended and differential linear amplifiers , differential and multistage amplifiers; 2 stage CMOS OPAMP, frequency response of amplifiers; negative feedback in amplifiers, R-C frequency compensation.

INSTR F266 Study Project 3

Course description is same as given under BIO F266.

INSTR F311 Electronic Instrumentation & Instrumentation Technology 3 1 4

Electronic indicating, display, recording and analysis instruments, signal generators, frequency synthesizer, counters, elements of design, grounding and shielding, electronic circuits manufacturing technology, metrology, standards in quality management, instrumentation in hazardous area, industrial communication techniques.

INSTR F312 Transducers and Measurement Systems 3 0 3

Course description is same as given under INSTR C381.

INSTR F313 Analog & Digital VLSI Design 3 0 3

Moore's Law, Y chart, MOS device models including Deep Sub-Micron effects; an overview of fabrication of CMOS circuits, parasitic capacitances, MOS scaling techniques, latch up, matching issues, common centroid geometries in layout. Digital circuit design styles for logic, arithmetic and sequential blocks design; device sizing using logical effort; timing issues (clock skew and jitter) and clock distribution techniques; estimation and minimization of energy consumption; Power delay trade-off, interconnect modelling; memory architectures, memory circuits design, sense amplifiers; an overview of testing of integrated circuits. Basic and cascaded NMOS/PMOS/CMOS gain stages, Differential amplifier and advanced OPAMP design , matching of devices, mismatch analysis, CMRR, PSRR and slew rate issues, offset voltage , advanced current mirrors; current and voltage references design, common mode feedback circuits, Frequency response, stabilty and noise issues in amplifiers; frequency compensation techniques.

INSTR F341 Analog Electronics 3 1 4

Introduction to operational amplifiers: The difference amplifier and the ideal operational amplifier models, concept of negative feedback and virtual short; Analysis of simple operational amplifier circuits; Effects of real operational amplifier parameters on circuit perfor-

mance. Linear applications of operational amplifiers: Instrumentation and Isolation amplifiers; Current and voltage sources; Active filters. Non-linear applications of operational amplifiers: Comparators; Linearization amplifiers; Logarithmic amplifiers, multifunction modules & circuits, true rms convertors, Precision and signal conditioning circuits, Waveform Generation: sinusoidal and non-sinusoidal signal generation; Wave shape converters. Timer 555 based circuits, Phase lock loop circuits & applications, IC regulators, Output stage and large signal amplifiers, Power amplifiers, Tuned amplifiers, Analog and Digital interface circuits: A/D, D/A Converters.

INSTR F342 Power Electronics 3 1 4

Need for power conversion; Power electronic converters: classifications and scope; Power semiconductor switches: diodes, SCR , GTO and transistors (BJT, MOSFET and IGBT): Ratings, static and dynamic characteristics, drive and switching aid circuits and cooling; DC to DC conversion: Buck, Boost and Buck-Boost converters: circuit configuration and analysis with different kinds of loads; Choppers: single quadrant and two quadrant operation with DC motor load and steady state analysis; Rectifiers: single phase and three phase operation, power factor, harmonics and effect of source inductance; Dual converters; Drive concept: Four quadrant drive and load characteristics, selection of motor, control and stability of electric drives, feed back control of drives; DC motor drive; Inverters: single phase and three phase bridge inverters and PWM inverters; Single phase AC voltage regulators and cycloconverter; Induction motor drive - Variable frequency operation of 3- phase induction motor, stator voltage control and V/f control methods; Non-drive application of power electronic converters: UPS, active power line conditioner, electronic ballast and induction.

INSTR F343 Industrial Instrumentation and Control 3 0 3

Course description is same as given under INSTR C312.

INSTR F366 Lab Project 3

INSTR F367 Lab Project 3

Course description is same as given under BIO F366 and BIO F367.

INSTR F376 Design Project 3

INSTR F377 Design Project 3

Course description is same as given under BIO F376 and BIO F377.

INSTR F411 Opto-Electronic Instruments 3 0 3

Course description is same as given under INSTR C411.

INSTR F412 Analysis Instrumentation 3 0 3

Course description is same as given under INSTR C392.

INSTR F413 Advanced Process Control 3 0 3

Course description is same as given under CHE C473.

INSTR F414 Telecommunication Switching Systems & Networks 3 0 3

Course description is same as given under CS C414.

INSTR F415 Digital Control 3 0 3

Course Description is to be developed.

INSTR F419 Virtual Instrumentation 3 1 4

Fundamentals of virtual instrumentation**---** Concept of virtual instrumentation – PC based data acquisition – Typical on board DAQ card – Resolution and sampling frequency - Multiplexing of analog inputs – Single-ended and differential inputs – Different strategies for sampling of multi-channel analog inputs. Concept of universal DAQ card - Use of timer-counter and analog outputs on the universal DAQ card. Concepts of graphical programming – Lab-view software – Concept of VIs and sub VI - Display types – Digital – Analog – Chart – Oscilloscopic types – Loops – Case and sequence structures - Types of data – Arrays – Formulae nodes –Local and global variables – String and file I/O., Analysis tools and simple applications **:**Fourier transform - Power spectrum - Correlation – Windowing and filtering tools – Simple temperature indicator – ON/OFF controller – P-I-D controller - CRO emulation - Simulation of a simple second order system.

INSTR F420 Design of Instrumentation Systems 3 0 3

Design of transducers, signal conditioning circuits, instrument air system, control valve, control panel design, Human machine interface, Reliability, Electronic product design, Noise reduction, P&I diagrams, safety instrumentation systems, life cycle activities: requirement specifications, I&C system design and implementation, system integration, validation, operation maintenance, case studies of ISD in various sectors.

INSTR F422 Instrumentation for Petrochemical Industry 3 0 3

Petroleum Processing: Petroleum exploration – Recovery techniques – Oil - Gas separation –Processing wet gases - refining of crude oil, Unit Operations in Petroleum Industry: Measurement in Petrochemical Industry: Parameter to be measured in refinery and petrochemical industry – Selection and maintenance of measuring instruments – Intrinsic safety of instruments Control Loops in Petrochemical Industry: Process control in refinery and petrochemical industry – Control of distillation column control of catalytic crackers and pyrolysis , Automatic control of polyethylene production – Control on vinyl chloride and PVC production.

INSTR F432 Medical Instrumentation 3 0 3

Course description is same as given under EEE C432.

INSTR F473 Wind Electrical Systems 3 0 3

Course description is same as given under EEE F473.

INSTR F491 Special Projects 3

Course description is same as given under BIO F491.

INSTR G611 Advanced Control Systems 3 2 5

Review of State variable modelling of linear continuous, linear discrete and non linear control systems; Time varying systems; Time domain solution; Controllability and observability; Stability; direct method of Lyapunov; Modal control; Optimal

Control System; Calculus of variation, Minimum principle, dynamic programming, search techniques, Ricatti equation, Stochastic processes and Stochastic estimation and control; Adaptive Control system.

INSTR G612 Instrumentation Systems 2 2 5

Course description is same as given under BITS G654.

INSTR G621 Industrial Automation 3 2 5

Computer control theory, sampling of continuous time signals, computer oriented mathematical models, discrete time systems, and analysis of the same, translation of analog design, state space design methods, pole-placement design based on input/output models. Adaptive control principles, implementation of digital controllers, model reference adaptive systems, self-tuning regulators, stochastic adaptive control, auto-tuning, expert controllers, learning systems and other applications.

Information Systems

IS C311 Computer Concepts and Software Systems 3 0 3

Computer Structures; Machine and Assembly languages; Computer Architecture and Operating Systems; Operating Environment for Application Programs.

IS C312 Information Analysis 3 0 3

Software Requirements; Problem Identification and Feasibility Assessment; Notations for Problem Analysis like Data Flow Diagrams, Data Dictionaries and Entity-Relation Diagrams; Requirements Analysis Techniques like SADT and Object-Oriented Analysis; Software Requirements Specification; Behavioural and Non-Behavioural Requirements Specification; Requirements Prototyping; CASE Tools and Applications.

IS C313 Object Oriented Programming and Design 3 2 4

Course description is same as given under CS C313.

IS C314 Software Development for Portable Devices 2 2 3

(= CS C314)

Course description is same as given under CS C314.

IS C321 Program, Data and File Structures 3 0 3

Problem-solving using a high level programming language; Data abstraction and structuring; Data structures such as Stacks, Queues, Lists, Trees and Graphs and their implementation; Algorithms; Recursion; Sorting and Searching techniques; Files and file structures.

IS C331 Personal Computers and Computing 1 4 3

Personal Computers, State of Art of Personal Computing; Operations and Programming; Study and Practice of General Purpose Software Packages on PCs.

IS C332 Database Systems and Applications 3 0 3

Introduction to Database Management Systems; File organization; Data Independence in databases; Data Models; Query processing systems; Database Design techniques; Concepts of security and integrity in databases; Distributed Databases; Applications using DBMS.

IS C341 Software Engineering 3*

Prerequisite: TA C252

Course description is same as given under BITS C461.

IS C342 Structures of Programming Languages 3 0 3

Programming paradigms and programming languages; programming language processors;

syntax and semantics, binding; data types, structures; abstract data types; sub-program structure; sequence control; recursion; data control; storage management; syntax; translation; operating and programming environments; some theoretical models; case studies from some popular and widely used programming languages.

IS C351 Computer Organization and Architecture 3 2 4

Overview of logic design; Instruction set architecture; Assembly language programming; Pipelining; Computer Arithmetic; Control unit; Memory hierarchy; Virtual memory; Input and output systems; Interrupts and exception handling; Implementation issues; Case studies; This course covers the fundamentals of computer organization and architecture from a programmer's perspective.

IS C352 Management Information Systems 3 0 3

Course description is same as given under BITS C471.

IS C362 Operating Systems 3 0 3

Course description is same as given under CS C372.

IS C363 Data Structures and Algorithms 3 2 4

Course description is same as given under CS C363.

IS C411 Information Systems Project 3*

Practical work to be conducted through a project on analysis, planning and design of an information system.

IS C415 Data Mining 3 0 3

Course description is same as given under CS C415.

IS C421 Modelling and Decision Systems 3 0 3

Principles of decision making; modelling, tools of decision making, Decision Support Systems; Study work on available decision systems & packages.

IS C422 Parallel Computing 3 0 3

Course description is same as given under CS C422.

IS C424 Software for Embedded Systems 3 0 3

Course description is same as given under CS C424.

IS C431 Educational Software 1 4 3

Principles of text editing; elementary graphics; concepts of motion and animation; Visual effects in illustrations; design of simple educational software for elementary level subjects.

IS C442 Advanced Algorithms and Complexity 3 0 3

Course description is same as given under CS C442.

IS C444 Real-Time Systems 3 0 3

Course description is same as given under CS C444.

IS C446 Data Storage Technologies and Networks 3 0 3

Course description is same as given under CS C446 Data Storage Technologies and Networks.

IS C461 Computer Networks 2 2 3

Course description is same as given under CS C461.

(Prerequisite: IS C362 Conc.)

IS C462 Network Programming 3 0 3

Overview of computer networks; inter-process communication; network programming; socket interface; client-server computing model: design issues, concurrency in server and clients; external data representation; remote procedure calls; network file systems; distributed systems design.

IS C471 Computer Graphics 2 2 3

Course description is same as given under CS C471.

IS C472 Geographical Information Systems 3 0 3

Introduction to geographical information systems, theory and applications of GIS, data sensing and collection, fundamental database concepts, fundamental spatial concepts, models of spatial information, representation & algorithms, structures & access methods, architectures and interfaces, data output and display techniques, next generation systems.

IS C481 Graphical User Interfaces 3 0 3

Course description is same as given under CS C481.

IS F211 Data Structures & Algorithms 3 1 4

The course description is same as given under CS F211.

IS F213 Object Oriented Programming 3 1 4

The course description is same as given under CS F213.

IS F214 Logic in Computer Science 3 0 3

The course description is same as given under CS F214.

IS F222 Discrete Structures for Computer Science 3 0 3

The course description is same as given under CS F222.

ISF241 Digital Electronics and Microprocesors 3 1 4

Binary logic gates; logic circuits; Boolean algebra and K-map simplification; number systems and codes; arithmetic logic units; flipflops; registers and counters; introduction to microprocessors; architecture; instruction set and programming; memory and I/O interfacing; examples of system design.

IS F242 Computer Organization 3 1 4

This course covers the fundamentals of computer organization and architecture. Computer system components; Interconnection structures; Instruction set architecture; Computer arithmetic; Memory system; I/O systems; Control unit design; Instruction execution and scalar pipelining; Parallel processing and Super scalar pipelining; Introduction to parallel processing architecture including multi-core systems.

IS F243 Database Systems & Application 3 1 4

Introduction to Database Management Systems; Data Independence in databases; DBMS architecture; Data Models; Relational Model; Query Languages: Relational Algebra and SQL, Database Design techniques; Normalization; Data Organization; File Systems and Indexing; Concepts of security and integrity in databases; Transaction Processing ; Query processing and optimization; DBMS based application development; internet applications XML data management; multimedia databases; Distributed Databases.

IS F266 Study Project 3

Course description is same as given under BIO F266.

IS F301 Principles of Programming Languages 2 0 2

The course description is same as given under CS F301.

IS F303 Computer Networks **3 1 4**

The course description is same as given under CS F303.

IS F311 Computer Graphics **3 0 3**

Graphics I/O hardware; Generation of dot, lines, conics, curves, surfaces & polygons; Filling closed regions, 2D & 3D Graphics & Transformations, Windowing, Viewing & Clipping, Efficient algorithms, Solid Modeling, Color Models & Dithering, Visible surface detection, Rendering, Animation Techniques, Advanced modeling and Future directions.

IS F322 Software Testing **2 1 3**

Brief description of importance of software, Life cycle model and process, Basic software testing, all definitions, Types of testing and techniques (CFG, CDG etc.), Black Box & white box Testing Methodologies, Finite State Machine Model, State based Testing, Static Testing and analysis, Test cases, Test Data Generation ,Test selection ,Minimizations and Prioritization, Test adequacy criteria, Software Testing on Web Engineering, Object based Software Testing, Architecture of Testing tool, Software Test Effort Estimation, Testing behavior and process model, Qualitative analysis, Quality factors in software testing, Selection of testing tools.

IS F341 Software Engineering **3 1 4**

Ethics of software Engineering (ACM/IEEE code of Ethics),Type of Software, Application of Software ,Software Life Cycle Model, Agile Modeling Requirement Engineering, Object Oriented Analysis and Design(using UML), Introduction of Web Engineering, Software Integration and Testing, Support Processes and Software Quality, Software change Management, Software Product and Process Metrics Measurement, Software Project Management ,Scheduling ,Staff Measurement, Risk Management, Componnet based Software Engineering, Quality and Reliability Model, Maturity Models , Software Reengineering, deployment models.

IS F342 Compiler Design **2 1 3**

Introduction - Compilation and Execution Environments -Compilers and Interpreters – Requirements and Motivation; Front-end and Back-end of compilers/interpreters; Intermediate Representation and Intermediate Languages; Compile Time vs. Execution Time; Translators, and Assemblers; Virtual Machine - Just-in-Time Compilers. Structure of a Compiler – Phases and Passes. In-memory data - intermediate versions of code, symbol table. Lexical Analysis: Regular expressions and DFA (introduction where needed), Defining tokens using regular expressions, Designing and implementing scanners / lexical analyzers. Parsers: Context Free Languages (introduction where needed)and Recognizing CFLs. Parsing techniques – LL , LR - LR (0),LR(1), LALR) . Intermediate Representation: Parse Trees and Abstract Syntax Trees; 3-address code. Semantic Analysis. Back End Phases: Machine Independent optimizations: Loop Optimization Techniques - Loop Unrolling, Induction variable based optimization, Loop-Invariant code elimination. Procedure Call Optimization, and Dead Code Elimination. Target Code Generation : Data Flow Analysis, Register Allocation, Instruction Selection & Scheduling. Memory Management : Memory allocation support, Memory- de-allocation – Garbage Collection Techniques. Advanced Topics :Issues in compiling Object Oriented Languages, Functional Languages, Concurrent Languages, Script & Query Languages.

IS F366 Lab Project **3**

IS F367 Lab Project **3**

Course description is same as given under BIO F366 and BIO F367.

IS F376 Design Project **3**

IS F377 Design Project **3**

Course description is same as given under BIO F376 and BIO F377.

IS F372 Operating Systems **3 0 3**

Introduction to operating systems; Various approaches to design of operating systems ; Overview of hardware support for 0perating systems; Process/thread management: synchronization and mutual exclusion, inter process communication, CPU scheduling approaches ;Memory management: paging, segmentation ,virtual memory, page replacement algorithms ; File systems: design and implementation of file systems; Input /Output systems; device controllers and device drivers; Security and protection ; Case studies on design and implementation of operating system modules.

IS F462 Network Programming **3 0 3**

Course description is same as given under IS C462 Network Programming.

IS F491 Special Projects **3**

Course description is same as given under BIO F491.

Internet Technology & e-Business

ITEB G511 Overview of e-Business **3**

e-Business Environment and Opportunities: Background; e-Business evolution; e-Business environment; Diverse opportunities in e-Business; e-Businesses on the Internet. Categories of e-Business - B2B/E2EI, B2C, C2C; Overview of e-Business implementation technologies. e-Business Models - Enterprise portal, CRM, ERP, Supply Chain Planning (SCP), Transport Management System (TMS), Warehouse Management System (WMS), Content Management. e-Business Products-Development products; integration products; generic tools; performance analyzer tools; content management tools; component generator tools. Electronic Transaction and Security – Online

payment system and security issues; Secure Transport Protocols, Secure Transactions, Secure Electronic Payment Protocol (SEPP), Secure Electronic Transaction (SET); Security features – certificates for authentication (SSL, third party certifications); security on Web servers and Enterprise Network. Emerging e-Businesses Scenario- Changing economic considerations; Emerging business opportunities and revenue models; emerging technologies; Social aspects.

ITEB G521 e-Business Technologies I 4

Overview of E-Business Architecture- DNA concept; Evolution of DNA – 3-tier and n-tier; Introduction to Presentation, Business and Data layers; HTTPS, Secure Socket Layer, Firewall, Proxy, Network Address Translator. Internet Servers – IIS, Netscape and Apache Servers; Installation, configuration and administration. Presentation Layer – HTML, DHTML, XML, CGI, Perl Script, Java Script; MS Platform – ASP, Active X controls, VB Scripts; SUN Platform- JSP, Java Applets. Business Layer - Technology/computing-COM/DCOM, COM+, CORBA, Java Servlets, EJB.

ITEB G522 e-Business Technologies II 4

Business Layer – Application servers- Weblogic, ATG Dynamo, Websphere, Coldfusion, iPlanet; Transaction Servers- MTS, Jaguar CTS, Tuxedo; MOM Servers-MSMQ, MQ Series, third party MOM servers. Data Layer – Data warehousing concepts; OLAP- concept and tools; XML support in ORACLE and SQL server; ADO, ODBC/JDBC, OLEDB. Case studies using Microsoft and Sun Technologies.

ITEB G621 Supply Chain Management 4

Customer driven strategies in production and distribution systems; Integrated production & distribution networks; SCM in the context of JIT and MRP-II; Distribution Resource Planning; Management of dealer networks; Total Quality Control & product innovation across the supply chain; Incoming logistics & supplier relationships; Value addition analysis; Metrics for management of supply chain performance; Mathematical models and computer assisted decision support for SCM; mathematical programming for SCM.

ITEB G542 Knowledge Management 3

Increasing knowledge work in organizations; technologies to support growth of knowledge work in organizations; scope, cost, efficiency and reliability of technologies to support knowledge work; role of knowledge in an enterprise; knowledge management process; knowledge management strategies; human aspects of knowledge management; knowledge management technologies; applications of technologies to be covered through cases, reading assignments and use of appropriate software.

ITEB G552 Change Management 3

Nature of organizational change; change management; change perspectives and paradigms; Action Research Teaming; Understanding the human change process; need and opportunity in change initiatives; teamwork; data based change process; motivating and enabling change; becoming an effective change leader; change management competencies and its development.

Japanese

JAP N101T Beginning Japanese 3 0 3

Basic Japanese scripts (Hiragana, Katakana and Kanji); constructing words using Hiragana and Katakana and understanding their meanings; forming sentences, understanding their meanings, learning the related Kanjis; listening and reading comprehension, conversion practice, revision and additional practice through audio cassettes.

Mathematics

MATH C191 Mathematics I (Advanced Calculus) 3 0 3

Functions and graphs; limit and continuity; applications of derivative and integral. Conics; polar coordinates; convergence of sequences and series. Maclaurin and Taylor series. Partial derivatives. Vector calculus in R^n; vector analysis; theorems of Green, Gauss and Stokes.

MATH C192 Mathematics II (Complex Variables and Linear Algebra) 3 0 3

Complex numbers, analytic functions, Cauchy's theorems; elementary functions; series expansions; calculus of residues and applications.

Vector space; basis and dimension; linear transformation; range and kernel of a linear transformation; row reduction method and its application to linear system of equations.

MATH C222 Discrete Structures for Computer Science 3 0 3

Introduction to discrete mathematical structures; Formal logic and predicate calculus; Sets, relations and functions; Proof techniques; Graphs and trees; Primes, factorization, greatest common divisor, residues and application to cryptology; Boolean algebra; Permutations, combinations and partitions; Recurrence relations and generating functions; Introduction to error-correcting codes; Formal languages and grammars, finite state machines.

MATH C231 Number Theory 3 0 3

Primes and factorization; division algorithm; congruences and modular arithmetic; Chinese remainder theorem Euler phi-function and primitive roots of unity; Gauss's quadratic reciprocity law; applications to periodic decimals and periodic continued fractions.

MATH C241 Mathematics III (Differential Equations) 3 0 3

Eigen-values and eigen-vectors. Inner product space and orthonormal bases. Elementary differential equa-

tions, Hypergeometric equations, Lengendre polynomials, Bessel functions; Fourier series; Sturm-Liouville problem, series solution for differential equation, systems of first order equations; Laplace transformation and application to differential equations; one dimensional wave equation, one dimensional heat equation & Laplace equation in rectangular form.

MATH C311 Algebra I **3 0 3**

Groups, subgroups, a counting principle, normal subgroups and quotient groups, Cayley's theorem, automprhisms, permutation groups, and Sylow's thorems.

Rings, ring of real quaternions, ideals and quotient rings, homorphisms, Eculidean rings, polynomial rings, and polynomials over the rational field.

MATH C312 Algebra II **3 0 3**

Prerequisite: MATH C311

Dual spaces, modules, fields, finite fields, extension of fields: algebraic extension, separable and inseparable extension, normal extension, sptitting fields, Galois extension, and Galois group.

The algebra of linear transformations, characteristic roots and characteristic vectors, canonical forms: triangular form, nilpotent form, and Jordan form.

MATH C321 Elementary Real Analysis **3 0 3**

Countability and uncountability of sets; real numbers; limits and continuity; compactness and connectedness in a metric space; Riemann integration; uniform convergence.

MATH C322 Measure and Integration **3 0 3**

Prerequisite: MATH C321

Lebesgue measure and integration in real numbers, Convergence and Convergence theorems, absolutely continuous functions, differentiability and integrability, theory of square integrable functions, and abstract spaces.

MATH C331 Introduction to Topology **3 0 3**

Metric Spaces; Topological Spaces – subspaces, Continuity and homoeomorphism, Quotient spaces and product spaces; separation Axioms; Urysohn's Lemma and Tietze extension Theorem; Connectedness; Compactness, Tychonoff's Theorem, Locally Compact Spaces; Homotopy and the fundamental group.

MATH C332 Introduction to Functional Analysis **3 0 3**

Prerequisite: MATH C321

Banach spaces; fundamental theorems of functional analysis; Hilbert space; elementary operator theory; spectral theory for self-adjoint operators.

MATH C352 Differential Geometry **3 0 3**

Prerequisite: MATH C321

Curve in the plane and 3D-space; Curvature of curves; Surfaces in 3D-space; First Fundamental form; Curvature of Surfaces; Gaussian and mean Curvatures; Theorema Egreguim; Geodesics; Gauss-Bonnet Theorem.

MATH C353 Statistical Inference and Applications **3 0 3**

(Prerequisite: AAOC C111 Probability and Statistics)

Review of elements of probability and statistical methods, Classical Decision theory including parametric and non-parametric methods for testing of hypotheses, Analysis of Variance: One way and two way classifications, Design of experiments: Analysis of Completely randomized design, Randomized block design and Latin square design with one or more missing values, Statistical Quality control for variables and measurements.

MATH C411 Complex Analysis **3 0 3**

A rigorous treatment of the theory of analytic functions of complex variables including Cauchy's theorems; maximum modulus theorem; the principles of argument; Jensen's formula; Mittag Lefler theorem; Weierstrass canonical products and analytic continuation.

MATH C412 Concepts of Geometry **3 0 3**

Euclidean geometry and non-Euclidean geometries; affine and projective geometry; synthetic projective geometry, duality, perspectiviy, projectivity, coordinatization; analytic projective geometry, polarities, involutions, conics, finite geometries and their applications.

MATH C413 Topological Groups **3 0 3**

Basic concepts and eamples; compact and locally compact groups; integration on locally compact groups; convolutions of functions and measures; representation theory; characters and duality theory; applications.

MATH C421 Combinatorial Mathematics **3 0 3**

Course description is same as given under CS C451.

MATH C422 Algebraic and Differential Topology **3 0 3**

Fundamental group; universal covering space; simplicial approximation; simplicial homology theory; differentiable structures and smoothness; ideas of curvature.

MATH C431 Distribution Theory **3 0 3**

Prerequisite: MATH C321

C-infinity functions, distributions and their derivatives; support, convolution and regularization; distributions of finite order; multiplication of distributions; Fourier transforms of distributions; temperate distributions and their Fourier transforms; fundamental solutions.

MATH C441 Discrete Mathematical Structures 3 0 3

Course description is same as given under CS C453.

MATH C451 Ordinary Differential Equations 3 0 3

Existence and uniqueness theorems; properties of linear systems; behaviour of solutions of nth order equations; asymptotic behaviour of linear systems; stability of linear and weakly nonlinear systems; conditions for boundedness and the number of zeros of the nontrivial solutions of second order equations; stability by Liapunov's direct method; autonomous and nonautonomous systems.

MATH C452 Partial Differential Equations 3 0 3

Non linear equations of first order, Charpits Method, Method of Characteristics; Elliptic, parabolic and hyperbolic partial differential equations of order 2, maximum principle, Duhamels principle, Greens function, Laplace transform & fourier transform technique, solutions satisfying given conditions, partial differential equations in engineering & science.

MATH C461 Integral Equations 3 0 3

Classification of integral equations; modelling of problems as integral equations; Volterra equations of the first and second kind; Green's functions; Fredholm equations with degenerate kernels and symmetric kernels; Fredholm equations of the second kind; existence of solutions; numerical solutions.

MATH C471 Nonlinear Optimization 3 0 3

Introduction; convexity and cones; Kuhun Tucker theory; unconstrained and constrained optimization; gradient methods; polynomial optimization; penalty function; generalized convex functions; duality in nonlinear programming; optimality criterion for generalised convex functions; fractional programming.

MATH C481 Commutative Algebra 3 0 3

Modules; direct sums and products; finitely generated modules, exact sequences; tensor product of modules; rings and modules of fractions; localization; Noetherian modules and primary decompositions; integral dependence and valuation theory; integrally discrete valuation rings and Dedekind domains; fractional ideals.

MATH C491 Special Projects 3

Course description is same as given under BIO C491.

MATH D021 Remedial Mathematics 5 0 5

Algebra: Number systems; quadratic equations; progression; permutations and combinations; binomial theorem; vectors, matrices and determinants. Coordinate Geometry: Systems of coordinates, equation of a line and a circle.

Trigonometry: Trigonometric functions, heights and distances; trigonometric identities; sum and product formulae; properties of triangles.

Calculus: Functions and graphs; limits; derivatives of simple functions and their applications; integral as antiderivative; methods of integration; definite integral.

MATH F111 Mathematics I 3 0 3

Course description is same as given under MATH C191.

MATH F112 Mathematics II

Course description is same as given under MATH C192.

MATH F113 Probability & Statistics 3 0 3

Course description is same as given under AAOC C111.

MATH F211 Mathematics III 3 0 3

Course description is same as given under MATH C241.

MATH F212 Optimization 3 0 3

Course description is same as given under AAOC C222.

MATH F213 Discrete Mathematics 3 0 3

Logic and methods of proof, Elementary Combinatorics, recurrence relations, Relations and digraphs, orderings, Boolean algebra and Boolean functions.

MATH F214 Elementary Real Analysis 3 0 3

Course description is same as given under MATH C321.

MATH F215 Algebra-I 3 0 3

Course description is same as given under MATH C311.

MATH F231 Number Theory 3 0 3

Course description is same as given under MATH C231.

MATH F241 Mathematical Methods 3 0 3

Integral Transforms: Fourier, Fourier sine/cosine and their inverse transforms (properties, convolution theorem and application to solve differential equation), Discrete Fourier Series, Fast Fourier transform, Calculus of Variation: Introduction, Variational problem with functionals containing first order derivatives and Euler equations, Variational problem with moving boundaries. Integral equations: Classification of integral equations, Voltera equations, Fredholm equations, Greens functions.

MATH F242 Operations Research 3 0 3

Course description is same as given under AAOC C312.

MATH F243 Graphs and Networks 3 0 3

Course description is same as given under AAOC C221.

MATH F244 Measure and Integration **3 0 3**

Course description is same as given under MATH C322

MATH F266 Study Project **3**

Course description is same as given under BIO F266.

MATH F311 Introduction to Topology **3 0 3**

Course description is same as given under MATH C331.

MATH F312 Ordinary Differential Equations **3 0 3**

Course description is same as given under MATH C451.

MATH F313 Numerical Analysis **3 0 3**

Course description is same as given under AAOC C341.

MATH F314 Algebra II **3 0 3**

Course description is same as given under MATH C312.

MATH F341 Introduction to Functional Analysis **3 0 3**

Course description is same as given under MATH C332.

MATH F342 Differential Geometry **3 0 3**

Course description is same as given under MATH C352.

MATH F343 Partial Differential Equations **3 0 3**

Course description is same as given under MATH C452.

MATH F344 Mathematical Fluid Dynamics **3 0 3**

Introduction to the Fluid Dynamics and Fundamental Concepts, Langrange and Eulerian Descriptions, Continuum hypothesis, Conservation of Mass based on different approaches, Equation of Continuity in different Coordinates,Potential Flow, Laplace Equation, one-,two- and three-dimensional flow, Conservation of Linear Momentum,Euler's Equation,Bernoulli's equation, Constitutive equations for Newtonian Fluid, Navier-Stokes Equations, First Law of Thermodynamics, Reynolds number, Exact Solution of Navier-Stocks Equation, Boundary Layer Approximations, Setting up the Boundary-Layer Equations, Limit Equation For the Flat Plate, Discussion of Blasius' Equation, Description of Flow Past a Circular Cylinder, Decay of a Laminar Shear Layer.

Prerequisite:MATH-I(MATH F111),MATH-II(MATH F112) AND MATH-III (MATH F211)

MATH F353 Statistical Inference and Applications **3 0 3**

Course description is same as given under MATH C353.

MATH F354 Complex Analysis **3 0 3**

Course description is same as given under MATH C411.

MATH F366 Lab Project **3**

MATH F367 Lab Project **3**

Course description is same as given under BIO F366 and BIO F367.

MATH F376 Design Project **3**

MATH F377 Design Project **3**

Course description is same as given under BIO F376 and BIO F377.

MATH F420 Mathematical Modeling **3 0 4**

Elementary mathematical models; Role of mathematics in problem solving; Concepts of mathematical modeling; Pitfalls in modelling; System approach; formulation, Analyses of models; Sensitivity analysis, Simulation approach. One or more of the interrelated topics will be covered from the following: optimal harvesting models, Environmental models, traffic flow models, bio-fluid flow models, socio-economic models, financial models, stochastic models, etc. providing a fertile ground for interdisciplinary courses. The selection of topics will depend upon the circumstances and mutual interest of the current students and faculty

Pre-requisite: MATH F211 Mathematics III

MATH F421 Combinatorial Mathematics **3 0 3**

Course description is same as given under CS C451.

MATH F422 Numerical Methodology for Partial Differential Equations **3 1 4**

Classification of PDEs, nature of well-posed problems, interpretation of PDEs by characteristics and physical basis, appropriate boundary/initial conditions. Numerical methods for PDEs: Finite difference approximations to partial derivatives, Explicit and implicit schemes, Richardson Extrapolation Convergence, Stability and Consistency of Elliptic, Parabolic and Hyperbolic PDEs. Introduction to finite volume method, Computational experiments based on the algorithms

Prerequisite: MATH F211 (Mathematics III)

and MATH F313/CHE F242/CE F324

MATH F431 Distribution Theory **3 0 3**

Course description is same as given under MATH C431.

MATH F441 Discrete Mathematical Structures **3 0 3**

Course description is same as given under CS C453.

MATH F444 Numerical Solutions of Ordinary Differential Equations **3 0 3**

Introduction to ODEs, Numerical Techniques for One Step Methods, Convergence and Absolute Stability, Numerical techniques for Linear Multi-Step Methods,

Zero Stability, Consistency, Convergence, Predictor-Corrector methods, Absolute Stability of Predictor-Corrector methods, Stiff ODEs and its numerical methods, Finite Difference Methods to Linear and Nonlinear Boundary Value Problems, Stability and Convergence Analysis, Differential Algebraic Equations, Numerical techniques for Differential Algebraic Equations, Introduction to One dimensional Finite Element Methods, Comparison between Finite Difference Methods and Finite Element Methods, Variational formulation, Finite Element Approximation, Approximation Errors, Convergence of solution, Order of Convergence.

Pre-requisites: MATH F211 Mathematics III; and one of {MATH F313/ CE F324 Numerical Analysis; CHE F242 Numerical Methods for Chemical Engineers }

MATH F445 Mathematical Fluid Dynamics 3 0 3

Introduction to the Fluid Dynamics and Fundamental Concepts, Lagrange and Eulerian Descriptions, Continuum hypothesis, Conservation of Mass based on different approaches, Equation of Continuity in different Coordinates, Potential Flow, Laplace Equation, one-, two- and three-dimensional flow, Conservation of Linear Momentum, Euler's Equation, Bernoulli's equation, Constitutive equations for Newtonian Fluid, Navier-Stokes Equations, First Law of Thermodynamics, Reynolds number, Exact Solution of Navier-Stokes Equation, Boundary Layer Approximations, Setting up the Boundary-Layer Equations, Limit Equation For the Flat Plate, Discussion of Blasius' Equation, Description of Flow Past a Circular Cylinder , Decay of a Laminar Shear Layer

Prerequisite:

Mathematics-I (MATH F111), Mathematics-II (MATH F112) & Mathematics-III (MATH F211).

MATH F456 Cosmology 3 0 3

History of cosmological ideas, Observational overview of the universe, Expansion of the universe, Newtonian gravity, Friedman equation, the fluid and acceleration equations, Geometry of the universe, Infinite and observable universe, Big bang, Simple cosmological models, Hubble law, redshift, Observational parameters, the cosmological constant, the age of the universe, weighing the universe, dark matter, CMB, the early universe, Nucleosynthesis, Inflationary universe, Initial singularity, standard cosmological model, general relativistic cosmology, classic cosmology, neutrino cosmology, baryogensis, structure of the universe.

MATH F471 Nonlinear Optimization 3 0 3

Course description is same as given under MATH C471.

MATH F481 Commutative Algebra 3 0 3

Course description is same as given under MATH C481.

MATH F491 Special Projects 3

Course description is same as given under BIO F491.

MATH G511 Design and Analysis of Algorithms 5

Course description is same as given under CS G511.

MATH G512 Selected Topics in Advanced Mathematics for Engineering Situations 5

The topics may include mathematical theory of probability and stochastic processes, Graph theoretical techniques; information theory; pattern recognition; fuzzy sets.

MATH G521 Applied Functional Analysis 5

MATH G531 Number Theory 5

MATH G541 Advanced Methods in Discrete Mathematics 5

Course description for the above courses are to be developed.

MATH G611 Algebraic Number Theory 5

Localization, Galois extensions, Dedekind rings, discrete valuation rings; completion, unramified extensions, ramified extensions; the different and discriminant; cyclotomic fields, roots of unity, quadratic fields, relations in ideal classes; the unit theorem, Minkowski's constant, Zeta function.

MATH G612 Riemann Surfaces 5

Compact Riemann surfaces, algebraic functions, analytic continuations, branched coverings, study of line bundles, Riemann- Roch theorem, Serre duality theorem.

MATH G621 Fibre Bundles 5

Differential manifolds, tangent bundle, vector bundles, principal bundles, functorial properties, the Milnor construction, homotopy classification, Grassmannians, universal bundles, characteristic classes, introduction to K-theory.

MATH G622 Algebraic Geometry 5

Study of varieties, introduction to complex varieties, some ideas on schemes, complete varieties, cohomology of coherent sheaves.

MATH G632 Lie Groups and Lie Algebras 5

Lie groups: basic definitions, one parameter subgroups, maximal tori, representation theory; Lie algebras: basic definitions, solvable and nilpotent lie algebras, cartan subalgebras, roots and weights, simple lie algebras, classification theorem universal enveloping algebras, PBW theorem.

MATH G642 Complex Manifolds 5

Manifolds and vector bundles: manifolds, vector bundles, & operator & almost complex manifolds; sheaf theory: Sheaf cohomology & Cech cohomology; differential geometry: Hermitian differential geometry, canonical connection & curvature of Hermitian holomorphic bundles, Chern classes of bundles.

Master of Business Administration

MBA C311 Business Structure and Processes 4

Fundamental concepts, development of management theory, business forms, (proprietorship etc.); review of managerial functions (planning, organising, staffing, leading and controlling); business processes, structure and systems, socio-economic interface; overview of functional areas: operations/production, finance, accounting, personnel, marketing, materials, international business; developing an industrial culture.

MBA C312 Managerial Economics 3 0 3

Fundamental concepts, supply, demand, market mechanism; theory of demand (consumer behaviour); production, costs (theory of the firm); market structures (perfect competition, monopoly, monopolistic competition, oligopoly); circular flow of income, national income accounting, national income determination; money and banking, employment, interest, inflation.

MBA C314 Business Structure & Processes 3*

Fundamental concepts, development of management theory, business forms, (proprietorship etc.); review of managerial functions (planning, organizing, staffing, leading and controlling); business processes, structure and systems, socio-economic interface.

MBA C315 International Financial Markets & Services 3 0 3

Course description is same as given under FIN C312.

MBA C319 Negotiation Skills and Techniques 2 0 2

Course description is same as given under BITS C319.

MBA C320 Managerial Skills 2*

(= BITS C320)

Course description is same as given under BITS C320.

MBA C321 Legal and Economic Environment of Business 4*

Course description is same as given under BITS C321.

MBA C322 Management Framework & Functions 2 0 2

Overview of management, its role and range of applications, building blocks and interrelations, core concepts, functional and strategic areas, quantitative tools and techniques, issues and approaches to problem solving, developing professional perceptions and attitudes.

MBA C323Functions and Working of Stock Exchanges 3 0 3

Course description is same as given under CDP C323.

MBA C341 Investment Banking and Financial Services 3 0 3

Course description is same as given under FIN C341.

MBA C411 Organisational Behaviour 4

Evolution and relevance; perception emotions and learning in an organisational set up; attitudes and values, groups and group processes, leadership, power and politics, organizational change, resistance and development, managing conflict.

MBA C412 Human Resource Management 4

Strategic human resource management, manpower planning, job analysis, recruitment and selection, placement, induction, training and development, appraising and managing performance, compensation, employee discipline, workplace safety and health, collective bargaining, industrial relations, human resource accounting and audit.

MBA C413 Quantitative Methods 4

Grouping data, measures of central tendency and dispersion, probability distribution, sampling and estimation, testing hypotheses, chi-square and analysis of variance, regression and correlation, non-parametric methods, time series and forecasting, index numbers, decision theory, linear programming, transportation and assignment problems, queuing theory, network problems, simulation; application of statistical software (SYSTAT, SPSS, SIMULA8, etc.) and spreadsheets.

MBA C414 Technology Management 3 0 3

Course description is same as given under MGTS C414.

MBA C415 Financial and Management Accounting 4

Basic concepts, double entry accounting, journal, ledger, trial balance, profit & loss account, balance sheet, cash flow statement, financial statement analysis, ratio analysis, cost-volume-profit analysis, inventory valuation, inflation accounting, cost accounting and budgetary control systems, financial analysis and forecasting.

MBA C416 Corporate Finance and Taxation 4

Role and environment of managerial finance, time value of money (NPV, IRR), project feasibility, budgeting, long term investment decisions, long term financing decisions (LT & ST), capital structure, dividend decisions, short term financing decisions, working capital management, principles of corporate taxation, income tax, capital gains tax, tax laws and provisions, financial engineering.

MBA C417 Managerial Communication 4

Written communication: memos, letters, notices, agenda, minutes, resolutions, (project) proposals, reports; electronic communication: mail, privacy and workplace monitoring, teleconferencing; oral communication: group communications, presentations, public speaking, media; non-verbal communication, effective listening and feedback; reading skills.

MBA C418 Marketing 4

Definition, marketing research and forecasting demand, creating customer value, satisfaction and loyalty, analysing consumer and business markets, market segmentation, brand equity, brand positioning, product and pricing strategies, managing services, managing value networks and channels, integrated marketing communications, international marketing.

MBA C419 Production and Operations Management 4

Product & service design, plant location, aggregate planning, capacity, process, layout, sequencing & scheduling, line balancing, maintenance, quality (control, assurance, management), statistical quality control, queuing theory, project management. CPM, PERT.

MBA C421 Supply Chain Management 4

Purchase/procurement, stores, material handling systems, inventory analysis, inventory models, disposals, make or buy, outsourcing; vendor selection, development, and relations; Material requirements planning, manufacturing resources planning, ERP, JIT, inbound and outbound logistics, warehousing, transportation, packaging.

MBA C422 Business and Society 4

Corporate social responsibility, business ethics, policies, codes, standards, ethics and decision making, environmental and social issues, workplace diversity, fostering ethics at work (whistle blower policy); business and social etiquette, internet and online behaviour, etiquette and office electronics.

MBA C423 Business Policy and Strategic Management 4

Mission, vision, strategic intent, hierarchical levels of strategy, PEST analysis, SWOT analysis, industry analysis, organisational analysis, BCG matrix, GE matrix, core competencies, five force theory, value chain, competitive advantage, generic strategies, diversification, strategy implementation and control.

MBA C424 International Business 3 0 3

Course description is same as given under FIN C451.

MBA C425 R&D Management 3 0 3

Course description is same as given under STD C322.

MBA C426 Database Management Systems 4

Introduction to data bases and management; data files and structures; hierarchical, relational, network models; distributed data bases; query processing and query optimization, query languages; concepts of security and protection; case study of a data base system.

MBA C427 e-Business and Internet Marketing 4

e-business evolution & opportunities; categories of e-business; e-business models; network infrastructure & web based tools for e-business; e-business risks & risks management; network security and firewall; cryptography and authentication; billing/payment systems; regulatory environment of e-business; ERP/SCM/CRM and web based marketing; business intelligence & intelligent systems; data warehousing and data mining; implementing e-business systems & change management. Case studies and projects in e-business areas; emerging e-business scenarios.

MBA C428 Internet Security and Cyber Laws 4

Examination of issues related to network and information security, security concepts, security attacks and risks, security architectures, security policy management, security mechanisms, cryptography algorithms, security standards, security system interoperation and case studies of the current major security systems.

MBA C429 Recent Advances in ETM 4

Course description is to be developed.

MBA C431 Managerial Communication 2*

Business communication basics; issue interpretation, reformulation and summation; interviews, questionnaires and forms; presentation techniques; technology and communication; business correspondence; business documents; group communication and meetings; employment communication.

MBA C432 Risk Management and Insurance 3 0 3

Course description is same as given under FIN C413.

MBA C433 Advertising and Sales Promotion 3 0 3

Course description is same as given under FIN C433.

MBA C436 Strategic Financial Management 3 0 3

(Pre-requisite: ECON C481= FIN C342= MGTS C382 Financial Management or MBA C416 Corporate Finance and Taxation)

Course description is same as given under ECON C436.

MBA C437 Security Analysis and Portfolio Management 3 0 3

Course description is the same as given under CDP C313.

MBA C442 Consumer Behaviour 3 0 3

Course description is same as given under MGTS C442.

MBA C451 Internetworking Technologies 3 0 3

Course description is same as given under EA C451.

MBA C454 Project Appraisal 3 0 3

Course description is same as given under ECON C411.

MBA C462 Services Marketing 3 0 3

Course description is same as given under MGTS C462.

MBA C463 Industrial Marketing 3 0 3

Course description is same as given under MGTS C481.

MBA C471 Management Information Systems 3 0 3

Course description is same as given under BITS C471.

MBA C474 Retail Management Systems 3 0 3

Course description is same as given under EA C474.

MBA C475 Financial Engineering 3 0 3

Course description is same as given under EA C475.

MBA C481 Expert Systems 4

Course description is same as given under EA C481.

MBA C482 Creating & Leading Entrepreneurial Organizations 3 0 3

Course description is same as given under BITS C482.

MBA C483 Marketing Research 3 0 3

Course description is same as given under MGTS C483.

MBA C486 Product and Brand Management 3 0 3

Course description is same as given under BITS C486.

MBA C488 Services Management System 3 0 3

Course description is same as given under BITS C488.

MBA C489 Enterprise Resource Planning

Course description is same as given under BITS C489.

MBA C493 Business Analysis and Valuation 3 0 3

Course description is same as given under BITS C493.

MBA G512 Manufacturing Strategy 4

Course description is same as given under MM G512.

MBA G522 Total Quality Management 4

Course description is same as given under MM G522.

MBA G523 Project Management 4

Course description is same as given under CM ZG523

MBA G552 Total Productive Maintenance 4

Course description is same as as given under MM G552.

MBA G553 Organizational Change and Development 3 0 3

Business Organisation: The Domain of Change; Concept of Change; Perspectives on Organizational Change; Models of Change; Organizational Resistance to Change; Organizational Change and Change Agents; Strategic Management of Change; Organizational Diagnosis; Organizational Development (OD); Organizational Transformation (OT); Role of Change Agents and Leadership; Manager as Catalyst of Change; Implementing Organizational Change; Organizational Culture and Change; Learning Organization: The Ultimate Objective of Change Management.

MBA G554 Innovative Leadership 3 0 3

Leadership for innovation, Stimulating Bottom-Up innovation, Steering innovation Top-down, Appointing an Innovation Conductor, Leadership Imperative for Innovation Strategy, Leading development of new products, Leading the creation of totally new product/service, Innovation leaders as pragmatic architect, Leading improved customer solutions, Building an innovative leadership environment, Attracting, developing and keeping Innovative Leaders.

MBA G555 International Human Resource Management 3 0 3

Enduring context of International Human Resource Management (IHRM), Context of Cross-border Alliances and SMEs, Staffing International Operations for Sustained Global Growth, Recruiting and Selecting Staff for International Assignments, International Training and Development, International Compensation, Re-entry and Career Issues (Expatriation Issues), IHRM in the Host Country Context, International Industrial Relations ,Performance Management, IHRM Trends: Complexity, Challenges and Choices in the Future.

MBA G556 Performance Management 3 0 3

Overview of Performance Appraisal & Management, Performance Management in the Organizational Context, systems & processes ; Goal Setting, Approaches to Performance Appraisal, Performance Appraisal Techniques, Data Gathering, Observing, and Documenting, The Performance Appraisal Meeting, Feedback, Performance Diagnosis and Improvement, Linkage to Rewards & Compensation, Training & Development Requirements, Potential Appraisal & Career Progression, issues: Problems, Role of HR, Training the appraisers, Performance Appraisal in India.

MBA G622 Software Project Management 4

Course description is same as given under SECT ZG622.

Mechanical Engineering

ME C211 Applied Thermodynamics **3 0 3**

Thermodynamics of power developing and power absorbing reciprocating machines; vapour, gas and refrigeration cycles; regeneration, reheat, compound cycle modifications, combined gas turbine-vapour cycle, binary systems; thermodynamic relations; reactive systems; combustion, adiabatic flame temperature, dissociation, equilibrium.

ME C212 Transport Phenomena I **3 0 3**

Fundamentals of the momentum, heat and mass transfer; the control volume approach and integral equations; differential analysis for momentum, heat and mass transfer, and solutions for one- dimensional steady state situations; convective heat and mass transfer; dimensional analysis.

ME C312 Design of Machine Elements **3 0 3**

Fundamentals and principles of design; design and selection of machine elements such as shafts, bearings and gears etc; design of mechanisms.

ME C314 Power Plant Engineering **3 0 3**

Classification of power plants. Components and layout of; thermal, nuclear, hydro electric power plants. Site selection for various power plants. Combined cycle power plants. Magneto Hydro Dynamics (MHD) systems. Economics of power generation, economic loading of power stations. Load curve analysis; load factor, diversity factor. Power plant instrumentation and controls.

ME C331 Transport Phenomena II **3 2 4**

(For Mechanical Engineering)

Fundamental concepts of heat transfer; steady-state and unsteady- state heat conduction; analytical and empirical relations for forced and free convection heat transfer; heat exchanger analysis and design, heat transfer by radiation; elements of mass transfer; one dimensional compressible flow; flow in open channels, associated laboratory.

ME C332 Prime Movers and Fluid Machines **3 2 4**

Theoretical analysis of energy and momentum transfer between fluid and rotor; principles of axial, mixed and radial flow compressors, turbines and pumps; design considerations; cascade aerodynamics and performance limitations; applications to power plant systems, laboratory exercises in testing reciprocating machines; rotary machines and refrigeration plants.

ME C342 Production Techniques **3 2 4**

Analysis, economics and quality control of metal cutting, plastic working of metals, joining and casting processes, laboratory exercises in metal cutting, plastic working of metals, testing and inspection of weldments and castings.

ME C382 Computer Aided Design **3 0 3**

Course description is same as given under EA C342.

ME C392 Advanced Mechanics of Solids & Kinematics **3 0 3**

Energy methods; asymmetrical bending; curved beams; thick cylinders; contact stresses; introduction to mechanisms; velocity and acceleration analysis using vector polygon method; kinematics of cams & synthesis of cam profile; gear trains.

ME C412 Production Planning & Control **3 0 3**

Course description is same as given under ET C412.

ME C422 Dynamics of Machines & Vibration **3 0 3**

Dynamic force analysis in mechanisms; determination of flywheel size; balancing of rotating & reciprocating masses; whirling of shafts; forced vibration & vibration isolation; multi-degree freedom systems; systems with distributed mass & elasticity.

ME C432 Computer Aided Manufacturing **3 0 3**

Introduction, features of NC machine tools, NC part programming, CAM system devices, interpolators for manufacturing systems, control loops of NC systems, computerized numerical control, adaptive control systems, CAD to CAM, CAPP, industrial robots, computer aided production planning & control, computer aided inspection and quality control, CIM systems.

ME C441 Automotive Vehicles **3 0 3**

Internal combustion engines; vehicle performance; analysis and design of vehicle components. Experimental or theoretical investigation of problems selected from the field of automotive vehicles.

ME C442 Advances in Materials Science **3 0 3**

Deformation of materials, deformation at high temperatures and creep, recovery, recrystallization and grain growth, fracture of materials and fatigue failure, deterioration of materials, corrosion and oxidation, surface properties, surface energy and tribology, polymers and fibre reinforced polymeric composites, mechanical testings, nondestructive testing techniques.

ME C443 Quality Control, Assurance & Reliability **3 0 3**

Basic concepts of probability and probability distributions, standard probability distribution, sampling and sampling distributions, confidence intervals, testing significance, statistical tolerance, various types of control charts, statistical process control techniques, value analysis, defect diagnosis and prevention, basic concepts of reliability, reliability design evaluation and control, methods of applying total quality management, production process.

ME C451 Mechanical Equipment Design 3 0 3

Design analysis for additional machine elements; retainment of bearings and design of machine housing; introduction to techniques of optimisation reliability and value analysis; exercises in detail design; design solutions to meet specified functional requirements.

ME C452 Composite Materials and Design 3 0 3

Introduction to composites, concepts of reinforcement, strengthening mechanisms, fibrous reinforcements, matrix materials, micro-mechanical aspects of composites, manufacturing methods, composite production design methods-design of tensile members, pressure vessels, storage tanks, and other chemical process equipment made of FRP, design of joints, damage of composites by impact, FRP grids, recent development in manufacturing of composites and technologies.

ME C461 Refrigeration and Air Conditioning 3 0 3

Course description is same as given under CE C461.

ME C472 Precision Engineering 3 0 3

Concept of accuracy, accuracy of numerical control systems, tolerances and fits, acceptance tests for machine tools, static stiffness and its influence on machining accuracy, inaccuracies due to thermal effects, influence of forced vibrations on accuracy, dimensional wear of cutting tools and its influences on accuracy, clamping and setting errors, location principles and errors due to location, surface roughness and microfinishing processes, dimensioning and dimensional chains, methods of improving accuracy and surface finish, thread and gear measuring instruments, coordinate measuring machines, introduction to computer aided tolerancing.

ME C481 Project Appraisal 3 0 3

Prerequisite: ECON C212

Course description is same as given under ECON C411.

ME C491 Special Projects 3

Course description is same as given under BIO C491.

ME F110 Workshop Practice 0 4 2

Laboratory exercises for different manufacturing processes like machining on lathe, drilling, grinding, milling and shaper; sand moulding and casting; metal forming; joining processes like arc welding, gas welding, brazing and soldering; carpentry; fitting; use of metrology equipments in measurement; demonstrations on CNC machines and CNC part programming.

ME F211 Mechanics of Solids 3 0 3

Fundamental Principles of mechanics; introduction of mechanics of deformable bodies; force and moment transmitted by slender members; stress and strain; stress-strain-temperature relations; torsion of circular member, stress and deflection due to bending, stability of equilibrium. Static failure criteria, ductile & brittle material; Dynamic failure criteria.

ME F212 Fluid Mechanics 3 0 3

Fluid Statics; fundamentals of mass, momentum and energy transfer, control volume approach and integral equations. Differential analysis of mass, momentum and energy transfer, solutions for one dimensional steady state situations. Viscous and in-viscid flow. Dimensional analysis. Introduction to computational fluid dynamics.

ME F213 Materials Science & Engineering 2 0 2

Introduction, Structure of Materials (Metal and Ceramics), Dislocations, heat treatment of steel and strengthening Mechanisms of Metals, Phase diagrams, Iron-carbide phase diagram, Phase transformation in Metals, Mechanical and thermal properties of Metals, Polymers (Structure, processes and properties), powder metallurgy.

ME F214 Applied Thermodynamics 3 0 3

Availability and irreversibility, thermodynamic relations, gas and vapor cycles, combined power generation cycles, gas mixtures, refrigeration cycles, psychometrics and heat load calculations, gas turbine cycles , compressors, boilers and accessories

ME F215 Mechanical Engineering Laboratory 0 2 2

The course shall aim to train the student in the skill of operation of instruments and equipments. Testing of mechanical properties like tensile testing, hardness, impact, bending of beams, spring testing, basic fluid mechanics experiments like measurements of pressure, temperature, viscosity, flow measurement, basic electrical & electronics like experiments on diodes, rectifiers, OPAMPS, dc motors, transformers, induction and synchronous motors.

ME F241 Machine Design & Drawing 3 1 4

Fundamentals and principles of Design. Design and selection of Machine elements such as shafts, Screw fasteners, Welded joints, Springs, Brakes & Clutches, Bearings & Gears. Fundamentals of Machine Drawing; practices for Orthographic drawing of machine parts, sectional view, assembly drawing & exploded view.

ME F242 IC Engines 2 0 2

Working cycles and operation of two stroke, four stroke SI and CI engine cycles. Ignition, combustion, alternative fuels, emission and their control.

ME F243 Production Techniques I 2 1 3

Metal casting methods, patterns and molding, different types of casting processes, injection molding, die casting and casting defects. Casting analysis. Metal forming, different bulk metal forming processes like rolling, extrusion, forging and wire drawing. Metal forming pro-

cess analysis and forming defects. Welding, brazing and soldering, different techniques and welding defects. Welding analysis. Simple description of various machining operations, machine tools and cutting tool geometry. Limits & Fits and Metrology. Fabrication project.

ME F244 Kinematics & Dynamics of Machinery 3 0 3

Kinematics of mechanism: introduction to mechanisms, position, displacement, velocity, acceleration analysis, Synthesis of mechanisms (Planer), cam design, Kinematics of gears (spur, helical, bevel and worm), gear trains, Dynamics of machines: static force analysis, dynamic force analysis (planar),dynamics of reciprocating engines, balancing, cam dynamics, flywheels, governors and gyroscopes.

ME F266 Study Project 3

Course description is same as given under BIO F266.

ME F311 Heat Transfer 3 1 4

Fundamental concepts of heat transfer; steady state and unsteady- state heat conduction; analytical and empirical relations for forced and free convection heat transfer; heat exchanger analysis and design, heat transfer by radiation; associated laboratory.

ME F312 Advanced Mechanics of Solids 3 0 3

Generalized Hooke's law; Energy methods; torsion of non-circular members; shear center and asymmetrical bending; curved beams; thick cylinders; plates and shells; contact stress.

ME F313 Production Techniques II 3 1 4

Metal cutting theory. Analysis, economics and quality control of metal cutting, laboratory exercises in metal cutting and fabrication project. Different machine tools their description and operation. Non-traditional machining processes. Micro-manufacturing technologies. Introduction to computer aided manufacturing (CAM), CNC machines and CNC part programming.

ME F341 Prime Movers & Fluid Machines 2 1 3

Theoretical analysis of energy and momentum transfer between fluid and rotor; principles of axial, mixed and radial flow compressors, turbines and pumps; design considerations; cascade aerodynamics and performance limitations; applications to power plant systems; model similitude for turbo-machines; Introduction to fluid power system, laboratory exercises in testing reciprocating machines, rotary machines and fluid power system.

ME F342 Computer Aided Design 3 1 4

CAD software and CAD hardware. Mathematical modeling of parametric curves, surfaces and solids, and their computer simulation on spreadsheets and using specialized solid modeling packages. CAD/CAM data exchange. Introduction to finite element analysis and FEM practice on a specialized CAE package. Rapid prototyping. Students will be required to do several assignments and one CAD project.

ME F343 Mechanical Vibrations 3 0 3

Small oscillations of linear dynamical systems, free and forced vibrations of single and multi-degree-of-freedom systems, normal modes and orthogonality relations, generalized co-ordinates and Lagrange's equations, matrix formulation, eigenvalue problem and numerical solutions, transient response of one-dimensional systems, approximate energy methods, continuous system, vibration of string, rods, bars and beams. Introduction to control systems.

ME F344 Engineering Optimization 2 0 2

Linear programming methods, simplex method, transportation model and its variants, queuing systems, PERT/CPM, Optimal problem formulation, engineering optimization problems, single variable optimization algorithms, multivariable optimization algorithms, constrained optimization algorithms.

ME F366 Lab Project 3

ME F367 Lab Project 3

Course description is same as given under BIO F366 and BIO F367.

ME F376 Design Project 3

ME F377 Design Project 3

Course description is same as given under BIO F376 and BIO F377.

ME F411 Fluid Power Systems 3 1 4

Introduction to Fluid power, advantages of fluid power, applications, Introduction to Pneumatics, Air preparation and Components, Pneumatics Circuits and Applications, Electro pneumatics, Electrical Controls for fluid power circuits, , Physical properties of hydraulic fluids, Energy and Power in Hydraulic Systems, Frictional Losses in Hydraulic Pipelines, Hydraulic Pumps, Hydraulic Cylinders and Cushioning Devices, Hydraulic Motors, Hydraulic Valves, Hydraulic Circuit Design and Analysis, Ancillary Hydraulic Devices, Hydraulic Conductions and Fittings, Maintenance of Hydraulic Systems, Use of PLC programming for interfacing pneumatics and Hydraulic Circuits.

ME F412 Production Planning and Control 3 0 3

Course description is same as given under me C412.

ME F413 Nonlinear Vibrations 3 0 3

Introduction, sources of nonlinearity, examples, qualitative analysis: phase plane, singular points, stability of singular points, Forced response, Perturbation methods: straightforward expansion, the method of multiple scales, harmonic balance, method of averaging, Nonlinear normal modes, Nonlinear Multiple-DOF Systems, Bifurcations, Centre manifold reduction,

Flouquet Theory, Chaos Theory, Melnikov Criterion, Applications to vehicle dynamics, structures and microsystems etc. Use of softwares for simulations and numerical solutions.

ME F415 Gas Dynamics 3 0 3

Introduction to Gas Dynamics, Basic equations of compressible flow, Wave propagation, Steady one-dimensional flow (Varying-area adiabatic flow), Normal shock waves, Oblique shock and expansion waves, Prandtl-Meyer Flow, Flow with Friction and Heat Transfer, Potential equation for compressible flow, Similarity rule.

ME F416 Reverse Engineering and Rapid Prototyping 3 0 3

Introduction to reverse engineering, methodologies and techniques for reverse engineering, reverse engineering hardware and software, selecting reverse engineering system, introduction to rapid prototyping, relationship between reverse engineering and rapid prototyping. Reverse engineering in automotive engineering, aerospace engineering, medical device industry. Legal aspects and barriers for reverse engineering. Project work.

ME F417 Advanced Metal Forming 3 0 3

The stress and strain tensors in macroscopic plasticity and failure criteria for metal forming, effective stress and effective strain, flow rules for plastic deformation and principle of normality. Work hardening, determination of work hardening exponent. Plastic instability and effect of inhomogeneity on uniform strain. Strain rate and temperature effects on plastic deformation and flow stress, super-plasticity, temperature rise during metal forming. Ideal work and redundant work. Slab, upper-bound, slip-line field and finite element methods of analysis of various bulk and sheet metal forming processes. Bulk and sheet metal formability tests and forming limit diagram. Sheet metal properties and plastic anisotropy.

ME F418 Rocket and Spacecraft Propulsion 3 0 3

Thrust and specific impulse. Compressible flows. Detailed analysis of liquid, solid and hybrid propulsion systems. Includes propellants, injection systems, combustion and chemical equilibrium, thrust chambers, nozzles and plumes. Electro-thermal thrusters. Plasmas and electromagnetic thrusters.

ME F419 Total Product Integration Engineering 3 0 3

Quality design across global supply chain. Robust product architecture for market variety and technology advances. Product development risk management.

ME F420 Power Plant Engineering 3 0 3

Course description is same as given under ME C314.

ME F423 Micro Fluidics and its Application 4*

Course description is same as given under EA C417.

ME F432 Computer Aided manufacturing 3 0 3

Course description is same as given under ME C422.

ME F433 Solar Thermal Process Engineering 3 1 4

Fundamentals of solar energy, earth-sun angles, solar spectrum, solar radiation, measurement and estimation of solar energy on horizontal and tilted surface, conversion routes and technologies, Standards and Performance Testing, thermal utilization of solar energy, modes of heat transfer and equations for performance calculations of systems- conduction, convection and radiation of heat, Flat plate collectors, solar concentrator systems, geometric optics, tracking methods, thermal analysis, energy storage, materials and properties, solar process loads and system calculations for time dependent loads, Life cycle cost analysis and economic analysis for various applications of solar thermal processes, solar water heating, space heating and cooling in Buildings, Industrial process heating, solar air-conditioning and refrigeration, Use of Simulation tools for performance simulation and Project Assignments, solar thermal power generation, Role of Govt., policies and plans.

ME F441 Automotive Vehicles 3 0 3

Course description is same as given under ME C441.

ME F443 Quality Control, Assurance and Reliability 3 0 3

Course description is same as given under ME C443.

ME F451 Mechanical Equipment Design 3 0 3

Course description is same as given under ME C451.

ME F452 Composite Materials & Design 3 0 3

Course description is same as given under ME C452.

ME F461 Refrigeration and Air conditioning 3 0 3

Course description is same as given under CE C461.

ME F472 Precision Engineering 3 0 3

Course description is same as given under ME C472.

ME F481 Project Appraisal 3 0 3

Course Description is to be developed.

ME F482 Combustion 3 0 3

Fuels, Combustion, Adiabatic Flame Temperature, Chemical Kinetics, Chain Reactions, Conservation Equations for Reacting Flows, Laminar and Turbulent Premixed Flames, Diffusion Flames, Droplet and Particle Combustion, Emissions, Applications.

ME F483 Wind Energy 3 0 3

Historic development of wind energy technology, basic principles of wind energy conversion, different types of wind machines and their performances, wind rotor aerodynamics and its application in the turbine design, statistical methods of measurement and analysis of wind spectra for energy use, developing models for es-

timating the wind energy potential of a prospective site, Constructional features of various systems and subsystems of a Wind Energy Conversion System(WECS), Features of wind farms, performance models of WECS, Optimal matching of WECS, environmental aspects of wind energy conversion, Economics of wind energy conversion.

ME F484 Automotive Technology 3 0 3

Historic development of wind energy technology, basic principles of wind energy conversion, different types of wind machines and their performances, wind rotor aerodynamics and its application in the turbine design, statistical methods of measurement and analysis of wind spectra for energy use, developing models for estimating the wind energy potential of a prospective site, Constructional features of various systems and subsystems of a Wind Energy Conversion System(WECS), Features of wind farms, performance models of WECS, Optimal matching of WECS, environmental aspects of wind energy conversion, Economics of wind energy conversion.

ME F485 Numerical Techniques for Fluid Flow and Heat Transfer 3 0 3

Introduction to CFD, Partial Differential Equation (PDE): Physical classifications, Mathematical Classifications, Well posed problem. Basic of Discretization Methods: Finite difference method, Truncation error, consistency, error and stability analysis, convergence, various discretization schemes. Introduction commercial software: OpenFOAM or Fluent. Application of numerical methods to selected model equations: Wave equation, Heat equation, Laplace's equations. Solution of Navier-Stokes equation for incompressible flows.

ME F491 Special Projects 3

Course description is same as given under BIO F491.

ME G511 Mechanisms & Robotics 2 3 5

Classification of robots & manipulators; fields of application; synthesis of planar & spatial mechanisms; methods of function & path generation; coupler curve synthesis; linkages with open loop; actuators & drive elements; microprocessor application and control of robots.

ME G512 Finite Element Methods 5

Fundamental concepts, matrix algebra and gaussian limination, one-dimensional problems, trusses, two-dimensional problems using constant strain triangles, axisymmetric solids subjected to axisymmetric loading, two-dimensional isoparametric elements and numerical integration, beams and frames, three-dimensional problems in stress analysis, scalar field problems, dynamic considerations, pre-processing and post processing.

ME G513 Heating and Cooling of Buildings 3 2 5

Introduction to HVAC design, basic scientific principles, climatic conditions, building heat transmission surfaces, infiltration and ventilation, heating loads, heat gains and cooling loads, HVAC psychometrics, codes and standards for HVAC systems design, acoustics and vibration, human comfort, air distribution, duct system design, fans and central air systems, air system heating and cooling, air cleaning and filtration, introduction to electrical systems, controls for air distribution systems.

ME G514 Turbomachinery 3 2 5

Introduction, thermodynamics, gas turbine plants, steam turbine plants, fluid dynamics, dimensional analysis and performance parameters, flow through cascades, axial turbine stages, high temperature turbine stages, axial compressor stages, centrifugal compressor stages, radial turbine stages, axial fans and propellers, centrifugal fans and blowers, and wind turbines.

ME G515 Computational Fluid Dynamics 3 2 5

Philosophy of computational fluid dynamics (CFD), governing equations of fluid dynamics, mathematical behavior of partial differential equations, basics of the numerics : basic aspects of discretization, grids with appropriate transformations, and simple CFD techniques, applications, numerical solutions of quasi-one-dimensional nozzle flows, numerical solution of a two-dimensional supersonic flow, incompressible couette flow, and supersonic flow over a flat plate, advanced topics in CFD.

ME G516 Energy Systems Engineering 5

Basic concepts of energy conversion, generation of electrical and thermal energy, transmission and distribution of electrical energy, load management, detailed analysis of utilization of thermal energy in : boilers, furnaces, compressors, heat transfer equipments, and HVAC systems, energy audit, waste heat recovery systems, cogeneration, demand side management, and management and organization of energy saving projects.

ME G521 Mechanical System Design 3 2 5

Concept of system design; modeling of structural and kinematic systems, and determination of system characteristics; reliability of systems; design of machine elements for specified reliability; concepts of optimization; techniques of design optimization for linear and non-linear problems.

ME G532 Machine Tool Engineering 3 2 5

Design principles of machine tools; stiffness and rigidity of separate construction elements and their combined behaviour under load; design of stepped and stepless drives; electrical, mechanical and hydraulic drives; design of bearings and sideways; machine tool controls; machine tool dynamics; recent developments in machine tool design.

ME G533 Conduction and Radiation Heat Transfer 5*

Conduction: Steady and unsteady problems and their solutions in cartesian, cylindrical and spherical coordinates. Separation of variables. Duhamel's theorem. Laplace transform. Problems involving change of phase. Inverse heat conduction, Microscale heat transfer, Radiation: Radiative exchange among black and grey and spectral surfaces, Shape factors. Applications to cavities and enclosures. Integral equations approach. Radiation from gases, vapours and flames.

ME G534 Convective Heat and Mass Transfer 5*

Conservation equations, boundary layers, free convection, forced convection. Heat transfer in laminar and turbulent, internal as well as external flows, mixed convection. Combined convection and radiation. Boiling and Condensation. Molecular diffusion in fluids, mass transfer coefficient. Simultaneous heat and mass transfer; Applications.

ME G535 Advanced Engineering Mathematics 3 2 5

Boundary value problems; wave equations; nonlinear partial differential equations; calculus of variations; Eigen value problems; iteration problems including forward and inverse iteration schemes – Graham Schmidt deflation – simultaneous iteration method – subspace iteration – Lanczo's algorithm – estimation of core and time requirements.

ME G536 Thermal Equipment Design 5

Course description is to be developed.

ME G537 Cryogenic Engineering 5

Introduction to cryogenics and its applications, properties of cryogenic fluids, properties of materials at cryogenic temperature, gas-Liquefaction and refrigeration systems, gas separation, cryocoolers, cryogenic insulations, vacuum technology, instrumentation in cryogenics, safety in cryogenics.

ME G538 Toyota Production System 3 2 5

Birth of Toyota production system, house of Toyota production system, stability, standardization, just-in-time,jidoka, involvement, hoshin planning, Toyota culture, Toyota way, Case Studies.

ME G539 Computer Integrated Manufacturing 3 2 5

Computer Modeling for mass property analysis. Computer Numerical Control. Computer-aided Manufacturing, operation of CNC machine tools. Design of manufacturing work cells, Automated Manufacturing and Programmable Controller.

ME G611 Computer Aided Analysis and Design 2 3 5

Course description is same as given under CE G611.

ME G612 Plastics Engineering 3 2 5

General properties of Plastics, Mechanical Behavior of Plastics, Processing of Plastics like Extrusion, injection moulding, thermoforming, calendaring, rotational moulding, compression moulding, transfer moulding, analysis of polymer melt flow, rheological models for polymer melt flow, analysis of heat transfer during polymer processing, elastic behavior of polymer melts, testing methods of polymers like DSC, TGA, DMA, XRD etc. FRP composites, Properties of FRP composites in longitudinal and transverse directions, volume and weight fraction relationships of fibers, failure mechanisms, mechanical properties and fiber orientation effects, processing of composite materials, advancement of composite materials in applications like wind mill blades, bullet proof jackets, etc.

ME G621 Fluid Dynamics 2 3 5

Course description is same as given under CE G621.

ME G631 Advanced Heat Transfer 3 2 5

(= CHE G614)

Course description is same as given under CHE G614.

ME G641 Theory of Elasticity and Plasticity 3 2 5

Course description is same as given under CE G641.

Microelectronics

MEL G512 Optoelectronic Devices, Circuits and Systems 3 2 5

Course description is same as given under EEE G521.

MEL G531 Testable Design and Fault Tolerant Computing 3 2 5

Course description is same as given under CS G531.

MEL G532 Digital Signal Processing 3 2 5

Course description is same as given under EEE G572.

MEL G611 IC Fabrication Technology 3 2 5

Material properties; crystal growth and doping; diffusion; oxidation; epitaxy; ion implantation; deposition of films using CVD, LPCVD and sputtering techniques; wet and dry etching and cleaning; lithographic process; device and circuit fabrication; process modeling and simulation.

MEL G612 Integrated Electronics Systems Design 2 2 4

General architectural features of 8/16/32 bit microprocessors, programmers model of 8086, assembly language programming, hardware design around 8086, bus based systems design, system design around IBM PC, design of real-time systems, ASIC's development tools.

MEL G621 VLSI Design 3 2 5

Introduction to NMOS and CMOS circuits; NMOS and CMOS processing technology; CMOS circuits and logic design; circuit characterization and performance estimation; structured design and testing; symbolic layout systems; CMOS subsystem design; system case studies.

MEL G622 Introduction to Artificial Neural Networks **2 2 4**

Fundamentals and definitions; Perceptrons, backpropagation and counterpropagation Networks; Statistical methods for network training; Hopfield nets; Associative memories; Optical neural networks; Applications of neural networks in speech processing, computer networks and visual processing.

MEL G623 Advanced VLSI Design **5**

Deep submicron device behavior and models, Interconnect modeling for parasitic estimation, Clock signals and system timing--Digital phase locked loop design, memory and array structures, Input/output circuits design, ASIC technology, FPGA technology, High speed arithmetic circuits design,-Parallel prefix computation, Logical effort in circuit design, Low power VLSI circuits-Adiabatic logic circuits, Multi threshold circuits, Digital BICMOS circuits, Design of VLSI systems.

MEL G624 Advanced VLSI Architectures **5**

Instruction set design and architecture of programmable DSP architectures; dedicated DSP architectures for filters and FFTs; DSP transformation and their use in DSP architecture design; Application Specific Instruction set Processor; superscalar and VLIW architectures.

MEL G625 Advanced Analog and Mixed Signal Design **5**

Mixed signal blocks and design issues, Design of high speed comparators, opamps, Design of sample and hold circuits, Different architectures of analog to digital and digital to analog converters, Design of CMOS analog multipliers and dividers, Design of switched capacitor filters, Design of phase locked loop, Layout techniques for analog and mixed signal design, noise issues.

MEL G626 VLSI Test and Testability **5**

Fault models and types; automated test generation for combinational logic; test generation for sequential logic; need for adding testability logic; design for testability; Adhoc DFT methods; structured DFT; test generation for delay fault; issues in analog circuit testing and testability.

MEL G631 Physics and Modelling of Microelectronic Devices **3 2 5**

Physics and properties of semiconductor - a review; pn junction diode; bipolar transistor; metal-semiconductor contacts; JFET and MESFET; MOSFET and scaling; CCD and photonic devices.

MEL G632 Analog IC Design **3 2 5**

Basic concepts; BICMOS process and technology; current and voltage sources; differential and operational amplifiers; multipliers and modulators; phase-lock techniques; D-to-A and A- to-D converters; micropower circuits; high voltage circuits; radiation resistant circuits; filter design considerations.

MEL G641 CAD for IC Design **3 2 5**

Introduction to VLSI design methodologies and supporting CAD tool environment; overview of `C', data structure, graphics and CIF; concepts, structures and algorithms of some of the following CAD tools; schematic editors; layout editors; module generators; silicon compilers; placement and routing tools; behavioural, functional, logic and circuit simulators; aids for test generation and testing.

MEL G642 VLSI Architectures **2 2 4**

Overview of CISC processor architectures; Instruction set architecture of CISC processor; hardware flowcharting methods; implementing microprocessor logic from hard-ware flowcharts; RISC instruction set architecture; Pipelined execution of RISC instructions; pipeline execution unit design; control hazards; design of memory hierarchy.

Manufacturing Engineering

MF C211 Applied Thermodynamics **3 0 3**

Course description is same as given under ME C211.

MF C212 Transport Phenomena I **3 0 3**

Course description is same as given under ME C212.

MF C312 Design of Machine Elements **3 0 3**

Course description is same as given under ME C312.

MF C313 Kinematics and Dynamics of Machines **3 0 3**

Kinematics of mechanism: introduction to mechanisms, position, displacement, velocity, acceleration analysis, cam design, gear trains, synthesis of linkages. Dynamics of machines: static force analysis, dynamic force analysis (planar), dynamics of reciprocating engines, balancing, cam dynamics, flywheels, governors and gyroscopes, free and forced vibrations.

MF C314 Metal Forming and Machining **3 2 4**

Metal forming: introduction, metal forming machines, metal forming process analysis and design. Machining: introduction, metal cutting machine tools, mechanics of metal cutting, other aspects of machining processes, grinding and finishing operations, non-conventional machining processes and processing of plastics.

MF C315 Casting and Welding **3 2 4**

Casting: fundamentals of casting processes, design of castings, furnaces, foundry mechanization, special casting processes, economics of casting, inspection and defects of casting. Powder metallurgy: introduction, methods of powder production, characteristics and properties of powder, manufacturing methods, furnaces, finishing processes, economics of powder metallurgy. Welding: introduction, various welding processes, design for welding, safe practices in welding,

inspection and defects of welding, economics of welding, brazing and soldering.

MF C316 Manufacturing Management 3 0 3

Introduction, product planning, forecasting, facilities location, process planning and design, layout of facilities, performance measures and capacity planning, planning and scheduling, material requirements planning and Just-in-time systems, inventory control, human resource management, financial management, marketing management, customer relationship management.

MF C317 Instrumentation and Control 3 0 3

Course description is same as given under ET C341.

MF C318 Design of Machine Tools 3 0 3

Introduction to machine tool drives and mechanisms - general principles of machine tool design, regulation of speed and feed rates, design of machine tool structures, design of guideways and power screws, design of spindles and spindle supports, dynamics of machine tools, control systems in machine tools.

MF C319 Mechatronics and Automation 3 0 3

Introduction to mechatronics, sensors and transducers, pneumatic and hydraulic actuation systems, mechanical actuation systems, electrical actuation systems, digital logic, microprocessors and programmable logic controllers; Introduction to automation, features of numerical control machine tools, numerical control part programming, control loops for numerical control systems, computerized numerical control, adaptive control systems, industrial robots, automatic identification and data capture, automated production lines and automated assembly systems.

MF C321 Mechanical Engineering Drawing 3 0 3

Introduction to design process and drawings, review of sectioning, drawing standards, dimensioning and notes, fasteners - screws, bolts and nuts, riveted joints, pins, locking devices, welded joints, pipe joints, unions and valves, assembly drawings with sectioning and bill of materials, cotter and knuckle joints, Assemblies involving machine elements like shafts, couplings, bearings, pulleys, gears, belts, brackets, tool drawings including jigs and fixtures, engine mechanisms - assembly and disassembly, detailed part drawings from assembly drawings, production drawings - limits, fits and tolerances, dimensional and geometric tolerances, surface finish symbols, layout drawings, schematics, process and instrumentation diagrams, piping drawings, structural drawings – examples for reading and interpretation, use of software packages for engineering drawings and reverse engineering.

MF C343 Maintenance and Safety 3 0 3

Course description is same as given under ENGG C242.

MF C382 Computer Aided Design 3*

Course description is same as given under EA C382.

MF C411 Tool and Fixture Design 3 0 3

Tool-design methods, tool making practices, tooling materials and heat treatment, design of cutting tools, gages and gage design, locating and clamping methods, design of drill jigs, design of fixtures, design of sheet metal blanking and piercing dies, design of sheet metal bending, forming and drawing dies, using plastics as tooling materials, tool design for numerically controlled machine tools and automatic screw machines.

MF C412 Automotive Systems 3 0 3

Frame, suspension, springs and wheels, clutch and gear box, propeller shaft, universal joint, final drive, differential and rear axle, front axle and steering mechanism, brakes, automotive air conditioning, electrical vehicles, automotive electrical systems, automotive electronics systems.

MF C413 Mechanical Vibrations and Acoustics 3 0 3

Introduction, single degree-of-freedom systems: free and forced vibration problems, concept of resonance and damping, vibration isolation, multi-degree-of-freedom systems: modeling of multi-degree-of freedom systems, eigen value problem and calculation of normal modes of a system, forced response using modal superposition techniques, introduction to acoustics - terminology used in acoustics and definitive of fundamental quantities 1D wave, equation (plane waves) & 3D wave equation, formulation and fundamental solution to the equations, measurement of noise & vibration – vibration measurement principles.

MF C414 Manufacturing Excellence 3 0 3

Introduction, frameworks of manufacturing excellence, practices for manufacturing excellence: leadership and change management, manufacturing strategy, innovative product planning, total productive maintenance, total quality management, lean manufacturing, customer relations management, green manufacturing, supply chain management, knowledge management and social responsibility.

MF C415 Noise Engineering 3 0 3

Fundamentals of vibrations, vibrations of strings and bars, vibrations of membranes and plates, acoustic wave equation, acoustic energy and sound intensity, propagation of sound, concept of acoustic impedance, sound power transmission, transmission loss, human response and ratings, various measures of sound, weighting filters, loudness, indices of loudness, acoustic radiation from spherical source and piston source, acoustic sensors, measuring techniques and instruments, octave filtering, sound intensity measurement, intensity mapping, different types of measurement environment and uses, response of beam subjected to an

acoustic plane wave, transmission loss of panels, sound absorption coefficient, noise control measures in building, reverberation time and auditorium design, industrial noise control, noise in machinery, traffic noise, vehicle noise, design of silencers and mufflers, active noise control, duct noise control and cabin noise control, practicals on noise measurements in different situations.

MF C416 Work System Design 3 0 3

Introduction to work systems design, productivity and work study, method study: process analysis, man-machine analysis, operation analysis and micro-motion study, introduction to ergonomics and principles of motion economy, work measurement: stop watch time study, work sampling, standard data and predetermined motion time systems, job enlargement and job enrichment, incentive schemes.

MF C417 Internal Combustion Engines 3 0 3

Air standard cycles, fuel air cycles, actual cycles and their analysis, fuels, alternative fuels, carburetion, mechanical and electronic injection systems, ignition, combustion and combustion chambers, engine friction and lubrication, heat rejection and cooling, engine emissions and their control, measurements and testing, performance parameters and characteristics, engine electronics, supercharging, two-stroke engines.

MF C418 Lean Manufacturing 3 0 3

Fundamentals of continuous improvement, value added and waste elimination, elements of lean production: small lot production, setup time reduction, maintaining and improving equipment, pull production systems, focused factories and group technologies, work cells and cellular manufacturing, standard operations, quality of design, systems for eliminating defects, simplified production planning and control systems: scheduling for smooth flow, synchronizing and balancing process, planning and control in pull production, beyond the production systems: managing the supply chain, activity based costing, performance measurement.

MF C421 Supply Chain Management 4*

Course description is same as given under MBA C421.

MF C432 Computer Aided Manufacturing 3 0 3

Course description is same as given under ET C422.

MF C441 Quality Control Assurance and Reliability 3 0 3

Course description is same as given under ET C432.

MF C442 Advances in Materials Science 3 0 3

Course description is same as given under ME C442.

MF C453 Industrial Relations 3 0 3

Course description is same as given under CDP C364.

MF C472 Precision Engineering 3 0 3

Course description is same as given under ME C472.

MF C473 Product Design and Development 3 0 3

Introduction to product design and development, product development planning and process tools, technical and business concerns, understanding customer needs, function modeling, benchmarking and engineering specifications, product architecture, concept generation, concept selection, concept embodiment, modeling of product metrics, design for X, physical prototypes, physical models and experimentation, robust design.

MF C474 Product Design and Development Projects 3

The course will essentially deal with the practice of product design and development. The student will involve in the design and development of different products. He will be guided by the instructor/resource person. The effort must culminate with a product along with the project report.

MF C481 Project Appraisal 3 0 3

Course description is same as given under ECON C411.

MF C491 Special Projects 3

Course description is same as given under BIO C491.

MF F211 Mechanics of Solids 3 0 3

Fundamental Principles of mechanics; introduction to mechanics of deformable bodies; force and moment transmitted by slender members; stress and strain; stress-strain-temperature relations; torsion of circular member, stress and deflection due to bending, stability of equilibrium. Static failure criteria, ductile & brittle material; Dynamic failure criteria.

MF F212 Fluid Mechanics 3 0 3

Fluid Statics; fundamentals of mass, momentum and energy transfer, control volume approach and integral equations. Differential analysis of mass, momentum and energy transfer, solutions for one dimensional steady state situations. Viscous and in-viscid flow. Dimensional analysis. Introduction to computational fluid dynamics.

MF F213 Materials Science & Engineering 2 0 2

Lattice structure and dislocations, binary phase dia-

grams , iron-ironcarbide phase diagram, heat treatment of steel, Phase transformation in Metals, Metallurgical techniques for property enhancement, Mechanical and thermal properties of Metals, and polymers, powder metallurgy. Material standards.

MF F214 Applied Thermodynamics 3 0 3

Availability and irreversibility, thermodynamic relations,Compressible flow, Ideal gas and vapour cycles, combined power generation cycles, gas mixtures, refrigeration cycles, psychrometrics and Introduction to heat load calculations, gas turbine cycles , compressors, boilers and accessories.

MF F215 Mechanical Engineering Laboratory 0 2 2

The course shall aim to train the student in the skill of operation of instruments and equipments related to Mechanical Engineering. Testing of mechanical properties like tensile testing, hardness, impact, bending of beams, spring testing, basic fluid mechanics experiments like measurements of pressure, temperature, viscosity, flow measurement, basic electrical & electronics like experiments on diodes, rectifiers, OPAMPS, dc motors, transformers, induction and synchronous motors.

MF F241 Machine Design & Drawing 3 1 4

Fundamentals and principles of Design. Design and selection of Machine elements such as shafts, Screw fasteners, Welded joints, Springs, Brakes & Clutches, Bearings & Gears, Fundamentals of machine drawing; practices for orthographic drawing of machine parts, sectional view, assembly drawing & exploded view.

MF F242 Manufacturing Management 2 0 2

Course description is same as given under MF C316.

MF F243 Manufacturing Processes 2 1 3

Foundry practices and Metal casting methods, Plastic working of metals, Welding and cutting, Machining Processes and machine tools. Nonconventional manufacturing processes, Finishing and Cleaning processes, Limits & Fits. Production quality control, Manufacturing and environment.

MF F244 Kinematics & Dynamics of Machinery 3 0 3

Course description is same as given under MF C313.

MF F266 Study Project 3

Course description is same as given under BIO F266.

MF F311 Mechatronics & Automation 2 1 3

Mechatronics design approaches, interfacing, instrumentation and control systems, modeling of mechanical and electromechanical systems, sensors and actuators, introduction to automation, pneumatics and hydraulics in automation, pneumatic circuits for automation, PLC programming and interfacing with pneumatic and hydraulic systems, introduction to MEMS, modeling and simulation of MEMS, CNC machines, automated material handling, introduction to FMS.

MF F312 Tool and Fixture Design 3 0 3

Course description is same as given under MF C411.

MF F313 Metal Forming and Machining 3 1 4

Plastic deformation of metals and related properties, metal forming processes, Yield conditions and stress-strain relations, Theory of slip lines, upper and lower bound theorems, Analysis of various hot & cold metal forming processes, Mechanics of machining processes and analysis, thermal aspects and cutting fluids, grinding and finishing operations, non conventional machining processes.

MF F341 Design of Machine Tools 3 0 3

Determination of machining forces and power in turning, milling, grinding, drilling and shaper. Kinematics of machine tools and design of gearboxes, step-less regulation. Design of machine tool guide ways, beds, tables and columns. Design of power screws, spindle units and built-in inspection units. Bearings and lubrication in machine tools. Electric and hydraulic systems of machine tools. Introduction to dynamic analysis and vibrations in machine tools. Micro-displacement in machine tools, Design of CNC machines.

MF F342 Computer Aided Design 3 1 4

CAD software and CAD hardware. Mathematical modeling of parametric curves, surfaces and solids, and their computer simulation on spreadsheets and using specialized solid modeling packages. CAD/CAM data exchange. Introduction to finite element analysis and FEM practice on a specialized CAE package. Rapid prototyping. Hands-on in assignments and CAD project.

MF F343 Casting and Welding 3 1 4

Casting processes, Pattern and Mould design, metal melting and handling, metallurgical aspects of casting, Metal flow and heat transfer, analysis of casting defects. Injection moulding of plastics Gas cutting and welding processes including its physics, chemistry and metallurgy, power source characteristics, different welding techniques, selection of welding processes, destructive and non destructive testing of weldments welding standards and codes, analysis of welded joints, brazing and soldering.

MF F344 Engineering Optimization 2 0 2

Linear programming methods, simplex method, transportation model and its variants, queuing systems, PERT/CPM, Optimal problem formulation, engineering optimization problems, single variable optimization algorithms, multivariable optimization algorithms, constrained optimization algorithms.

MF F366 Lab Project **3**

MF F367 Lab Project **3**

Course description is same as given under BIO F366 and BIO F367.

MF F376 Design Project **3**

MF F377 Design Project **3**

Course description is same as given under BIO F376 and BIO F377.

MF F411 Fluid Power Systems **3 1 4**

Introduction to Fluid power, advantages of fluid power, applications, Introduction to Pneumatics, Air preparation and Components, Pneumatics Circuits and Applications, Electro pneumatics, Electrical Controls for fluid power circuits, , Physical properties of hydraulic fluids, Energy and Power in Hydraulic Systems, Frictional Losses in Hydraulic Pipelines, Hydraulic Pumps, Hydraulic Cylinders and Cushioning Devices, Hydraulic Motors, Hydraulic Valves, Hydraulic Circuit Design and Analysis, Ancillary Hydraulic Devices, Hydraulic Conductions and Fittings, Maintenance of Hydraulic Systems, Use of PLC programming for interfacing pneumatics and Hydraulic Circuits.

MF F412 Automotive Systems **3 0 3**

Course description is same as given under MF C412.

MF F413 Mechanical Vibrations and Acoustics **3 0 3**

Course description is same as given under MF C413.

MF F414 Manufacturing Excellence **3 0 3**

Course description is same as given under MF C414.

MF F415 Noise Engineering **3 0 3**

Course Description is same as in MF C415.

MF F416 Work System Design **3 0 3**

Course Description is same as in MF C416.

MF F418 Lean Manufacturing **3 0 3**

Course description is same as given under MF C418.

MF F421 Supply Chain Management **4**

Course description is same as given under MBA C421.

MF F442 Advances in Materials Science **3 0 3**

Course description is same as given under ME C442.

MF F453 Industrial Relations **3 0 3**

Course description is same as given under CDP C364.

MF F463 Maintenance and Safety **3 0 3**

Course description is same as given under ENGG C242.

MF F471 Instrumentation and Control **3 0 3**

Course description is same as given under ET C341.

MF F472 Precision Engineering **3 0 3**

Course description is same as given under ME C472.

MF F473 Product Design and Development **3 0 3**

Course description is same as given under MF C473.

MF F474 Product Design and Development Projects **3**

Course description is same as given under MF C474.

MF F485 Sustainable Manufacturing **3 0 3**

Overview of sustainable manufacturing, 6R, WEEE, triple bottom concept of environment, economy and society, driver for, barriers to and stakeholders of sustainable manufacturing and their modelling, performance measures of sustainable manufacturing, evaluation of manufacturing systems based on environmental factors, eco-innovation and design for environment, recycling, remanufacturing, reuse, strategic and operational evaluation of technologies using life cycle management, environmental impact assessment models, end-of-life strategies, reverse logistics, sustainable product service systems, green factories.

MF F491 Special Projects **3**

Course description is same as given under BIO F491.

Management

MGTS C211 Principles of Management **3 0 3**

Fundamental concepts of management - planning; organizing; staffing; directing and controlling; production, financial, personnel, legal and marketing functions; accounting and budgeting, balance sheets.

MGTS C233 Principles of Marketing for Engineers **3 0 3**

Prerequisite: MGTS C211- Principles of Management

Defining marketing for 21st century. gathering information and scanning the environment. conducting marketing research and forecasting demand, creating customer value satisfaction and loyalty, analyzing consumer markets, analyzing business markets, identifying market segments and targets, branding and positioning, setting product strategy, developing pricing strategies and programs, designing and managing value networks and channels, managing retailing wholesaling and logistics, designing and managing integrated marketing communications, managing mass communications, managing personal communications.

MGTS C322 Marketing **3 0 3**

Course description is same as given under FIN C431.

MGTS C351 Organisational Behaviour **3 0 3**

Course description is same as given under FIN C441.

MGTS C362 Human Resource Development 3 0 3

The strategic role of human resources management; human resource development – concept, goal, mechanism, and design the system; manpower planning and policies; staffing process- recruitment & placement, job analysis, selection, managing employee separation, downsizing and outplacement; maintaining & developing people- training & development, developing managers, appraising performance, managing career, employee remuneration; governance- developing employee relations & communication, respective employee rights & managing discipline; trade union; managing safety & health.

MGTS C371 Management Information Systems 3 0 3

Course description is same as given under BITS C471.

MGTS C372 Corporate Planning 3 0 3

Course description is same as given under FIN C442.

MGTS C381 Management Accounting 3 0 3

Course description is same as given under FIN C331.

MGTS C382 Financial Management 3 0 3

Course description is same as given under ECON C481.

MGTS C392 Operations Management 3 0 3

Production systems; operations strategy; product and process design; facility location & layout; capacity planning; aggregate planning; operations scheduling and control; productivity of operations; inventory planning & independent demand systems; MRP; quality management; project management; Japanese approach to operations management (JIT, TPM, continuous improvement).

MGTS C412 Security Analysis and Portfolio Management 3 0 3

Course description is same as given under CDP C313.

MGTS C414 Technology Management 3 0 3

Concept of technology, nature of technological change, economics of technology, corporate technology strategy, analysis for technology strategy, adoption and management of new technology, accounting for technology, appropriate technologies, transfer of technology, influence of government policies on technology, technology, management for sustainable development.

MGTS C422 Function & Working of Stock Ex- changes 3 0 3

Course description is same as given under CDP C323.

MGTS C424 Money, Banking and Financial Markets 3 0 3

Course description is same as given under ECON C362.

MGTS C432 Quality Control, Assurance and Reliability 3 0 3

Course description is same as given under ET C432.

MGTS C433 Advertising and Sales Promotion 3 0 3

Course description is same as given under FIN C433.

MGTS C441 Marketing Non-profit Organizations 3 0 3

Particular aspects of marketing for non-profit organizations; characterization of non-profit organizations, organising, analysis, planning, adaptive marketing techniques for non-profit organisation; attracting resources for nonprofit organisations.

MGTS C442 Consumer Behaviour 3 0 3

Concepts and characteristics of modern consumer behaviour; marketers' and consumers' views of consumer behaviour; market segmentation of consumers; consumer motivation; personality, values and involvement; consumers' perception, learning and attitudes, external influences on consumer behaviour-social, cultural, and situational; influences of sales persons and advertising on consumer behaviour; consumer decision process.

MGTS C443 Econometrics 3 0 3

Course description is same as given under ECON C342.

MGTS C451 Project Appraisal 3 0 3

Prerequisite: ECON C212

Course description is same as given under ECON C411

MGTS C452 Materials Management 3 0 3

Course description is same as given under ET C342.

MGTS C453 Industrial Relations 3 0 3

Course description is same as given under CDP C364.

MGTS C461 Technology Forecasting 3 0 3

Course description is same as given under ECON C451

MGTS C462 Services Marketing 3 0 3

Course description is same as given under FIN C462.

MGTS C463 Government and Business 3 0 3

Need for government regulations; statutory provisions governing business transactions; contract act; sales of goods act; regulative role of state; promotional role of state.

MGTS C472 International Financial Markets & Services 3 0 3

Course description is same as given under FIN C312.

MGTS C473 International Business 3 0 3

Course description is same as given under FIN C451.

MGTS C481 Industrial Marketing **3 0 3**

Market/consumer orientation, marketing in industrial context, industrial market behaviour, organisational buying and buying behaviour, business forecasting and planning, product planning, new product development, pricing, distribution, management of communications, advertising & personal selling, management of sales force, corporate strategy and industrial marketing.

MGTS C482 Franchising **3 0 3**

History and Development, pros and cons of franchising, evaluating, purchasing and financing a franchise, preparations and guidelines for franchise operations, franchise agreement and manuals, international franchising.

MGTS C483 Marketing Research **3 0 3**

An examination of the concepts and practical methodology used in marketing research. An overview of marketing research process, with emphasis on research design; data instrument design; questionnaire formulation; sampling plans; data collection methods - interviewing, panels; data analysis and use of computer based information systems for marketing intelligence. Also Time-series & Regression based models of sales forecasting, control and evaluation of marketing function and survey methodology are covered.

Emphasis will be on cases and research projects.

MGTS C491 Special Projects **3**

Course description is same as given under BIO C491.

MGTS F211 Principles of Management **3 0 3**

Course description is same as given under MGTS C211.

MGTS G511 Advanced Marketing Theories and Advertisement **5**

Strategic planning, theory and methods with emphasis on customer, competitor industry and environmental analysis and its application to strategy development and choice. Marketing communication through advertising and related mass media and promotion campaigns and its influence on market and other organisation. Globalisation and marketing aspects.

MGTS G513 Public Programme Evaluation **5**

Value judgements & public choice, social welfare-Paretion Welfare Economics; market system, income distribution and government & the market. social cost benefit Analysis (SCBA):SCBA and public sector investment planning, efficiency pricing & the rational of new methodology, problems of pricing comparative advantage, social pricing; the application SCBA: economic pricing of factor of production, social pricing, distribution & public sector; management values of public sector undertakings.

MGTS G521 Business Policy-Structure and Organisation **5**

Frame-work of business dynamics; missions; objective and goals; social aspects of business policy; environmental analysis; the dynamic setting of business policy; internal analysis of resources - strength and weaknesses; strategic planning choice, implementation and evaluation; functional policies; orientation in special cases - MNC's high-tech companies, non-profit organisations etc.

MGTS G531 Recent Advances in Organisation Behaviour Theory **5**

Emerging challenges of human resource management- a futuristic perspective; unified global theory of management; empowerment; employeeship; entrepreneurship; organisation diagnosis and development; social system and organisational culture-both in the national and global context interpersonal and group dynamics; employee attitudes; leadership and decision making; motivating employees; quality of work life and socio - technical systems; dealing with subordinates, boss, peers, problem employees.

MGTS G541 Management Information and Decision Support Systems **5**

Course description is same as given under BITS G641.

MGTS G551 Frontiers in Financial Management **5**

Course description to be developed.

MGTS G561 Institutional Finance and Project Appraisal **5**

Mobilization of funds internally, externally, financial institutions and international financial institutions, financial and monetary framework of international financial management, foreign exchange markets and negotiations, project definition, preparation of feasibility assessment and selection, project reporting, conventional project appraisal - limitations, towards a new framework.

Management Systems

MGSYS C411 Marketing **2 2 4**

Definition and scope, consumer behaviour, competitive behaviour, demand estimation, new product introduction, product/brand management, pricing policies, channels of distribution, credit management, advertising and other sales promotion, positioning, marketing regulation, market research basics of industrial marketing.

MGSYS C421 Organization: Design and Process **2 2 4**

Organizational structural characteristics, efficiency, effectiveness and adaptability, structural characteristics

including management hierarchy, the design of departments, divisions and groups, reward and control system as well as organizational goals, objectives, politices and procedures, conceptual model for organization behaviour, the dynamics of organization behaviour - group dynamics, communication, conflict and stresses, leadership processes and styles, team development and team building, motivation, organization development process, consultant and consultancy styles, many agement of change, resistance to change.

MGSYS C431 Accounting and Finance 2 2 4

Financial accounting, GAAP, cost accounting, budgetary control, valuation of inventory and assets, modern trends, role of internal auditing, internal versus external auditing, accounting control and information systems, introduction to financial management, financial planning and control, working capital management, management of fixed assets.

MGSYS C441 Human Resource Management 2 2 4

Introduction, manpower planning, career and succession planning, procurement of personnel, performance appraisal, job satisfaction and morale, job rotation, employee communication, audit and control, management training and development, wage and salary administration, welfare administration, trade unions and collective bargaining, industrial dispute and worker participation in management.

MGSYS C451 Production & Operations Man- 2 2 4 agement

Production & operations management functions; capacity requirement planning; inventory control; layout, handling & location decisions; resource procurement & operation control; project scheduling & resource allocation; the production & operating function; methods of forecasting demand; financial analysis of operating plans; determination of economic order quantity; development of efficient work methods, quality control, management of R&D, technological forecasting, equipment replacement and interfaces with other functional areas.

MGSYS G511 Legal Environment of Business 2 2 4

Need for government regulations; Companies Act; Financial regulations, SEBI, BIFR and others, Contract Act and Sale of Goods Act. Corporate tax laws - Direct and Indirect.

MGSYS G521 Institutional Finance and Project 2 2 4 Appraisal

Framework for domestic/international institutional finance evaluation; Project identification, feasibility, appraisal, financial and capital structures, capital market instruments; managing new issues; negotiation with FIs, FIIs and other market players; issue pricing, SEBI guidelines, syndication of loans including term loans, lease financing. Financial projections, profitability, cost and benefit analysis, appraisal criteria- financial, economic and social, risk analysis.

MGSYS G531 Decision Analysis 2 2 4

Introduction to quantitative techniques and statistics, Decision making, intelligence design and choice phases, basic theory of decision making under uncertainty; decision trees, qualification of judgments and preferences, Bayes theorem, the structuring of complex decisions, and multi-attribute utility theory. Statistical estimation and forecasting.

MGSYS G541 Economic Environment of Busi- 2 2 4 ness

Economic environment, theories and techniques of price and output decision, theory and measurement of demand, production functions, cost output relationships, pricing practices and competitive and eligopolistic market, the social, policital technological and ethical issues confronting contemporary managers and the modern corporation, the role of business in society. Aggregate economies; savings and investment analysis; fiscal policy; monitory policy; central budgets.

MGSYS G551 International Business 2 2 4

International business - an overview, general international environment - political, legal, socio-cultural and economic factors, international operational framework, tax aspects, marketing factors, labour factors and economic integration. BOP analysis, foreign exchange control, governmental policies, international finance, economic community, IMF, managing multinationals/globalization of operations.

MGSYS G611 Strategic Management & Busi- 2 2 4 ness Policy

Strategic management elements; internal, external, external environment. assessment of corporate strengths, weaknesses and opportunities; planning and deployment of capital assets; profit planning and control functions problems, pressures, responsibilities, limits of the chief executive; evaluation of one's own business undertaking; formulating objectives, strategies, policies and programmes for improving compay's present situation; personnel strength and implementation of the policies and programmes, development, implementation, evaluation and control of strategies, strategic management of MNCs, management style and behaviour, corporate style, behaviour and culture.

MGSYS G621 Advanced Marketing Theories 2 2 4 and Advertising

Strategic planning, theory and methods with emphasis on customer, competitor industry and environmental analysis and its application to strategy development and choice. Advertising and promotion management;

profit, goals, market share objectives, setting the budget; target audience selection and action objects; Profiling the decision maker, communication objectives; Brand attitude strategy, processing brand awareness, promotion's action and communication objectives, consumer trial promotions, consumer usage promotion; media selection, media scheduling by effective frequency; advertising strategy research. Ad testing compaign, Evaluation research.

MGSYS G631 Advanced Financial Management 2 2 4

Introduction to financial environment, financing and dividend policies, capital markets and valuation of company, asset pricing model; arbitrage pricing theory; options, futures and swaps; rational expectations; financial signalling; expected utility theory; diversification, portfolio seletion; international capital budgeting; mergers and acquisitions.

MGSYS G641 Management Information and Decision Support Systems 2 2 4

MIS introduction and concept, concept of information, system and management, database management system, decision making, planning, designing, developing implementing and evaluating IS, organisation structure and MIS placement, management support systems; DSS, EIS. ES; applications of artificial intelligence in business.

Manufacturing Management

MM G511 Manufacturing Organization and Management 5

Manufacturing environment; Engineering considerations; Design and planning of manufacturing systems; Manufacturing cost control; Material flow control; Quality; Human resources; Financial management; Marketing management.

MM G512 Manufacturing Strategy 4

Corporate strategy; Missing links in manufacturing strategy; Audit approach; Restructuring; Manufacturing strategy process in practice; Formulation as a process; Operating strategies; Methodology framework; Lean production; Competitive priorities; Strategic value of response time and product variety; Flexibility in context of manufacturing strategy; Manufacturing focus; Business process reengineering; Theory of constraints; Link between strategy and organizational culture; Evolution of manufacturing systems; Operations management strategic perspective.

MM G521 Financial Management 4

Concepts and techniques of financial management decision; concepts in valuation - time value of money; valuation of a firm's stock, capital asset pricing model; investment in assets and required returns; risk analysis; financing and dividend policies, capital structure decision; working capital management, management of cash, management of accounts receivable; inventory management, short and intermediate term financing, long term financial tools of financial analysis, financial ratio analysis, funds analysis and financial forecasting, operating and financial leverages.

MM G522 Total Quality Management 4

TQM principles and practices; leadership; customer satisfaction; employee involvement; continuous process improvement; supplier partnership; performance measures; statistical process control; ISO 9000; benchmarking; quality function deployment; concurrent engineering; experimental design; Taguchi's quality engineering; product liability.

MM G531 Concurrent Engineering 5

Course description is same as given under MSE G531.

MM G532 Logistics Management 4

Role of logistics; Customer service; Logistics information systems; Managing materials flow; Transportation; Warehousing; Packaging issues; Global logistics; Organizing for effective logistics; Methods to control logistics performance; Supply chain management; Implementing logistics strategy.

MM G542 Just-in-Time Manufacturing 4

Introduction; Toyota production system; JIT implementation surveys; Design, development and implementation of JIT manufacturing systems; Supply management for JIT; Framework for implementation of JIT; Theoretical research in JIT systems; Various case studies.

MM G552 Total Productive Maintenance 4

Outline of TPM; TPM – Challenging limits; Maximizing equipment effectiveness; Organizing for TPM implementation; TPM implementation and stabilization; TPM small group activities; the PM prize for outstanding TPM plants.

Public Health

MPH C431 Accounting & Finance 4

Course description is same as given under MGSYS C431.

MPH G510 Biostatistics & Computers in Public Health 5

Introduction to data classification, analysis and probability; statistical inference – estimation and hypothesis testing; linear regression and correlation; design of experiments; analysis of variance; non parametric procedures & tests; statistical quality control; experimental design in clinical trials and validation; basic techniques in optimization.

Introduction to computer and its component, operating systems; principles and use of standard software packages having application in drug design, development, analysis, etc; principles of software creation; processing concepts, flow charting and algorithms,

programming constructs, programming languages, program development sequence; information systems; need, significance concepts, their analysis, design and implementation; software life cycle with special reference to software planning and maintenance.

MPH G512 Environmental & Occupational Health **4**

Introduction to environmental health and its importance; pollution from water, air, automobile, chemicals used in agricultural sector and their implication on health and environment; techniques for studying, monitoring and controlling pollution; handling and disposal of domestic industrial and bio-medical refuse, incineration of waste materials; methods of vector control; effect of low frequency electromagnetic radiation and nuclear radiation on public health, occupational health hazards; disaster management.

MPH G513 Public Health & Diseases **4**

Tropical diseases – their geography, identification, treatment methods, medicines, design of standard protocols and immunization processes including planning and execution; infections due to ticks and mites; bacterial, parasitic and viral infections- types and their classification, host–parasite relationships, their mode of proliferation, mechanisms of infestation, carriers, preventive methods and processes; understanding the public health problems related TB, AIDS, leprosy, GI infections and other communicable diseases.

MPH G515 Communication in Health Care **4**

Role and importance of communication; effectiveness in oral and written communication; technical reports; technical proposals; research papers, interpersonal communication; business correspondence; use of modern communication aids and mass media; behavioral change communication; design, management & evaluation of IEC.

MPH G521 Health Care Management **4**

Basis of organizational culture and management techniques for efficient administration of health delivery; general principles of HR, materials and operation management; understanding the organizational culture that exists in public, private and non-Govt. sector agencies; management information system.

MPH G522 Preventive Nutrition & Health Promotion **4**

Basic concepts; nutritional requirements of essential nutrients, proteins, fats, carbohydrates, vitamins and minerals; balanced diet; nutritional problems in public health; nutritional factors in selected diseases; assessment of nutritional status; nutritional surveillance; mal-nutrition; special nutritional programme.

MPH G523 Epidemic & Disaster Management **4**

Disaster management; impact and response; relief phase; disaster mitigation in health sector; disaster preparedness; policy development; man-made disasters; international agencies providing health based humanitarian assistance; and strategies for disaster management.

MPH G531 Health Economics & Financial Management **4**

Concepts & methods of economic analysis related to health system; organization and policy; demand and supply of scarce resource for health care; health financing & population coverage; determinants of cost & utilization; health insurance; cost-benefit analysis; costing for decision making; fundamentals of accounting; financial statement analysis; budget process & budgetary control; capital investment decision.

MPH G535 Family & Community Health Measures **4**

Community-level indicators (CLI) measure aspects of the physical, legal, social and economic environment that reflect and are likely to influence the attitudes and behavior of individuals and community members. They also measure an important step in community-based health promotion interventions, Topics like, rural health services and health sector reforms from community perspective.

MPH G537 Law & Ethics in Public Health **3**

Various Acts/ legislations/ rules pertaining to public health and related fields like, drug & pharmaceuticals, medical practice, PNDT, CPCSEA, IHEC, Regulations related to waste disposal.

MPH G538 Telemedicine **3**

Advancing the use of digital telecommunications technology for the purpose of improving health care delivery to rural and underserved remote populations. Service areas include clinical services, educational programs, and research and development to provide high quality specialty care in participating rural communities and evaluation of the clinical utility and cost impact of telemedicine. Topic included will be Introduction to Telemedicine, Telehealth, Telemedicine Services, Telemedicine Systems and Telecommunications, Telemedicine Applications, Benefits and Drawbacks of Telemedicine, Information Sources, Advancing Telemedicine, etc.

MPH G539 Inter-sectoral co-ordination in Health Services **3**

Roles of public, private, government, non-government sectors in providing health services, Public works department, Sanitation, Waste disposal and management, Water and air pollution monitoring and control, Deforestation, Urbanization and rural development, Employment and occupational health hazards, Training of administrators and enforcement agency staff, Public awareness programs, etc.

MPH G540 Role of Voluntary bodies/ NGO's in Public Health **3**

Civil society organizations, Red Cross, Red Crescent movement and nongovernmental organizations in fund raising, international and local humanitarian responses, partnerships and collaborations with civil society, Operations in remote areas and marginalized groups; Role of indigenous voluntary bodies, Functioning of NGOs, WHO in preparedness and response efforts and Needs-based deployment of available resources, Effective health services coordination, etc.

MPH G613 Health Systems and Society **2**

Introduction to health systems; functions of health systems; managing health systems; problems of health systems management; Major environmental health problems including quality of water, waste disposal food production and processing, vector control etc. Air pollution and its controlling, Hazards of radiation, municipal and other wastes, Occupational health hazards.

MPH G661 Research Methodology I **5**

Course description is same as given under SKILL G661.

MPH G665 Hospital Operations Management **3**

Course description is same as given under HHSM ZG665.

MPH G681 Strategic Management **3**

Concepts of Strategic Planning; Environment Analysis; Internal and External; Resource Analysis; Organizational Structure and Linkage with Strategies, Formulation, Implementation and Control of Strategic Plan; Communicating Strategic Plan; Case studies.

MPH G692 Epidemiology **2**

Introduction to the principles and methods of epidemiology. Epidemiology of some illustrative infectious diseases (of bacterial, rickettsial and viral origins), sexually transmitted diseases, chronic diseases such as cancer, cardiovascular diseases, neurological disorders etc. Use of biostatistics in epidemiology.

Manufacturing Systems Engineering

MSE G511 Mechatronics **3 2 5**

Concepts of measurement of electrical and non-electrical parameters; displacement, force, pressure etc. and related signal conditioning techniques, drives and actuators, concepts of microprocessors/ microcontrollers architecture and programming, memory and I/O interfacing. System design concepts through case studies.

MSE G512 Manufacturing Planning and Control **4**

Introduction, operations and manufacturing strategy for competitive advantage, product design and planning, forecasting product demand, facilities location, process selection and design, capacity planning, layout of facilities, job design and work measurement, aggregate planning, master manufacturing schedules, material requirements planning for dependent demand, short-term schedules and shop floor control, independent demand inventory systems, logistics and supply chain management, just-in-time systems, maintenance and reliability, quality management, managing projects, strategies for manufacturing excellence.

MSE G513 Maintenance Engineering **3 1 4**

Introduction, maintenance systems, methods and tools of maintenance analysis, eliability and safety, maintainability, supportability, design for maintenance, maintenance integration, computerized maintenance management systems, TPM, world-class maintenance systems, and maintenance effectiveness and performance evaluation.

MSE G514 Leadership and Managing Change **3 1 4**

Individuals as leaders, team leadership and organizational leadership. Introduction to managing change, management of change : organisational structure, culture, recruitment, performance management, human resource development, reward management, employee relations and involvement, downsizing, and evaluating and promoting.

MSE G521 World-Class Manufacturing **3 2 5**

The world-class manufacturing challenge, developing a world-class manufacturing strategy, just-in-time, total quality, total employee envolvement, world-class information systems, managing the change, methods and procedures; improved brainstorming methods, using the check-total quality - the first steps, getting people involved, monitoring world-class performance.

MSE G531 Concurrent Engineering **3 2 5**

Introduction of concurrent engineering and need, concurrent engineering tools, advances in design and manufacturing engineering, design for manufacture, design for assembly, rapid prototyping, simulation, concurrent approaches to design, manufacturing and other aspects of engineering.

Materials Science and Technology

MST F331 Materials Characterization **3 1 4**

Thermal properties of Materials and Characterization, Electrical Characterization: Temperature dependent DC conductivity in materials, impedance spectroscopy, Characterization instruments like impedance analyzer, Optical Characterization: UV- Visible spectroscopy, FTIR spectroscopy, optical microscopy, Confocal microscopy, Mechanical Characterization: Time dependent and time independent mechanical behavior of materials, Dynamic Mechanical Analysis, Instruments:Universal testing machine, Fatigue machine, Izod and charpy impact testers, Hardness indenters, Abrasion tester, Physical Characterization: Microstructure Characterization, Characterization instruments:

SEM, TEM, X-ray diffractometer, AFM, Rheological Characterization: Linear and non-linear visco-elastic behavior of materials. Magnetic Characterization: Basics of diamagnetism, ferromagnetism and paramagnetism, anti ferromagnetism and ferrimagnetism, hysteresis and anisotropy, AC susceptibility and SQUID magnetometer.

MST F332 Materials Processing 3 0 3

Processing of metals: electrometallurgy, hydrometallurgy, pyrometallurgy, extraction, and refining, Powder processing of metals and ceramics: Powder handling, compaction and forming techniques. Drying, burnout, densification, sintering, and grain growth in powder compacts. Crystal growth, epitaxial growth, Deposition of thin films – Plasma Laser deposition, metal organic chemical vapour deposition, Production of carbon-based materials: Controlled pyrolysis, electro-spinning.

Processing of plastics and fiber reinforced plastics: Processing by using techniques such as extrusion, injection molding, compression molding, SMC, pultrusion and filament winding.

MST F333 Introduction to Biomaterials 3 0 3

Proteins, polysaccharides, oils and fats, fibers and biopolymers, structure and characterization of biomaterials, isolation and processing of biomaterials, development of polymers and composites from biomaterials, structure-property relationships (thermal, mechanical, biocompatibility, biodegradation etc.). Value-added products developed by using biomaterials, adhesives, bioplastics, composites for insulation and construction applications, biomedical applications such as, dental implants, sutures etc.,

MST F334 Materials for Catalytic applications 3 0 3

Classification of different industrial catalysis technology; Classification of solid catalysts; Synthesis of bulk and nanomaterials; Chemical properties of energy-relevant materials environmental catalytic materials at the nanoscale.; Metals and metallic alloys supported on oxide-based catalytic materials; Metal-support interaction; Structure sensitivity of catalytic reactions; Reaction mechanisms in catalysis on metal supported catalysts; Porous materials for catalyst supports; Oxide non-stoichiometry - structural defects; Semiconductor character - photocatalysts; Acidic and Basic oxide catalysts; Lewis and Brønsted acidity in oxides; Hydrotalcites - precursors for base oxides; Sulfide based catalysts.

MST F335 Coating and Thin film technology 3 0 3

Coating composition, pigments, binders, solvents, additives, Industrial process of making coatings, Rheology and mechanical properties of coatings, coatings in building and automotive sector, Introduction and formation of thin films by processes such as CVD, PVD, electrochemical deposition, thermal sprays, etc. Characterization of thin films such as coating hardness, thickness, assessment of friction & wear, roughness using nano-scale tests. Applications such as in defense, solar energy, consumer goods and implant materials.

MST F336 Glass Technology 3 0 3

Introduction to glass, glass transition, principles of glass formation and molecular structure of glass. Structural basis for glass formation. Characterization of properties of Glass. Glass making: Raw materials and mixing methods, batch wetting and compaction techniques. Glass batch melting reactions and principles. Glass technology and commercial glasses: Press and blow, Individual selection machines, molds, and container design. Surface treatments and chemical durability. Flat glass forming and fabrication. Fabrication processes: chemical strengthening, annealing, tempering, and laminating. Strengthening of glass by physical and chemical means. Gorilla glass. Fiber glass manufacturing methods and products for application in insulation, filtration, polymer reinforcement and textiles.

MST F337 Materials for Energy Applications 3 0 3

Overview of conventional and non- conventional energy resources, Silicon based Photovoltaic Solar cells, Photovoltaic thin films, Lightweight composites for wind turbine blades, Metals and ceramics used in thermal power plants, Ceramics for Energy storage and conversion, Ceramics and Composites for Nuclear energy, Photoelectrochemical Cells for hydrogen generation, Functional materials for Hydrogen storage, Functional Materials for fuel cells, Membrane electrode assemblies for fuel cells including DMFC's, Novel materials for Solid oxide fuel cells (SOFC) systems.

MST F338 Metals and Alloys 3 0 3

Introduction, classification of Ferrous metals, Nonferrous metals such as Titanium, Aluminium, Magnesium, Copper and their alloys, Structure-property relationship, Phase diagrams and Phase kinetics, processing and applications of metals and alloys, degradation of metals, Applications in transportation, chemical and medical sectors.

MST F339 Polymer Materials 3 0 3

Polymerization techniques; classification of polymers; mechanism and kinetics of formation of polymers; Theoretical and experimental techniques for determination of different types of molecular weights and molecular weight distributions; polymer solution viscosity; melting and glass transitions, rheology; polymerization techniques used in industry, polymer solution thermodynamics; viscoelastic behaviour; degradation and stability; polymer processing and applications. Engineering thermoplastics, additives, blends, polymer composites and Biopolymers. Applications in automobile, biomedical and electronic and other industries.

MST G511 Nondestructive Testing Techniques 3 2 5

Ultrasonic testing, X-radiography, eddycurrent testing,

magnetic methods of crack detection, liquid penetrant inspection, acoustic emission and acousto-ultrasonic testing techniques.

MST G512 Ceramics Technology 3 2 5

Ceramic raw materials, their beneficiations and characterisations; crystal structure of important ceramic systems and structural defects; various types of ceramics; white wares, glasses, refractories, cements, abrasives, glass-ceramic, ceramic coatings, electronic ceramics; fabrication processes; grinding, pressing, slip casting, drying, sintering, glass blowing; development of ceramic microstructures; properties of ceramic materials; mechanical, thermal, electrical, optical, magnetic and chemical; ceramic composites, cermets.

MST G521 Materials Characterization Techniques 3 2 5

Materials characterisation - definition; importance and application with case studies, principles and general methods of compositional, structural and defect characterisation, techniques of X-ray, electron and neutron diffraction, EDAX, thermal methods - DTA, TGA, DSC. TMA and DMA; microscopy-optical, electron (TEM & SEM) and spectroscopy -UV, visible, IR and Raman spectroscopy, ESCA and Auger spectroscopy, SIMS resonance method- NMR, ESR, Mossbauer techniques, particle size analysis, electrical and magnetic characterization techniques.

MST G522 Advanced Composites 3 2 5

Definition of composite materials; classification; particulates and dispersion hardened composites, continuous and discontinuous fibre reinforced composites, metal-matrix composites, carbon-carbon composites, molecular composites, micro and multilayer composites, theory of reinforcement; reinforcement by continuous and discontinuous fibres, concept of microfibril; effect of orientation and adhesion; mechanical behaviour of composites, stress-strain relationship, strength, fracture thoughness and fatigue; properties of fibre reinforcement and production technology of composites.

MST G531 Experimental Stress Analysis Techniques 3 2 5

Strain gauges, photoelasticity, brittle lacquer, three dimensional photoelasticity, Moire methods.

MST G532 Electronic Materials 3 2 5

Electrical conduction in glasses and ceramics, non-stoichiometry and valence controlled conduction, ceramic heating elements, fast ion conductors, superconducting materials and devices, dielectric ceramics, ceramics in micro electronics, voltage dependent resistors, positive and negative temperature coefficient resistors. Piezo electric, pyroelectric, ferroelectric and electrooptic ceramic materials and devices, ceramic sensors, magnetic and magneto-optic ceramic devices, ceramics for microwave applications, luminescent and photoconducting ceramics, light transmitting filters, IR transmitting glass, optical fibre technology.

Music

MUSIC N103T Indian Classical Music (Vocal) I 3*

MUSIC N104T Indian Classical Music (Vocal) II 3*

MUSIC N203T Indian Classical Music (Vocal) III 3*

MUSIC N204T Indian Classical Music (Vocal) IV 3*

MUSIC N113T Indian Classical Music (Instrumental) I 3*

MUSIC N114T Indian Classical Music (Instrumental) II 3*

MUSIC N213T Indian Classical Music (Instrumental) III 3*

MUSIC N214T Indian Classical Music (Instrumental) IV 3*

The eight courses given above – four in vocal and four in instrumental - are designed to give theoretical and practical knowledge of Indian Classical Music in Hindustani or Carnatic style.

In the Hindustani series, the student will be introduced to the Hindustani system, *swara gyan,* structure of *Raag*s and *Taal*s, the ten *Thaat*s, and practice in performing selected *raag*s through compositions with elaborations.

For the Carnatic style series, the syllabus includes basic *Swara gyana*, structure of *Raagas* and *Taalas*, renderings of graded compositions in the form of *Geetam, Swarajati, Varnam* and *Keertanam*, introduction to the *Melakarta* and *Janya Raaga* system with reference to the seventy two Melakartas, performance practice including compositions and elaborations.

These courses are not available for fulfilling the requirements of any programme in the institute and can be taken only as audit courses.

MUSIC N105T Western Classical Music I 3*

MUSIC N106T Western Classical Music II 3*

MUSIC N205T Western Classical Music III 3*

MUSIC N206T Western Classical Music IV 3*

The above four courses are designed to introduce and train the student in notation, rhythmic concepts and practice of western classical music.

The beginning level will develop the skills of reading and writing notations, supported by singing exercises. The objective of the theory part is to impart the required skills for reading music while either playing an instrument or plain vocal. The student will be trained further in keyboard or violin practice.

At the advanced level, the student will be trained in more complex notations, rhythms, concept of Harmony melody etc., and composing rhythms and melodies. Training syllabus and examination tests will be based

on that of the Associated Board of the Royal Schools of Music, London, and/or the Trinity-Guildhall board of music examinations.

(These courses are not available for fulfilling the requirements of any programme in the institute and can be taken only on audit).

MUSIC N303T Advanced Indian Music Practice 0 (Vocal)

MUSIC N313T Advanced Indian Music Practice 0 (Instrumental)

These courses are designed to allow facilities for practice with minimum supervision for students who have satisfactorily completed MUSIC N204T or MUSIC N214T respectively. These courses carry zero units. A student who has met the prerequisite can take these courses as audit courses as many times as he needs.

Pharmacy

PHA C211 Biological Chemistry 3 0 3

Course description is same as given under BIO C211.

PHA C212 Pharmaceutical Analysis 2 3 3

Basic techniques of pharmaceutical analysis, data handling and analysis, sources of error in analysis. The analytical methods would comprise of various titrimetric methods, such as acid-base, complexometric, non-aqueous, oxidation-reduction, precipitation, conductometric; physical and instrumental analysis such as gravimetric, polarography, nephelometry, amperometry, turbidometry, potentiometry; chromatographic separations such as TLC, coloumn, ion-exchange,

extraction methods such as gel-filtration, fractionation processes, analysis of metallic and non-metallic elements; water content, as well as evaluation of drug constituents in various pharmaceutical preparation.

PHA C213 Introduction to Physical Pharmacy 2 1 3

Introduction to ingredients, excipients used in pharmaceutical manufacturing, their physico-chemical properties, ionic equilibrium and kinetics, phase diagram, viscosity, refractive index, specific rotation, order of reaction, solubility curves, surface tension, molecular structure and crystal lattices and their significance in pharmacy, pharmaceutical additives their sources, types and uses, flow properties, posology and micromeritics, various systems of medicine, monographs and literature of standards, types of dosage forms.

PHA C241 Microbiology 2 3 3

Course description is same as given under BIO C241.

PHA C311 Natural Drugs 2 3 3

The course imparts a knowledge of the crude drugs of natural origin used in pharmaceutical and medical practice. Study will include the different systems of classifications of crude drugs; cell contents; general principles of cultivation, collection, drying, storage and commerce of natural products of current medical and pharmaceutical importance; their morphologial and microscopical study: use and knowledge of common substitutes and adulterants.

PHA C312 Forensic Pharmacy 3 0 3

A study of the professional pharmacist's relation to the public and to other professions; a critical survey of statutory regulations governing the practice of pharmacy and drug industry in all its aspects; history and ethics of the profession of pharmacy.

PHA C321 Anatomy, Physiology and Hygiene 2 3 3

Anatomical study of the important organs of human body; physiology of various functional systems of human body; general principles of personal and community hygiene and prevention of communicable diseases.

PHA C322 Dispensing Pharmacy 2 3 3

Prescriptions, principles involved in the dispensing of prescriptions; physical, chemical and therapeutic incompatibilities involved and their remedy in such prescriptions; techniques involved in dispensing of mixtures. ENT preparations, parenteral products, radiopharmaceuticals, etc.

PHA C331 Industrial Pharmacy 2 3 3

Pharmaceutical processes and equipments commonly used in pharmaceutical industries; drug extraction and clarification; mixing and granulation; pharmaceutical preparations such as aromatic waters, spirits, syrups, elixirs, lotions, liniments, official solutions, etc.; galenical products like infusions, decoctions, tinctures, extracts, etc, glandular preparations and blood plasma substitutes.

PHA C332 Pharmacology and Toxicology 2 3 3

Pharmacology of important classes of drugs including their mechanism of action, therapeutic uses, side effects, toxic manifestations, indications and contra-indications.

PHA C342 Medicinal Chemistry 2 3 3

Chemistry of selected synthetic and natural organic medicinals and study of structure-activity relationships; representative drugs selected from the following major classes: anaesthetics, hypnotics, sedatives, analgesics, chemotherapeutic agents, antihistaminics, drugs affecting peripheral nervous system, hypotensive drugs and anticancer agents.

PHA C391 Instrumental Methods of Analysis 1 6 4

Course description is same as given under BIO C391.

PHA C411 Physical Pharmacy 2 3 3

Course description is same as given under CHEM C451.

PHA C412 Veterinary Pharmacy 3 0 3

Basic framework of various anatomical systems of animals, physiological features of various systems, comparative aspects on pharmacokinetics and pharmacodynamics of veterinary drugs; Tropical diseases of domestic animals, formulation of drug dosage form for animals, dispensing equipment, their selection.

PHA C413 Pharmaceutical Management & Quality Control **3 0 3**

Concepts of Pharmaceutical management, Managing of pharmaceutical industry, planning, layouts, designs, current good manufacturing practices, pharmaceutical process validation, documentation, pilot plant scale up technique optimization, pharmaceutical marketing, quality aspects and quality control, managing hospital pharmacy and its importance.

PHA C414 Biopharmaceutics **3 0 3**

Biopharmaceutics and Biopoharmaceutical aspects of drug delivery covering absorptions, distribution, metabolism and elimination (ADME) characters of drugs. Compartment model, pharmacokinetics of drugs and their applications, bioavailability, bioequivalence and their studies, drug-drug interactions and other related matters.

PHA C415 Pathophysiology **3 0 3**

Cellular pathology, inflammatory, genetic and immunological disorders, infectious diseases- their expression and cause, targets for therapy, diseases of the organ systems, environmental and nutritional pathology.

PHA C416 Chemistry of Synthetic Drugs **3 0 3**

Heterocyclic drugs; methods of heterocyclic drug synthesis; mechanisms of important heterocyclic compounds; mechanism based optimization of lead compounds on target sites; biological properties of heterocyclic durgs; synthesis of other special organic compounds of biological importance like steroids, prostaglandins etc.

PHA C417 Pharmacoeconomics **3 0 3**

Economic aspects of health care and its applications in the health sector are broadly emphasized. Cost-benefit, cost-effectiveness, cost-minimization, and cost-utility analyses to compare the different pharmaceutical products, drug therapy and treatments are focused. Economic concepts such as supply, demand, efficiency, equity, health policy, market failures, health insurance, pharmaceutical market, measurement of direct and indirect costs to a health care program, economic issues, pharmaceutical regulations, pricing policy and related topics will be covered.

PHA C421 Pharmaceutical Formulations and Biopharmaceutics **2 3 3**

Physical, chemical and biopharmaceutical considerations in formulations, absorption, distribution and elimination of drugs; pharmaceutical additives; formulation and stability aspects of solid dosage forms, semi-solid dosage forms and liquids dosage forms; sustained release medication; aerosol products and packaging.

PHA C422 Cosmetic Science **2 3 3**

Principles of formulation of typical cosmetic preparations such as cosmetic creams, powders, lipsticks, rouges, hair preparations, dentrifices, aerosol cosmetics, perfumes for cosmetic, their blending and mixing techniques. Some recent and new trends.

PHA C431 Pharmacognosy **2 3 3**

The course is intended to impart knowledge to the students in the isolation and evaluation of the active constituents of natural products of medicinal and pharmaceutical importance. Study of active constituents and their variability in the natural products; a systematic study of natural products of medicinal and pharmaceutical importance with special reference to their identification, isolation, separation techniques and properties; biogenesis of alkaloids and glycosides, evaluation of crude drugs including quantitative microscopy.

PHA C432 Hospital Pharmacy **3 0 3**

Definition and function, location, organisation, staff, space, equipment. Pharmaceutical services, Medical stores, objectives, procedures for procurement and suplies, Distribution & control, inspection of stocks, Licensing procedures for stocking of alcohol, narcotics, Maintenance ofrecords of stocks, issue and use. Pharmaceutical services for out - patient and in - patient department.

PHA C441 Biochemical Engineering **3 0 3**

Course description is same as given under BIO C441.

PHA C442 Applied Pharmaceutical Chemistry **3 0 3**

The course comprises of structure, reactions and synthesis of selected carbocyclic and heterocyclic ring systems. Their application for drug design, structure activity relationship, pharmacological action, methods of assay.

PHA C461 Phytochemistry **2 3 3**

This course is intended to impart knowledge to the students in the isolation, characterization and chemistry of the natural products derived from various sources, which are of pharmaceutical importance. Intriguing chemistry involved in their invivo production and their importance as structural materials, biologically active molecules like toxins, hormones, life process substrates and drugs will be covered in this course, the evaluation of these substances using qualitative and quantitative methods will also be covered; specail emphasis will be given to newer techniques in the biogenesis of these molecules.

PHA C491 Special Projects **3**

Course description is same as given under BIO C491.

PHA F211 Pharmaceutical Analysis **2 1 3**

Course description is same as given under PHA C212.

PHA F212 Dispensing Pharmacy **2 1 3**

Course description is same as given under PHA C322.

PHA F213 Microbiology **2 1 3**

Course description is same as given under BIO C241.

PHA F214 Anatomy Physiology & Hygiene **2 1 3**

Course description is same as given under PHA C321.

PHA F215 Introduction to Molecular Biology & Immunology **3 0 3**

Basic aspects of cell and molecular biology, DNA replication, transcription, translation and control mechanisms of protein synthesis. Post transcriptional modifications, DNA-protein interactions and regulation of gene expression. Basic aspects of immune system, cell-mediated and humoral immunity.

PHA F241 Pharmaceutical Chemistry **2 1 3**

This course deals with study of important classes of organic compounds such as alcohols, ethers, esters, aldehydes etc and their reactions. The mechanisms for various reactions will also be dealt with to comprehensively cover the basics of chemical reactions. Some important five and six member heterocycles with their reactions will also be part of the course. This course also emphasizes the use of inorganic compounds in pharmacy.

PHA F242 Biological Chemistry **2 1 3**

Course description is same as given under BIO C211.

PHA F243 Industrial Pharmacy **2 1 3**

Course description is same as given under PHA C331.

PHA F244 Physical Pharmacy **2 1 3**

Course description is same as given under CHEM C451.

PHA F266 Study Project **3**

Course description is same as given under BIO F266.

PHA F311 Pharmacology I **2 1 3**

This course is intended to impart the knowledge regarding the sources, routes of drug administration, pharmacokinetics (ADME) and pharmacodynamics (mechanism of action) of various drugs. This course is also intended to impart the knowledge regarding the concepts of action of drugs on various systems of the human body including ANS, SNS and CNS. The course also deals with therapeutic uses, side effects and contraindications of the drugs, which are commonly prescribed for the treatment of various disease conditions.

PHA F312 Medicinal Chemistry I **2 1 3**

This course deals with the study of important classes of drugs predominantly acting on CNS, ANS, SNS. Various aspects like structure, properties, therapeutic and pharmaceutical importance and the uses of drug molecules both of natural and synthetic origin will be covered. Study of physiochemical properties, mechanism of action, S.A.R. and metabolism of drugs will also be emphasized. Special emphasis will be given on important topics such as Cholinergic drugs, Adrenergic drugs, Local anesthetics and volatile anesthetics, Sedative hypnotics and anti anxiety drugs, Antiepileptics, Antihistamines, NSAIDS etc.

PHA F313 Instrumental Methods of Analysis **2 1 4**

Course description is same as given under BIO C391.

PHA F314 Pharmaceutical Formulations and Biopharmaceutics **2 1 3**

Course description is same as given under PHA C421.

PHA F341 Pharmacology II **2 1 3**

This course is intended to impart the knowledge regarding the concepts of actions of drugs on various systems of the human body including cardiovascular system, urinogenital system, respiratory system, gastrointestinal and endocrine system etc. The course also imparts the knowledge regarding the mechanisms of action of various antimicrobial agents in the treatment and prevention of various diseases caused by the bacteria, fungi viruses and parasites. The course also deals with the drug-drug interactions, therapeutic uses, side effects and contraindications of the drugs, which are commonly prescribed for the treatment of various disease conditions.

PHA F342 Medicinal Chemistry II **2 1 3**

This course deals with the study of important classes of drugs. Various aspects like structure, properties, therapeutic and pharmaceutical importance and the uses of drug molecules both of natural and synthetic origin will be covered. Study of physico-chemical properties, mechanism of action, S.A.R. and metabolism of drugs dealt will also be emphasized. Special emphasis will be given on Important topics such as Anti hypertensive drugs, Drugs affecting sugar metabolism, Antimalarial drugs, Anticancer agents, Antiviral agents etc.

PHA F343 Forensic Pharmacy **2 - 2**

Course description is same as given under PHA C312.

PHA F344 Natural Drugs **2 1 3**

Course description is same as given under PHA C311.

PHA F366 Lab Project **3**

PHA F367 Lab Project **3**

Course description is same as given under BIO F366

and BIO F367.

PHA F376 Design Project 3

PHA F377 Design Project 3

Course description is same as given under BIO F376 and BIO F377.

PHA F413 Pharmaceutical Management and Quality Control 3 0 3

Course description is same as given under PHA C413.

PHA F414 Biopharmaceutics 3 0 3

Course description is same as given under PHA C414.

PHA F415 Pathophysiology 3 0 3

Course description is same as given under PHA C415.

PHA F416 Chemistry of Synthetic Drugs 3 0 3

Course description is same as given under PHA C416.

PHA F417 Pharmacoeconomics 3 0 3

Course description is same as given under PHA C417.

PHA F422 Cosmetic Science 2 1 3

Course description is same as given under PHA C422.

PHA F432 Hospital Pharmacy 3 0 3

Course description is same as given under PHA C432.

PHA F441 Biochemical Engineering 3 0 3

Course description is same as given under BIO C 441.

PHA F442 Applied Pharmaceutical Chemistry 3 0 3

Course description is same as given under PHA C442.

PHA F461 Phytochemistry 2 1 3

Course description is same as given under PHA C461.

PHA F491 Special Projects 3

Course description is same as given under BIO F491.

PHA G510 Application of Statistics and Computer in Pharmacy 5

Course description is same as given under BIO G510.

PHA G511 Fermentation & Biotechnology 2 3 5

Industrial scale production by fermentation processes of antibiotics, vitamins, alcohol and other selected products, development, selection, isolation and preservation of mutants, media sterilisation, accretion and air sterlisation, continuous fermentation, recent advances in fermentation biotechnology, enzymes, their large scale extraction and purification, principles of immobilisation of enzymes and its applications.

PHA G512 Chemistry of Natural Drugs 3 1 4

Study of recent methods of phytochemical investigations with reference to alkaloids like rauwolfia,vinca, cantharanthus etc.; some selected steroids, terpenes & flavoring agents, their chemistry, structure activity relationship, pharmacological actions and synthetic routes.

PHA G521 Molecular Biology & Immunology 3 1 4

General principles governing the structures and functions of various molecules of the immune system, acquired immune responses, immunological tolerance, genetic control of immunity, hypersensitivity reactions, protein structure, functions, RNA and DNA cloning, principles of Genetic Engineering and its future in drug production.

PHA G522 Chemistry of Macromolecules 2 2 4

Physical, Chemical and Biological properties of biopolymers like proteins, nucleic acids, poly saccharides. Synthetic polymers, biomedical and pharmaceutical polymers with emphasis on recent development.

PHA G523 Total Quality Management and Regulatory Affairs (5*)

Quality control, quality assurance, total quality management, various parameters for achieving quality products, application of statistics in quality assurance, statistical process control, current good manufacturing practice (cGMP), introduction to process validation, drug regulatory affairs, clinical research protocols, new drug applications, intellectual property rights.

PHA G531 Disinfection and Sterilization 2 2 4

Theories and kinetics of the disinfection reaction, study of the principles involved in vivo and in vitro evaluation of disinfectants and antiseptics, structure activity relationships of the representative groups of disinfectants, sterilisation, heat, ionizing and ultraviolet radiations, ultrasonic waves, filtration, gaseous sterilisation and cellular dessication methods, controls used and special problems involved.

PHA G532 Quality Assurance & Regulatory Affairs 3 2 5

Quality control, quality assurance, quality management, various parameters for achieving quality pharmaceutical products, application of statistics in quality assurance, reliability, current good manufacturing practice (cGMP) for pharmaceutical manufacturing, pharmaceutical process validation, drug regulatory affairs, clinical research protocols, new drug applications, drug product labeling.

PHA G541 Computer Aided Drug Design 3 2 5

3D structure and function of bio-molecules; targets of drugs and design principles; molkecular modeling methodologies; quantitative structure-activity relationships; chemical compound databases and search tools; interactive graphics in drug design; molecular surfaces and algorithm of automated docking of durgs into receptor sites; receptor mapping; introduction to molecular modeling and docking software.

PHA G542 Advanced Physical Pharmaceutics 3 2 5

Preliminary evaluations and molecular optimization,

Drug substance considerations including protein, peptide and biological products, Bulk characterization, Solubility analysis, Rheology and dispersed systems, Micromeritics and shape factor analysis, Compression and compaction, Principles of dissolution, Dissolution test design and release kinetics evaluation, Compatibility testing, Stability analysis and test design according to international standard, Studies of broad category of polymers used in drug delivery, Rationale basis of formulation recommendation.

PHA G543 Clinical Research 5*

Fundamentals of clinical trials including design, conduct, analysis and interpretation, randomization and blinding methods, sample size determination, recruitment methods, choice of controls, ethical, regulatory and research clearance including GCP, trial requirements-multi-centric/collaborative and related operational issues, data collection, processing, protocol management and quality control issues, interim analysis and critical review of intervention and therapies, design and results, statistical techniques in analysis and interpretation of results, documentation and reporting, pharmacovigilance.

PHA G544 Advanced Pharmaceutical Chemistry 3 2 5

Stereochemical aspects of drugs and biological molecules; effect of stereochemistry on drug action and isomerism in various drugs; rearrangements and name reactions useful in synthesis of bioactive molecules; example applications of rearrangements and name reactions in synthesis of existing drugs.

PHA G545 Intellectual property rights and Pharmaceuticals 3 0 3

Key aspects of intellectual property law and their impact on Pharmaceutical industry; concept of property with respect to intellectual creativity; emerging debates, policy issues and law reforms related to IPR with respect to pharmaceuticals; Issues of Intellectual Property such as Patents, Copyright, Trademarks, and Design; rules and regulations of marketing and competition; Patent processing, infringement of patents, ethics and economic issues related to IPR;

PHA G611 Advanced Pharmacology 2 3 5

Biochemical pharmacology; pharmacologically active polypeptides; general pharmacological principles involving immunological processes, pharmacogenetics, teratology, pharmacokinetics, drug resistance and related phenomena, drug-interaction; recent advances in the therapy of neoplastic diseases, viral diseases, atherosclerosis and hypertension; topics of recent interest like contraception; use of gases and ions in therapy etc.

PHA G612 Pharmacokinetics & Clinical Pharmacy 3 2 5

The study of pharmacokinetics and its clinical applications in the development, evaluation and use of drugs; the time course of drug and metabolite levels in different fluids, tissues and excreta of the body, mathematical relationship required to develop models to interpret the data for single and multiple dosing, study of bioavailability, dosage regimen adjustment in renal impairment, application of the pharmacokinetic principles to the therapeutic management of patients.

PHA G613 Pharmaceutical Biotechnology 3 2 5

Molecular biology, immunology, recombinant DNA technology and principles of biochemical engineering. Application of biotechnology in diagnosis, therapeutics and production of products of fermentation. Bioinformatic tools required to store, analyze and use biological information for therapeutic utility, immense potentiality and application f decoding the human genome.

PHA G614 Clinical Pharmacy and Therapeutics 3 2 5

Basic concepts of Clinical pharmacy and its applications, analysis of patient data interpretation of clinical laboratory tests, drug information queries, their sources and interpretation of the information. Clinical pharmacokinetics, therapeutic drug monitoring, drug-drug interactions.

PHA G615 Pharmacy Practice 3 2 5

Overview of health care systems, providing drug information, physical examination, diagnostic procedures, drug administration, selection of alternate therapies, clinical alert, nutrition and electrolyte therapy, documentation of pharmacy services, patient counseling, paediatric pharmacy practice, evaluation of drug related problems, environmental, and health care management.

PHA G616 Pharmaceutical Administration and Management 3 2 5

Technology innovation and creativity, new drugs and products planning, strategic considerations, project implementation, product development, production management and scale up, preparation of product literature and marketing strategy, IPR processes, human resource development, industrial relations, documentation, R & D management, ethical aspects.

PHA G617 Advanced Drug Delivery Systems 3 2 5

A study of physicochemical and biopharmaceutical factors involved in the design of novel drug delivery systems like mucosal, particulate systems for systemic delivery of bioactive molecules. Special considerations for delivery of protein, peptide and other biological products. In vitro and in vivo evaluation of novel drug delivery systems.

PHA G618 Reterosynthetic Analysis 3 2 5

Methods and techniques to transform target molecule to precursors, functional group, stereo-chemical, struc-

tural, transform based and topological strategies involving organic reactions, functional group interconversions, reconnection and disconnection approaches, acyclic, ring structure synthesis, rearrangement reactions pertaining to the synthesis of selected medicinally important compounds.

PHA G619 Screening Methods and Techniques In Pharmacology **5***

Biochemical assays, qualitative and quantitative estimation of receptor specific drugs, animal handling, breeding, nutrition and diet manipulation for testing, methods and techniques involved, therein. Design and development of new animal models and evaluation techniques for co-morbid illnesses and their standardization, toxicological, teratogenic, carcinogenic studies, data analysis, normalization in tabular and graphical formats.

PHA G621 Advanced Medicinal Chemistry **2 3 5**

Methods of synthesis; properties, uses, methods of assay and structure-activity relationship of non-mercurial diuretics, psychopharmacologicals, anti-cancer agents; chemistry of prostaglandins; some concepts of receptor theories, dose response curves, introduction to QSAR.

PHA G622 Chemistry of Natural Drugs & Macromolecules **3 2 5**

Size and shape of macromolecules, biomedical polymers, their structure, synthesis and function, chemistry of newer oral contraceptive agents, terpenes used as flavouring agents, newer phytochemical investigations in glycosides, alkaloids, etc.

PHA G632 Dosage Form Design **2 3 5**

A study of physical and chemical, pharmacological and biopharmaceutic factors involved in the design and stability of dosage forms; transport of drugs across biological membranes; absorption, distribution and elimination of drugs; formulation additives, closures and containers and sustained release dosage forms; microencapsulation; radio pharmaceuticals.

PHA G642 Laboratory Project **6**

Exercises illustrating principles discussed in theory courses.

PHA G645 Molecular Pharmacology **3 0 3**

Molecular basis of the action of drugs; the characteristics of interactions between drug molecules and substrates of drug action in the cell; molecular, biochemical and cell biological techniques; response of cells to pharmacologic agents.

Philosophy

PHIL C211 Introductory Philosophy **3 0 3**

An overview of some philosophical theories and issues both from India and the western world; nature and purpose of philosophy; theories of cosmology, metaphysics and epistemology; skepticism and its philosophical value; contemporary philosophy.

PHIL C221 Symbolic Logic **3 0 3**

A brief historical survey of the development of logic; nature and kinds of arguments; sentential connectives; symbolization of statements and arguments; truth tables, establishing validity of arguments by truth tables and different types of proofs, quantified statements; quantified arguments and their validity.

Physics

PHY C122 General Physics **3 0 3**

Philosophy of Science; Newtons laws of motion; Work Energy, Impulse and Momentum; Equilibrium; Moment of a force; Rotation; Periodic motion; First law of thermodynamics; Second law of thermodynamics; Electromagnetic waves; Interference and diffraction; Polarization; Relativistic mechanics; Photons, Electrons and Atoms; Quantum Mechanics; Atoms, Molecules and Solids; Nuclear Physics.

PHY C131 Physics I (Mechanics, Waves & Optics) **3 0 3**

Conservation Principles, Rotational Dynamics, Oscillations, Wave Motion, Reflection and Refraction, Interference, Diffraction, Polarisation.

PHY C132 Physics II (Electricity, Magnetism & Modern Physics) **3 0 3**

Electric Field, Magnetic Field, Electric Current, Electromagnetic Induction, Maxwell's Equations, Electromagnetic Waves, Bohr Atom, Atomic spectra, Wave Practicle Duality, Uncertainty Principle.

PHY C212 Classical Mechanics **3 0 3**

Dynamics of particles; generalized coordinates, Lagrange's and Hamilton's equations; rigid body dynamics; small oscillations; normal modes; canonical transformations; Poisson's brackets; action-angle variables.

PHY C221 Modern Physics **3 0 3**

Special theory of relativity; quantum mechanics and applications; atomic and molecular physics; statistical physics; nuclear physics.

PHY C231 Physics Project Laboratory **3***

The course includes projects involving laboratory investigation or laboratory development in physics. The course is normally available to students of second year or higher level. The course must coterminate with a project report.

PHY C232 Computational Physics **3 0 3**

Numerical solution of physics problems selected from the basic courses of Mechanics & Vibrations, Electricity of Magnetism, Optics and Modern physics. Various topics like Newton's equation of motion, damped, forced and coupled oscillations, electric fields and potential of charge distributions, interference and diffraction patterns for different slit geometry, energy eigen-

values and eigenfunctions, reflection and transmission coefficients in one dimension, random walk problems, chaotic dynamics and fractals.

PHY C241 Atmospheric Physics 3 0 3

Fundamental concepts, the earth's gravitational field, satellite orbits, distribution of sea level pressure, atmospheric tides; properties of atmospheric gases; properties and behaviour of cloud particles; solar and terrestrial radiation, energy transfer near the earth's surface, heat conduction into the earth, turbulent transfer, vertical fluxes of heat and water vapor, nocturnal cooling, fog formation; geomagnetic phenomena, general properties of waves, scattering of radiation, atmospheric probing, natural signal phenomena, effects of nuclear explosions.

PHY C242 Theory of relativity 3 0 3

Experimental background and postulates; relativistic kinematics and dynamics; relativistic electromagnetism; principles of equivalence; gravitational red shift; general relativity theory.

PHY C311 Electromagnetic Theory I 3 0 3

Boundary value problems, electrostatic and magnetostatic fields in matter, Maxwell's equations, potential formulations of electrodynamics, multipole expansions, energy and momentum in electrodynamics, electromagnetic waves, dipole radiation.

PHY C312 Statistical Mechanics 3 0 3

Brief review of Thermodynamics, Equilibrium Statistical Mechanics: Microcanonical, Canonical and Grand Canonical ensembles and applications; Quantum Statistical Mechanics, Ideal Fermi and Bose Gases, Cluster expansion, introduction to nonequilibrium Statistical mechanics.

PHY C321 Quantum Mechanics I 3 0 3

State vectors, operators and observables; the uncertainty relation of arbitrary observables; Schrodinger and Heisenberg formulation; equivalence of Schrodinger and Heisenberg formulations; stationary states; the spectrum of the Hamiltonian; orthogonality and completeness; probability amplitudes; survey of exactly solvable problems; Coulomb problem; oscillator; square well, delta function potentials; time independent perturbation theory; variation methods, applicable to bound systems.

PHY C322 Solid State Physics 3 0 3

X-ray diffraction, reciprocal lattice, Brillouin zone, Lattie vibrations, thermal properties, free electron theory of metals, periodic potentials, band theory of solids, semiconductors, magnetism, superconductivity.

PHY C332 Methods of Mathematical Physics I 3 0 3

Generalized functions, Green's functions and boundary value problems for ordinary differential equations. Strum-Liouville problem, eigenfunction expansions, Green's functions and boundary value problems for partial differential equations, group theory, tensor analysis, approximation techniques.

PHY C341 Nuclear Physics 3 0 3

Two nucleon problem, nuclear force, nuclear properties, models of nuclei - vibrational, rotational and shell models, nuclear excitations and decay, nuclear reactions, nuclear reactors, experimental methods in nuclear physics, elementary particles.

PHY C351 Methods of Experimental Physics 2 3 3

Vacuum techniques, sample preparation techniques, X-ray diffraction, SEM, EDX, low temperature techniques, magnetic measurements, Mossbauer and positron annihilation spectroscopy, neutron diffraction, Rutherford back-scattering, techniques in nuclear experimentation, high energy accelerators.

PHY C352 Atomic & Molecular Spectroscopy 3 0 3

Atomic structure, X-ray spectra, Angular momentum and selection rules in Atomic spectra, Alkali spectra, Fine structure, LS coupling, jj-coupling, Doppler Effect, Effect of magnetic field in Atomic spectra, Zeeman Effect, Paschen-Back Effect, Hyper fine structure, stark effect. Rotational spectra of diatomic and polyatomic molecules, the vibrating diatomic molecule, the diatomic vibrating rotator, interaction of rotation and vibration, the vibrations of polyatomic molecules, Raman Spectroscopy, Electronic Spectroscopy of Molecules, Spin in an applied field, Nuclear Magnetic Resonance spectroscopy, Electron Spin Resonance spectroscopy.

PHY C353 Optical Physics & Applications 3 0 3

Review of Maxwell's equations & wave equation, optics of planar interfaces, light waves in matter, paraxial optics, matrix methods, two and multiple beam interference, Fresnel & Fraunhoffer diffraction, temporal & spatial coherence, statistical optics, image formation, polarization, crystal optics, lasers, holography, fiber optics.

PHY C362 Particle Physics 3 0 3

Symmetries, SU(2) & SU(3) symmetries, quark model, relativistic quantum theory, Dirac and Klein-Gordon equations, quantization of radiation, minimal coupling, QED, Standard Model review.

PHY C391 Instrumental methods of Analysis 4

Course description is same as given under BIO C391.

PHY C411 Electromagnetic Theory II 3 0 3

Multipole radiation, the Lienard - Wiechert potentials, field of a uniformly moving charge, radiation from an accelerated charge, Hamiltonian and Lagrangian in electronmagnetic fields, relativistic electrodynamics.

PHY C412 Introduction to Quantum Field Theory 3 1 4

Klein-Gordan equation, SU(2) and rotation group, SL(2,C) and Lorentz Group, antiparticles, construction of Dirac Spinors, algebra of gamma matrices, Maxwell

and Proca equations, Maxwell's equations and differential geometry; Lagrangian Formulation of particle mechanics, real scalar field and Noether's theorem, real and complex scalar fields, Yang-Mills field, geometry of gauge fields, cannonical quantization of Klein-Gordan, Dirac and Electromagnetic field, spontaneously broken gauge symmetries, Goldstone theorem, superconductivity.

PHY C415 General Theory of Relativity and Cosmology **3 1 4**

Review of relativistic mechanics, gravity as geometry, descriptions of curved space-time, tensor analysis, geodesic equations, affine connections, parallel transport, Riemann and Ricci tensors, Einstein's equations, Schwarzschild solution, classic tests of general theory of relativity, mapping the universe, Friedmann-Robertson-Walker (FRW) cosmological model, Friedmann equation and the evolution of the universe, thermal history of the early universe, shortcomings of standard model of cosmology, theory of inflation, cosmic microwave background radiations (CMBR), baryogenesis, dark matter & dark energy.

PHY C421 Quantum Mechanics II **3 0 3**

Prerequisite: PHY C321

Theory of scattering, phaseshift analysis; the S matrix, time- dependent and time-independent approaches to scattering theory; Born and Eikonel approximations; examples from typical potentials like square well, exponential and delta function potentials; resonances in potential scattering; Coulomb scattering problem and scattering from coulomb and nuclear fields; variational principle applicable in scattering theory; time-dependent perturbation theory; theory of angular momentum; identical particles and spin; Dirac and Klein Gordon equations.

PHY C422 Group Theory & Applications **3 0 3**

Abstract group theory; theory of group 141epresenttations, crystal- symmetry operators, the crystallographic point groups, elementary representations of the three-dimensional rotation group, crystal-field splitting of atomic energy levels, intermediate crystal- field case, weak-crystal-field case and crystal double groups, introduction of spin effects in the medium-field case, group theoretical matrix-element theorems, application of group theory to directed valence; full rotation group and angular momentum; quantum mechanics of atoms; molecular quantum mechanics; solid- state theory.

PHY C423 Special Topics in Statistical Mechanics **3 1 4**

The Ising Model – Definition, equivalence to other models, spontaneous magnetization, Bragg- William approximation, Bethe-Peierls Approximation, one dimensional Ising model, exact solution in one and two dimensions; Landau's mean field theory for phase transition – the order parameter, correlation function and fluctuation-dissipation theorem, critical exponents, calculation of critical exponents, scale invariance, field driven transitions, temperature driven condition, Landau-Ginzberg theory, two-point correlation function, Ginzberg criterion, Gaussian approximation; Scaling hypothesis – universality and universality classes, renormalization group; Elements of nonequilibrium statistical mechanics – Brownian motion, diffusion and Langevin equation, relation between dissipation and fluctuating force, Fokker-Planck equation.

PHY C432 Laser & Applications **3 0 3**

Properties of laser light, Theories of some simple optical processes, Basic principles of lasers, Solid-state lasers, Gas lasers, Semiconductor lasers, Free electron lasers, Liquid, Dye and Chemical lasers, Dynamics of laser processes, Advances in laser physics, Q-switching, Mode-locking (active and passive), Saturable absorbers, Kerr lens mode locking, Non-linear Optics, Laser Spectroscopy, Time resolved spectroscopy, Multi-photon spectroscopy.

PHY C441 Physics Laboratory **0 9 3**

Specially designed for M.Sc. (Hons.) Physics; cannot be taken by others under any circumstances. This laboratory course is designed only for M.Sc. (Hons) Physics students in order to develop competence in selected experiments in physics.

PHY C451 Materials Science **3 0 3**

Intrinsic and extrinsic semiconductors; Excess carriers in semiconductors; Material technology; Measurement of semiconductor properties; Theory of p-n junctions; Rectifiers; Transistors; Other semiconductor devices.

PHY C461 Process Analysis Instrumentation **3 0 3**

Course description is same as given under INSTR C392.

PHY C471 Astrophysics **3 0 3**

Celestial Mechanics; Solar System; Stars; Nebulae and Galaxies; Constellations; Cosmology; Techniques of Space-exploration; Latest discoveries and programmes for space exploration. Observation of heavenly bodies.

PHY C491 Special projects **3**

Course description is same as given under BIO C491.

PHY F110 Physics Laboratory **0 2 1**

An introductory experimental course covering experiments in Mechanics, Oscillations and Waves. In addition to performing classic experiments in physics, the course aims at strengthening experimental skills and ability to take proper measurements. The course should motivate students to enter the exciting world of experimental physics.

PHY F111 Mechanics, Oscillations and Waves 3 0 3

Course description is same as given under PHY C131.

PHY F112 General Physics 3 0 3

Philosophy of Science; Newton's laws of motion; Work Energy, Impulse and Momentum; Equilibrium; Moment of a force; Rotation; Periodic motion; First law of thermodynamics; Second law of thermodynamics; Electromagnetic waves; Interference and diffraction; Polarization; Relativistic mechanics; Photons, Electrons and Atoms; Quantum Mechanics; Atoms, Molecules and Solids; Nuclear Physics.

PHY F211 Classical Mechanics 3 1 4

Review of Newtonian mechanics, constraints and generalized coordinates, Lagrange's equation of motion, calculus of variation and principle of least action, central force motion, kinematics of rigid body motion, rigid body equations of motion, heavy symmetrical top, Hamilton's equations of motion, canonical transformations.

PHY F212 Electromagnetic Theory I 3 0 3

Review of mathematics - scalar and vector fields, calculus of scalar and vector fields in Cartesian and curvilinear coordinates, Dirac delta function; Electrostatics - electric field, divergence & curl of electric field, electric potential, work and energy in electrostatics, conductors, electric dipole; Electrostatics in Matter - polarization and field of a polarized object, electric displacement, linear dielectrics; Magnetostatics - Lorentz force law, Biot-Savart law, divergence & curl of magnetic field, magnetic vector potential, magnetic dipole; Magnetostatics in matter - magnetization and field of a magnetized object, the H-field, linear & non-linear magnetic media; Electrodynamics - electromotive force, electromagnetic induction, Maxwell's equations in free space, plane wave solutions of Maxwell's equations in free space.

PHY F213 Optics 3 0 3

Geometrical optics - light as rays, Fermat's principle, matrix methods in ray tracing; scalar wave theory of light, spatial and temporal coherence, theory of diffraction - Fresnel & Fraunhoffer diffraction, diffraction at rectangular and circular aperture, diffraction around opaque objects; crystal optics - electromagnetic wave propagation in anisotropic media, birefringence, e-m waves in nonlinear media, elements of nonlinear optics; scattering of light – Thomson and Rayleigh scattering; elements of modern optics - lasers and applications, holography, fiber optics, Fourier optics.

PHY F214 Electricity, Magnetism, and Optics Lab 0 2 2

This lab will consist of experiments on electromagnetism, optics and lasers.

PHY F215 Introduction to Astronomy and Astrophysics 3 0 3

Introduction and scope, telescopes, distance and size measurements of astronomical objects, celestial mechanics, the Sun, planets, planet formation, interstellar medium, star formation, stellar structure, stellar evolution, star clusters - open clusters, globular clusters, the Milky-Way galaxy, nature of galaxies - normal and active galaxies, Newtonian cosmology, cosmic microwave background radiation, the early universe.

PHY F241 Electromagnetic Theory II 3 1 4

Maxwell's equations in matter, boundary conditions on electric and magnetic fields; energy of e-m fields and Poynting's theorem, linear momentum and angular momentum of e-m fields, Maxwell's stress tensor; electromagnetic waves in dielectric media – reflection, refraction and transmission at interfaces; wave propagation in metals – absorption and dispersion; guided waves; potential formulation of e-m fields, retarded potentials & Jefimenko's equations, Lienard-Weichert potentials and fields of a moving point charge; dipole radiation & radiation due to point charges; special theory of relativity, relativistic mechanics, relativistic electrodynamics.

PHY F242 Quantum Mechanics I 3 0 3

Origin of the quantum theory - black body radiation, photoelectric effect, Compton scattering, electron diffraction, Bohr model of hydrogen atom, Frank-Hertz experiment, Bohr-Sommerfeld quantization condition; notion of wave function, statistical interpretation of the wave function, issues of normalization, the Heisenberg uncertainty relation; Schrodinger equation, stationary states and time independent Schrodinger equation, energy eigenvalues and eigenfunctions, one-dimensional problems – potential wells, potential barriers, the harmonic oscillator; Hilbert space formalism – state vectors, Dirac's bra-ket notation, observables as Hermitian operators, eigenvalues and eigenstates of Hermitian operators, the measurement postulate.

PHY F243 Mathematical Methods of Physics 3 0 3

Tensor analysis in Cartesian and curvilinear coordinates; linear vector spaces, linear transformations and theory of matrices; functions of a complex variable, contour integration and applications; elements of calculus of variation; series solution of ordinary differential equations, special functions, Sturm-Liouville theory; Fourier integral; partial differential equations of physics, solution of partial differential equations by separation of variables method, the Green function method.

PHY F244 Modern Physics Lab 0 2 2

This lab will consist of experiments on modern physics and electromagnetism.

PHY F266 Study Project 3

Course description is same as given under BIO F266.

PHY F311 Quantum Mechanics II **3 0 3**

Hilbert space formalism (continued from QM-I) - operators and their matrix representations, change of basis, position and momentum representations, commuting and non-commuting observables, the generalized uncertainty relation; the time evolution operator and Schrodinger equation, Schrodinger and Heisenberg picture, simple harmonic oscillator using operator method; angular momentum operators and their commutation relations, eigenvalues and eigenvectors of angular momentum, spherically symmetric potentials, the hydrogen atom; time independent perturbation theory, WKB approximation, variational method; time dependent perturbation theory, interaction of atom with classical radiation field; identical particles.

PHY F312 Statistical Mechanics **3 0 3**

Review of Thermodynamics - First and the second law of thermodynamics, reversible and irreversible processes, entropy, absolute temperature, thermodynamic potentials ; Statistical description of macroscopic systems - micro and macro states, phase space distribution, Liouville theorem, microcanonical ensemble, statistical definition of temperature, pressure and entropy; Canonical ensembles, probability distribution in canonical ensemble, partition function and calculation of thermodynamic quantities, equipartition and virial theorems, Maxwell velocity distribution, paramgnetism, harmonic oscillators, polyatomic molecules; Grand canonical ensembles - probability distribution in grand canonical ensemble, grand partition function, calculation of thermodynamic quantities; Quantum statistics - indistinguishable particles, Bose-Einstein and Fermi-Dirac distribution, classical limit, photon statistics, Planck distribution; Ideal Fermi gas - equation of state of ideal Fermi gas, free electron gas in metals, Pauli paramagnetism, Landau diamagnetism, statistical equilibrium of white dwarf stars; Ideal Bose Gas - equation of state, Bose-Einstein condensation.

PHY F313 Computational Physics **3 0 3**

Review of programming language - C/C++, Matlab and Mathematica; Functions and roots - Newton-Raphson method, rate of convergence, system of algebraic equations; Numerical integration - Romberg integration, Gaussian quadrature; Ordinary differential equations - Euler Method, Runge-Kutta method, predictor-corrector method, system of equations; Partial differential equations - boundary value problems, finite difference method, finite element method; discrete and fast Fourier transform; Eigen-value problems; Monte-Carlo method - random numbers, sampling rules, metropolis algorithm.

PHY F315 Theory of Relativity **3 0 3**

Special theory of relativity : Experimental background and postulates of the special theory, Lorentz transformation equations and their implications, space-time diagrams, Four vectors, tensors in flat space-time, relativistic kinematics and dynamics, relativistic electromagnetism. General theory of relativity : Principle of equivalence, gravitational red shift, geometry of curved space-time, Einstein field equation, spherically symmetric solution of field equation.

PHY F341 Solid State Physics **3 0 3**

Crystal structure - direct and reciprocal lattice, Brillouin zone, X-ray diffraction and crystal structure; free electron theory of metals; periodic potential and band theory of solids, the tight-binding approximation; lattice vibration and thermal properties; semiconductors - energy band gap in semiconductors, carrier density of intrinsic and extrinsic semiconductors, the p-n junction; magnetism - paramagnetism and diamagnetism, spontaneous magnetism, magnetic ordering; super conductivity-basic properties, the London equation, elements of BCS theory.

PHY F342 Atomic and Molecular Physics **3 0 3**

Interaction of electromagnetic field with atoms - transition rates, dipole approximation, Einstein coefficients, selection rules and spectrum of one electron atom, line intensities and shapes, line widths and lifetimes; one electron atoms - fine and hyperfine structure, interaction with external electric and magnetic fields; two electron atoms - para and ortho states, level scheme, ground and exited states of two electron atoms; many electron atoms - central field approximation, Thomas – Fermi model, Hartree- Fock method, L-S coupling and j-j coupling; Molecular structure - Born-Oppenheimer approximation, rotation and vibration of diatomic and polyatomic molecules, electronic structure and spin, rotational-vibrational and electronic spectra of diatomic molecules, nuclear spin.

PHY F343 Nuclear and Particle Physics **3 0 3**

Bethe-Weizsacker mass formula, nuclear size, mirror nuclei, electric multipole moments, Spherically and axially symmetric charge distribution, electric quadrupole moment, nuclear magnetic moment, nuclear decay, alpha and beta decay processes, nuclear fission, Bohr-Wheeler theory, two-body problem, deuteron wave function with central and non-central potential, electric quadrupole moment & magnetic moment, exchange forces, low energy nucleon-nucleon scattering, scattering length, effective range theory, spin dependence of n-p scattering, magic numbers, independent particle model, collective model. Mesons and baryons, antiparticles, neutrinos, strange particles, eightfold way, quark model, intermediate vector bosons, four fundamental forces, basic vertices and charactesitics of quantum electrodynamics, quantum flavordyamics and quantum chromo dynamics, decays and conservations laws, basic ideas of standard model of particle physics, qualitative discussion of current issues in particle physics.

PHY F344 Advanced Physics Lab **0 3 3**

This lab will consist of experiments on solid state phys-

ics, spectroscopy and nuclear physics.

PHY F345 Quantum Mechanics for Engineers 3 0 3

Wave particle duality, Schrödinger wave equation, probability and current densities, position and momentum operators and state space, expectation values of operators, normalization, particle in a box, particle in finite height barrier and finite well, reflection and transmission, Harmonic oscillator, particle in linearly varying potential, Infinite potential well, delta function potential. Time dependent Schrödinger equation, time evolution of stationary states: Infinite well and harmonic oscillator, wave packets and time evolution with example, group velocity.

Crystals, one electron approximation, Bloch theorem, density of states in k space, effective mass theory, effective mass approximation in semiconductor heterostructures, density of states in energy, density of states in quantum well, K.P model for two-band semi conductor. Band structure calculations for cubic crystals, Nanostructures: quantum wire, quantum well, quantum dots

Pre-requisites: PHY F111 (Mechanics, Oscillations and Waves) , MATH F111 (Mathematics I) , MATH F112 (Mathematics II), MATH F211 (Mathematics III)

PHY F366 Lab Project 3

PHY F367 Lab Project 3

Course description is same as given under BIO F366 and BIO F367.

PHY F376 Design Project 3

PHY F377 Design Project 3

Course description is same as given under BIO F376 and BIO F377.

PHY F412 Introduction to Quantum Field Theory 3 1 4

Course description is same as given under PHY C412.

PHY F413 Particle Physics 3 1 4

Klein-Gordan equation, time-dependent non-relativistic perturbation theory, spinless electron-muon scattering and electron-positron scattering, crossing symmetry, Dirac equation, standard examples of scattering, parity violation and V-A interaction, beta decay, muon decay, weak neutral currents, Cabibo angle, weak mixing angles, CP violation, Weak isospin and hypercharge, basic electroweak interaction, Lagrangian and single particle wave-equation, U(1) local gauge invariance and QED, non-abelian gauge invariance and QCD, spontaneous symmetry breaking, Higgs mechanism, spontaneous breaking of local SU(2) gauge symmetry.

PHY F414 Physics of Advanced Materials 3 1 4

Review of fundamentals of crystallography, structural properties of crystals, polymers and glasses, processes involved in materials preparation, viz., diffusion, phase diagrams, advanced techniques to prepare low dimensional systems and thin films, kinetics of phase transformations, Mechanical, structural, thermal and electrical characterization of advanced materials, e.g., high Tc superconductors, superionic conductors, conducting polymers, dielectrics, ferroelectric materials, polycrystalline semiconducting materials, magnetic semiconductors, magneto resistance and GMR materials, shape memory alloys.

PHY F415 General Theory of Relativity and Cosmology 3 1 4

Course description is same as given under PHY C415.

PHY F416 Soft Condensed Matter Physics 3 1 4

Forces, energies, timescale and dimensionality in soft condensed matter, phase transition, mean field theory and its breakdown, simulation of Ising spin using Monte Carlo and molecular dynamics, colloidal dispersion, polymer physics, molecular order in soft condensed matter – i) liquid crystals ii) polymer, supramolecular self assembly.

PHY F417 Experimental Methods of Physics 3 1 4

Vacuum techniques, sample preparation techniques, X-ray diffraction, scanning probe microscopy, scanning electron microscopy, low temperature techniques, magnetic measurements, Mossbauer and positron annihilation spectroscopy, neutron diffraction, Rutherford backscattering, techniques in nuclear experimentation, high energy accelerators.

PHY F418 Lasers and Applications 3 1 4

Properties of laser light, theories of some simple optical processes, basic principles of lasers, solid-state lasers, gas lasers, semiconductor lasers, free electron lasers, liquid, dye and chemical lasers, dynamics of laser processes, advances in laser physics, Q-switching, modelocking (active and passive), saturable absorbers, Kerr lens mode locking, non-linear optics, laser spectroscopy, time resolved spectroscopy, multiphoton spectroscopy.

PHY F419 Advanced Solid State Physics 3 1 4

Schrodinger field theory (second quantized formalism), Bose and Fermi fields, equivalence with many body quantum mechanics, particles and holes, single particle Green functions and propagators, diagrammatic techniques, application to Fermi systems (electrons in a metal, electron – phonon interaction) and Bose systems (superconductivity, superfluidity).

PHY F420 Quantum Optics 3 1 4

Quantization of the electromagnetic field, single mode and multimode fields, vacuum fluctuations and zero-point energy, coherent states, atom - field interaction - semiclassical and quantum, the Rabi model, Jaynes-Cummings model, beam splitters and interferometry, squeezed states, lasers.

PHY F421 Advanced Quantum Mechanics 3 1 4

Symmetries, conservation laws and degeneracies;

Discrete symmetries - parity, lattice translations and time reversal; Identical particles, permutation symmetry, symmetrization postulate, two-electron system, the helium atom; Scattering theory - Lippman-Schwinger equation, Born approximation, optical theorem, eikonal approximation, method of partial waves; Quantum theory of radiation - quantization of electromagnetic field, interaction of electromagnetic radiation with atoms; relativistic quantum mechanics.

PHY F422 Group Theory and Applications 3 1 4

Basic concepts – group axioms and examples of groups, subgroups, cosets, invariant subgroups; group representation – unitary representation, irreducible representation, character table, Schur's lemmas; the point symmetry group and applications to molecular and crystal structure; Continuous groups – Lie groups, infinitesimal transformation, structure constants; Lie algebras, irreducible representations of Lie groups and Lie algebras; linear groups, rotation groups, groups of the standard model of particle physics.

Pre-requisite: MATH F112 Mathematics II

PHY F423 Special Topics in Statistical Mechanics 3 1 4

Course description is same as given under PHY C423.

PHY F424 Advanced Electrodynamics 3 1 4

Review of Maxwell's equations – Maxwell's equations, scalar and vector potentials, gauge transformations of the potentials, the electromagnetic wave equation, retarded and advanced Green's functions for the wave equation and their interpretation, transformation properties of electromagnetic fields; Radiating systems – multipole expansion of radiation fields, energy and angular momentum of multipole radiation, multipole radiation in atoms and nuclei, multipole radiation from a linear, centre-fed antenna; Scattering and diffraction – perturbation theory of scattering, scattering by gases and liquids, scattering of EM waves by a sphere, scalar and vector diffraction theory, diffraction by a circular aperture; Dynamics of relativistic particles and EM fields – Lagrangian of a relativistic charged particle in an EM field, motion in uniform, static electromagnetic fields, Lagrangian of the EM fields, solution of wave equation in covariant form, invariant Green's functions; Collisions, energy loss and scattering of a charged particle, Cherenkov radiation, the Bremsstrahlung; Radiation by moving charges – Lienard-Wiechert potentials and fields, Larmor's formula and its relativistic generalization; Radiation damping – radiative reaction force from conservation of energy, Abraham-Lorentz model.

PHYF425 Advanced Mathematical Methods of Physics 3 1 4

Course description is to be developed.

PHY F426 Physics of Semiconductor Devices 3 1 4

Course description is to be developed.

PHY F427 Atmospheric Physics 3 0 3

Course description is to be developed.

PHY F491 Special Projects 3

Course description is same as given under BIO F491.

PHY G511 Theoretical Physics 5

Calculus of Variations and its applications to Lagrangian and Hamiltonian Dynamics, Thermodynamics and Geometric Optics and Electrodynamics. Geometric and Group theoretic foundations of Hamiltonian Dynamics, Hamilton-Jacobi Theory, Integrability and Action-Angle Variables, Adiabatic Invariants, Transformation (Lie) Groups and Classical Mechanics. Modern Theory of Phase Transitions and Critical Phenomenon: Thermodynamics and Statistical Mechanics of Phase Transitions, General Properties (eg Scaling, Universality, Critical exponents) and Order of Phase Transitions; Introduction to Landau-Ginzburg (Mean Field Theory) theory for Second Order Phase Transitions, the Ising Model and some Examples, Phase Transitions as a *symmetry-breaking* phenomenon.

PHY G512 Advanced Quantum Field Theory 3 0 3

Diagrammatics : Feynman diagrams & rules, Loop diagrams, S-matrix, Path integrals, Gauge theories, QED and QCD Lagrangians, Renormalization group, Non-perturbative states.

Pre-requisite: PHY F412(Introduction To Quantum Field Theory)

PHY G513 Classical Electrodynamics 4

Review of Electrostatics, Magnetostatics, and solution of Boundary Value Problems. Method of Images. Maxwell equations for time dependent fields, Propagation of electromagnetic waves in unbounded media. Waveguides & Cavity Resonators. Absorption, Scattering and Diffraction, Special Relativity, Covariant formulation of Classical Electrodynamics. Dynamics of charged particles in electromagnetic fields. Radiation by moving charges and Cerenkov Radiation.

PHY G514 Quantum Theory and Applications 4

Mathematics of linear vector spaces, Postulates of Quantum Mechanics, Review of exactly solvable bound state problems, WKB methods, Angular momentum, Spin, Addition of angular momenta, Systems with many degrees of freedom, Perturbation theory, Scattering theory, Dirac equation.

PHY G515 Condensed Matter Physics I 4

Free electron models, Reciprocal lattice, Electrons in weak periodic potential, Tight-binding method, Semiclassical model of electron dynamics, Theory of conduction in metals, Theory of harmonic crystals, Anharmonic effects, Semiconductors, Diamagnetism and paramagnetism, Superconductivity.

PHY G516 Statistical Physics & Applications 4

Liouville's theorem, Boltzmann transport equation, H-Theorem; Postulate of statistical Mechanics; Temperature; Entropy; Micro-canonical, Canonical, Grand-canonical ensembles - Derivation, calculation of macroscopic quantities, fluctuations, equivalence of ensembles, Applications, Ideal gases, Gibbs Paradox; Quantum mechanical ensemble theory; Bose-Einstein statistics –derivation, Bose Einstein condensation, applications; Fermi-Dirac Statistics – derivation, applications - Equation of state of ideal Fermi gas, Landau Diamagnetism, etc; Radiation; Maxwell-Boltzmann statistics; Interacting systems – cluster expansion, Ising model in 1-d & 2-d; Liquid Helium, phase transitions and renormalization group.

PHY G517 Topics in Mathematical Physics 4

Functions of complex variables, special functions, fourier analysis, sturm-Liuoville theory, partial differential equation with examples, Greens functions, Group theory, differential forms, approximation methods in solutions of PDE's, vector valued PDE's.

PHY G521 Nuclear and Particle Physics 5

Course description for the above course is to be developed.

PHY G531 Selected Topics in Solid State Physics 5

Schrodinger Field Theory (2nd Quantized formalism), Bose and Fermi fields, equivalence with many body quantum mechanics, particles and holes, Single particle Green functions and propagators, Diagrammatic techniques, Application to Fermi systems electrons in a metal, electron-phonon interaction) and Bose systems (superconductivity, superfluidity).

PHY G541 Physics of Semiconductor Devices 5

Electrons and Phonons in Crystals; Carrier dynamics in semiconductors; Junctions in semiconductors (including metals and insulators); Heterostructures; Quantum wells and Low-dimensional systems; Tunnelling transport; Optoelectronics properties; Electric and magnetic fields; The 2d Electron gas; Semiconductor spintronic devices

Political Science

POL C211 Indian National Movement 3 0 3

Indian renaissance; birth of the Indian national congress and progress of Indian nationalism; moderates and extremists rise of communal politics; Gandhi and the non-cooperation movement; swaraj party; Simon Commission and the Nehru report; civil disobedience and the Round Table Conferences; World War II and the constitutional deadlock; Cripps proposals; Quit-India Movement; CR formula and the Wavell Plan, Cabinet Mission Plan; Netaji Subhash Chandra Bose and the I.N.A., Mountbatten Plan - India divided; the aftermath.

POL C212 Modern Political Concepts 3 0 3

Nature and scope of political science; emergence and basis of the state; rights and duties; forms of government; democracy, fascism, capitalism, socialism, anarchism, communism, Maoism, radicalism and Gandhism.

POL C311 Gandhian Thoughts 3 0 3

Sources of Gandhian thoughts, metaphysical convictions, ethical principles, ends and means; Gandhi and religion; theory of satyagraha; political thought; economic thought; social reforms; untouchability; Gandhi and Muslims; Gandhi and women; some items of constructive programme, Gandhi and Marx; his nonviolent state; Gandhism after Gandhi.

POL C312 Marxian Thoughts 3 0 3

Marx and his times; basic tenets; dialectical materialism; economic determinism; doctrine of surplus value; doctrine of class struggle; different schools of Marxism; Leninism; Stalinism; Maoism; future of Marxism.

POL C321 International Relations 3 0 3

Rise of nationalism, World War I, Interregnum; World War II and after; bi-polar politics and detente; instruments for promotion of national interest; diplomacy; propaganda and political warfare; integration of Western Europe; West Asia and world politics; panchsheel and nonalignment; major national foreign policies--USA, USSR, UK and Pakistan; disarmament; UN and World peace.

Psychology

PSY C211 Introductory Psychology 3 0 3

The development of psychology as a science -- individual and the environment; nature; kinds and determinants of perceptions; response mechanism and kinds of responses, motivations, modifications of behaviour through learning, memory and transfer of training; thought processes, problem solving and creative thinking; nature and characteristics of psychological tests; nature and evaluation techniques of intelligence and personality.

PSY C311 Psychology of Human Adjustment 3 0 3

Course description to be developed.

Russian

RUS N101T Beginning Russian 3 0 3

Basic grammar; vocabulary; reading practice; translation of simple passages.

Not available for meeting the requirements of any programme except as prerequisite for another Russian course. Can be taken only on audit.

RUS N102T Technical Russian 3 0 3

Prerequisite: RUS N101T

Phrases and sentence patterns in technical literature;

special technical vocabulary; reading and translation of current technical literature from Russian to English with the help of a dictionary. This course is designed to meet the foreign language requirement of the Ph.D. programme. Can be taken only on audit.

Sanskrit

SANS C111 Sanskrit 3 0 3

Simple pieces of Sanskrit prose and poetry to be used for teaching the basic construction of Sanskrit words and sentences. The course will aim at making the student read elementary Sanskrit like a Subhashita Sloka or a Sloka from Ramayana or Mahabharata and be able to understand it with the help of a dictionary.

SANS F111 Sanskrit 3 0 3

Course description is same as given under SANS C111.

(This course is introduced in the pool of humanities electives for all A, B, and C group programmes).

Science

SCI C121 Social Hygiene 3 0 3

General principles of personal and community hygiene; food and nutrition; environmental sanitation; sources of water; microscopic and macroscopic examination of water; air and ventilation, air pollution; noise and its various aspects; drug addiction and its social consequences; health statistics.

SCI C212 Applied Nutrition 3 0 3

Introduction to nutrition; foods for health; the composition of food; energy requirements; nutritional needs; nutrition and diseases; clinical dietetics.

SCI C311 Agricultural Science 3 0 3

Soils and soil systems; chemical composition of soils and soil fertility; soil fauna and flora and their relationships with soil; important crop plants; methods to improve yield; environmental factors and plant growth; plant diseases and their control; weeds and their control; common agricultural practices in India.

SCI D021 Remedial Science 5 0 5

Physics: Vectors, Newton's laws, conservation of momentum and energy, angular momentum, moment of inertia, simple harmonic motion, Coulomb's law, Ampere's law, Faraday's law, Lenz's law, Kirchhoff's law, a.c., electrical instruments, interference, diffraction, polarization, structure of atom, atomic energy, and wave-particle duality.

Chemistry: Chemical formula and equations; phase diagram; solutions; chemical dynamics; chemical equilibria; electrochemistry.

Skill Area

SKILL G611 Computer Operation and Software Development I 5

SKILL G612 Computer Operation and Software Development II 5

Prerequisite for both: TA C252

These two courses to be offered in two successive semesters will aim to develop the computer skills for running program packages and writing and developing software programmes for as wide areas as possible. Areas would include both the developmental processes involved in innovative education and of academic and applied research.

The operation of and evaluation in the courses would be done through seminars, group discussions, log books and programme outputs. One component of the evaluation will invariably consist of a lengthy involvement on an intricate task.

SKILL G621 Computer Maintenance I 5

SKILL G622 Computer Maintenance II 5

Prerequisite for both: TA C252

These two courses, to be offered in two successive semesters, will aim to develop the skill for maintenance of computer systems. Through these courses the student would be required to acquire a competence of planned and preventive maintenance, trouble shooting safety procedures etc. If required the student may be asked to undergo part of his training in established computer maintenance organisations. The operation and the evaluation of this course would be achieved through practicals, log books, seminars, quizzes etc. One component of the evaluation will invariably consist of a lengthy involvement on an intricate task.

SKILL G631 Professional Communication I 5

SKILL G632 Professional Communication II 5

These two courses, to be offered in two successive semesters, will aim at imparting communicative competence and demand training in the art of teaching and development of subject matter pertaining to the overall goal of the programme. The courses will operate on unstructured basis and would be monitored by a team of teachers identified for the purpose. Professional Communication II will be a project Course and must coterminate with a project report.

SKILL G641 Modern Experimental Methods I 5

SKILL G642 Modern Experimental Methods II 5

These two courses to be offered in two successive semesters will impart experimental skills in modern areas of interest to the Institute. Emphasis will be laid on operation and use of sophisticated instruments. The organisation and evaluation of these courses would be achieved through practicals, demonstrations, discussion on significance of results, seminars, quizzes etc. One component of evaluation will invariably be full finding of lengthy assignments. These courses will be

conducted by a team of teachers who will incorporate professional competence into experimental method taken up for study.

SKILL G651 Techniques in Development Management I **5**

SKILL G652 Techniques in Development Management II **5**

These two courses, to be offered in two successive semesters, will aim to lead a student into the theory and practice of activities connected with innovation, institutional change and development of teaching and research. Actual cases would be included from BITS. New cases are to be developed. The power of analysis design of models would be the main thread of treatment in these courses. These courses will be operated by a team of teachers. The organisation and evaluation would be achieved through practicals, log books, seminars, quizzes etc. One component shall invariably be a full finding of a lengthy assignment on a particular instrument (Technique) or their use in a larger context of teaching and research.

SKILL G661 Research Methodology I

SKILL G662 Research Methodology II **5**

These two courses, to be offered in two consecutive semesters, are designed to impart training in methodology of research such as analysis of research problems, mathematical and statistical analysis of data, computer simulation methods, experimental techniques etc. The actual contents of these courses will depend upon the needs and research goals of a particular student. A project report has to be submitted by each student at the end of each course.

The organisation and evaluation of these courses would be achieved through seminars, group discussions, project reports etc. The courses will be conducted by a team of teachers.

Note: All the above mentioned Skill courses will be 'Unstructured' in the sense that they would be completely of 'non- lecture, type but would require committed involvement in the concerned professional engagement. Each course is a combination of two course numbers I & II running in two successive semesters where grades would be awarded for the two components separately. While normally a student will be required to take I & II, in rare occasions he may be asked to take only Course No. I depending on his prior preparation and the ultimate goal to be achieved through the programme. No student can register I and II of the same course concurrently in a semester. Where there is sufficient academic justification to meet the goals of these courses, the Dean Instruction may permit delayed registration in course No. II or in the pair of courses.

Sociology

SOC C211 Dynamics of Social Change **3 0 3**

Nature of society, social institutions; concept and nature of socio-cultural change, obstacles, rate and direction of change; factors of social change-ideological, economic, technological and political demographies; agencies of social change-education, leadership, propaganda, legislative reforms; five-year plans and social change, peasant and land reform, bhoodan and gramdan; changing pattern of family, marriage, caste and religion.

Software Systems

SS G511 Design and Analysis of Algorithms **5**

Course description is same as given under CS G511

SS G512 Object Oriented Programming **4**

Course description is same as given under BITS G512.

SS G513 Network Security **3 1 4**

Course description is same as given under CS G513.

SS G514 Object Oriented Analysis and Design **2 2 4**

Course description is same as given under CS G514.

SS G515 Data Warehousing **3 2 5**

Introduction, evolution of data warehousing; decision support systems; goals, benefit, and challenges of data warehousing; architecture; data warehouse information flows; software and hardware requirements; approaches to data warehouse design; creating and maintaining a data warehouse; Online Analytical Processing (OLAP) and multi-dimensional data, multi-dimensional modeling; view materialization; data marts; data warehouse metadata; data mining.

SS G516 Computer Organization & Software Systems **5**

Programmer model of CPU; Basic concept of buses and interrupts; Memory subsystem organization; I/O organization; Concept of assembler, linker & loader; Types of operating systems; Concept of process; OS functions: Process scheduling, Memory management, I/O management and related issues.

SS G517 Data Structures & Algorithm Analysis **5**

Abstract data types; Linear data structures; Hash functions, Binary and other trees, traversal algorithms; Heaps and balanced trees; Sorting and searching techniques; Divide and conquer, recursion, backtracking, branch and bound; Computational complexity and bounds.

SS G518 Database Design & Applications **5**

DBMS architecture; Data models: Network model, Hierarchical model and Relational model; Database design & optimization; Query processing & Query optimization; Transaction Processing; Concurrency control;

Recovery; Security & protection; Introduction to Object Oriented data model & Multimedia Databases.

SS G520 Advanced Data Mining 3 1 4

Prerequisite: CS C415/ IS C415 – Data Mining (= CS G520)

Course description is same as given under CS G520.

SS G521 Fourth Generation Languages and Applications 4

Course description is same as given under BITS G521.

SS G522 Software Development Standards 4

Course description is same as given under BITS G522.

SS G523 Software for Embedded Systems 3 2 5

(=CS G523)

The course description is the same as given under CS G523.

SS G527 Cloud Computing 5

(= CS G527)

Course description is same as given under CS G527.

SS G531 Pervasive Computing 4*

(=CS G541)

Course description is same as given under CS G541

SS G532 Information Theory 4

Course description is same as given under BITS G532.

SS G541 User Interfaces 4

Course description is same as given under BITS G541.

SS G542 Knowledge Management 3

Increasing knowledge work in organizations; technologies to support growth of knowledge work in organizations; scope, cost, efficiency and reliability of technologies to support knowledge work; role of knowledge in an enterprise; knowledge management process; knowledge management strategies; human aspects of knowledge management; knowledge management technologies; applications of technologies to be covered through cases; reading assignments and use of appropriate software.

SS G551 Advanced Compilation Techniques 5

Course description is same as given under CS G551.

SS G552 Software Testing Methodologies 4

Course description is same as given under SECT ZG552.

SS G554 Distributed Data Systems 3 2 5

Course description is same as given under CS G554.

SS G562 Software Engineering & Management 5

Current concepts, methods, techniques, and tools of the software engineering process; software process models; process definition and assessment; software measurement and metrics; project planning, estimation and control; requirements analysis and specification, design methods; quality assurance and testing; configuration management; process improvement; case studies and project work.

SS G624 Computer Based Simulation and Modlling 5

Course description is same as given under BITS G624.

SS G641 Management Information and Decision Support Systems 5

Course description is same as given under BITS G641.

SS G651 Project Formulation and Preparation 5

Course description is same as given under BITS G651.

SS G653 Software Architectures 3 2 5

Course description is same as given under CS G653.

Science and Technology Development

STD C312 Science Communication 3 0 3

Communication within scientific community and between scientific community and the world outside; a special look at science education at all levels; awareness and practical experience in terms of channels of communication, traditional and modern technology based; language of science: some introductory portion of structure of language; issues in the dissemination of science in a traditional society.

STD C322 R&D Management 3 0 3

Distinctive need and particular structure for management of R&D systems; the close relationship between R&D objectives and innovation and precise time targets; micro considerations like economics and cost, science policy, criteria of choice, various issues connected with availability, transfer and marketing of technology; micro considerations in planning, organisation, project selection, formulation and management, R&D cost estimating and budgeting human resources availability, evaluation and measurement of performance, control problems; mission-oriented research; technology missions enunciated by Indian Government.

STD C331 Science Policy 3 0 3

Growth of science in India, external and internal parameters responsible for scientific growth, science and industry in India, transfer of technology, research priorities in developing countries, criteria for scientific choice, basic and applied research in India, science

planning in India, choice of technology, organisation and scientific institutions in India.

STD C342 S&T Development: India Case Study 3 0 3

The course will lay the foundation of characteristics of modern science and its related technology with all earlier science and technology. A back-drop discussion will attempt to examine the manifestation of modern science and technology in non-western societies. The main thrust of the course will be to make a critical analysis of the development of science and technology in India, primarily from the point of view of scientific methods and technological imperative. It will comment on the approach followed so far through comparative studies of establishment of scientific and technological institutions. The coverage will also include an open-ended approach towards formulation of method of implementation of the technology missions recently announced.

The different aspects of the course may be handled by different teachers. If necessary, a term paper will be required with a view to make the student use the concepts and search for source data in the library.

STD C351 An Approach Towards Science of Science 3 0 3

The purpose of this course is to endeavour, on the anticipated prior preparation of an STD student, to embark the student upon this interdisciplinary area. The approach will be to unify the principles of concepts in science, imperatives in technology, philosophy of science, sociology of science, science policy in order for the student to achieve proficiency and develop further in this meta-science.

STD C361 History of S&T 3 0 3

The course will attempt to examine the various stages of manifestation of science and technology in human society; two important benchmarks on the scale of time- advent of modern science with Galileo and beginning of industrial revolution in England - would be the basis in order to appreciate that within science and within technology there is a development prompted by the scientific method and technological imperatives. The course will, within the time available, attempt to identify the various historical and social settings in which a particular stage of development of S&T has taken place. Focussing will be made on how progress of modern science along with development of technology have fundamentally influenced the scientists' approach towards method of science and mode of technology.

STD C371 Issues in Technology 3 0 3

The course is designed to investigate into the methods of technology assessment and choice; aspects of technology innovation and alternate and appropriate technologies; technology forecasting; mode of technology transfer across all boundaries and methods of technology diffusion; fall-out effects of technology; technological imperatives; transformation of technology and its relation to the development of science and the nature of society; the issue of autonomy of technology; measurement of technological change and the concept in ideas of progress.

STD C422 Technology Forecasting 3 0 3

Course description is same as given under ECON C451.

STD C442 Science Writings 3 0 3

Course description is same as given under ENGL C342.

STD C451 Technological Order 3 0 3

A review of the movements associated with the rise of a technological society; analysis of the cultural milieu created by the total stock of technology and the technological acts; consequences of technology in terms of improvement of human condition and also in terms of new problems generated in its wake; technology and human values.

STD C452 Energy Management 3 0 3

Course description is same as given under ET C352.

STD C461 Science Policy: Country Case Studies 3 0 3

A comparative study of different types of science policy declared or implied in relation to the country of origin and practice.

STD C462 Selected Topics from Science & Society 3

This course is specially designed to introduce motivated students into the realm of classics: studies encompassing several disciplines, even in the areas of hard science and mathematics; the selected topics could also be taken from the areas of application for a specific time-bound assignment; the outcome from the course must be accompanied by a report.

STD C471 Analysis and Assessment of Development 3 0 3

An introductory analysis of issues of development and related concepts, definition of development; the relationship between the technical knowledge, technical operation and technical objects; critical study of some of the much accepted premises and processes of development, the phenomenon of the world of means overwhelming the world of ends, concepts and contradictions in the theory of efficiency and economy of scales; the validity or otherwise of a linear theory of growth; the place of man in the ensemble of techniques, materials and devices.

STD C481 Marketing Non-profit Organisations 3 0 3

Course description is same as given under MGTS C441.

STD C491 Special Projects **3**

Course description is same as given under BIO C491.

Technical Arts

TA C111 Engineering Graphics **2 4 4**

Forms; proportion and presentation; orthographic views; auxiliary views; lines and planes; intersection and development; free hand sketching; working drawing of simple machine parts.

TA C112 Workshop Practice **2 4 4**

Casting; metal forming; forging, welding and brazing; metal cutting machines e.g., lathe 'shaper and planer; drilling, milling and grinding; laboratory exercises involving machining, fitting and joining.

TA C162 Computer Programming I **3 0 3**

Introduction to computers: building blocks of computers, I/O devices, concept of auxilary and main memory and memory devices; introduction to number systems and information representation inside computer; introduction to UNIX; problem analysis, solution design and program coding using structured programming language.

TA C211 Measurement Techniques I **0 4 2**

A laboratory course that covers the lab. components associated with six core science courses in the integrated first degree structure. While the exact component and assignments may vary from time to time the assignments would invariably be illustrative of the theory covered in this portion as well as aim to emphasize the aspects of measurement as a theme in experimental science.

This course is a compulsory requirement for all students who have to compulsorily do the six core science courses. Other students may be permitted to register in this course with prior approval.

TA C222 Measurement Techniques II **1 6 4**

Measurement of basic electrical and non-electrical quantities; system performance measurements; analysis of experimental data. The course shall aim to train the student in the skill of operation of instruments in the electrical and electronics, chemical, civil and mechanical engineering applications. Precise lab. exercises will be prescribed from time to time.

TA C231 Business Communication **3 0 3**

Managerial communication – national and international contexts, Interpersonal Communication, persuasive communication, communication technology, effective listening group communication, professional presentation.

TA C252 Computer Programming II **3***

Prerequisite: TA C162

Shell programming in Unix; use of advanced filters and other tools like sed and awk; system calls; advanced programming concepts: macro definition and usage, recursion and problem solving; concept of pointers, dynamic data structures using pointers, advanced usage of pointers; bit operations; handling command line arguments, dynamic memory allocation and management; file management; problem solving using simple data structures like stacks, queues, linked lists and binary trees. This course will focus on non-trivial problem solving using the various programming tools available in Unix and the C programming language.

TA C312 Technical Report Writing **3**

Elements of effective writing; art of condensation; business letter writing; memos; formal reports; technical proposals; conducting and participating, meetings; notices, agenda and minutes; strategies for writing technical descriptions, definitions and classifications; oral presentation; use of graphic and audio- visual aids; editing.

Technique Oriented Courses

TOC C112 Book-keeping **3 0 3**

Concept of double entry; positing and maintenance of basic business accounts; cash book, ledger, journal. Preparation of income and expenditure statement; trial balance and balance sheet.

TOC C211 Book-keeping and Accountancy **3 0 3**

Theory of accounting; single and double entry; ledgers; trial balance; manufacturing, trading, profit and loss and appropriation accounts; distinction between capital and revenue; depreciation reserves and provisions; sinking funds; balance sheet.

Negotiable instruments; goods on sale or return; consignments; partnership accounts; goodwill and problems connected therewith; investment accounts; receipts and payments accounts; income and expenditure accounts; royalty, hire purchase and instalment purchase. Company accounts; issue, forfeiture and redemption of shares and debentures; profit prior to incorporation; divisible profits and dividends; statements, returns and other accountancy provisions under companies act.

TOC C212 Library Science **3 0 3**

Foundation of Library Science-survey of basic principles and concepts; problem of large scale book selection, acquisition and technical processes; quick and long range reference service; bibliography, abstracting and annotations; information retrieval and literature search; reprography techniques; reprographic reproduction- microfilms, slides, microfiche, photocopying and other non-book material; the role of higher education in the larger society and the innovative role the library can play will be stressed.

TOC C213 Civil Engineering Practice **3***

Basic civil engineering practices such as surveying,

soil mechanics, structures, concrete technology, public health, estimating and costing.

Actual structuring will be announced from time to time. Home assignments, fieldwork, etc. will also constitute part of these hours.

TOC C215 Language Laboratory Practice 0 6 3

Writing: Grammar and usage, sentence completion, jumbled sentences, emphatic word order, vocabulary building, message organization, paragraph development techniques and note taking. Reading: Skimming, scanning, rapid reading, analytical reading, factual reading, and aesthetic reading. Listening: Content listening, critical listening, aesthetic listening, empathetic listening, listening to short conversations, stories, lectures, talks, and great speeches: exposure to different varieties of spoken English through films and clippings. Speaking: Sounds of English, word accent, features of connected speech, transcription, conversation, role play, impromptu, extempore and reading from manuscript. This course is practice oriented and all the exercises and evaluation components will be designed to enhance and assess the student's ability to use the English language actively and effectively.

TOC C223 Comfort Conditioning and Refrigeration 3*

Refrigeration theory; refrigeration cycles; refrigeration systems; refrigeration components and their use; psychrometrics; refrigerants; metering devices; refrigeration and air-conditioning applications; methods of installation; maintenance; diagnosis; repair of refrigeration and air conditioning equipment; heating and cooling loads; distribution components and systems.

Actual structuring will be announced from time to time. Home assignments, fieldwork, etc. will also constitute part of these hours.

TOC C224 Corporate Taxation 3 0 3

Course description is same as given under BITS C224.

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TOC C235 Electrical & Electronics Engineering Practice 0 6 3

Electrical drawings, tests on energy conversion devices, motor and transformer winding, electrical estimation and costing, hands on experience on electronic bench equipments, device testing, soldering practice, PCB layout and fabrication, simple trouble shooting of eletronic circuits, earthing, shielding, experiments on microprocessor kits.

TOC C236 Electronics and Instrumentation Engineering Practice 0 6 3

Operation and maintenance of instruments, electronic equipments and services.

TOC C244 Production and Processing 0 6 3

Machine and hardware specifications, stores and stores keeping, purchase procedures, job estimation and costing; methods analysis, work measurement; investment analysis.

TOC C253 Computer Oriented Problem Solving I 3*

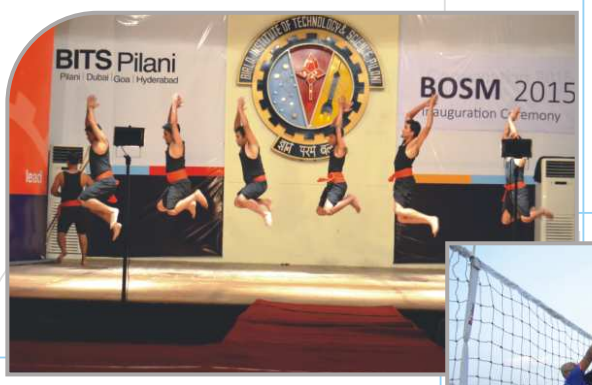
Principles of numeric processing; errors; propagation, simple numerical methods, solving of linear simultaneous equations; numerical differentiation and integration; basic applications of computer oriented numeric methods.

TOC C254 Computer Oriented Problem Solving II 3*

Non numeric processing; string manipulations; applications of non- numeric processing; introduction to computer graphics; applications from business and CAI

PART VII

COURSE DESCRIPTIONS (Off-Campus)



See enclosed CD for Contents.

AAOC ZC111 Probability and Statistics 3

Probability spaces; conditional probability and independence; random variables and probability distributions; marginal and conditional distributions; independent random variables; mathematical expectation; mean and variance; binomial, Poisson and normal distributions; sum of independent random variables; law of large numbers; central limit theorem (without proof); sampling distribution and test for mean using normal and student's t-distribution; test of hypothesis; correlation and linear regression.

AAOC ZC221 Graphs and Networks 3

Basic concepts of graphs and digraphs behind electrical communication and other networks behind social, economic and empirical structures; connectivity, reachability and vulnerability; trees, tournaments and matroids; planarity; routing and matching problem; representations; various algorithms; applications.

AAOC ZC222 Optimization 3

Optimization of functions of one and many variables with and without constraints; Kuhn-Tucker conditions; gradient methods; linear programming; simplex based and integer programming methods; duality theory; transportation and assignment problems; dynamic programming; branch and bound methods; models of linear production systems, sequencing and scheduling, PERT, CPM.

AETT ZG511 Mechatronics 5

Concepts of measurement of electrical and non-electrical parameters; displacement, force, pressure etc. and related signal conditioning techniques, drives and actuators, concepts of microprocessors/ microcontrollers architecture and programming, memory and I/O interfacing. System design concepts through case studies.

AETT ZG512 Embedded System Design 4

Introduction to embedded systems; embedded architectures: Architectures and programming of microcontrollers and DSPs. Embedded applications and technologies; power issues in system design; introduction to software and hardware co-design.

AETT ZG513 Maintenance Engineering 5

Introduction, maintenance systems, methods and tools of maintenance analysis, eliability and safety, maintainability, supportability, design for maintenance, maintenance integration, computerized maintenance management systems, TPM, world-class maintenance systems, and maintenance effectiveness and performance evaluation.

AETT ZG514 Advanced Automotive Systems 4

Frame, suspension, springs and wheels, clutch and gear box, propeller shaft, universal joint, final drive, differential and rear axle, front axle and steering mechanism, brakes, automotive air conditioning, electrical vehicles, automotive electrical systems, automotive electronics systems.

AETT ZG515 Non-Destructive Testing 5

Ultrasonic testing, X-radiography, eddycurrent testing, magnetic methods of crack detection, liquid penetrant inspection, acoustic emission and acousto-ultrasonic testing techniques.

AETT ZG516 Advances in Internal Combustion Engines 4

Air standard cycles, fuel air cycles, actual cycles and their analysis, fuels, alternative fuels, carburetion, mechanical and electronic injection systems, ignition, combustion and combustion chambers, engine friction and lubrication, heat rejection and cooling, engine emissions and their control, measurements and testing, performance parameters and characteristics, engine electronics, supercharging, two-stroke engines. Power-train auxiliary systems integration, newer engine technologies such as hybrid engines.

AETT ZG521 World Class Manufacturing 5

The world-class manufacturing challenge, developing a world-class manufacturing strategy, just-in-time, total quality, total employee envolvement, world-class information systems, managing the change, methods and procedures; improved brainstorming methods, using the check-total quality - the first steps, getting people involved, monitoring world-class performance.

AETT ZG523 Project Management 4

Concepts and techniques of project formulation, evaluation and implementation; Project planning and scheduling; Risk management; Time-cost trade off; Resource leveling and allocation; Project monitoring and control; Contract management.

AETT ZG524 Vehicle Dynamics 4

Fundamentals of vehicle dynamics, steering, single and two degree-of-freedom systems, vibration isolation, absorbers, anti- vibration mounts, exhaust mount, tire properties, influence on vehicle dynamics, tire forces/moments & kinematics, modified SAE tire axes & terminology, introduction to tire modeling ,suspension and steering effects, basic tire modeling consideration, brush tire model, steady state lateral/longitudinal slip force generation, interaction between lateral slip and longitudinal slip, transient tire forces, steady state cornering stability analysis, handling diagram, quasi steady state cornering, straight line braking stability analysis, transient cornering dynamic cornering, principles of anti-lock braking system (ABS), steady state cornering of single unit heavy trucks, effect of tandem axles and dual tires, equivalent wheelbase handling diagram of complex vehicles, vehicle parameters and states estimation, road and basic driver models principles, basic powertrain, modeling, brake system modeling, electronic stability control (ESC), vibration mounts, construction and heavy engineering equipment.

AETT ZG531 Product Design 5

Introduction to creative design; user research and requirements analysis, product specifications, Computer Aided Design; standardization, variety reduction, preferred numbers and other techniques; modular design; design economics, cost analysis, cost reduction and value analysis techniques, design for production; human factors in design: anthropometric, ergonomic, psychological, physiological considerations in design decision making; legal factors, engineering ethics and society.

AETT ZG532 Computer Aided Engineering 5

Mathematics and computer implementation methodologies of parametric geometric modeling for computer aided design including modeling of curves, surfaces, solids and NURBS, geometric transformations, concepts of elasticity and material behavior, theories of failure, finite element analysis (FEA) of one-, two- and three-dimensional problems with special emphasis on the application areas of noise and noise, vibration and harshness (NVH), durability, crash, occupant safety, computational fluid dynamics (CFD) and heat transfer, FEA of mechanical vibrations and fracture. In all implementation work and assignments, suitable commercial CAE software packages such as ABAQUS is required to be used.

AETT ZG535 Advanced Engineering Mathematics 5

Boundary value problems; wave equations; nonlinear partial differential equations; calculus of variations; Eigen value problems; iteration problems including forward and inverse iteration schemes – Graham Schmidt deflation – simultaneous iteration method – subspace iteration – Lanczo's algorithm – estimation of core and time requirements.

AETT ZG542 Just-in-time Manufacturing 4

Introduction; Toyota production system; JIT implementation surveys; Design, development and implementation of JIT manufacturing systems; Supply management for JIT; Framework for implementation of JIT; Theoretical research in JIT systems; Various case studies.

AETT ZG611 Computational Fluid Dynamics and Heat Transfer 4

Integral and differential conservation laws for mass, momentum, and energy, solution of Navier-Stokes equations, theory of potential flow, boundary layer theory, hydrodynamic stability turbulent flow, compressible flow quasi-one-dimensional nozzle flows numerical solution of a two-dimensional supersonic flow, incompressible Couette flow. supersonic flow over a flat plate, experimental techniques and uncertainty analysis, integral and differential forms of energy conservation law for heat transfer, heat transfer in internal laminar and turbulent flow, heat transfer in external laminar and turbulent flow, natural convection heat transfer, mixed convection heat transfer, convective heat transfer in porous media flow, condensation, evaporation, and boiling. radiation heat transfer in non-participating and participating media. radiation transport equation, heat transfer of engine cooling, exhaust manifold and HVAC for automobiles, computational analysis of fluid flow, heat transfer and multi-

phase flow problems with special emphasis on problems relevant to automotive applications.

AETT ZG612 Advances in Materials, Composites & Plastics 4

Definition of composite materials; classification; particulates and dispersion hardened composites, continuous and discontinuous fiber reinforced composites, metal-matrix composites, carbon-carbon composites, molecular composites, micro and multilayer composites, theory of reinforcement; reinforcement by continuous and discontinuous fibers, concept of microfibril; effect of orientation and adhesion; mechanical behaviour of composites, stress-strain relationship, strength, fracture toughness and fatigue; properties of fibre reinforcement and production technology of composites. Plastics and their processing technology including injection moulding, blow moulding etc. Mathematical modeling and simple computational techniques for the mechanics of composites and plastics. Applications of plastics and composite in automotive and aerospace structures. Advanced metals and alloys including titanium, aluminum and magnesium, Ceramic and metal alloys (CERMETS) including Aluminum based alloys and other ceramic components.

AETT ZG613 Tribology 5

Introduction, lubricants and lubrication, surface texture, bearing materials, fundamentals of viscous flow, reynolds equation and applications, thrust bearings, journal bearings, squeeze-film bearings, hydrostatic bearings, gas bearings, dry and starved bearings, selecting bearing type and size, principles and operating limits, friction, wear and lubrication.

AETT ZG614 Fracture Mechanics 5

Introduction, energy release rate, stress intensity factor and complex cases, anelastic deformation at the crack tip, elastic plastic analysis through J-integral, crack tip opening displacement, test methods, fatigue failure, numerical analysis, mixed mode crack initiation and growth.

AETT ZG621 Durability, Crash and Safety Engineering 4

Classical failure theory ,creep, fatigue, buckling, low and high cycle fatigue test, crack initiation and fracture mechanics, Effect of surface and metallurgical parameters on fatigue, EN-SN curves, plasticity corrections, Road load acquisition methods/instruments, Proving ground events & duty cycle preparation accordance with vehicle GVW, Joint Design, bolt slippage & torque relaxation methods in FEM. Durability of plastics - material failure criteria, Rattle & squeeze issues in automotive trims, IP panels. Optimization techniques/algorithms - Influence of space, size, weight etc., on form design, aesthetic and ergonomic considerations, Fundamentals of Crash Analysis, Transient Dynamic solutions, Lagarangian and Eulerian codes of solution, explicit and implicit methods of solving crash problems, crash worthiness, Contact theory and algorithms, Quasi-static and dynamic events for crash analysis, time-step computation and mass scaling of models, different element types, formulations and application, Material representations for Crash analysis, Human modeling and biomechanics, Human injuries and remedies, Impact sensor, types and developments, Active and Passive safety, Regulations for Automotive safety, Crash Worthiness Ratings, Model building and integration, Quasi-static load cases – Roof Strength, side door intrusion, Seating load cases, Internal head impacts, Whiplash, Airbag – types, modeling and applications.

AETT ZG622 Advanced Manufacturing Processes 4

High strength material forming, tooling for high strength materials, Cold and hot stamping, hydro forming, vacuum forming, high speed stamping, Aluminium forming & tooling technology including progressive and transfer dies for sheet metal forming, Advanced Automotive BIW assembly/welding technology, laser welding technology , robotic hemming. Tooling for lightweight composites, Carbon fibre moulds & advanced plastic moulding technology, High speed machining, precision machining technology, Resistance welding. Aluminium part manufacturing technique including die casting, tailor-made blanking etc. Mathematical modelling and analytical and numerical computations for sheet metal forming processes using AutoForm. Newer sheet metal forming techniques.

AETT ZG629T Dissertation 16

A student registered in this course must take a topic in an area of professional interest drawn from the on the job work requirement which is simultaneously of direct relevance to the degree

pursued by the student as well as to the employing / collaborating organization of the student and submit a comprehensive report at the end of the semester working under the overall supervision and guidance of a professional expert who will be deemed as the supervisor for evaluation of all components of the dissertation. Normally the Mentor of the student would be the Dissertation supervisor and in case Mentor is not approved as the supervisor, Mentor may play the role of additional supervisor. The final grades for dissertation are Non-letter grades namely Excellent, Good, Fair and Poor, which do not go into CGPA computation.

AETT ZG633 Advances in Vehicle Body Structures 4

Light Weight design of Vehicle Structure i.e. Front-End, Under Body etc; Materials Selection in Automotive Design; Material Matching and gauge Optimization; Lightweight Automotive Alloys; Mechanical Behaviour of Structural Polymers; Designing and Manufacturing with Lightweight Automotive Materials; Design and Manufacturing for Environment – Light Weight material perspective; Vehicle Crashworthiness - Light Weight material perspective; Advanced Light Weight Steels for Automobiles; Fuel Cell Materials and Manufacturing; Automotive Assembly Processes - Light Weight material perspective; Analysis of Lightweight Automotive Structures; Light Weight Power-train Materials and Design; Environmental Degradation of Materials - Light Weight material perspective; Application of Hybrid material and Joining methods.

AE* ZG511 Mechatronics 5

Concepts of measurement of electrical and non-electrical parameters; displacement, force, pressure etc. and related signal conditioning techniques, drives and actuators, concepts of microprocessors/ microcontrollers architecture and programming, memory and I/O interfacing. System design concepts through case studies.

AE* ZG512 Embedded System Design 4

Introduction to embedded systems; embedded architectures: Architectures and programming of microcontrollers and DSPs. Embedded applications and technologies; power issues in system design; introduction to software and hardware co-design.

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Introduction, maintenance systems, methods and tools of maintenance analysis, eliability and safety, maintainability, supportability, design for maintenance, maintenance integration, computerized maintenance management systems, TPM, world-class maintenance systems, and maintenance effectiveness and performance evaluation.

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Frame, suspension, springs and wheels, clutch and gear box, propeller shaft, universal joint, final drive, differential and rear axle, front axle and steering mechanism, brakes, automotive air conditioning, electrical vehicles, automotive electrical systems, automotive electronics systems.

AE* ZG515 Non-Destructive Testing 5

Ultrasonic testing, X-radiography, eddycurrent testing, magnetic methods of crack detection, liquid penetrant inspection, acoustic emission and acousto-ultrasonic testing techniques.

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Air standard cycles, fuel air cycles, actual cycles and their analysis, fuels, alternative fuels, carburetion, mechanical and electronic injection systems, ignition, combustion and combustion chambers, engine friction and lubrication, heat rejection and cooling, engine emissions and their control, measurements and testing, performance parameters and characteristics, engine electronics, supercharging, two-stroke engines. Power-train auxiliary systems integration, newer engine technologies such as hybrid engines.

AE* ZG521 World Class Manufacturing 5

The world-class manufacturing challenge, developing a world-class manufacturing strategy, just-in-time, total quality, total employee envolvement, world-class information systems, managing the change, methods and procedures; improved brainstorming methods, using the check-total quality - the first steps, getting people involved, monitoring world-class performance.

AE* ZG523 Project Management 4

Concepts and techniques of project formulation, evaluation and implementation; Project planning and scheduling; Risk management; Time-cost trade off; Resource leveling and allocation;

Project monitoring and control; Contract management.

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Fundamentals of vehicle dynamics, steering, single and two degree-of-freedom systems, vibration isolation, absorbers, anti- vibration mounts, exhaust mount, tire properties, influence on vehicle dynamics, tire forces/moments & kinematics, modified SAE tire axes & terminology, introduction to tire modeling ,suspension and steering effects , basic tire modeling consideration, brush tire model, steady state lateral/longitudinal slip force generation, interaction between lateral slip and longitudinal slip, transient tire forces, steady state cornering stability analysis, handling diagram, quasi steady state cornering, straight line braking stability analysis, transient cornering dynamic cornering, principles of anti-lock braking system (ABS), steady state cornering of single unit heavy trucks, effect of tandem axles and dual tires, equivalent wheelbase handling diagram of complex vehicles, vehicle parameters and states estimation, road and basic driver models principles, basic powertrain, modeling, brake system modeling, electronic stability control (ESC), vibration mounts, construction and heavy engineering equipment.

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Introduction to creative design; user research and requirements analysis, product specifications, Computer Aided Design; standardization, variety reduction, preferred numbers and other techniques; modular design; design economics, cost analysis, cost reduction and value analysis techniques, design for production; human factors in design: anthropometric, ergonomic, psychological, physiological considerations in design decision making; legal factors, engineering ethics and society.

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Mathematics and computer implementation methodologies of parametric geometric modeling for computer aided design including modeling of curves, surfaces, solids and NURBS, geometric transformations, concepts of elasticity and material behavior, theories of failure, finite element analysis (FEA) of one-, two- and three-dimensional problems with special emphasis on the application areas of noise and noise, vibration and harshness (NVH), durability, crash, occupant safety, computational fluid dynamics (CFD) and heat transfer, FEA of mechanical vibrations and fracture. In all implementation work and assignments, suitable commercial CAE software packages such as ABAQUS is required to be used.

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AE* ZG629T Dissertation 16

A student registered in this course must take a topic in an area of professional interest drawn from the on the job work requirement which is simultaneously of direct relevance to the degree pursued by the student as well as to the employing / collaborating organization of the

student and submit a comprehensive report at the end of the semester working under the overall supervision and guidance of a professional expert who will be deemed as the supervisor for evaluation of all components of the dissertation. Normally the Mentor of the student would be the Dissertation supervisor and in case Mentor is not approved as the supervisor, Mentor may play the role of additional supervisor. The final grades for dissertation are Non-letter grades namely Excellent, Good, Fair and Poor, which do not go into CGPA computation.

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BA* ZG522 Business Data Mining 4

Principles and current practices of data mining; data analytics tools and applications; acquiring and cleaning data, role of data warehousing in data mining; challenges and issues in data mining; Knowledge Discovery in Databases (KDD); role of data mining in KDD; algorithms for classification, association rules, and clustering; Time series analysis

BA* ZG525 Big Data Analytics 4

Big Data and its applications in various domains such as banking and finance, social media, e-commerce, and healthcare. Five V's of big data, namely Volume, Variety, Velocity, Veracity, and Value. Analysis of structured and unstructured data in various forms, including web logs, videos, e-mails, photographs, tweets etc. Uncovering hidden patterns and unknown correlations for better business decisions. Key technologies used in storing, manipulating, and analyzing big data. Tools for statistical analysis and key methods used in machine learning as applied to Big Data. Distributed computing techniques used in Big Data Analytics. Open source frameworks for data analysis including tools, languages, and platforms such as Hadoop, Pig, Hive, R, Spark, Mahout Etc.

BA* ZC416 Investment Banking Analytics 4

Modern portfolio theory, Capital Asset Pricing Model (CAPM), Arbitrage Pricing Theory (APT), and efficient market theory; Passive investing: indexing; Introduction to behavioral finance; Active investing: security analysis – fundamental analysis (strategic, financial, marketing tools) and technical analysis; Portfolio management including allocation, rebalancing and risk management; Transaction cost analysis; Fixed-Income and Credit Sensitive Instruments.

BA* ZC417 Financial Risk Analytics 4

The course will first cover the basics of Financial Risk and then focus on applications such as: currency, interest rate derivatives, equity markets and products, and commodity markets and products. Major topics include methodologies for measuring and analyzing volatility (a key metric of risk) including EWMA, ARCH & GARCH processes, volatility clusters and the issue of time varying volatility; Extreme value theory; Measuring risk using Value-at-Risk, including computation of VaR by various methods, and stress testing; Monte Carlo simulation, address issues in generating price process (such as Brownian Motion, Ito Process), Cholesky decomposition in computing multi-asset VaR; Currency risk analysis in global investing, interest rate parity (covered and uncovered); Value at risk for fixed income portfolios; Credit Risk Analytics. The topics covered in this course will have inbuilt case studies in financial risk management so as to understand the practical implications of the methodologies covered in the course.

BA* ZC418 Advanced Financial Modeling 4

Valuation of equity securities, fixed income securities, and derivatives. Topics include Introduction to Financial Modelling and Spreadsheet Essentials, Measuring Risk (Testing market efficiency with regression analysis & pivot tables), Portfolio optimization (Mean-variance portfolio selection, Bond portfolio selection, Term structure estimation, Capital budgeting), Advanced risk analysis (Monte-Carlo simulation, Risk analysis of discounted cash flow models, Spreadsheet features using @Risk for Monte-

Carlo simulation and combining macros with @Risk), Business and equity valuation modeling , LBO Analysis Model , Stock Merger Model, etc.

BA* ZC420 Data Visualization 3

Information overload and issues in decision making. Design of visual encoding schemes to improve comprehension of data and their use in decision making; presentation and visualization of data for effective communication. elementary graphics programming, charts, graphs, animations, user interactivity, hierarchical layouts, and techniques for visualization of high dimensional data & discovered patterns.

BA* ZC421 Marketing Models 4

The primary purpose of this course is to enhance your ability to develop and critically evaluate marketing models. The course will examine a variety of models, including models of consumer behavior, industrial buying and firm behavior, (aggregate) market models (e.g., competition, market entry), strategic marketing models, forecasting methods, new product models, marketing response models (e.g., channels, pricing, advertising, promotion), forecasting models and decision support systems.

BA* ZC423 Retail Analytics 4

RFM (recency, frequency, monetary) analysis, chum modeling, retention modeling, shopper analytics, market basket association analysis, customer segmentation and profiling, propensity scoring models to identify prospective customers, best customers, lifetime value modeling, marketing campaign response modeling, cross sell modeling, etc.

BA* ZC426 Real-time Analytics 4

Motivation and challenges of real-time, distributed, fault-tolerant data processing, Distributed messaging architecture (Apache Kafka), Real time data processing platform: Storm, Storm basic programming skills, linking Spouts, and connecting to the live Twitter API to process real-time tweets, multi-language capability of storm (with Python scripts), Case study: Networking fault prediction. This course also helps a student to analyze and understand Big-data using visuals. Topics include, Design principles, Perception, color, statistical graphs, maps, trees and networks, high dimensional data, data visualization tools.

BA* ZC471 Management Information Systems 3

Introduction to Information Systems; Concepts of management, concepts of information, systems concepts; Information Systems and Organizations; decision making process; database systems; data communications; planning, designing, developing and implementing information systems; quality assurance and evaluation of information systems; future developments and their organizational and social implications; decision support system and expert systems.

BA* ZG523 Introduction to Data Science 3

Context and use of Data Science. High-dimensional data, graphs, vectors in high dimensional space and large matrices; Algorithms for massive data problems, sampling techniques. Techniques for extracting information/patterns from data

BA* ZG537 Text Analytics 4

Emerging methods of organizing, summarizing, and analyzing collections of unstructured and lightly-structured text. Basics of text processing and natural language processing. Applications of text analysis such as sentiment analysis and opinion mining. Text processing techniques stop word removal, text parsing, and other relevant tree processing steps; text preprocessing, feature selection, text classification, text clustering, and summarization. Natural language processing techniques/steps – Syntactic Analysis, Semantic analysis, and Pragmatic analysis. Case studies with focus on business processes.

BA* ZG512 Predictive Analytics 4

Basic concepts in predictive analytics / predictive modeling. Two core paradigms for predictive modeling: classification and regression. Identification of important variables and their relation to each another. Basic modeling techniques such as k-nearest neighbors, classification and regression trees (CART), and Bayesian classifiers. Ensemble techniques. Model selection techniques.

BA* ZC413 Introduction to Statistical Methods 3

Different types of data; Data Visualization; Data summarization methods; Tables, Graphs, Charts, Histograms, Frequency distributions, Relative frequency measures of central tendency and dispersion; Box Plot; Chebychev's Inequality on relationship between the mean and the standard deviation of a probability distribution. Basic

probability concepts, Conditional probability, Bayes Theorem, Probability distributions, Continuous and discrete distributions, Transformation of random variables, Moments, Correlation and Covariance, Parameter Estimation, Hypothesis Testing.

BA* ZG521 Financial Management 4

Concepts and techniques of financial management decision; concepts in valuation – time value of money; valuation of a firm's stock, capital asset pricing model; investment in assets and required returns; risk analysis; financing and dividend policies, capital structure decision; working capital management, management of cash, management of accounts receivable; inventory management, short and intermediate term financing, long term financial tools of financial analysis, financial ratio analysis, funds analysis and financial forecasting, operating and financial leverages.

BA* ZG524 Advanced Statistical Methods 4

Point and interval estimation and hypothesis testing, chi-square tests, non- parametric statistics, analysis of variance, regression; linear and multiple linear, correlation, factor models, decision theory, Bayesian statistics and autocorrelation, multivariate regression, randomization and sampling processes, Markov processes with discrete/continuous state space, statistical simulation and pattern recognition, Time Series Analysis.

BA* ZC412 Models and Applications in Operations Research 4

This course provides a survey of selected topics in operations research (OR). Emphasis is placed on the practical application of OR tools rather than on the mathematical properties. Application areas include: financial planning and portfolio selection, production, priority planning and marketing. Topics include linear programming and its applications; programming to achieve a set of goals or targets with applications in finance and production; capital budgeting and project selection; transportation and network models; and portfolio models.

BA* ZC415 Analytics for Competitive Advantage 4

In today's competitive business environment, high performing companies are doing more than just collecting data, storing it and generating reports. They are developing competitive strategies using Business Analytics. In this course we will look at how to use data-driven insights to differentiate a firm's business/ product strategy from other companies that are making the same product or delivering the same service. This course is designed for analysts in any function: marketing, operations, quality, customer service, IT, finance/accounting or human resources. We will use case studies and other experiential components to study the application of data-driven insights in the context of various industries.

BA* ZC422 Marketing Analytics 4

This course discusses in detail how analytics can play a vital role in the various elements of the marketing research process viz. Problem Definition, Development of an approach to the problem, Research Design formulation, Fieldwork or Data collection, Data preparation & Analysis and finally Report preparation and Presentation. The emphasis of the course is proportionately focused on Concepts, Techniques & Methodology, and Marketing Research Applications.

BA* ZC424 Supply Chain Analytics 4

Demand Management and Forecasting: static, adaptive and rolling plans. Supply chain Network design: Mathematical Programming Models for Selecting the right number, location, territory, and size of warehouses, plants, and production lines; and optimizing the flow of all products through the supply chain. Space Determination and Layout Methods. Inventory Management: Inventory aggregation Models, Dynamic Lot sizing Methods, Multi-Echelon Inventory models. Transportation Network Models and scheduling algorithms: Efficient and responsive supply chains. Maximal Flow Problems, Multistage Transshipment. Supply chain dynamics and integration: Cost analysis of supplier selection, order fulfillment process, levers for improved supply chain performance, pricing and revenue management and coordination in supply chain. Application of Analytic Hierarchy Process (AHP) to supply chain analytics.

BA* ZC425 HR Analytics 4

In this course students will learn how to leverage analytic techniques in the context of the challenges faced by the HR and Talent Acquisition and Management functions. The primary goal is to leverage analytical techniques to deliver meaningful insights for effectively managing employees for achieving the goals of the organization. Applications include attracting right talent, forecasting future staffing needs,

managing attrition and improving employee satisfaction levels. We will be extensively leveraging experiential components such as case studies to understand how various organizations have applied these concepts in practice.

BA* ZC414 Optimization Methods for Analytics 4

This course will focus on development of analytical models using optimization (and simulation) techniques to analyze and recommend appropriate solutions for complex business problems across various functional areas including finance, economics, operations, and marketing. Key topics covered in this course are as follows: solving various problems related to planning, production, transportation, microeconomics, etc. using LP models. Decision making in the context of multi stage LP models. Application of Goal Programming (GP) and Analytic Hierarchy Process (AHP) for decisions relating to large teams and complex problems with long term implications. We will use various tools including spreadsheets and other software for the experiential components of this course to illustrate the application of these techniques to various industries.

BITS ZC411 Object Oriented Programming 3

Object orientation concepts and principles: abstraction, encapsulation, modularity, inheritance, and polymorphism; classes and objects; static and dynamic binding; class utilities; metaclasses; object oriented software engineering; programming and problem solving using one or more of the popular object-oriented programming languages like C++ or Java.

BA* ZG621 Supply Chain Management 4

Customer driven strategies in production and distribution systems; Integrated production and distribution networks; SCM in the context of JIT and MRP–II; Distribution Resource Planning; Management of dealer networks; Total Control & Product innovation across the supply chain; Incoming logistics and supplier relationships; Value addition analysis; Metrics for management of supply chain performance; Mathematical models and computer assisted decision support for SCM; Mathematical programming for SCM.

BITS ZC423T Project Work 20

Consistent with the student's professional background and work-environment, the student will be required to carry out work-oriented projects. The student would be required to select an area of work that is considered vital to the sponsoring organization. The topic of the project and detailed project outline that is prepared by the student, in consultation with his/her Mentor, needs to be approved by the Dean, WILPD. On approval, the student carries on with the work-centered project, adhering to the guidelines provided in the detailed course handout, taking all the prescribed evaluation components on time. At the end of the semester, the student should submit a comprehensive Project Report, to the Institute for evaluation. The student will be evaluated on the basis of the various interim evaluation components, contents of the report and Seminar/Viva-Voce that may be conducted at Pilani or at any other Centre approved by the Institute.

BITS ZC424T Project Work 10

Consistent with the student's professional background and work-environment, the student will be required to carry out a work-oriented project. At the beginning of the semester, the student should select an area of work that is considered vital to the sponsoring organization, and prepare a detailed project outline, in consultation with his/her Mentor. The student carries on with the work-centered project, adhering to the guidelines provided in the detailed course handout, and taking all the prescribed evaluation components on time. At the end of the semester, the student should submit a comprehensive Project Report. The student will be evaluated on the basis of the various interim evaluation components, contents of the report and a final seminar and viva-voce.

BITS ZC461 Software Engineering 3

Software engineering concepts and methodology; formal requirements specification; estimation; software project planning; detailed design; techniques of design; productivity; documentation; programming languages styles, code review; tool, integration and validation; software quality assurance; software maintenance; metrics, automated tools in software engineering.

BITS ZC471 Management Information Systems 3

Introduction to Information Systems; Concepts of management, concepts of information, systems concepts; Information Systems and

Organizations; decision making process; database systems; data communications; planning, designing, developing and implementing information systems; quality assurance and evaluation of information systems; future developments and their organizational and social implications; decision support system and expert systems.

BITS ZC481 Computer Networks 3

Introduction, history and development of computer networks; Reference models; Physical Layer: theoretical basis, transmission media, types of transmission; MAC sub-layer: local area networks, FDDI; Data Link Layer: Sliding Window protocols, design aspects; Network Layer: routing algorithms, congestion control algorithms, internetworking; Transport Layer: Integrated Services Digital Network (ISDN), Asynchronous Transfer Mode (ATM) - reference models, service classes, switch design, LAN emulation; Application Layer protocols.

BITS ZG553 Real Time Systems 5

Real time software, Real time operating systems-scheduling, virtual memory issues and file systems, real time data bases, fault tolerance and exception handling techniques, reliability evaluation, data structures and algorithms for real time/embedded systems, programming languages, compilers and run time environment for real time/embedded systems, real time system design, real time communication and security, real time constraints and multi processing and distributed systems.

BITS ZG628T Dissertation 16

A student registered in this course must take a topic in an area of professional interest drawn from the on the job work requirement which is simultaneously of direct relevance to the degree pursued by the student as well as to the employing / collaborating organization of the student and submit a comprehensive report at the end of the semester working under the overall supervision and guidance of a professional expert who will be deemed as the supervisor for evaluation of all components of the dissertation. Normally the Mentor of the student would be the Dissertation supervisor and in case Mentor is not approved as the supervisor, Mentor may play the role of additional supervisor. The final grades for dissertation are Non-letter grades namely Excellent, Good, Fair and Poor, which do not go into CGPA computation.

BITS ZG629T Dissertation 20

A student registered in this course must take a topic in an area of professional interest drawn from the on the job work requirement which is simultaneously of direct relevance to the degree pursued by the student as well as to the employing / collaborating organization of the student and submit a comprehensive report at the end of the semester working under the overall supervision and guidance of a professional expert who will be deemed as the supervisor for evaluation of all components of the dissertation. Normally the Mentor of the student would be the Dissertation supervisor and in case Mentor is not approved as the supervisor, Mentor may play the role of additional supervisor. The final grades for dissertation are Non-letter grades namely Excellent, Good, Fair and Poor, which do not go into CGPA computation.

BITS ZG659 Technical Communication 4

Role and importance of communication; effectiveness in oral and written communication; technical reports; technical proposals; technical descriptions; definitions and classifications; business correspondence; precis writing; memorandum; notices, agenda and minutes; oral communication related to meetings, seminars, conferences, group discussions, etc.; use of modern communication aids.

CM ZC471 Management Information Systems 3

Introduction to Information Systems; Concepts of management, concepts of information, systems concepts; Information Systems and Organizations; decision making process; database systems; data communications; planning, designing, developing and implementing information systems; quality assurance and evaluation of information systems; future developments and their organizational and social implications; decision support system and expert systems.

CM ZC473 International Business 3

International business - an overview, general international environment - political, legal, socio-cultural and economic factors, international operational framework, tax aspects, marketing factors, labor factors and economic integration. BOP analysis, foreign exchange control,

governmental policies, international finance, economic community, IMF, managing multinationals/globalization of operations.

CM ZC483 Marketing Research 3

An examination of the concepts and practical methodology used in marketing research. An overview of marketing research process, with emphasis on research design; data instrument design; questionnaire formulation; sampling plans; data collection methods -interviewing, panels; data analysis and use of computer based information systems for marketing intelligence. Also Time-series & Regression based models of sales forecasting, control and evaluation of marketing function and survey methodology are covered. Emphasis will be on cases and research projects.

CM C489 Enterprise Resource Planning 3

Introduction to ERP; Re-engineering and ERP systems; ERP planning, design, and implementation; ERP systems – sales and marketing; ERP systems – accounting and finance; ERP systems – production and materials management; ERP systems – human resources; Managing and ERP project; Supply chain management and e-Market place.

CM ZG511 Consultancy Practice 4

Strategic planning and marketing of consultancy services, client consultant relationships, technology transfers, negotiations, agreements, guarantees, organizing and executing consultancy services, quality in consultancy services, technical audit, government policies such as industrial policy, trade policy, technology policy, patent and trade marks etc.

CM ZG512 Consulting & People Skills 4

Facilitation skills, Communication skills, Presentation and Interviewing skills, Analytical Skills, Creativity, Partnership and networking skills, Critical thinking skills, Emotional Intelligence Development, Stress Management, Ethics and respect for the client, Vision and Framing of issues, Synthesizing Skills, Leadership skills.

CM ZG513 Financial Management 4

Concepts and techniques of financial management decision; concepts in valuation – time value of money; valuation of a firm's stock, capital asset pricing model; investment in assets and required returns; risk analysis; financing and dividend policies, capital structure decision; working capital management, management of cash, management of accounts receivable; inventory management, short and intermediate term financing, long term financial tools of financial analysis, financial ratio analysis, funds analysis and financial forecasting, operating and financial leverages.

CM ZG515 Quantitative Methods 4

Basic concepts in Operations Research; Analytical & Mathematical Modeling Techniques; Model Building; Inventory Control, queuing theory; Linear Programming; Transportation and assignment problems, simulation, index numbers, decision theory, etc.

CM ZG516 Consulting & People Skills 4

Facilitation skills, Communication skills, Presentation and Interviewing skills, Analytical Skills, Creativity, Partnership and networking skills, Critical thinking skills, Emotional Intelligence Development, Stress Management, Ethics and respect for the client, Vision and Framing of issues, Synthesizing Skills, Leadership skills.

CM ZG523 Project Management 4

Concepts and techniques of project formulation, evaluation and implementation; Project planning and scheduling; Risk management; Time-cost trade off; Resource leveling and allocation; Project monitoring and control; Contract management.

CM ZG524 Business Process Analysis 4

Course description to be developed.

CM ZG532 Total Quality Management 4

Nature of quality, dimensions, determinants, costs of quality, traditional quality management, emerging quality standards, ISO 9000, Malcom Baldridge Award, Top management commitment and involvement, customer involvement, quality function deployment, designing and controlling production processes and improving process capability, reliability concepts, developing supplier partnerships, building teams of empowered employees, quality circles, benchmarking and continuous improvement, TQM in services.

CM ZG542 Knowledge Management 3

Increasing knowledge work in organizations; technologies to support growth of knowledge work in organizations; scope, cost, efficiency and reliability of technologies to support knowledge work; role of knowledge in an enterprise; knowledge management process; knowledge management strategies; human aspects of knowledge management; knowledge management technologies; applications of technologies to be covered through cases, reading assignments and use of appropriate software.

CM ZG561 Management of Technology 4

Technology Forecasting and its application in decision making, study of different industrial profiles, choice of technologies considering impact on people and environment, Promotion of Indigenous technology, technology transfer, foreign collaborations, process licensing, equipment selection and purchase, training and retraining of manpower.

CM ZG611 Strategic Management & Business Policy 4

Strategic management elements; internal, external, external environment. assessment of corporate strengths, weaknesses and opportunities; planning and deployment of capital assets; profit planning and control functions problems, pressures, responsibilities, limits of the chief executive; evaluation of one's own business undertaking; formulating objectives, strategies, policies and programmes for improving company's present situation; personnel strength and implementation of the policies and programmes, development, implementation, evaluation and control of strategies, strategic management of MNCs, management style and behavior, corporate style, behavior and culture.

CM ZG619 Professional Practice 4

This course will aim to achieve a professional development of the student in the context of the overall goal of his/her programme. Depending upon the profession, this course will be conducted in terms of actual participation in professional activities such as teaching laboratory organization, course development, organizational development, R&D work, design, production, data organization, data preparation or management of institutions / hospitals / voluntary organizations etc. The course will also deal with communication aspects such as teaching a course, presenting a paper in the seminar/conference, articulating ideas and concepts to professional audience/customers etc. This course will also deal with the laws and ethics concerned with the profession of an individual.

CM ZG621 Supply Chain Management 4

Customer driven strategies in production and distribution systems; Integrated production and distribution networks; SCM in the context of JIT and MRP–II; Distribution Resource Planning; Management of dealer networks; Total Control & Product innovation across the supply chain; Incoming logistics and supplier relationships; Value addition analysis; Metrics for management of supply chain performance; Mathematical models and computer assisted decision support for SCM; Mathematical programming for SCM.

CM ZG631 Strategic Change Management 4

Results-based management, managing for outcomes–objectives and targets; strategy; indicator, performance information; environmental scan and SWOT analysis; planning, budgeting, implementation, review - the (strategic) management cycle Models and theories of planned change, Strategic management: transformational leadership or change management (or learning), Strategic management in a context of joint action and networks, Participation and Empowerment, Teams and Teamwork, Parallel learning structures, OD Interventions, Team Interventions, Intergroup and third party interventions, Structural and Comprehensive interventions, Action research, Socio-clinical and Socio-technical Approaches, Issues in Consultant-Client Relationships, Power Politics and Organization Development.

CM ZG629T Dissertation 20

A student registered in this course must take a topic in an area of professional interest drawn from the on the job work requirement which is simultaneously of direct relevance to the degree pursued by the student as well as to the employing / collaborating organization of the student and submit a comprehensive report at the end of the semester working under the overall supervision and guidance of a professional expert who will be deemed as the supervisor for evaluation of all components of the dissertation.

Normally the Mentor of the student would be the Dissertation supervisor and in case Mentor is not approved as the supervisor, Mentor may play the role of additional supervisor. The final grades for dissertation are Non-letter grades namely Excellent, Good, Fair and Poor, which do not go into CGPA computation.

CM ZG631 Strategic Change Management 4

Results-based management, managing for outcomes –objectives and targets; strategy; indicator, performance information; environmental scan and SWOT analysis; planning, budgeting, implementation, review - the (strategic) management cycle Models and theories of planned change, Strategic management: transformational leadership or change management (or learning), Strategic management in a context of joint action and networks, Participation and Empowerment, Teams and Teamwork, Parallel learning structures, OD Interventions, Team Interventions, Intergroup and third party interventions, Structural and Comprehensive interventions, Action research, Socio- clinical and Socio-technical Approaches, Issues in Consultant-Client Relationships, Power Politics and Organization Development.

CONS ZG511 Philosophy and Consciousness 4

The Problem of consciousness. The materialist, Physicalist, Behaviorist and Epiphenomenalist Positions concerning Consciousness. The Neurobiological Approach. the Mind Body problem. Self-identity; the Continuity of the Self; Memory, Consciousness and Intentionality. The Question of "Conscious Experience". Consciousness and Language. Consciousness and the Meaning of Creativity. Artificial Consciousness and Artificial Intelligence. Consciousness and Robots. The transcendence of Consciousness. The Theories of Consciousness in Indian Philosophies. Is Solipsism tenable? The problem of other minds. Intersubjectivity and Humanism.

CONS ZG512 Philosophy and Consciousness - Advanced Topics 4

Course description to be developed.

CONS ZG531 Physics and Consciousness 4

Quantum Mechanics: Philosophical background of modern physics-classical interpretation quantum mechanics (Planck, Einstein and chaos, duality and complimentarity, complimentarity and causality, Heisenberg's uncertainty principle - the indeterminacy relation and philosophical implications - eigen function - normalization and orthogonalisation - Schrodinger equation (time independent) - probability current density - expectation values - Ehrenfest's theorem-group and phase velocities-Gaussian wave packets. Time independent Schrodinger equation-stationary states-nondegeneracy-degeneracy parity. Eigen values and eigenstats problems-one dimensional quantized systems- degeneracy in deep square well penetration of potential barrier. Statistical Mechanics: Classical statistical mechanics: statistical basis of thermodynamics, derivation of thermodynamic formulae, phase space, phase volume, Liouville's theorem, micro-canonical ensemble, canonical ensemble, grand-canonical ensemble and corresponding partition function. Quantum statistical mechanics postulates of quantum statistical mechanics-density matrix-quantum statistical microcanonical, canonical and grand canonical ensembles and their partition functions. Theory of special relativity: The speed of light and ether- Einstein's principle of relativity- the combination of velocities.

CONS ZG532 Neuroscience & Consciousness 4

Embryology, anatomy, physiology, biochemistry, pharmacology, etc. of the nervous system brain, neurons and synapses-apraxias, aphasias, and agnosias- growth and aging- disturbances of consciousness- hemispheric specialization-thinking, learning and memory- sensation & perception and special senses-speech neurolinguistics, speech and communication-emotions, pleasure, and pain-sleep and dream-drugs altering consciousness, psychedelic-pypnosis & related phenomena; meditation & its effect on health psychopharmacology- extra sensory perception – psychoneuro - immunology-psycho-neuroendocrinology.

CONS ZG541 Biology and Consciousness 4

Living system and cellular organization- heredity and genetic information- the dynamics of genetic matter and modes of transfer of genetic information -the packaging of genetic information and chromosomes- translation of genetic information to proteins and enzymes- hereditary changes, mutation, and mutagene- assimilation, transport, and channel- response of living state to internal and external stimuli, immune response

and antibody- hormones and peptide- neurons and nervous system- sensory and motor functions- brain, mind and consciousness- where we lead to?

CONS ZG542 Consciousness Studies – Advanced Topics 4

Matter and quantum theory, philosophical perspective of matter, principles and experimental data of neuroscience including its relevance to consciousness studies, non-classical nature of quantum theory, relational view point for interpreting quantum physical reality, relational view points from biological & mathematics pertaining to consciousness studies.

CONS ZG551 Artificial Intelligence and Consciousness 4

A review of technical progress and difficulties in AI; The `intelligence machine' concept - Turning's `imitation game' metaphor. Searie's `Chinese Room' counter; The `knowledge representation' approach- symbol-system hypothesis of Brain Smith; The symbol grounding problem; Limits to computation arguments; The theory of neural nets; `symbol generation' approach to AI.

CONS ZG552 Foundations of Physics 4

Philosophy of physics including epistemological and ontological issues, Michelson-Morley Experiment; Interpretation; Postulates of Special Theory; Derivation of Lorentz Transformation; Length contraction; Time Dilation; Relativistic kinematics – Relativistic Momentum; Mass-Energy equivalence; Electromagnetism and Relativity- Maxwell's Equations; Lorentz transformation; Relativistic invariance; Field of a moving charge; General Theory of Relativity- Principle of equivalence; Space-Time curvature; Geodesic equation; Gravitation and Metric; Experimental evidence of GTR.

CONS ZG561 Vedanta and Consciousness I 4

A brief history of the Western theories of knowledge' Plato, Aristotle, Descartes, Locke, Hume, Berkeley, Kant, Bohr and Einstein. Introduction to the basic principles of Vedanta-vis-a-vis the concept of matter, conscious, self, Time and God. The differences between Western mind/body dualism and Vedantic jiva / God dualism. The distinction between mind and conscious self in Vendanta. The Vedantic concept of Maya. The Vedantic view of the mind/body problem and the conscious self/matter interaction. Its possible relevance to emerging foundational issues in quantum physics, artificial intelligence and neuroscience. The course will be based on the Vedanta as elucidated by the Cananyane School of Vaishnavism, of which the more popular Advaita edanta can be seen as a proper subset.

CONS ZG562 Physics and Consciousness - Advanced Topics 4

The axiomatic foundation of classical and quantum theory; the inter-relationship between state, observables and measurement in classical and quantum theory; differences in the physical meaning of the state vector and eigenvectors in Hilbert space; a statement of the measurement problem-the apparent need for the `collapse' postulate; a review of the important differences in the approaches of Bohr and Einstein to the measurement problem. Toward a new quantum theory of the individual quantum system based on a `particle' ontology that integrates the essential insights of Bohr, Einstein and modern `ontological' Copenhagen interpretation. The complementary relationship between the present quantum theory which is a `wave' ontology and a possible new theory based on `particle' ontology. The different role of consciousness in classical and mechanics. Classical and quantum notions of `information'.

CONS ZG571 Mind, Body Medicine – Current Trends 4

The course will explore the interface between consciousness and clinical medicine. It will scientifically scrutinize the areas in clinical medicine where the issue of the nature and role of consciousness plays a significant role; encourage the study and critical examination of the existing credible scientific models of consciousness that account for relevant phenomena; and empower students to propose fresh and new plausible models with underlying scientific reasoning, especially where none presently exist, using experimental criteria for validation of the proposed models.

CONS ZG572 Matter and Consciousness in Bhagavata Sankhya 4

In-depth study and analysis of the concepts of Sankhya, brief history of the Western Theories of knowledge: Plato, Aristotle, Descartes, Locke, Hume, Berkeley, Kant, Bohr and Einstein; possibilities of applying the concepts of Bhagavata Sankhya for the field of consciousness studies.

CONS ZG573 Study in Advanced Topics I 5

CONS ZG574 Study in Advanced Topics II 5

In the above two courses students will be assigned study work in advanced areas of professional interest. Each student will work under the overall supervision and guidance of a faculty member and will in the end submit a project report encompassing critical review of the material studied. The organization and evaluation of the course would be achieved through seminars, group discussions, project report etc. The course will be conducted by the team of teachers who provide guidance for study work.

CONS ZG581 Medicine & Consciousness Advanced Topics 4

Course description to be developed.

CONS ZG582 Psychology and Consciousness 4

Course description to be developed.

CONS ZG591 Selected Topics in Consciousness Studies 5

Course description to be developed

CONS ZG629T Dissertation 20

A student registered in this course must take a topic in an area of professional interest drawn from the on the job work requirement which is simultaneously of direct relevance to the degree pursued by the student as well as to the employing / collaborating organization of the student and submit a comprehensive report at the end of the semester working under the overall supervision and guidance of a professional expert who will be deemed as the supervisor for evaluation of all components of the dissertation. Normally the Mentor of the student would be the Dissertation supervisor and in case Mentor is not approved as the supervisor, Mentor may play the role of additional supervisor. The final grades for dissertation are Non-letter grades namely Excellent, Good, Fair and Poor, which do not go into CGPA computation.

CONS ZG656 Technical Writing 4

Competent technical writing, content editing, review of elementary and advanced consideration in writing effective sentences with correct grammar, methodology for surveying the technical literature on a particular subject, competent presentation of technical ideas of other researchers succinctly.

CS ZC444 Real-Time Systems 3

Introduction to real-time systems, clock synchronization, task assignment and scheduling, programming language with real-time support, ADA, real-time communication protocols, real-time databases, fault tolerant techniques, reliability evaluation methods; case studies in real-time operating systems, simulation of real-time systems, embedded system programming.

CS ZG524 Real Time Operating Systems 5

Introduction to real-time systems, clock synchronization task assignment and scheduling, programming language with real-time support, ADA, real-time communication protocols, real-time database, fault tolerant techniques, reliability evaluation methods; case studies in real-time operating systems, simulation of real-time systems, embedded system programming.

CS ZG525 Advanced Computer Networks 5

Topics in advanced networking – Quality of Service in IP networks, IPv6, Wireless and Mobile Networks, Carrier Technologies (Frame Relay, FDDI, ISDN, ATM), Peer-to-Peer Networks and Overlays, Routing and QoS Issues in Optical Networks.

CS ZG551 Advanced Compilation Techniques 5

Generic Code Optimization Techniques - loop optimization, inlining, and other transformations. Impact of architectures on code generation and optimization: RISC architectures, VLIW architectures, special-purpose architectures. Architecture-specific code optimizations – register allocation, instruction scheduling. Code Optimizations under real-time / embedded constraints - cacheless / diskless memory models, bounded time responses. Garbage Collection Techniques. Virtual Machines and Just-in-Time Compilation techniques - HotSpot-like optimizations. Implementation of exception handling, concurrency, and generic jumps (like call/cc).

CS ZG623 Advanced Operating Systems 5

Overview of advanced operating systems: motivation for their design, and various types of advanced operating systems; Distributed operating systems: architecture of distributed systems, theoretical foundation of distributed

systems, deadlock detection/resolution, agreement protocols, file systems, distributed shared memory, scheduling, fault tolerance and recovery; Multiprocessor operating systems: multiprocessor system architectures, multiprocessor operating system design issues, threads, process synchronization, process scheduling and memory management; Data base operating systems: introduction, concurrency control: theoretical and algorithmic aspects; Case Study: Amoeba and Mach.

DEET ZC312 Industrial Instrumentation and Control 3

Importance of process control, elements of process loop, mathematical modeling, dynamic closed loop characteristics, controller principles & tuning, direct digital loop, hydraulic controllers, pneumatic controllers, electronic controllers, complex & multivariable control schemes, final control elements, P& I diagrams, PLCs, Distributed Control Systems (DCS), AI techniques: expert systems, neural networks, fuzzy logic, genetic algorithms & applications.

DEET ZG511 Mechatronics 5

Concepts of measurement of electrical and non-electrical parameters; displacement, force, pressure etc. and related signal conditioning techniques, drives and actuators, concepts of microprocessors/ microcontrollers architecture and programming, memory and I/O interfacing. System design concepts through case studies.

DEET ZG512 Finite Element Methods 5

Element properties, Isoparametric elements, Finite element methods and analysis, Applications in design including continuum mechanics, Dynamic systems, Heat conduction and Electrical potentials, etc. will be taken up.

DEET ZG515 Computational Fluid Dynamics 5

Philosophy of computational fluid dynamics (CFD), governing equations of fluid dynamics, mathematical behavior of partial differential equations, basics of the numerics : basic aspects of discretization, grids with appropriate transformations, and simple CFD techniques, applications, numerical solutions of quasi-one-dimensional nozzle flows, numerical solution of a two-dimensional supersonic flow, incompressible couette flow, and supersonic flow over a flat plate, advanced topics in CFD.

DEET ZG521 World-Class Manufacturing 5

The world-class manufacturing challenge, developing a world-class manufacturing strategy, just-in-time, total quality, total employee envolvement, world-class information systems, managing the change, methods and procedures; improved brainstorming methods, using the check-total quality - the first steps, getting people involved, monitoring world-class performance.

DEET ZG523 Project Management 4

Concepts and techniques of project formulation, evaluation and implementation; Project planning and scheduling; Risk management; Time-cost trade off; Resource leveling and allocation; Project monitoring and control; Contract management.

DEET ZG525 Mechanical System Design 5

Concept of system design; modeling of structural and kinematic systems, and determination of system characteristics; reliability of systems; design of machine elements for specified reliability; concepts of optimization; techniques of design optimization for linear and non-linear problems.

DEET ZG532 Quality Assurance and Reliability 5

Quality planning and control, economics of quality control, Specifications, tolerances and process capability studies, total quality control concepts in quality circles, quality incentives. Fundamental concepts of reliability engineering, Failure analysis, Reliability versus quality control, Systems reliability evaluation, reliability allocation, maintainability, and designing for reliability. Illustrative examples of design ensuring reliability to be taken up.

DEET ZG541 Product Design 5

Introduction to creative design; user research and requirements analysis, product specifications, Computer Aided Design; standardization, variety reduction, preferred numbers and other techniques; modular design; design economics, cost analysis, cost reduction and value analysis techniques, design for production; human factors in design: anthropometric, ergonomic, psychological, physiological considerations in design decision making; legal factors, engineering ethics and society.

DEET ZG611 Dynamics & Vibrations 5

Steady and transient Vibration of single and multi degree freedom systems. Systems with distributed mass and elasticity. Non-linear and self-excited vibrations, structural damping, Random vibrations, vibration analysis, vibration control - reduction, isolation and vibration absorbers.

DEET ZG629T Dissertation 20

A student registered in this course must take a topic in an area of professional interest drawn from the on the job work requirement which is simultaneously of direct relevance to the degree pursued by the student as well as to the employing / collaborating organization of the student and submit a comprehensive report at the end of the semester working under the overall supervision and guidance of a professional expert who will be deemed as the supervisor for evaluation of all components of the dissertation. Normally the Mentor of the student would be the Dissertation supervisor and in case Mentor is not approved as the supervisor, Mentor may play the role of additional supervisor. The final grades for dissertation are Non-letter grades namely Excellent, Good, Fair and Poor, which do not go into CGPA computation.

DEET ZG631 Materials Technology & Testing 5

Study of characteristics and technology of metals, plastics, rubbers, ceramics, polymers, composites, optical fibres and other modern engineering materials and their application with particular reference to Railways. Destructive and non-destructive testing techniques and their applications in Railways.

DEET ZG659 Technical Communication 4

Role and importance of communication; effectiveness in oral and written communication; technical reports; technical proposals; technical descriptions; definitions and classifications; business correspondence; precis writing; memorandum; notices, agenda and minutes; oral communication related to meetings, seminars, conferences, group discussions, etc.; use of modern communication aids.

DE* ZC415 Introduction to MEMS 4

Overview, history and industry perspective; working principles; mechanics and dynamics, thermofluid engineering; scaling law; microactuators, microsensors and microelectromechanical systems; microsystem design, modeling and simulation; materials; packaging; microfabrication: bulk, surface, LIGA etc; micromanufacturing; microfludidics; microrobotics; case studies.

DE* ZG511 Mechatronics 5

Concepts of measurement of electrical and non-electrical parameters; displacement, force, pressure etc. and related signal conditioning techniques, drives and actuators, concepts of microprocessors/ microcontrollers architecture and programming, memory and I/O interfacing. System design concepts through case studies.

DE* ZG512 Finite Element Methods 5

Element properties, Isoparametric elements, Finite element methods and analysis, Applications in design including continuum mechanics, Dynamic systems, Heat conduction and Electrical potentials, etc. will be taken up.

DE* ZG614 Fracture Mechanics 5

Introduction, energy release rate, stress intensity factor and complex cases, anelastic deformation at the crack tip, elastic plastic analysis through J-integral, crack tip opening displacement, test methods, fatigue failure, numerical analysis, mixed mode crack initiation and growth.

DE* ZG515 Computational Fluid Dynamics 5

Philosophy of computational fluid dynamics (CFD), governing equations of fluid dynamics, mathematical behavior of partial differential equations, basics of the numerics : basic aspects of discretization, grids with appropriate transformations, and simple CFD techniques, applications, numerical solutions of quasi-one-dimensional nozzle flows, numerical solution of a two-dimensional supersonic flow, incompressible couette flow, and supersonic flow over a flat plate, advanced topics in CFD.

DE* ZG521 World-Class Manufacturing 5

The world-class manufacturing challenge, developing a world-class manufacturing strategy, just-in-time, total quality, total employee envolvement, world-class information systems, managing the change, methods and procedures; improved brainstorming methods, using the check-total quality - the first steps, getting people involved, monitoring world-class performance.

DE* G522 Advanced Composites 5

Definition of composite materials; classification; particulates and dispersion hardened composites, continuous and discontinuous fibre reinforced composites, metal-matrix composites, carbon-carbon composites, molecular composites, micro and multilayer composites, theory of reinforcement; reinforcement by continuous and discontinuous fibres, concept of microfibril; effect of orientation and adhesion; mechanical behaviour of composites, stress-strain relationship, strength, fracture thoughness and fatigue; properties of fibre reinforcement and production technology of composites.

DE* ZG523 Project Management 4

Concepts and techniques of project formulation, evaluation and implementation; Project planning and scheduling; Risk management; Time-cost trade off; Resource leveling and allocation; Project monitoring and control; Contract management.

DE* ZG525 Mechanical System Design 5

Concept of system design; modeling of structural and kinematic systems, and determination of system characteristics; reliability of systems; design of machine elements for specified reliability; concepts of optimization; techniques of design optimization for linear and non-linear problems.

DE* ZG663 Concurrent Engineering 5

Introduction of concurrent engineering and need, concurrent engineering tools, advances in design and manufacturing engineering, design for manufacture, design for assembly, rapid prototyping, simulation, concurrent approaches to design, manufacturing and other aspects of engineering.

DE* ZG532 Quality Assurance and Reliability 5

Quality planning and control, economics of quality control, Specifications, tolerances and process capability studies, total quality control concepts in quality circles, quality incentives. Fundamental concepts of reliability engineering, Failure analysis, Reliability versus quality control, Systems reliability evaluation, reliability allocation, maintainability, and designing for reliability. Illustrative examples of design ensuring reliability to be taken up.

DE* ZG535 Advanced Engineering Mathematics 5

Boundary value problems; wave equations; nonlinear partial differential equations; calculus of variations; Eigen value problems; iteration problems including forward and inverse iteration schemes – Graham Schmidt deflation – simultaneous iteration method – subspace iteration – Lanczo's algorithm – estimation of core and time requirements.

DE* ZG541 Product Design 5

Introduction to creative design; user research and requirements analysis, product specifications, Computer Aided Design; standardization, variety reduction, preferred numbers and other techniques; modular design; design economics, cost analysis, cost reduction and value analysis techniques, design for production; human factors in design: anthropometric, ergonomic, psychological, physiological considerations in design decision making; legal factors, engineering ethics and society.

DE ZG542 Machine Tool Engineering 5

Design principles of machine tools; stiffness and rigidity of separate construction elements and their combined behaviour under load; design of stepped and stepless drives; electrical, mechanical and hydraulic drives; design of bearings and sideways; machine tool controls; machine tool dynamics; recent developments in machine tool design.

DE* ZG561 Mechanisms & Robotics 5

Classification of robots & manipulators; fields of application; synthesis of planar & spatial mechanisms; methods of function & path generation; coupler curve synthesis; linkages with open loop; actuators & drive elements; microprocessor application and control of robots.

DE* ZG611 Dynamics & Vibrations 5

Steady and transient Vibration of single and multi degree freedom systems. Systems with distributed mass and elasticity. Non-linear and self-excited vibrations, structural damping, Random vibrations, vibration analysis, vibration control - reduction, isolation and vibration absorbers.

DE* G621 Computer Aided Analysis and Design 5

The course aims at developing complete self reliance in solving analysis & design problems of engineering with the aid of computers. It stresses upon the use of more powerful tools including system planning, simulation and modelling. The student will take up a design project and will work independently on the project guided by the instructor or resource person as and when required. The effort must culminate with a CAAD program and a project report.

DE* ZG631 Materials Technology & Testing 5

Study of characteristics and technology of metals, plastics, rubbers, ceramics, polymers, composites, optical fibres and other modern engineering materials and their application with particular reference to Railways. Destructive and non-destructive testing techniques and their applications in Railways.

DE* ZG641 Theory of Elasticity and Plasticity 5

Basic equations of theory of elasticity; elementary elasticity problems in two and three dimensions; theories of plastic flow; problems in plastic flow of ideally plastic and strain hardening materials; theory of metal forming processes.

EA ZC412 Flexible Manufacturing Systems 4

Introduction CAD/CAM systems, overview of FMS, system hardware and general functions, material handling system, work holding systems, cutting tools and tool management, physical planning of system, software structure functions and description, cleaning and automated inspection, communications and computer networks for manufacturing, quantification of flexibility, human factors in manufacturing, FMS and CIM in action (case studies), justification of FMS, modelling for design, planning and operation of FMS.

EA ZC451 Internetworking Technologies 3

Introduction to internetworking concepts; the internet architecture; goals and key issued related to internet working technologies; design aspects; HTTP and other relevant protocols; agent technology and tools relevant to the internet; techniques of data compression; voice, video, and interactive video-on-demand over the internet; multimedia operating systems and their impact; multimedia networking; mobile computing; internet security, case studies.

EA ZC473 Multimedia Computing 3

Introduction to multimedia; media & data streams; image, video & audio file formats; image & video processing, synthesis of sound signal; image coding & compression, video & audio codes, low bit rate video telephony; audio-visual integration, lip reading, face animation; augmented reality; multimedia search services, content based image & video indexing; access to multimedia, human-machine interfaces, spoken language interface; algorithm vs. architecture based approaches, multimedia processors, performance quantification; case studies, vision 2010.

EBCT ZG511 Overview of e-Business 3

E-Business Environment and Opportunities: Background; E-Business evolution; E-Business environment; Diverse opportunities in E-Business; E-Businesses on the Internet. Categories of E-Business - B2B/E2EI, B2C, C2C; Overview of E-Business implementation technologies. E-Business Models - Enterprise portal, CRM, ERP, Supply Chain Planning (SCP), Transport Management System (TMS), Warehouse Management System (WMS), Content Management. E-Business Products- Development products; integration products; generic tools; performance analyzer tools; content management tools; component generator tools. Electronic Transaction and Security – Online payment system and security issues; Secure Transport Protocols, Secure Transactions, Secure Electronic Payment Protocol (SEPP), Secure Electronic Transaction (SET); Security features – certificates for authentication (SSL, third party certifications); security on Web servers and Enterprise Network. Emerging E-Businesses Scenario- Changing economic considerations; Emerging business opportunities and revenue models; emerging technologies; Social aspects.

ED* ZC113 Probability and Statistics 3

Probability spaces; conditional probability and independence; random variables and probability distributions; marginal and conditional distributions; independent random variables; mathematical expectation; mean and variance; binomial, Poisson and normal distributions; sum of independent random variables; law of large numbers; central limit theorem (without proof); sampling distribution and test for mean using normal and student's t-distribution; test of hypothesis; correlation and linear regression.

ED* ZC164 Computer Programming 4

Basic Computing Steps and Flow Charting (Assignment, Sequencing, Conditionals, Iteration). Programming Constructs – Expressions, Statements, Conditionals, Iterators/Loops, Functions/ Procedures; Data Types – Primitive Types, Tuples, Choices (Unions or Enumerations), Lists/Arrays, Pointers and Dynamically Allocated Data. Input output and Files. Laboratory Component: Programming Exercises involving development and testing of iterative and procedural programs using bounded and unbounded iterations, function composition, random access lists, sequential access lists, dynamically allocated lists, and file access.

ED* ZC211 Electrical & Electronics Technology 3

Electric circuit, electromagnetism, magnetic circuit, electrostatics, AC voltage and current, single-phase circuits, semiconductor devices, amplifiers, digital systems, microprocessors, DC machines, polyphase circuits, transformers, synchronous machines, induction motors, power electronics, measurements, illumination.

ED* ZC231 Principles of Management 3

Fundamental concepts of management - planning; organizing; staffing; directing and controlling; production, financial, personnel, legal and marketing functions; accounting and budgeting, balance sheets.

ED* ZC232 Engineering Materials 3

Mechanical, electrical, electronic and chemical properties and applications of common engineering materials; ferrous and non- ferrous metals and alloys; thermosetting and thermoplastic plastics; natural and synthetic resins; rubber; glass; abrasives and ceramics; common building materials, namely, timber, stone, lime and cement; corrosion of metals and methods of preventing corrosion; protective and decorative coatings; insulating materials; testing of materials.

ED* ZC233 Calculus 4

Limits, continuity, differentiation, integration, Fourier series, ordinary differential equations for initial and boundary value problems, solution through Laplace transforms, numerical solution using Picard's iteration and higher order methods, partial derivatives, partial differential equations, analytical solution techniques.

ED* ZC235 Linear Algebra & Optimization 3

Vector and matrix algebra, systems of linear algebraic equations and their solutions; eigenvalues, eigenvectors and diagonalization of matrices; Formulation of linear programming problems, Simplex method, Big-M method, Two phase method, Sensitivity analysis, Revised and Dual Simplex Methods.

ED* ZC241 Technical Report Writing 3

Elements of effective writing; art of condensation; business letter writing; memos; formal reports; technical proposals; conducting, and participating, meetings; agenda and minutes; strategies for writing technical descriptions, definitions, and classifications; oral presentation; use of graphic and audio- visual aids; editing.

ED* ZC245 Fluid Mechanics and Machines 4

Introduction and fundamental concepts, fluid statics, kinematics and dynamics of fluid flow, inviscid flows, pipe flow and network design, open channel flow, incompressible viscous flow, laminar boundary layers, turbulent flows, essentials of compressible flow, dimensional and model analysis, orifice, venturi, notches and weirs, hydraulic turbines, centrifugal and reciprocating pumps, fluid couplings and torque convertors, compressors.

ED* ZC251 Engineering Measurements 3

Performance characteristics of measuring instruments, measurement methods for mechanical, electrical, radiant, chemical, magnetic and thermal energy variables. Emphasis in this course shall be on the operation and use of instruments.

ED* ZC261 Mechanical Technology 3

Fundamental concepts of heat, work and energy; second law of thermodynamics; properties of gases and vapors; basic cycles; flow of liquids; steam boilers; steam engines and pumps; steam turbines and condensers; hydraulic pumps and turbines; internal combustion engine.

ED* ZC311 Manufacturing Process 3

Fundamentals of casting process; forging; powder metallurgy; soldering; brazing and welding technology; metal forming process, its analysis and design; Introduction to Metal cutting, machine tools; mechanics of metal cutting; other machining processes; grinding and finishing operations; non convention machining; chipless machining

processes; NC machines programming; control system in CNC; CNC, DNC; FMS and machining center.

ED* ZC321 Mechanics of Solids 3

Fundamental principles of mechanics; introduction of mechanics of deformable bodies; forces and moments transmitted by slender members; stress and strain; stress-strain-temperature relations; torsion; stresses and defections due to bending; stability of equilibrium.

ED* ZC324 Mechatronics & Automation 4

Mechatronics design approaches, interfacing, instrumentation and control systems, modeling of mechanical and electromechanical systems, sensors and actuators, introduction to automation, pneumatics and hydraulics in automation, pneumatic circuits for automation, PLC programming and interfacing with pneumatic and hydraulic systems, introduction to MEMS, modeling and simulation of MEMS, CNC machines, automated material handling, introduction to FMS.

ED* ZC322 Kinematics & Dynamics of Machines 3

Kinematics of mechanism: introduction to mechanisms, position, displacement, velocity, acceleration analysis, cam design, gear trains, synthesis of linkages. Dynamics of machines: static force analysis, dynamic force analysis (planar), dynamics of reciprocating engines, balancing, cam dynamics, flywheels, governors and gyroscopes, free and forced vibrations.

ED* ZC332 Mechanical Engineering Design I 4

Introduction to mechanical engineering design, stress and strain, deflection and stiffness, introduction to materials and manufacturing, failures resulting from static loading, failures resulting from variable loading, design of mechanical elements: screws, fasteners, permanent joints, nonpermanent joints and mechanical springs. Practice of machine part and assembly drawings using Pro/Engineer or similar solid modeling environment.

ED* ZC342 Mechanical Engineering Design-II 4

Lubrication and journal bearings, rolling contact bearings, introduction to gearing, spur helical, bevel and worm gears, clutches, brakes, couplings, flywheels, belts, chains, wire rope, shafts and axles. Practice of machine part and assembly drawings using Pro/Engineer or similar solid modeling environment.

ED* ZC421 Fluid Power Engineering 3

Course description to be developed.

ED* ZC423 Polymer Science and Engineering 3

Course description to be developed.

ED* ZC423T Project Work 20

Consistent with the student's professional background and work-environment, the student will be required to carry out work-oriented projects. The student would be required to select an area of work that is considered vital to the sponsoring organization. The topic of the project and detailed project outline that is prepared by the student, in consultation with his/her Mentor, needs to be approved by the Dean, WILPD. On approval, the student carries on with the work-centered project, adhering to the guidelines provided in the detailed course handout, taking all the prescribed evaluation components on time. At the end of the semester, the student should submit a comprehensive Project Report, to the Institute for evaluation. The student will be evaluated on the basis of the various interim evaluation components, contents of the report and Seminar/Viva-Voce that may be conducted at Pilani or at any other Centre approved by the Institute.

ED* ZC434, Quality Control, Assurance & Reliability 4

Basic concepts of probability and probability distributions, standard probability distribution, sampling and sampling distributions, confidence intervals, testing significance, statistical tolerance, various types of control charts, statistical process control techniques, value analysis, defect diagnosis and prevention, basic concepts of reliability, reliability design evaluation and control, methods of applying total quality management, production process. Practical assignments on statistical quality control using suitable statistical software tools such as R-software, MS Excel, SAS, Minitab or SPSS.

ED* ZC441 Automotive Vehicles 3

Internal combustion engines; vehicle performance; analysis and design of vehicle components. Experimental or theoretical

investigation of problems selected from the field of automotive vehicles.

ED* ZC452 Composite Materials and Design 4

Introduction to composites, concepts of reinforcement, strengthening mechanisms, fibrous reinforcements, matrix materials, micromechanical aspects of composites, manufacturing methods, composite production design methods design of tensile members, pressure vessels, storage tanks, and other chemical process equipment made of FRP, design of joints, damage of composites by impact, FRP grids, recent development in manufacturing of composites and technologies. Simulation of mechanics of composite materials using suitable software tools.

ED* ZC453 Product Design & Development 4

Introduction to product design and development, product development planning and process tools, technical and business concerns, understanding customer needs, function modeling, product teardown and experimentation, benchmarking and engineering specifications, product architecture, concept generation, concept selection, concept embodiment, modeling of product metrics, design for X, physical prototypes, physical models and experimentation, robust design, case studies.

ED* ZC454 Reverse Engineering and Rapid Prototyping 4

Introduction to reverse engineering, methodologies and techniques for reverse engineering, reverse engineering hardware and software, selecting reverse engineering system, introduction to rapid prototyping, relationship between reverse engineering and rapid prototyping. Reverse engineering in automotive engineering, aerospace engineering, medical device industry. Legal aspects and barriers for reverse engineering. Practice of virtual and physical rapid prototyping of simple models.

ED* ZC471 Management Information Systems 3

Introduction to Information Systems; Concepts of management, concepts of information, systems concepts; Information Systems and Organizations; decision making process; database systems; data communications; planning, designing, developing and implementing information systems; quality assurance and evaluation of information systems; future developments and their organizational and social implications; decision support system and expert systems.

EDET ZC161 Engineering Mathematics I 3

Limit concept; derivatives of elementary functions and their applications; introduction to ordinary and partial differential equations and initial/boundary value problems. Convergence tests for series; power series and interval of convergence; series solution of differential equations. Approximation and error, interpolation; roots of algebraic and transcendental functions, Newton's method.

EDET ZC162 Engineering Mathematics II 3

Algebra of vectors and matrices; Gauss's row-reduction process; applications of simultaneous linear equations and matrix inversion; determinants and Cramer's rule. Numerical differentiation and integration; numerical methods for solving ordinary and partial differential equations.

EDET ZC211 Electrical & Electronics Technology 3

Electric circuit, electromagnetism, magnetic circuit, electrostatics, AC voltage and current, single-phase circuits, semiconductor devices, amplifiers, digital systems, microprocessors, DC machines, polyphase circuits, transformers, synchronous machines, induction motors, power electronics, measurements, illumination.

EDET ZC231 Principles of Management 3

Fundamental concepts of management - planning; organizing; staffing; directing and controlling; production, financial, personnel, legal and marketing functions; accounting and budgeting, balance sheets.

EDET ZC232 Engineering Materials 3

Mechanical, electrical, electronic and chemical properties and applications of common engineering materials; ferrous and non- ferrous metals and alloys; thermosetting and thermoplastic plastics; natural and synthetic resins; rubber; glass; abrasives and ceramics; common building materials, namely, timber, stone, lime and cement; corrosion of metals and methods of preventing corrosion; protective and decorative coatings; insulating materials; testing of materials.

EDET ZC241 Technical Report Writing 3

Elements of effective writing; art of condensation; business letter writing; memos; formal reports; technical proposals; conducting, and participating, meetings; agenda and minutes; strategies for writing technical descriptions, definitions, and classifications; oral presentation; use of graphic and audio- visual aids; editing.

EDET ZC242 Fluid Mechanics and Machines 3

Introduction and fundamental concepts, fluid statics, kinematics and dynamics of fluid flow, inviscid flows, pipe flow, open channel flow, incompressible viscous flow, laminar boundary layers, turbulent flows, essentials of compressible flow, dimensional analysis and similitude, flow measurements, hydraulic turbines, pumps and fluid couplings, compressors.

EDET ZC251 Engineering Measurements 3

Performance characteristics of measuring instruments, measurement methods for mechanical, electrical, radiant, chemical, magnetic and thermal energy variables. Emphasis in this course shall be on the operation and use of instruments.

EDET ZC311 Manufacturing Process 3

Fundamentals of casting process; forging; powder metallurgy; soldering; brazing and welding technology; metal forming process, its analysis and design; Introduction to Metal cutting, machine tools; mechanics of metal cutting; other machining processes; grinding and finishing operations; non convention machining; chipless machining processes; NC machines programming; control system in CNC; CNC, DNC; FMS and machining center.

EDET ZC312 Computer Programming 3

Elementary computer organization; introduction to Number Systems; Representation of integers, real numbers and characters on computers; concept of range and accuracy; Arithmetic Overflow; Algorithms and algorithm development; structured program development through step wise refinement. Introduction to C language; Functions; Recursion; Data structure & algorithms; File management & file handling; Problem solving using C.

EDET ZC321 Mechanics of Solids 3

Fundamental principles of mechanics; introduction of mechanics of deformable bodies; forces and moments transmitted by slender members; stress and strain; stress-strain-temperature relations; torsion; stresses and defections due to bending; stability of equilibrium.

EDET ZC322 Kinematics & Dynamics of Machines 3

Kinematics of mechanism: introduction to mechanisms, position, displacement, velocity, acceleration analysis, cam design, gear trains, synthesis of linkages. Dynamics of machines: static force analysis, dynamic force analysis (planar), dynamics of reciprocating engines, balancing, cam dynamics, flywheels, governors and gyroscopes, free and forced vibrations.

EDET ZC331 Optimization 3

Optimization of functions of one and many variables with and without constraints; Kuhn-Tucker conditions; gradient methods; linear programming; simplex based and integer programming methods; duality theory; transportation and assignment problems; dynamic programming; branch and bound methods; models of linear production systems, sequencing and scheduling, PERT, CPM.

EDET ZC332 Mechanical Engineering Design I 3

Introduction to mechanical engineering design, stress and strain, deflection and stiffness, introduction to materials and manufacturing, failures resulting from static loading, failures resulting from variable loading, design of mechanical elements: screws, fasteners, permanent joints, nonpermanent joints and mechanical springs.

EDET ZC341 Thermal Engineering I 3

Introduction, temperature, work and heat transfer, first law, second law, entropy applications, properties of pure substances, vapour and gas power cycles, internal combustion engines, refrigeration cycles, psychrometrics and air-conditioning, elements of heat transfer.

EDET ZC342 Thermal Engineering II 3

Thermal power plants, hydroelectric power plants, nuclear power plants, gas turbine and diesel power plants, non-conventional power generation and analysis.

EDET ZC421 Fluid Power Engineering 3

Course description to be developed.

EDET ZC422 Polymer Science and Engineering 3

Course description to be developed.

EDET ZC423T Project Work 20

Consistent with the student's professional background and work-environment, the student will be required to carry out work-oriented projects. The student would be required to select an area of work that is considered vital to the sponsoring organization. The topic of the project and detailed project outline that is prepared by the student, in consultation with his/her Mentor, needs to be approved by the Dean, WILPD. On approval, the student carries on with the work-centered project, adhering to the guidelines provided in the detailed course handout, taking all the prescribed evaluation components on time. At the end of the semester, the student should submit a comprehensive Project Report, to the Institute for evaluation. The student will be evaluated on the basis of the various interim evaluation components, contents of the report and Seminar/Viva-Voce that may be conducted at Pilani or at any other Centre approved by the Institute.

ET ZC434, Quality Control, Assurance & Reliability 4

Basic concepts of probability and probability distributions, standard probability distribution, sampling and sampling distributions, confidence intervals, testing significance, statistical tolerance, various types of control charts, statistical process control techniques, value analysis, defect diagnosis and prevention, basic concepts of reliability, reliability design evaluation and control, methods of applying total quality management, production process. Practical assignments on statistical quality control using suitable statistical software tools such as R-software, MS Excel, SAS, Minitab or SPSS.

EDET ZC431 Mechanical Engineering Design II 3

Lubrication and journal bearings, rolling contact bearings, introduction to gearing, spur helical, bevel and worm gears, clutches, brakes, couplings, flywheels, belts, chains, wire rope, shafts and axles.

EDET ZC432 Quality Control Assurance and Reliability 3

Basic concepts of probability and probability distributions, standard probability distribution, sampling and sampling distributions, confidence intervals, testing significance, statistical tolerance, various types of control charts, statistical process control techniques, value analysis, defect diagnosis and prevention, basic concepts of reliability, reliability design evaluation and control, methods of applying total quality management, production process.

EDET ZC441 Automotive Vehicles 3

Internal combustion engines; vehicle performance; analysis and design of vehicle components. Experimental or theoretical investigation of problems selected from the field of automotive vehicles.

EDET ZC451 Product Design & Development 3

Introduction to product design and development, product development planning and process tools, technical and business concerns, understanding customer needs, function modeling, benchmarking and engineering specifications, product architecture, concept generation, concept selection, concept embodiment, modeling of product metrices, design for X, physical prototypes, physical models and experimentation, robust design.

EE* ZG511 Environmental Chemistry 5

Fundamentals of Physical Chemistry, Water Chemistry, Water pollution, Green Chemistry, Fundamentals of Analytical Chemistry, Atmospheric Chemistry and air pollution, Energy and climate change, Toxic compounds, Metals, soils, sediments and waste disposal, Case studies

EE* ZG512 Environmental Biotechnology 5

Principles, concepts and applications of Biotechnology to the management of environmental problems, Microbial technologies for waste management, Bioremediation of toxicants, Microbial systems for detoxification, Microbial technologies for waste management, Biochemical kinetics and engineering, Concept of rDNA technology, Regulation and ethics

EE* ZG515 Environmental Management Systems 5

Study of environmental policies, Environmental laws, Environmental regulations and permit

procedures; ISO series; Life Cycle analysis; Environmental audit; Environmental impact assessment, Risk assessment, Hazardous waste management, Integrating environmental and safety management; Case studies.

EE* ZG513 Applied Transport Phenomena 5

Introduction to fluid, heat and mass transport, Newton's laws of viscosity, Fourier's laws of heat conduction, Fick's laws of diffusion, Continuity equation, Concept of laminar and turbulent flow, Convective heat and mass transfer, Introduction to transport equations for fluid, heat and mass transport, Sedimentation, Packed beds, Fluidization, Pumps and compressors, Piping networks, Heat and mass transfer equipment related to environmental systems, Dimensionless numbers and their significance

EE* ZG514 Environmental Sampling and analytical methods 5

Principles of sample collection and data analysis / interpretation, Gravimetric methods, titrimetric methods, electrochemical methods, Spectrometric methods of analysis, Chromatographic methods of analysis, Sampling techniques for air and water pollution, Biological methods of analysis, Interpretation of data in environmental monitoring

EE* ZG521 Physico – Chemical treatment principles & design for wastewater systems 4

Pollutant classification, Source selection process, Selection of treatment chain, Plant siting, Physical treatment methods like screening, sedimentation, filteration, etc., Chemical treatment principles like precipitation, coagulation, ozonation etc., adsorption, Novel processes like membranes, electrodialysis, etc., Design of physico-chemical systems for wastewater treatment, Case studies.

EE* ZG522 Biological treatment principles & design for wastewater systems 4

Fundamentals of biological treatment, Biochemistry and kinetics of biochemical processes like oxidation, nitrification & denitirification, Dephosphatization, Acedogensis and methogenasis, Aerobic and anaerobic treatment processes, Basic description of equipment and design methodologies, Design of reactors and configurations; Case studies for industrial and wastewater treatment.

EE* ZG523 Environmental Statistics 4

Introduction to probability and Statistics, Probability concepts and probability distributions, Fundamentals of data analysis, Uncertainty in Measurement, Precision and accuracy, Reproducibility/repeatability, Types of errors, Error propagation, Confidence intervals, Hypothesis testing for equality of mean and standard deviation: t-test, chi-square test and F-test, Errors in hypothesis testing, Experiment design and analysis of variances, Autocorrelation, cross-correlation and sensitivity analysis in data sets, Linear least-squares regression. Precision of parameter estimates, Coefficient of determination; Interpreting statistical results, documentation and recommendations, Theory of attributes, Time series analysis, Case studies

EE* ZG532 Pumps and Automation Systems 4

Pumps and Pumping stations: Need of pumping, classification and type of pumps, Pumping power, Head and capacity of pump, site selection pump specification and selection; Distribution system: Type of distribution system, different layout of distribution system, methods of supplying water, pressures in distribution system, distribution resources and its capacity, type of reservoirs & accessories; Valves and Fittings: Different type of valves, hydrants, meters, stop cock & water tap, pipe fittings, leakage & waste of water factors, affecting losses & wastes. Introduction to Automation: Sensors and actuators for pumping, basic control concepts, micro controllers and PLC's, Introduction to SCADA and HMI interface; Pump Drivers: Basics of AC motors, Types, Starting methods, types coupling, motor and coupling selection; Water Automation systems: Automatic switching systems, control of Submersible Pumps, timer based control, level based control, Tank to Tank Flow Automation System.

EE* ZG533 Industrial Pollution Abatement 4

Different types of wastes generated in an industry, their effects on living and non-living things; environmental regulatory legislations and standards and climate changes; quantification and analysis of wastewater and treatment; different unit operations and unit processes involved in conversion of highly polluted water to potable standards; atmospheric dispersion of air pollutants, and operating principles, design

calculations of particulate control devices; analysis and quantification of hazardous and non-hazardous solid wastes, treatment and disposal.

EE* ZG534 Urban Water Management 4

The urban water cycle (description, social imperatives, environmental considerations, and economic challenges); water supply (availability, service levels, and technical options); free basic water, demand management, loss control, use of recycled water; sewage (public health considerations, service levels and technical options, the dry-versus-wet sanitation debate, social acceptance, and grey water management); drainage (service levels and technical options, sustainable urban drainage systems (SUDS), urban litter management, urban rivers, risk management, and groundwater issues); management (water sensitive urban design, introduction to asset management, GIS as a water management tool, and sustainability indicators).

EE* ZG611 Energy generation and management in waste treatment Plants 4

Energy audit and minimization in waste treatment facilities; Novel energy conservation technologies, Estimation of energy potential of waste; Selection of energy generation technologies coupled with waste treatment, e.g. incinerators, pyrolysis units, bio-digesters and purification and enrichment of off gases from these units; Utilization of fuel & fertilizer value of gases & liquids from bio-digesters and pyrolysis units; Energy generation from waste sludge.

EE* ZG612 Environmental remote sensing and GIS 4

Principles of remote sensing, Components of GIS: Hardware, Software and Organization Context, Types of Maps; Spatial and Non Spatial, Types of Projections, Editing the Raster and Vector data structures, Analysis using raster and Vector Data, Data Retrieval, Data Reclassification, Data Overlaying and Buffering; Data Output; Pollution data gathering in GIS area under consideration through terrestrial and aerial stations, unmanned aerial vehicles (UAV) equipped with imaging and spectroscopic probes; Pollution mapping coupled to GIS through wireless network; Water body pollution monitoring instruments coupled to GIS through wireless network, Thermal and microwave remote sensing, Space imaging, Case studies on various applications of GIS for environmental management.

EE* ZG613 Environmental systems modeling 4

Introduction to air quality models, Atmospheric stability and turbulence, Gaussian dispersion models, single source and multisource models, Transport and fate of pollutant in aquatic systems, Introduction to modeling of river, lake and estuarine hydrodynamics, Stratification and eutrophication of water bodies, Dissolved oxygen model for water streams, Computational methods in environmental modeling and simulation, Transport and fate of pollutants in soils and ground water, Applications of public domain models and software; Case studies.

EE* ZG614 Air Pollution Control Technologies4

Introduction to air pollution, Atmospheric diffusion of air pollutants, Particulate control, Gaseous pollutant control, Methods for monitoring and control, Selection and design of control equipments, Meteorological aspects of air pollution, Applications and case studies

EE* ZG621 Solid Waste Management 4

Introduction to solid waste management: Sources and classification, Composition and Properties of Solid Waste and emerging e-waste, Onsite handling, storage and processing including segregation, Collection of solid waste, Transfer and transport, Recycling, Incineration pyrolysis and composting, Processing technique and equipment, Recovery of resources, conversion products, and energy, Biomedical and hazardous waste, Electronic waste, Regulatory framework, categorization, generation, collection, transport, treatment and disposal, Leacheate collection and treatment, Bioleaching and bioremediation; Case studies

EE* ZG622 Environmental Process Engineering 4

Origin, Nature and composition of solid, liquid and gaseous emissions from various processes in Industries, institutions and human habitats, Assessment of pollution potential through study of process chemistry and process engineering, Understanding block flow diagrams (BFD), Process Flow Diagrams (PFD) and Piping and Instrumentation Diagram (P&ID) and Process Pollution Flow Diagram (PPFD), Maximum Attainable Control Technologies (MACT) and Best Available Control Technologies (BACT), Reasonably Available Control Technology (RACT) and Lowest Attainable Emission Rate (LAER), List

of equipment and processes for BACT/RACT/LAER and their description, Estimating thermo-physical and thermodynamic data for pollutants, Use of software in Environmental Process Engineering Equipment design and datasheet generation, Technical audit of Existing process technology, Environmental carrying capacity calculations; Interpretation of field/on-site and laboratory data, Case studies.

EE* ZG623 Environmental Impact and Risk Assessment 4

Introduction to Environmental Impact Assessment (EIA), Environmental assessment framework, Impact assessment methodologies; Air and water quality Impact analysis (AQIA / WQIA), Energy and noise impact analysis (EnIA / NIA), Vegetation, wild life and socio-impact analysis, Environment risk assessment, Environmental Impact statement.

EE* ZG624 Advanced Water Treatment Technology and Water Supply Systems 4

The course will cover estimation of water demand, characterization of water quality (physical, chemical and biological), different unit operations for treatment of water (screening, sedimentation, coagulation, filtration, disinfection etc.), nature of emerging contaminants (types of contaminants and sources, physical & chemical characteristics and their health hazard), advanced techniques for water purification (includes advanced process such as reverse osmosis, desalinization process, membrane filtration etc., and advanced material such as nanomaterial, composite material etc.), water distribution system, pumping at the mains, water leakage and their detection, water auditing.

EE* ZG625 Advanced Wastewater Engineering 4

The course will cover design of sewer system (including pumping of swage, sewer hydraulic, layout and construction), Characterization of waste (physical, chemical and biological characteristics), Natural attenuation, Wastewater unit operation (preliminary treatment, secondary or biological treatment), Sludge disposal, Industrial waste and their characterization (physical, chemical characteristics, health hazard), Advanced wastewater treatment (nature of waste, application of nanotechnology, biotechnology, and other advanced material etc.), Solid waste management (source and nature of waste, disposal method, recycle and reuse, guideline and legislation); Water and wastewater sampling and laboratory analysis.

EEE ZG512 Embedded System Design 4

Introduction to embedded systems; embedded architectures: Architectures and programming of microcontrollers and DSPs. Embedded applications and technologies; power issues in system design; introduction to software and hardware co-design.

EMMM ZC471 Management Information Systems 3

Introduction to Information Systems; Concepts of management, concepts of information, systems concepts; Information Systems and Organizations; decision making process; database systems; data communications; planning, designing, developing and implementing information systems; quality assurance and evaluation of information systems; future developments and their organizational and social implications; decision support system and expert systems.

EMMM ZG511 Manufacturing Organization and Management 5

Manufacturing environment; Engineering considerations; Design and planning of manufacturing systems; Manufacturing cost control; Material flow control; Quality; Human resources; Financial management; Marketing management.

EMMM ZG523 Project Management 4

Concepts and techniques of project formulation, evaluation and implementation; Project planning and scheduling; Risk management; Time-cost trade off; Resource leveling and allocation; Project monitoring and control; Contract management.

EMMM ZG621 Supply Chain Management 4

Customer driven strategies in production and distribution systems; Integrated production and distribution networks; SCM in the context of JIT and MRP–II; Distribution Resource Planning; Management of dealer networks; Total Control & Product innovation across the supply chain; Incoming logistics and supplier relationships; Value addition analysis; Metrics for management of supply chain performance; Mathematical

models and computer assisted decision support for SCM; Mathematical programming for SCM.

EMMM ZC441 Human Resource Management 4

Introduction, manpower planning, career and succession planning, procurement of personnel, performance appraisal, job satisfaction and morale, job rotation, employee communication, audit and control, management training and development, wage and salary administration, welfare administration, trade unions and collective bargaining, industrial dispute and worker participation in management.

EMMM ZG521 Financial Management 4

Concepts and techniques of financial management decision; concepts in valuation - time value of money; valuation of a firm's stock, capital asset pricing model; investment in assets and required returns; risk analysis; financing and dividend policies, capital structure decision; working capital management, management of cash, management of accounts receivable; inventory management, short and intermediate term financing, long term financial tools of financial analysis, financial ratio analysis, funds analysis and financial forecasting, operating and financial leverages.

EMMM ZG538 Toyota Production System 5

Birth of Toyota production system, house of Toyota production system, stability, standardization, just-in-time,jidoka, involvement, hoshin planning, Toyota culture, Toyota way, Case Studies.

EMMM ZG541 Product Design 5

Introduction to creative design; user research and requirements analysis, product specifications, Computer Aided Design; standardization, variety reduction, preferred numbers and other techniques; modular design; design economics, cost analysis, cost reduction and value analysis techniques, design for production; human factors in design: anthropometric, ergonomic, psychological, physiological considerations in design decision making; legal factors, engineering ethics and society.

EMMM ZC411 Marketing 4

Definition and scope, consumer behavio, competitive behavior, demand estimation, new product introduction, product/brand management, pricing policies, channels of distribution, credit management, advertising and other sales promotion, positioning, marketing regulation, market research basics of industrial marketing.

EMMM ZG531 Mechatronics 5

Concepts of measurement of electrical and nonelectrical parameters; displacement, force, pressure etc. and related signal conditioning techniques, drives and actuators, concepts of microprocessors/ microcontrollers architecture and programming, memory and I/O interfacing. System design concepts through case studies.

EMMM ZG532 Quality Assurance & Reliability 5

Quality planning and control, economics of quality control, Specifications, tolerances and process capability studies, total quality control concepts in quality circles, quality incentives. Fundamental concepts of reliability engineering, Failure analysis, Reliability versus quality control, Systems reliability evaluation, reliability allocation, maintainability, and designing for reliability. Illustrative examples of design ensuring reliability to be taken up.

EMMM ZG611 Strategic Management & Business Policy 4

Strategic management elements; internal, external, external environment. assessment of corporate strengths, weaknesses and opportunities; planning and deployment of capital assets; profit planning and control functions problems, pressures, responsibilities, limits of the chief executive; evaluation of one's own business undertaking; formulating objectives, strategies, policies and programmes for improving company’s present situation; personnel strength and implementation of the policies and programmes, development, implementation, evaluation and control of strategies, strategic management of MNCs, management style and behavior, corporate style, behavior and culture.

EMMM ZG629T Dissertation 20

A student registered in this course must take a topic in an area of professional interest drawn from the on the job work requirement which is simultaneously of direct relevance to the degree pursued by the student as well as to the employing / collaborating organization of the student and submit a comprehensive report at the end of the semester working under the overall supervision and guidance of a professional expert

who will be deemed as the supervisor for evaluation of all components of the dissertation. Normally the Mentor of the student would be the Dissertation supervisor and in case Mentor is not approved as the supervisor, Mentor may play the role of additional supervisor. The final grades for dissertation are Non-letter grades namely Excellent, Good, Fair and Poor, which do not go into CGPA computation.

ENGG ZC111 Electrical & Electronics Technology 3

Electric circuit, electromagnetism, magnetic circuit, electrostatics, AC voltage and current, single-phase circuits, semiconductor devices, amplifiers, digital systems, microprocessors, DC machines, polyphase circuits, transformers, synchronous machines, induction motors, power electronics, measurements, illumination.

ENGG ZC232 Engineering Materials 3

Mechanical, electrical, electronic and chemical properties and applications of common engineering materials; ferrous and non- ferrous metals and alloys; thermosetting and thermoplastic plastics; natural and synthetic resins; rubber; glass; abrasives and ceramics; common building materials, namely, timber, stone, lime and cement; corrosion of metals and methods of preventing corrosion; protective and decorative coatings; insulating materials; testing of materials.

ENGG ZC241 Mechanical Technology 3

Fundamental concepts of heat, work and energy; second law of thermodynamics; properties of gases and vapors; basic cycles; flow of liquids; steam boilers; steam engines and pumps; steam turbines and condensers; hydraulic pumps and turbines; internal combustion engine.

ENGG ZC242 Maintenance & Safety 3

Objectives, functions, and types of maintenance; defects due to wear; lubrication and surfacing techniques to reduce wear; maintenance of different equipments and their elements; spares planning; overhauling; TPM; safety and safety management; environmental safety; chemical safety; occupational health management; control of major industrial hazards; managing emergencies; employee participation in safety; HRD for maintenance and safety.

ES ZC261 Digital Electronics and Microprocessors 3

Binary logic gates; logic circuits; Boolean algebra and K-map simplification; number systems and codes; arithmetic logic units; flipflops; registers and counters; introduction to microprocessors; architecture; instruction set and programming; memory and I/O interfacing examples of system design.

ES ZC343 Microprocessors & Microcontollers 3

Introduction to microprocessors and microcontrollers. Architecture of 8086 microprocessor; Assembly directives, Assembly language programs with algorithms, Memory interfacing and timing diagrams; Architecture of 8-bit microcontrollers; Assembly language programming for microcontrollers; Interfacing I/O devices; System design examples.

ESET ZC511 Mechatronics 3

Basic Electricity – electrical parameters like voltage, current, resistance, AC/DC supply: electrical circuit; electromagnetism, its circuits, introduction to single phase and three phase supply, electrical components – relays, MCB, limit switches etc; transformers; elimination; electrical motors – types like induction motors, synchronous machines etc;, its speed control; introduction to electronic devices; semiconductor devices; SCRs, electronic circuits – power supplies, sensing devices; timers; industrial electronics and its application for heating, measuring / gauging etc., Introduction and application of PLCs; introduction to microprocessors; application in an industry Oil hydraulics; fluid logics; hydraulic elements like reservoir, fluid conditioners, pressure control valves, directional control valves and flow control valves; Basic hydraulic circuits for application in machine tools; Pneumatics, its principle, logics, pneumatic elements, basic pneumatic circuits used in machine tools.

ESET ZC424 Software for Embedded System 3

Real-time and Embedded Systems; Software issues in Embedded Systems; Software Development Process; Requirements Analysis– Use Cases, Identification and Analysis of use cases, Use Case Diagrams. Design – Architectural Design, Design Patterns, Detailed Design. Implementation – Languages, Compilers, Runtime Environments and Operating Systems

for embedded software. Testing – Methodologies, Test Cases.

ESET ZG512 Embedded System Design 4

Introduction to embedded systems; embedded architectures: Architectures and programming of microcontrollers and DSPs. Embedded applications and technologies; power issues in system design; introduction to software and hardware co-design.

ESET ZG523 Project Management 4

Concepts and techniques of project formulation, evaluation and implementation; Project planning and scheduling; Risk management; Time-cost trade off; Resource leveling and allocation; Project monitoring and control; Contract management.

ESET ZG525 Avionics Systems 5

Civil avionics systems, fly-by-wire technology, flight control systems, engine control systems, fuel systems, hydraulic systems, electrical systems, pneumatic systems, environmental control systems, navigational systems, emergency systems, rotary wing systems, advanced systems, system design and development, avionics technology, environmental conditions, flight management systems, vehicle health management systems, communication protocols, hardware certification process, software certification process, certification considerations for highly integrated / complex aircraft systems.

ESET ZG531 Pervasive Computing 4

Select application architectures; hardware aspects; human-machine interfacing; device technology: hardware, operating system issues; software aspects, java; device connectivity issues and protocols; security issues; device management issues and mechanisms; role of web; wap devices and architectures; voice-enabling techniques; PDAs and their operating systems; web application architectures; architectural issues and choices; smart card-based authentication mechanisms; applications; issues and mechanisms in WAP-enabling; access architectures; wearable computing architectures.

ESET ZG553 Real Time Systems 5

Real time software, Real time operating systems-scheduling, virtual memory issues and file systems, real time data bases, fault tolerance and exception handling techniques, reliability evaluation, data structures and algorithms for real time/embedded systems, programming languages, compilers and run time environment for real time/embedded systems, real time system design, real time communication and security, real time constraints and multi processing and distributed systems.

ESET ZG573 Digital Signal Processing 3

Introduction; design of analog filters; design of digital filters: (IIR and FIR); structures for the realization of digital filters; random signals and random processes; linear estimation and prediction; Wiener filters; DSP processor architecture; DSP algorithms for different applications.

ESET ZG611 Advanced Control Systems 5

Review of State variable modelling of linear continuous, linear discrete and non linear control systems; Time varying systems; Time domain solution; Controllability and observability; Stability; direct method of Lyapunov; Modal control; Optimal Control System; Calculus of variation, Minimum principle, dynamic programming, search techniques, Ricatti equation, Stochastic processes and Stochastic estimation and control; Adaptive Control system.

ESET ZG612 Fault Tolerant System Design 5

Principles of fault tolerant systems, redundancy, parallel and shared resources, spatial systems, configurations, design aspects etc.

ESET ZG629T Dissertation 20

A student registered in this course must take a topic in an area of professional interest drawn from the on the job work requirement which is simultaneously of direct relevance to the degree pursued by the student as well as to the employing / collaborating organization of the student and submit a comprehensive report at the end of the semester working under the overall supervision and guidance of a professional expert who will be deemed as the supervisor for evaluation of all components of the dissertation. Normally the Mentor of the student would be the Dissertation supervisor and in case Mentor is not approved as the supervisor, Mentor may play the role of additional supervisor. The final grades for dissertation are Non-letter grades namely Excellent, Good, Fair and Poor, which do not go into CGPA computation.

ESET ZG641 Hardware Software Co-Design 4

FPGA and ASIC based design, Low-Power Techniques in RT Embedded Systems On-chip networking. Hardware Software partitioning and scheduling, Co-simulation, synthesis and verifications, Architecture mapping, HW-SW Interfaces and Re-configurable computing.

ESET ZG651 Networked Embedded Applications 4

Networked embedded systems, Clock synchronization, Protocol mechanisms protocol performance, CAN Bus architecture, USB Architecture, Embedded Internet, Distributed computing, Use of Java in building networked systems, Reliability & Fault Tolerance etc. Mission-critical distributed real-time applications, e.g., military, air traffic control; Prototyping benchmark applications, e.g. simulated air traffic visualization, radar display; Networking: TCP/IP, distributed objects; Embedded system programming and middleware: I/O, analog / digital conversion, DSP, runtime monitoring of CPU, processes, network equipment; Modeling distributed real-time systems; Quality of service maintenance.

ESJD ZC424 Software for Embedded System 3

Real-time and Embedded Systems; Software issues in Embedded Systems; Software Development Process; Requirements Analysis– Use Cases, Identification and Analysis of use cases, Use Case Diagrams. Design – Architectural Design, Design Patterns, Detailed Design. Implementation – Languages, Compilers, Runtime Environments and Operating Systems for embedded software. Testing – Methodologies, Test Cases.

ESJD ZC441 Robotics 3

The objective of this course is to make the students familiar with Robotics, the main components of kinematics, sensors, transmission and drives, control systems, intelligence and vision, geometric modelling and reasoning, assembly planning, grasping, collision avoidance, mobile robots, force strategies, uncertainty analysis, and representation of visual world.

ESJD ZG511 Mechatronics 5

Concepts of measurement of electrical and non-electrical parameters; displacement, force, pressure etc. and related signal conditioning techniques, drives and actuators, concepts of microprocessors/ microcontrollers architecture and programming, memory and I/O interfacing. System design concepts through case studies.

ESJD ZG512 Embedded System Design 4

Introduction to embedded systems; embedded architectures: Architectures and programming of microcontrollers and DSPs. Embedded applications and technologies; power issues in system design; introduction to software and hardware co-design.

ESJD ZG523 Project Management 4

Concepts and techniques of project formulation, evaluation and implementation; Project planning and scheduling; Risk management; Time-cost trade off; Resource leveling and allocation; Project monitoring and control; Contract management.

ESJD ZG545 Control and Instrumentation for Systems 5

The regulation and control problem with reference to power electronic converters. Converter models for feedback: basic converter dynamics, fast switching, piece-wise linear models, discrete-time models. Voltage mode and current mode controls for DC-DC converters, comparator based control for rectifier systems, proportional and proportional-integral control applications. Control design based on linearisation: transfer functions, compensation and filtering, compensated feedback control systems. Hysteresis control basics, and application to DC-DC converters and inverters. General boundary control: behaviour near a boundary, and choice of suitable boundaries. Basic ideas of fuzzy control techniques, and performance issues. Sensors for power electronic circuits, speed and torque transducers.

ESJD ZG553 Real Time Systems 5

Real time software, Real time operating systems-scheduling, virtual memory issues and file systems, real time data bases, fault tolerance and exception handling techniques, reliability evaluation, data structures and algorithms for real time/embedded systems, programming languages, compilers and run time environment for real time/embedded systems, real time system design, real time communication and security, real time constraints and multi processing and distributed systems.

ESJD ZG556 DSP Based Control of Electric Drives 3

State space and transfer matrix representations, representation of nonlinear systems by update of parameters, output feedback and state feedback control, basic notion of state estimation. Sampling of signals, discrete representation of signals, z-transforms. Nature of discrete time poles and zeros. A/D and D/A converters as system elements. FIR and IIR behaviour, noise and its nature. AR, MA, and ARMA models of systems. The Fourier transform and what it conveys. Processing requirements of a DSP, floating point DSP's: the TMS320C3x family. Memory organisation, interrupt systems, and I/O interface with the TMS320C3x family. The TMS320C31 as an embedded controller, drive control features. Applications in vector and direct torque control of synchronous motors, vector and direct torque control of induction motors, torque control of SRM's.

ESJD ZG573 Digital Signal Processing 3

Introduction; design of analog filters; design of digital filters: (IIR and FIR); structures for the realization of digital filters; random signals and random processes; linear estimation and prediction; Wiener filters; DSP processor architecture; DSP algorithms for different applications.

ESJD ZG611 Advanced Control Systems 5

Review of State variable modelling of linear continuous, linear discrete and non linear control systems; Time varying systems; Time domain solution; Controllability and observability; Stability; direct method of Lyapunov; Modal control; Optimal Control System; Calculus of variation, Minimum principle, dynamic programming, search techniques, Ricatti equation, Stochastic processes and Stochastic estimation and control; Adaptive Control system.

ESJD ZG629T Dissertation 20

A student registered in this course must take a topic in an area of professional interest drawn from the on the job work requirement which is simultaneously of direct relevance to the degree pursued by the student as well as to the employing / collaborating organization of the student and submit a comprehensive report at the end of the semester working under the overall supervision and guidance of a professional expert who will be deemed as the supervisor for evaluation of all components of the dissertation. Normally the Mentor of the student would be the Dissertation supervisor and in case Mentor is not approved as the supervisor, Mentor may play the role of additional supervisor. The final grades for dissertation are Non-letter grades namely Excellent, Good, Fair and Poor, which do not go into CGPA computation.

ESJD ZG641 Hardware Software Co-Design 4

FPGA and ASIC based design, Low-Power Techniques in RT Embedded Systems On-chip networking. Hardware Software partitioning and scheduling, Co-simulation, synthesis and verifications, Architecture mapping, HW-SW Interfaces and Re-configurable computing.

ESJD ZG651 Networked Embedded Applications 4

Networked embedded systems, Clock synchronization, Protocol mechanisms protocol performance, CAN Bus architecture, USB Architecture, Embedded Internet, Distributed computing, Use of Java in building networked systems, Reliability & Fault Tolerance etc. Mission-critical distributed real-time applications, e.g., military, air traffic control; Prototyping benchmark applications, e.g. simulated air traffic visualization, radar display; Networking: TCP/IP, distributed objects; Embedded system programming and middleware: I/O, analog / digital conversion, DSP, runtime monitoring of CPU, processes, network equipment; Modeling distributed real-time systems; Quality of service maintenance.

ESLT ZC424 Software for Embedded Systems 3

Real-time and Embedded Systems; Software issues in Embedded Systems; Software Development Process; Requirements Analysis – Use Cases, Identification and Analysis of use cases, Use Case Diagrams. Design – Architectural Design, Design Patterns, Detailed Design. Implementation – Languages, Compilers, Runtime Environments and Operating Systems for embedded software. Testing – Methodologies, Test Cases

ESLT ZG511 Mechatronics 5

Concepts of measurement of electrical and non-electrical parameters; displacement, force, pressure etc. and related signal conditioning techniques, drives and actuators, concepts of

microprocessors/ microcontrollers architecture and programming, memory and I/O interfacing. System design concepts through case studies.

ESLT ZG512 Embedded System Design 4

Introduction to embedded systems; embedded architectures: Architectures and programming of microcontrollers and DSPs. Embedded applications and technologies; power issues in system design; introduction to software and hardware co-design.

ESLT ZG523 Project Management 4

Concepts and techniques of project formulation, evaluation and implementation; Project planning and scheduling; Risk management; Time-cost trade off; Resource leveling and allocation; Project monitoring and control; Contract management.

ESLT ZG525 Avionics Systems 5

Civil avionics systems, fly-by-wire technology, flight control systems, engine control systems, fuel systems, hydraulic systems, electrical systems, pneumatic systems, environmental control systems, navigational systems, emergency systems, rotary wing systems, advanced systems, system design and development, avionics technology, environmental conditions, flight management systems, vehicle health management systems, communication protocols, hardware certification process, software certification process, certification considerations for highly integrated / complex aircraft systems.

ESLT ZG533 Reconfigurable Computing 5

Overview of Programmable Logics. FPGA fabric architectures. Logic Elements and Switch Networks. Design and Synthesis of Combinational and Sequential Elements. Placement and Routing. Pipelining and other Design Methodologies. Fine-grained and Coarse-Grained FPGAs. Static and Dynamic Reconfiguration. Partitioning. Hardware/Software Portioning and Partial Evaluation.Systolic Architectures.

ESLT ZG553 Real Time Systems 5

Real time software, Real time operating systems-scheduling, virtual memory issues and file systems, real time data bases, fault tolerance and exception handling techniques, reliability evaluation, data structures and algorithms for real time/embedded systems, programming languages, compilers and run time environment for real time/embedded systems, real time system design, real time communication and security, real time constraints and multi processing and distributed systems.

ESLT ZG573 Digital Signal Processing 3

Introduction; design of analog filters; design of digital filters: (IIR and FIR); structures for the realization of digital filters; random signals and random processes; linear estimation and prediction; Wiener filters; DSP processor architecture; DSP algorithms for different applications.

ESLT ZG611 Advanced Control Systems 5

Review of State variable modelling of linear continuous, linear discrete and non linear control systems; Time varying systems; Time domain solution; Controllability and observability; Stability; direct method of Lyapunov; Modal control; Optimal Control System; Calculus of variation, Minimum principle, dynamic programming, search techniques, Ricatti equation, Stochastic processes and Stochastic estimation and control; Adaptive Control system.

ESLT ZG612 Fault Tolerant System Design 5

Principles of fault tolerant systems, redundancy, parallel and shared resources, spatial systems, configurations, design aspects etc.

ESLT ZG629T Dissertation 20

A student registered in this course must take a topic in an area of professional interest drawn from the on the job work requirement which is simultaneously of direct relevance to the degree pursued by the student as well as to the employing / collaborating organization of the student and submit a comprehensive report at the end of the semester working under the overall supervision and guidance of a professional expert who will be deemed as the supervisor for evaluation of all components of the dissertation. Normally the Mentor of the student would be the Dissertation supervisor and in case Mentor is not approved as the supervisor, Mentor may play the role of additional supervisor. The final grades for dissertation are Non-letter grades namely Excellent, Good, Fair and Poor, which do not go into CGPA computation.

ESLT ZG641 Hardware Software Co-Design 4

FPGA and ASIC based design, Low-Power Techniques in RT Embedded Systems On-chip

networking. Hardware Software partitioning and scheduling, Co-simulation, synthesis and verifications, Architecture mapping, HW-SW Interfaces and Re-configurable computing.

ESLT ZG651 Networked Embedded Applications 4

Networked embedded systems, Clock synchronization, Protocol mechanisms protocol performance, CAN Bus architecture, USB Architecture, Embedded Internet, Distributed computing, Use of Java in building networked systems, Reliability & Fault Tolerance etc. Mission-critical distributed real-time applications, e.g., military, air traffic control; Prototyping benchmark applications, e.g. simulated air traffic visualization, radar display; Networking: TCP/IP, distributed objects; Embedded system programming and middleware: I/O, analog / digital conversion, DSP, runtime monitoring of CPU, processes, network equipment; Modeling distributed real-time systems; Quality of service maintenance.

ESPC ZC421 Computer Networks 3

Introduction, history and development of computer networks; Reference models; Physical Layer: theoretical basis, transmission media, types of transmission; MAC sub-layer: local area networks, FDDI; Data Link Layer: Sliding Window protocols, design aspects; Network Layer: routing algorithms, congestion control algorithms, internetworking; Transport Layer: Integrated Services Digital Network (ISDN), Asynchronous Transfer Mode (ATM) - reference models, service classes, switch design, LAN emulation; Application Layer protocols.

ESPC ZC424 Software for Embedded System 3

Real-time and Embedded Systems; Software issues in Embedded Systems; Software Development Process; Requirements Analysis– Use Cases, Identification and Analysis of use cases, Use Case Diagrams. Design – Architectural Design, Design Patterns, Detailed Design. Implementation – Languages, Compilers, Runtime Environments and Operating Systems for embedded software. Testing – Methodologies, Test Cases.

ESPC ZC446 Data Storage Technologies & Networks 3

Storage Media and Technologies – Magnetic, Optical and Semiconductor media, techniques for read/write operations, issues and limitations. Usage and Access – Positioning in the memory hierarchy, Hardware and Software Design for access, Performance issues. Large Storages – Hard Disks, Networked Attached Storage, Scalability issues, Networking issues. Storage Architecture. - Storage Partitioning, Storage System Design, Caching, Legacy Systems. Storage Area Networks – Hardware and Software Components, Storage Clusters/Grids. Storage QoS – Performance, Reliability, and Security issues.

ESPC ZG512 Embedded System Design 4

Introduction to embedded systems; embedded architectures: Architectures and programming of microcontrollers and DSPs. Embedded applications and technologies; power issues in system design; introduction to software and hardware co-design.

ESPC ZG513 Network Security 4

This course examines issues related to network and information security. Topics include security concepts, security attacks and risks, security architectures, security policy management, security mechanisms, cryptography algorithms, security standards, security system interoperation and case studies of the current major security systems.

ESPC ZG520 Wireless & Mobile Communication 5

Signal propagation in a mobile environment, modulation, coding, equalization; first generation generation systems; multiple access techniques like FDMA, TDMA, CDMA, spread spectrum sytems; second & third generation systems, UMTS, IMT-2000; Wireless LAN, Wireless ATM and Mobile IP; emerging trends in Wireless & Mobile Communication.

ESPC ZG531 Pervasive Computing 4

Select application architectures; hardware aspects; human-machine interfacing; device technology: hardware, operating system issues; software aspects, java; device connectivity issues and protocols; security issues; device management issues and mechanisms; role of web; wap devices and architectures; voice-enabling techniques; PDAs and their operating systems; web application architectures; architectural issues and choices; smart card-based authentication mechanisms; applications;

issues and mechanisms in WAP-enabling; access architectures; wearable computing architectures.

ESPC ZG553 Real Time Systems 5

Real time software, Real time operating systems-scheduling, virtual memory issues and file systems, real time data bases, fault tolerance and exception handling techniques, reliability evaluation, data structures and algorithms for real time/embedded systems, programming languages, compilers and run time environment for real time/embedded systems, real time system design, real time communication and security, real time constraints and multi processing and distributed systems.

ESPC ZG573 Digital Signal Processing 3

Introduction; design of analog filters; design of digital filters: (IIR and FIR); structures for the realization of digital filters; random signals and random processes; linear estimation and prediction; Wiener filters; DSP processor architecture; DSP algorithms for different applications.

ESPC ZG612 Fault Tolerant System Design 5

Principles of fault tolerant systems, redundancy, parallel and shared resources, spatial systems, configurations, design aspects etc.

ESPC ZG629T Dissertation 20

A student registered in this course must take a topic in an area of professional interest drawn from the on the job work requirement which is simultaneously of direct relevance to the degree pursued by the student as well as to the employing / collaborating organization of the student and submit a comprehensive report at the end of the semester working under the overall supervision and guidance of a professional expert who will be deemed as the supervisor for evaluation of all components of the dissertation. Normally the Mentor of the student would be the Dissertation supervisor and in case Mentor is not approved as the supervisor, Mentor may play the role of additional supervisor. The final grades for dissertation are Non-letter grades namely Excellent, Good, Fair and Poor, which do not go into CGPA computation.

ESPC ZG641 Hardware Software Co-Design 4

FPGA and ASIC based design, Low-Power Techniques in RT Embedded Systems On-chip networking. Hardware Software partitioning and scheduling, Co-simulation, synthesis and verifications, Architecture mapping, HW-SW Interfaces and Re-configurable computing.

ESPC ZG651 Networked Embedded Applications 4

Networked embedded systems, Clock synchronization, Protocol mechanisms protocol performance, CAN Bus architecture, USB Architecture, Embedded Internet, Distributed computing, Use of Java in building networked systems, Reliability & Fault Tolerance etc. Mission-critical distributed real-time applications, e.g., military, air traffic control; Prototyping benchmark applications, e.g. simulated air traffic visualization, radar display; Networking: TCP/IP, distributed objects; Embedded system programming and middleware: I/O, analog / digital conversion, DSP, runtime monitoring of CPU, processes, network equipment; Modeling distributed real-time systems; Quality of service maintenance.

ES* ZC424 Software for Embedded Systems 3

Real-time and Embedded Systems; Software issues in Embedded Systems; Software Development Process; Requirements Analysis– Use Cases, Identification and Analysis of use cases, Use Case Diagrams. Design – Architectural Design, Design Patterns, Detailed Design. Implementation – Languages, Compilers, Runtime Environments and Operating Systems for embedded software. Testing – Methodologies, Test Cases.

ES* ZC441 Robotics 3

The objective of this course is to make the students familiar with Robotics, the main components of kinematics, sensors, transmission and drives, control systems, intelligence and vision, geometric modelling and reasoning, assembly planning, grasping, collision avoidance, mobile robots, force strategies, uncertainty analysis, and representation of visual world.

ES* ZC446 Data Storage Technologies & Networks 3

Storage Media and Technologies – Magnetic, Optical and Semiconductor media, techniques for read/write operations, issues and limitations. Usage and Access – Positioning in the memory hierarchy, Hardware and Software Design for access, Performance issues. Large Storages – Hard Disks, Networked Attached Storage,

Scalability issues, Networking issues. Storage Architecture. - Storage Partitioning, Storage System Design, Caching, Legacy Systems. Storage Area Networks – Hardware and Software Components, Storage Clusters/Grids. Storage QoS – Performance, Reliability, and Security issues.

ES* ZC481 Computer Networks 3

Introduction, history and development of computer networks; Reference models; Physical Layer: theoretical basis, transmission media, types of transmission; MAC sub-layer: local area networks, FDDI; Data Link Layer: Sliding Window protocols, design aspects; Network Layer: routing algorithms, congestion control algorithms, internetworking; Transport Layer: Integrated Services Digital Network (ISDN), Asynchronous Transfer Mode (ATM) - reference models, service classes, switch design, LAN emulation; Application Layer protocols.

ES* ZG511 Mechatronics 5

Concepts of measurement of electrical and non-electrical parameters; displacement, force, pressure etc. and related signal conditioning techniques, drives and actuators, concepts of microprocessors/ microcontrollers architecture and programming, memory and I/O interfacing. System design concepts through case studies.

ES* ZG512 Embedded System Design 4

Introduction to embedded systems; embedded architectures: Architectures and programming of microcontrollers and DSPs. Embedded applications and technologies; power issues in system design; introduction to software and hardware co-design.

ES* ZG513 Network Security 4

This course examines issues related to network and information security. Topics include security concepts, security attacks and risks, security architectures, security policy management, security mechanisms, cryptography algorithms, security standards, security system interoperation and case studies of the current major security systems.

ES* ZG514 Mechanisms & Robotics 5

Classification of robots & manipulators; fields of application; synthesis of planar & spatial mechanisms; methods of function & path generation; coupler curve synthesis; linkages with open loop; actuators & drive elements; microprocessor application and control of robots.

ES* ZG520 Wireless & Mobile Communication 5

Signal propagation in a mobile environment, modulation, coding, equalization; first generation generation systems; multiple access techniques like FDMA, TDMA, CDMA, spread spectrum sytems; second & third generation systems, UMTS, IMT-2000; Wireless LAN, Wireless ATM and Mobile IP; emerging trends in Wireless & Mobile Communication.

ES* ZG523 Project Management 4

Concepts and techniques of project formulation, evaluation and implementation; Project planning and scheduling; Risk management; Time-cost trade off; Resource leveling and allocation; Project monitoring and control; Contract management.

ES* ZG524 Real Time Operating Systems 5

Introduction to real-time systems, clock synchronization task assignment and scheduling, programming language with real-time support, ADA, real-time communication protocols, real-time database, fault tolerant techniques, reliability evaluation methods; case studies in real-time operating systems, simulation of real-time systems, embedded system programming.

ES* ZG525 Avionics Systems 5

Civil avionics systems, fly-by-wire technology, flight control systems, engine control systems, fuel systems, hydraulic systems, electrical systems, pneumatic systems, environmental control systems, navigational systems, emergency systems, rotary wing systems, advanced systems, system design and development, avionics technology, environmental conditions, flight management systems, vehicle health management systems, communication protocols, hardware certification process, software certification process, certification considerations for highly integrated / complex aircraft systems.

ES* ZG531 Pervasive Computing 4

Select application architectures; hardware aspects; human-machine interfacing; device technology: hardware, operating system issues; software aspects, java; device connectivity issues and protocols; security issues; device management issues and mechanisms; role of web; wap devices and architectures; voice-

enabling techniques; PDAs and their operating systems; web application architectures; architectural issues and choices; smart card-based authentication mechanisms; applications; issues and mechanisms in WAP-enabling; access architectures; wearable computing architectures.

ES* ZG545 Control & Instrumentation for Systems 5

The regulation and control problem with reference to power electronic converters. Converter models for feedback: basic converter dynamics, fast switching, piece-wise linear models, discrete-time models. Voltage mode and current mode controls for DC-DC converters, comparator based control for rectifier systems, proportional and proportional-integral control applications. Control design based on linearisation: transfer functions, compensation and filtering, compensated feedback control systems. Hysteresis control basics, and application to DC-DC converters and inverters. General boundary control: behaviour near a boundary, and choice of suitable boundaries. Basic ideas of fuzzy control techniques, and performance issues. Sensors for power electronic circuits, speed and torque transducers.

ES* ZG553 Real Time Systems 5

Real time software, Real time operating systems-scheduling, virtual memory issues and file systems, real time data bases, fault tolerance and exception handling techniques, reliability evaluation, data structures and algorithms for real time/embedded systems, programming languages, compilers and run time environment for real time/embedded systems, real time system design, real time communication and security, real time constraints and multi processing and distributed systems.

ES* ZG554 Reconfigurable Computing 5

Overview of Programmable Logics. FPGA fabric architectures. Logic Elements and Switch Networks. Design and Synthesis of Combinational and Sequential Elements. Placement and Routing. Pipelining and other Design Methodologies. Fine-grained and Coarse-Grained FPGAs. Static and Dynamic Reconfiguration. Partitioning. Hardware/Software Portioning and Partial Evaluation.Systolic Architectures.

ES* ZG556 DSP Based Control of Electric Drives 3

State space and transfer matrix representations, representation of nonlinear systems by update of parameters, output feedback and state feedback control, basic notion of state estimation. Sampling of signals, discrete representation of signals, z-transforms. Nature of discrete time poles and zeros. A/D and D/A converters as system elements. FIR and IIR behaviour, noise and its nature. AR, MA, and ARMA models of systems. The Fourier transform and what it conveys. Processing requirements of a DSP, floating point DSP's: the TMS320C3x family. Memory organisation, interrupt systems, and I/O interface with the TMS320C3x family. The TMS320C31 as an embedded controller, drive control features. Applications in vector and direct torque control of synchronous motors, vector and direct torque control of induction motors, torque control of SRM's.

ES* ZG573 Digital Signal Processing 3

Introduction; design of analog filters; design of digital filters: (IIR and FIR); structures for the realization of digital filters; random signals and random processes; linear estimation and prediction; Wiener filters; DSP processor architecture; DSP algorithms for different applications.

ES* ZG611 Advanced Control Systems 5

Review of State variable modelling of linear continuous, linear discrete and non linear control systems; Time varying systems; Time domain solution; Controllability and observability; Stability; direct method of Lyapunov; Modal control; Optimal Control System; Calculus of variation, Minimum principle, dynamic programming, search techniques, Ricatti equation, Stochastic processes and Stochastic estimation and control; Adaptive Control system.

ES* ZG612 Fault Tolerant System Design 5

Principles of fault tolerant systems, redundancy, parallel and shared resources, spatial systems, configurations, design aspects etc.

ES* ZG625 Safety Critical Embedded System Design 4

Architecture / Design practices for Safety critical systems; DO178B standards. Methodology of Certification and Qualifiction for DO178B, Modelling real time systems (UML-RT, and the

tools), Reliable, common system bus – VME, ASCB, SafeBus, MultiBus II etc. Safety critical system busses & protocols, ARINC 429, 629, Mil-1553B & 1773, Ethernet based switched network for safety critical applications, Real time and safety standard and certifications, Reliability Maintainability & Safety of Embedded Systems. FPGA and ASIC based design, Low-Power Techniques in RT Embedded Systems On-chip networking. Hardware Software partitioning and scheduling, Co-simulation, synthesis and verifications, Architecture mapping, HW-SW Interfaces and Re-configurable computing.

ES* ZG641 Hardware Software Co-Design 4

FPGA and ASIC based design, Low-Power Techniques in RT Embedded Systems On-chip networking. Hardware Software partitioning and scheduling, Co-simulation, synthesis and verifications, Architecture mapping, HW-SW Interfaces and Re-configurable computing.

ES* ZG642 VLSI Architecture 4

Overview of CISC processor architectures; Instruction set architecture of CISC processor; hardware flow-charting methods; implementing microprocessor logic from hardware flowcharts; RISC instruction set architecture; pipelined execution of RISC instructions; pipeline execution unit design; control hazards; design of memory hierarchy.

ES* ZG651 Networked Embedded Applications 4

Networked embedded systems, Clock synchronization, Protocol mechanisms protocol performance, CAN Bus architecture, USB Architecture, Embedded Internet, Distributed computing, Use of Java in building networked systems, Reliability & Fault Tolerance etc. Mission-critical distributed real-time applications, e.g., military, air traffic control; Prototyping benchmark applications, e.g. simulated air traffic visualization, radar display; Networking: TCP/IP, distributed objects; Embedded system programming and middleware: I/O, analog / digital conversion, DSP, runtime monitoring of CPU, processes, network equipment; Modeling distributed real-time systems; Quality of service maintenance.

ET ZC234 Manufacturing Processes 3

Fundamentals of casting process; forging; powder metallurgy; soldering; brazing and welding technology; metal forming process, its analysis and design; Introduction to Metal cutting, machine tools; mechanics of metal cutting; other machining processes; grinding and finishing operations; non convention machining; chipless machining processes; NC machines programming; control system in CNC; CNC, DNC; FMS and machining center.

ET ZC323 Mechatronics and Automation 3

Introduction to mechatronics, sensors and transducers, pneumatic and hydraulic actuation systems, mechanical actuation systems, electrical actuation systems, digital logic, microprocessors and programmable logic controllers; Introduction to automation, features of numerical control machine tools, numerical control part programming, control loops for numerical control systems, computerized numerical control, adaptive control systems, industrial robots, automatic identification and data capture, automated production lines and automated assembly systems.

ET ZC341 Instrumentation & Control 3

Measurement systems, transducers, feedback control, components: electrical, hydraulic, pneumatic; Signal conditioning and processing, controllers, display, recording, direct digital control, programmable logic controllers, PC based instrumentation.

ET ZC342 Materials Management 3

Integrated materials management, policy aspects, purchasing management, warehousing and storage of inventory control systems; appraisal and control; just in time (JIT); automation in materials management.

ET ZC344 Instrumentation & Control 4

Generalized measurement system and performance characteristics, Transducers - principles and applications, Signal conditioning circuits – bridges, amplifiers, data converters, filters; Process control – control schemes, controllers, multi-loop control configuration, Control valves; Programmable Logic Controllers, DCS and SCADA, Simulation, Case Studies.

ET ZC352 Energy Management 3

Energy management principles; energy conservation; energy auditing; analysis; formulation of energy management options; economic evaluation, implementation & control; energy conservation techniques – conservation in

energy intensive industries; steam generation, distribution systems, and electrical systems; integrated resource planning; demand-side. management; cogeneration; total energy schemes; thermal insulation; energy storage; economic evaluation of conservation technologies; analysis of typical applications.

ET ZC362 Environmental Pollution Control 3

Air and water pollutants; sampling and analysis; control methods for air & water pollutants; modeling of different control techniques; advanced wastewater treatment processes; solid waste management, noise pollution; case studies.

ET ZC412 Production Planning & Control 3

Generalized model of production systems; types of production flows; life cycle concepts; facilities location and layout planning; aggregate and batch production planning; inventory systems; materials requirements planning; elements of monitoring & production control.

ET ZC413 Engineering Design 4

The Engineering Design Process, Current Practices in Engineering Design, Establishing Need, Design Proposal, Formulating the Problem, Structuring the Search for a Solution: Design Goals and Specifications; Applying and Protecting Technical Knowledge, Abstraction and Modeling, Synthesis in Engineering Design, Ethics and Product Liability Issues, Hazard Analysis and Failure Analysis, Design Analysis - Alternative Designs, Prioritizing the Design Goals, Decision Matrix and Economic Analysis, Implementation - Transforming a Design Concept into Reality, Materials Selection in Design, Common Fabrication Materials, Materials Testing, Manufacturing Processes, Communicating the Design, Case Studies.

ET ZC414 Project Appraisal 3

Overview of project and project phases; project formulation aspects in terms of market studies, technical studies, financial studies, economic studies, environmental studies, etc.; project evaluation aspects in terms of commercial profitability prospects, national economic profitability prospects; issues of project preparation in project implementation.

ET ZC415 Manufacturing Excellence 3

Introduction, frameworks of manufacturing excellence, practices for manufacturing excellence: leadership and change management, manufacturing strategy, innovative product planning, total productive maintenance, total quality management, lean manufacturing, customer relations management, green manufacturing, supply chain management, knowledge management and social responsibility.

ET ZC423 Essentials of Project Management 3

Programmes project management, project manager: role and responsibilities, project management and organization, project planning and scheduling, graphical techniques and PERT, CPM, price estimation and cost control; proposal, control valuation monitoring and trade off analysis in a project environment, pitfalls and future scenario.

ET ZC426 Plant Layout & Design 3

Factors affecting plant layout, Types of layout, procedure for plant layout, techniques and tools for planning layout, quantitative layout analysis, material handing equipment, improving and revising existing layout, evaluation of layout, plant location, evaluation of location, design of layout, computer applications in layout design.

ET ZC432 Quality Control, Assurance & Reliability 3

Basic concepts of probability and probability distributions, standard probability distribution, sampling and sampling distributions, confidence intervals, testing significance, statistical tolerance, various types of control charts, statistical process control techniques, value analysis, defect diagnosis and prevention, basic concepts of reliability, reliability design evaluation and control, methods of applying total quality management, production process.

FIN ZC415 Financial and Management Accounting 4

Basic concepts, double entry accounting, journal, ledger, trial balance, profit & loss account, balance sheet, cash flow statement, financial statement analysis, ratio analysis, cost-volume-profit analysis, inventory valuation, inflation accounting, cost accounting and budgetary control systems, financial analysis and forecasting.

FIN ZG512 Global Financial Markets and Products 4

Capital markets; stock markets, bond markets, derivative markets; operations of these markets from a global perspective; Overview and features

of key financial products, equities, fixed income securities and derivatives; bond features, indenture, coupon, maturity, YTM, zero coupon, valuation, duration, convexity; Equities, product features, basic valuation concepts; derivatives, forwards, futures, options, swaps, commodity derivatives, cost of carry, concepts, basic features, payoff, put call parity, basic option strategies; relevant case studies, simulations, modeling.

FIN ZG513 Management of Banks & Financial Institutions 4

Overview and operation of financial institutions and banks; Commercial banking, Investment banking; Define, quantify, and manage various types of risks faced by financial institutions; asset liability management - overview, strategies; off balance sheet activities of banks; sovereign risk; deposit insurance; capital adequacy; study current best practices using selected case studies; bank management failures; insights from collapse of Lehman Brothers; introduction to bank regulation; international considerations; relevant case studies, simulations, modeling.

FIN ZG514 Derivatives and Risk Management 4

Overview of Financial Markets. Introduction to derivatives. Definition of future, forward, option and swap. Difference between various players of derivative market, their motives and types of position they can hold. Mechanics of future, option & swap markets. Hedging strategies. Option Pricing and understanding of various factors affecting option price. Calculations of Greeks. Introduction to interest rates, yield, term structure and forward rates. Mechanics of Bond Market. Review of concept of compounding and time value of money. Difference between floating rate and fixed income bonds. Price quotes and accrued interest. Pricing of Bonds. Computation of yield. Bond Price volatility. Duration, Modified Duration and convexity. Factors affecting Bond Yields and the Term Structure. Concept of Risk. Perspective of Risk from view point of individuals, companies & financial institutions. Commercial Banks and risks faced by them. Different types of Insurance and risk faced insurance companies. Introduction to various risks: Market Risk, Credit Risk, Operational Risk, Liquidity risk & Model Risk. Concept of Value at Risk.

FIN ZG518 Multinational Finance 4

Effective financial decision making in a multinational corporation; issues in global financial management, international monetary system, balance of payments, foreign exchange markets, international parity conditions, foreign currency options, transaction exposure, operating exposure, translation exposure, sourcing capital globally, foreign investment decisions, basics of multinational taxation, transfer pricing, principles of multinational capital budgeting, and managing multinational operations . Extensive use of case studies and simulations to connect theory with practice.

FIN ZG519 Business Analysis and Valuation 4

Theory of finance, value maximization, stakeholder theory, and corporate objective function: value creation – ways and means, business analysis: The techniques of strategy and competitive analysis, value chain analysis for competitive advantages, business valuation – approaches and methods, the dark side of valuation: strategic investment decisions.

FIN ZG520 Security Analysis and Portfolio Management 4

Introduction to investment and securities; profile of financial assets; new issue market or primary market, initial public offerings (IPO); secondary market; framework of risk & return; fundamental analysis- economy, industry; company analysis; stock evaluation models; multiple holding period and multiple growth rate; bond analysis and bond management strategies; technical analysis; efficient market theory; portfolio management; Markowitz model; Sharpe's Single Index model; capital asset pricing model; financial derivatives, options & futures.

FIN ZG528 Venture Capital & Private Equity 4

This course will lay a strong foundation in core concepts, features and characteristics of the venture capital and private equity markets; specialized services provided by VC's and PE funds; stages in VC investing; deal flow; deal sourcing, evaluation; risk return tradeoff of VC/ PE investments; valuation of VC/ PE transactions; structuring and execution of deals; exit options, distributions; Course will make extensive use of case studies to understand industry best practices and current trends.

FIN ZG521 Financial Management 4

Concepts and techniques of financial management decision; concepts in valuation – time value of money; valuation of a firm's stock, capital asset pricing model; investment in assets and required returns; risk analysis; financing and dividend policies, capital structure decision;

working capital management, management of cash, management of accounts receivable; inventory management, short and intermediate term financing, long term financial tools of financial analysis, financial ratio analysis, funds analysis and financial forecasting, operating and financial leverages.

FIN ZG522 Mergers, Acquisitions, and Corporate Restructuring 4

Basics of M&A (corporate finance, strategy, economics), merger types, trends; theories underlying M&A; legal aspects; evaluating an acquisition target; valuation of mergers and acquisitions, MVA, relative valuation, multiples, DCF, FCFF, FCFE; M&A deal structuring; synergy analysis; break-up valuation; sensitivity analysis; terms of merger; financing considerations; capital structure decisions; structuring and valuing of Leveraged Buy-out (LBO) transaction; financing considerations; exit strategies; extensive use of relevant case studies, simulations, modeling.

FIN ZG523 Market Risk Management 4

Market risk measurement and management in foreign exchange markets, debt markets, equity markets, commodities markets; application of Value-at-Risk (VaR) to market risk management, VaR methods, VaR mapping, stress testing, multi factor VaR, limitations of VaR, alternative metrics to VaR, expected shortfall; market risk in bank trading strategies; market risk management in fixed income securities, duration, convexity, advanced term structure models, mortgage backed securities, pre-payment risk, burnout, modeling pre-payment risk; volatility smiles, exotic options; measuring and managing corporate risk, cash flow exposures; extensive use of relevant case studies, simulations, modeling.

FIN ZG524 Credit Risk Management 4

Default, charge-off, bankruptcy; loan restructuring, loan moratorium; counterparty credit risk, measurement, management; credit risk modeling, quantitative models, Probability of Default, Exposure at Default, Loss Given Default, Expected and Unexpected losses; qualitative framework, five Cs of credit; application of Value-at-Risk (VaR) to credit risk management, i.e. Credit VaR, default risk measurement and management in Fixed Income securities, and securitization; extensive use of relevant case studies, simulations, modeling.

FIN ZG525 Operational Risk Management 4

Topics covered include: operational risk measurement, management framework; internal loss data, external loss data; key risk indicators; scenario analysis, stress testing; risk appetite; reputational risk and operational risk; application of value-at-risk (VaR) to operational risk management; liquidity risk, definition, measurement and management; liquidity adjusted VaR; liquidity and leverage; legal risk, compliance risk; fraud risk (internal and external); model risk; enterprise risk management; extensive use of relevant case studies, simulations, modeling.

FIN ZG526 Advanced Risk Models 4

Advanced VaR models, expected shortfall, stressed VaR, historical simulation, delta/ gamma models, full revaluation, risk factor selection, volatility clustering, structured Monte Carlo analysis, stress testing, scenario analysis, back testing; country and sovereign risk models; management of country and sovereign risks, external and internal credit ratings methodology and framework; expected and unexpected loss framework and related metrics; extensive use of relevant case studies, simulations, modeling.

FIN ZG527 International Regulatory Framework for Banks 4

Three pillars of the Basel II framework; key elements of risk management in banks; various methodologies used to calculate capital and provision requirements under Basel III framework, capital conservation buffer, counter cyclical capital buffer; liquidity coverage ratio, NSFR, leverage ratio; implications for the management of credit risk, market risk and operational risk; basic approach, standardized approach, advanced approach, etc.; extensive use of relevant case studies relating to bank failures and 2008 financial crisis.

HHSM ZC417 Managerial Communication 4

Written communication: memos, letters, notices, agenda, minutes, resolutions, (project) proposals, reports; electronic communication: mail, privacy and workplace monitoring, teleconferencing; oral communication: group communications, presentations, public speaking, media; non-verbal communication, effective listening and feedback; reading skills.

HHSM ZC471 Management Information Systems 3

Introduction to Information Systems; Concepts of management, concepts of information, systems concepts; Information Systems and Organizations; decision making process; database systems; data communications; planning, designing, developing and implementing information systems; quality assurance and evaluation of information systems; future developments and their organizational and social implications; decision support system and expert systems.

HHSM ZG513 Biostatistics & Epidemiology 4

Methods of collection and presentation of statistical data; calculation and interpretation of various measures like mean, median, mode, standard deviation, kurtosis, correlation coefficient; probability distributions; sampling and estimation of parameters; tests of hypothesis; data analysis. Introduction to the principles and methods of epidemiology. Epidemiology of some illustrative infectious diseases (of bacterial, rickettsial and viral origins), sexually transmitted diseases, chronic diseases such as cancer, cardiovascular diseases, neurological disorders etc. Use of biostatistics in epidemiology.

HHSM ZG514 Health Care Marketing & Strategic Management 4

Strategic management function within contemporary health services organization with focus on organizational strategic planning processes including principles and methods of strategic assessment, strategy formulation, evaluation, implementation, and control, as well as the role and function of marketing strategy as part of the strategic implementation process.

HHSM ZG515 Quantitative Methods 3

Basic concepts in Operations Research; Analytical & Mathematical Modeling Techniques; Model Building; Inventory Control, queuing theory; Linear Programming; Transportation and assignment problems, simulation, index numbers, decision theory, etc.

HHSM ZG516 Epidemic & Disaster Management 4

Disaster management; impact and response; relief phase; disaster mitigation in health sector; disaster preparedness; policy development; man-made disasters; international agencies providing health based humanitarian assistance; and strategies for disaster management.

HHSM ZG517 Health Care Management 4

Basis of organizational culture and management techniques for efficient administration of health delivery; general principles of HR, materials and operation management; understanding the organizational culture that exists in public, private and non-Govt. sector agencies; management information system.

HHSM ZG518 Total Quality Management 4

TQM principles and practices; leadership; customer satisfaction; employee involvement; continuous process improvement; supplier partnership; performance measures; statistical process control; ISO 9000; benchmarking; quality function deployment; concurrent engineering; experimental design; Taguchi's quality engineering; product liability.

HHSM ZG519 Project Management 4

Concepts and techniques of project formulation, evaluation and implementation; Project planning and scheduling; Risk management; Time-cost trade off; Resource leveling and allocation; Project monitoring and control; Contract management.

HHSM ZG629T Dissertation 20

A student registered in this course must take a topic in an area of professional interest drawn from the on the job work requirement which is simultaneously of direct relevance to the degree pursued by the student as well as to the employing / collaborating organization of the student and submit a comprehensive report at the end of the semester working under the overall supervision and guidance of a professional expert who will be deemed as the supervisor for evaluation of all components of the dissertation. Normally the Mentor of the student would be the Dissertation supervisor and in case Mentor is not approved as the supervisor, Mentor may play the role of additional supervisor. The final grades for dissertation are Non-letter grades namely Excellent, Good, Fair and Poor, which do not go into CGPA computation.

HHSM ZG531 Health Economics & Financial Management 4

Concepts & methods of economic analysis related to health system; organization and policy; demand

and supply of scarce resource for health care; health financing & population coverage; determinants of cost & utilization; health insurance; cost-benefit analysis; costing for decision making; fundamentals of accounting; financial statement analysis; budget process & budgetary control; capital investment decision.

HHSM ZG631 Introduction to Health Systems & Environmental Health 4

Introduction to health systems; functions of health systems; managing health systems; problems of health systems management; Major environmental health problems including quality of water, waste disposal food production and processing, vector control etc. Air pollution and its controlling, Hazards of radiation, municipal and other wastes, Occupational health hazards.

HHSM ZG665 Hospital Operation Management 3

Operation Management aspects connected with outpatient ward, casualty, operation theatres, diagnostic laboratories, pathology laboratories, pharmacy, diet and nutrition, blood bank, laundry, medical records, security, scheduling and deployment of doctors, nurses and other staff, accounts among others. The course will involve on site visits in a hospital, discussions and presentations on the practical aspects of hospital operations management.

IS ZC313 Object Oriented Programming & Design 4

Object oriented concepts and design, abstraction, architecture and design patterns, GUI programming and frameworks, design of object oriented solutions using UML, design for concurrency, implementation of solutions using object oriented languages like C++ or Java; Language level mapping and realization of object oriented constructs, realization and performance issues versus abstraction and usability.

IS ZC314 Software Development for Portable Devices 3

Introduction to mobile computing and emerging mobile application and hardware platforms; Developing and assessing mobile applications; Software lifecycle for mobile application – design and architecture, development – tools, techniques, frameworks, deployment; Human factors and emerging human computer interfaces (tangible, immersive, attentive, gesture, zero-input); Select application domains such as pervasive health care, m-Health; Mobile web browsing, gaming and social networking.

IS ZC323 Systems Programming 3

Batch processing Systems programs; operating characteristics and limitations; parallel processing of I/O and interrupt handling, multiprogramming; multiprocessing systems; design of system modules and interfaces; other selected topics.

IS ZC327 Systems Programming 4

Batch processing; Systems programs; operating characteristics and limitations; parallel processing of I/O and interrupt handling, multiprogramming; multiprocessing systems; design of system modules and interfaces with focus on contemporary open source operating system-specific programming; laboratory experiments or programming assignments involving Unix/Linux System-specific Programming including shell-scripting via online laboratory facility.

IS ZC332 Database System & Application 3

Introduction to Database Management Systems; File organization; Data Independence in databases; Data Models; Query processing systems; Database Design techniques; Concepts of security and integrity in databases; Distributed Databases; Applications using DBMS.

IS ZC337 Database Systems & Applications 4

Introduction to Database Management Systems; File organization; Data Independence in databases; Data Models; Query processing systems; Database Design techniques; Concepts of security and integrity in databases; Distributed Databases; Applications using DBMS, database programming experiments involving use of SQL, database creation etc. via online laboratory facility.

IS ZC341 Software Engineering 3

Software engineering concepts and methodology; formal requirements specification; estimation; software project planning; detailed design; techniques of design; productivity; documentation; programming languages styles, code review; tool, integration and validation; software quality assurance; software maintenance; metrics, automated tools in software engineering.

IS ZC353 Computer Organization & Architecture 4

Overview of logic design; Instruction set architecture; Assembly language programming; Pipelining; Computer Arithmetic; Control unit; Memory hierarchy; Virtual memory; Input and output systems; Interrupts and exception handling; Implementation issues; Case studies; This course covers the fundamentals of computer organization and architecture from a programmer's perspective.

IS ZC362 Operating Systems 3

Introduction to operating systems; Various approaches to design of operating systems; Overview of hardware support for operating systems; Process management: process synchronization and mutual exclusion, interprocess communication, process scheduling; CPU scheduling approaches; Memory management: paging, segmentation, virtual memory, page replacement algorithms; File systems: design and implementation of file systems; input/output systems; device controllers and device drivers; Security and protection; Case studies on design and implementation of operating system modules.

IS ZC363 Data Structures & Algorithms 4

Introduction to software design principles, modularity, abstract data types, data structures and algorithms; Analysis of algorithms; Linear data structures – stacks, arrays, lists, queues and linked representations; Pre-fix, in-fix and post-fix expressions; Recursion; Set operations; Hashing and hash functions; Binary and other trees, traversal algorithms, Huffman codes; Search trees, priority queues, heaps and balanced trees; Sorting techniques; Graphs and digraphs; Algorithmic design techniques; Data structures for external storage, multi-way search and B-trees; Implementation techniques for different data structures including trees, graphs and search structures; Performance evaluation of data structures and algorithms; Implementation issues in large data structures.

IS ZC364 Operating Systems 4

Introduction to operating systems; Various approaches to design of operating systems; Overview of hardware support for operating systems; Process management: process synchronization and mutual exclusion, interprocess communication, process scheduling; CPU scheduling approaches; Memory management: paging, segmentation, virtual memory, page replacement algorithms; File systems: design and implementation of file systems; input/output systems; device controllers and device drivers; Security and protection; Case studies on design and implementation of operating system modules, select laboratory experiments related to creating different elements of operating system and/or implementation of select scheduling, memory management and I/O related algorithms/schemes, using system calls for creating file system specific command, creating simple file system etc. via online laboratory facility.

IS ZC372 Complier Design 4

Introduction to Progg. Languages and Compilers, Programming Language Features, Front End of a Compiler, Back End of a Compiler, Special aspects of compilers and runtime.

IS ZC415 Data Mining 3

Data Mining – introduction, fundamental concepts; motivation and applications; role of data warehousing in data mining; challenges and issues in data mining; Knowledge Discovery in Databases (KDD); role of data mining in KDD; algorithms for data mining; tasks like decision-tree construction, finding association rules, sequencing, classification, and clustering; applications of neural networks and machine learning for tasks of classification and clustering.

IS ZC422 Parallel Computing 3

Introduction to parallel computing; Models of parallel computers; Interconnection networks, basic communication operations; Introduction to parallel algorithms; Parallel programming paradigms; issues in implementing algorithms on parallel computers; Parallel programming with message passing interface; Performance analysis; Scalability analysis; Basic design techniques for parallel algorithms; Parallel algorithms for selected topics like sorting, searching and merging, matrix algebra, graphs, discrete optimization problems and computational geometry.

IS ZC423 Software Development for Portable Devices 3

Introduction to mobile computing and emerging mobile application and hardware platforms;

Developing and assessing mobile applications; Software lifecycle for mobile application – design and architecture, development – tools, techniques, frameworks, deployment; Human factors and emerging human computer interfaces (tangible, immersive, attentive, gesture, zero-input); Select application domains such as pervasive health care, m-Health; Mobile web browsing, gaming and social networking.

IS ZC424 Software for Embedded Systems 3

Real-time and Embedded Systems; Software issues in Embedded Systems; Software Development Process; Requirements Analysis– Use Cases, Identification and Analysis of use cases, Use Case Diagrams. Design – Architectural Design, Design Patterns, Detailed Design. Implementation – Languages, Compilers, Runtime Environments and Operating Systems for embedded software. Testing – Methodologies, Test Cases.

IS ZC425 Data Mining 3

Data Mining – introduction, fundamental concepts; motivation and applications; role of data warehousing in data mining; challenges and issues in data mining; Knowledge Discovery in Databases (KDD); role of data mining in KDD; algorithms for data mining; tasks like decision-tree construction, finding association rules, sequencing, classification, and clustering; applications of neural networks and machine learning for tasks of classification and clustering.

IS ZC444 Artificial Intelligence 3

The object of this course is to give an introduction to the problems and techniques of A.I. along with the applications of A.I. techniques to the fields like natural language understanding, image processing, game theory and problem solving. The course also aims at understanding its implementation using LISP and PROLOG languages.

IS ZC446 Data Storage Technologies & Networks 3

Storage Media and Technologies – Magnetic, Optical and Semiconductor media, techniques for read/write operations, issues and limitations. Usage and Access – Positioning in the memory hierarchy, Hardware and Software Design for access, Performance issues. Large Storages – Hard Disks, Networked Attached Storage, Scalability issues, Networking issues. Storage Architecture. - Storage Partitioning, Storage System Design, Caching, Legacy Systems. Storage Area Networks – Hardware and Software Components, Storage Clusters/Grids. Storage QoS – Performance, Reliability, and Security issues.

IS ZC462 Network Programming 3

Overview of computer networks; inter-process communication; network programming; socket interface; client-server computing model: design issues, concurrency in server and clients; external data representation; remote procedure calls; network file systems; distributed systems design.

IS ZC464 Machine Learning 3

Neural networks; neuro-computing theory and applications, knowledge representation; computational learning theory; statistical / probabilistic methods, genetic algorithms; inductive / analytic / reinforcement learning and bayesian networks; selected topics such as alpha-beta pruning in game trees, computer models of mathematical reasoning, natural language understanding and philosophical implications.

IS ZC467 Computer Networks 4

Introduction, history and development of computer networks; Reference models; Physical Layer: theoretical basis, transmission media, types of transmission; MAC sub-layer: local area networks, FDDI; Data Link Layer: Sliding Window protocols, design aspects; Network Layer: routing algorithms, congestion control algorithms, internetworking; Transport Layer: Integrated Services Digital Network (ISDN), Asynchronous Transfer Mode (ATM) - reference models, service classes, switch design, LAN emulation; Application Layer protocols, Laboratory experiments / assignments related to simulation of network protocols, programming simple network applications, implementing select routing algorithms via online laboratory facility.

IS ZC471 Management Information Systems 3

Introduction to Information Systems; Concepts of management, concepts of information, systems concepts; Information Systems and Organizations; decision making process; database systems; data communications; planning, designing, developing and implementing information systems; quality assurance and evaluation of information systems; future

developments and their organizational and social implications; decision support system and expert systems.

IS ZC472 Computer Graphics 3

Generation of dots, lines, arcs and polygons; color graphics, shades and levels; image transformation, windowing and clipping; 2-D and 3-D graphics; data structures, algorithms and optimization methods; case studies using GKS, CORE, etc; graphic languages and compilers.

IS ZC481 Computer Networks 3

Introduction, history and development of computer networks; Reference models; Physical Layer: theoretical basis, transmission media, types of transmission; MAC sub-layer: local area networks, FDDI; Data Link Layer: Sliding Window protocols, design aspects; Network Layer: routing algorithms, congestion control algorithms, internetworking; Transport Layer: Integrated Services Digital Network (ISDN), Asynchronous Transfer Mode (ATM) - reference models, service classes, switch design, LAN emulation; Application Layer protocols.

MATH ZC161 Engineering Mathematics I 3

Limit concept; derivatives of elementary functions and their applications; introduction to ordinary and partial differential equations and initial/boundary value problems. Convergence tests for series; power series and interval of convergence; series solution of differential equations. Approximation and error, interpolation; roots of algebraic and transcendental functions, Newton's method.

MATH ZC222 Discrete Structure for Computer Science 3

Sets and relations; graphs and digraphs; trees, lists and their uses; partially ordered sets and lattices; Boolean algebras and Boolean expressions; semigroups and machines; codes and applications.

MATH ZC232 Engineering Mathematics II 3

Algebra of vectors and matrices; Gauss's row-reduction process; applications of simultaneous linear equations and matrix inversion; determinants and Cramer's rule. Numerical differentiation and integration; numerical methods for solving ordinary and partial differential equations.

MATH ZC233 Calculus 4

Limits, continuity, differentiation, integration, Fourier series, ordinary differential equations for initial and boundary value problems, solution through Laplace transforms, numerical solution using Picard's iteration and higher order methods, partial derivatives, partial differential equations, analytical solution techniques.

MATH ZC234 Linear Algebra & Optimization 3

Vector and matrix algebra, systems of linear algebraic equations and their solutions; eigenvalues, eigenvectors and diagonalization of matrices; Formulation of linear programming problems, Simplex method, Big-M method, Two phase method, Sensitivity analysis, Revised and Dual Simplex Methods.

MBA ZC411 Marketing 4

Definition and scope, consumer behavior, competitive behavior, demand estimation, new product introduction, product/brand management, pricing policies, channels of distribution, credit management, advertising and other sales promotion, positioning, marketing regulation, market research basics of industrial marketing.

MBA ZC415 Financial and Management Accounting 4

Basic concepts, double entry accounting, journal, ledger, trial balance, profit & loss account, balance sheet, cash flow statement, financial statement analysis, ratio analysis, cost-volume-profit analysis, inventory valuation, inflation accounting, cost accounting and budgetary control systems, financial analysis and forecasting.

MBA ZC416 Managerial Economics 4

Fundamental concepts, supply, demand, market mechanism; theory of demand (consumer behaviour); production, costs (theory of the firm); market structures (perfect competition, monopoly, monopolistic competition, oligopoly); circular flow of income, national income accounting, national income determination; money and banking, employment, interest, inflation, economics of information, problem of adverse selection, moral hazard problem, market failure, externalities, public goods.

MBA ZC417 Quantitative Methods 4

Grouping data, measures of central tendency and dispersion, probability distribution, sampling and

estimation, testing hypotheses, chi-square and analysis of variance, regression and correlation, non-parametric methods, time series and forecasting, index numbers, decision theory, linear programming, transportation and assignment problems, queuing theory, network problems, simulation; application of statistical software (SYSTAT, SPSS, SIMULA8, etc.) and spreadsheets.

MBA ZG511 Managing People & Organizations 4

Concepts and principles of management as applied to a variety of organizations; study of managerial roles, styles, activities and decision making; relationship with organizational effectiveness; planning activities, leadership & control; manpower development; organizational behavior and theory.

MBA ZG513 Enterprise Resource Planning 4

Course description to be developed.

MBA ZG514 Leadership & Managing Change 4

Individuals as leaders, team leadership and organizational leadership. Introduction to managing change, management of change: organizational structure, culture, recruitment, performance management, human resource development, reward management, employee relations and involvement, downsizing, and evaluating and promoting.

MBA ZG515 Consulting & People Skills 4

Facilitation skills, Communication skills, Presentation and Interviewing skills, Analytical Skills, Creativity, Partnership and networking skills, Critical thinking skills, Emotional Intelligence Development, Stress Management, Ethics and respect for the client, Vision and Framing of issues, Synthesizing Skills, Leadership skills.

MBA ZG521 Financial Management 4

Concepts and techniques of financial management decision; concepts in valuation - time value of money; valuation of a firm's stock, capital asset pricing model; investment in assets and required returns; risk analysis; financing and dividend policies, capital structure decision; working capital management, management of cash, management of accounts receivable; inventory management, short and intermediate term financing, long term financial tools of financial analysis, financial ratio analysis, funds analysis and financial forecasting, operating and financial leverages.

MBA ZG522 Total Quality Management 4

TQM principles and practices; leadership; customer satisfaction; employee involvement; continuous process improvement; supplier partnership; performance measures; statistical process control; ISO 9000; benchmarking; quality function deployment; concurrent engineering; experimental design; Taguchi's quality engineering; product liability.

MBA ZG523 Project Management 4

Concepts and techniques of project formulation, evaluation and implementation; Project planning and scheduling; Risk management; Time-cost trade off; Resource leveling and allocation; Project monitoring and control; Contract management.

MBA ZG524 Business Process Analysis 4

Course description to be developed.

MBA ZG525 Quality Management System 5

Quality system & quality management, evolution of quality post world war II era i.e. Quality control, quality assurance, total quality control & total quality management; ISO 9000 series of standards, formation of ISO (1947), background & development of ISO 9000. ISO 9000 family of standards, selection & use of appropriate model of ISO 9000. Requirements of ISO 9001; System demonstration & documentation, how to organize formal quality assurance system, pyramid of quality system documentation structure, two tier, three tier & four tier documentation, preparation of quality manual & quality procedures, quality records; Implementing documented quality system, how to proceed, how to implement change, obtaining top management commitment, assessing current company position, developing the implementation plan, initiating people (employees) to own the system, system development; System audit & review, objective of system audit, types of quality audit, product Vs system audit, internal quality audit, management review; System certification, benefits of third party certification, choice of certification body, route to certification, surveillance & renewal; Other quality system standards, relating ISO 9000 with QS 9000 and ISO 14000.

MBA ZG526 Operations Management 4

Operations strategy; process view vs. functional view in operations; factors in product and process design and selection; facility configuration; demand planning and forecasting; capacity planning; aggregate planning; planning service operations; productivity of operations; inventory planning and independent demand systems; materials requirements planning; quality management; uncertainty and variability; project management; current developments in operations management.

MBA ZG531 Statistical Quality Control 5

Sources of Variation: Common and Assignable Causes, Descriptive Statistics, Statistical Process Control Methods, Control Charts for Variables, Control Charts for Attributes, C-Charts, Process Capability, Acceptance Sampling, Operating characteristic curve, Statistical Quality Control in Services.

MBA ZG537 Lean Manufacturing 5

Course description to be developed.

MBA ZG541 Consultancy Practice 4

Strategic planning and marketing of consultancy services, client consultant relationships, technology transfers, negotiations, agreements, guarantees, organizing and executing consultancy services, quality in consultancy services, technical audit, government policies such as industrial policy, trade policy, technology policy, patent and trade marks etc.

MBA ZG611 Strategic Management & Business Policy 4

Strategic management elements; internal, external, external environment. assessment of corporate strengths, weaknesses and opportunities; planning and deployment of capital assets; profit planning and control functions problems, pressures, responsibilities, limits of the chief executive; evaluation of one's own business undertaking; formulating objectives, strategies, policies and programmes for improving company's present situation; personnel strength and implementation of the policies and programmes, development, implementation, evaluation and control of strategies, strategic management of MNCs, management style and behavior, corporate style, behavior and culture.

MBA ZG621 Supply Chain Management 4

Customer driven strategies in production and distribution systems; Integrated production and distribution networks; SCM in the context of JIT and MRP–II; Distribution Resource Planning; Management of dealer networks; Total Control & Product innovation across the supply chain; Incoming logistics and supplier relationships; Value addition analysis; Metrics for management of supply chain performance; Mathematical models and computer assisted decision support for SCM; Mathematical programming for SCM.

MBA ZG634 Strategic Change Management 4

Results-based management, managing for outcomes–objectives and targets; strategy; indicator, performance information; environmental scan and SWOT analysis; planning, budgeting, implementation, review - the (strategic) management cycle Models and theories of planned change, Strategic management: transformational leadership or change management (or learning), Strategic management in a context of joint action and networks, Participation and Empowerment, Teams and Teamwork, Parallel learning structures, OD Interventions, Team Interventions, Intergroup and third party interventions, Structural and Comprehensive interventions, Action research, Socio-clinical and Socio-technical Approaches, Issues in Consultant-Client Relationships, Power Politics and Organization Development.

MBA ZG641 Management Information & Decision Support Systems 5

Data & information; characteristics of information; components of management information systems; information flows; design and maintenance of management information systems; decision support systems.

MBA ZG661 Software Quality Management 4

Software quality challenges and expectations; quality dilemma; software life cycle and link to quality; quality gates, formal reviews, system requirement reviews, preliminary design reviews, critical design reviews, test reviews; engineering reviews, walkthroughs, inspections, internal reviews; quality gate categories; technical environment and quality; planning for software quality, quality requirements for planning, quality needs, elements of quality planning, quality

assessments during planning, software quality organization requirements; quality evaluation of software development process, process quality attributes, measuring software process quality; software process metrics; quality gate integrity; software product quality, standards and conventions, metrics; quality hierarchy, factors; quality assessment; quality evaluation techniques, reviews, walkthroughs, audit, inspections, analytical evaluation techniques; quality systems.

MBA ZG623T Project 12

Consistent with the student's professional background and work-environment, the student will be required to carry out work-oriented projects. The student would be required to select an area of work in Engineering / Management aspects that are considered vital to the sponsoring organization. At the end of the semester, the student should submit a comprehensive Project Report. The student will be evaluated on the basis of the various interim evaluation components, contents of the report and a final seminar & viva-voce.

ME* ZC112 Electrical and Electronics Technology 3

Electric circuit, electromagnetism, magnetic circuit, electrostatics, AC voltage and current, single phase circuits, semiconductor devices, amplifiers, digital systems, microprocessors, DC machines, polyphase circuits, transformers, synchronous machines, induction motors, power electronics, measurements, illumination.

ME* ZC113 Probability and Statistics 3

Probability spaces; conditional probability and independence; random variables and probability distributions; marginal and conditional distributions; independent random variables; mathematical expectation; mean and variance; binomial, Poisson and normal distributions; sum of independent random variables; law of large numbers; central limit theorem (without proof); sampling distribution and test for mean using normal and student's t-distribution; test of hypothesis; correlation and linear regression.

ME* ZC164 Computer Programming 4

Basic Computing Steps and Flow Charting (Assignment, Sequencing, Conditionals, Iteration). Programming Constructs – Expressions, Statements, Conditionals, Iterators/Loops, Functions/ Procedures; Data Types – Primitive Types, Tuples, Choices (Unions or Enumerations), Lists/Arrays, Pointers and Dynamically Allocated Data. Input output and Files. Laboratory Component: Programming Exercises involving development and testing of iterative and procedural programs using bounded and unbounded iterations, function composition, random access lists, sequential access lists, dynamically allocated lists, and file access.

ME* ZC213 Engineering Measurements 3

Performance characteristics of measuring instruments, measurement methods for mechanical, electrical, radiant, chemical, magnetic and thermal energy variables. Emphasis in this course shall be on the operation and use of instruments.

ME* ZC231 Principles of Management 3

Fundamental concepts of management - planning; organizing; staffing; directing and controlling; production, financial, personnel, legal and marketing functions; accounting and budgeting, balance sheets.

ME* ZC233 Calculus 4

Limits, continuity, differentiation, integration, Fourier series, ordinary differential equations for initial and boundary value problems, solution through Laplace transforms, numerical solution using Picard's iteration and higher order methods, partial derivatives, partial differential equations, analytical solution techniques.

ME* ZC234 Maintenance & Safety 3

Objectives, functions, and types of maintenance; defects due to wear; lubrication and surfacing techniques to reduce wear; maintenance of different equipments and their elements; spares planning; overhauling; TPM; safety and safety management; environmental safety; chemical safety; occupational health management; control of major industrial hazards; managing emergencies; employee participation in safety; HRD for maintenance and safety.

ME* ZC235 Linear Algebra & Optimization 3

Vector and matrix algebra, systems of linear algebraic equations and their solutions; eigenvalues, eigenvectors and diagonalization of matrices; Formulation of linear programming problems, Simplex method, Big-M method, Two phase method, Sensitivity analysis, Revised and Dual Simplex Methods.

ME* ZC236 Engineering Materials 3

Mechanical, electrical, electronic and chemical properties and applications of common engineering materials; ferrous and non- ferrous metals and alloys; thermosetting and thermoplastic plastics; natural and synthetic resins; rubber; glass; abrasives and ceramics; common building materials, namely, timber, stone, lime and cement; corrosion of metals and methods of preventing corrosion; protective and decorative coatings; insulating materials; testing of materials.

ME* ZC241 Technical Report Writing 3

Elements of effective writing; art of condensation; business letter writing; memos; formal reports; technical proposals; conducting, and participating, meetings; agenda and minutes; strategies for writing technical descriptions, definitions, and classifications; oral presentation; use of graphic and audio- visual aids; editing.

ME* ZC242 Manufacturing Process 3

Fundamentals of casting process; forging; powder metallurgy; soldering; brazing and welding technology; metal forming process, its analysis and design; Introduction to Metal cutting, machine tools; mechanics of metal cutting; other machining processes; grinding and finishing operations; non convention machining; chipless machining processes; NC machines programming; control system in CNC; CNC, DNC; FMS and machining center.

ME* ZC251 Mechanical Technology 3

Fundamental concepts of heat, work and energy; second law of thermodynamics; properties of gases and vapors; basic cycles; flow of liquids; steam boilers; steam engines and pumps; steam turbines and condensers; hydraulic pumps and turbines; internal combustion engine.

ME* ZC261 Mechanics of Solids 3

Fundamental principles of mechanics; introduction of mechanics of deformable bodies; forces and moments transmitted by slender members; stress and strain; stress-strain-temperature relations; torsion; stresses and defections due to bending; stability of equilibrium.

ME* ZC271 Manufacturing Excellence 3

Introduction, frameworks of manufacturing excellence, practices for manufacturing excellence: leadership and change management, manufacturing strategy, innovative product planning, total productive maintenance, total quality management, lean manufacturing, customer relations management, green manufacturing, supply chain management, knowledge management and social responsibility.

ME* ZC311 Automobile Technology –I 3

Introduction; working and construction of IC Engines; its components; cycles; fuel air cycle; diesel cycles; combustion in SI and CI Engines; fuels and combustion; fuel supply systems; scavenging process; engine cooling and lubrication; engine cooling system, friction and lubrication, engine testing and performance; super charging, analytical method of performance and estimation; emission controls; alternate fuels; modern trends in engine development.

ME* ZC312 Automobile Technology-II 3

Vehicle classification; chassis construction; clutches-friction clutches, fluid coupling; gear box-arrangement and design of gear boxes; epicyclical gear box; torque converters, semiautomatic and automatic gear boxes; propeller shaft; universal joint; differential; rear axle suspension systems; front axle and steering mechanisms – power steering mechanism; brakes –mechanical, hydraulic and air brakes; servo and power operated brake systems; wheels and tyres; testing and performance of automobiles; vehicle vibration; and human comfort; auto-electrical systems; ignition system-conventional and electronic system, alternators; charging system; storage batteries; wiper motors; lighting system; electrical vehicles; automobile law.

ME* ZC323 Design of Machine Elements 4

Fundamentals and principles of design; properties of engineering materials; design of simple machine parts; shafts, keys and couplings; power screws; threaded joints, welded and riveted joints, bearings and seals, gears, cams and followers; design of mechanisms.

ME* ZC324 Mechatronics and Automation 4

Introduction to mechatronics, sensors and transducers, Concepts of measurement of electrical and nonelectrical parameters; displacement, force, pressure etc. and related signal conditioning techniques , pneumatic and hydraulic actuation systems, mechanical actuation systems, electrical actuation systems, digital logic, microprocessors and programmable logic

controllers; Introduction to automation, control loops for numerical control systems, adaptive control systems, industrial robots, automatic identification and data capture, automated production lines and automated assembly systems, System design concepts through case studies.

ME* ZC331 Production Planning & Control 3

Types of production systems and problems of planning and control, product planning, forecasting, product demand, process planning, project management, capacities location and layout of facilities, aggregate planning and scheduling, materials requirement, planning, inventory management, systems and recent trends in production management.

ME* ZC332 Operations Research 3

Sampling, simulation, design of experiments and analysis of variance, nonparametric tests; correlation and regression analysis; quality control, reliability; decision theory; queuing theory; deterministic and probabilistic inventory systems.

ME* ZC343 Materials Management 3

Integrated materials management, policy aspects, purchasing management, warehousing and storage of inventory control systems; stores management; material planning, make or buy decisions; scheduling, strategic sourcing, JIT, Kanban system; inventory costing principle; concept of MRP II; vendor development; central excise, customs, importing, sales tax.

ME* ZC412 Flexible Manufacturing Systems 4

Introduction CAD/CAM systems, overview of FMS, system hardware and general functions, material handling system, work holding systems, cutting tools and tool management, physical planning of system, software structure functions and description, cleaning and automated inspection, communications and computer networks for manufacturing, quantification of flexibility, human factors in manufacturing, FMS and CIM in action (case studies), justification of FMS, modelling for design, planning and operation of FMS.

ME* ZC418 Lean Manufacturing 3

Fundamentals of continuous improvement, value added and waste elimination, elements of lean production: small lot production, setup time reduction, maintaining and improving equipment, pull production systems, focused factories and group technologies, work cells and cellular manufacturing, standard operations, quality of design, systems for eliminating defects, simplified production planning and control systems: scheduling for smooth flow, synchronizing and balancing process, planning and control in pull production, beyond the production systems: managing the supply chain, activity based costing, performance measurement.

ME* ZC421 Essentials of Project Management 3

Programmes project management, project manager: role and responsibilities, project management and organization, project planning and scheduling, graphical techniques and PERT, CPM, price estimation and cost control; proposal, control valuation monitoring and trade off analysis in a project environment, pitfalls and future scenario.

ME* ZC432 Quality Control, Assurance & Reliability 3

Basic concepts of probability and probability distributions, standard probability distribution, sampling and sampling distributions, confidence intervals, testing significance, statistical tolerance, various types of control charts, statistical process control techniques, value analysis, defect diagnosis and prevention, basic concepts of reliability, reliability design evaluation and control, methods of applying total quality management, production process.

ME* ZC471 Management Information Systems 3

Introduction to Information Systems; Concepts of management, concepts of information, systems concepts; Information Systems and Organizations; decision making process; database systems; data communications; planning, designing, developing and implementing information systems; quality assurance and evaluation of information systems; future developments and their organizational and social implications; decision support system and expert systems.

MEBF ZC211 Engineering Mathematics-I 3

Limit concept; derivatives of elementary functions and their applications; introduction to ordinary and partial differential equations and initial/boundary value problems. Convergence tests for series; power series and interval of convergence; series

solution of differential equations. Approximation and error, interpolation; roots of algebraic and transcendental functions, Newton's method.

MEBF ZC212 Engineering Mathematics-II 3

Algebra of vectors and matrices; Gauss's row-reduction process; applications of simultaneous linear equations and matrix inversion; determinants and Cramer's rule. Numerical differentiation and integration; numerical methods for solving ordinary and partial differential equations.

MEBF ZC221 Computer Programming 3

Elementary computer organization; introduction to Number Systems; Representation of integers, real numbers and characters on computers; concept of range and accuracy; Arithmetic Overflow; Algorithms and algorithm development; structured program development through step wise refinement. Introduction to C language; Functions; Recursion; Data structure & algorithms; File management & file handling; Problem solving using C.

MEBF ZC222 Engineering Materials 3

Mechanical, electrical, electronic and chemical properties and applications of common engineering materials; ferrous and non- ferrous metals and alloys; thermosetting and thermoplastic plastics; natural and synthetic resins; rubber; glass; abrasives and ceramics; common building materials, namely, timber, stone, lime and cement; corrosion of metals and methods of preventing corrosion; protective and decorative coatings; insulating materials; testing of materials.

MEBF ZC231 Principles of Management 3

Fundamental concepts of management - planning; organizing; staffing; directing and controlling; production, financial, personnel, legal and marketing functions; accounting and budgeting, balance sheets.

MEBF ZC232 Engineering Measurements and Techniques 3

Performance characteristics of measuring instruments, measurement methods for mechanical, electrical, radiant, chemical, magnetic and thermal energy variables. Emphasis in this course shall be on the operation and use of instruments.

MEBF ZC241 Technical Report Writing 3

Elements of effective writing; art of condensation; business letter writing; memos; formal reports; technical proposals; conducting, and participating, meetings; agenda and minutes; strategies for writing technical descriptions, definitions, and classifications; oral presentation; use of graphic and audio- visual aids; editing.

MEBF ZC242 Manufacturing Process 3

Fundamentals of casting process; forging; powder metallurgy; soldering; brazing and welding technology; metal forming process, its analysis and design; Introduction to Metal cutting, machine tools; mechanics of metal cutting; other machining processes; grinding and finishing operations; non convention machining; chipless machining processes; NC machines programming; control system in CNC; CNC, DNC; FMS and machining center.

MEBF ZC251 Mechanical Technology 3

Fundamental concepts of heat, work and energy; second law of thermodynamics; properties of gases and vapors; basic cycles; flow of liquids; steam boilers; steam engines and pumps; steam turbines and condensers; hydraulic pumps and turbines; internal combustion engine.

MEBF ZC261 Mechanics of Solids 3

Fundamental principles of mechanics; introduction of mechanics of deformable bodies; forces and moments transmitted by slender members; stress and strain; stress-strain-temperature relations; torsion; stresses and defections due to bending; stability of equilibrium.

MEBF ZC271 Manufacturing Excellence 3

Introduction, frameworks of manufacturing excellence, practices for manufacturing excellence: leadership and change management, manufacturing strategy, innovative product planning, total productive maintenance, total quality management, lean manufacturing, customer relations management, green manufacturing, supply chain management, knowledge management and social responsibility.

MEBF ZC311 Automobile Technology –I 3

Introduction; working and construction of IC Engines; its components; cycles; fuel air cycle; diesel cycles; combustion in SI and CI Engines; fuels and combustion; fuel supply systems; scavenging process; engine cooling and

lubrication; engine cooling system, friction and lubrication, engine testing and performance; super charging, analytical method of performance and estimation; emission controls; alternate fuels; modern trends in engine development.

MEBF ZC312 Automobile Technology-II 3

Vehicle classification; chassis construction; clutches-friction clutches, fluid coupling; gear box-arrangement and design of gear boxes; epicyclical gear box; torque converters, semiautomatic and automatic gear boxes; propeller shaft; universal joint; differential; rear axle suspension systems; front axle and steering mechanisms – power steering mechanism; brakes –mechanical, hydraulic and air brakes; servo and power operated brake systems; wheels and tyres; testing and performance of automobiles; vehicle vibration; and human comfort; auto-electrical systems; ignition system-conventional and electronic system, alternators; charging system; storage batteries; wiper motors; lighting system; electrical vehicles; automobile law.

MEBF ZC321 Quality Assurance and Reliability 3

Basic concepts of probability and probability distributions, standard probability distribution, sampling and sampling distributions, confidence intervals, testing significance, statistical tolerance, various types of control charts, statistical process control techniques, value analysis, defect diagnosis and prevention, basic concepts of reliability, reliability design evaluation and control, methods of applying total quality management, production process.

MEBF ZC322 Materials Management 3

Integrated materials management, policy aspects, purchasing management, warehousing and storage of inventory control systems; stores management; material planning, make or buy decisions; scheduling, strategic sourcing, JIT, Kanban system; inventory costing principle; concept of MRP II; vendor development; central excise, customs, importing, sales tax.

MEBF ZC331 Production Planning & Control 3

Types of production systems and problems of planning and control, product planning, forecasting, product demand, process planning, project management, capacities location and layout of facilities, aggregate planning and scheduling, materials requirement, planning, inventory management, systems and recent trends in production management.

MEBF ZC332 Operations Research 3

Sampling, simulation, design of experiments and analysis of variance, nonparametric tests; correlation and regression analysis; quality control, reliability; decision theory; queuing theory; deterministic and probabilistic inventory systems.

MEBF ZC341 Mechatronics 3

Basic Electricity – electrical parameters like voltage, current, resistance, AC/DC supply: electrical circuit; electromagnetism, its circuits, introduction to single phase and three phase supply, electrical components – relays, MCB, limit switches etc; transformers; elimination; electrical motors – types like induction motors, synchronous machines etc;, its speed control; introduction to electronic devices; semiconductor devices; SCRs, electronic circuits – power supplies, sensing devices; timers; industrial electronics and its application for heating, measuring / gauging etc., Introduction and application of PLCs; introduction to microprocessors; application in an industry Oil hydraulics; fluid logics; hydraulic elements like reservoir, fluid conditioners, pressure control valves, directional control valves and flow control valves; Basic hydraulic circuits for application in machine tools; Pneumatics, its principle, logics, pneumatic elements, basic pneumatic circuits used in machine tools.

MEBF ZC342 Machine Design 3

Fundamentals and principles of design, design and selection of machine elements such as shafts, spindle supports, gears, bearings; etc; design of mechanism; design of machine tool structure; dynamics of machine tools; introduction to CAD, CAM, CIM; Design of jigs and fixtures; press tools for blanking; punching; drawing; combination tools and progressive tools.

MEBF ZC352 Maintenance Engineering and Safety 3

Objectives; functions and type of maintenance; wear and service life of industrial equipment; concepts of assembly; points of wear, defects due to wear, lubrication, and surfacing technique to reduce wear; maintenance of different equipment and their elements; safety and safety management; occupational control of industrial

hazards; health management; employees participation; training and development.

MEBF ZC423T Project Work 20

Consistent with the student's professional background and work-environment, the student will be required to carry out work-oriented projects. The student would be required to select an area of work that is considered vital to the sponsoring organization. The topic of the project and detailed project outline that is prepared by the student, in consultation with his/her Mentor, needs to be approved by the Dean, WILPD. On approval, the student carries on with the work-centered project, adhering to the guidelines provided in the detailed course handout, taking all the prescribed evaluation components on time. At the end of the semester, the student should submit a comprehensive Project Report, to the Institute for evaluation. The student will be evaluated on the basis of the various interim evaluation components, contents of the report and Seminar/Viva-Voce that may be conducted at Pilani or at any other Centre approved by the Institute.

MEL* ZC415 Introduction to MEMS 4

Overview, history and industry perspective; working principles; mechanics and dynamics, thermofluid engineering; scaling law; microactuators, microsensors and microelectromechanical systems; microsystem design, modeling and simulation; materials; packaging; microfabrication: bulk, surface, LIGA etc; micromanufacturing; microfludidics; microrobotics; case studies.

MEL* ZG510 RF Microelectronics 5

Introduction; application of RF electronics in modern systems; basic concepts in RF circuit design, active RF components: various RF diodes and transistors and their circuit models, matching and biasing networks, RF amplifier design: low power, low noise and broadband amplifiers, RF oscillator design; negative resistance oscillator; dielectric resonator oscillators, phase noise. RF Mixers: Balanced mixers; low noise mixers; noise in RF circuits, microwave transmitters and receivers.

MEL* ZG511 Design & Analysis of Algorithms 5

Design techniques such as divide-and-conquer, recursion, backtracking, branch-and-bound, simulation; Analysis in terms of average level and worst level efficiency; Relationship to appropriate data structures; Illustrations dealing with problems in computer science, graph theory and mathematics; Computational complexity and bounds; NP-hard and NP-complete problems.

MEL* ZG512 Optoelectronic Devices, Circuit & Systems 5

Physics of optical radiation and principles of calculation in radiation physics & optics, fundamental laws of photometry. Interaction between optical radiation and matter. Radiation sources. Parameters of IR detectors and junction photodetectors, parameters common to emitters and receiver, radiation measurements, optoelectronic components, optoelectronic integrated devices, photodetector circuits, methods of modulation and optoelectronic system design and applications.

MEL* ZG520 Wireless & Mobile Communication 5

Signal propagation in a mobile environment, modulation, coding, equalization; first generation generation systems; multiple access techniques like FDMA, TDMA, CDMA, spread spectrum sytems; second & third generation systems, UMTS, IMT-2000; Wireless LAN, Wireless ATM and Mobile IP; emerging trends in Wireless & Mobile Communication.

MEL* ZG524 Real Time Operating Systems 5

Introduction to real-time systems, clock synchronization task assignment and scheduling, programming language with real-time support, ADA, real-time communication protocols, real-time database, fault tolerant techniques, reliability evaluation methods; case studies in real-time operating systems, simulation of real-time systems, embedded system programming.

MEL* ZG526 Embedded System Design 4

Introduction to embedded systems; embedded architectures: Architectures and programming of microcontrollers and DSPs. Embedded applications and technologies; power issues in system design; introduction to software and hardware co-design.

MEL* ZG531 Testability for VLSI 5

BIST, boundary sean, stuck-at faults, test generation algorithms for combinatorial logic circuits and sequential circuits, logic simulation and fault simulation, synthesis for test, built in self test, pseudo-random test techniques, other test methods - IDDQ testing, boundary scan etc.

MEL* ZG553 Real Time Systems 5

Real time software, Real time operating systems-scheduling, virtual memory issues and file systems, real time data bases, fault tolerance and exception handling techniques, reliability evaluation, data structures and algorithms for real time/embedded systems, programming languages, compilers and run time environment for real time/embedded systems, real time system design, real time communication and security, real time constraints and multi processing and distributed systems.

MEL* ZG554 Reconfigurable Computing 5

Overview of Programmable Logics. FPGA fabric architectures. Logic Elements and Switch Networks. Design and Synthesis of Combinational and Sequential Elements. Placement and Routing. Pipelining and other Design Methodologies. Fine-grained and Coarse-Grained FPGAs. Static and Dynamic Reconfiguration. Partitioning. Hardware/Software Portioning and Partial Evaluation.Systolic Architectures.

MEL* ZG573 Digital Signal Processing 3

Introduction; design of analog filters; design of digital filters: (IIR and FIR); structures for the realization of digital filters; random signals and random processes; linear estimation and prediction; Wiener filters; DSP processor architecture; DSP algorithms for different applications.

MEL* ZG611 IC Fabrication Technology 5

Material properties; Crystal growth and doping; diffusion; oxidation; epitaxy; Ion implantation; Deposition of films using CVD, LPCVD and sputtering techniques; Wet and dry etching and cleaning; Lithographic process; Device and circuit fabrication; Process modeling and simulation.

MEL* ZG613 Advanced Digital Signal Processing 4

Review of stochastic processes, models and model classification, the identification problem, some field of applications, classical methods of identification of impulse response and transfer function models, model learning techniques, linear least square estimator, minimum variance algorithm, stochastic approximation method and maximum likelihood method, simultaneous state and parameter estimation of extended kalmanfilter, non-linear identification, quasi linearization, numerical identification methods.

MEL* ZG621 VLSI Design 5

Introduction to NMOS and CMOS circuits; NMOS and CMOS processing technology; CMOS circuits and logic design; circuit characterization and performance estimation; Structured design and testing; Symbolic layout systems; CMOS subsystem design; System case studies.

MEL* ZG623 Advanced VLSI Design 5

Deep submicron device behavior and models, Interconnect modeling for parasitic estimation, Clock signals and system timing--Digital phase locked loop design, memory and array structures, Input/output circuits design, ASIC technology, FPGA technology, High speed arithmetic circuits design,-Parallel prefix computation, Logical effort in circuit design, Low power VLSI circuits-Adiabatic logic circuits, Multi threshold circuits, Digital BICMOS circuits, Design of VLSI systems.

MEL* ZG625 Advanced Analog and Mixed Signal Design 5

Design of high speed compartors and Op-amps; analog buffers; different architectures of A/D and D/A converters; analog multipliers and dividers; design of PLLS; design methods for switched capacitor filters sample and hold circuits; mixed signal design issues; noise coupling from substrate and its reduction; cross talk and shielding; analog layout techniques for mixed signal designs.

MEL* ZG631 Physics & Modelling of Microelectronic Devices 5

Physics and properties of semiconductor - a review; pn junction diode; bipolar transistor; metalsemiconductor contacts; JFET and MESFET; MOSFET and scaling; CCD and photonic devices.

MEL* ZG632 Analog IC Design 5

Basic concepts; BICMOS process and technology; current and voltage sources; Differential and Operational Amplifiers; Multipliers and modulators; phase-lock techniques; D-to-A

and A- to-D converters; Micropower circuits; High voltage circuits; Radiation Resistant Circuits; Filter design considerations.

MEL* ZG641 CAD for IC Design 5

Introduction to VLSI design methodologies and supporting CAD tool environment; Overview of `C', Data structure, Graphics and CIF; Concepts, structures and algorithms of some of the following CAD tools; Schematic editors; Layout editors; Module generators; Silicon compilers; Placement and routing tools; Behavioral, functional, logic and circuit simulators; Aids for test generation and testing.

MEL* ZG642 VLSI Architecture 4

Overview of CISC processor architectures; Instruction set architecture of CISC processor; hardware flow-charting methods; implementing microprocessor logic from hardware flowcharts; RISC instruction set architecture; pipelined execution of RISC instructions; pipeline execution unit design; control hazards; design of memory hierarchy.

MEL* ZG651 Hardware Software Co-Design 4

FPGA and ASIC based design, Low-Power Techniques in RT Embedded Systems On-chip networking. Hardware Software partitioning and scheduling, Co-simulation, synthesis and verifications, Architecture mapping, HW-SW Interfaces and Re-configurable computing.

MEL* ZG652 Networked Embedded Applications 4

Networked embedded systems, Clock synchronization, Protocol mechanisms protocol performance, CAN Bus architecture, USB Architecture, Embedded Internet, Distributed computing, Use of Java in building networked systems, Reliability & Fault Tolerance etc. Mission-critical distributed real-time applications, e.g., military, air traffic control; Prototyping benchmark applications, e.g. simulated air traffic visualization, radar display; Networking: TCP/IP, distributed objects; Embedded system programming and middleware: I/O, analog / digital conversion, DSP, runtime monitoring of CPU, processes, network equipment; Modeling distributed real-time systems; Quality of service maintenance.

MELWT ZG511 Design & Analysis of Algorithms 5

Design techniques such as divide-and-conquer, recursion, backtracking, branch-and-bound, simulation; Analysis in terms of average level and worst level efficiency; Relationship to appropriate data structures; Illustrations dealing with problems in computer science, graph theory and mathematics; Computational complexity and bounds; NP-hard and NP-complete problems.

MELWT ZG512 Embedded System Design 4

Introduction to embedded systems; embedded architectures: Architectures and programming of microcontrollers and DSPs. Embedded applications and technologies; power issues in system design; introduction to software and hardware co-design.

MELWT ZG531 Testability for VLSI 5

BIST, boundary sean, stuck-at faults, test generation algorithms for combinatorial logic circuits and sequential circuits, logic simulation and fault simulation, synthesis for test, built in self test, pseudo-random test techniques, other test methods - IDDQ testing, boundary scan etc.

MELWT ZG573 Digital Signal Processing 3

Introduction; design of analog filters; design of digital filters: (IIR and FIR); structures for the realization of digital filters; random signals and random processes; linear estimation and prediction; Wiener filters; DSP processor architecture; DSP algorithms for different applications.

MELWT ZG611 IC Fabrication Technology 5

Material properties; Crystal growth and doping; diffusion; oxidation; epitaxy; Ion implantation; Deposition of films using CVD, LPCVD and sputtering techniques; Wet and dry etching and cleaning; Lithographic process; Device and circuit fabrication; Process modeling and simulation.

MELWT ZG621 VLSI Design 5

Introduction to NMOS and CMOS circuits; NMOS and CMOS processing technology; CMOS circuits and logic design; circuit characterization and performance estimation; Structured design and testing; Symbolic layout systems; CMOS subsystem design; System case studies.

MELWT ZG625 Advanced Analog and Mixed Signal Design 5

Design of high speed compartors and Op-amps; analog buffers; different architectures of A/D and D/A converters; analog multipliers and dividers; design of PLLS; design methods for switched capacitor filters sample and hold circuits; mixed signal design issues; noise coupling from substrate and its reduction; cross talk and shielding; analog layout techniques for mixed signal designs.

MELWT ZG629T Dissertation 20

A student registered in this course must take a topic in an area of professional interest drawn from the on the job work requirement which is simultaneously of direct relevance to the degree pursued by the student as well as to the employing / collaborating organization of the student and submit a comprehensive report at the end of the semester working under the overall supervision and guidance of a professional expert who will be deemed as the supervisor for evaluation of all components of the dissertation. Normally the Mentor of the student would be the Dissertation supervisor and in case Mentor is not approved as the supervisor, Mentor may play the role of additional supervisor. The final grades for dissertation are Non-letter grades namely Excellent, Good, Fair and Poor, which do not go into CGPA computation.

MELWT ZG631 Physics & Modeling of Micro-Electronics Device 5

Physics and Properties of semiconductor - a review; PN junction diode; bipolar transistor; Metal-semiconductor contacts; JFET and MESFET; MOSFET and scaling; CCD and photonic devices.

MELWT ZG632 Analog IC Design 5

Basic concepts; BICMOS process and technology; current and voltage sources; Differential and Operational Amplifiers; Multipliers and modulators; phase-lock techniques; D-to-A and A- to-D converters; Micropower circuits; High voltage circuits; Radiation Resistant Circuits; Filter design considerations.

MELWT ZG641 CAD for IC Design 5

Introduction to VLSI design methodologies and supporting CAD tool environment; Overview of `C', Data structure, Graphics and CIF; Concepts, structures and algorithms of some of the following CAD tools; Schematic editors; Layout editors; Module generators; Silicon compilers; Placement and routing tools; Behavioral, functional, logic and circuit simulators; Aids for test generation and testing.

MELWT ZG642 VLSI Architecture 4

Overview of CISC processor architectures; Instruction set architecture of CISC processor; hardware flow-charting methods; implementing microprocessor logic from hardware flowcharts; RISC instruction set architecture; pipelined execution of RISC instructions; pipeline execution unit design; control hazards; design of memory hierarchy.

MELWT ZG651 Hardware Software Co-Design 4

FPGA and ASIC based design, Low-Power Techniques in RT Embedded Systems On-chip networking. Hardware Software partitioning and scheduling, Co-simulation, synthesis and verifications, Architecture mapping, HW-SW Interfaces and Re-configurable computing.

MELWT ZG659 Technical Communication 4

Role and importance of communication; effectiveness in oral and written communication; technical reports; technical proposals; technical descriptions; definitions and classifications; business correspondence; precis writing; memorandum; notices, agenda and minutes; oral communication related to meetings, seminars, conferences, group discussions, etc.; use of modern communication aids.

MEKE ZC211 Engineering Mathematics-I 3

Limit concept; derivatives of elementary functions and their applications; introduction to ordinary and partial differential equations and initial/boundary value problems. Convergence tests for series; power series and interval of convergence; series solution of differential equations. Approximation and error, interpolation; roots of algebraic and transcendental functions, Newton's method.

MEKE ZC212 Engineering Mathematics-II 3

Algebra of vectors and matrices; Gauss's row-reduction process; applications of simultaneous linear equations and matrix inversion; determinants and Cramer's rule. Numerical differentiation and integration; numerical methods for solving ordinary and partial differential equations.

MEKE ZC221 Computer Programming 3

Elementary computer organization; introduction to Number Systems; Representation of integers, real numbers and characters on computers; concept of range and accuracy; Arithmetic Overflow; Algorithms and algorithm development; structured program development through step wise refinement. Introduction to C language; Functions; Recursion; Data structure & algorithms; File management & file handling; Problem solving using C.

MEKE ZC222 Engineering Materials 3

Mechanical, electrical, electronic and chemical properties and applications of common engineering materials; ferrous and non- ferrous metals and alloys; thermosetting and thermoplastic plastics; natural and synthetic resins; rubber; glass; abrasives and ceramics; common building materials, namely, timber, stone, lime and cement; corrosion of metals and methods of preventing corrosion; protective and decorative coatings; insulating materials; testing of materials.

MEKE ZC231 Principles of Management 3

Fundamental concepts of management - planning; organizing; staffing; directing and controlling; production, financial, personnel, legal and marketing functions; accounting and budgeting, balance sheets.

MEKE ZC232 Engineering Measurements and Techniques 3

Performance characteristics of measuring instruments, measurement methods for mechanical, electrical, radiant, chemical, magnetic and thermal energy variables. Emphasis in this course shall be on the operation and use of instruments.

MEKE ZC241 Technical Report Writing 3

Elements of effective writing; art of condensation; business letter writing; memos; formal reports; technical proposals; conducting, and participating, meetings; agenda and minutes; strategies for writing technical descriptions, definitions, and classifications; oral presentation; use of graphic and audio- visual aids; editing.

MEKE ZC242 Manufacturing Process 3

Fundamentals of casting process; forging; powder metallurgy; soldering; brazing and welding technology; metal forming process, its analysis and design; Introduction to Metal cutting, machine tools; mechanics of metal cutting; other machining processes; grinding and finishing operations; non convention machining; chipless machining processes; NC machines programming; control system in CNC; CNC, DNC; FMS and machining center.

MEKE ZC251 Mechanical Technology 3

Fundamental concepts of heat, work and energy; second law of thermodynamics; properties of gases and vapors; basic cycles; flow of liquids; steam boilers; steam engines and pumps; steam turbines and condensers; hydraulic pumps and turbines; internal combustion engine.

MEKE ZC252 Production and Operations Management 3

Production & Operation Management functions; capacity requirement planning; inventory control; layout, handling & location decision; resource procurement & operation control; project scheduling & resource allocation; the production & operating function; Methods of forecasting demand; financial analysis of operating plans; determination of economic order quantity; development of efficient work methods.

MEKE ZC311 Automobile Technology –I 3

Introduction; working and construction of IC Engines; its components; cycles; fuel air cycle; diesel cycles; combustion in SI and CI Engines; fuels and combustion; fuel supply systems; scavenging process; engine cooling and lubrication; engine cooling system, friction and lubrication, engine testing and performance; super charging, analytical method of performance and estimation; emission controls; alternate fuels; modern trends in engine development.

MEKE ZC312 Automobile Technology-II 3

Vehicle classification; chassis construction; clutches-friction clutches, fluid coupling; gear box-arrangement and design of gear boxes; epicyclical gear box; torque converters, semiautomatic and automatic gear boxes; propeller shaft; universal joint; differential; rear axle suspension systems; front axle and steering mechanisms – power steering mechanism; brakes –mechanical, hydraulic and air brakes; servo and power operated brake systems; wheels and tyres; testing and performance of automobiles; vehicle vibration; and human comfort; auto-electrical systems; ignition system-conventional and

electronic system, alternators; charging system; storage batteries; wiper motors; lighting system; electronic system, alternators; charging system; storage batteries; wiper motors; lighting system; electrical vehicles; automobile law.

MEKE ZC321 Quality Assurance and Reliability 3

Basic concepts of probability and probability distributions, standard probability distribution, sampling and sampling distributions, confidence intervals, testing significance, statistical tolerance, various types of control charts, statistical process control techniques, value analysis, defect diagnosis and prevention, basic concepts of reliability, reliability design evaluation and control, methods of applying total quality management, production process.

MEKE ZC322 Materials Management 3

Integrated Materials Management; Materials planning and Control; Inventory Control Techniques Materials Development and Management Purchase Management; Stores Management and Retrieval Systems JIT and MRP Systems; Materials Management and Legal Environment; Value Analysis; Price Negotiation Strategies; Information Systems for Effective Materials management.

MEKE ZC331 Production Planning & Control 3

Generalized model of production systems; types of production flows; life cycle concepts; facilities location and layout planning; aggregate and batch production planning; inventory systems; materials requirements planning; elements of monitoring & production control.

MEKE ZC332 Operations Research 3

Sampling, simulation, design of experiments and analysis of variance, nonparametric tests; correlation and regression analysis; quality control, reliability; decision theory; queuing theory; deterministic and probabilistic inventory systems.

MEKE ZC341 Mechatronics 3

Basic Electricity – electrical parameters like voltage, current, resistance, AC/DC supply: electrical circuit; electromagnetism, its circuits, introduction to single phase and three phase supply, electrical components – relays, MCB, limit switches etc; transformers; elimination; electrical motors – types like induction motors, synchronous machines etc;, its speed control; introduction to electronic devices; semiconductor devices; SCRs, electronic circuits – power supplies, sensing devices; timers; industrial electronics and its application for heating, measuring / gauging etc., Introduction and application of PLCs; introduction to microprocessors; application in an industry Oil hydraulics; fluid logics; hydraulic elements like reservoir, fluid conditioners, pressure control valves, directional control valves and flow control valves; Basic hydraulic circuits for application in machine tools; Pneumatics, its principle, logics, pneumatic elements, basic pneumatic circuits used in machine tools.

MEKE ZC342 Machine Design 3

Fundamentals and principles of design, design and selection of machine elements such as shafts, spindle supports, gears, bearings; etc; design of mechanism; design of machine tool structure; dynamics of machine tools; introduction to CAD, CAM, CIM; Design of jigs and fixtures; press tools for blanking; punching; drawing; combination tools and progressive tools.

MEKE ZC351 Industrial Engineering 3

Industrial systems and organization; engineering economy; work measurement techniques; motivation and time studies; factory planning and materials handling; industrial standardization; critical path methods; quality control; reliability; maintenance and management planning; scheduling; job analysis (evaluation); value engineering.

MEKE ZC352 Maintenance Engineering and Safety 3

Basic maintenance systems and practice; maintenance planning; estimating and budgeting; scheduling maintenance jobs; importance of safety; factors affecting safety; safety aspects of site and plant; hazards of commercial chemical reaction and operation; instrumentation for safe operation; safety education and training; personnel safety; disaster planning and measuring safety effectiveness; future trends in industrial safety; maintenance of components and equipments; new dimensions in maintenance covering plant engineering, tribology, materials technology, terotechnology (life cycle costing) etc.; extensive case studies.

MEKE ZC423T Project Work 20

Consistent with the student's professional background and work-environment, the student will be required to carry out work-oriented

projects. The student would be required to select an area of work that is considered vital to the sponsoring organization. The topic of the project and detailed project outline that is prepared by the student, in consultation with his/her Mentor, needs to be approved by the Dean, WILPD. On approval, the student carries on with the work-centered project, adhering to the guidelines provided in the detailed course handout, taking all the prescribed evaluation components on time. At the end of the semester, the student should submit a comprehensive Project Report, to the Institute for evaluation. The student will be evaluated on the basis of the various interim evaluation components, contents of the report and Seminar/Viva-Voce that may be conducted at Pilani or at any other Centre approved by the Institute.

META ZC211 Engineering Mathematics-I 3

Limit concept; derivatives of elementary functions and their applications; introduction to ordinary and partial differential equations and initial/boundary value problems. Convergence tests for series; power series and interval of convergence; series solution of differential equations. Approximation and error, interpolation; roots of algebraic and transcendental functions, Newton's method.

META ZC212 Engineering Mathematics-II 3

Algebra of vectors and matrices; Gauss's row-reduction process; applications of simultaneous linear equations and matrix inversion; determinants and Cramer's rule. Numerical differentiation and integration; numerical methods for solving ordinary and partial differential equations.

META ZC221 Computer Programming 3

Elementary computer organization; introduction to Number Systems; Representation of integers, real numbers and characters on computers; concept of range and accuracy; Arithmetic Overflow; Algorithms and algorithm development; structured program development through step wise refinement. Introduction to C language; Functions; Recursion; Data structure & algorithms; File management & file handling; Problem solving using C.

META ZC222 Engineering Materials 3

Mechanical, electrical, electronic and chemical properties and applications of common engineering materials; ferrous and non- ferrous metals and alloys; thermosetting and thermoplastic plastics; natural and synthetic resins; rubber; glass; abrasives and ceramics; common building materials, namely, timber, stone, lime and cement; corrosion of metals and methods of preventing corrosion; protective and decorative coatings; insulating materials; testing of materials.

META ZC231 Principles of Management 3

Fundamental concepts of management - planning; organizing; staffing; directing and controlling; production, financial, personnel, legal and marketing functions; accounting and budgeting, balance sheets.

META ZC232 Engineering Measurements and Techniques 3

Performance characteristics of measuring instruments, measurement methods for mechanical, electrical, radiant, chemical, magnetic and thermal energy variables. Emphasis in this course shall be on the operation and use of instruments.

META ZC241 Technical Report Writing 3

Elements of effective writing; art of condensation; business letter writing; memos; formal reports; technical proposals; conducting, and participating, meetings; agenda and minutes; strategies for writing technical descriptions, definitions, and classifications; oral presentation; use of graphic and audio- visual aids; editing.

META ZC242 Manufacturing Process 3

Fundamentals of casting process; forging; powder metallurgy; soldering; brazing and welding technology; metal forming process, its analysis and design; Introduction to Metal cutting, machine tools; mechanics of metal cutting; other machining processes; grinding and finishing operations; non convention machining; chipless machining processes; NC machines programming; control system in CNC; CNC, DNC; FMS and machining center.

META ZC251 Mechanical Technology 3

Fundamental concepts of heat, work and energy; second law of thermodynamics; properties of gases and vapors; basic cycles; flow of liquids; steam boilers; steam engines and pumps; steam turbines and condensers; hydraulic pumps and turbines; internal combustion engine.

META ZC252 Production and Operations Management 3

Production & Operation Management functions; capacity requirement planning; inventory control; layout, handling & location decision; resource procurement & operation control; project scheduling & resource allocation; the production & operating function; Methods of forecasting demand; financial analysis of operating plans; determination of economic order quantity; development of efficient work methods.

META ZC311 Automobile Technology –I 3

Introduction; working and construction of IC Engines; its components; cycles; fuel air cycle; diesel cycles; combustion in SI and CI Engines; fuels and combustion; fuel supply systems; scavenging process; engine cooling and lubrication; engine cooling system, friction and lubrication, engine testing and performance; super charging, analytical method of performance and estimation; emission controls; alternate fuels; modern trends in engine development.

META ZC312 Automobile Technology-II 3

Vehicle classification; chassis construction; clutches-friction clutches, fluid coupling; gear box-arrangement and design of gear boxes; epicyclical gear box; torque converters, semiautomatic and automatic gear boxes; propeller shaft; universal joint; differential; rear axle suspension systems; front axle and steering mechanisms – power steering mechanism; brakes –mechanical, hydraulic and air brakes; servo and power operated brake systems; wheels and tyres; testing and performance of automobiles; vehicle vibration; and human comfort; auto-electrical systems; ignition system-conventional and electronic system, alternators; charging system; storage batteries; wiper motors; lighting system; electrical vehicles; automobile law.

META ZC321 Quality Assurance and Reliability 3

Basic concepts of probability and probability distributions, standard probability distribution, sampling and sampling distributions, confidence intervals, testing significance, statistical tolerance, various types of control charts, statistical process control techniques, value analysis, defect diagnosis and prevention, basic concepts of reliability, reliability design evaluation and control, methods of applying total quality management, production process.

META ZC322 Materials Management 3

Integrated Materials Management; Materials planning and Control; Inventory Control Techniques Materials Development and Management Purchase Management; Stores Management and Retrieval Systems JIT and MRP Systems; Materials Management and Legal Environment; Value Analysis; Price Negotiation Strategies; Information Systems for Effective Materials management.

META ZC331 Production Planning & Control 3

Generalized model of production systems; types of production flows; life cycle concepts; facilities location and layout planning; aggregate and batch production planning; inventory systems; materials requirements planning; elements of monitoring & production control.

META ZC332 Operations Research 3

Sampling, simulation, design of experiments and analysis of variance, nonparametric tests; correlation and regression analysis; quality control, reliability; decision theory; queuing theory; deterministic and probabilistic inventory systems.

META ZC341 Mechatronics 3

Basic Electricity – electrical parameters like voltage, current, resistance, AC/DC supply: electrical circuit; electromagnetism, its circuits, introduction to single phase and three phase supply, electrical components – relays, MCB, limit switches etc; transformers; elimination; electrical motors – types like induction motors, synchronous machines etc;, its speed control; introduction to electronic devices; semiconductor devices; SCRs, electronic circuits – power supplies, sensing devices; timers; industrial electronics and its application for heating, measuring / gauging etc., Introduction and application of PLCs; introduction to microprocessors; application in an industry Oil hydraulics; fluid logics; hydraulic elements like reservoir, fluid conditioners, pressure control valves, directional control valves and flow control valves; Basic hydraulic circuits for application in machine tools; Pneumatics, its principle, logics, pneumatic elements, basic pneumatic circuits used in machine tools.

META ZC342 Machine Design 3

Fundamentals and principles of design, design and selection of machine elements such as shafts, spindle supports, gears, bearings; etc; design of mechanism; design of machine tool structure; dynamics of machine tools; introduction to CAD, CAM, CIM; Design of jigs and fixtures; press tools for blanking; punching; drawing; combination tools and progressive tools.

META ZC351 Industrial Engineering 3

Industrial systems and organization; engineering economy; work measurement techniques; motivation and time studies; factory planning and materials handling; industrial standardization; critical path methods; quality control; reliability; maintenance and management planning; scheduling; job analysis (evaluation); value engineering.

META ZC352 Maintenance Engineering and Safety 3

Basic maintenance systems and practice; maintenance planning; estimating and budgeting; scheduling maintenance jobs; importance of safety; factors affecting safety; safety aspects of site and plant; hazards of commercial chemical reaction and operation; instrumentation for safe operation; safety education and training; personnel safety; disaster planning and measuring safety effectiveness; future trends in industrial safety; maintenance of components and equipments; new dimensions in maintenance covering plant engineering, tribology, materials technology, terotechnology (life cycle costing) etc.; extensive case studies.

META ZC423T Project Work 20

Consistent with the student's professional background and work-environment, the student will be required to carry out work-oriented projects. The student would be required to select an area of work that is considered vital to the sponsoring organization. The topic of the project and detailed project outline that is prepared by the student, in consultation with his/her Mentor, needs to be approved by the Dean, WILPD. On approval, the student carries on with the work-centered project, adhering to the guidelines provided in the detailed course handout, taking all the prescribed evaluation components on time. At the end of the semester, the student should submit a comprehensive Project Report, to the Institute for evaluation. The student will be evaluated on the basis of the various interim evaluation components, contents of the report and Seminar/Viva-Voce that may be conducted at Pilani or at any other Centre approved by the Institute.

MGTS ZC211 Principles of Management 3

Fundamental concepts of management - planning; organizing; staffing; directing and controlling; production, financial, personnel, legal and marketing functions; accounting and budgeting, balance sheets.

MM ZC411 Marketing 4

Definition and scope, consumer behavior, competitive behavior, demand estimation, new product introduction, product/brand management, pricing policies, channels of distribution, credit management, advertising and other sales promotion, positioning, marketing regulation, market research basics of industrial marketing.

MM ZC412 Flexible Manufacturing Systems 4

Introduction CAD/CAM systems, overview of FMS, system hardware and general functions, material handling system, work holding systems, cutting tools and tool management, physical planning of system, software structure functions and description, cleaning and automated inspection, communications and computer networks for manufacturing, quantification of flexibility, human factors in manufacturing, FMS and CIM in action (case studies), justification of FMS, modelling for design, planning and operation of FMS.

MM ZC441 Human Resource Management 4

Introduction, manpower planning, career and succession planning, procurement of personnel, performance appraisal, job satisfaction and morale, job rotation, employee communication, audit and control, management training and development, wage and salary administration, welfare administration, trade unions and collective bargaining, industrial dispute and worker participation in management.

MM ZG511 Manufacturing Organization and Management 5

Manufacturing environment; Engineering considerations; Design and planning of manufacturing systems; Manufacturing cost control; Material flow control; Quality; Human

resources; Financial management; Marketing management.

MM ZG512 Manufacturing Strategy 4

Corporate strategy; Missing links in manufacturing strategy; Audit approach; Restructuring; Manufacturing strategy process in practice; Formulation as a process; Operating strategies; Methodology framework; Lean production; Competitive priorities; Strategic value of response time and product variety; Flexibility in context of manufacturing strategy; Manufacturing focus; Business process reengineering; Theory of constraints; Link between strategy and organizational culture; Evolution of manufacturing systems; Operations management strategic perspective.

MM ZG513 Maintenance Engineering 5

Introduction, maintenance systems, methods and tools of maintenance analysis, eliability and safety, maintainability, supportability, design for maintenance, maintenance integration, computerized maintenance management systems, TPM, world-class maintenance systems, and maintenance effectiveness and performance evaluation.

MM ZG514 Leadership and Managing Change 4

Individuals as leaders, team leadership and organizational leadership. Introduction to managing change, management of change : organizational structure, culture, recruitment, performance management, human resource development, reward management, employee relations and involvement, downsizing, and evaluating and promoting.

MM ZG515 Quantitative Methods 4

Basic concepts in Operations Research; Analytical & Mathematical Modeling Techniques; Model Building; Inventory Control, queuing theory; Linear Programming; Transportation and assignment problems, simulation, index numbers, decision theory, etc.

MM ZG521 Financial Management 4

Concepts and techniques of financial management decision; concepts in valuation - time value of money; valuation of a firm's stock, capital asset pricing model; investment in assets and required returns; risk analysis; financing and dividend policies, capital structure decision; working capital management, management of cash, management of accounts receivable; inventory management, short and intermediate term financing, long term financial tools of financial analysis, financial ratio analysis, funds analysis and financial forecasting, operating and financial leverages.

MM ZG522 Total Quality Management 4

TQM principles and practices; leadership; customer satisfaction; employee involvement; continuous process improvement; supplier partnership; performance measures; statistical process control; ISO 9000; benchmarking; quality function deployment; concurrent engineering; experimental design; Taguchi's quality engineering; product liability

MM ZG523 Project Management 4

Concepts and techniques of project formulation, evaluation and implementation; Project planning and scheduling; Risk management; Time-cost trade off; Resource leveling and allocation; Project monitoring and control; Contract management.

MM ZG525 World Class Manufacturing 5

The world-class manufacturing challenge, developing a world-class manufacturing strategy, just-in-time, total quality, total employee envolvement, world-class information systems, managing the change, methods and procedures; improved brainstorming methods, using the check-total quality - the first steps, getting people involved, monitoring world-class performance.

MM ZG526 Operations Management 4

Production systems; operations strategy; product and process design; facility location & layout; capacity planning; aggregate planning; operations scheduling and control; productivity of operations; inventory planning & independent demand systems; MRP; quality management; project management; Japanese approach to operations management (JIT, TPM, continuous improvement).

MM ZG527 Decision Engineering 4

Course description to be developed.

MM ZG533 Manufacturing Planning & Control 5

Planning and control of manufacturing operations; material flow planning; product and process planning; demand forecasting and forecasting

models; facility location; plant layout planning and design; machine cells; capacity planning; designing work methods; material handling; line balancing; aggregate planning; inventory models and systems for independent demand; materials requirements planning; elements of monitoring and production control; current developments in operations management.

MM ZG534 Sustainable Manufacturing 4

Introduction to sustainable manufacturing, sustainable manufacturing design, practice and matrices, life cycle management and assessment, end of life (EOL) strategies, implementation framework, sustainable business models, waste minimization, case studies.

MM ZG535 Decision Analysis 4

Introduction to quantitative techniques and statistics, Decision making, intelligence design and choice phases, basic theory of decision making under uncertainty; decision trees, qualification of judgments and preferences, Bayes theorem, the structuring of complex decisions, and multi-attribute utility theory. Statistical estimation and forecasting.

MM ZG537 Lean Manufacturing 5

Course description to be developed.

MM ZG538 Toyota Production System 5

Birth of Toyota production system, house of Toyota production system, stability, standardization, just-in-time, jidoka, involvement, hoshin planning, Toyota culture, Toyota way, Case Studies.

MM ZG541 Product Design 5

Introduction to creative design; user research and requirements analysis, product specifications, Computer Aided Design; standardization, variety reduction, preferred numbers and other techniques; modular design; design economics, cost analysis, cost reduction and value analysis techniques, design for production; human factors in design: anthropometric, ergonomic, psychol giccl, physiological considerations in design decision making; legal factors, engineering ethics and society.

MM ZG611 Strategic Management & Business Policy 4

Strategic management elements; internal, external, external environment. assessment of corporate strengths, weaknesses and opportunities; planning and deployment of capital assets; profit planning and control functions problems, pressures, responsibilities, limits of the chief executive; evaluation of one's own business undertaking; formulating objectives, strategies, policies and programmes for improving company's present situation; personnel strength and implementation of the policies and programmes, development, implementation, evaluation and control of strategies, strategic management of MNCs, management style and behavior, corporate style, behavior and culture.

MM ZG621 Supply Chain Management 4

Customer driven strategies in production and distribution systems; Integrated production and distribution networks; SCM in the context of JIT and MRP–II; Distribution Resource Planning; Management of dealer networks; Total Control & Product innovation across the supply chain; Incoming logistics and supplier relationships; Value addition analysis; Metrics for management of supply chain performance; Mathematical models and computer assisted decision support for SCM; Mathematical programming for SCM.

MM ZG627Managerial Corporate Finance 4

Introduction to corporate finance; financial statements - analysis and interpretation; value creation – ways and means; time value of money; risk and return; understanding and analyzing various cost concepts and behaviour; analysis and impact of leverage; cost of capital; project appraisal and management - emphasis on technology projects (Diamond framework: NTPC - Novelty, Technology, Pace and Complexity); dimensions of adaptive technology project management; measuring and controlling assets employed in a project; project risk analysis; management control of projects; project financing – leasing and hire purchase; management control system - budget preparation; analyzing financial performance reports (variance analysis) and performance measurement system; working capital management – managing operating capital.

MM ZG628T Dissertation 16

A student registered in this course must take a topic in an area of professional interest drawn from the on the job work requirement which is simultaneously of direct relevance to the degree pursued by the student as well as to the

employing / collaborating organization of the student and submit a comprehensive report at the end of the semester working under the overall supervision and guidance of a professional expert who will be deemed as the supervisor for evaluation of all components of the dissertation. Normally the Mentor of the student would be the Dissertation supervisor and in case Mentor is not approved as the supervisor, Mentor may play the role of additional supervisor. The final grades for dissertation are Non-letter grades namely Excellent, Good, Fair and Poor, which do not go into CGPA computation.

MT* ZC342 Machine Design 4

Fundamentals and principles of design, design and selection of machine elements such as shafts, spindle supports, gears, bearings; etc; design of mechanism; design of machine tool structure; dynamics of machine tools; introduction to CAD, CAM, CIM; Design of jigs and fixtures; press tools for blanking; punching; drawing; combination tools and progressive tools. Machine Drawing of part and assembly drawing using Pro/Engineer (CREO) or similar software tools are to be conducted.

MT* ZC344 Metal Forming and Machining 4

Metal forming: introduction, metal forming machines, metal forming process analysis and design. Machining: introduction, metal cutting machine tools, mechanics of metal cutting, other aspects of machining processes, grinding and finishing operations, non-conventional machining processes and processing of plastics. It may consist of virtual practical work using software tool CNC Simulator-Pro (http://cncsimulator.info/). Similarly we need to get metal forming process animations in 3DS-Max, Maya or similar software tools. Virtual simulation of metal forming and machining processes.

MT* ZC345 Casting and Welding 4

Casting: fundamentals of casting processes, design of castings, furnaces, foundry mechanization, special casting processes, economics of casting, inspection and defects of casting. Powder metallurgy: introduction, methods of powder production, characteristics and properties of powder, manufacturing methods, furnaces, finishing processes, economics of powder metallurgy. Welding: various welding processes, design for welding, safe practices in welding, inspection and defects of welding, economics of welding, brazing and soldering. Virtual simulation of casting and welding processes.

MT* ZC331 Production Planning & Control 4

Types of production systems and problems of planning and control, product planning, forecasting, product demand, process planning, project management, capacities location and layout of facilities, aggregate planning and scheduling, materials requirement, planning, inventory management, systems and recent trends in production management. Simulations using software tools such as FlexSim or Quest may be conducted.

MT* ZC418 Lean Manufacturing 4

Fundamentals of continuous improvement, value added and waste elimination, elements of lean production: small lot production, setup time reduction, maintaining and improving equipment, pull production systems, focused factories and group technologies, work cells and cellular manufacturing, standard operations, quality of design, systems for eliminating defects, simplified production planning and control systems: scheduling for smooth flow, synchronizing and balancing process, planning and control in pull production, beyond the production systems: managing the supply chain, activity based costing, performance measurement. Logistics case studies using software tools such as FlexSim may be conducted.

MT* ZC412 Flexible Manufacturing Systems 4

Introduction CAD/CAM systems, overview of FMS, system hardware and general functions, material handling system, work holding systems, cutting tools and tool management, physical planning of system, software structure functions and description, cleaning and automated inspection, communications and computer networks for manufacturing, quantification of flexibility, human factors in manufacturing, FMS and CIM in action (case studies), justification of FMS, modelling for design, planning and operation of FMS. FlexSim/Quest based simulations.

MT* ZC324 Mechatronics & Automation 4

Introduction to mechatronics, sensors and transducers, Concepts of measurement of electrical and nonelectrical parameters; displacement, force, pressure etc. and related

signal conditioning techniques , pneumatic and hydraulic actuation systems, mechanical actuation systems, electrical actuation systems, digital logic, microprocessors and programmable logic controllers; Introduction to automation, control loops for numerical control systems, adaptive control systems, industrial robots, automatic identification and data capture, automated production lines and automated assembly systems, System design concepts through case studies. Virtual demonstration of mechatronics elements, their assembly to obtain devices and products etc.

MT* ZC343 Materials Management 4

Integrated materials management, policy aspects, purchasing management, warehousing and storage of inventory control systems; stores management; material planning, make or buy decisions; scheduling, strategic sourcing, JIT, Kanban system; inventory costing principle; concept of MRP II; vendor development; central excise, customs, importing, sales tax. FlexSim/Quest based simulations.

MT* ZC471 Manufacturing Excellence 4

Introduction, frameworks of manufacturing excellence, practices for manufacturing excellence: leadership and change management, manufacturing strategy, innovative product planning, total productive maintenance, total quality management, lean manufacturing, customer relations management, green manufacturing, supply chain management, knowledge management and social responsibility. FlexSim/Quest based simulations.

MT* ZC311 Automobile Technology-I 4

Introduction; working and construction of IC Engines; its components; cycles; fuel air cycle; diesel cycles; combustion in SI and CI Engines; fuels and combustion; fuel supply systems; scavenging process; engine cooling and lubrication; engine cooling system, friction and lubrication, engine testing and performance; super charging, analytical method of performance and estimation; emission controls; alternate fuels; modern trends in engine development. Virtual demonstration of automobile parts and assemblies may be demonstrated. Some amount of Pro/Engineer (CREO) modeling of automobile structures may be practiced.

MT* ZC312 Automobile Technology-II 4

Vehicle classification; chassis construction; clutches-friction clutches, fluid coupling; gear boxarrangement and design of gear boxes; epicyclical gear box; torque converters, semiautomatic and automatic gear boxes; propeller shaft; universal joint; differential; rear axle suspension systems; front axle and steering mechanisms – power steering mechanism; brakes –mechanical, hydraulic and air brakes; servo and power operated brake systems; wheels and tyres; testing and performance of automobiles; vehicle vibration; and human comfort; auto-electrical systems; ignition system-conventional and electronic system, alternators; charging system; storage batteries; wiper motors; lighting system; electrical vehicles; automobile law. Virtual demonstration of automobile parts and assemblies may be demonstrated. Some amount of Pro/Engineer (CREO) modeling of automobile structures may be practiced.

MT* ZC332 Operations Research 4

Sampling, simulation, design of experiments and analysis of variance, nonparametric tests; correlation and regression analysis; quality control, reliability; decision theory; queuing theory; deterministic and probabilistic inventory systems. FlexSim and Lingo/Lindo based virtual simulations.

MT* ZC434, Quality Control, Assurance & Reliability 4

Basic concepts of probability and probability distributions, standard probability distribution, sampling and sampling distributions, confidence intervals, testing significance, statistical tolerance, various types of control charts, statistical process control techniques, value analysis, defect diagnosis and prevention, basic concepts of reliability, reliability design evaluation and control, methods of applying total quality management, production process. Practical assignments on statistical quality control using suitable statistical software tools such as R-software, MS Excel, SAS, Minitab or SPSS.

NCSM ZG511 History of Science & Technology 4

Scientific traditions, philosophy of science; case studies on evolution concepts and method of science; landmarks of Indian science & technology in ancient & medieval periods; scientific revolution and industrial revolution in

Western countries and their effect in colonial India; evolution of S&T museums.

NCSM ZG521 Concepts in Science Communication 3

Introduction to communication in S&T; historical development of communication in science; growth of scientific languages; different modes of communication –print, electronic, audio-visual & interactive; evolution of exhibit ideas and activities from everyday observations; creative thinking and criteria of creativity; passive, active and interactive exhibits; role of interaction and participation in learning process; development of exhibits /activities on socially relevant themes.

NCSM ZG531 Technical Communication 4

Role and importance of communication; theories and process of communication; different modes and media of communication; effectiveness in oral and written communication; technical reports; technical proposals; technical descriptions; business correspondence; precis writing; memorandum; notices, agenda and minutes; popular science writing, captions/label writing – exhibit specific; oral communication related to meetings, seminars, conferences, group discussions, etc.; use of modern communication aids.

NCSM ZG541 Professional Skills & Techniques-I 4

Design of animated and working exhibits involving mechanical systems and drives; mechanical, optical, Polaroid animation; design of electro-mechanical animation involving power control circuits, electronic control circuits and sequential switching operations using relays, solid state devices; integrated circuits and microprocessor and transducers of different types; concepts in design, design assignments; R&D work leading to development of new concepts and techniques for animated and interactive exhibits; laboratory and project work.

NCSM ZG512 Museum Planning & Organization 4

Methods of planning and theories of management as applicable to development of science museums; safety measures in museums; organization of science popularization network; leadership, decision making and creative planning, financial control and material management; project management; audience research; evaluation and monitoring of activities; use of computer in management and monitoring.

NCSM ZG522 Exhibits & Presentation 3

Exhibits planning, design & evaluation; presentation methods and techniques; types of exhibits & exhibitions; types of learning resources; visitors circulation; colour; illumination; aesthetics; visual communication; ancillary aids; media selection; material study; delivery systems; publication; exposure to photography; silk-screen printing; fibre-glass moulding & casting; video production; digital printing.s

NCSM ZG532 Science Communication & IT 4

Computer concepts; computer languages; operating systems; application programmes; software & hardware basics; data analysis; prototyping. IT in Science communication.

NCSM ZG542 Professional Skills & Techniques-II 4

Basics of Science journalism; basics of presentation and public speaking; popular science writing, script writing, science advertising; label writing; composition and techniques of slide/video demonstrations; video camera operation, editing and special effects, music and synchronized narration; basics of film animation and computer graphics; elements of computer multimedia and CAD; operation and maintenance of equipments; project work.

NCSM ZG611 Museum Management & Operations 4

Organization fundamentals; administration functions; networking operations; execution; man-management; events management; marketing & P.R.; accounting basics; financial aspects; recruitment & training; job evaluation. IPR issues; Procurement, storage and management of collections and exhibits; code of ethics; Maintenance and conservation techniques for S&T objects; methods of documentation of objects; use of computer/video/CD ROM in documentation of objects; security & safety; archiving.

NCSM ZG621 Science Learning in Non Formal Settings 4

Concepts in formal & non-formal education; human psychology and role of creative play; educational technology; teaching-learning process in science museum; development of concepts and

themes of educational aids and supporting programs for teachers; mass communication through traveling exhibitions, demonstrations, science drama, puppetry, science fairs/seminars, polyvalent adult education programmes and people science movement; development of new concepts.

NCSM ZG631 Science & Society 3

Science & Society relationship; impact of Science & Technology in society; appropriate technology, role of society in the development of science; scientific temper and public view of science; ethical issues and values in modern science; science policy studies; Science for citizens; relationship amongst science, culture and mass media; gender and S&T.

NCSM ZG641 Professional Skills & Techniques-III 4

Animated and interactive exhibits; Multimedia with CD ROM, DVI, CDI; virtual presentation; development of software for educational and interactive programs; systems operation and maintenance; electronic, multimedia animation techniques; project work.

NCSM ZG629T Dissertation 20

A student registered in this course must take a topic in an area of professional interest drawn from the on the job work requirement which is simultaneously of direct relevance to the degree pursued by the student as well as to the employing / collaborating organization of the student and submit a comprehensive report at the end of the semester.

OPLVP ZC111 Introductory Optometry 2

Basic principles of Optometry; Optometric terminology; Vision Screening; Introduction to Optometric instruments; Overview of the history of the profession, Orientation of profession of Optometry, Review of the current modalities of clinical practice.

OPLVP ZC112 General Anatomy 2

Tissues of Body, General Plan of Organ System, Cell structure, and other anatomical aspects of vital organs of body.

OPLVP ZC113 Remedial Mathematics 2

Basic mathematical concepts from algebra, trigonometry and calculus.

OPLVP ZC114 Remedial Biology 2

Living systems and their properties; major biological compounds; basic physiological processes; introduction to genetics; environment and evolution.

OPLVP ZC121 Ocular Anatomy 2

Anatomy & Embryology of Sclera, cornea, Uvea, retina & visual pathway.

OPLVP ZC 122 General Physiology 5

Cell physiology, Blood, Digestion, Excretion, Endocrines, Reproduction circulation, Nervous System & Special Senses.

OPLVP ZC 131 Ocular Physiology 3

Protective Mechanism in the eye, extraocular muscle, physiology, lens metabolism, Refractive Errors, Visual Acuity, color vision.

OPLVP ZC132 Pharmacology 2

Mechanism of drug action, Dose response relationship, Tachyphylaxis, Pharmacokinetics of drug absorption, distribution, biotransformation; Principles of ocular pharmacology, Optometric diagnostic drugs.

OPLVP ZC141 Physical Optics 4

Nature of light, Interference, Diffraction, Polarization, Laser Optics, Spectrum, Scattering, Surface tension, Viscosity, Newton's rings, Grating, Resolving power of a telescope.

OPLVP ZC142 Basic Biochemistry II 3

Hormones and metabolic regulation; Whole body metabolism; Ocular Biochemistry - aspect of eye, viz. tears, cornea, lens, aqueous, vitreous, retina and pigment Rhodopsin; Biochemistry techniques; Clinical Biochemistry.

OPLVP ZC151 Basic Biochemistry I 3

Chemistry and functions of constituents of cells and tissues; Introduction to Carbohydrates; Proteins; Lipids; Enzymes; Vitamins; Minerals.

OPLVP ZC152 Pathology & Microbiology 3

Inflammation & repair, Infection, Neoplasia, Circulatory disturbances, Clinical pathology, Principles of cultivation of bacteria, sterilization and disinfection.

OPLVP ZC161 Functional English & Communication 3

Grammar in usage - Tenses, Prepositions, Phrasal verbs; Communication - Process,

Speaking, Listening, Reading, Memory, Self image; Comprehension, Precis writing; Report writing.

OPLVP ZC162 Mathematics II 2

Heuristic approach to manipulations with sets; language of logic; vectors and matrices, elementary applications; simplex method for a linear programming problem; elementary probability and statistical tools for tests of significance; game theory; graphs and networks; applications to behavioral and managerial sciences.

OPLVP ZC171 Mathematics I 2

Limits; sequences and series; continuity and differentiability of real valued functions of a real variable; integration; applications of derivatives and integrals; linear differential equations with constant coefficients; analytical geometry of conics.

OPLVP ZC172 Geometric Optics II 3

Stile Grawford Effect, Ametropia, Correction of Spherical Ametropia, Magnification, Presbyopia, Aphakia Spherometer & lens gauge, Critical Angle; spectrometer, Facimeter Refractive Index of lenses.

OPLVP ZC181 Geometric Optics I 4

Photometry, Refraction through Spherical Surfaces, Aberration, Fiber Optics, Color theory, Lens Power, Prismatic Power, Gull strands, Schematic Eye, Visual Acuity.

OPLVP ZC182 Hospital Procedures 1

Administration, Bioengineering department, Medical Records, Reception, Computer, Appointment scheduling and Accounts, Laboratory, Funds, fluorescein angiography, Medical Photography, Correspondence, Stores.

OPLVP ZC192 Visual Optics I 2

Review of Geometric optics, Optics of ocular structures, Measurement of the optical constants of the eye. Refractive anomalies and their causes, Refractive conditions, Far and near points of accommodation.

OPLVP ZC211 Low Vision Aids 1

Identifying and evaluating a low-vision patient; Refraction; Demonstrating Aids; Low vision care and rehabilitation; Diagnostic procedures in Low Vision Aids, Case management; Optics of Low Vision Aids; Telescopes.

OPLVP ZC212 Dispensing Optics 3

Surfacing & Polishing, Glazing frame manipulations, Facial development and frame choice. Dispensing, lens, faults inspection, Marking & edging of bifocal lenses.

OPLVP ZC221 Optometric Optics I 3

Form of lenses, Base curves, lens tools & blanks, Cylindrical lenses, Spherocylinders, Ophthalmic prism, Determining lens power, Aberrations in Ophthalmic lenses, Absorptive lenses.

OPLVP ZC222 Optometric Optics II 3

Types of spectacle frames and lenses, Toric surfaces, Vertex distance & power, Decentration of lenses, Bifocal & multifocal lenses, Tinted lenses, Safety & industrial eye protective lenses, spectacle magnifiers, Fresnel prisms.

OPLVP ZC231 Optometric Instruments 3

Simple and compound microscope, Refractive instruments like trial case, retinoscope, Optometers, Ophthalmoscope, Lensometer, Slit lamp, Tonometer, Fundus camera, Keratometer, Orthoptic instruments, Color vision.

OPLVP ZC232 Nutrition 1

Energy, Carbohydrates, Proteins, Fats, Minerals, Vitamins, Miscellaneous associated eye disorders.

OPLVP ZC241 Clinical Examination of Visual Systems 2

History, Visual acuity testing, ocular motility examination, slit lamp examination, IOP, Gonioscopy, Opthalmoscopy, Examination of lachrymal system, orbit, macular function tests, visual field charting.

OPLVP ZC242 Ocular Diseases II 3

Diseases of eye lids, Lacrimal system, Orbit, Sclera, Conjunctiva and Cornea, Uvea, Vitreoretinal disorders, Cataract, Trauma, Blindness, Neuro-opthalmic disorders.

OPLVP ZC251 Clinics I 4

OPLVP ZC252 Contact Lens I 1

History of development, review of corneal physiology and contact lenses besides detailed instruction to preliminary measurements and investigations, fitting of Hard and Soft Lenses in high and low emetropia, children and adults.

OPLVP ZC261 Visual Optics II 3

Correction of apherical ametropia, Axial vs refractive ametropia, Retinoscopy - principles and methods, objective and subjective methods; noncylinder, transposition of lenses, Spherical equivalent, Effective power of spectacle, Ocular refraction vs spectacle refraction, ocular accommodation vs spectacle accommodation, spectacle magnification and relative spectacle magnification, retinal image blur, depth of focus and depth of field.

OPLVP ZC262 Binocular Vision I 1

Spatial Sense, Grade of Binocular Vision, Panum's Space, Development of Binocular Vision.

OPLVP ZC271 Ocular Diseases I 3

Diseases of eyelids, Lacrimal system, Orbit, Sclera, Conjunctiva and cornea, Uvea, Vitreoretinal disorders, Cataract, Trauma, Blindness, Neuro-opthalmic disorders.

OPLVP ZC272 Computer Programming 3

Elementary computer organization; introduction to Number Systems; Representation of integers, real numbers and characters on computers; concept of range and accuracy; Arithmetic Overflow; Algorithms and algorithm development; structured program development through step wise refinement. Introduction to C language; Functions; Recursion; Data structure & algorithms; File management & file handling; Problem solving using C.

OPLVP ZC281 Public Health and Community Optometry 1

Philosophy of public health, Epidemiology, Health care system, Modes of health & vision care, Environmental vision.

OPLVP ZC282 Clinics II 5

OPLVP ZC311 Biostatistics 3

Methods of collection and presentation of statistical data; calculation and interpretation of various measures like mean, median, mode, standard deviation, kurtosis, correlation coefficient; probability distributions; sampling and estimation of parameters; tests of hypothesis; data analysis. Topics covered will aim to relate to the health field; introduction to decision analysis; decision theory; decision models.

OPLVP ZC312 Geriatric Optometry 1

Structural and Physiological changes in eye; Optical and Refractive changes in eye; Aphakia; ocular diseases in old age.

OPLVP ZC321 Systemic Disease 1

Hypertension, Diabetes, Acquired heart disease, Genetics, Thyroid disorders, Connective tissue disease, General medical emergencies, introduction to neurology.

OPLVP ZC322 Pediatric Optometry 1

Examination and Diagnosis in children; Refractive status; Ocular motility examination; Normal appearance; Pathology and Structural anomalies of Orbit, Eyelids, Lacrimal system, Conjunctiva; Compensatory treatment and Remedial therapy for various diseases.

OPLVP ZC331 Epidemiology 3

Introduction to the principles and methods of epidemiology. Epidemiology of some illustrative infectious diseases (of bacterial, rickettsial and viral origins), sexually transmitted diseases, chronic diseases such as cancer, cardiovascular diseases, neurological disorders etc. Use of biostatistics in epidemiology.

OPLVP ZC332 Principles of Lighting 1

Visual tasks, Synthesis of light, Additive and subtractive synthesis of color, light sources, illumination, lighting installation, photometry, Eye care & lighting.

OPLVP ZC341 Clinics & Special Clinics I 8

OPLVP ZC372 Clinics and Special Clinics II 8

Case sheet, History taking, Lensometry, Visual acuity, Tests for phorias and tropias, External examination, Slit lamp examination, Drugs and method of application, Do's and don’ts - pupillary dilatation, Direct ophthalmology, Indirect ophthalmoscopy, Instrumentation, Patients selection, Keratometry reading, Refraction, Fluorescein pattern, Over refraction, Slit lamp examination, Fitting of hard lenses, Rigid gas permeable lenses & soft lenses in refractive errors and in specialized condition.

The students are made to observe the interns initially, then gradually they are encouraged to work up a patient, and perform various examination techniques.

OPLVP ZC342 Medical Psychology 1

Definition, Emotions & feelings, Motivation, Personality, Normality & Abnormality, Impact of eye diseases on the patient, Rehabilitation of the blind.

OPLVP ZC351 Contact Lens II 1

Toric contact Lens, Bifocal contact lens, disposable contact lens, specialty contact lens, contact lens fitting in post operative cases and bandage lenses, contact lens complications and post fitting management.

OPLVP ZC352 Occupational Optometry 2

Occupational health, hygiene, Factories Act, ESI Act, Occupational diseases, Safety, prevention, Visual standards, Problems of special occupational groups.

OPLVP ZC361 Binocular Vision II 1

ARC, Amblyopia, Clinical evaluation of squint, Heterophoriqs & Tropiqs, Nystagmus.

OPLVP ZC362 Law and Optometry 1

Legal environment and techniques, Therapy of linensure, Optometrists in court, Malpractice, Insurance, Negligence, Ethics, Laws governing Practice of medical profession and Para medical profession in India.

OPLVP ZC371 Basic Accountancy 2

Terms, Principles, Journal & Journalizing, Ledger & Ledger posting, Trial balance, Cash book, Sales & Purchases register, Bank reconciliation, Depreciation, Balance sheet, Income and Sales tax.

OPLVP ZC381 Public Relations 1

Definition - Universe, Phrases, Benefits; Methods - Press relation, Printed word, spoken word, Radio and other Audio media, Film & TV, Research; In action - Employee public, Customer public, Government public, Community public; Specialized - Welfare agencies, Health agencies, Hospitals.

OPLVP ZC382 Project 5

Student are given a project assignment. They visit nearby schools, factories and help in the running of eye camps.

OPLVP ZC411 Internship I 20

OPLVP ZC412 Internship II 20

During the internship programme the students are rotated in various subspecialties like General out-patient department, Community out-patient department, contact lens clinic, low vision aid clinics, vitreo-retinal clinic, glaucoma clinic, uvea clinic, lens clinic, emergency clinic, cornea clinic. The students work up on their own and they are given exposure in their specialties.

OPTO ZC111 Functional English and Communication 3

OPTOM ZC111 Functional English and Communication 3

Grammar in usage - Tenses, Prepositions, Phrasal verbs; Communication - Process, Speaking, Listening, Reading, Memory, Self image; Comprehension, Precis writing; Report writing.

OPTO ZC112 Basic Accountancy 2

OPTOM ZC112 Basic Accountancy 2

Terms, Principles, Journal & Journalizing, Ledger & Ledger posting, Trial balance, Cash book, Sales & Purchases register, Bank reconciliation, Depreciation, Balance sheet, Income and Sales tax.

OPTO ZC121 Mathematics I 2

OPTOM ZC121 Mathematics I 2

Limits; sequences and series; continuity and differentiability of real valued functions of a real variable; integration; applications of derivatives and integrals; linear differential equations with constant coefficients; analytical geometry of conics.

OPTO ZC122 Public Relations 1

OPTOM ZC122 Public Relations 1

Definition - Universe, Phrases, Benefits; Methods - Press relation, Printed word, spoken word, Radio and other Audio media, Film & TV, Research; In action - Employee public, Customer public, Government public, Community public; Specialized - Welfare agencies, Health agencies, Hospitals.

OPTO ZC123 Geometric Optics II **3**

OPTOM ZC123 Geometric Optics II **3**

Stile Grawford Effect, Ametropia, Correction of Spherical Ametropia, Magnification, Presbyopia, Aphakia Spherometer & lens gauge, Critical Angle; spectrometer, Facimeter Refractive Index of lenses.

OPTO ZC131 Physical Optics **4**

OPTOM ZC131 Physical Optics **4**

Nature of light, Interference, Diffraction, Polarization, Laser Optics, Spectrum, Scattering, Surface tension, Viscosity, Newton's rings, Grating, Resolving power of a telescope.

OPTO ZC132 Pharmacology **2**

OPTOM ZC132 Pharmacology **2**

Mechanism of drug action, Dose response relationship, Tachyphylaxis, Pharmacokinetics of drug absorption, distribution, biotransformation; Principles of ocular pharmacology, Optometric diagnostic drugs.

OPTO ZC133 Hospital Procedures **1**

Administration, Bioengineering department, Medical Records, Reception, Computer, Appointment scheduling and Accounts, Laboratory, Funds, fluorescein angiography, Medical Photography, Correspondence, Stores.

OPTO ZC141 Basic Biochemistry I **3**

OPTOM ZC141 Basic Biochemistry I **3**

Chemistry and functions of constituents of cells and tissues; Introduction to Carbohydrates; Proteins; Lipids; Enzymes; Vitamins; Minerals.

OPTO ZC142 Ocular Anatomy **2**

OPTOM ZC142 Ocular Anatomy **2**

Anatomy & Embryology of Sclera, cornea, Uvea, retina & visual pathway.

OPTO ZC151 General Anatomy **2**

OPTOM ZC151 General Anatomy **2**

Tissues of Body, General Plan of Organ System, Cell structure, and other anatomical aspects of vital organs of body.

OPTO ZC152 Ocular Physiology **3**

OPTOM ZC152 Ocular Physiology **3**

Protective Mechanism in the eye, extraocular muscle, physiology, lens metabolism, Refractive Errors, Visual Acuity, color vision.

OPTO ZC161 General Physiology **5**

OPTOM ZC161 General Physiology **5**

Cell physiology, Blood, Digestion, Excretion, Endocrines, Reproduction circulation, Nervous System & Special Senses.

OPTO ZC162 Basic Biochemistry II **3**

OPTOM ZC162 Basic Biochemistry II **3**

Hormones and metabolic regulation; Whole body metabolism; Ocular Biochemistry - aspect of eye, viz. tears, cornea, lens, aqueous, vitreous, retina and pigment Rhodopsin; Biochemistry techniques; Clinical Biochemistry.

OPTO ZC171 Geometric Optics I **4**

OPTOM ZC171 Geometric Optics I **4**

Photometry, Refraction through Spherical Surfaces, Aberration, Fiber Optics, Color theory, Lens Power, Prismatic Power, Gull strands, Schematic Eye, Visual Acuity.

OPTO ZC172 Nutrition **1**

OPTOM ZC172 Nutrition **1**

Energy, Carbohydrates, Proteins, Fats, Minerals, Vitamins, Miscellaneous associated eye disorders.

OPTO ZC181 Remedial Mathematics **2**

OPTOM ZC181 Remedial Mathematics **2**

Basic mathematical concepts from algebra, trigonometry and calculus.

OPTO ZC182 Principles of Lighting **1**

OPTOM ZC182 Principles of Lighting **1**

Visual tasks, Synthesis of light, Additive and subtractive synthesis of color, light sources, illumination, lighting installation, photometry, Eye care & lighting.

OPTO ZC191 Remedial Biology **2**

OPTOM ZC191 Remedial Biology **2**

Living systems and their properties; major biological compounds; basic physiological

processes; introduction to genetics; environment and evolution.

OPTO ZC192 Mathematics II 2

OPTOM ZC192 Mathematics II 2

Heuristic approach to manipulations with sets; language of logic; vectors and matrices, elementary applications; simplex method for a linear programming problem; elementary probability and statistical tools for tests of significance; game theory; graphs and networks; applications to behavioral and managerial sciences.

OPTO ZC211 Computer Programming 3

OPTOM ZC211 Computer Programming 3

Elementary computer organization; introduction to Number Systems; Representation of integers, real numbers and characters on computers; concept of range and accuracy; Arithmetic Overflow; Algorithms and algorithm development; structured program development through step wise refinement. Introduction to C language; Functions; Recursion; Data structure & algorithms; File management & file handling; Problem solving using C.

OPTO ZC212 Medical Psychology 1

OPTOM ZC212 Medical Psychology 1

Definition, Emotions & feelings, Motivation, Personality, Normality & Abnormality, Impact of eye diseases on the patient, Rehabilitation of the blind.

OPTO ZC221 Optometric Optics I 3

OPTOM ZC221 Optometric Optics I 3

Form of lenses, Base curves, lens tools & blanks, Cylindrical lenses, Spherocylinders, Ophthalmic prism, Determining lens power, Aberrations in Ophthalmic lenses, Absorptive lenses.

OPTO ZC222 Pathology & Microbiology 3

OPTOM ZC222 Pathology & Microbiology 3

Inflammation & repair, Infection, Neoplasia, Circulatory disturbances, Clinical pathology, Principles of cultivation of bacteria, sterilization and disinfection.

OPTO ZC231 Optometric Instruments 3

OPTOM ZC231 Optometric Instruments 3

Simple and compound microscope, Refractive instruments like trial case, retinoscope, Optometers, Ophthalmoscope, Lensometer, Slit lamp, Tonometer, Fundus camera, Keratometer, Orthoptic instruments, Color vision.

OPTO ZC232 Optometric Optics II 3

OPTOM ZC232 Optometric Optics II 3

Types of spectacle frames and lenses, Toric surfaces, Vertex distance & power, Decentration of lenses, Bifocal & multifocal lenses, Tinted lenses, Safety & industrial eye protective lenses, spectacle magnifiers, Fresnel prisms.

OPTO ZC241 Clinical Examination of Visual Systems 2

OPTOM ZC241 Clinical Examination of Visual Systems 2

History, Visual acuity testing, ocular motility examination, slit lamp examination, IOP, Gonioscopy, Opthalmoscopy, Examination of lachrymal system, orbit, macular function tests, visual field charting.

OPTO ZC242 Ocular Diseases II 3

OPTOM ZC242 Ocular Diseases II 3

Diseases of eye lids, Lacrimal system, Orbit, Sclera, Conjunctiva and Cornea, Uvea, Vitreoretinal disorders, Cataract, Trauma, Blindness, Neuro-opthalmic disorders.

OPTO ZC251 Ocular Diseases I 3

OPTOM ZC251 Ocular Diseases I 3

Diseases of eyelids, Lacrimal system, Orbit, Sclera, Conjunctiva and cornea, Uvea, Vitreoretinal disorders, Cataract, Trauma, Blindness, Neuro-opthalmic disorders.

OPTO ZC252 Visual Optics II 3

OPTOM ZC252 Visual Optics II 3

Correction of apherical ametropia, Axial vs refractive ametropia, Retinoscopy - principles and methods, objective and subjective methods; noncylinder, transposition of lenses, Spherical equivalent, Effective power of spectacle, Ocular refraction vs spectacle refraction, ocular accommodation vs spectacle accommodation, spectacle magnification and relative spectacle magnification, retinal image blur, depth of focus and depth of field.

OPTO ZC261 Visual Optics I **2**

OPTOM ZC261 Visual Optics I **2**

Review of Geometric optics, Optics of ocular structures, Measurement of the optical constants of the eye. Refractive anomalies and their causes, Refractive conditions, Far and near points of accommodation.

OPTO ZC272 Clinics II **5**

OPTO ZC281 Clinics I **4**

OPTOM ZC272 Clinics II **5**

OPTOM ZC281 Clinics I **4**

Course description for the above courses to be developed.

OPTO ZC282 Dispensing Optics **3**

OPTOM ZC282 Dispensing Optics **3**

Surfacing & Polishing, Glazing frame manipulations, Facial development and frame choice. Dispensing, lens, faults inspection, Marking & edging of bifocal lenses.

OPTO ZC292 Monocular Sensory Perception **2**

Visual physiology; introduction to psychophysics; luminance perception; modulation transfer function and optical transfer function; contrast sensitivity function, resolution and recognition acuities; basics of color vision; basics of motion perception.

OPTO ZC311 Binocular Vision I **1**

OPTOM ZC311 Binocular Vision I **1**

Spatial Sense, Grade of Binocular Vision, Panum's Space, Development of Binocular Vision.

OPTO ZC312 Binocular Vision II **1**

OPTOM ZC312 Binocular Vision II **1**

ARC, Amblyopia, Clinical evaluation of squint, Heterophoriqs & Tropiqs, Nystagmus.

OPTO ZC322 Law & Optometry **1**

OPTOM ZC322 Law & Optometry **1**

Legal environment and techniques, Therapy of linensure, Optometrists in court, Malpractice, Insurance, Negligence, Ethics, Laws governing Practice of medical profession and Para medical profession in India.

OPTO ZC323 Contact Lens I **1**

OPTOM ZC323 Contact Lens I **1**

History of development, review of corneal physiology and contact lenses besides detailed instruction to preliminary measurements and investigations, fitting of Hard and Soft Lenses in high and low emetropia, children and adults.

OPTO ZC324 Contact Lens II **1**

OPTOM ZC324 Contact Lens II **1**

Toric contact Lens, Bifocal contact lens, disposable contact lens, specialty contact lens, contact lens fitting in post operative cases and bandage lenses, contact lens complications and post fitting management.

OPTO ZC331 Systemic Disease **1**

OPTOM ZC331 Systemic Disease **1**

Hypertension, Diabetes, Acquired heart disease, Genetics, Thyroid disorders, Connective tissue disease, General medical emergencies, introduction to neurology.

OPTO ZC332 Public Health & Community Optometry **1**

OPTOM ZC332 Public Health & Community Optometry **1**

Philosophy of public health, Epidemiology, Health care system, Modes of health & vision care, Environmental vision.

OPTO ZC341 Glaucoma **1**

OPTOM ZC341 Glaucoma **1**

Aqueous humor dynamics, IOP & Tonometry, Evaluation of Optic nerve head, Visual fields, Open angle glaucoma, Angle closure glaucoma, Secondary glaucoma, Principles of medical therapy.

OPTO ZC342 Paediatric Optometry **1**

OPTOM ZC342 Paediatric Optometry **1**

Examination and Diagnosis in children; Refractive status; Ocular motility examination; Normal appearance; Pathology and Structural anomalies of Orbit, Eyelids, Lacrimal system, Conjunctiva; Compensatory treatment and Remedial therapy for various diseases.

OPTO ZC352 Occupational Optometry 2

OPTOM ZC352 Occupational Optometry 2

Occupational health, hygiene, Factories Act, ESI Act, Occupational diseases, Safety, prevention, Visual standards, Problems of special occupational groups.

OPTO ZC371 Clinics & Special Clinics I 8

OPTO ZC372 Clinics & Special Clinics II 8

OPTOM ZC371 Clinics & Special Clinics I 8

OPTOM ZC372 Clinics & Special Clinics II 8

Case sheet, History taking, Lensometry, Visual acuity, Tests for phorias and tropias, External examination, Slit lamp examination, Drugs and method of application, Do's and don'ts - pupillary dilatation, Direct ophthalmology, Indirect ophthalmoscopy, Instrumentation, Patients selection, Keratometry reading, Refraction, Fluorescein pattern, Over refraction, Slit lamp examination, Fitting of hard lenses, Rigid gas permeable lenses & soft lenses in refractive errors and in specialized condition. The students are made to observe the interns initially, then gradually they are encouraged to work up a patient, and perform various examination techniques.

OPTO ZC381 Low Vision Aids 1

OPTOM ZC381 Low Vision Aids 1

Identifying and evaluating a low-vision patient; Refraction; Demonstrating Aids; Low vision care and rehabilitation; Diagnostic procedures in Low Vision Aids, Case management; Optics of Low Vision Aids; Telescopes.

OPTO ZC382 Geriatric Optometry 1

OPTOM ZC382 Geriatric Optometry 1

Structural and Physiological changes in eye; Optical and Refractive changes in eye; Aphakia; ocular diseases in old age.

OPTO ZC411 Internship I 20

OPTO ZC412 Internship II 20

OPTOM ZC411 Internship I 20

OPTOM ZC412 Internship II 20

During the internship programme the students are rotated in various subspecialties like General out-patient department, Community out-patient department, contact lens clinic, low vision aid clinics, vitreo-retinal clinic, glaucoma clinic, uvea clinic, lens clinic, emergency clinic, cornea clinic. The students work up on their own and they are given exposure in their specialties. Six months of their internship is at Sankara Nethralaya and 6 months at the Rural Eye Hospital, St. Thomas Mount, Chennai.

OPTO ZC421 Epidemiology 3

OPTOM ZC421 Epidemiology 3

Introduction to the principles and methods of epidemiology. Epidemiology of some illustrative infectious diseases (of bacterial, rickettsial and viral origins), sexually transmitted diseases, chronic diseases such as cancer, cardiovascular diseases, neurological disorders etc. Use of biostatistics in epidemiology.

OPTO ZC422 Project 5

OPTOM ZC422 Project 5

Students are given a project assignment. They visit nearby schools, factories and help in the running of eye camps.

OPTO ZC431 Biostatistics 3

OPTO ZC431 Biostatistics 3

Methods of collection and presentation of statistical data; calculation and interpretation of various measures like mean, median, mode, standard deviation, kurtosis, correlation coefficient; probability distributions; sampling and estimation of parameters; tests of hypothesis; data analysis. Topics covered will aim to relate to the health field; introduction to decision analysis; decision theory; decision models.

OPTO ZG511 Special Clinics I 4

OPTO ZG512 Special Clinics II 4

OPTO ZG513 Special Clinics III 4

Course description for the above courses to be developed.

OPTO ZG611 Advanced Contact Lens II 4

Appearance of Contact Lenses: Pre and Post cleaning; Calculation of DK/L, EOP and oedema; Measurements of corneal swelling with the Phachometer; Measurement of the Oxygen needs of the eye or needs and contact lens transmissibility; The effect of materials and deposits of DK/L; Identification of Lens deposits; The effect of hypoxia on corneal structure; Soft wearing schedules DW Vs EW; Bifocal Contact Lens fitting and assessment; Toric SCL Lenses;

Toric RGP Lenses; Advancements in Contact Lens instrumentation and techniques; Visual recognition of conditions and problem solving; Fitting consideration for sports vision; Corneal prosthesis; Special applications of Contact Lens in Research and Industry; Future trends in industry, R & D and marketing for Contact Lenses and associated product: Vision correction by refractive surgery, Ortho keratology etc; Advanced study of Contact Lens research methods and analysis of Contact Lens literature and data basis.

OPTO ZG612 Advanced Contact Lens I 4

Current concepts in anatomy and Physiology of the cornea and tear film, Microbiology and Immunology in relation to Contact Lens wear; Vision and Optics with Contact Lenses; Corneal Topography measurement; use of Slit Lamp in Contact Lens Practice; Correlation of illumination with conditioning observed Pharmacology of Contact Lens solutions; Review of Contact Lens solution contents; The effects of wear on Contact Lenses; Contact Lens wear in dry eye; Soft Contact Lens EW complications: Causes and management; Rigid vs permeable, EW complications: Clinical management; Keratoconus; Overview and contact lens fitting; Contact lens for children; Contact Lenses for aphakics; Contact Lenses for Pseudo Aphakics; Contact Lenses in post refractive surgery/PRK; Lens choice for astigmatism; Soft Contact Lens Design; R.G.P. Lens modification; Contact Lenses and Driving; Bandage Lenses-Assessment of deposits/micro organisms.

OPTO ZC613 Ophthalmic Photography 3

External photography of the eye: Macro photography, slit lamp mydriatic and non mydriatic fundus cameras, slit lamp photography of cornea and lens including high magnification techniques, Photograph of the angle of anterior chamber, Fundus photography by conventional and infrared imaging systems: Fluoresce in photography, Methods of image enhancement, Preparing slides for projection. Advances in video imaging would also be taught.

OPTO ZG614 Neurological Basis and Electrophysiology of Vision -I 4

Neurohistology, electrophysiology of the nerve cell, the retina, phototransduction, outer plexiform, layer connections, inner plexiform, layer connections, retinal projections, sub-cortex to cortex, visual cortex, parallel visual pathways.

OPTO ZG615 Neurological Basis and Electrophysiology of Vision -II 4

Electrophysiology of vision, electroretino-graphy, electrooculography, electro-diagnostic applications in retinal diseases, visual evoked potentials, factors affecting the recording techniques, interpretation of visual electrodiagnostic tests, significance of evoked potentials, CT and PET scanning, and MRI.

OPTO ZG616 Low Vision Care and Vision Enhancement Techniques -I 4

Visual disorders – medical, functional and psychosocial perspectives, interactions of vision impairment with other disabilities and sensory impairments.

OPTO ZG617 Low Vision Care and Vision Enhancement Techniques -II 4

Environment and vision impairment; universal design, vision rehabilitation, psychological and social factors in visual adaptation and rehabilitation, rehabilitation of children and youth with vision impairment, rehabilitation of working age adults with vision impairment, rehabilitation of older adults with vision impairment, functional consequences of vision impairment, vision evaluation of infants, educational assessment of visual function in infants and children, functional orientation and mobility, functional assessment of low vision for activities of daily living, psychosocial assessment of adults with vision impairment, assistive devices and technology for low vision, assistive devices and technology for blind, vision and reading - normal vision versus low vision, clinical implications of color vision deficiencies, electrodiagnosis in evaluating and managing the low vision patients.

OPTO ZG623 Research Methodology I 3

Methods of collecting and presentation of statistical data, Calculation and interpretation of various measures like mean, mode, median, mode standard deviations, Probability distribution, Correlation and regression, Significance tests and confidence intervals, Tests for equality of proportion, Tests for the equality of means, Measures of association, Prevalence incidence, rates, ratios, proportions, Questionnaires etc.

OPTO ZG629T Dissertation 20

A student registered in this course must take a topic in an area of professional interest drawn from the on the job work requirement which is simultaneously of direct relevance to the degree pursued by the student as well as to the employing / collaborating organization of the student and submit a comprehensive report at the end of the semester working under the overall supervision and guidance of a professional expert who will be deemed as the supervisor for evaluation of all components of the dissertation. Normally the Mentor of the student would be the Dissertation supervisor and in case Mentor is not approved as the supervisor, Mentor may play the role of additional supervisor. The final grades for dissertation are Non-letter grades namely Excellent, Good, Fair and Poor, which do not go into CGPA computation.

OPTO ZG631 Advanced Glaucoma I 4

OPTIC DISC: Ophthalmoscopic techniques for evaluation of the optic nerve head and optic disc drawings; Optic disc photography; Flicker analysis; Plaimetry; Sterophotogrammetry; Image analyzers, Retinal nerve fiber layer evaluation.

OPTO ZG642 Computers & Information Systems 3

Introduction to MS-Windows; Introduction to MIS, SSADM; Word-processing using MS-Word; Database management and programming using MS-Foxpro; SpreadSheet using MS-Excel; Presentation Graphics using MS-PowerPoint.

OPTO ZG644 Recent Advances in Optometry 4

Course description to be developed

OPTO ZG653 Visual Perception 4

Signal detection theory, psychophysical methods and procedures, detection of light, pattern vision (contrast detection and discrimination), color vision, motion perception, object and face recognition.

OPTO ZG659 Technical Communication 4

Role and importance of communication; effectiveness in oral and written communication; technical reports; technical proposals; technical descriptions; definitions and classifications; business correspondence; precis writing; memorandum; notices, agenda and minutes; oral communication related to meetings, seminars, conferences, group discussions, etc.; use of modern communication aids.

OPTO ZG663 Research Methodology II 3

Epidemiological basis of disease, Planning a research project, sensitivity, specificity, predictive values, Bias and randomization, Retrospective and prospective studies, Clinical trials, Screening Studies and measures of agreement, Case control studies, Sampling methodology, Data analysis.

OPTO ZG673 Clinical Optometry I 4

The Course in Clinical Optometry consists of the Study of diseases affecting the lids and adnexa including the orbit, ocular motility, refractive errors, Diseases affecting the cornea, sclera.

OPTO ZG 681 Medical Records 4

Introduction to medical records: History, Need for medical record; Content of medical records: Content, Special records, Formats; Forms design and control; Filing methods, storage and retention; Nomenclatures and classification systems; Indexes and registers; Legal aspects of medical records; quality assurance; Recent advances in medical records system.

OPTO ZG682 Advanced Glaucoma II 4

Visual fields: Interpretation without statistical analysis; Interpretation with statistical analysis. Newer programmes; Psychophysical changes in glaucoma; Psychophysiological and electrophysiological testing of vision in glaucoma; Ultrasound biomicroscopy: Early diagnosis of glaucoma.

OPTO ZG683 Clinical Optometry II 4

Diseases affecting uveal tract, retina, vitreous, lens, optic nerve, cranial nerves connected with vision and visual apparatus. It will also involve the study of ocular manifestations of systemic diseases.

OPTO ZG696 Advanced Occupational Optometry I 4

Occupational Health Services – World and Indian scenario, Occupational health Law, Disability and work, Ethical issues, Work & workers, Worker's compensation system, Biological Monitoring, Ergonomics, Occupational Hygiene, Personal Protection, Toxicology, Psychosocial and organizational factors, Organizations and health and safety, Hours of work, Environmental policy,

Safety programmes. Lighting, Radiation - Ionizing & Non Ionizing, Visual Display units, Accident prevention.

OPTO ZG697 Advanced Occupational Optometry II 4

Chemical properties of Metals and toxicity to eye, Industries based on Biological resources, Natural resources, Chemical Industries, Manufacturing Industries, Textiles & Apparel Industries, Transport Industries , Construction, Service & Trade Industries and their impact on eye, workplace health promotion, Vision standards for various occupations, Visual task analysis, Assessment of eye for the fitness of the work, Occupational Health Hazards & Diseases.

OPTO ZG698 Advanced Binocular Vision I 4

Binocular vision assessment and diagnosis – Basic and advanced issues, diagnostic approaches, strabismus, amblyopia, AC/A and CA/C ratio; Special clinical conditions – Nystagmus, acquired brain injury, Learning disability, association between vision and learning, vision development, visual perceptual disorders, visual information processing disorders.

OPTO ZG699 Advanced Binocular Vision II 4

Vision therapy – Formulating a protocol and Hierarchical approach, vision therapy equipments, Behavioral approach to vision therapy, Myopia control, prisms and applications, prisms in vision therapy, Sports Vision.

PAT ZC121 Mathematics I 3

Limits; sequences and series; continuity and differentiability of real valued functions of a real variable; integration; applications of derivatives and integrals; linear differential equations with constant coefficients; analytical geometry of conics.

PAT ZC122 Mathematics II 3

Heuristic approach to manipulations with sets; language of logic; vectors and matrices, elementary applications; simplex method for a linear programming problem; elementary probability and statistical tools for tests of significance; game theory; graphs and networks; applications to behavioral and managerial sciences.

PAT ZC131 Introduction to Computers 3

How the PC works. The anatomy of a PC: Elementary DOS usage; Exercises on keyboard familiarity and DOS; Applications of PC like word-processing, spreadsheeting desk, personal information management etc.

PAT ZC132 Scientific Measurements I 3

Measurement in the fields of biology, chemistry and physics. Emphasis in this course shall be on the operation and use of modern laboratory instruments.

PAT ZC141 Biological Chemistry 3

Chemistry and functions of constituents of cells and tissues; introduction to enzymes; metabolism of carbohydrates, lipids, aminoacids; nucleic acids and protein synthesis; vitamins and hormones.

PAT ZC142 Nutrition and Dietetics 4

Emergence, Scope and Methodology of nutrition as a science; Energy metabolism, Food energy (carbohydrates, fat, protein) and individual nutrients (vitamins and minerals) with special reference to distribution in the body and biochemical role, amount in ordinary foods, digestion, absorption, transport, storage, utilization and disposal, requirements and recommended allowances and their modification under stress conditions, effects of deficiency, incidence, etiology and prevention of deficiency disease, inter-relations with other nutrients; Assessment of nutrients; Assessment of nutritional status of the individual and the community; Formulation of balanced diets, Common nutritional disorders, nutritional adaptation; Nutrition and infection; Principles of dietetics, Diet adaptation; Nutrition and infection; Principles of dietetics, Dietary management of Diseases, Practicals: BSA, BMR measurements and calculations, anthropometric measurements, taking dietary history and nutrient calculations, etc.

PAT ZC151 General Anatomy 3

Tissues of Body, General Plan of Organ system, cell structure and other anatomical aspects of vital organs of body. Practicals: Autopsy and dissection classes, Computer software, models and charts, etc.

PAT ZC152 Clinical Biochemistry 5

Role of biochemistry in diagnosis of diseases, clinical manifestations in carbohydrates lipids and

protein metabolism including inborn errors of metabolism and their evaluation. Disorders of kidney and liver and their diagnostic test; blood coagulation disorders and their estimation; clinical enzymology; disorders of ions Ca+and P+metabolism and their diagnosis. Endocrine disorders and diagnosis neurotransmitters, Radioactive isotopes in diagnosis. Practicals: Specimen collection, Clinical haematology, Blood coagulation tests, Biochemical tests, Renal function tests, Estimation of myocardial enzymes, Liver function tests, Urine analysis, Serological screening for HIV, Hepatitis, Syphilis, etc.

PAT ZC161 General Physiology 3

Cell physiology, Blood, Digestion, Excretion, Endocrines, Reproduction, circulation, Nervous System & Special Senses. Practicals; Autopsy and dissection classes, Computer software, models and charts, etc.

PAT ZC162 Paediatrics and Geriatrics 2

Physiological and psychological fundamentals of child development and disorders, infant feeding major paediatric illnesses, management of paediatric emergencies. Physiological and psychological fundamentals of aging process and disorders, major geriatric ailments and management.

PAT ZC171 Cell Biology 3

Fundamental processes of life at cellular and subcellular levels, cell environments, membrane transport, cell movements, division and control mechanisms. Cell differentiation, cell signaling, cell-cell communication. Theory of heredity; sex-linked inheritance; chromosome; chromosome aberrations and disorders. Cell biology practicals; Microscopy, microtome/chromosome aberrations and disorders. Cell biology practicals; Microscopy, microtome/ cryostat. Haematology, Buccal epithelium & Barr bodies, Blood groupings and Rhesus factor, Simple Mendelian Traits and Karyotyping.

PAT ZC212 Introduction to Surgery 2

History of Surgery, Role of the surgeon, Importance of team work and anticipating the needs of surgeons; stresses that may arise during operative procedure; Surgical terminology, types of incision and indications for the use of particular incision; Hemorrhage-signs and symptoms of internal and external; classification and management; identification of types of tourniquets-reasons for use and duration of application, dangers of use; Wounds, types, process of healing, treatment and complications; inflammation; wound infections-causes and treatment; incision and drainage of abscesses; importance of personal cleanliness and aseptic techniques; Pre-operative and post-operative care of the surgical patient; Emergency procedures: Endotracheal incubation; Tracheotomy.

PAT ZC222 Introduction to Medicine 3

Disease of respiratory system : Tuberculosis; Pneumonia; Allergic disease; Tumors of the lung; Disease of Liver and Gall Bladder Jaundice; Hepatitis; Hepatic Coma; Cirrhosis of Liver; Hemochromatosis; Cholelithiasis; Cholecystitis; Disease of Excretory System : Acute and Chronic nephritis; Nephrotic Syndrome; Acute and chronic renal failure; Renal calculi; Hemodialysis; Peritoneal Dialysis; Renal Trans plants; Disease of Alimentary System; Peptic ulcer; Cancer stomach; Malabsorption syndrome and inflammatory bowel disorder; Tumors of large and small intestine; Disease of Musculo Skeletal System: Arthritis and allied Rheumatic disorder; Bone Diseases; Disease of endocrine system : Thyroid Disorder : Hyperthyroidism; Hypothyroidism; Thyroid tumor; Parathyroid: Hyperparathyroidism; Pheochromacytoma; Metabolic Disease : diabetes Mellitus; Disease of Central Nervous System : Epilepsy; Cerebrovascular Disease; Infection; Disease of Extrapyramidal system; Infectious Disease: Bacterial, Rickettsial, Chlamydial Disease; Gram positive, Gram negative; Syphilis; Typhoid; Viral Diseases : measles; Rubella; Rabies; Chicken pox; AIDS; Protozoal Disease : Amoebiasis; Malaria; Helminthes : Filaria; Round worm; Hook worm.

PAT ZC231 Microbiology 3

Microbes in our environment; Microbes on & in our body; Microscope; Morphology of bacteria; Cultivation of bacteria and growth requirements; Mode, Source & Spread of infections; Destruction of Microbes - I: Antiseptics & Disinfections; Destruction of Microbes - II: Sterilization; Destruction of infecting Agent: Antibiotics & Chemotherapy; Immunology; Microbes causing infection in man : Collection, Transport & Preservation of specimens; Microbes causing bacteremia & septicemia in man - Blood culture technique ; Urinary tract infections (UTI);

Respiratory tract infections-upper respiratory infections (URI); Lower respiratory tract infections (LRI); Pyogenic infections; Infections of CNC & Body cavities; G.I. Infections; Serological diagnosis of microbial diseases; Antibiotic assay in serum; Fungal infections; Viral infections; Parasitic infections; Surveillance in prevention & control of hospital associated infections (HAI) : Bacteriological analysis of water; Sterility tests for I.V. Fluids; "In-use" testing of disinfectant.

PAT ZC251 Principles of Management 3

Fundamental concepts of management - planning; organizing; staffing; directing and controlling; production, financial, personnel, legal and marketing functions; accounting and budgeting, balance sheets..

PAT ZC261 Technical Report Writing 3

Elements of effective writing; art of condensation; business letter writing; memos; formal reports; technical proposals; conducting, and participating, meetings; agenda and minutes; strategies for writing technical descriptions, definitions, and classifications; oral presentation; use of graphic and audio- visual aids; editing.

PAT ZC262 Introduction to Psychology 3

The development of Psychology as a science - individual and the environment; nature, kinds and determinants of perceptions, response mechanism and kinds of responses, motivations, modifications of behavior through learning, memory and transfer of training, thought processes, problem solving and creative thinking; nature and characteristics of psychological tests; nature and evaluation techniques of intelligence and personality.

PAT ZC282 Molecular Genetics 3

Genetic foundations; Genetic counseling; Transformation, transduction and conjugation; Recombination and complementation; genetic mapping and linkage analysis; Genome organization; Genome maintenance; Gene regulation in Prokaryotis and Eukaryotics. Cloning techniques in E.coli and Eukaryotic cells; Restriction maps; Nucleic acid blotting and hybridization.

PAT ZC311 Cardiology & Cardiac Surgery 4

Cardiology; the Structural Basis of Cardiovascular Diseases. Embryology of Heart; The Chambers of the Heart; The Heart Valves; Surface Marking of Cardiovascular System; The Great Vessels; Blood supply of the Heart. The functional Basis of Cardiovascular Diseases, Cardiac Cycle; Heart Sounds; The Circulation of Blood; Cardiovascular responses to Exercise; Heart failure and Compensatory Mechanism. The Cellular basis of Cardiovascular Function in Health & Diseases, Heart Cell; Contraction and Relaxation; Excitation; Coronary Perfusion. The Effects of Cardiovascular Diseases. Angina; Dyspnoea; Fatigue; Pedal edema; palpitation; Clubbing-Cyanosis - Pulse; Blood Pressure. the Diagnostic Tools. ECG; Chest X-ray; ECHO cardiography; Cardiac Catheterization & Coronary Angiography; Blood Analysis. Congenital heart Disease. Development of Heart & Great Vessels; Cyanotic Heart Diseases; Acyanotic Heart Diseases. The Blood Pressure. Control of Blood Pressure; Hypertension - a. Essential Hypertension; b. Malignant Hypertension; Arterial Disease; Structure; Atherosclerosis; Risk Factors; Burger's Disease; Raynaud's Phenomenon Arteries. Thrombosis. Bleeding; Haemostasis; Fibrinolysis; Thrombosis Formation and Structure; Venous & Arterial Thrombosis; Modifying Mechanism. Ischaemic Heart Disease (Ischaemia & Infarct) Angina; Physical Signs; Investigations; management; Infractive Endocarditis; Cause; Pathology; Features; Investigations; Management; Rheumatic Heart Disease; Clinical manifestations; Jone's Criteria; prevention; Physiological & Pathological changes; Practical Management of Cardiovascular Problems; Arrhythmias; Conduction Block; Hypovolemia and Hypervolemia; Heart failure; Hypotension and Hyperactive Care; Preparing a patient mentally & physically; Investigations and plan; Post operative Management; Rehabilitation Programme. Prevention of Heart Diseases; Habits; Food; cardiac surgery; Cardiac patient; Evaluation of cardiac status; The Risk factors; Congenital heart Disease; Cyanotic Heart Disease; Acyanotic Heart Disease; Acquired Heart Disease; Infective; Non infective; Pre-operative Care; The Cardiac Surgery; A. Cardiopulmonary Bypass : Adults, Paediatrics B. Various Closed and Open Heart Operations. Closed Heart Operations a. PDA ligation b. Closed Mitral Valvotomy c. Block trussing Shunt d. Pulmonary Artery Banding e. Pericardiectomy f. Pericardial Window g. Coarctation of Aorta h. Other Shunt operations. Open Heart Operations. Congenital a. Atrial Septal Defect Closure b. Ventricular Septal Defect

Closure c. Tetralogy of Fallot Correction d. Surgery for Valvular Disease e. Surgery for Transpositions f. Surgery for Total Anomalies of Pulmonary Venous Connection g. Surgery for Truncus Arteriosus h. Surgery for Pulmonary Atresia i. Other Corrective Surgery, Acquired a. Mitral Valve replacement b. Valvuloplasty c. Aortic Valve replacement d. Tricuspid valve repair e. Coronary surgeries. Postoperative care; postoperative complications; Immediate, Late; Rehabilitation; The follow up of postoperative patient.

PAT ZC312 Advances in Cardiology 2

The advanced topics will be discussed in detail with the help of latest journals and reviews. The latest investigation procedures and treatments will be discussed in the course.

PAT ZC322 Advances in Cardiac Surgery 2

The advanced topics will be discussed in detail with the help of latest journals and reviews. The latest investigation procedures and cardiac surgical treatment will be discussed in the course.

PAT ZC332 Principles of Emergency Medicine 1

Definition of emergency; use of sedation and local, regional and general anaesthesia in the emergency of pain; various routes of intravenous access in emergency patients; Metabolic emergencies related to diabetes mellitus, hypoglycemia, adrenal, thyroid, kidney, liver and hypertensive crisis; different types of allergic reactions from local to systemic and the treatment for the same.

PAT ZC341 Cardiac Nursing 2

Nursing aspects of Angina; Dyspnoea; Cyanosis Administration of oxygen & its methods; Blood pressure; Nursing aspect of cardiac catheterization & coronary angiography blood analysis; Nursing aspects of cyanotic and acyanotic heart disease; Nursing considerations in atherosclerosis; Nursing considerations in angina; Nursing management in infective endocarditis; Nursing management in cardiac arrest; Nursing considerations in pre-operative & post-operative care; Cardiac surgery-Nursing assessment of cardiac patients; Nursing considerations in congenital heart disease & acquired heart disease; Pre-operative Nursing considerations; Nursing considerations after cardiac surgery; Introduction to pharmacology; Nursing responsibilities while administering medications, the dose, side effects & adverse reactions; Introduction to anaesthesia; Nursing considerations in using anaesthesia in ICUs; Nursing considerations in oxygen administration; Nursing considerations in Haemodynamic monitoring cardiac output determination & ABG Analysis; Nursing aspects in CPR; Nursing aspects in artificial Ventilation (i) Adult, (ii) paediatrics; Nursing aspects in fluid & electrolyte balance; Rehabilitation; Physiotherapy in Cardiac patient pre & post operative.

PAT ZC342 Medical Instrumentation 2

Basic components of bio-medical instruments, bioelectric signals & recording electrodes, transducers, recording and display devices. Patient care and monitoring systems, cardiovascular measurements, blood pressure, blood flow, cardiac output, heart sounds etc.; instrumentation for respiratory and nervous systems, analysis of EEG, ECG, EMG, and action potentials, non-invasive diagnostic measurement temperature, ultrasonic diagnosis, CAT scan techniques, sensory measurements - monitor response, analysis of behavior etc. biotelemetry, biofeedback, clinical laboratory instruments; X-ray diagnosis, recent advances in biomedical instrumentation - microprocessor based systems, lasers & optical fiber based systems.

PAT ZC381 Anaesthesiology 1

Pharmacology of drugs used in Anaesthesia and intensive care; Oxygen delivery systems and its applications; Haemodynamic Monitoring; Cardiac output determination and its prognostic significance; Principles of Arterial Blood Gas Analysis; Cardiac Pulmonary Resuscitation; Basic Life Support Systems - BCLS; Active Life Support systems - ACLS; Principles of Artificial Ventilation I; Principles of Artificial Ventilation II; Intra Aortic Balloon Pump & Cardiac Assist Devices; Paediatric Ventilatory Management & Critical Care; Fluid & Electrolyte Balance Principles; Principles of Cardio Pulmonary Bypass & Management.

PAT ZC382 Data Processing 3

Introduction to data processing; files and file structures; indexing techniques; sorting, searching and merging techniques; introduction to database management systems; design of information systems; emerging trends in data processing.

PAT ZC411 Inservice Training I 10

Rotational Inservice Training I in OPD (out patient department), Biochemistry lab. Pathology lab, CCU (Coronary care unit), Cath lab, Anesthesia, perfusion, OT (Operation theatre), ICU (Intensive care unit), General ward, Rehabilitation.

PAT ZC412 Inservice Training II 10

Rotational Inservice Training II in OPD (Out patient department), Biochemistry lab, Pathology lab, CCU (Coronary care unit), Cath lab, Anesthesia, perfusion, OT (Operation theatre), ICU (Intensive care unit), General ward, Rehabilitation.

PAT ZC421 Inservice Training III 10

The student will be trained in one specific inservice department from the list of departments for the Inservice Training - I (PAT ZC411) & Inservice Training - II (PAT ZC412).

PAT ZC422 Inservice Training IV 10

It is a continuation of Inservice Training - III (PAT ZC421).

PAT ZC423 Pharmacology & Toxicity 3

Pharmacology of important classes of drugs including their mechanism of action, therapeutic uses, side effects, toxic manifestations, indications and contra-indications.

PAT ZC431 Biostatistics 3

Methods of collection and presentation of statistical data; calculation and interpretation of various measures like mean, median, mode, standard deviation, kurtosis, correlation coefficient; probability distributions; sampling and estimation of parameters; tests of hypothesis; data analysis. Topics covered will aim to relate to the health field; introduction to decision analysis; decision theory; decision models.

PAT ZC442 Internship I 20

During Internship I, the students work as full-time assistants to the regular hospital staff. They are given exposure in specialty areas and opportunity to undertake projects or studies of a practical nature by which they develop their clinical skills.

Students are evaluated on a continuous basis. They have also to submit a project report and take a comprehensive examination.

PAT ZC443 Internship II 20

The course is a continuation of the course PAT ZC442. The operational aspects of the course remain the same as in PAT ZC442.

PAT ZC482 Management Information Systems 3

Introduction to Information Systems; Concepts of management, concepts of information, systems concepts; Information Systems and Organizations; decision making process; database systems; data communications; planning, designing, developing and implementing information systems; quality assurance and evaluation of information systems; future developments and their organizational and social implications; decision support system and expert systems.

PE* ZC112 Electrical and Electronics Technology 3

Electric circuit, electromagnetism, magnetic circuit, electrostatics, AC voltage and current, single phase circuits, semiconductor devices, amplifiers, digital systems, microprocessors, DC machines, polyphase circuits, transformers, synchronous machines, induction motors, power electronics, measurements, illumination.

PE* ZC113 Probability and Statistics 3

Probability spaces; conditional probability and independence; random variables and probability distributions; marginal and conditional distributions; independent random variables; mathematical expectation; mean and variance; binomial, Poisson and normal distributions; sum of independent random variables; law of large numbers; central limit theorem (without proof); sampling distribution and test for mean using normal and student's t-distribution; test of hypothesis; correlation and linear regression.

PE* ZC164 Computer Programming 4

Basic Computing Steps and Flow Charting (Assignment, Sequencing, Conditionals, Iteration). Programming Constructs – Expressions, Statements, Conditionals, Iterators/Loops, Functions/ Procedures; Data Types – Primitive Types, Tuples, Choices (Unions or Enumerations), Lists/Arrays, Pointers and Dynamically Allocated Data. Input output and Files. Laboratory Component: Programming Exercises involving development and testing of iterative and procedural programs using bounded and unbounded iterations, function composition,

random access lists, sequential access lists, dynamically allocated lists, and file access.

PE* ZC211 Principles of Management 3

Fundamental concepts of management - planning; organizing; staffing; directing and controlling; production, financial, personnel, legal and marketing functions; accounting and budgeting, balance sheets.

PE* ZC213 Engineering Measurements 3

Performance characteristics of measuring instruments, measurement methods for mechanical, electrical, radiant, chemical, magnetic and thermal energy variables. Emphasis in this course shall be on the operation and use of instruments.

PE* ZC214 Pharmaceutical Analysis 3

Basic techniques of pharmaceutical analysis, data handling and analysis, sources of error in analysis. The analytical methods would comprise of various titrimetric methods, such as acid-base, complexometric, non-aqueous, oxidation-reduction, precipitation, conductometric; physical and instrumental analysis such as gravimetric, polarography, nephelometry, amperometry, turbidometry, potentiometry; chromatographic separations such as TLC, coloumn, ion-exchange, extraction methods such as gel-filtration, fractionation processes, analysis of metallic and non-metallic elements; water content, as well as evaluation of drug constituents in various pharmaceutical preparation.

PE* ZC221 Disinfection & Sterilization Processes 3

Common sources of microbes, contamination methods; processes involved in disinfection of materials; enclosed space, sanitation; sterilization methods – dry heat, moist heat, air, filtration; aseptic processing, sterility testing, indicators and sampling methods; skin disinfection.

PE* ZC231Engineering Materials 3

Mechanical, electrical, electronic and chemical properties and applications of common engineering materials; ferrous and non- ferrous metals and alloys; thermosetting and thermoplastic plastics; natural and synthetic resins; rubber; glass; abrasives and ceramics; common building materials, namely, timber, stone, lime and cement; corrosion of metals and methods of preventing corrosion; protective and decorative coatings; insulating materials; testing of materials.

PE* ZC233 Calculus 4

Limits, continuity, differentiation, integration, Fourier series, ordinary differential equations for initial and boundary value problems, solution through Laplace transforms, numerical solution using Picard's iteration and higher order methods, partial derivatives, partial differential equations, analytical solution techniques.

PE* ZC234 Manufacturing Processes 3

Fundamentals of casting process; forging; powder metallurgy; soldering; brazing and welding technology; metal forming process, its analysis and design; Introduction to Metal cutting, machine tools; mechanics of metal cutting; other machining processes; grinding and finishing operations; non convention machining; chipless machining processes; NC machines programming; control system in CNC; CNC, DNC; FMS and machining center.

PE* ZC235 Linear Algebra & Optimization 3

Vector and matrix algebra, systems of linear algebraic equations and their solutions; eigenvalues, eigenvectors and diagonalization of matrices; Formulation of linear programming problems, Simplex method, Big-M method, Two phase method, Sensitivity analysis, Revised and Dual Simplex Methods.

PE* ZC241 Mechanical Technology 3

Fundamental concepts of heat, work and energy; second law of thermodynamics; properties of gases and vapors; basic cycles; flow of liquids; steam boilers; steam engines and pumps; steam turbines and condensers; hydraulic pumps and turbines; internal combustion engine.

PE* ZC311 Chemical Engineering Thermodynamics 4

Concept of heat and work, Ideal and real gas systems, Thermodynamic Laws, P-V-T behaviour of real gases, Concept of entropy, Heat effects, First and Second law analysis of processes including power plants and refrigeration systems, Thermodynamic Property relations, Vapour liquid equilibrium, Solutions thermodynamics: Theory and applications, Chemical Reaction equilibria, Special topics in Phase equilibrium, Role of thermodynamics in process simulation, Case studies

PE* ZC313 Technical Report Writing 3

Elements of effective writing; art of condensation; business letter writing; memos; formal reports; technical proposals; conducting, and participating, meetings; agenda and minutes; strategies for writing technical descriptions, definitions, and classifications; oral presentation; use of graphic and audio- visual aids; editing.

PE* ZC314 Power Plant Engineering 3

Classification of power plants. Components and layout of; thermal, nuclear, hydro electric power plants. Site selection for various power plants. Combined cycle power plants. Magneto Hydro Dynamics (MHD) systems. Economics of power generation, economic loading of power stations. Load curve analysis; load factor, diversity factor. Power plant instrumentation and controls.

PE* ZC315 Materials Management 3

Integrated materials management, policy aspects, purchasing management, warehousing and storage of inventory control systems; appraisal and control; just in time (JIT); automation in materials management.

PE* ZC316 Transport Phenomena – I 4

Diffusional transport of fluid heat and mass (a comparison), Fluid statics, Laminar and turbulent flows, Boundary layer concept (hydrodynamic, thermal and concentration), Continuity equation, Bernoulli's equation, Introduction to equations of motion, Laminar and turbulent flow in pipes, concept of drag, packed beds and fluidization, steady state heat conduction, concept of heat transfer coefficient, convective heat transfer (forced and natural convection correlations), introduction to radiative heat transfer, interphase mass transfer and mass transfer coefficients, analogy between fluid flow, heat and mass transfer.

PE* ZC317 Transport Phenomena – II 4

Transportation and metering of fluids (pumps, fittings, valves and compressors), flow measurement, Condensation and boiling, heat exchange equipment, absorption, concept of equilibrium stage operations, distillation, extraction selected operations like crushing, grinding, drying, filtration, evaporation, etc.

PE* ZC318 Fundamentals of Transport Processes 4

Concept of momentum transfer, Newton's law of viscosity, Continuity and Bernoulli's equation, Concept of pressure drop and drag, Introduction to conduction, convection (free and forced) and radiation including Fourier's law of heat conduction, Newton's law of cooling, Stefan Boltzmann and Kirchhoff's laws, concept of resistance and lumped capacitance; Boundary layer theory (momentum, thermal and mass), Heat transfer correlations; Phase change heat transfer, Diffusion fundamentals including Fick's law, Interphase mass transfer, Concept of mass transfer coefficient, Momentum, heat and mass transfer analogies, Introduction to transport equations.

PE* ZC319 Unit Operations - 1 4

Pumps and compressors, Flow measurement devices, Piping networks, Agitation and mixing, Packed and fluidized beds, Heat exchangers including boilers and condensers, LMTD, epsilon-NTU method, Co-current counter-current and cross flows, NTU – epsilon method for exchanger evaluation, Distillation, Absorption, Leaching, Humidification and drying, Cooling towers.

PE* ZC320 Unit Operations - II 4

Sedimentation, Evaporation, Liquid – Liquid extraction, adsorption, Mechanical separations like filtration, centrifugation, froth floatation etc., Solid separations based on size reduction including sieving operations and related equipment like crushers, mills, pulverizers etc., special separation processes like ion-exchange, membranes, chromatography etc.

PE* ZC321 Chemical Process Calculations 3

Properties of gases, liquids and solids; material and energy balances; elementary process analysis involving phase equilibria and chemical reactions; recycling and unsteady state processes; combustion calculations and typical industrial applications.

PE* ZC322 Process Design Principles 4

Process invention using heuristics and analysis (The Design process, Process creation and heuristics for process synthesis), Sequencing of separation trains, concept of pinch technology and heat exchanger network analysis, Cost

estimation and profitability analysis, Role of simulators in process engineering, Case studies.

PE* ZC323 Corrosion Engineering 3

Corrosion principles: electrochemical aspects, environmental effects, metallurgical & other aspects; various forms of corrosion. Materials: metals and alloys, non-metallics (polymers and ceramics). Corrosion prevention: Materials selection, alteration of environment, design, cathodic and anodic protection, Coatings, Case Studies.

PE* ZC324 Chemical Reaction Engineering 3

Ideal reactor concepts, design equations for batch and continuous reactors (constant and variable volume), Kinetics and interpretation of batch reactor data, Catalytic reactors including external diffusion and intra-particle diffusion effects, Non-ideal reactor concepts, Industrial reactor systems.

PE* ZC331 Quality Control Assurance & Reliability 3

Basic concepts of probability and probability distributions, standard probability distribution, sampling and sampling distributions, confidence intervals, testing significance, statistical tolerance, various types of control charts, statistical process control techniques, value analysis, defect diagnosis and prevention, basic concepts of reliability, reliability design evaluation and control, methods of applying total quality management, production process.

PE* ZC343 Industrial Pharmacy 3

Pharmaceutical processes and equipment commonly used in pharmaceutical industries; drug extraction and clarification; mixing and granulation; pharmaceutical preparations such as aromatic waters, spirits, syrups, elixirs, lotions, liniments, official solutions etc.; galenical products like infusions, decoctions, tinctures, extracts, etc, glandular preparations and blood plasma substitutes.

PE* ZC344 Thermodynamics & Reaction Engineering 4

Development and applications of the combined first and second laws; relations between state properties; chemical equilibria in reacting and nonreacting systems; Kinetics of homogeneous, heterogeneous reactions; ideal reactors; selectivity; analysis and design of chemical reactors.

PE* ZC352 Energy Management 4

World and Indian Energy scenario including production, consumption and pricing, Energy conservation and its importance, Energy conservation act and its features, Energy Management and Audit including energy audit instruments, Energy action planning, Energy monitoring and targeting, Energy economics, Energy efficiency in thermal utilities, Energy efficiency in electrical utilities, Energy performance assessment for equipment and utilities, Application through case studies.

PE* ZC353 Industrial Engineering 3

Industrial systems and organization; engineering economy; work measurement techniques; motivation and time studies; factory planning and materials handling; industrial standardization; critical path methods; quality control; reliability; maintenance and management planning; scheduling; job analysis (evaluation); value engineering.

PE* ZC361 Environmental Pollution Control 3

Air and water pollutants; sampling and analysis; control methods for air & water pollutants; modeling of different control techniques; advanced wastewater treatment processes; solid waste management, noise pollution; case studies.

PE* ZC382 Cement Technology 3

Indian & Global Cement Industries; Geological classification of rock; Geo-chemistry of lime stone; Crushing, Grinding and Raw material handling process; different type of milling systems and applications - Raw mill, Coal mill, Cement mill; Kiln system and process, Fuel and firing system, Clinker cooling, storage, grinding and packing; merging trends in cement manufacture.

PE* ZC385 Fertilizer Technology 3

Introduction, fertilizer industry in India during last few decades; technology / production of fertilizer products such as intermediates, nitrogenous fertilizers, phosphatic fertilizers, potassic fertilizers, complex fertilizers; guidelines for mixing fertilizers.

PE* ZC383 Extractive Metallurgy 3

Introduction, Methods of extraction and refining of metals, principles of pyrometallurgy, heat transfer and fluid flow, rates of metallurgical reactions, analysis of unit processes, principles of electro and hydrometallurgy.

PE* ZC411 Production Planning & Control 3

Generalized model of production systems; types of production flows; life cycle concepts; facilities location and layout planning; aggregate and batch production planning; inventory systems; materials requirements planning; elements of monitoring & production control.

PE*ZC412 Process Equipment Design 4

Process design of major fluid, heat and separation equipment including pumps and heat exchangers, Mechanical Design considerations and material of construction, Pressure vessel design, Storage vessel design, Design of flange and vessel heads, Mechanical design of specific equipment like heat exchangers, distillation columns etc., Case studies.

PE* ZC423 Essentials of Project Management 3

Programmes project management, project manager: role and responsibilities, project management and organization, project planning and scheduling, graphical techniques and PERT, CPM, price estimation and cost control; proposal, control valuation monitoring and trade off analysis in a project environment, pitfalls and future scenario.

PE* ZC423T Project Work 10

Consistent with the student's professional background and work-environment, the student will be required to carry out a work-oriented project. At the beginning of the semester, the student should select an area of work that is considered vital to the sponsoring organization, and prepare a detailed project outline, in consultation with his/her Mentor. The student carries on with the work-centered project, adhering to the guidelines provided in the detailed course handout, and taking all the prescribed evaluation components on time. At the end of the semester, the student should submit a comprehensive Project Report. The student will be evaluated on the basis of the various interim evaluation components, contents of the report and a final seminar and viva-voce.

PE* ZC434, Quality Control, Assurance & Reliability 4

Basic concepts of probability and probability distributions, standard probability distribution, sampling and sampling distributions, confidence intervals, testing significance, statistical tolerance, various types of control charts, statistical process control techniques, value analysis, defect diagnosis and prevention, basic concepts of reliability, reliability design evaluation and control, methods of applying total quality management, production process. Practical assignments on statistical quality control using suitable statistical software tools such as R-software, MS Excel, SAS, Minitab or SPSS.

PE* ZC452 Process Plant Safety and Environment 4

Role of safety in society; engineering aspects of process plant safety; chemical hazards and worker safety; hazardous properties of chemicals; safety aspects in site selection and plant layout; design and inspection of pressure vessels; storage, handling and transportation of hazardous chemicals; risk assessment methods; toxic release, fire and explosions; boiling liquid expanding vapor explosions; safety audit; emergency planning and disaster management; Introduction to air pollutants, water pollutants and solid wastes; sampling & analysis techniques; impact of these on environment; national and international regulations, case studies.

PE* ZC453 Process Control & Instrumentation 4

Importance of Process Control; Process dynamics, modeling and transient response; Control actions and feedback control; Hydraulic-, pneumatic- and electronic controllers; Controller design, tuning and stability; Measuring instruments and their working principles; Instrument characteristics and transmission; Transducers, sensor and actuators; Control valves; Piping and Instrumentation diagrams; Signal conditioning and processing; Display and recording; Signal-flow graph and Mason's gain formula; Feed forward, cascade and ratio control; Direct digital control; Programmable logic controllers; DCS and SCADA systems; PC based instrumentation; Introduction to multivariable control system.

PEAB ZC111 Computer Programming 3

PEHC ZC111 Computer Programming 3

PEHR ZC111 Computer Programming 3

Elementary computer organization; introduction to Number Systems; Representation of integers, real numbers and characters on computers; concept of range and accuracy; Arithmetic Overflow;

Algorithms and algorithm development; structured program development through step wise refinement. Introduction to C language; Functions; Recursion; Data structure & algorithms; File management & file handling; Problem solving using C.

PEJS ZC112 Electrical and Electronics Technology 3

PEVA ZC112 Electrical and Electronics Technology 3

Electric circuit, electromagnetism, magnetic circuit, electrostatics, AC voltage and current, single phase circuits, semiconductor devices, amplifiers, digital systems, microprocessors, DC machines, polyphase circuits, transformers, synchronous machines, induction motors, power electronics, measurements, illumination.

PEAB ZC121 Electrical & Electronics Engineering 3

PEHC ZC121 Electrical & Electronics Engineering 3

PEHR ZC121 Electrical & Electronics Engineering 3

PEAB ZC131 Engineering Mathematics I 3

PEHC ZC131 Engineering Mathematics I 3

PEHR ZC131 Engineering Mathematics I 3

Limit concept; derivatives of elementary functions and their applications; introduction to ordinary and partial differential equations and initial/boundary value problems. Convergence tests for series; power series and interval of convergence; series solution of differential equations. Approximation and error, interpolation; roots of algebraic and transcendental functions, Newton's method.

PEJS ZC164 Computer Programming 4

PEVA ZC164 Computer Programming 4

Basic Computing Steps and Flow Charting (Assignment, Sequencing, Conditionals, Iteration). Programming Constructs – Expressions, Statements, Conditionals, Iterators/Loops, Functions/ Procedures; Data Types – Primitive Types, Tuples, Choices (Unions or Enumerations), Lists/Arrays, Pointers and Dynamically Allocated Data. Input output and Files. Laboratory Component: Programming Exercises involving development and testing of iterative and procedural programs using bounded and unbounded iterations, function composition, random access lists, sequential access lists, dynamically allocated lists, and file access.

PEJS ZC211 Principles of Management 3

PEVA ZC211 Principles of Management 3

Fundamental concepts of management - planning; organizing; staffing; directing and controlling; production, financial, personnel, legal and marketing functions; accounting and budgeting, balance sheets.

PEAB ZC212 Engineering Mathematics II 3

PEHC ZC212 Engineering Mathematics II 3

PEHR ZC212 Engineering Mathematics II 3

PEJS ZC212 Engineering Mathematics II 3

Algebra of vectors and matrices; Gauss's row-reduction process; applications of simultaneous linear equations and matrix inversion; determinants and Cramer's rule. Numerical differentiation and integration; numerical methods for solving ordinary and partial differential equations.

PEJS ZC213 Engineering Measurements 3

PEVA ZC213 Engineering Measurements 3

Performance characteristics of measuring instruments, measurement methods for mechanical, electrical, radiant, chemical, magnetic and thermal energy variables. Emphasis in this course shall be on the operation and use of instruments.

PEAB ZC221 Principles of Management 3

PEHC ZC221 Principles of Management 3

PEHR ZC221 Principles of Management 3

Fundamental concepts of management - planning; organizing; staffing; directing and controlling; production, financial, personnel, legal and marketing functions; accounting and budgeting, balance sheets.

PEAB ZC222 Fluid Mechanics 3

PEHC ZC222 Fluid Mechanics 3

PEHR ZC222 Fluid Mechanics 3

Fundamental concepts; fluid statics; integral and differential analyses for fluid motion; dimensional analysis; internal and external fluid flow; fluid machinery; flow through packed bed; agitation; introduction to compressible flow.

PEJS ZC231 Engineering Materials 3

PEVA ZC231 Engineering Materials 3

Mechanical, electrical, electronic and chemical properties and applications of common engineering materials; ferrous and non- ferrous metals and alloys; thermosetting and thermoplastic plastics; natural and synthetic resins; rubber; glass; abrasives and ceramics; common building materials, namely, timber, stone, lime and cement; corrosion of metals and methods of preventing corrosion; protective and decorative coatings; insulating materials; testing of materials.

PEAB ZC232 Engineering Materials 3

PEHC ZC232 Engineering Materials 3

PEHR ZC232 Engineering Materials 3

PEJS ZC232 Engineering Materials 3

Mechanical, electrical, electronic and chemical properties and applications of common engineering materials; ferrous and non- ferrous metals and alloys; thermosetting and thermoplastic plastics; natural and synthetic resins; rubber; glass; abrasives and ceramics; common building materials, namely, timber, stone, lime and cement; corrosion of metals and methods of preventing corrosion; protective and decorative coatings; insulating materials; testing of materials.

PEJS ZC233 Calculus 4

PEVA ZC233 Calculus 4

Limits, continuity, differentiation, integration, Fourier series, ordinary differential equations for initial and boundary value problems, solution through Laplace transforms, numerical solution using Picard's iteration and higher order methods, partial derivatives, partial differential equations, analytical solution techniques.

PEVA ZC234 Manufacturing Processes 3

Fundamentals of casting process; forging; powder metallurgy; soldering; brazing and welding technology; metal forming process, its analysis and design; Introduction to Metal cutting, machine tools; mechanics of metal cutting; other machining processes; grinding and finishing operations; non convention machining; chipless machining processes; NC machines programming; control system in CNC; CNC, DNC; FMS and machining center.

PEJS ZC235 Linear Algebra & Optimization 3

PEVA ZC235 Linear Algebra & Optimization 3

Vector and matrix algebra, systems of linear algebraic equations and their solutions; eigenvalues, eigenvectors and diagonalization of matrices; Formulation of linear programming problems, Simplex method, Big-M method, Two phase method, Sensitivity analysis, Revised and Dual Simplex Methods.

PEJS ZC242 Thermodynamics & Kinetics 3

Importance and Fundamental concepts of Thermodynamics, concept of states, systems, equilibrium, extensive and intensive properties, homogeneous and heterogeneous systems, First Law of Thermodynamics, Internal energy, heat capacity, isothermal, and adiabatic processes, Second law of Thermodynamics, criteria of equilibrium, Maxwell's relations, Gibbs-Helmholtz equation, Entropy, Kinetic Theory, Auxiliary Functions, Heat Capacity, Enthalpy, Phase Equilibrium in one component system, Concept of Third law, relation between Cp and Cv, Fugacity, equilibrium constant, use of Y S - functions, Ellingham-Richardson diagrams, phase stability diagrams, Behaviour of Solutions, Thermodynamics of non reacting mixtures, reaction rate theory, Introduction to metallurgical kinetics, heterogeneous reaction kinetics-gas-solid, solid-liquid, liquid-liquid and solid-solid systems, concept of Johnson- Mehl equation, effect of temperature on reaction rates, energy of activation, Solutions, partial molal quantities, ideal and non-ideal solutions, Henry's law, Gibbs - Duhem equation, regular solution, Change of standard state, Phase relations and phase rule, Free energy composition diagrams for binary alloy systems, determination of liquidus, solidus and solvus lines, Effect of pressure on phase transformation and phase equilibria.

PEJS ZC252 Mineral Beneficiations and Agglomeration 3

Early development in Metal Extraction, General methods of extraction, The necessity and methods of beneficiation, mineralogical assessment, Minerals and ores, refining, importance of mineral dressing, principles of flotation, Refractories, different comminution methods-fracture, Crushing and Grinding machines, liberation, size-criteria, energy-size relationships, crushing grinding and attrition, screening and classification, cyclones,

concentration processes-density, electrical, magnetic separators and other physical methods, Interfacial phenomenon, surfactants, Floatation principles and froth floatation, liquid-solid separation-floculation, thickening, classification, free and hindered settling, Dry and wet sizing, Jigging, surface chemistry of minerals, dewatering, Pollution in beneficiation plants, Agglomeration: Basic processes-Nodulization, briquetting, Pelletization, sintering, Material Balances in process flows: Component and total mass balances of reactive and non reactive systems including recycling, Batch and steady state flows, Unit Processes in pyrometallurgy: calcination, roasting, sintering, smelting , converting, distillation, Metallothermic reduction and hydrogen reduction, refining processes with examples for metals like copper, nickel, lead, zinc, etc. Unit processes in hydrometallurgy: leaching, purification of leach liquor, solvent extraction and ion exchange process, metal recovery from aqueous phase. Unit processes in electrometallurgy: Faraday's laws of electrolysis, concept of overvoltage, limiting current density, overall cell voltage, series and parallel electrical circuits in refining, Electrowinning and electrorefining with reference to Cu, Zu, Al, Mg.

PEJS ZC262 Iron Making 3

World production of Iron and steel, occurrence and distribution of iron ore, coal and limestone in India and world, General layout of integrated steel plant, Raw materials in ferrous production metallurgy, coke production, agglomeration of iron ores. Technology of blast furnace iron making - operational details, Study of blast furnace processes and blast furnace slag, Blast furnace reactions, Raceway, Cohesive zone, Thermodynamics of slag-metal reactions, high top pressure, oxygen enrichment, injection of auxiliary fuels. Blast furnace design, Furnace productivity, the coke rate, hot metal quality. Alternate routes of iron making, Temperature profile, Aerodynamics, different factors, Irregularities etc., Heat exchange zones in blast furnace.

PEJS ZC272 Furnace Technology 3

Conventional, non-conventional and newer sources of energy, energy management problems in metallurgical Industries, role of high temperature systems and materials , deposits, manufacturing, properties and testing of solid, liquid and gaseous fuels; Principles of fuel combustion and burner design. Classification of refractory, manufacturing and properties of common refractories such as silica, fire clay, high alumina, dolomite, magnesite and chrome refractories. Furnaces, Types, Design of high temperature furnaces, waste heat utilization, heat recuperators and refrigerators, stack design, gas cleaning, heat balance diagrams; furnace dynamics: fluid flow calculations, fuel fired furnaces, electric arc furnaces, vacuum, electron beam, plasma, laser furnaces.

PEAB ZC311 Chemical Engineering Thermodynamics 3

PEHC ZC311 Chemical Engineering Thermodynamics 3

PEHR ZC311 Chemical Engineering Thermodynamics 3

PEJS ZC311 Chemical Engineering Thermodynamics 3

PEVA ZC311 Chemical Engineering Thermodynamics 3

Development and applications of the combined first and second laws; relations between state properties; chemical equilibria in reacting and nonreacting systems; statistical concepts, and brief exposure to irreversible thermodynamics; extensive problem assignments throughout.

PEJS ZC312 Steel Making & Casting 3

Fundamentals of Steel making, Historical development of steel making processes. Open hearth, basic oxygen, electric arc and induction furnace steel making, processes, Thermodynamics, kinetics and transport phenomena in steel making, Introduction to ladle metallurgy. Refining of Steel. Continuous Casting, near net shape making, clean steel practices, stainless steel making and emerging trends in steel making and continuous casting. Introduction to casting, Molding Equipment Processes, Molding Sand, Cores, Core Materials, Solidification of Metals.

PEAB ZC313 Technical Report Writing 3

PEHC ZC313 Technical Report Writing 3

PEHR ZC313 Technical Report Writing 3

PEJS ZC313 Technical Report Writing 3

PEVA ZC313 Technical Report Writing 3

Elements of effective writing; art of condensation; business letter writing; memos; formal reports;

technical proposals; conducting, and participating, meetings; agenda and minutes; strategies for writing technical descriptions, definitions, and classifications; oral presentation; use of graphic and audio- visual aids; editing.

PEAB ZC314 Power Plant Engineering 3

PEHC ZC314 Power Plant Engineering 3

PEHR ZC314 Power Plant Engineering 3

PEVA ZC314 Power Plant Engineering 3

Classification of power plants. Components and layout of; thermal, nuclear, hydro electric power plants. Site selection for various power plants. Combined cycle power plants. Magneto Hydro Dynamics (MHD) systems. Economics of power generation, economic loading of power stations. Load curve analysis; load factor, diversity factor. Power plant instrumentation and controls.

PEJS ZC316 Transport Phenomena – I 4

PEVA ZC316 Transport Phenomena – I 4

Diffusional transport of fluid heat and mass (a comparison), Fluid statics, Laminar and turbulent flows, Boundary layer concept (hydrodynamic, thermal and concentration), Continuity equation, Bernoulli's equation, Introduction to equations of motion, Laminar and turbulent flow in pipes, concept of drag, packed beds and fluidization, steady state heat conduction, concept of heat transfer coefficient, convective heat transfer (forced and natural convection correlations), introduction to radiative heat transfer, interphase mass transfer and mass transfer coefficients, analogy between fluid flow, heat and mass transfer.

PEJS ZC317 Transport Phenomena – II 4

PEVA ZC317 Transport Phenomena – II 4

Transportation and metering of fluids (pumps, fittings, valves and compressors), flow measurement, Condensation and boiling, heat exchange equipment, absorption, concept of equilibrium stage operations, distillation, extraction selected operations like crushing, grinding, drying, filtration, evaporation, etc.

PEAB ZC321 Chemical Process Calculations 3

PEHC ZC321 Chemical Process Calculations 3

PEHR ZC321 Chemical Process Calculations 3

PEJS ZC321 Chemical Process Calculations 3

PEVA ZC321 Chemical Process Calculations 3

Properties of gases, liquids and solids; material and energy balances; elementary process analysis involving phase equilibria and chemical reactions; recycling and unsteady state processes; combustion calculations and typical industrial applications.

PEAB ZC322 Kinetics & Reactor Design 3

PEHC ZC322 Kinetics & Reactor Design 3

PEHR ZC322 Kinetics & Reactor Design 3

Kinetics of homogeneous, heterogeneous reactions; ideal reactors, nonideal flow; selectivity; analysis and design of chemical reactors.

PEAB ZC331 Quality Control Assurance & Reliability 3

PEHC ZC331 Quality Control Assurance & Reliability 3

PEHR ZC331 Quality Control Assurance & Reliability 3

PEJS ZC331 Quality Control, Assurance & Reliability 3

PEVA ZC331 Quality Control, Assurance & Reliability 3

Basic concepts of probability and probability distributions, standard probability distribution, sampling and sampling distributions, confidence intervals, testing significance, statistical tolerance, various types of control charts, statistical process control techniques, value analysis, defect diagnosis and prevention, basic concepts of reliability, reliability design evaluation and control, methods of applying total quality management, production process.

PEJS ZC332 Testing of Materials 3

Purpose, sampling and interpretation of testing methods. Destructive testing, Hardness - Hardness tests like Brinell, Rockwell, Vickers, Meyer, Knoop etc., relationship with flow curve, Engineering & true stress-strain curves, evaluation of tensile properties, effect of strain-rate & temperature on flow properties, Comparison, buckling & barreling, Pure bending & flexure formula, Torsion, Stresses for elastic & plastic strain, Torsion Vs. Tension, Tensile testing with associated parameters, Impact, Notched bar impact tests, transition Temperature & metallurgical factors affecting it, Creep, stress rupture & stress relaxation tests, development of creep resistant alloys, prediction of long time

properties. Fatigue - Stress cycles & S-N curve, effect of variables like mean stress, stress concentration, surface, size, metallurgical factors etc., Fatigue and fatigue crack growth studies, Formability testing, Transverse rupture strength of brittle materials,torsion testing, Fracture toughness testing (KIC, J-integral etc.).

PEAB ZC341 Heat Transfer **3**

PEHC ZC341 Heat Transfer **3**

PEHR ZC341 Heat Transfer **3**

Steady and unsteady state heat conduction; forced and natural convection; radiation; condensation and boiling heat transfer; evaporation; heat exchanger.

PEAB ZC351 Mass Transfer **3**

PEHC ZC351 Mass Transfer **3**

PEHR ZC351 Mass Transfer **3**

Introduction to molecular diffusion and mass transfer coefficients; interphase mass transfer; design of absorption, distillation, extraction and leaching processes.

PEAB ZC352 Energy Management **3**

PEHC ZC352 Energy Management **3**

PEHR ZC352 Energy Management **3**

PEJS ZC352 Energy Management **3**

PEVA ZC352 Energy Management **3**

Energy management principles; energy conservation; energy auditing; analysis; formulation of energy management options; economic evaluation, implementation & control; energy conservation techniques – conservation in energy intensive industries; steam generation, distribution systems, and electrical systems; integrated resource planning; demand-side. management; cogeneration; total energy schemes; thermal insulation; energy storage; economic evaluation of conservation technologies; analysis of typical applications.

PEVA ZC353 Industrial Engineering **3**

Industrial systems and organization; engineering economy; work measurement techniques; motivation and time studies; factory planning and materials handling; industrial standardization; critical path methods; quality control; reliability; maintenance and management planning; scheduling; job analysis (evaluation); value engineering.

PEJS ZC362 Steel Processing **3**

Introduction to metal casting, Moulding, materials and processes, patterns, sand and binders. directional solidification, rapid solidification. Solidification of short & long freezing range alloy castings, Gating and Risering of castings, Cupola, rotary furnace, induction furnace, crucible furnace melting, Introduction to cast alloys, classification, microstructures and properties of cast irons, plain carbon and Hadfield Manganese steels, Heat treatment of cast alloys, Casting defects and remedy, Special casting processes, Introduction to metal joining processes, welding, Fundamentals of metal working, Temperature, strain rate, friction & lubrication, Rolling, Classification & processes Forging, Extrusion, Drawing, cold working and warm working, Bulk and sheet metal forming, Mechanical and Hydraulic Presses, Stretching, drawing and bending of sheet metal, Metallurgical changes during metal working; thermo-mechanical processes. Slab analysis of plane strain and axisymmetric upsetting.

PEAB ZC382 Cement Technology **3**

Indian & Global Cement Industries; Geological classification of rock; Geo-chemistry of lime stone; Crushing, Grinding and Raw material handling process; different type of milling systems and applications - Raw mill, Coal mill, Cement mill; Kiln system and process, Fuel and firing system, Clinker cooling, storage, grinding and packing; merging trends in cement manufacture.

PEHC ZC382 Fertilizer Technology **3**

Introduction, fertilizer industry in India during last few decades; technology / production of fertilizer products such as intermediates, nitrogenous fertilizers, phosphatic fertilizers, potassic fertilizers, complex fertilizers; guidelines for mixing fertilizers.

PEHR ZC383 Extractive Metallurgy **3**

PEHC ZC383 Extractive Metallurgy **3**

PEVA ZC383 Extractive Metallurgy **3**

Introduction, Methods of extraction and refining of metals, principles of pyrometallurgy, heat transfer and fluid flow, rates of metallurgical reactions, analysis of unit processes, principles of electro and hydrometallurgy.

PEVA ZC411 Production Planning & Control 3

Generalized model of production systems; types of production flows; life cycle concepts; facilities location and layout planning; aggregate and batch production planning; inventory systems; materials requirements planning; elements of monitoring & production control.

PEAB ZC412 Process Equipment Design 3

PEHC ZC412 Process Equipment Design 3

PEHR ZC412 Process Equipment Design 3

PEVA ZC412 Process Equipment Design 3

Application of principles of Chemical Engineering to the selection and design of equipment for Chemical industries; design, cost estimation and selection of process equipment; piping, pressure vessels, heat exchangers, distillation columns etc. Use of computer software packages in the design; plant safety practices; use of codes.

PEAB ZC413 Process Plant Safety and Environment 3

PEHC ZC413 Process Plant Safety and Environment 3

PEHR ZC413 Process Plant Safety and Environment 3

PEJS ZC413 Process Plant Safety and Environment 3

Role of safety in society; engineering aspects of process plant safety; chemical hazards and worker safety; hazardous properties of chemicals; safety aspects in site selection and plant layout; design and inspection of pressure vessels; storage, handling and transportation of hazardous chemicals; risk assessment methods; toxic release, fire and explosions; boiling liquid expanding vapor explosions; safety audit; emergency planning and disaster management; case studies

PEJS ZC414 Project Appraisal 3

Overview of project and project phases; project formulation aspects in terms of market studies, technical studies, financial studies, economic studies, environmental studies, etc.; project evaluation aspects in terms of commercial profitability prospects, national economic profitability prospects; issues of project preparation in project implementation.

PEJS ZC423T Project Work 10

PEVA ZC423T Project Work 10

Consistent with the student's professional background and work-environment, the student will be required to carry out a work-oriented project. At the beginning of the semester, the student should select an area of work that is considered vital to the sponsoring organization, and prepare a detailed project outline, in consultation with his/her Mentor. The student carries on with the work-centered project, adhering to the guidelines provided in the detailed course handout, and taking all the prescribed evaluation components on time. At the end of the semester, the student should submit a comprehensive Project Report. The student will be evaluated on the basis of the various interim evaluation components, contents of the report and a final seminar and viva-voce.

PEAB ZC423T Project Work 20

PEHC ZC423T Project Work 20

PEHR ZC423T Project Work 20

Consistent with the student's professional background and work-environment, the student will be required to carry out work-oriented projects. The student would be required to select an area of work that is considered vital to the sponsoring organization. The topic of the project and detailed project outline that is prepared by the student, in consultation with his/her Mentor, needs to be approved by the Dean, WILPD. On approval, the student carries on with the work-centered project, adhering to the guidelines provided in the detailed course handout, taking all the prescribed evaluation components on time. At the end of the semester, the student should submit a comprehensive Project Report, to the Institute for evaluation. The student will be evaluated on the basis of the various interim evaluation components, contents of the report and Seminar/Viva-Voce that may be conducted at Pilani or at any other Centre approved by the Institute.

PEAB ZC441 Process Control & Instrumentation 3

PEHC ZC441 Process Control & Instrumentation 3

PEHR ZC441 Process Control & Instrumentation 3

PEHZ ZC441 Process Control & Instrumentation 3

PEJS ZC441 Process Control & Instrumentation 3

Introduction to process control; mathematical models of simple systems, elements of process control loop; stability, time response, design of simple control system; principles of sensors and transducers; instrumentation for typical industries.

PEJS ZG442 Advances in Materials Science 3

Deformation of materials, deformation at high temperatures and creep, recovery, recrystallization and grain growth, fracture of materials and fatigue failure, deterioration of materials, corrosion and oxidation, surface properties, surface energy and tribology, polymers and fibre reinforced polymeric composites, mechanical testings, nondestructive testing techniques.

PEJS ZC452 Process Plant Safety and Environment 4

PEVA ZC452 Process Plant Safety and Environment 4

Role of safety in society; engineering aspects of process plant safety; chemical hazards and worker safety; hazardous properties of chemicals; safety aspects in site selection and plant layout; design and inspection of pressure vessels; storage, handling and transportation of hazardous chemicals; risk assessment methods; toxic release, fire and explosions; boiling liquid expanding vapor explosions; safety audit; emergency planning and disaster management; Introduction to air pollutants, water pollutants and solid wastes; sampling & analysis techniques; impact of these on environment; national and international regulations, case studies.

PEJS ZC453 Process Control & Instrumentation 4

PEVA ZC453 Process Control & Instrumentation 4

Importance of Process Control; Process dynamics, modeling and transient response; Control actions and feedback control; Hydraulic-, pneumatic- and electronic controllers; Controller design, tuning and stability; Measuring instruments and their working principles; Instrument characteristics and transmission; Transducers, sensor and actuators; Control valves; Piping and Instrumentation diagrams; Signal conditioning and processing; Display and recording; Signal-flow graph and Mason's gain formula; Feed forward, cascade and ratio control; Direct digital control; Programmable logic controllers; DCS and SCADA systems; PC based instrumentation; Introduction to multivariable control system.

PERL ZC112 Electrical and Electronics Technology 3

Electric circuit, electromagnetism, magnetic circuit, electrostatics, AC voltage and current, single phase circuits, semiconductor devices, amplifiers, digital systems, microprocessors, DC machines, polyphase circuits, transformers, synchronous machines, induction motors, power electronics, measurements, illumination.

PERL ZC113 Probability and Statistics 3

Probability spaces; conditional probability and independence; random variables and probability distributions; marginal and conditional distributions; independent random variables; mathematical expectation; mean and variance; binomial, Poisson and normal distributions; sum of independent random variables; law of large numbers; central limit theorem (without proof); sampling distribution and test for mean using normal and student's t-distribution; test of hypothesis; correlation and linear regression.

PERL ZC164 Computer Programming 4

Basic Computing Steps and Flow Charting (Assignment, Sequencing, Conditionals, Iteration). Programming Constructs – Expressions, Statements, Conditionals, Iterators/Loops, Functions/ Procedures; Data Types – Primitive Types, Tuples, Choices (Unions or Enumerations), Lists/Arrays, Pointers and Dynamically Allocated Data. Input output and

Files. Laboratory Component: Programming Exercises involving development and testing of iterative and procedural programs using bounded and unbounded iterations, function composition, random access lists, sequential access lists, dynamically allocated lists, and file access.

PERL ZC211 Principles of Management 3

Fundamental concepts of management - planning; organizing; staffing; directing and controlling; production, financial, personnel, legal and marketing functions; accounting and budgeting, balance sheets.

PERL ZC213 Engineering Measurements 3

Performance characteristics of measuring instruments, measurement methods for mechanical, electrical, radiant, chemical, magnetic and thermal energy variables. Emphasis in this course shall be on the operation and use of instruments.

PERL ZC214 Pharmaceutical Analysis 3

Basic techniques of pharmaceutical analysis, data handling and analysis, sources of error in analysis. The analytical methods would comprise of various titrimetric methods, such as acid-base, complexometric, non-aqueous, oxidation-reduction, precipitation, conductometric; physical and instrumental analysis such as gravimetric, polarography, nephelometry, amperometry, turbidometry, potentiometry; chromatographic separations such as TLC, coloumn, ion-exchange, extraction methods such as gel-filtration, fractionation processes, analysis of metallic and non-metallic elements; water content, as well as evaluation of drug constituents in various pharmaceutical preparation.

PERL ZC221 Disinfection & Sterilization Processes 3

Common sources of microbes, contamination methods; processes involved in disinfection of materials; enclosed space, sanitation; sterilization methods – dry heat, moist heat, air, filtration; aseptic processing, sterility testing, indicators and sampling methods; skin disinfection.

PERL ZC231Engineering Materials 3

Mechanical, electrical, electronic and chemical properties and applications of common engineering materials; ferrous and non- ferrous metals and alloys; thermosetting and thermoplastic plastics; natural and synthetic resins; rubber; glass; abrasives and ceramics; common building materials, namely, timber, stone, lime and cement; corrosion of metals and methods of preventing corrosion; protective and decorative coatings; insulating materials; testing of materials.

PERL ZC233 Calculus 4

Limits, continuity, differentiation, integration, Fourier series, ordinary differential equations for initial and boundary value problems, solution through Laplace transforms, numerical solution using Picard's iteration and higher order methods, partial derivatives, partial differential equations, analytical solution techniques.

PERL ZC235 Linear Algebra & Optimization 3

Vector and matrix algebra, systems of linear algebraic equations and their solutions; eigenvalues, eigenvectors and diagonalization of matrices; Formulation of linear programming problems, Simplex method, Big-M method, Two phase method, Sensitivity analysis, Revised and Dual Simplex Methods.

PERL ZC311 Chemical Engineering Thermodynamics 3

Development and applications of the combined first and second laws; relations between state properties; chemical equilibria in reacting and nonreacting systems; statistical concepts, and brief exposure to irreversible thermodynamics; extensive problem assignments throughout.

PERL ZC313 Technical Report Writing 3

Elements of effective writing; art of condensation; business letter writing; memos; formal reports; technical proposals; conducting, and participating, meetings; agenda and minutes; strategies for writing technical descriptions, definitions, and classifications; oral presentation; use of graphic and audio- visual aids; editing.

PERL ZC316 Transport Phenomena – I 4

Diffusional transport of fluid heat and mass (a comparison), Fluid statics, Laminar and turbulent flows, Boundary layer concept (hydrodynamic, thermal and concentration), Continuity equation, Bernoulli's equation, Introduction to equations of motion, Laminar and turbulent flow in pipes, concept of drag, packed beds and fluidization, steady state heat conduction, concept of heat transfer coefficient, convective heat transfer (forced and natural convection correlations),

introduction to radiative heat transfer, interphase mass transfer and mass transfer coefficients, analogy between fluid flow, heat and mass transfer.

PERL ZC317 Transport Phenomena – II 4

Transportation and metering of fluids (pumps, fittings, valves and compressors), flow measurement, Condensation and boiling, heat exchange equipment, absorption, concept of equilibrium stage operations, distillation, extraction selected operations like crushing, grinding, drying, filtration, evaporation, etc.

PERL ZC321 Chemical Process Calculations 3

Properties of gases, liquids and solids; material and energy balances; elementary process analysis involving phase equilibria and chemical reactions; recycling and unsteady state processes; combustion calculations and typical industrial applications.

PERL ZC352 Energy Management 3

Energy management principles; energy conservation; energy auditing; analysis; formulation of energy management options; economic evaluation, implementation & control; energy conservation techniques – conservation in energy intensive industries; steam generation, distribution systems, and electrical systems; integrated resource planning; demand-side. management; cogeneration; total energy schemes; thermal insulation; energy storage; economic evaluation of conservation technologies; analysis of typical applications.

PERL ZC361 Environmental Pollution Control 3

Air and water pollutants; sampling and analysis; control methods for air & water pollutants; modeling of different control techniques; advanced wastewater treatment processes; solid waste management, noise pollution; case studies.

PERL ZC411 Production Planning & Control 3

Generalized model of production systems; types of production flows; life cycle concepts; facilities location and layout planning; aggregate and batch production planning; inventory systems; materials requirements planning; elements of monitoring & production control.

PERL ZC412 Process Equipment Design 3

Application of principles of Chemical Engineering to the selection and design of equipment for Chemical industries; design, cost estimation and selection of process equipment; piping, pressure vessels, heat exchangers, distillation columns etc. Use of computer software packages in the design; plant safety practices; use of codes.

PERL ZC452 Process Plant Safety and Environment 4

Role of safety in society; engineering aspects of process plant safety; chemical hazards and worker safety; hazardous properties of chemicals; safety aspects in site selection and plant layout; design and inspection of pressure vessels; storage, handling and transportation of hazardous chemicals; risk assessment methods; toxic release, fire and explosions; boiling liquid expanding vapor explosions; safety audit; emergency planning and disaster management; Introduction to air pollutants, water pollutants and solid wastes; sampling & analysis techniques; impact of these on environment; national and international regulations, case studies.

PERL ZC453 Process Control & Instrumentation 4

Importance of Process Control; Process dynamics, modeling and transient response; Control actions and feedback control; Hydraulic-, pneumatic- and electronic controllers; Controller design, tuning and stability; Measuring instruments and their working principles; Instrument characteristics and transmission; Transducers, sensor and actuators; Control valves; Piping and Instrumentation diagrams; Signal conditioning and processing; Display and recording; Signal-flow graph and Mason's gain formula; Feed forward, cascade and ratio control; Direct digital control; Programmable logic controllers; DCS and SCADA systems; PC based instrumentation; Introduction to multivariable control system.

PEM ZC494 Environmental Impact Assessment 4**

Environment and global problems; Framing Environmental issues; effects of infrastructure development on environment; prediction and assessment of environmental impacts of infrastructure projects: technical and procedural aspects, guidelines and legal aspects of environmental protection, impacts on air, water, soil and noise environment, valuation, strategic assessment, mathematical modeling for

environmental processes; social impact assessment (SIA), dislocation/disruption impact of Infrastructure projects; Life Cycle Assessments (LCA) and risk analysis methodologies; mitigation of environmental impacts; case studies; environmental management plan (EMP), national and international certification and guidelines including ISO.

PEM ZG511 Systems Engineering 4**

Dynamical systems; modeling of deterministic and also stochastic systems; system optimization; system reliability; estimation, forecasting techniques; information systems; computer applications; simulation studies. These topics will draw heavily from the appropriate areas of advanced mathematics like matrix algebra, functional analysis, probability theory, non-linear mathematics, stochastic differential equations, etc.

PEM ZG512 Project Costing & Finance 5**

Understanding, measuring and analyzing various project cost components from different perspectives; types of budgets, fixed and flexible budget, budgetary control - zero-base budgeting, performance budgeting; standard costing and variance analysis; procedures for obtaining long term finance including loans from financial institutions; internal and external sources of working capital finance; utilization of foreign sources of finance; procedures for obtaining venture capital for risky and software projects, procedural and economic aspects of leasing, framework for evaluating lease options.

PEM ZG520 Infrastructure Planning and Management 4**

The goals and perspectives of planning; forecasting and design of alternatives; plan testing: economic, financial and environmental evaluation; the challenges of managing infrastructure; Information management and decision support system; Concepts of total quality management; Economics: life-cycle analysis and maintenance, Rehabilitation and Reconstruction (M.R & R) programming; Infrastructure management system (IMS) development and implementation; Rural Infrastructure Planning.

PEM ZG521 Project Formulation & Appraisal5**

Project initiation, scope planning, definition and verification; feasibility studies; market feasibility study - market microstructure analysis, market segmentation and demand forecasting; technical feasibility study- measuring appropriateness of technology, technology sourcing, financial feasibility study - financial analysis and appraisal criteria; risk analysis viz. scenario analysis, sensitivity analysis and decision tree analysis.

PEM ZG522 Project Risk Management & Insurance 5**

Key issues and concepts involved in effective risk, safety and uncertainty management; uncertainty in projects, identifying risks and developing the risk analysis structure; qualitative and quantitative risk analysis tools; risk management processes, writing risk management plans, contactor perspective, risk monitoring, control and mitigation strategies.

PEM ZG531 Project Information Management 4**

Project communication planning, information dissemination, performance evaluation and reporting- workplan summary, workplan progress reports, periodic performance reports, cumulative performance reports, financial reports by status and by coverage indicators, framework for semantic web-based information management, project status forecasting, project closure.

PEM ZG532 Contracts Management 4**

Principles and practices relating to acceptance and withdrawal of contracts / tenders; contracts administration, legal aspects of managing contracts in a project environment, managing relationships with vendors, concepts of agreement, contract, proposal, acceptance, consideration, capacity to contract, free consent, legality of object, discharge of contract, contract of indemnity, guarantee, bailment, validity and performance, sale, conditions, warranties, title delivery and performance; contracts closure.

PEM ZG533 Advanced Composite Materials for Structures 4**

Introduction and History of FRP, Overview of Composite materials, Physical and Mechanical Properties and Test methods, Design of RC Structures reinforced with FRP Bars, Flexural Strengthening of RC Beams, Shear Strengthening of Beams, Flexural Strengthening of Slabs, Strengthening of Axially and Eccentrically Loaded Columns, Seismic Retrofit of Columns.

PEM ZG541 Project Quality Management 4**

Foundations of quality management in a project based environment, quality planning, quality assurance; project quality control, quality management tools and techniques, cost of quality, quality audits and quality improvements, Baldrige Quality programme.

PEM ZG542 Project Management Techniques 4**

Project management tools and techniques, CPM, Critical chain method, PERT, PERT Simulation, PDM, GERT, Gantt Chart, work breakdown structures, crashing, work responsibility matrix, earned value methodology, development methodology: implementing project methodologies, project templates, project processes and trends.

PEM ZG611 Project Human Resource Management 4**

Manpower planning and acquisition, assignment of human resources to activities in the project, team behavior, current models in team motivation, human factors and team dynamics in project management, key elements of team performance, key stages of team development, facilitation techniques, leadership aspects.

PEM ZG612 Concurrent Engineering 5**

Introduction of concurrent engineering and need, concurrent engineering tools, advances in design and manufacturing engineering, design for manufacture, design for assembly, rapid prototyping, simulation, concurrent approaches to design, manufacturing and other aspects of engineering.

PEM ZG621 Software Project Management 4**

Managing a software development project, concepts, objects of a project, environment of a software project, system development life cycle, tools, review process; documentation in software program management, procedures, diagramming techniques, management; Planning and monitoring a software project, project planning, management tools, software project definitions, project management packages, project control; software project definition, classification, project sizes and methodologies, feasibility, requirements and start-up; programmer productivity; software planning, control tools, accelerated design; prototyping and role in software project management; software production and software project management; software system installation, managing testing requirements, test plans, alpha and beta systems; emerging directions in project management.

PEM ZG622 Supply Chain Management 5**

Customer driven strategies in production and distribution systems; Integrated production and distribution networks; SCM in the context of JIT and MRP–II; Distribution Resource Planning; Management of dealer networks; Total Control & Product innovation across the supply chain; Incoming logistics and supplier relationships; Value addition analysis; Metrics for management of supply chain performance; Mathematical models and computer assisted decision support for SCM; Mathematical programming for SCM.

PEM ZG629T Dissertation 20**

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PEM ZG631 Business Process Management 4**

Overview of Business Process Management, business drivers and adoption trends, framework for BPM, BPM architecture, components of BPM server, BPM system activities, technology enablers of BPM and value proposition, enabling standards, BPM packaged applications and vendors.

PEM ZG632 Plant Layout and Material Handling 5**

Plant layout, design, scope and planning, Plant location, Industrial buildings and the layout, Types of layout, analysis of materials and product flow, Developing and presenting layouts - plot plans, detailed layouts, visualizing layouts, Evaluation

and installation. Locating - electrical, water, sewage, compressed air, gases, steam and communication facilities, Materials handling - Principles, classification and types, Material handling equipment - conveyors, cranes, trolleys, forklifts etc., Prevention against noise, air and water pollution, Environment management plan.

PEM ZG641 Software Quality Management 4**

Software quality challenges and expectations; quality dilemma; software life cycle and link to quality; quality gates, formal reviews, system requirement reviews, preliminary design reviews, critical design reviews, test reviews; engineering reviews, walkthroughs, inspections, internal reviews; quality gate categories; technical environment and quality; planning for software quality, quality requirements for planning, quality needs, elements of quality planning, quality assessments during planning, software quality organization requirements; quality evaluation of software development process, process quality attributes, measuring software process quality; software process metrics; quality gate integrity; software product quality, standards and conventions, metrics; quality hierarchy, factors; quality assessment; quality evaluation techniques, reviews, walkthroughs, audit, inspections, analytical evaluation techniques; quality systems.

PEM ZG643 Earthquake Resistant Design of Structures 4**

Theory of Vibration - free and forced vibration analysis, Response of general dynamic loadings, Numerical evaluation of dynamic response, Effect of damping, Balancing of rotating and reciprocating masses, Whirling of shafts, Vibration isolation and transmissibility, Critical speed, Equivalent viscous damping, Multi-degree freedom systems with distributed mass and elasticity, Vibration absorbers; Earthquake engineering - Response Spectrum Analysis, guidelines for earthquake resistant structures, geo-technical aspects of earthquake engineering, Evaluation of wind, blast, wave loading and other dynamic forces on structures, Modeling and dynamic analysis of buildings, bridges, water tanks, liquid storage tanks, stack-like structures, machine foundations etc. Wind load on chimneys, natural draught, cooling towers and tall buildings, structural ductility.

PEM ZG651 Software Engineering & Management 5**

Current concepts, methods, techniques, and tools of the software engineering process; software process models; process definition and assessment; software measurement and metrics; project planning, estimation and control; requirements analysis and specification, design methods; quality assurance and testing; configuration management; process improvement; case studies and project work.

POMLM ZC441 Human Resource Management 4

Introduction, manpower planning, career and succession planning, procurement of personnel, performance appraisal, job satisfaction and morale, job rotation, employee communication, audit and control, management training and development, wage and salary administration, welfare administration, trade unions and collective bargaining, industrial dispute and worker participation in management.

POMLM ZC471 Management Information Systems 3

Introduction to Information Systems; Concepts of management, concepts of information, systems concepts; Information Systems and Organizations; decision making process; database systems; data communications; planning, designing, developing and implementing information systems; quality assurance and evaluation of information systems; future developments and their organizational and social implications; decision support system and expert systems.

POMLM ZG513 Financial Management 4

Concepts and techniques of financial management decision; concepts in valuation – time value of money; valuation of a firm's stock, capital asset pricing model; investment in assets and required returns; risk analysis; financing and dividend policies, capital structure decision; working capital management, management of cash, management of accounts receivable; inventory management, short and intermediate term financing, long term financial tools of financial analysis, financial ratio analysis, funds analysis and financial forecasting, operating and financial leverages.

POMLM ZG515 Pharmaceutical Administration and Management 5

Technology innovation and creativity, new drugs and products planning, strategic considerations, project implementation, product development, production management and scale up, preparation of product literature and marketing strategy, IPR processes, human resource development, industrial relations, documentation, R & D management, ethical aspects.

POMLM ZG522 Quality Assurance & Regulatory Affairs 5

Quality control, quality assurance, quality management, various parameters for achieving quality pharmaceutical products, application of statistics in quality assurance, reliability, current good manufacturing practice (cGMP) for pharmaceutical manufacturing, pharmaceutical process validation, drug regulatory affairs, clinical research protocols, new drug applications, drug product labeling.

POMLM ZG523 Project Management 4

Concepts and techniques of project formulation, evaluation and implementation; Project planning and scheduling; Risk management; Time-cost trade off; Resource leveling and allocation; Project monitoring and control; Contract management.

POMLM ZG525 Pharmaceutical Process Development & Scale-up 4

Optimization techniques in pharmaceutical processing; development of test systems to evaluate performance of dosage forms and unit operations; Scale-up of unit operations related to various pharmaceutical formulations; process analytical technology (PAT) and its applications in solving problems of scale-up.

POMLM ZG531 Manufacturing Organization and Management 5

Manufacturing environment; Engineering considerations; Design and planning of manufacturing systems; Manufacturing cost control; Material flow control; Quality; Human resources; Financial management; Marketing management.

POMLM ZG532 Supply Chain Management 4

Customer driven strategies in production and distribution systems; Integrated production and distribution networks; SCM in the context of JIT and MRP–II; Distribution Resource Planning; Management of dealer networks; Total Control & Product innovation across the supply chain; Incoming logistics and supplier relationships; Value addition analysis; Metrics for management of supply chain performance; Mathematical models and computer assisted decision support for SCM; Mathematical programming for SCM.

POMLM ZG534 Advanced Pharmaceutical Technology 5

Overview of pharmaceutical processes used in pharmaceutical manufacturing; advanced manufacturing equipments for various pharmaceutical dosage forms; current manufacturing techniques for large scale production of tablets, hard and soft gelatin capsules, aerosols, semi-solid preparations including ophthalmic formulations, small and large volume parenterals, and multiparticulate systems; approaches of in-process quality assurance and documentation in automated manufacture; advanced packaging technology for various pharmaceutical dosage forms.

POMLM ZG542 Production and Operations Management 4

Production & operations management functions; capacity requirement planning; inventory control; layout, handling & location decisions; resource procurement & operation control; project scheduling & resource allocation; the production & operating function; methods of forecasting demand; financial analysis of operating plans; determination of economic order quantity; development of efficient work methods, quality control, management of R&D, technological forecasting, equipment replacement and interfaces with other functional areas.

POMLM ZG629T Dissertation 16

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approved as the supervisor, Mentor may play the role of additional supervisor. The final grades for dissertation are Non-letter grades namely Excellent, Good, Fair and Poor, which do not go into CGPA computation.

POMLM ZG631 TQM Tools and Techniques 5

Benchmarking; introduction, why benchmark; Planning: what to benchmark, benchmarking partners, data collection methods; Analysis: determining the current competitive gap, projecting future performance levels; Integration: developing action plan, implementing specific actions & monitoring progress, re-calibration; Maturity: beyond benchmarking; Quality function deployment, QFD concept, overview & QFD process, the voice of customer developing a QFD matrix, reviewing the matrix for priority items, organizing teams & planning QFD projects; Process RE-engineering, BPR philosophy, possibilities & pitfalls, BPF framework, opportunity assessment, planning & BPR project, risk & impact assessment, planning & implementing the transition; Failure mode & effect analysis; FMEA: concepts & applications in TQM; Quality cost, concepts, quality cost definitions, quality cost program implementation use of quality cost, reducing quality cost.

POMSA ZC471 Management Information Systems 3

Introduction to Information Systems; Concepts of management, concepts of information, systems concepts; Information Systems and Organizations; decision making process; database systems; data communications; planning, designing, developing and implementing information systems; quality assurance and evaluation of information systems; future developments and their organizational and social implications; decision support system and expert systems.

POMSA ZG511 Disinfection and Sterilisation 4

Theories and kinetics of the disinfection reaction, study of the principles involved in vivo and in vitro evaluation of disinfectants and antiseptics, structure activity relationships of the representative groups of disinfectants, sterilization, heat, ionizing and ultraviolet radiations, ultrasonic waves, filtration, gaseous sterilization and cellular dessication methods, controls used and special problems involved.

POMSA ZG512 Dosage Form Design 5

A study of physical and chemical, pharmacological and biopharmaceutic factors involved in the design and stability of dosage forms; transport of drugs across biological membranes; absorption, distribution and elimination of drugs; formulation additives, closures and containers and sustained release dosage forms; micro-encapsulation; radio pharmaceuticals.

POMSA ZG521 Statistical Process Control 5

What is SPC, history & development of SPC, averages & measures of dispersion, process variation, variable & attribute data, simple statistical problem solving tools: check sheets, histograms, Pareto diagrams, stratification graph, scatter plots, cause & effect diagram; Various types of control charts, control chart for attributes, cumulative sum charts, X bar R charts; construction & interpretation of control charts process capability; Lot try lot acceptance sampling for attributes, acceptance sampling variables, other acceptance sampling procedures.

POMSA ZG522 Quality Assurance & Regulatory Affairs 5

Quality control, quality assurance, quality management, various parameters for achieving quality pharmaceutical products, application of statistics in quality assurance, reliability, current good manufacturing practice (cGMP) for pharmaceutical manufacturing, pharmaceutical process validation, drug regulatory affairs, clinical research protocols, new drug applications, drug product labeling.

POMSA ZG531 Manufacturing Organization and Management 5

Manufacturing environment; Engineering considerations; Design and planning of manufacturing systems; Manufacturing cost control; Material flow control; Quality; Human resources; Financial management; Marketing management.

POMSA ZG532 Supply Chain Management 4

Customer driven strategies in production and distribution systems; Integrated production and distribution networks; SCM in the context of JIT and MRP–II; Distribution Resource Planning; Management of dealer networks; Total Control & Product innovation across the supply chain; Incoming logistics and supplier relationships;

Value addition analysis; Metrics for management of supply chain performance; Mathematical models and computer assisted decision support for SCM; Mathematical programming for SCM.

POMSA ZG541 Modern Analytical Techniques 4

Fundamentals and applications of sophisticated analytical instruments like NMR, Mass spectrometer; X-ray crystallography; GC, HPLC, UV, IR, Atomic absorption spectrophotometer, High voltage electrophoresis, gel electrophoresis, ultracentrifuge, spectrofluorimeter, DTA, DSC polarimeter in pharmaceutical industry including spectral data analysis and molecular characterization

POMSA ZG542 Production and Operations Management 4

Production & operations management functions; capacity requirement planning; inventory control; layout, handling & location decisions; resource procurement & operation control; project scheduling & resource allocation; the production & operating function; methods of forecasting demand; financial analysis of operating plans; determination of economic order quantity; development of efficient work methods, quality control, management of R&D, technological forecasting, equipment replacement and interfaces with other functional areas.

POMSA ZG611 Advanced Pharmacology 5

Biochemical pharmacology; pharma-cologically active polypeptides; general pharmacological principles involving immunological processes, pharmacogenetics, teratology, pharmacokinetics, drug resistance and related phenomena, drug-interaction; recent advances in the therapy of neoplastic disease, viral diseases, atherosclerosis and hypertension; topics of recent interest like contraception; use of gases and ions in therapy etc.

POMSA ZG621 Management Information and Decision Support Systems 5

Data & information; characteristics of information; components of management information systems; information flows; design and maintenance of management information systems; decision support systems.

POMSA ZG629T Dissertation 16

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POMSA ZG631 TQM Tools and Techniques 5

Benchmarking; introduction, why benchmark; Planning: what to benchmark, benchmarking partners, data collection methods; Analysis: determining the current competitive gap, projecting future performance levels; Integration: developing action plan, implementing specific actions & monitoring progress, re-calibration; Maturity: beyond benchmarking; Quality function deployment, QFD concept, overview & QFD process, the voice of customer developing a QFD matrix, reviewing the matrix for priority items, organizing teams & planning QFD projects; Process RE-engineering, BPR philosophy, possibilities & pitfalls, BPF framework, opportunity assessment, planning & BPR project, risk & impact assessment, planning & implementing the transition; Failure mode & effect analysis; FMEA: concepts & applications in TQM; Quality cost, concepts, quality cost definitions, quality cost program implementation use of quality cost, reducing quality cost.

POMSA ZG641 Technical Communication 4

Role and importance of communication; effectiveness in oral and written communication; technical reports; technical proposals; technical descriptions; definitions and classifications; business correspondence; precis writing; memorandum; notices, agenda and minutes; oral communication related to meetings, seminars, conferences, group discussions, etc.; use of modern communication aids.

POMWH ZC471 Management Information Systems 3

Introduction to Information Systems; Concepts of management, concepts of information, systems

concepts; Information Systems and Organizations; decision making process; database systems; data communications; planning, designing, developing and implementing information systems; quality assurance and evaluation of information systems; future developments and their organizational and social implications; decision support system and expert systems.

POMWH ZG512 Dosage Form Design 5

A study of physical and chemical, pharmacological and biopharmaceutic factors involved in the design and stability of dosage forms; transport of drugs across biological membranes; absorption, distribution and elimination of drugs; formulation additives, closures and containers and sustained release dosage forms; micro-encapsulation; radio pharmaceuticals.

POMWH ZG515 Pharmaceutical Administration and Management 5

Technology innovation and creativity, new drugs and products planning, strategic considerations, project implementation, product development, production management and scale up, preparation of product literature and marketing strategy, IPR processes, human resource development, industrial relations, documentation, R & D management, ethical aspects.

POMWH ZG521 Statistical Process Control 5

What is SPC, history & development of SPC, averages & measures of dispersion, process variation, variable & attribute data, simple statistical problem solving tools: check sheets, histograms, Pareto diagrams, stratification graph, scatter plots, cause & effect diagram; Various types of control charts, control chart for attributes, cumulative sum charts, X bar R charts; construction & interpretation of control charts process capability; Lot try lot acceptance sampling for attributes, acceptance sampling variables, other acceptance sampling procedures.

POMWH ZG522 Quality Assurance & Regulatory Affairs 5

Quality control, quality assurance, quality management, various parameters for achieving quality pharmaceutical products, application of statistics in quality assurance, reliability, current good manufacturing practice (cGMP) for pharmaceutical manufacturing, pharmaceutical process validation, drug regulatory affairs, clinical research protocols, new drug applications, drug product labeling.

POMWH ZG523 Project Management 4

Concepts and techniques of project formulation, evaluation and implementation; Project planning and scheduling; Risk management; Time-cost trade off; Resource leveling and allocation; Project monitoring and control; Contract management.

POMWH ZG525 Pharmaceutical Process Development & Scale-up 4

Optimization techniques in pharmaceutical processing; development of test systems to evaluate performance of dosage forms and unit operations; Scale-up of unit operations related to various pharmaceutical formulations; process analytical technology (PAT) and its applications in solving problems of scale-up.

POMWH ZG531 Manufacturing Organization and Management 5

Manufacturing environment; Engineering considerations; Design and planning of manufacturing systems; Manufacturing cost control; Material flow control; Quality; Human resources; Financial management; Marketing management.

POMWH ZG532 Supply Chain Management 4

Customer driven strategies in production and distribution systems; Integrated production and distribution networks; SCM in the context of JIT and MRP–II; Distribution Resource Planning; Management of dealer networks; Total Control & Product innovation across the supply chain; Incoming logistics and supplier relationships; Value addition analysis; Metrics for management of supply chain performance; Mathematical models and computer assisted decision support for SCM; Mathematical programming for SCM.

POMWH ZG534 Advanced Pharmaceutical Technology 5

Overview of pharmaceutical processes used in pharmaceutical manufacturing; advanced manufacturing equipments for various pharmaceutical dosage forms; current manufacturing techniques for large scale production of tablets, hard and soft gelatin capsules, aerosols, semi-solid preparations including ophthalmic formulations, small and large

volume parenterals, and multiparticulate systems; approaches of in-process quality assurance and documentation in automated manufacture; advanced packaging technology for various pharmaceutical dosage forms.

POMWH ZG542 Production and Operations Management 4

Production & operations management functions; capacity requirement planning; inventory control; layout, handling & location decisions; resource procurement & operation control; project scheduling & resource allocation; the production & operating function; methods of forecasting demand; financial analysis of operating plans; determination of economic order quantity; development of efficient work methods, quality control, management of R&D, technological forecasting, equipment replacement and interfaces with other functional areas.

POMWH ZG629T Dissertation 16

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POMWH ZG631 TQM Tools and Techniques 5

Benchmarking; introduction, why benchmark; Planning: what to benchmark, benchmarking partners, data collection methods; Analysis: determining the current competitive gap, projecting future performance levels; Integration: developing action plan, implementing specific actions & monitoring progress, re-calibration; Maturity: beyond benchmarking; Quality function deployment, QFD concept, overview & QFD process, the voice of customer developing a QFD matrix, reviewing the matrix for priority items, organizing teams & planning QFD projects; Process RE-engineering, BPR philosophy, possibilities & pitfalls, BPF framework, opportunity assessment, planning & BPR project, risk & impact assessment, planning & implementing the transition; Failure mode & effect analysis; FMEA: concepts & applications in TQM; Quality cost, concepts, quality cost definitions, quality cost program implementation use of quality cost, reducing quality cost.

POM* ZC441 Human Resource Management 4

Introduction, manpower planning, career and succession planning, procurement of personnel, performance appraisal, job satisfaction and morale, job rotation, employee communication, audit and control, management training and development, wage and salary administration, welfare administration, trade unions and collective bargaining, industrial dispute and worker participation in management.

POM* ZC471 Management Information Systems 3

Introduction to Information Systems; Concepts of management, concepts of information, systems concepts; Information Systems and Organizations; decision making process; database systems; data communications; planning, designing, developing and implementing information systems; quality assurance and evaluation of information systems; future developments and their organizational and social implications; decision support system and expert systems.

POM* ZC473 International Business 3

International business - an overview, general international environment - political, legal, socio-cultural and economic factors, international operational framework, tax aspects, marketing factors, labor factors and economic integration. BOP analysis, foreign exchange control, governmental policies, international finance, economic community, IMF, managing multinationals/globalization of operations.

POM* ZG511 Disinfection and Sterilisation 4

Theories and kinetics of the disinfection reaction, study of the principles involved in vivo and in vitro evaluation of disinfectants and antiseptics, structure activity relationships of the representative groups of disinfectants, sterilization, heat, ionizing and ultraviolet radiations, ultrasonic waves, filtration, gaseous

sterilization and cellular dessication methods, controls used and special problems involved.

POM* ZG512 Dosage Form Design 5

A study of physical and chemical, pharmacological and biopharmaceutic factors involved in the design and stability of dosage forms; transport of drugs across biological membranes; absorption, distribution and elimination of drugs; formulation additives, closures and containers and sustained release dosage forms; micro-encapsulation; radio pharmaceuticals.

POM* ZG513 Financial Management 4

Concepts and techniques of financial management decision; concepts in valuation – time value of money; valuation of a firm's stock, capital asset pricing model; investment in assets and required returns; risk analysis; financing and dividend policies, capital structure decision; working capital management, management of cash, management of accounts receivable; inventory management, short and intermediate term financing, long term financial tools of financial analysis, financial ratio analysis, funds analysis and financial forecasting, operating and financial leverages.

POM* ZG515 Pharmaceutical Administration and Management 5

Technology innovation and creativity, new drugs and products planning, strategic considerations, project implementation, product development, production management and scale up, preparation of product literature and marketing strategy, IPR processes, human resource development, industrial relations, documentation, R & D management, ethical aspects.

POM* ZG521 Statistical Process Control 5

What is SPC, history & development of SPC, averages & measures of dispersion, process variation, variable & attribute data, simple statistical problem solving tools: check sheets, histograms, Pareto diagrams, stratification graph, scatter plots, cause & effect diagram; Various types of control charts, control chart for attributes, cumulative sum charts, X bar R charts; construction & interpretation of control charts process capability; Lot try lot acceptance sampling for attributes, acceptance sampling variables, other acceptance sampling procedures.

POM* ZG522 Quality Assurance & Regulatory Affairs 5

Quality control, quality assurance, quality management, various parameters for achieving quality pharmaceutical products, application of statistics in quality assurance, reliability, current good manufacturing practice (cGMP) for pharmaceutical manufacturing, pharmaceutical process validation, drug regulatory affairs, clinical research protocols, new drug applications, drug product labeling.

POM* ZG523 Project Management 4

Concepts and techniques of project formulation, evaluation and implementation; Project planning and scheduling; Risk management; Time-cost trade off; Resource leveling and allocation; Project monitoring and control; Contract management.

POM* ZG525 Pharmaceutical Process Development & Scale-up 4

Optimization techniques in pharmaceutical processing; development of test systems to evaluate performance of dosage forms and unit operations; Scale-up of unit operations related to various pharmaceutical formulations; process analytical technology (PAT) and its applications in solving problems of scale-up.

POM* ZG531 Manufacturing Organization and Management 5

Manufacturing environment; Engineering considerations; Design and planning of manufacturing systems; Manufacturing cost control; Material flow control; Quality; Human resources; Financial management; Marketing management.

POM* ZG532 Supply Chain Management 4

Customer driven strategies in production and distribution systems; Integrated production and distribution networks; SCM in the context of JIT and MRP–II; Distribution Resource Planning; Management of dealer networks; Total Control & Product innovation across the supply chain; Incoming logistics and supplier relationships; Value addition analysis; Metrics for management of supply chain performance; Mathematical models and computer assisted decision support for SCM; Mathematical programming for SCM.

POM* ZG534 Advanced Pharmaceutical Technology 5

Overview of pharmaceutical processes used in pharmaceutical manufacturing; advanced manufacturing equipments for various pharmaceutical dosage forms; current manufacturing techniques for large scale production of tablets, hard and soft gelatin capsules, aerosols, semi-solid preparations including ophthalmic formulations, small and large volume parenterals, and multiparticulate systems; approaches of in-process quality assurance and documentation in automated manufacture; advanced packaging technology for various pharmaceutical dosage forms.

POM* ZG541 Modern Analytical Techniques 4

Fundamentals and applications of sophisticated analytical instruments like NMR, Mass spectrometer; X-ray crystallography; GC, HPLC, UV, IR, Atomic absorption spectrophotometer, High voltage electrophoresis, gel electrophoresis, ultracentrifuge, spectrofluorimeter, DTA, DSC polarimeter in pharmaceutical industry including spectral data analysis and molecular characterization

POM* ZG542 Production and Operations Management 4

Production & operations management functions; capacity requirement planning; inventory control; layout, handling & location decisions; resource procurement & operation control; project scheduling & resource allocation; the production & operating function; methods of forecasting demand; financial analysis of operating plans; determination of economic order quantity; development of efficient work methods, quality control, management of R&D, technological forecasting, equipment replacement and interfaces with other functional areas.

POM* ZG611 Advanced Pharmacology 5

Biochemical pharmacology; pharma-cologically active polypeptides; general pharmacological principles involving immunological processes, pharmacogenetics, teratology, pharmacokinetics, drug resistance and related phenomena, drug-interaction; recent advances in the therapy of neoplastic disease, viral diseases, atherosclerosis and hypertension; topics of recent interest like contraception; use of gases and ions in therapy etc.

POM* ZG629T Dissertation 16

A student registered in this course must take a topic in an area of professional interest drawn from the on the job work requirement which is simultaneously of direct relevance to the degree pursued by the student as well as to the employing / collaborating organization of the student and submit a comprehensive report at the end of the semester working under the overall supervision and guidance of a professional expert who will be deemed as the supervisor for evaluation of all components of the dissertation. Normally the Mentor of the student would be the Dissertation supervisor and in case Mentor is not approved as the supervisor, Mentor may play the role of additional supervisor. The final grades for dissertation are Non-letter grades namely Excellent, Good, Fair and Poor, which do not go into CGPA computation.

POM* ZG631 TQM Tools and Techniques 5

Benchmarking; introduction, why benchmark; Planning: what to benchmark, benchmarking partners, data collection methods; Analysis: determining the current competitive gap, projecting future performance levels; Integration: developing action plan, implementing specific actions & monitoring progress, re-calibration; Maturity: beyond benchmarking; Quality function deployment, QFD concept, overview & QFD process, the voice of customer developing a QFD matrix, reviewing the matrix for priority items, organizing teams & planning QFD projects; Process RE-engineering, BPR philosophy, possibilities & pitfalls, BPF framework, opportunity assessment, planning & BPR project, risk & impact assessment, planning & implementing the transition; Failure mode & effect analysis; FMEA: concepts & applications in TQM; Quality cost, concepts, quality cost definitions, quality cost program implementation use of quality cost, reducing quality cost.

POW* ZC112 Electrical and Electronics Technology 3

Electric circuit, electromagnetism, magnetic circuit, electrostatics, AC voltage and current, single phase circuits, semiconductor devices, amplifiers, digital systems, microprocessors, DC machines, polyphase circuits, transformers, synchronous machines, induction motors, power electronics, measurements, illumination.

POW* ZC113 Probability and Statistics 3

Probability spaces; conditional probability and independence; random variables and probability distributions; marginal and conditional distributions; independent random variables; mathematical expectation; mean and variance; binomial, Poisson and normal distributions; sum of independent random variables; law of large numbers; central limit theorem (without proof); sampling distribution and test for mean using normal and student's t-distribution; test of hypothesis; correlation and linear regression.

POW* ZC164 Computer Programming 4

Basic Computing Steps and Flow Charting (Assignment, Sequencing, Conditionals, Iteration). Programming Constructs – Expressions, Statements, Conditionals, Iterators/Loops, Functions/ Procedures; Data Types – Primitive Types, Tuples, Choices (Unions or Enumerations), Lists/Arrays, Pointers and Dynamically Allocated Data. Input output and Files. Laboratory Component: Programming Exercises involving development and testing of iterative and procedural programs using bounded and unbounded iterations, function composition, random access lists, sequential access lists, dynamically allocated lists, and file access.

POW* ZC231 Thermodynamics 3

Concepts and laws of thermodynamics; macroscopic thermodynamic properties; application to closed and open system; microscopic approach to entropy; equations of state; thermodynamics of nonreacting mixtures.

POW* ZC232 Principles of Management 3

Fundamental concepts of management - planning; organizing; staffing; directing and controlling; production, financial, personnel, legal and marketing functions; accounting and budgeting, balance sheets.

POW* ZC233 Calculus 4

Limits, continuity, differentiation, integration, Fourier series, ordinary differential equations for initial and boundary value problems, solution through Laplace transforms, numerical solution using Picard’s iteration and higher order methods, partial derivatives, partial differential equations, analytical solution techniques.

POW* ZC234 Linear Algebra & Optimization 3

Vector and matrix algebra, systems of linear algebraic equations and their solutions; eigenvalues, eigenvectors and diagonalization of matrices; Formulation of linear programming problems, Simplex method, Big-M method, Two phase method, Sensitivity analysis, Revised and Dual Simplex Methods.

POW* ZC242 Engineering Measurements 3

Performance characteristics of measuring instruments, measurement methods for mechanical, electrical, radiant, chemical, magnetic and thermal energy variables. Emphasis in this course shall be on the operation and use of instruments.

POW* ZC312 Quality Control, Assurance and Reliability 3

Basic concepts of probability and probability distributions, standard probability distribution, sampling and sampling distributions, confidence intervals, testing significance, statistical tolerance, various types of control charts, statistical process control techniques, value analysis, defect diagnosis and prevention, basic concepts of reliability, reliability design evaluation and control, methods of applying total quality management, production process.

POW* ZC313 Power Generation 4

Indian power scenario, sources of energy, working of thermal, nuclear, IC engine, gas turbine, hydro and renewable energy based power plants, power plant building and layout, economics of power generation, environmental impact assessment of power generation.

POW* ZC314 Prime Movers & Fluid Machines 4

Theoretical analysis of energy and momentum transfer between fluid and rotor; principles of axial, mixed and radial flow compressors, turbines and pumps; design considerations; cascade aerodynamics and performance limitations; applications to power plant systems, laboratory exercises in testing reciprocating machines.

POW* ZC315 Transport Phenomena 4

Fundamental concepts of fluid flow, concept of momentum transfer, Newton’s law of viscosity, Continuity and Bernoulli’s equation, concept of pressure drop and drag; Heat transfer: steady state and unsteady state heat conduction; analytical and empirical relations for forced and

free convection heat transfer; heat exchanger analysis and design, heat transfer by radiation; Elements of mass transfer; one dimensional compressible flow; associated laboratory on condenser, boiler, economizer, super heater etc.

POW* ZC321 Technical Report Writing 3

Elements of effective writing; art of condensation; business letter writing; memos; formal reports; technical proposals; conducting, and participating, meetings; agenda and minutes; strategies for writing technical descriptions, definitions, and classifications; oral presentation; use of graphic and audio- visual aids; editing.

POW* ZC332 Energy Management 3

System's view of energy in society involving societal goals, energy resources, the sub-systems for the generation. T&D, and utilization of energy carriers, energy economics and analysis, energy strategies, policies, policy instruments, policy agents and policy implementation. The "development-oriented end-use approach" to energy analysis, strategy design and policy formulation involving the disaggregation and scrutiny of demand beyond sectors into end-uses and basic needs. Energy management at the national, state, firm, city and village levels.

POW* ZC342 Power Systems Engineering I 3

Parameters of transmission lines, electrical and mechanical characteristics of transmission line, synchronous phase modifiers - overhead insulators - underground cables - distribution lines - substation practice -relevant portions of Indian Electricity Act.

POW* ZC344 Instrumentation & Control 4

Generalized measurement system and performance characteristics, Transducers - principles and applications, Signal conditioning circuits – bridges, amplifiers, data converters, filters; Process control – control schemes, controllers, multi-loop control configuration, Control valves; Programmable Logic Controllers, DCS and SCADA, Simulation, Case Studies.

POW* ZC411 Environmental Pollution Control 3

Environmental pollution: Solid, liquid and gaseous pollutants; removal of soluble and particulate pollutants from atmosphere, natural water systems and process systems; use of current literature for pollution control problems.

POW* ZC413 Process Control 3

Dynamic modeling and simulation of momentum, energy and mass transfer and reacting systems; analysis of the dynamic behaviour of lumped and distributed parameter systems; analysis and design of simple feedback and advanced control systems; design of control systems with multiple input and multiple output; introduction to computer control.

POW* ZC421 Essentials of Project Management 3

Programmes project management, project manager: role and responsibilities, project management and organization, project planning and scheduling, graphical techniques and PERT, CPM, price estimation and cost control; proposal, control valuation monitoring and trade off analysis in a project environment, pitfalls and future scenario.

POW* ZC431 Maintenance & Safety 3

Basic maintenance systems and practice; maintenance planning; estimating and budgeting; scheduling maintenance jobs; importance of safety; factors affecting safety; safety aspects of site and plant; hazards of commercial chemical reaction and operation; instrumentation for safe operation; safety education and training; personnel safety; disaster planning and measuring safety effectiveness; future trends in industrial safety; maintenance of components and equipments; new dimensions in maintenance covering plant engineering, tribology, materials technology, terotechnology (life cycle costing) etc.; extensive case studies.

POW* ZC434, Quality Control, Assurance & Reliability 4

Basic concepts of probability and probability distributions, standard probability distribution, sampling and sampling distributions, confidence intervals, testing significance, statistical tolerance, various types of control charts, statistical process control techniques, value analysis, defect diagnosis and prevention, basic concepts of reliability, reliability design evaluation and control, methods of applying total quality management, production process. Practical assignments on statistical quality control using suitable statistical software tools such as R-software, MS Excel, SAS, Minitab or SPSS.

POW* ZC441 Power Systems Engineering II 3

Elementary principles of power system economics - Powers systems stability, equal area criterion and step by step method - protection, relays and relaying, protection of transmission lines, transformer and generators - High voltage Protection - Symmetrical components, symmetrical and unsymmetrical faults.

POW* ZC412 Power System Operation & Control 3

POW* ZC422 Power System Drawing and Design 3

Course description for the above courses to be developed.

POW* ZC452 Renewable Energy 3

Introduction of renewable energy, advantages, potential, status of development, broad details of different renewable energy systems such as solar, wind, biomass, microhydel, geothermal etc; Renewable energy development policy, Renewable energy industries, international co-operation, HRD and career growth opportunities, consultancy areas and future thrust areas in renewable energy development.

POW* ZC461 Power Plant Engineering 3

POW* ZC471 Power Electronics & Drives 3

Course description for the above courses to be developed.

POW* ZC481 Plant Layout & Design 3

Factors affecting plant layout, Types of layout, procedure for plant layout, techniques and tools for planning layout, quantitative layout analysis, material handing equipment, improving and revising existing layout, evaluation of layout, plant location, evaluation of location, design of layout, computer applications in layout design.

POW ZC211 Computer Programming 3**

Elementary computer organization; introduction to Number Systems; Representation of integers, real numbers and characters on computers; concept of range and accuracy; Arithmetic Overflow; Algorithms and algorithm development; structured program development through step wise refinement. Introduction to C language; Functions; Recursion; Data structure & algorithms; File management & file handling; Problem solving using C.

POW ZC212 Engineering Mathematics II 3**

Algebra of vectors and matrices; Gauss's row-reduction process; applications of simultaneous linear equations and matrix inversion; determinants and Cramer's rule. Numerical differentiation and integration; numerical methods for solving ordinary and partial differential equations.

POW ZC221 Engineering Mathematics I 3**

Limit concept; derivatives of elementary functions and their applications; introduction to ordinary and partial differential equations and initial/boundary value problems. Convergence tests for series; power series and interval of convergence; series solution of differential equations. Approximation and error, interpolation; roots of algebraic and transcendental functions, Newton's method.

POW ZC222 Electronics and Microprocessor 3**

PN Junction diodes; rectifiers, amplifiers - biasing and modeling, frequency response, combinational digital circuits, sequential building blocks, A/C and D/A converters, Architecture of any typical microprocessor and programming, memories, basic of memory and I/O interfacing, system design with microprocessor.

POW ZC231 Thermodynamics 3**

Concepts and laws of thermodynamics; macroscopic thermodynamic properties; application to closed and open system; microscopic approach to entropy; equations of state; thermodynamics of nonreacting mixtures.

POW ZC232 Principles of Management 3**

Fundamental concepts of management - planning; organizing; staffing; directing and controlling; production, financial, personnel, legal and marketing functions; accounting and budgeting, balance sheets.

POW ZC242 Engineering Measurements 3**

Performance characteristics of measuring instruments, measurement methods for mechanical, electrical, radiant, chemical, magnetic and thermal energy variables. Emphasis in this course shall be on the operation and use of instruments.

POW ZC251 Electrical Technology 3**

Electric circuits; Network Theorems; Electromagnetism; Inductance & Capacitance; Alternating voltage and current; Single phase and

poly phase circuits; Transformers; Synchronous Machines; Induction Motors; DC Machines; Measuring Instruments.

POW ZC311 Prime Movers & Fluid Machines 4**

Theoretical analysis of energy and momentum transfer between fluid and rotor; principles of axial, mixed and radial flow compressors, turbines and pumps; design considerations; cascade aerodynamics and performance limitations; applications to power plant systems, laboratory exercises in testing reciprocating machines; rotary machines and refrigeration plants.

POW ZC312 Quality Control, Assurance and Reliability 3**

Basic concepts of probability and probability distributions, standard probability distribution, sampling and sampling distributions, confidence intervals, testing significance, statistical tolerance, various types of control charts, statistical process control techniques, value analysis, defect diagnosis and prevention, basic concepts of reliability, reliability design evaluation and control, methods of applying total quality management, production process.

POW ZC321 Technical Report Writing 3**

Elements of effective writing; art of condensation; business letter writing; memos; formal reports; technical proposals; conducting, and participating, meetings; agenda and minutes; strategies for writing technical descriptions, definitions, and classifications; oral presentation; use of graphic and audio- visual aids; editing.

POW ZC322 Power Generation 3**

Sources of energy; types of power plants; selection of equipment for I.C. engine, gas turbine, steam, hydraulic and atomic power plants; power plant building and layout; gas loop; feed water system; piping systems; sharing of loads; Solar Energy; Wind energy; Tidal energy; Geothermal energy.

POW ZC331 Instrumentation & Control 3**

Measurement systems, transducers, feedback control, components: electrical, hydraulic, pneumatic; Signal conditioning and processing, controllers, display, recording, direct digital control, programmable logic controllers, PC based instrumentation.

POW ZC332 Energy Management 3**

System's view of energy in society involving societal goals, energy resources, the sub-systems for the generation. T&D, and utilization of energy carriers, energy economics and analysis, energy strategies, policies, policy instruments, policy agents and policy implementation. The "development-oriented end-use approach" to energy analysis, strategy design and policy formulation involving the disaggregation and scrutiny of demand beyond sectors into end-uses and basic needs. Energy management at the national, state, firm, city and village levels.

POW ZC342 Power Systems Engineering I 3**

Parameters of transmission lines, electrical and mechanical characteristics of transmission line, synchronous phase modifiers - overhead insulators - underground cables - distribution lines - substation practice -relevant portions of Indian Electricity Act.

POW ZC411 Environmental Pollution Control 3**

Environmental pollution: Solid, liquid and gaseous pollutants; removal of soluble and particulate pollutants from atmosphere, natural water systems and process systems; use of current literature for pollution control problems.

POW ZC421 Essentials of Project Management 3**

Programmes project management, project manager: role and responsibilities, project management and organization, project planning and scheduling, graphical techniques and PERT, CPM, price estimation and cost control; proposal, control valuation monitoring and trade off analysis in a project environment, pitfalls and future scenario.

POW ZC423T Project Work 20**

Consistent with the student's professional background and work-environment, the student will be required to carry out work-oriented projects. The student would be required to select an area of work that is considered vital to the sponsoring organization. The topic of the project and detailed project outline that is prepared by the student, in consultation with his/her Mentor, needs to be approved by the Dean, WILPD. On approval, the student carries on with the work-centered project, adhering to the guidelines provided in the detailed course handout, taking all

the prescribed evaluation components on time. At the end of the semester, the student should submit a comprehensive Project Report, to the Institute for evaluation. The student will be evaluated on the basis of the various interim evaluation components, contents of the report and Seminar/Viva-Voce that may be conducted at Pilani or at any other Centre approved by the Institute.

POW ZC431 Maintenance & Safety 3**

Basic maintenance systems and practice; maintenance planning; estimating and budgeting; scheduling maintenance jobs; importance of safety; factors affecting safety; safety aspects of site and plant; hazards of commercial chemical reaction and operation; instrumentation for safe operation; safety education and training; personnel safety; disaster planning and measuring safety effectiveness; future trends in industrial safety; maintenance of components and equipments; new dimensions in maintenance covering plant engineering, tribology, materials technology, terotechnology (life cycle costing) etc.; extensive case studies.

POW ZC441 Power Systems Engineering II 3**

Elementary principles of power system economics - Powers systems stability, equal area criterion and step by step method - protection, relays and relaying, protection of transmission lines, transformer and generators - High voltage Protection - Symmetrical components, symmetrical and unsymmetrical faults.

POW ZC412 Power System Operation & Control 3**

POW ZC422 Power System Drawing and Design 3**

POW ZC451 Alternative Energy Sources 3**

POW ZC461 Power Plant Engineering 3**

POW ZC471 Power Electronics & Drives 3**

Course description for the above courses to be developed.

POW ZC481 Plant Layout & Design 3**

Factors affecting plant layout, Types of layout, procedure for plant layout, techniques and tools for planning layout, quantitative layout analysis, material handing equipment, improving and revising existing layout, evaluation of layout, plant location, evaluation of location, design of layout, computer applications in layout design.

QM ZC441 Human Resource Management 4

Introduction, manpower planning, career and succession planning, procurement of personnel, performance appraisal, job satisfaction and morale, job rotation, employee communication, audit and control, management training and development, wage and salary administration, welfare administration, trade unions and collective bargaining, industrial dispute and worker participation in management.

QM ZG514 Leadership & Managing Change 4

Individuals as leaders, team leadership and organizational leadership. Introduction to managing change, management of change: organizational structure, culture, recruitment, performance management, human resource development, reward management, employee relations and involvement, downsizing, and evaluating and promoting.

QM ZG515 Quantitative Methods 4

Basic concepts in Operations Research; Analytical & Mathematical Modeling Techniques; Model Building; Inventory Control, queuing theory; Linear Programming; Transportation and assignment problems, simulation, index numbers, decision theory, etc.

QM ZG521 Quality Management Systems 5

Quality system & quality management, evolution of quality post world war II era i.e. Quality control, quality assurance, total quality control & total quality management; ISO 9000 series of standards, formation of ISO (1947), background & development of ISO 9000. ISO 9000 family of standards, selection & use of appropriate model of ISO 9000. Requirements of ISO 9001; System demonstration & documentation, how to organize formal quality assurance system, pyramid of quality system documentation structure, two tier, three tier & four tier documentation, preparation of quality manual & quality procedures, quality records; Implementing documented quality system, how to proceed, how to implement change, obtaining top management commitment, assessing current company position, developing the implementation plan, initiating people (employees) to own the system, system development; System audit & review, objective of system audit, types of quality audit, product Vs

system audit, internal quality audit, management review; System certification, benefits of third party certification, choice of certification body, route to certification, surveillance & renewal; Other quality system standards, relating ISO 9000 with QS 9000 and ISO 14000.

QM ZG523 Project Management 4

Concepts and techniques of project formulation, evaluation and implementation; Project planning and scheduling; Risk management; Time-cost trade off; Resource leveling and allocation; Project monitoring and control; Contract management.

QM ZG526 Operations Management 4

Operations strategy; process view vs. functional view in operations; factors in product and process design and selection; facility configuration; demand planning and forecasting; capacity planning; aggregate planning; planning service operations; productivity of operations; inventory planning and independent demand systems; materials requirements planning; quality management; uncertainty and variability; project management; current developments in operations management.

QM ZG527 Decision Engineering 4

Course description to be developed.

QM ZG528 Reliability Engineering 5

Basic Reliability Models, Reliability of Systems, Design for Reliability and Maintainability, Maintainability, availability and reliability; Data Collection and Empirical Methods, Reliability Testing, Identifying Failure and Repair Distributions, Reliability Estimation and Application.

QM ZG531 Statistical Quality Control 5

Sources of Variation: Common and Assignable Causes, Descriptive Statistics, Statistical Process Control Methods, Control Charts for Variables, Control Charts for Attributes, C-Charts, Process Capability, Acceptance Sampling, Operating characteristic curve, Statistical Quality Control in Services.

QM ZG532 Total Quality Management 4

TQM principles and practices; leadership; customer satisfaction; employee involvement; continuous process improvement; supplier partnership; performance measures; statistical process control; ISO 9000; benchmarking; quality function deployment; concurrent engineering; experimental design; Taguchi's quality engineering; product liability

QM ZG533 Manufacturing Planning & Control 5

Planning and control of manufacturing operations; material flow planning; product and process planning; demand forecasting and forecasting models; facility location; plant layout planning and design; machine cells; capacity planning; designing work methods; material handling; line balancing; aggregate planning; inventory models and systems for independent demand; materials requirements planning; elements of monitoring and production control; current developments in operations management.

QM ZG535 Decision Analysis 4

Introduction to quantitative techniques and statistics, Decision making, intelligence design and choice phases, basic theory of decision making under uncertainty; decision trees, qualification of judgments and preferences, Bayes theorem, the structuring of complex decisions, and multi-attribute utility theory. Statistical estimation and forecasting.

QM ZG536 Design of Experiments 4

Course description to be developed.

QM ZG541 Product Design 5

Introduction to creative design; user research and requirements analysis, product specifications, Computer Aided Design; standardization, variety reduction, preferred numbers and other techniques; modular design; design economics, cost analysis, cost reduction and value analysis techniques, design for production; human factors in design: anthropometric, ergonomic, psychological, physiological considerations in design decision making; legal factors, engineering ethics and society.

QM ZG611 Strategic Management & Business Policy 4

Strategic management elements; internal, external, external environment. assessment of corporate strengths, weaknesses and opportunities; planning and deployment of capital assets; profit planning and control functions problems, pressures, responsibilities, limits of the chief executive; evaluation of one's own business undertaking; formulating objectives, strategies,

policies and programmes for improving company's present situation; personnel strength and implementation of the policies and programmes, development, implementation, evaluation and control of strategies, strategic management of MNCs, management style and behavior, corporate style, behavior and culture.

QM ZG661 Software Quality Management 4

Software quality challenges and expectations; quality dilemma; software life cycle and link to quality; quality gates, formal reviews, system requirement reviews, preliminary design reviews, critical design reviews, test reviews; engineering reviews, walkthroughs, inspections, internal reviews; quality gate categories; technical environment and quality; planning for software quality, quality requirements for planning, quality needs, elements of quality planning, quality assessments during planning, software quality organization requirements; quality evaluation of software development process, process quality attributes, measuring software process quality; software process metrics; quality gate integrity; software product quality, standards and conventions, metrics; quality hierarchy, factors; quality assessment; quality evaluation techniques, reviews, walkthroughs, audit, inspections, analytical evaluation techniques; quality systems.

QM ZG663 Concurrent Engineering 5

Introduction of concurrent engineering and need, concurrent engineering tools, advances in design and manufacturing engineering, design for manufacture, design for assembly, rapid prototyping, simulation, concurrent approaches to design, manufacturing and other aspects of engineering.

QMJ ZC411 Marketing 4

Definition and scope, consumer behavior, competitive behavior, demand estimation, new product introduction, product/brand management, pricing policies, channels of distribution, credit management, advertising and other sales promotion, positioning, marketing regulation, market research basics of industrial marketing.

QMJ ZG511 TQM-Core Concepts 5

Historical perspective; Customer Orientation; Leadership & Management Commitment, Leadership Vs Management, Leadership Style, The Power style, Visioning, Creating Quality Environment, Delegation Vs Empowerment, Management of learning, Conflict resolution; Teamwork & Employee Involvement, Establishing an inspiring mission, setting up of sound objectives & goals, theory of motivation, create & maintain awareness on quality, promoting open communication, recognition & rewards, team building, self managing teams, quality circles, self development & empowerment; Learning for continuous improvement, Introducing training for participation and employee involvement, analyzing training needs, promoting multifunctionality, evaluation & monitoring of training.; TQM & Systems, system thinking, evolution of organization for quality integrating quality into strategic management, quality policy, resources for quality activities, designing & implementing quality system; Implementing TQM, establishing need to change, cultural change, gaining & sustaining change for continuous improvement, measuring success, communication, recognition.

QMJ ZG512 Human Resource Management & Organizational Learning 5

Developing the human resource; Training & development: analyzing training needs, training methods, evaluation & monitoring of training; Learning organization; Organizational learning single loop & double loop learning; System thinking personal mastery, mental models, shared vision, team learning; Organization development; Formal & informal organization, organization culture, shared beliefs & values; Interpersonal relations; Understanding determinants of interpersonal behaviors, interpersonal styles: an understanding about self & other T.A. approach; Personal effectiveness (Johari Window), interpersonal communication with emphasis on listening.; Team work & employee involvement; Inaslow's need hierarchy, theory of motivation, factors affecting employee involvement, job enlargement, enrichment and rotation, Small group activities: quality circles (structure, launching and institutionalizing), KAIZEN, 5.5 working.

QMJ ZG521 Quality Management System 5

Quality system & quality management, evolution of quality post world war II era i.e. Quality control, quality assurance, total quality control & total quality management; ISO 9000 series of standards, formation of ISO (1947), background & development of ISO 9000. ISO 9000 family of standards, selection & use of appropriate model of ISO 9000. Requirements of ISO 9001; System

demonstration & documentation, how to organize formal quality assurance system, pyramid of quality system documentation structure, two tier, three tier & four tier documentation, preparation of quality manual & quality procedures, quality records; Implementing documented quality system, how to proceed, how to implement change, obtaining top management commitment, assessing current company position, developing the implementation plan, initiating people (employees) to own the system, system development; System audit & review, objective of system audit, types of quality audit, product Vs system audit, internal quality audit, management review; System certification, benefits of third party certification, choice of certification body, route to certification, surveillance & renewal; Other quality system standards, relating ISO 9000 with QS 9000 and ISO 14000.

QMJ ZG522 Quality Through Measurement System 5

Measurement principles, measurement process: some statistical concepts, accuracy, precision and trueness, repeatability & reproducibility; Accuracy, error & uncertainty; Error & uncertainty propagation; Quality assurance in measurement; Calibration programme, traceability compliance to ISO 9000 requirements for control of test & measurement equipment; Gage accuracy, gage repeatability and gage reproducibility; Testing & calibration laboratory NABL accreditation system.

QMJ ZG523 Project Management 4

Concepts and techniques of project formulation, evaluation and implementation; Project planning and scheduling; Risk management; Time-cost trade off; Resource leveling and allocation; Project monitoring and control; Contract management.

QMJ ZG531 Statistical Process Control 5

What is SPC, history & development of SPC, averages & measures of dispersion, process variation, variable & attribute data, simple statistical problem solving tools: check sheets, histograms, Pareto diagrams, stratification graph, scatter plots, cause & effect diagram; Various types of control charts, control chart for attributes, cumulative sum charts, X bar R charts; construction & interpretation of control charts process capability; Lot try lot acceptance sampling for attributes, acceptance sampling variables, other acceptance sampling procedures.

QMJ ZG532 Environmental Management System 5

Introduction; Principles & elements of successful environmental management UNO and Rio declaration on environment and development (1992); Ecological degradation & ecological balance; EMS; Creating an environmental management system in fine with ISO 14000; Benefits of an environmental management system; Principles & elements of successful environmental management: leadership, environmental management planning, implementing an environmental management system, measurement & evaluations required for an environmental management system, environmental management reviews & improvements; Legal and regulatory concerns; Integrating ISO 9000 & ISO 14000.

QMJ ZG541 TQM Tools & Techniques 5

Benchmarking; introduction, why benchmark; Planning: what to benchmark, benchmarking partners, data collection methods; Analysis: determining the current competitive gap, projecting future performance levels; Integration: developing action plan, implementing specific actions & monitoring progress, re-calibration; Maturity: beyond benchmarking; Quality function deployment, QFD concept, overview & QFD process, the voice of customer developing a QFD matrix, reviewing the matrix for priority items, organizing teams & planning QFD projects; Process RE-engineering, BPR philosophy, possibilities & pitfalls, BPF framework, opportunity assessment, planning & BPR project, risk & impact assessment, planning & implementing the transition; Failure mode & effect analysis; FMEA: concepts & applications in TQM; Quality cost, concepts, quality cost definitions, quality cost program implementation use of quality cost, reducing quality cost.

QMJ ZG611 Strategic Management & Business Policy 4

Strategic management elements; internal, external, external environment. assessment of corporate strengths, weaknesses and opportunities; planning and deployment of capital assets; profit planning and control functions problems, pressures, responsibilities, limits of the chief executive; evaluation of one's own business undertaking; formulating objectives, strategies, policies and programmes for improving company’s present situation; personnel strength

and implementation of the policies and programmes, development, implementation, evaluation and control of strategies, strategic management of MNCs, management style and behavior, corporate style, behavior and culture.

QMJ ZG621 Supply Chain Management 4

Customer driven strategies in production and distribution systems; Integrated production and distribution networks; SCM in the context of JIT and MRP–II; Distribution Resource Planning; Management of dealer networks; Total Control & Product innovation across the supply chain; Incoming logistics and supplier relationships; Value addition analysis; Metrics for management of supply chain performance; Mathematical models and computer assisted decision support for SCM; Mathematical programming for SCM.

QMJ ZG629T Dissertation 16

A student registered in this course must take a topic in an area of professional interest drawn from the on the job work requirement which is simultaneously of direct relevance to the degree pursued by the student as well as to the employing / collaborating organization of the student and submit a comprehensive report at the end of the semester working under the overall supervision and guidance of a professional expert who will be deemed as the supervisor for evaluation of all components of the dissertation. Normally the Mentor of the student would be the Dissertation supervisor and in case Mentor is not approved as the supervisor, Mentor may play the role of additional supervisor. The final grades for dissertation are Non-letter grades namely Excellent, Good, Fair and Poor, which do not go into CGPA computation.

QMJ ZG658 Technical Communication 4

Role and importance of communication; effectiveness in oral and written communication; technical reports; technical proposals; technical descriptions; definitions and classifications; business correspondence; precis writing; memorandum; notices, agenda and minutes; oral communication related to meetings, seminars, conferences, group discussions, etc.; use of modern communication aids.

SEAY ZC421 Computer Networks 3

Introduction, history and development of computer networks; Reference models; Physical Layer: theoretical basis, transmission media, types of transmission; MAC sub-layer: local area networks, FDDI; Data Link Layer: Sliding Window protocols, design aspects; Network Layer: routing algorithms, congestion control algorithms, internetworking; Transport Layer: Integrated Services Digital Network (ISDN), Asynchronous Transfer Mode (ATM) - reference models, service classes, switch design, LAN emulation; Application Layer protocols.

SEAY ZC473 Multimedia Computing 3

Introduction to multimedia; media & data streams; image, video & audio file formats; image & video processing, synthesis of sound signal; image coding & compression, video & audio codes, low bit rate video telephony; audio-visual integration, lip reading, face animation; augmented reality; multimedia search services, content based image & video indexing; access to multimedia, human-machine interfaces, spoken language interface; algorithm vs. architecture based approaches, multimedia processors, performance quantification; case studies, vision 2010.

SEAY ZG512 Object Oriented Analysis & Design 4

Object orientation concepts, theories and principles; fundamental concepts of the object model: classes, objects, methods and messages, encapsulation and inheritance, interface and implementation, reuse and extension of classes, inheritance and polymorphism; process of object-oriented requirements specification, analysis and design; notations for object-oriented analysis and design; case studies and applications using some object oriented programming languages.

SEAY ZG513 Network Security 4

This course examines issues related to network and information security. Topics include security concepts, security attacks and risks, security architectures, security policy management, security mechanisms, cryptography algorithms, security standards, security system interoperation and case studies of the current major security systems.

SEAY ZG516 Embedded System Design 4

Introduction to embedded systems; embedded architectures: Architectures and programming of microcontrollers and DSPs. Embedded applications and technologies; power issues in system design; introduction to software and hardware co-design.

SEAY ZG518 Database Design and Applications 5

DBMS architecture; Data models: Network model, Hierarchical model and Relational model; Database design & optimization; Query processing & Query optimization; Transaction Processing; Concurrency control; Recovery; Security & protection; Introduction to Object Oriented data model & Multimedia Databases.

SEAY ZG520 Wireless and Mobile Communication 5

Signal propagation in a mobile environment, modulation, coding, equalization; first generation generation systems; multiple access techniques like FDMA, TDMA, CDMA, spread spectrum sytems; second & third generation systems, UMTS, IMT-2000; Wireless LAN, Wireless ATM and Mobile IP; emerging trends in Wireless & Mobile Communication.

SEAY ZG525 Advanced Computer Networks 5

Topics in advanced networking – Quality of Service in IP networks, IPv6, Wireless and Mobile Networks, Carrier Technologies (Frame Relay, FDDI, ISDN, ATM), Peer-to-Peer Networks and Overlays, Routing and QoS Issues in Optical Networks.

SEAY ZG552 Software Testing Methodologies 4

Concepts and principles of software testing and quality assurance; software testing tools; functional, structural, integration and system testing techniques; software testing process and its management; evaluation of test effectiveness; testing specialized systems and applications; automated software testing; case studies.

SEAY ZG582 Telecom Network Management 5

Network architecture and protocols; LAN, MAN and WANs; internetworking; network planning; network management concepts and standards; administrative, operational and fault management; security issues; remote network management.

SEAY ZG622 Software Project Management 4

Managing a software development project, concepts, objects of a project, environment of a software project, system development life cycle, tools, review process; documentation in software program management, procedures, diagramming techniques, management; Planning and monitoring a software project, project planning, management tools, software project definitions, project management packages, project control; software project definition, classification, project sizes and methodologies, feasibility, requirements and start-up; programmer productivity; software planning, control tools, accelerated design; prototyping and role in software project management; software production and software project management; software system installation, managing testing requirements, test plans, alpha and beta systems; emerging directions in project management.

SEAY ZG629T Dissertation 20

A student registered in this course must take a topic in an area of professional interest drawn from the on the job work requirement which is simultaneously of direct relevance to the degree pursued by the student as well as to the employing / collaborating organization of the student and submit a comprehensive report at the end of the semester working under the overall supervision and guidance of a professional expert who will be deemed as the supervisor for evaluation of all components of the dissertation. Normally the Mentor of the student would be the Dissertation supervisor and in case Mentor is not approved as the supervisor, Mentor may play the role of additional supervisor. The final grades for dissertation are Non-letter grades namely Excellent, Good, Fair and Poor, which do not go into CGPA computation.

SEAY ZG651 Software Architectures 5

Systems engineering and software architectures; Hatley-Pirbhai architectural template; architecture flow diagrams; requirements engineering and software architecture; architectural design processes; design post-processing; real-time architectures; architectural design patterns; software architecture and maintenance management; object oriented architectures; client-server architectures; forward engineering for object oriented and client-server architectures; emerging software architectures.

SEBM ZC425 Data Mining 3

Data Mining – introduction, fundamental concepts; motivation and applications; role of data warehousing in data mining; challenges and issues in data mining; Knowledge Discovery in Databases (KDD); role of data mining in KDD; algorithms for data mining; tasks like decision-tree construction, finding association rules, sequencing, classification, and clustering;

applications of neural networks and machine learning for tasks of classification and clustering.

SEBM ZC462 Network Programming 3

Overview of computer networks; inter-process communication; network programming; socket interface; client-server computing model: design issues, concurrency in server and clients; external data representation; remote procedure calls; network file systems; distributed systems design.

SEBM ZG512 Object Oriented Analysis & Design 4

Object orientation concepts, theories and principles; fundamental concepts of the object model: classes, objects, methods and messages, encapsulation and inheritance, interface and implementation, reuse and extension of classes, inheritance and polymorphism; process of object-oriented requirements specification, analysis and design; notations for object-oriented analysis and design; case studies and applications using some object oriented programming languages.

SEBM ZG513 Network Security 4

This course examines issues related to network and information security. Topics include security concepts, security attacks and risks, security architectures, security policy management, security mechanisms, cryptography algorithms, security standards, security system interoperation and case studies of the current major security systems.

SEBM ZG517 Usability Engineering 5

Usability-driven approach to Information Design; software usability bridge& its critical components; Iterative & evaluation of a two-level approach of UCID (User-Centered Information Design); five key principles of UCID; getting UCID into organization ; Benefits of implementing UCID; key features of UCID;UCID process & analysis; traditional processes for information development & their limitations; Managing UCID; role of usability engineers; preparing the usability plan; implementing a metrics program in typical UCID projects; key contributors; goal setting for software usability & information quality; critical design goals; designing the information architecture ;designing the specifications & prototypes; evaluating prototypes; two-level design activities; designing software labels; designing effective messages; designing online support elements & printed support elements; achieving information design goals; online search & navigation; evaluating information; two-level evaluation; approach achieving information design goals for improved software usability; testing information & validating; quality indicators; retrievability; implementation techniques & issues ;Application of Usability Engineering in typical live projects to validate improved software usability .

SEBM ZG518 Database Design & Applications 5

DBMS architecture; Data models: Network model, Hierarchical model and Relational model; Database design & optimization; Query processing & Query optimization; Transaction Processing; Concurrency control; Recovery; Security & protection; Introduction to Object Oriented data model & Multimedia Databases.

SEBM ZG519 Data Structures & Algorithm Design 5

Introduction to Abstract Data Types, Data structures and Algorithms; Analysis of Algorithms – Time and Space Complexity, Complexity Notation, Solving Recurrence Relations.; Divide-and-Conquer as a Design Technique; Recursion – Design of Recursive Functions / Procedures, Tail Recursion, Conversion of Recursive Functions to Iterative Form. Linear data structures – Lists, Access Restricted Lists (Stacks and Queues) – Implementation using Arrays and Linked Lists; Searching and Order Queries. Sorting – Sorting Algorithms (Online vs. Offline, In-memory vs. External, In-space vs. Out-of-space, QuickSort and Randomization). Unordered Collections: Hashtables (Separate Chaining vs. Open Addressing, Probing, Rehashing). Binary Trees – Tree Traversals. Partially Ordered Collections: Search Trees and Height Balanced Search Trees, Heaps and Priority Queues. Algorithm Design: Greedy Algorithms and Dynamic Programming. Graphs and Graph Algorithms: Representation schemes, Problems on Directed Graphs (Reachability and Strong Connectivity, Traversals, Transitive Closure. Directed Acyclic Graphs - Topological Sorting), Problems on Weighted Graphs (Shortest Paths. Spanning Trees). Introduction to Complexity Classes (P and NP) and NP-completeness. NP-Hard problems. Designing Algorithms for Hard Problems – Back tracking, Branch-and-Bound, and Approximation Algorithms.

SEBM ZG562 Software Engineering & Management 5

Current concepts, methods, techniques, and tools of the software engineering process; software process models; process definition and assessment; software measurement and metrics; project planning, estimation and control; requirements analysis and specification, design methods; quality assurance and testing; configuration management; process improvement; case studies and project work.

SEBM ZG622 Software Project Management 4

Managing a software development project, concepts, objects of a project, environment of a software project, system development life cycle, tools, review process; documentation in software program management, procedures, diagramming techniques, management; Planning and monitoring a software project, project planning, management tools, software project definitions, project management packages, project control; software project definition, classification, project sizes and methodologies, feasibility, requirements and start-up; programmer productivity; software planning, control tools, accelerated design; prototyping and role in software project management; software production and software project management; software system installation, managing testing requirements, test plans, alpha and beta systems; emerging directions in project management.

SEBM ZG623 Advanced Operating Systems 5

Overview of advanced operating systems: motivation for their design, and various types of advanced operating systems; Distributed operating systems: architecture of distributed systems, theoretical foundation of distributed systems, deadlock detection/resolution, agreement protocols, file systems, distributed shared memory, scheduling, fault tolerance and recovery; Multiprocessor operating systems: multiprocessor system architectures, multiprocessor operating system design issues, threads, process synchronization, process scheduling and memory management; Data base operating systems: introduction, concurrency control: theoretical and algorithmic aspects; Case Study: Amoeba and Mach.

SEBM ZG651 Software Architecture 5

Systems engineering and software architectures; Hatley-Pirbhai architectural template; architecture flow diagrams; requirements engineering and software architecture; architectural design processes; design post-processing; real-time architectures; architectural design patterns; software architecture and maintenance management; object oriented architectures; client-server architectures; forward engineering for object oriented and client-server architectures; emerging software architectures.

SEBM ZG552 Software Testing Methodologies 4

Concepts and principles of software testing and quality assurance; software testing tools; functional, structural, integration and system testing techniques; software testing process and its management; evaluation of test effectiveness; testing specialized systems and applications; automated software testing; case studies.

SEBN ZG629T Dissertation 20

A student registered in this course must take a topic in an area of professional interest drawn from the on the job work requirement which is simultaneously of direct relevance to the degree pursued by the student as well as to the employing / collaborating organization of the student and submit a comprehensive report at the end of the semester working under the overall supervision and guidance of a professional expert who will be deemed as the supervisor for evaluation of all components of the dissertation. Normally the Mentor of the student would be the Dissertation supervisor and in case Mentor is not approved as the supervisor, Mentor may play the role of additional supervisor. The final grades for dissertation are Non-letter grades namely Excellent, Good, Fair and Poor, which do not go into CGPA computation.

SECT ZC271 Mathematics I 3

Real-valued functions of one real variable; limits and indeterminate forms; differentiability of functions; indefinite and definite integrals; applications of derivatives and integrals. concept of a matrix; operations on matrices; various types of matrices; inverse and adjoint of a matrix; row-reduction method; solution of simultaneous linear equations by matrix methods.

SECT ZC272 Mathematics II 3

Linear inequalities and associated regions; concept of linear programming problems; graphical solution method; simplex method for maximization problems; concept of basic fleasible solutions; concept of stack variables and their uses in simplex method. basic ideas of statistics; frequency distributions; measures of central tendency, dispersion; moments; skewness and kurtosis; co-efficient of skewness, correlation, regression. Finite differences, Newton's interpolation formulae - forward and backward methods; Lagrange's interpolation formulae; numerical differentiation and integration. Numerical methods for solving equations, iteration method; regula-falsi method; Newton-Raphson method.

SECT ZC213 Probability & Statistics 3

Probability spaces; conditional probability and independence; random variables and probability distributions; marginal and conditional distributions; independent random variables; mathematical expectation; mean and variance; binomial, Poisson and normal distributions; sum of independent random variables; law of large numbers; central limit theorem (without proof); sampling distribution and test for mean using normal and student's t-distribution; test of hypothesis; correlation and linear regression.

SECT ZC221 Structured Programming 3

Algorithms and problem solving; paradigms of programming; imperative programming; structured programming methodologies; stepwise refinement procedures; structured programming through one of the structured programming languages like Pascal, C or Ada (the actual choice will be made each semester before the course is offered); elementary data types and uses; control structures; conditional structures; iterative structures; input and output handling; structured data types and uses; functions, library and user defined; scoping rules; parameter passing mechanisms; files and file handling; recursion; some advanced topics for programming.

SECT ZC222 Advanced Programming Techniques 3

Dynamic memory management; low level processing; debugging techniques; symbolic debugging tools; visual programming environments; user interfaces; event driven programming; visual design methodologies; prototyping with visual programming aids; creating multi-threaded applications; other emergent advanced programming topics.

SECT ZC241 Principles of Management 3

Fundamental concepts of management - planning; organizing; staffing; directing and controlling; production, financial, personnel, legal and marketing functions; accounting and budgeting, balance sheets.

SECT ZC252 Discrete Structures for Computer Science 3

Sets and relations; graphs and digraphs; trees, lists and their uses; partially ordered sets and lattices; Boolean algebras and Boolean expressions; semigroups and machines; codes and applications.

SECT ZC261 Digital Electronics & Microprocessors 3

Binary logic gates; logic circuits; Boolean algebra and K-map simplification; number systems and codes; arithmetic logic units; flipflops; registers and counters; introduction to microprocessors; architecture; instruction set and programming; memory and I/O interfacing examples of system design.

SECT ZC322 Database Management Systems 3

Introduction to Database Management Systems; File organization; Data Independence in databases; Data Models; Query processing systems; Database Design techniques; Concepts of security and integrity in databases; Distributed Databases; Applications using DBMS.

SECT ZC362 Programming Languages & Compiler Construction 3

Formal definition, syntax and semantics; simple statements including precedence, infix, prefix and postfix notation; structure of algorithmic languages; list processing and string manipulation languages, One-pass compilation techniques; organization of a compiler including compile-time and run-time symbol tables; lexical scan, syntax scan; object code generation; error diagnostics; code optimization techniques.

SECT ZC413 Computer Organization & Architecture 3

Overview of logic design; Instruction set architecture; Assembly language programming;

Pipelining; Computer Arithmetic; Control unit; Memory hierarchy; virtual memory; Input and output systems; Interrupts and exception handling; Implementation issues; Case studies

SECT ZC415 Data Structures & Algorithms 3

Introduction to software design principles, modularity, abstract data types, data structures and algorithms; analysis of algorithms; Linear data structures – stacks, arrays, lists queues and linked representations; Pre-fix, in-fix and post-fix expressions; Recursion; Set operations; Hashing and hash functions; Binary and other trees, traversal algorithms, Huffman codes; Search trees, priority queues, heaps and balanced trees; Sorting techniques; Graphs and digraphs; Algorithmic design techniques; Data structures for external storage, multi-way search and B-trees.

SECT ZC421 Computer Networks 3

Introduction, history and development of computer networks; Reference models; Physical Layer: theoretical basis, transmission media, types of transmission; MAC sub-layer: local area networks, FDDI; Data Link Layer: Sliding Window protocols, design aspects; Network Layer: routing algorithms, congestion control algorithms, internetworking; Transport Layer: Integrated Services Digital Network (ISDN), Asynchronous Transfer Mode (ATM) - reference models, service classes, switch design, LAN emulation; Application Layer protocols.

SECT ZC422 Operating Systems 3

Introduction to operating systems; Various approaches to design of operating systems; Overview of hardware support for operating systems; Process management: process synchronization and mutual exclusion, interprocess communication, process scheduling; CPU scheduling approaches; Memory management: paging, segmentation, virtual memory, page replacement algorithms; File systems: design and implementation of file systems; input/output systems; device controllers and device drivers; Security and protection; Case studies on design and implementation of operating system modules.

SECT ZC425 Data Mining 3

Data Mining – introduction, fundamental concepts; motivation and applications; role of data warehousing in data mining; challenges and issues in data mining; Knowledge Discovery in Databases (KDD); role of data mining in KDD; algorithms for data mining; tasks like decision-tree construction, finding association rules, sequencing, classification, and clustering; applications of neural networks and machine learning for tasks of classification and clustering.

SECT ZC432 Object Oriented Programming 3

Object orientation concepts and principles: abstraction, encapsulation, modularity, inheritance, and polymorphism; classes and objects; static and dynamic binding; class utilities; metaclasses; object oriented software engineering; programming and problem solving using one or more of the popular object-oriented programming languages like C++ or Java.

SECT ZC461 Software Engineering 3

Software engineering concepts and methodology; formal requirements specification; estimation; software project planning; detailed design; techniques of design; productivity; documentation; programming languages styles, code review; tool, integration and validation; software quality assurance; software maintenance; metrics, automated tools in software engineering.

SECT ZG511 Design & Analysis of Algorithms 5

Design techniques such as divide-and-conquer, recursion, backtracking, branch-and-bound, simulation; Analysis in terms of average level and worst level efficiency; Relationship to appropriate data structures; Illustrations dealing with problems in computer science, graph theory and mathematics; Computational complexity and bounds; NP-hard and NP-complete problems.

SECT ZG512 Object Oriented Analysis & Design 4

Object orientation concepts, theories and principles; fundamental concepts of the object model: classes, objects, methods and messages, encapsulation and inheritance, interface and implementation, reuse and extension of classes, inheritance and polymorphism; process of object-oriented requirements specification, analysis and design; notations for object-oriented analysis and design; case studies and applications using some object oriented programming languages.

SECT ZG513 Network Security 4

This course examines issues related to network and information security. Topics include security concepts, security attacks and risks, security

architectures, security policy management, security mechanisms, cryptography algorithms, security standards, security system interoperation and case studies of the current major security systems.

SECT ZG514 Data Warehousing 5

Introduction, evolution of data warehousing; decision support systems; goals, benefit, and challenges of data warehousing; architecture; data warehouse information flows; software and hardware requirements; approaches to data warehouse design; creating and maintaining a data warehouse; Online Analytical Processing (OLAP) and multi-dimensional data, multi-dimensional modeling; view materialization; data marts; data warehouse metadata; data mining.

SECT ZG517 Usability Engineering 5

Usability-driven approach to Information Design; software usability bridge& its critical components; Iterative & evaluation of a two-level approach of UCID (User-Centered Information Design); five key principles of UCID; getting UCID into organization ; Benefits of implementing UCID; key features of UCID;UCID process & analysis; traditional processes for information development & their limitations; Managing UCID; role of usability engineers; preparing the usability plan; implementing a metrics program in typical UCID projects; key contributors; goal setting for software usability & information quality; critical design goals; designing the information architecture ;designing the specifications & prototypes; evaluating prototypes; two-level design activities; designing software labels; designing effective messages; designing online support elements & printed support elements; achieving information design goals; online search & navigation; evaluating information; two-level evaluation; approach achieving information design goals for improved software usability; testing information & validating; quality indicators; retrievability; implementation techniques & issues ;Application of Usability Engineering in typical live projects to validate improved software usability .

SECT ZG518 Database Design & Applications 5

DBMS architecture; Data models: Network model, Hierarchical model and Relational model; Database design & optimization; Query processing & Query optimization; Transaction Processing; Concurrency control; Recovery; Security & protection; Introduction to Object Oriented data model & Multimedia Databases.

SEYI ZG519 Data Structures & Algorithms Design 5

Introduction to Abstract Data Types, Data structures and Algorithms; Analysis of Algorithms – Time and Space Complexity, Complexity Notation, Solving Recurrence Relations.; Divide-and-Conquer as a Design Technique; Recursion – Design of Recursive Functions / Procedures, Tail Recursion, Conversion of Recursive Functions to Iterative Form. Linear data structures – Lists, Access Restricted Lists (Stacks and Queues) – Implementation using Arrays and Linked Lists; Searching and Order Queries. Sorting – Sorting Algorithms (Online vs. Offline, In-memory vs. External, In-space vs. Out-of-space, QuickSort and Randomization). Unordered Collections: Hashtables (Separate Chaining vs. Open Addressing, Probing, Rehashing). Binary Trees – Tree Traversals. Partially Ordered Collections: Search Trees and Height Balanced Search Trees, Heaps and Priority Queues. Algorithm Design: Greedy Algorithms and Dynamic Programming. Graphs and Graph Algorithms: Representation schemes, Problems on Directed Graphs (Reachability and Strong Connectivity, Traversals, Transitive Closure. Directed Acyclic Graphs - Topological Sorting), Problems on Weighted Graphs (Shortest Paths. Spanning Trees). Introduction to Complexity Classes (P and NP) and NP-completeness. NP-Hard problems. Designing Algorithms for Hard Problems – Back tracking, Branch-and-Bound, and Approximation Algorithms.

SECT ZG527 Cloud Computing 5

Concurrency and distributed computing, message passing over the network, connectivity and failure models, local vs remote connectivity, distributed resource modeling, distributed data models; replication & consistency; virtualization; CPU virtualization, memory and storage virtualization, virtualized networks, computing over WAN and Internet; computing on the cloud, computing models, service models and service contracts, programming on the cloud; Cloud infrastructure, LAN vs Wan issue, resource scaling and resource provisions, performance models, scalability, performance measurement and enhancement techniques; cloud applications and infrastructure services.

SECT ZG552 Software Testing Methodologies 4

Concepts and principles of software testing and quality assurance; software testing tools; functional, structural, integration and system testing techniques; software testing process and its management; evaluation of test effectiveness; testing specialized systems and applications; automated software testing; case studies.

SECT ZG622 Software Project Management 4

Managing a software development project, concepts, objects of a project, environment of a software project, system development life cycle, tools, review process; documentation in software program management, procedures, diagramming techniques, management; Planning and monitoring a software project, project planning, management tools, software project definitions, project management packages, project control; software project definition, classification, project sizes and methodologies, feasibility, requirements and start-up; programmer productivity; software planning, control tools, accelerated design; prototyping and role in software project management; software production and software project management; software system installation, managing testing requirements, test plans, alpha and beta systems; emerging directions in project management.

SECT ZG629T Dissertation 20

A student registered in this course must take a topic in an area of professional interest drawn from the on the job work requirement which is simultaneously of direct relevance to the degree pursued by the student as well as to the employing / collaborating organization of the student and submit a comprehensive report at the end of the semester working under the overall supervision and guidance of a professional expert who will be deemed as the supervisor for evaluation of all components of the dissertation. Normally the Mentor of the student would be the Dissertation supervisor and in case Mentor is not approved as the supervisor, Mentor may play the role of additional supervisor. The final grades for dissertation are Non-letter grades namely Excellent, Good, Fair and Poor, which do not go into CGPA computation.

SECT ZG641 Management Information & Decision Support Systems 5

Data & information; characteristics of information; components of management information systems; information flows; design and maintenance of management information systems; decision support systems.

SECT ZG651 Software Architectures 5

Systems engineering and software architectures; Hatley-Pirbhai architectural template; architecture flow diagrams; requirements engineering and software architecture; architectural design processes; design post-processing; real-time architectures; architectural design patterns; software architecture and maintenance management; object oriented architectures; client-server architectures; forward engineering for object oriented and client-server architectures; emerging software architectures.

SECT ZG652 Software Maintenance Management 4

Issues in software maintenance, conceptual issues, scale of effort issues, organizational issues, productivity techniques issues, problem area issues; application systems; maintenance effort; impact of development tools and organizational controls; problems of maintenance; software evolution and maintenance; change management; impact analysis; system release planning; corrective maintenance; adaptive maintenance; perfective maintenance; reengineering source code, restructuring code, maintainability, flexibility, reusability, reliability, efficiency, reengineering tools; software testing & maintenance testing; system release and configuration management; managing the software maintenance process.

SECT ZG659 Technical Communication 4

Role and importance of communication; effectiveness in oral and written communication; technical reports; technical proposals; technical descriptions; definitions and classifications; business correspondence; precis writing; memorandum; notices, agenda and minutes; oral communication related to meetings, seminars, conferences, group discussions, etc.; use of modern communication aids.

SECT ZG661 Software Quality Management 4

Software quality challenges and expectations; quality dilemma; software life cycle and link to

quality; quality gates, formal reviews, system requirement reviews, preliminary design reviews, critical design reviews, test reviews; engineering reviews, walkthroughs, inspections, internal reviews; quality gate categories; technical environment and quality; planning for software quality, quality requirements for planning, quality needs, elements of quality planning, quality assessments during planning, software quality organization requirements; quality evaluation of software development process, process quality attributes, measuring software process quality; software process metrics; quality gate integrity; software product quality, standards and conventions, metrics; quality hierarchy, factors; quality assessment; quality evaluation techniques, reviews, walkthroughs, audit, inspections, analytical evaluation techniques; quality systems.

SECY ZC451 Internetworking Technologies 3

Introduction to internetworking concepts; the internet architecture; goals and key issued related to internet working technologies; design aspects; HTTP and other relevant protocols; agent technology and tools relevant to the internet; techniques of data compression; voice, video, and interactive video-on-demand over the internet; multimedia operating systems and their impact; multimedia networking; mobile computing; internet security, case studies.

SECY ZC351 Organizational Behaviour 3

A new perspective of management; conceptual model of organization behavior; the individual processes- personality, work attitude, perception, attribution, motivation, learning and reinforcement, work stress and stress management; the dynamics of organizational behavior- group dynamics, power & politics, conflict & negotiation, leadership process & styles, communication; the organizational processes- decision making, job design; organizational theory and design, organizational culture, managing cultural diversity; organizational change & development.

SECY ZG512 Object Oriented Analysis and Design 4

Object orientation concepts, theories and principles; fundamental concepts of the object model: classes, objects, methods and messages, encapsulation and inheritance, interface and implementation, reuse and extension of classes, inheritance and polymorphism; process of object-oriented requirements specification, analysis and design; notations for object-oriented analysis and design; case studies and applications using some object oriented programming languages.

SECY ZG513 Network Security 4

This course examines issues related to network and information security. Topics include security concepts, security attacks and risks, security architectures, security policy management, security mechanisms, cryptography algorithms, security standards, security system interoperation and case studies of the current major security systems.

SECY ZG514 Data Warehousing 5

Introduction, evolution of data warehousing; decision support systems; goals, benefit, and challenges of data warehousing; architecture; data warehouse information flows; software and hardware requirements; approaches to data warehouse design; creating and maintaining a data warehouse; Online Analytical Processing (OLAP) and multi-dimensional data, multi-dimensional modeling; view materialization; data marts; data warehouse metadata; data mining.

SECY ZG517 Data Structures and Algorithm Analysis 5

Abstract data types; Linear data structures; Hash functions, Binary and other trees, traversal algorithms; Heaps and balanced trees; Sorting and searching techniques; Divide and conquer, recursion, backtracking, branch and bound; Computational complexity and bounds.

SECY ZG518 Database Design and Applications 5

DBMS architecture; Data models: Network model, Hierarchical model and Relational model; Database design & optimization; Query processing & Query optimization; Transaction Processing; Concurrency control; Recovery; Security & protection; Introduction to Object Oriented data model & Multimedia Databases.

SECY ZG531 Pervasive Computing 4

Select application architectures; hardware aspects; human-machine interfacing; device technology: hardware, operating system issues; software aspects, java; device connectivity issues and protocols; security issues; device management issues and mechanisms; role of web; wap devices and architectures; voice-enabling techniques; PDAs and their operating

systems; web application architectures; architectural issues and choices; smart card-based authentication mechanisms; applications; issues and mechanisms in WAP-enabling; access architectures; wearable computing architectures.

SECY ZG562 Software Engineering & Management 5

Current concepts, methods, techniques, and tools of the software engineering process; software process models; process definition and assessment; software measurement and metrics; project planning, estimation and control; requirements analysis and specification, design methods; quality assurance and testing; configuration management; process improvement; case studies and project work.

SECY ZG623 Advanced Operating Systems 5

Overview of advanced operating systems: motivation for their design, and various types of advanced operating systems; Distributed operating systems: architecture of distributed systems, theoretical foundation of distributed systems, deadlock detection/resolution, agreement protocols, file systems, distributed shared memory, scheduling, fault tolerance and recovery; Multiprocessor operating systems: multiprocessor system architectures, multiprocessor operating system design issues, threads, process synchronization, process scheduling and memory management; Data base operating systems: introduction, concurrency control: theoretical and algorithmic aspects; Case Study: Amoeba and Mach.

SECY ZG629T Dissertation 20

A student registered in this course must take a topic in an area of professional interest drawn from the on the job work requirement which is simultaneously of direct relevance to the degree pursued by the student as well as to the employing / collaborating organization of the student and submit a comprehensive report at the end of the semester working under the overall supervision and guidance of a professional expert who will be deemed as the supervisor for evaluation of all components of the dissertation. Normally the Mentor of the student would be the Dissertation supervisor and in case Mentor is not approved as the supervisor, Mentor may play the role of additional supervisor. The final grades for dissertation are Non-letter grades namely Excellent, Good, Fair and Poor, which do not go into CGPA computation.

SECY ZG651 Software Architectures 5

Systems engineering and software architectures; Hatley-Pirbhai architectural template; architecture flow diagrams; requirements engineering and software architecture; architectural design processes; design post-processing; real-time architectures; architectural design patterns; software architecture and maintenance management; object oriented architectures; client-server architectures; forward engineering for object oriented and client-server architectures; emerging software architectures.

SECY ZG661 Software Quality Management 4

Software quality challenges and expectations; quality dilemma; software life cycle and link to quality; quality gates, formal reviews, system requirement reviews, preliminary design reviews, critical design reviews, test reviews; engineering reviews, walkthroughs, inspections, internal reviews; quality gate categories; technical environment and quality; planning for software quality, quality requirements for planning, quality needs, elements of quality planning, quality assessments during planning, software quality organization requirements; quality evaluation of software development process, process quality attributes, measuring software process quality; software process metrics; quality gate integrity; software product quality, standards and conventions, metrics; quality hierarchy, factors; quality assessment; quality evaluation techniques, reviews, walkthroughs, audit, inspections, analytical evaluation techniques; quality systems.

SEEMC ZC444 Cloud Computing 4

Concurrency and distributed computing, message passing over the network, connectivity and failure models, local vs remote connectivity, distributed resource modeling, distributed data models; replication & consistency; virtualization; CPU virtualization, memory and storage virtualization, virtualized networks, computing over WAN and Internet; computing on the cloud, computing models, service models and service contracts, programming on the cloud; Cloud infrastructure, LAN vs Wan issue, resource scaling and resource provisions, performance models, scalability, performance measurement and enhancement techniques; cloud applications and infrastructure services.

SEEMC ZC446 Data Storage Technologies & Networks 3

Storage Media and Technologies – Magnetic, Optical and Semiconductor media, techniques for read/write operations, issues and limitations. Usage and Access – Positioning in the memory hierarchy, Hardware and Software Design for access, Performance issues. Large Storages – Hard Disks, Networked Attached Storage, Scalability issues, Networking issues. Storage Architecture. - Storage Partitioning, Storage System Design, Caching, Legacy Systems. Storage Area Networks – Hardware and Software Components, Storage Clusters/Grids. Storage QoS – Performance, Reliability, and Security issues.

SEEMC ZC462 Network Programming 3

Overview of computer networks; inter-process communication; network programming; socket interface; client-server computing model: design issues, concurrency in server and clients; external data representation; remote procedure calls; network file systems; distributed systems design.

SEEMC ZG512 Object Oriented Analysis and Design 4

Object orientation concepts, theories and principles; fundamental concepts of the object model: classes, objects, methods and messages, encapsulation and inheritance, interface and implementation, reuse and extension of classes, inheritance and polymorphism; process of object-oriented requirements specification, analysis and design; notations for object-oriented analysis and design; case studies and applications using some object oriented programming languages.

SEEMC ZG513 Network Security 4

This course examines issues related to network and information security. Topics include security concepts, security attacks and risks, security architectures, security policy management, security mechanisms, cryptography algorithms, security standards, security system interoperation and case studies of the current major security systems.

SEEMC ZG531 Pervasive Computing 4

Select application architectures; hardware aspects; human-machine interfacing; device technology: hardware, operating system issues; software aspects, java; device connectivity issues and protocols; security issues; device management issues and mechanisms; role of web; wap devices and architectures; voice-enabling techniques; PDAs and their operating systems; web application architectures; architectural issues and choices; smart card-based authentication mechanisms; applications; issues and mechanisms in WAP-enabling; access architectures; wearable computing architectures.

SEEMC ZG552 Software Testing Methodologies 4

Concepts and principles of software testing and quality assurance; software testing tools; functional, structural, integration and system testing techniques; software testing process and its management; evaluation of test effectiveness; testing specialized systems and applications; automated software testing; case studies.

SEEMC ZG554 Distributed Data Systems 5

Distributed File Systems - File System Models; Replication and Synchronization - Caching; Failure & Recovery; File System Security. Distributed Databases - Distributed Data Sources and Updates; Database Connectivity; Concurrency Control and Distribution mechanism; Distributed indexing schemes. Database security. Data on the Web - Web as a distributed data repository. Data Collection and Use Crawlers, Search Engines, and Indexing Schemes. Information Retrieval Techniques. Data Exchange - Hierarchical Data Models, XML, and query languages. Semi-structured / Unstructured data - querying and synchronization. Pervasive Data - Data distribution and access for non-computing devices, small computing devices, embedded computing devices and sensory devices.

SEEMC ZG562 Software Engineering and Management 5

Current concepts, methods, techniques, and tools of the software engineering process; software process models; process definition and assessment; software measurement and metrics; project planning, estimation and control; requirements analysis and specification, design methods; quality assurance and testing; configuration management; process improvement; case studies and project work.

SEEMC ZG622 Software Project Management 4

Managing a software development project, concepts, objects of a project, environment of a software project, system development life cycle,

tools, review process; documentation in software program management, procedures, diagramming techniques, management; Planning and monitoring a software project, project planning, management tools, software project definitions, project management packages, project control; software project definition, classification, project sizes and methodologies, feasibility, requirements and start-up; programmer productivity; software planning, control tools, accelerated design; prototyping and role in software project management; software production and software project management; software system installation, managing testing requirements, test plans, alpha and beta systems; emerging directions in project management.

SEEMC ZG623 Advanced Operating Systems 5

Overview of advanced operating systems: motivation for their design, and various types of advanced operating systems; Distributed operating systems: architecture of distributed systems, theoretical foundation of distributed systems, deadlock detection/resolution, agreement protocols, file systems, distributed shared memory, scheduling, fault tolerance and recovery; Multiprocessor operating systems: multiprocessor system architectures, multiprocessor operating system design issues, threads, process synchronization, process scheduling and memory management; Data base operating systems: introduction, concurrency control: theoretical and algorithmic aspects; Case Study: Amoeba and Mach.

SEEMC ZG629T Dissertation 20

A student registered in this course must take a topic in an area of professional interest drawn from the on the job work requirement which is simultaneously of direct relevance to the degree pursued by the student as well as to the employing / collaborating organization of the student and submit a comprehensive report at the end of the semester working under the overall supervision and guidance of a professional expert who will be deemed as the supervisor for evaluation of all components of the dissertation. Normally the Mentor of the student would be the Dissertation supervisor and in case Mentor is not approved as the supervisor, Mentor may play the role of additional supervisor. The final grades for dissertation are Non-letter grades namely Excellent, Good, Fair and Poor, which do not go into CGPA computation.

SEEMC ZG651 Software Architectures 5

Systems engineering and software architectures; Hatley-Pirbhai architectural template; architecture flow diagrams; requirements engineering and software architecture; architectural design processes; design post-processing; real-time architectures; architectural design patterns; software architecture and maintenance management; object oriented architectures; client-server architectures; forward engineering for object oriented and client-server architectures; emerging software architectures.

SEMB ZC211 Mathematics I 3

Real-valued functions of one real variable; limits and indeterminate forms; differentiability of functions; indefinite and definite integrals; applications of derivatives and integrals. concept of a matrix; operations on matrices; various types of matrices; inverse and adjoint of a matrix; row-reduction method; solution of simultaneous linear equations by matrix methods.

SEMB ZC212 Mathematics II 3

Linear inequalities and associated regions; concept of linear programming problems; graphical solution method; simplex method for maximization problems; concept of basic fleasible solutions; concept of stack variables and their uses in simplex method. basic ideas of statistics; frequency distributions; measures of central tendency, dispersion; moments; skewness and kurtosis; co-efficient of skewness, correlation, regression. Finite differences, Newton's interpolation formulae - forward and backward methods; Lagrange's interpolation formulae; numerical differentiation and integration. Numerical methods for solving equations, iteration method; regula-falsi method; Newton-Raphson method.

SEMB ZC213 Probability & Statistics 3

Probability spaces; conditional probability and independence; random variables and probability distributions; marginal and conditional distributions; independent random variables; mathematical expectation; mean and variance; binomial, Poisson and normal distributions; sum of independent random variables; law of large numbers; central limit theorem (without proof); sampling distribution and test for mean using

normal and student's t-distribution; test of hypothesis; correlation and linear regression.

SEMB ZC221 Structured Programming 3

Algorithms and problem solving; paradigms of programming; imperative programming; structured programming methodologies; stepwise refinement procedures; structured programming through one of the structured programming languages like Pascal, C or Ada (the actual choice will be made each semester before the course is offered); elementary data types and uses; control structures; conditional structures; iterative structures; input and output handling; structured data types and uses; functions, library and user defined; scoping rules; parameter passing mechanisms; files and file handling; recursion; some advanced topics for programming.

SEMB ZC222 Advanced Programming Techniques 3

Dynamic memory management; low level processing; debugging techniques; symbolic debugging tools; visual programming environments; user interfaces; event driven programming; visual design methodologies; prototyping with visual programming aids; creating multi-threaded applications; other emergent advanced programming topics.

SEMB ZC241 Principles of Management 3

Fundamental concepts of management - planning; organizing; staffing; directing and controlling; production, financial, personnel, legal and marketing functions; accounting and budgeting, balance sheets.

SEMB ZC252 Discrete Structures for Computer Science 3

Sets and relations; graphs and digraphs; trees, lists and their uses; partially ordered sets and lattices; Boolean algebras and Boolean expressions; semigroups and machines; codes and applications.

SEMB ZC261 Digital Electronics & Microprocessors 3

Binary logic gates; logic circuits; Boolean algebra and K-map simplification; number systems and codes; arithmetic logic units; flipflops; registers and counters; introduction to microprocessors; architecture; instruction set and programming; memory and I/O interfacing examples of system design.

SEMB ZC322 Database Management Systems 3

Introduction to Database Management Systems; File organization; Data Independence in databases; Data Models; Query processing systems; Database Design techniques; Concepts of security and integrity in databases; Distributed Databases; Applications using DBMS.

SEMB ZC351 Organisational Behaviour 3

A new perspective of management; conceptual model of organization behavior; the individual processes- personality, work attitude, perception, attribution, motivation, learning and reinforcement, work stress and stress management; the dynamics of organizational behavior- group dynamics, power & politics, conflict & negotiation, leadership process & styles, communication; the organizational processes- decision making, job design; organizational theory and design, organizational culture, managing cultural diversity; organizational change & development.

SEMB ZC362 Programming Languages & Compiler Construction 3

Formal definition, syntax and semantics; simple statements including precedence, infix, prefix and postfix notation; structure of algorithmic languages; list processing and string manipulation languages, One-pass compilation techniques; organization of a compiler including compile-time and run-time symbol tables; lexical scan, syntax scan; object code generation; error diagnostics; code optimization techniques.

SEMB ZC413 Computer Organization & Architecture 3

Overview of logic design; Instruction set architecture; Assembly language programming; Pipelining; Computer Arithmetic; Control unit; Memory hierarchy; virtual memory; Input and output systems; Interrupts and exception handling; Implementation issues; Case studies

SEMB ZC415 Data Structures & Algorithms 3

Introduction to software design principles, modularity, abstract data types, data structures and algorithms; analysis of algorithms; Linear data structures – stacks, arrays, lists queues and linked representations; Pre-fix, in-fix and post-fix expressions; Recursion; Set operations; Hashing and hash functions; Binary and other trees, traversal algorithms, Huffman codes; Search trees, priority queues, heaps and balanced trees; Sorting techniques; Graphs and digraphs;

Algorithmic design techniques; Data structures for external storage, multi-way search and B-trees.

SEMB ZC421 Computer Networks 3

Introduction, history and development of computer networks; Reference models; Physical Layer: theoretical basis, transmission media, types of transmission; MAC sub-layer: local area networks, FDDI; Data Link Layer: Sliding Window protocols, design aspects; Network Layer: routing algorithms, congestion control algorithms, internetworking; Transport Layer: Integrated Services Digital Network (ISDN), Asynchronous Transfer Mode (ATM) - reference models, service classes, switch design, LAN emulation; Application Layer protocols.

SEMB ZC422 Operating Systems 3

Introduction to operating systems; Various approaches to design of operating systems; Overview of hardware support for operating systems; Process management: process synchronization and mutual exclusion, interprocess communication, process scheduling; CPU scheduling approaches; Memory management: paging, segmentation, virtual memory, page replacement algorithms; File systems: design and implementation of file systems; input/output systems; device controllers and device drivers; Security and protection; Case studies on design and implementation of operating system modules.

SEMB ZC432 Object Oriented Programming 3

Object orientation concepts and principles: abstraction, encapsulation, modularity, inheritance, and polymorphism; classes and objects; static and dynamic binding; class utilities; metaclasses; object oriented software engineering; programming and problem solving using one or more of the popular object-oriented programming languages like C++ or Java.

SEMB ZC451 Internetworking Technologies 3

Introduction to internetworking concepts; the internet architecture; goals and key issued related to internet working technologies; design aspects; HTTP and other relevant protocols; agent technology and tools relevant to the internet; techniques of data compression; voice, video, and interactive video-on-demand over the internet; multimedia operating systems and their impact; multimedia networking; mobile computing; internet security, case studies.

SEMB ZC452 Mobile Telecom Networks 3

Fundamentals of mobile telecommunications; with an overview of first generation (analog) systems and more detailed coverage of second generation (digital) technologies; technology basics including descriptions of wireless network elements, spectrum allocation, frequency re-use, characteristics of the transmission medium; over the-air (OTA) interface characteristics; capacity, coverage, speech coding, channel coding and modulation techniques of TDMA and CDMA technologies; network characteristics; architecture, signaling, element management of IS-41 and GSM networks; call processing; call setup and release, handoff, roaming, advanced services; mobile data communications; circuit and packet switched data services, third generation (wideband data) mobile communications system requirements / architecture.

SEMB ZC461 Software Engineering 3

Software engineering concepts and methodology; formal requirements specification; estimation; software project planning; detailed design; techniques of design; productivity; documentation; programming languages styles, code review; tool, integration and validation; software quality assurance; software maintenance; metrics, automated tools in software engineering.

SEMB ZC462 Network Programming 3

Overview of computer networks; inter-process communication; network programming; socket interface; client-server computing model: design issues, concurrency in server and clients; external data representation; remote procedure calls; network file systems; distributed systems design.

SEMB ZC473 Multimedia Computing 3

Introduction to multimedia; media & data streams; image, video & audio file formats; image & video processing, synthesis of sound signal; image coding & compression, video & audio codes, low bit rate video telephony; audio-visual integration, lip reading, face animation; augmented reality; multimedia search services, content based image & video indexing; access to multimedia, human-machine interfaces, spoken language interface; algorithm vs. architecture based approaches, multimedia processors, performance quantification; case studies, vision 2010.

SEMB ZC482 Satellite Communication 3

Review of microwave communications and LOS system; the various satellite orbits like GEO, MEO, LEO; the satellite link analysis and design; the communication transponder system like INSAT, INELSAT etc; the earth segment and earth station engineering; the transmission of analog and digital signals through satellite and various modulation techniques employed; the multiple access techniques like FDMA, TDMA, CDMA, DAMA, etc; the INSAT program; salient features of INSAT – systems and services offered; satellite services offered by INTELSAT, INMARSAT and future satellites like IRIDIUM etc; future trends in satellite communications.

SEMB ZG511 Design & Analysis of Algorithms 5

Design techniques such as divide-and-conquer, recursion, backtracking, branch-and-bound, simulation; Analysis in terms of average level and worst level efficiency; Relationship to appropriate data structures; Illustrations dealing with problems in computer science, graph theory and mathematics; Computational complexity and bounds; NP-hard and NP-complete problems.

SEMB ZG512 Object Oriented Analysis & Design 4

Object orientation concepts, theories and principles; fundamental concepts of the object model: classes, objects, methods and messages, encapsulation and inheritance, interface and implementation, reuse and extension of classes, inheritance and polymorphism; process of object-oriented requirements specification, analysis and design; notations for object-oriented analysis and design; case studies and applications using some object oriented programming languages.

SEMB ZG513 Network Security 4

This course examines issues related to network and information security. Topics include security concepts, security attacks and risks, security architectures, security policy management, security mechanisms, cryptography algorithms, security standards, security system interoperation and case studies of the current major security systems.

SEMB ZG514 Data Warehousing 5

Introduction, evolution of data warehousing; decision support systems; goals, benefit, and challenges of data warehousing; architecture; data warehouse information flows; software and hardware requirements; approaches to data warehouse design; creating and maintaining a data warehouse; Online Analytical Processing (OLAP) and multi-dimensional data, multi-dimensional modeling; view materialization; data marts; data warehouse metadata; data mining.

SEMB ZG516 Embedded System Design 4

Introduction to embedded systems; embedded architectures: Architectures and programming of microcontrollers and DSPs. Embedded applications and technologies; power issues in system design; introduction to software and hardware co-design.

SEMB ZG552 Software Testing Methodologies 4

Concepts and principles of software testing and quality assurance; software testing tools; functional, structural, integration and system testing techniques; software testing process and its management; evaluation of test effectiveness; testing specialized systems and applications; automated software testing; case studies.

SEMB ZG582 Telecom Network Management 5

Network architecture and protocols; LAN, MAN and WANs; internetworking; network planning; network management concepts and standards; administrative, operational and fault management; security issues; remote network management.

SEMB ZG591 Optical Communication 5

Optical communication systems and components; optical sources and transmitters (basic concept, design and applications); modulators (electro-optic, acousto-optic and laser modulation techniques; beam forming; focusing and coupling schemes to optical repeaters; optical amplifiers; optical field reception; coherent and non-coherent lightwave systems; fibre optic communication system design and performance; multichannel lightwave systems; long haul communications; fibre optic networks.

SEMB ZG622 Software Project Management 4

Managing a software development project, concepts, objects of a project, environment of a software project, system development life cycle, tools, review process; documentation in software program management, procedures, diagramming techniques, management; Planning and monitoring a software project, project planning, management tools, software project definitions, project management packages, project control;

software project definition, classification, project sizes and methodologies, feasibility, requirements and start-up; programmer productivity; software planning, control tools, accelerated design; prototyping and role in software project management; software production and software project management; software system installation, managing testing requirements, test plans, alpha and beta systems; emerging directions in project management.

SEMB ZG629T Dissertation 20

A student registered in this course must take a topic in an area of professional interest drawn from the on the job work requirement which is simultaneously of direct relevance to the degree pursued by the student as well as to the employing / collaborating organization of the student and submit a comprehensive report at the end of the semester working under the overall supervision and guidance of a professional expert who will be deemed as the supervisor for evaluation of all components of the dissertation. Normally the Mentor of the student would be the Dissertation supervisor and in case Mentor is not approved as the supervisor, Mentor may play the role of additional supervisor. The final grades for dissertation are Non-letter grades namely Excellent, Good, Fair and Poor, which do not go into CGPA computation.

SEMB ZG651 Software Architectures 5

Systems engineering and software architectures; Hatley-Pirbhai architectural template; architecture flow diagrams; requirements engineering and software architecture; architectural design processes; design post-processing; real-time architectures; architectural design patterns; software architecture and maintenance management; object oriented architectures; client-server architectures; forward engineering for object oriented and client-server architectures; emerging software architectures.

SEMB ZG659 Technical Communication 4

Role and importance of communication; effectiveness in oral and written communication; technical reports; technical proposals; technical descriptions; definitions and classifications; business correspondence; precis writing; memorandum; notices, agenda and minutes; oral communication related to meetings, seminars, conferences, group discussions, etc.; use of modern communication aids.

SEMB ZG661 Software Quality Management 4

Software quality challenges and expectations; quality dilemma; software life cycle and link to quality; quality gates, formal reviews, system requirement reviews, preliminary design reviews, critical design reviews, test reviews; engineering reviews, walkthroughs, inspections, internal reviews; quality gate categories; technical environment and quality; planning for software quality, quality requirements for planning, quality needs, elements of quality planning, quality assessments during planning, software quality organization requirements; quality evaluation of software development process, process quality attributes, measuring software process quality; software process metrics; quality gate integrity; software product quality, standards and conventions, metrics; quality hierarchy, factors; quality assessment; quality evaluation techniques, reviews, walkthroughs, audit, inspections, analytical evaluation techniques; quality systems.

SEPC ZC421 Computer Networks 3

Introduction, history and development of computer networks; Reference models; Physical Layer: theoretical basis, transmission media, types of transmission; MAC sub-layer: local area networks, FDDI; Data Link Layer: Sliding Window protocols, design aspects; Network Layer: routing algorithms, congestion control algorithms, internetworking; Transport Layer: Integrated Services Digital Network (ISDN), Asynchronous Transfer Mode (ATM) - reference models, service classes, switch design, LAN emulation; Application Layer protocols.

SEPC ZC451 Internetworking Technologies 3

Introduction to internetworking concepts; the internet architecture; goals and key issued related to internet working technologies; design aspects; HTTP and other relevant protocols; agent technology and tools relevant to the internet; techniques of data compression; voice, video, and interactive video-on-demand over the internet; multimedia operating systems and their impact; multimedia networking; mobile computing; internet security, case studies.

SEPC ZC462 Network Programming 3

Overview of computer networks; inter-process communication; network programming; socket interface; client-server computing model: design issues, concurrency in server and clients; external

data representation; remote procedure calls; network file systems; distributed systems design.

SEPC ZG511 Design & Analysis of Algorithms 5

Design techniques such as divide-and-conquer, recursion, backtracking, branch-and-bound, simulation; Analysis in terms of average level and worst level efficiency; Relationship to appropriate data structures; Illustrations dealing with problems in computer science, graph theory and mathematics; Computational complexity and bounds; NP-hard and NP-complete problems.

SEPC ZG512 Object Oriented Analysis & Design 4

Object orientation concepts, theories and principles; fundamental concepts of the object model: classes, objects, methods and messages, encapsulation and inheritance, interface and implementation, reuse and extension of classes, inheritance and polymorphism; process of object-oriented requirements specification, analysis and design; notations for object-oriented analysis and design; case studies and applications using some object oriented programming languages.

SEPC ZG513 Network Security 4

This course examines issues related to network and information security. Topics include security concepts, security attacks and risks, security architectures, security policy management, security mechanisms, cryptography algorithms, security standards, security system interoperation and case studies of the current major security systems.

SEPC ZG514 Data Warehousing 5

Introduction, evolution of data warehousing; decision support systems; goals, benefit, and challenges of data warehousing; architecture; data warehouse information flows; software and hardware requirements; approaches to data warehouse design; creating and maintaining a data warehouse; Online Analytical Processing (OLAP) and multi-dimensional data, multi-dimensional modeling; view materialization; data marts; data warehouse metadata; data mining.

SEPC ZG517 Data Structures & Algorithm Analysis 5

Abstract data types; Linear data structures; Hash functions, Binary and other trees, traversal algorithms; Heaps and balanced trees; Sorting and searching techniques; Divide and conquer, recursion, backtracking, branch and bound; Computational complexity and bounds.

SEPC ZG518 Database Design & Applications 5

DBMS architecture; Data models: Network model, Hierarchical model and Relational model; Database design & optimization; Query processing & Query optimization; Transaction Processing; Concurrency control; Recovery; Security & protection; Introduction to Object Oriented data model & Multimedia Databases.

SEPC ZG519 Data Structures & Algorithms Design 5

Introduction to Abstract Data Types, Data structures and Algorithms; Analysis of Algorithms – Time and Space Complexity, Complexity Notation, Solving Recurrence Relations.; Divide-and-Conquer as a Design Technique; Recursion – Design of Recursive Functions / Procedures, Tail Recursion, Conversion of Recursive Functions to Iterative Form. Linear data structures – Lists, Access Restricted Lists (Stacks and Queues) – Implementation using Arrays and Linked Lists; Searching and Order Queries. Sorting – Sorting Algorithms (Online vs. Offline, In-memory vs. External, In-space vs. Out-of-space, QuickSort and Randomization). Unordered Collections: Hashtables (Separate Chaining vs. Open Addressing, Probing, Rehashing). Binary Trees – Tree Traversals. Partially Ordered Collections: Search Trees and Height Balanced Search Trees, Heaps and Priority Queues. Algorithm Design: Greedy Algorithms and Dynamic Programming. Graphs and Graph Algorithms: Representation schemes, Problems on Directed Graphs (Reachability and Strong Connectivity, Traversals, Transitive Closure. Directed Acyclic Graphs - Topological Sorting), Problems on Weighted Graphs (Shortest Paths. Spanning Trees). Introduction to Complexity Classes (P and NP) and NP-completeness. NP-Hard problems. Designing Algorithms for Hard Problems – Back tracking, Branch-and-Bound, and Approximation Algorithms.

SEPC ZG527 Cloud Computing 5

Concurrency and distributed computing, message passing over the network, connectivity and failure models, local vs remote connectivity, distributed resource modeling, distributed data models; replication & consistency; virtualization; CPU virtualization, memory and storage virtualization, virtualized networks, computing

over WAN and Internet; computing on the cloud, computing models, service models and service contracts, programming on the cloud; Cloud infrastructure, LAN vs Wan issue, resource scaling and resource provisions, performance models, scalability, performance measurement and enhancement techniques; cloud applications and infrastructure services.

SEPC ZG552 Software Testing Methodologies 4

Concepts and principles of software testing and quality assurance; software testing tools; functional, structural, integration and system testing techniques; software testing process and its management; evaluation of test effectiveness; testing specialized systems and applications; automated software testing; case studies.

SEPC ZG562 Software Engineering & Management 5

Current concepts, methods, techniques, and tools of the software engineering process; software process models; process definition and assessment; software measurement and metrics; project planning, estimation and control; requirements analysis and specification, design methods; quality assurance and testing; configuration management; process improvement; case studies and project work.

SEPC ZG622 Software Project Management 4

Managing a software development project, concepts, objects of a project, environment of a software project, system development life cycle, tools, review process; documentation in software program management, procedures, diagramming techniques, management; Planning and monitoring a software project, project planning, management tools, software project definitions, project management packages, project control; software project definition, classification, project sizes and methodologies, feasibility, requirements and start-up; programmer productivity; software planning, control tools, accelerated design; prototyping and role in software project management; software production and software project management; software system installation, managing testing requirements, test plans, alpha and beta systems; emerging directions in project management.

SEPC ZG623 Advanced Operating Systems 5

Overview of advanced operating systems: motivation for their design, and various types of advanced operating systems; Distributed operating systems: architecture of distributed systems, theoretical foundation of distributed systems, deadlock detection/resolution, agreement protocols, file systems, distributed shared memory, scheduling, fault tolerance and recovery; Multiprocessor operating systems: multiprocessor system architectures, multiprocessor operating system design issues, threads, process synchronization, process scheduling and memory management; Data base operating systems: introduction, concurrency control: theoretical and algorithmic aspects; Case Study: Amoeba and Mach.

SEPC ZG629T Dissertation 20

A student registered in this course must take a topic in an area of professional interest drawn from the on the job work requirement which is simultaneously of direct relevance to the degree pursued by the student as well as to the employing / collaborating organization of the student and submit a comprehensive report at the end of the semester working under the overall supervision and guidance of a professional expert who will be deemed as the supervisor for evaluation of all components of the dissertation. Normally the Mentor of the student would be the Dissertation supervisor and in case Mentor is not approved as the supervisor, Mentor may play the role of additional supervisor. The final grades for dissertation are Non-letter grades namely Excellent, Good, Fair and Poor, which do not go into CGPA computation.

SEPC ZG651 Software Architectures 5

Systems engineering and software architectures; Hatley-Pirbhai architectural template; architecture flow diagrams; requirements engineering and software architecture; architectural design processes; design post-processing; real-time architectures; architectural design patterns; software architecture and maintenance management; object oriented architectures; client-server architectures; forward engineering for object oriented and client-server architectures; emerging software architectures.

SEPC ZG659 Technical Communication 4

Role and importance of communication; effectiveness in oral and written communication; technical reports; technical proposals; technical descriptions; definitions and classifications; business correspondence; precis writing;

memorandum; notices, agenda and minutes; oral communication related to meetings, seminars, conferences, group discussions, etc.; use of modern communication aids.

SEPC ZG661 Software Quality Management 4

Software quality challenges and expectations; quality dilemma; software life cycle and link to quality; quality gates, formal reviews, system requirement reviews, preliminary design reviews, critical design reviews, test reviews; engineering reviews, walkthroughs, inspections, internal reviews; quality gate categories; technical environment and quality; planning for software quality, quality requirements for planning, quality needs, elements of quality planning, quality assessments during planning, software quality organization requirements; quality evaluation of software development process, process quality attributes, measuring software process quality; software process metrics; quality gate integrity; software product quality, standards and conventions, metrics; quality hierarchy, factors; quality assessment; quality evaluation techniques, reviews, walkthroughs, audit, inspections, analytical evaluation techniques; quality systems.

SEPS ZC451 Internetworking Technologies 3

Introduction to internetworking concepts; the internet architecture; goals and key issued related to internet working technologies; design aspects; HTTP and other relevant protocols; agent technology and tools relevant to the internet; techniques of data compression; voice, video, and interactive video-on-demand over the internet; multimedia operating systems and their impact; multimedia networking; mobile computing; internet security, case studies.

SEPS ZC462 Network Programming 3

Overview of computer networks; inter-process communication; network programming; socket interface; client-server computing model: design issues, concurrency in server and clients; external data representation; remote procedure calls; network file systems; distributed systems design.

SEPS ZG512 Object Oriented Analysis and Design 4

Object orientation concepts, theories and principles; fundamental concepts of the object model: classes, objects, methods and messages, encapsulation and inheritance, interface and implementation, reuse and extension of classes, inheritance and polymorphism; process of object-oriented requirements specification, analysis and design; notations for object-oriented analysis and design; case studies and applications using some object oriented programming languages.

SEPS ZG513 Network Security 4

This course examines issues related to network and information security. Topics include security concepts, security attacks and risks, security architectures, security policy management, security mechanisms, cryptography algorithms, security standards, security system interoperation and case studies of the current major security systems.

SEPS ZG514 Data Warehousing 5

Introduction, evolution of data warehousing; decision support systems; goals, benefit, and challenges of data warehousing; architecture; data warehouse information flows; software and hardware requirements; approaches to data warehouse design; creating and maintaining a data warehouse; Online Analytical Processing (OLAP) and multi-dimensional data, multi-dimensional modeling; view materialization; data marts; data warehouse metadata; data mining.

SEPS ZG517 Data Structures and Algorithm Analysis 5

Abstract data types; Linear data structures; Hash functions, Binary and other trees, traversal algorithms; Heaps and balanced trees; Sorting and searching techniques; Divide and conquer, recursion, backtracking, branch and bound; Computational complexity and bounds.

SEPS ZG518 Database Design and Applications 5

DBMS architecture; Data models: Network model, Hierarchical model and Relational model; Database design & optimization; Query processing & Query optimization; Transaction Processing; Concurrency control; Recovery; Security & protection; Introduction to Object Oriented data model & Multimedia Databases.

SEPS ZG531 Pervasive Computing 4

Select application architectures; hardware aspects; human-machine interfacing; device technology: hardware, operating system issues; software aspects, java; device connectivity issues and protocols; security issues; device management issues and mechanisms; role of

web; wap devices and architectures; voice-enabling techniques; PDAs and their operating systems; web application architectures; architectural issues and choices; smart card-based authentication mechanisms; applications; issues and mechanisms in WAP-enabling; access architectures; wearable computing architectures.

SEPS ZG552 Software Testing Methodologies 4

Concepts and principles of software testing and quality assurance; software testing tools; functional, structural, integration and system testing techniques; software testing process and its management; evaluation of test effectiveness; testing specialized systems and applications; automated software testing; case studies.

SEPS ZG562 Software Engineering & Management 5

Current concepts, methods, techniques, and tools of the software engineering process; software process models; process definition and assessment; software measurement and metrics; project planning, estimation and control; requirements analysis and specification, design methods; quality assurance and testing; configuration management; process improvement; case studies and project work.

SEPS ZG623 Advanced Operating Systems 5

Overview of advanced operating systems: motivation for their design, and various types of advanced operating systems; Distributed operating systems: architecture of distributed systems, theoretical foundation of distributed systems, deadlock detection/resolution, agreement protocols, file systems, distributed shared memory, scheduling, fault tolerance and recovery; Multiprocessor operating systems: multiprocessor system architectures, multiprocessor operating system design issues, threads, process synchronization, process scheduling and memory management; Data base operating systems: introduction, concurrency control: theoretical and algorithmic aspects; Case Study: Amoeba and Mach.

SEPS ZG629T Dissertation 20

A student registered in this course must take a topic in an area of professional interest drawn from the on the job work requirement which is simultaneously of direct relevance to the degree pursued by the student as well as to the employing / collaborating organization of the student and submit a comprehensive report at the end of the semester working under the overall supervision and guidance of a professional expert who will be deemed as the supervisor for evaluation of all components of the dissertation. Normally the Mentor of the student would be the Dissertation supervisor and in case Mentor is not approved as the supervisor, Mentor may play the role of additional supervisor. The final grades for dissertation are Non-letter grades namely Excellent, Good, Fair and Poor, which do not go into CGPA computation.

SEPS ZG651 Software Architectures 5

Systems engineering and software architectures; Hatley-Pirbhai architectural template; architecture flow diagrams; requirements engineering and software architecture; architectural design processes; design post-processing; real-time architectures; architectural design patterns; software architecture and maintenance management; object oriented architectures; client-server architectures; forward engineering for object oriented and client-server architectures; emerging software architectures.

SEQC ZC473 Multimedia Computing 3

Introduction to multimedia; media & data streams; image, video & audio file formats; image & video processing, synthesis of sound signal; image coding & compression, video & audio codes, low bit rate video telephony; audio-visual integration, lip reading, face animation; augmented reality; multimedia search services, content based image & video indexing; access to multimedia, human-machine interfaces, spoken language interface; algorithm vs. architecture based approaches, multimedia processors, performance quantification; case studies, vision 2010.

SEQC ZG511 Design & Analysis of Algorithms 5

Design techniques such as divide-and-conquer, recursion, backtracking, branch-and-bound, simulation; Analysis in terms of average level and worst level efficiency; Relationship to appropriate data structures; Illustrations dealing with problems in computer science, graph theory and mathematics; Computational complexity and bounds; NP-hard and NP-complete problems.

SEQC ZG512 Object Oriented Analysis & Design 4

Object orientation concepts, theories and principles; fundamental concepts of the object

model: classes, objects, methods and messages, encapsulation and inheritance, interface and implementation, reuse and extension of classes, inheritance and polymorphism; process of object-oriented requirements specification, analysis and design; notations for object-oriented analysis and design; case studies and applications using some object oriented programming languages.

SEQC ZG516 Embedded System Design 4

Introduction to embedded systems; embedded architectures: Architectures and programming of microcontrollers and DSPs. Embedded applications and technologies; power issues in system design; introduction to software and hardware co-design.

SEQC ZG520 Wireless and Mobile Communication 5

Signal propagation in a mobile environment, modulation, coding, equalization; first generation generation systems; multiple access techniques like FDMA, TDMA, CDMA, spread spectrum sytems; second & third generation systems, UMTS, IMT-2000; Wireless LAN, Wireless ATM and Mobile IP; emerging trends in Wireless & Mobile Communication.

SEQC ZG531 Pervasive Computing 4

Select application architectures; hardware aspects; human-machine interfacing; device technology: hardware, operating system issues; software aspects, java; device connectivity issues and protocols; security issues; device management issues and mechanisms; role of web; wap devices and architectures; voice-enabling techniques; PDAs and their operating systems; web application architectures; architectural issues and choices; smart card-based authentication mechanisms; applications; issues and mechanisms in WAP-enabling; access architectures; wearable computing architectures.

SEQC ZG552 Software Testing Methodologies 4

Concepts and principles of software testing and quality assurance; software testing tools; functional, structural, integration and system testing techniques; software testing process and its management; evaluation of test effectiveness; testing specialized systems and applications; automated software testing; case studies.

SEQC ZG562 Software Engineering & Management 5

Current concepts, methods, techniques, and tools of the software engineering process; software process models; process definition and assessment; software measurement and metrics; project planning, estimation and control; requirements analysis and specification, design methods; quality assurance and testing; configuration management; process improvement; case studies and project work.

SEQC ZG573 Digital Signal Processing 3

Introduction; design of analog filters; design of digital filters: (IIR and FIR); structures for the realization of digital filters; random signals and random processes; linear estimation and prediction; Wiener filters; DSP processor architecture; DSP algorithms for different applications.

SEQC ZG622 Software Project Management 4

Managing a software development project, concepts, objects of a project, environment of a software project, system development life cycle, tools, review process; documentation in software program management, procedures, diagramming techniques, management; Planning and monitoring a software project, project planning, management tools, software project definitions, project management packages, project control; software project definition, classification, project sizes and methodologies, feasibility, requirements and start-up; programmer productivity; software planning, control tools, accelerated design; prototyping and role in software project management; software production and software project management; software system installation, managing testing requirements, test plans, alpha and beta systems; emerging directions in project management.

SEQC ZG629T Dissertation 20

A student registered in this course must take a topic in an area of professional interest drawn from the on the job work requirement which is simultaneously of direct relevance to the degree pursued by the student as well as to the employing / collaborating organization of the student and submit a comprehensive report at the end of the semester working under the overall supervision and guidance of a professional expert who will be deemed as the supervisor for

evaluation of all components of the dissertation. Normally the Mentor of the student would be the Dissertation supervisor and in case Mentor is not approved as the supervisor, Mentor may play the role of additional supervisor. The final grades for dissertation are Non-letter grades namely Excellent, Good, Fair and Poor, which do not go into CGPA computation.

SEQC ZG651 Hardware Software Co-Design 4

FPGA and ASIC based design, Low-Power Techniques in RT Embedded Systems On-chip networking. Hardware Software partitioning and scheduling, Co-simulation, synthesis and verifications, Architecture mapping, HW-SW Interfaces and Re-configurable computing.

SEQC ZG653 Software Architectures 5

Systems engineering and software architectures; Hatley-Pirbhai architectural template; architecture flow diagrams; requirements engineering and software architecture; architectural design processes; design post-processing; real-time architectures; architectural design patterns; software architecture and maintenance management; object oriented architectures; client-server architectures; forward engineering for object oriented and client-server architectures; emerging software architectures.

SESAP ZC211 Mathematics I 3

Real-valued functions of one real variable; limits and indeterminate forms; differentiability of functions; indefinite and definite integrals; applications of derivatives and integrals. concept of a matrix; operations on matrices; various types of matrices; inverse and adjoint of a matrix; row-reduction method; solution of simultaneous linear equations by matrix methods.

SESAP ZC212 Mathematics II 3

Linear inequalities and associated regions; concept of linear programming problems; graphical solution method; simplex method for maximization problems; concept of basic fleasible solutions; concept of stack variables and their uses in simplex method. basic ideas of statistics; frequency distributions; measures of central tendency, dispersion; moments; skewness and kurtosis; co-efficient of skewness, correlation, regression. Finite differences, Newton's interpolation formulae - forward and backward methods; Lagrange's interpolation formulae; numerical differentiation and integration. Numerical methods for solving equations, iteration method; regula-falsi method; Newton-Raphson method.

SESAP ZC213 Probability & Statistics 3

Probability spaces; conditional probability and independence; random variables and probability distributions; marginal and conditional distributions; independent random variables; mathematical expectation; mean and variance; binomial, Poisson and normal distributions; sum of independent random variables; law of large numbers; central limit theorem (without proof); sampling distribution and test for mean using normal and student's t-distribution; test of hypothesis; correlation and linear regression.

SESAP ZC221 Structured Programming 3

Algorithms and problem solving; paradigms of programming; imperative programming; structured programming methodologies; stepwise refinement procedures; structured programming through one of the structured programming languages like Pascal, C or Ada (the actual choice will be made each semester before the course is offered); elementary data types and uses; control structures; conditional structures; iterative structures; input and output handling; structured data types and uses; functions, library and user defined; scoping rules; parameter passing mechanisms; files and file handling; recursion; some advanced topics for programming.

SESAP ZC222 Advanced Programming Techniques 3

Dynamic memory management; low level processing; debugging techniques; symbolic debugging tools; visual programming environments; user interfaces; event driven programming; visual design methodologies; prototyping with visual programming aids; creating multi-threaded applications; other emergent advanced programming topics.

SESAP ZC241 Principles of Management 3

Fundamental concepts of management - planning; organizing; staffing; directing and controlling; production, financial, personnel, legal and marketing functions; accounting and budgeting, balance sheets.

SESAP ZC252 Discrete Structures for Computer Science 3

Sets and relations; graphs and digraphs; trees, lists and their uses; partially ordered sets and lattices; Boolean algebras and Boolean expressions; semigroups and machines; codes and applications.

SESAP ZC261 Digital Electronics & Microprocessors 3

Binary logic gates; logic circuits; Boolean algebra and K-map simplification; number systems and codes; arithmetic logic units; flipflops; registers and counters; introduction to microprocessors; architecture; instruction set and programming; memory and I/O interfacing examples of system design.

SESAP ZC322 Database Management Systems 3

Introduction to Database Management Systems; File organization; Data Independence in databases; Data Models; Query processing systems; Database Design techniques; Concepts of security and integrity in databases; Distributed Databases; Applications using DBMS.

SESAP ZC362 Programming Languages & Compiler Construction 3

Formal definition, syntax and semantics; simple statements including precedence, infix, prefix and postfix notation; structure of algorithmic languages; list processing and string manipulation languages, One-pass compilation techniques; organization of a compiler including compile-time and run-time symbol tables; lexical scan, syntax scan; object code generation; error diagnostics; code optimization techniques.

SESAP ZC413 Computer Organization & Architecture 3

Overview of logic design; Instruction set architecture; Assembly language programming; Pipelining; Computer Arithmetic; Control unit; Memory hierarchy; virtual memory; Input and output systems; Interrupts and exception handling; Implementation issues; Case studies

SESAP ZC415 Data Structures & Algorithms 3

Introduction to software design principles, modularity, abstract data types, data structures and algorithms; analysis of algorithms; Linear data structures – stacks, arrays, lists queues and linked representations; Pre-fix, in-fix and post-fix expressions; Recursion; Set operations; Hashing and hash functions; Binary and other trees, traversal algorithms, Huffman codes; Search trees, priority queues, heaps and balanced trees; Sorting techniques; Graphs and digraphs; Algorithmic design techniques; Data structures for external storage, multi-way search and B-trees.

SESAP ZC421 Computer Networks 3

Introduction, history and development of computer networks; Reference models; Physical Layer: theoretical basis, transmission media, types of transmission; MAC sub-layer: local area networks, FDDI; Data Link Layer: Sliding Window protocols, design aspects; Network Layer: routing algorithms, congestion control algorithms, internetworking; Transport Layer: Integrated Services Digital Network (ISDN), Asynchronous Transfer Mode (ATM) - reference models, service classes, switch design, LAN emulation; Application Layer protocols.

SESAP ZC422 Operating Systems 3

Introduction to operating systems; Various approaches to design of operating systems; Overview of hardware support for operating systems; Process management: process synchronization and mutual exclusion, interprocess communication, process scheduling; CPU scheduling approaches; Memory management: paging, segmentation, virtual memory, page replacement algorithms; File systems: design and implementation of file systems; input/output systems; device controllers and device drivers; Security and protection; Case studies on design and implementation of operating system modules.

SESAP ZC432 Object Oriented Programming 3

Object orientation concepts and principles: abstraction, encapsulation, modularity, inheritance, and polymorphism; classes and objects; static and dynamic binding; class utilities; metaclasses; object oriented software engineering; programming and problem solving using one or more of the popular object-oriented programming languages like C++ or Java.

SESAP ZC451 Internetworking Technologies 3

Introduction to internetworking concepts; the internet architecture; goals and key issued related to internet working technologies; design aspects; HTTP and other relevant protocols; agent technology and tools relevant to the internet; techniques of data compression; voice, video, and

interactive video-on-demand over the internet; multimedia operating systems and their impact; multimedia networking; mobile computing; internet security, case studies.

SESAP ZC461 Software Engineering 3

Software engineering concepts and methodology; formal requirements specification; estimation; software project planning; detailed design; techniques of design; productivity; documentation; programming languages styles, code review; tool, integration and validation; software quality assurance; software maintenance; metrics, automated tools in software engineering.

SESAP ZC462 Network Programming 3

Overview of computer networks; inter-process communication; network programming; socket interface; client-server computing model: design issues, concurrency in server and clients; external data representation; remote procedure calls; network file systems; distributed systems design.

SESAP ZC473 Multimedia Computing 3

Introduction to multimedia; media & data streams; image, video & audio file formats; image & video processing, synthesis of sound signal; image coding & compression, video & audio codes, low bit rate video telephony; audio-visual integration, lip reading, face animation; augmented reality; multimedia search services, content based image & video indexing; access to multimedia, human-machine interfaces, spoken language interface; algorithm vs. architecture based approaches, multimedia processors, performance quantification; case studies, vision 2010.

SESAP ZG511 Design & Analysis of Algorithms 5

Design techniques such as divide-and-conquer, recursion, backtracking, branch-and-bound, simulation; Analysis in terms of average level and worst level efficiency; Relationship to appropriate data structures; Illustrations dealing with problems in computer science, graph theory and mathematics; Computational complexity and bounds; NP-hard and NP-complete problems.

SESAP ZG512 Object Oriented Analysis & Design 4

Object orientation concepts, theories and principles; fundamental concepts of the object model: classes, objects, methods and messages, encapsulation and inheritance, interface and implementation, reuse and extension of classes, inheritance and polymorphism; process of object-oriented requirements specification, analysis and design; notations for object-oriented analysis and design; case studies and applications using some object oriented programming languages.

SESAP ZG513 Network Security 4

This course examines issues related to network and information security. Topics include security concepts, security attacks and risks, security architectures, security policy management, security mechanisms, cryptography algorithms, security standards, security system interoperation and case studies of the current major security systems.

SESAP ZG514 Data Warehousing 5

Introduction, evolution of data warehousing; decision support systems; goals, benefit, and challenges of data warehousing; architecture; data warehouse information flows; software and hardware requirements; approaches to data warehouse design; creating and maintaining a data warehouse; Online Analytical Processing (OLAP) and multi-dimensional data, multi-dimensional modeling; view materialization; data marts; data warehouse metadata; data mining.

SESAP ZG552 Software Testing Methodologies 4

Concepts and principles of software testing and quality assurance; software testing tools; functional, structural, integration and system testing techniques; software testing process and its management; evaluation of test effectiveness; testing specialized systems and applications; automated software testing; case studies.

SESAP ZG622 Software Project Management 4

Managing a software development project, concepts, objects of a project, environment of a software project, system development life cycle, tools, review process; documentation in software program management, procedures, diagramming techniques, management; Planning and monitoring a software project, project planning, management tools, software project definitions, project management packages, project control; software project definition, classification, project sizes and methodologies, feasibility, requirements and start-up; programmer productivity; software planning, control tools, accelerated design; prototyping and role in software project

management; software production and software project management; software system installation, managing testing requirements, test plans, alpha and beta systems; emerging directions in project management.

SESAP ZG629T Dissertation 20

A student registered in this course must take a topic in an area of professional interest drawn from the on the job work requirement which is simultaneously of direct relevance to the degree pursued by the student as well as to the employing / collaborating organization of the student and submit a comprehensive report at the end of the semester working under the overall supervision and guidance of a professional expert who will be deemed as the supervisor for evaluation of all components of the dissertation. Normally the Mentor of the student would be the Dissertation supervisor and in case Mentor is not approved as the supervisor, Mentor may play the role of additional supervisor. The final grades for dissertation are Non-letter grades namely Excellent, Good, Fair and Poor, which do not go into CGPA computation.

SESAP ZG651 Software Architectures 5

Systems engineering and software architectures; Hatley-Pirbhai architectural template; architecture flow diagrams; requirements engineering and software architecture; architectural design processes; design post-processing; real-time architectures; architectural design patterns; software architecture and maintenance management; object oriented architectures; client-server architectures; forward engineering for object oriented and client-server architectures; emerging software architectures.

SESAP ZG659 Technical Communication 4

Role and importance of communication; effectiveness in oral and written communication; technical reports; technical proposals; technical descriptions; definitions and classifications; business correspondence; precis writing; memorandum; notices, agenda and minutes; oral communication related to meetings, seminars, conferences, group discussions, etc.; use of modern communication aids.

SESAP ZG661 Software Quality Management 4

Software quality challenges and expectations; quality dilemma; software life cycle and link to quality; quality gates, formal reviews, system requirement reviews, preliminary design reviews, critical design reviews, test reviews; engineering reviews, walkthroughs, inspections, internal reviews; quality gate categories; technical environment and quality; planning for software quality, quality requirements for planning, quality needs, elements of quality planning, quality assessments during planning, software quality organization requirements; quality evaluation of software development process, process quality attributes, measuring software process quality; software process metrics; quality gate integrity; software product quality, standards and conventions, metrics; quality hierarchy, factors; quality assessment; quality evaluation techniques, reviews, walkthroughs, audit, inspections, analytical evaluation techniques; quality systems.

SESL ZC421 Computer Networks 3

SEMH ZC421 Computer Networks 3

Introduction, history and development of computer networks; Reference models; Physical Layer: theoretical basis, transmission media, types of transmission; MAC sub-layer: local area networks, FDDI; Data Link Layer: Sliding Window protocols, design aspects; Network Layer: routing algorithms, congestion control algorithms, internetworking; Transport Layer: Integrated Services Digital Network (ISDN), Asynchronous Transfer Mode (ATM) - reference models, service classes, switch design, LAN emulation; Application Layer protocols.

SESL ZC462 Network Programming 3

SEMH ZC462 Network Programming 3

Overview of computer networks; inter-process communication; network programming; socket interface; client-server computing model: design issues, concurrency in server and clients; external data representation; remote procedure calls; network file systems; distributed systems design.

SESL ZC473 Multimedia Computing 3

SEMH ZC473 Multimedia Computing 3

Introduction to multimedia; media & data streams; image, video & audio file formats; image & video processing, synthesis of sound signal; image coding & compression, video & audio codes, low bit rate video telephony; audio-visual integration, lip reading, face animation; augmented reality; multimedia search services, content based image & video indexing; access to multimedia, human-machine interfaces, spoken language interface;

algorithm vs. architecture based approaches, multimedia processors, performance quantification; case studies, vision 2010.

SESL ZG512 Object Oriented Analysis & Design 4

SEMH ZG512 Object Oriented Analysis & Design 4

Object orientation concepts, theories and principles; fundamental concepts of the object model: classes, objects, methods and messages, encapsulation and inheritance, interface and implementation, reuse and extension of classes, inheritance and polymorphism; process of object-oriented requirements specification, analysis and design; notations for object-oriented analysis and design; case studies and applications using some object oriented programming languages.

SESL ZG514 Data Warehousing 5

SEMH ZG514 Data Warehousing 5

Introduction, evolution of data warehousing; decision support systems; goals, benefit, and challenges of data warehousing; architecture; data warehouse information flows; software and hardware requirements; approaches to data warehouse design; creating and maintaining a data warehouse; Online Analytical Processing (OLAP) and multi-dimensional data, multi-dimensional modeling; view materialization; data marts; data warehouse metadata; data mining.

SESL ZG513 Network Security 4

SESL ZG513 Network Security 4

This course examines issues related to network and information security. Topics include security concepts, security attacks and risks, security architectures, security policy management, security mechanisms, cryptography algorithms, security standards, security system interoperation and case studies of the current major security systems.

SESL ZG622 Software Project Management 4

SEMH ZG622 Software Project Management 4

Managing a software development project, concepts, objects of a project, environment of a software project, system development life cycle, tools, review process; documentation in software program management, procedures, diagramming techniques, management; Planning and monitoring a software project, project planning, management tools, software project definitions, project management packages, project control; software project definition, classification, project sizes and methodologies, feasibility, requirements and start-up; programmer productivity; software planning, control tools, accelerated design; prototyping and role in software project management; software production and software project management; software system installation, managing testing requirements, test plans, alpha and beta systems; emerging directions in project management.

SESL ZG629T Dissertation 20

A student registered in this course must take a topic in an area of professional interest drawn from the on the job work requirement which is simultaneously of direct relevance to the degree pursued by the student as well as to the employing / collaborating organization of the student and submit a comprehensive report at the end of the semester working under the overall supervision and guidance of a professional expert who will be deemed as the supervisor for evaluation of all components of the dissertation. Normally the Mentor of the student would be the Dissertation supervisor and in case Mentor is not approved as the supervisor, Mentor may play the role of additional supervisor. The final grades for dissertation are Non-letter grades namely Excellent, Good, Fair and Poor, which do not go into CGPA computation.

SESL ZG651 Software Architectures 5

SEMH ZG651 Software Architectures 5

Systems engineering and software architectures; Hatley-Pirbhai architectural template; architecture flow diagrams; requirements engineering and software architecture; architectural design processes; design post-processing; real-time architectures; architectural design patterns; software architecture and maintenance management; object oriented architectures; client-server architectures; forward engineering for object oriented and client-server architectures; emerging software architectures.

SEWI ZC132 Linear Algebra & Optimization 3

SEWP ZC132 Linear Algebra & Optimization 3

SESAP ZC132 Linear Algebra & Optimization 3

Vector and matrix algebra, systems of linear algebraic equations and their solutions; eigenvalues, eigenvectors and diagonalization of

matrices; Formulation of linear programming problems, Simplex method, Big-M method, Two phase method, Sensitivity analysis, Revised and Dual Simplex Methods.

SEWI ZC142 Computer Programming 3

SEWP ZC142 Computer Programming 3

SESAP ZC142 Computer Programming 3

Elementary computer organization; introduction to Number Systems; Representation of integers, real numbers and characters on computers; concept of range and accuracy; Arithmetic Overflow; Algorithms and algorithm development; structured program development through step wise refinement. Introduction to C language; Functions; Recursion; Data structure & algorithms; File management & file handling; Problem solving using C.

SESL ZC211 Mathematics I 3

SEMH ZC211 Mathematics I 3

SEWI ZC211 Mathematics I 3

SEWP ZC211 Mathematics I 3

Real-valued functions of one real variable; limits and indeterminate forms; differentiability of functions; indefinite and definite integrals; applications of derivatives and integrals. concept of a matrix; operations on matrices; various types of matrices; inverse and adjoint of a matrix; row-reduction method; solution of simultaneous linear equations by matrix methods.

SESL ZC212 Mathematics II 3

SEMH ZC212 Mathematics II 3

SEWI ZC212 Mathematics II 3

SEWP ZC212 Mathematics II 3

Linear inequalities and associated regions; concept of linear programming problems; graphical solution method; simplex method for maximization problems; concept of basic fleasible solutions; concept of stack variables and their uses in simplex method. basic ideas of statistics; frequency distributions; measures of central tendency, dispersion; moments; skewness and kurtosis; co-efficient of skewness, correlation, regression. Finite differences, Newton's interpolation formulae - forward and backward methods; Lagrange's interpolation formulae; numerical differentiation and integration. Numerical methods for solving equations, iteration method; regula-falsi method; Newton-Raphson method.

SESL ZC213 Probability & Statistics 3

SEMH ZC213 Probability & Statistics 3

SEWI ZC213 Probability & Statistics 3

SEWP ZC213 Probability & Statistics 3

Probability spaces; conditional probability and independence; random variables and probability distributions; marginal and conditional distributions; independent random variables; mathematical expectation; mean and variance; binomial, Poisson and normal distributions; sum of independent random variables; law of large numbers; central limit theorem (without proof); sampling distribution and test for mean using normal and student's t-distribution; test of hypothesis; correlation and linear regression.

SESL ZC221 Structured Programming 3

SEMH ZC221 Structured Programming 3

SEWI ZC221 Structured Programming 3

SEWP ZC221 Structured Programming 3

Algorithms and problem solving; paradigms of programming; imperative programming; structured programming methodologies; stepwise refinement procedures; structured programming through one of the structured programming languages like Pascal, C or Ada (the actual choice will be made each semester before the course is offered); elementary data types and uses; control structures; conditional structures; iterative structures; input and output handling; structured data types and uses; functions, library and user defined; scoping rules; parameter passing mechanisms; files and file handling; recursion; some advanced topics for programming.

SESL ZC222 Advanced Programming Techniques 3

SEMH ZC222 Advanced Programming Techniques 3

SEWI ZC222 Advanced Programming Techniques 3

SEWP ZC222 Advanced Programming Techniques 3

Dynamic memory management; low level processing; debugging techniques; symbolic debugging tools; visual programming environments; user interfaces; event driven

programming; visual design methodologies; prototyping with visual programming aids; creating multi-threaded applications; other emergent advanced programming topics.

SESL ZC241 Principles of Management 3

SEMH ZC241 Principles of Management 3

SEWI ZC241 Principles of Management 3

SEWP ZC241 Principles of Management 3

Fundamental concepts of management - planning; organizing; staffing; directing and controlling; production, financial, personnel, legal and marketing functions; accounting and budgeting, balance sheets.

SESL ZC252 Discrete Structures for Computer Science 3

SEMH ZC252 Discrete Structures for Computer Science 3

SEWI ZC252 Discrete Structures for Computer Science 3

SEWP ZC252 Discrete Structures for Computer Science 3

Sets and relations; graphs and digraphs; trees, lists and their uses; partially ordered sets and lattices; Boolean algebras and Boolean expressions; semigroups and machines; codes and applications.

SESL ZC261 Digital Electronics & Microprocessors 3

SEMH ZC261 Digital Electronics & Microprocessors 3

SEWI ZC261 Digital Electronics & Microprocessors 3

SEWP ZC261 Digital Electronics & Microprocessors 3

Binary logic gates; logic circuits; Boolean algebra and K-map simplification; number systems and codes; arithmetic logic units; flipflops; registers and counters; introduction to microprocessors; architecture; instruction set and programming; memory and I/O interfacing examples of system design.

SEWP ZC312 Technical Report Writing 3

Elements of effective writing; art of condensation; business letter writing; memos; formal reports; technical proposals; conducting, and participating, meetings; agenda and minutes; strategies for writing technical descriptions, definitions, and classifications; oral presentation; use of graphic and audio- visual aids; editing.

SESL ZC322 Data Base Management Systems 3

SEMH ZC322 Data Base Management Systems 3

SEWI ZC322 Data Base Management Systems 3

SEWP ZC322 Data Base Management Systems 3

Introduction to Database Management Systems; File organization; Data Independence in databases; Data Models; Query processing systems; Database Design techniques; Concepts of security and integrity in databases; Distributed Databases; Applications using DBMS.

SEWI ZC332 Systems Programming 3

SEWP ZC332 Systems Programming 3

SESAP ZC332 Systems Programming 3

Batch processing Systems programs; operating characteristics and limitations; parallel processing of I/O and interrupt handling, multiprogramming; multiprocessing systems; design of system modules and interfaces; other selected topics.

SESL ZC362 Programming Languages & Compiler Construction 3

SEMH ZC362 Programming Languages & Compiler Construction 3

SEWI ZC362 Programming Languages & Compiler Construction 3

SEWP ZC362 Programming Languages & Compiler Construction 3

Formal definition, syntax and semantics; simple statements including precedence, infix, prefix and postfix notation; structure of algorithmic languages; list processing and string manipulation languages, One-pass compilation techniques; organization of a compiler including compile-time and run-time symbol tables; lexical scan, syntax scan; object code generation; error diagnostics; code optimization techniques.

SESL ZC413 Computer Organization & Architecture 3

SEMH ZC413 Computer Organization & Architecture 3

SEWI ZC413 Computer Organization & Architecture 3

SEWP ZC413 Computer Organization & Architecture 3

Overview of logic design; Instruction set architecture; Assembly language programming; Pipelining; Computer Arithmetic; Control unit; Memory hierarchy; virtual memory; Input and output systems; Interrupts and exception handling; Implementation issues; Case studies

SEWI ZC414 Telecom Switching Systems and Networks 3

Introduction, electromechanical switching, pulse dialing and DTMF dialing, stored program control, space division switching, speech digitization and transmission, time division switching, fundamentals of traffic engineering, telephone networks, signaling, data networks, layered architecture and protocols, LANs, packet switching networks, TCP/IP, ISDN, ATM networks.

SESL ZC415 Data Structures & Algorithms 3

SEMH ZC415 Data Structures & Algorithms 3

SEWI ZC415 Data Structures & Algorithms 3

SEWP ZC415 Data Structures & Algorithms 3

Introduction to software design principles, modularity, abstract data types, data structures and algorithms; analysis of algorithms; Linear data structures – stacks, arrays, lists queues and linked representations; Pre-fix, in-fix and post-fix expressions; Recursion; Set operations; Hashing and hash functions; Binary and other trees, traversal algorithms, Huffman codes; Search trees, priority queues, heaps and balanced trees; Sorting techniques; Graphs and digraphs; Algorithmic design techniques; Data structures for external storage, multi-way search and B-trees.

SEWI ZC416 Complier Design 3

SEWP ZC416 Complier Design 3

Introduction to Progg. Languages and Compilers, Programming Language Features, Front End of a Compiler, Back End of a Compiler, Special aspects of compilers and runtime

SESL ZC421 Computer Networks 3

SEMH ZC421 Computer Networks 3

SEWI ZC421 Computer Networks 3

SEWP ZC421 Computer Networks 3

Introduction, history and development of computer networks; Reference models; Physical Layer: theoretical basis, transmission media, types of transmission; MAC sub-layer: local area networks, FDDI; Data Link Layer: Sliding Window protocols, design aspects; Network Layer: routing algorithms, congestion control algorithms, internetworking; Transport Layer: Integrated Services Digital Network (ISDN), Asynchronous Transfer Mode (ATM) - reference models, service classes, switch design, LAN emulation; Application Layer protocols.

SESL ZC422 Operating Systems 3

SEMH ZC422 Operating Systems 3

SEWI ZC422 Operating Systems 3

SEWP ZC422 Operating Systems 3

Introduction to operating systems; Various approaches to design of operating systems; Overview of hardware support for operating systems; Process management: process synchronization and mutual exclusion, interprocess communication, process scheduling; CPU scheduling approaches; Memory management: paging, segmentation, virtual memory, page replacement algorithms; File systems: design and implementation of file systems; input/output systems; device controllers and device drivers; Security and protection; Case studies on design and implementation of operating system modules.

SEWP ZC423T Project Work 20

Consistent with the student's professional background and work-environment, the student will be required to carry out work-oriented projects. The student would be required to select an area of work that is considered vital to the sponsoring organization. The topic of the project and detailed project outline that is prepared by the student, in consultation with his/her Mentor, needs to be approved by the Dean, WILPD. On approval, the student carries on with the work-centered project, adhering to the guidelines provided in the detailed course handout, taking all the prescribed evaluation components on time. At the end of the semester, the student should

submit a comprehensive Project Report, to the Institute for evaluation. The student will be evaluated on the basis of the various interim evaluation components, contents of the report and Seminar/Viva-Voce that may be conducted at Pilani or at any other Centre approved by the Institute.

SEWI ZC424 Software Development for Portable Devices 3

SEWP ZC424 Software Development for Portable Devices 3

Introduction to mobile computing and emerging mobile application and hardware platforms; Developing and assessing mobile applications; Software lifecycle for mobile application – design and architecture, development – tools, techniques, frameworks, deployment; Human factors and emerging human computer interfaces (tangible, immersive, attentive, gesture, zero-input); Select application domains such as pervasive health care, m-Health; Mobile web browsing, gaming and social networking.

SEWI ZC425 Data Mining 3

SEWP ZC425 Data Mining 3

Data Mining – introduction, fundamental concepts; motivation and applications; role of data warehousing in data mining; challenges and issues in data mining; Knowledge Discovery in Databases (KDD); role of data mining in KDD; algorithms for data mining; tasks like decision-tree construction, finding association rules, sequencing, classification, and clustering; applications of neural networks and machine learning for tasks of classification and clustering.

SESL ZC432 Object Oriented Programming 3

SEMH ZC432 Object Oriented Programming 3

SEWI ZC432 Object Oriented Programming 3

SEWP ZC432 Object Oriented Programming 3

Object orientation concepts and principles: abstraction, encapsulation, modularity, inheritance, and polymorphism; classes and objects; static and dynamic binding; class utilities; metaclasses; object oriented software engineering; programming and problem solving using one or more of the popular object-oriented programming languages like C++ or Java.

SEWI ZC444 Real Time Systems 3

Introduction to real-time systems, clock synchronization, task assignment and scheduling, programming language with real-time support, ADA, real-time communication protocols, real-time databases, fault tolerant techniques, reliability evaluation methods; case studies in real-time operating systems, simulation of real-time systems, embedded system programming.

SEWP ZC444 Cloud Computing 4

Concurrency and distributed computing, message passing over the network, connectivity and failure models, local vs remote connectivity, distributed resource modeling, distributed data models; replication & consistency; virtualization; CPU virtualization, memory and storage virtualization, virtualized networks, computing over WAN and Internet; computing on the cloud, computing models, service models and service contracts, programming on the cloud; Cloud infrastructure, LAN vs Wan issue, resource scaling and resource provisions, performance models, scalability, performance measurement and enhancement techniques; cloud applications and infrastructure services.

SEWI ZC446 Data Storage Technologies and Networks 3

SEWP ZC446 Data Storage Technologies and Networks 3

Storage Media and Technologies – Magnetic, Optical and Semiconductor media, techniques for read/write operations, issues and limitations. Usage and Access – Positioning in the memory hierarchy, Hardware and Software Design for access, Performance issues. Large Storages – Hard Disks, Networked Attached Storage, Scalability issues, Networking issues. Storage Architecture. - Storage Partitioning, Storage System Design, Caching, Legacy Systems. Storage Area Networks – Hardware and Software Components, Storage Clusters/Grids. Storage QoS – Performance, Reliability, and Security issues.

SESL ZC451 Internetworking Technologies 3

SEMH ZC451 Internetworking Technologies 3

SEWI ZC451 Internetworking Technologies 3

SEWP ZC451 Internetworking Technologies 3

Introduction to internetworking concepts; the internet architecture; goals and key issued related

to internet working technologies; design aspects; HTTP and other relevant protocols; agent technology and tools relevant to the internet; techniques of data compression; voice, video, and interactive video-on-demand over the internet; multimedia operating systems and their impact; multimedia networking; mobile computing; internet security, case studies.

SEWI ZC452 Mobile Telecom Networks 3

Fundamentals of mobile telecommunications; with an overview of first generation (analog) systems and more detailed coverage of second generation (digital) technologies; technology basics including descriptions of wireless network elements, spectrum allocation, frequency re-use, characteristics of the transmission medium; over the-air (OTA) interface characteristics; capacity, coverage, speech coding, channel coding and modulation techniques of TDMA and CDMA technologies; network characteristics; architecture, signaling, element management of IS-41 and GSM networks; call processing; call setup and release, handoff, roaming, advanced services; mobile data communications; circuit and packet switched data services, third generation (wideband data) mobile communications system requirements / architecture.

SESL ZC461 Software Engineering 3

SEMH ZC461 Software Engineering 3

SEWI ZC461 Software Engineering 3

SEWP ZC461 Software Engineering 3

Software engineering concepts and methodology; formal requirements specification; estimation; software project planning; detailed design; techniques of design; productivity; documentation; programming languages styles, code review; tool, integration and validation; software quality assurance; software maintenance; metrics, automated tools in software engineering.

SESL ZC462 Network Programming 3

SEMH ZC462 Network Programming 3

SEWI ZC462 Network Programming 3

SEWP ZC462 Network Programming 3

Overview of computer networks; inter-process communication; network programming; socket interface; client-server computing model: design issues, concurrency in server and clients; external data representation; remote procedure calls; network file systems; distributed systems design.

SEWI ZC471 Management Information Systems 3

Introduction to Information Systems; Concepts of management, concepts of information, systems concepts; Information Systems and Organizations; decision making process; database systems; data communications; planning, designing, developing and implementing information systems; quality assurance and evaluation of information systems; future developments and their organizational and social implications; decision support system and expert systems.

SESL ZC473 Multimedia Computing 3

SEMH ZC473 Multimedia Computing 3

SEWI ZC473 Multimedia Computing 3

SEWP ZC473 Multimedia Computing 3

Introduction to multimedia; media & data streams; image, video & audio file formats; image & video processing, synthesis of sound signal; image coding & compression, video & audio codes, low bit rate video telephony; audio-visual integration, lip reading, face animation; augmented reality; multimedia search services, content based image & video indexing; access to multimedia, human-machine interfaces, spoken language interface; algorithm vs. architecture based approaches, multimedia processors, performance quantification; case studies, vision 2010.

SEWI ZC472 Computer Graphics 3

SEWP ZC472 Computer Graphics 3

Generation of dots, lines, arcs and polygons; color graphics, shades and levels; image transformation, windowing and clipping; 2-D and 3-D graphics; data structures, algorithms and optimization methods; case studies using GKS, CORE, etc; graphic languages and compilers.

SESL ZG511 Design & Analysis of Algorithms 5

SEMH ZG511 Design & Analysis of Algorithms 5

SEWI ZG511 Design & Analysis of Algorithms 5

SEWP ZG511 Design & Analysis of Algorithms5

Design techniques such as divide-and-conquer, recursion, backtracking, branch-and-bound, simulation; Analysis in terms of average level and worst level efficiency; Relationship to appropriate

data structures; Illustrations dealing with problems in computer science, graph theory and mathematics; Computational complexity and bounds; NP-hard and NP-complete problems.

SESL ZG512 Object Oriented Analysis & Design 4

SEMH ZG512 Object Oriented Analysis & Design 4

SEWI ZG512 Object Oriented Analysis & Design 4

SEWP ZG512 Object Oriented Analysis & Design 4

Object orientation concepts, theories and principles; fundamental concepts of the object model: classes, objects, methods and messages, encapsulation and inheritance, interface and implementation, reuse and extension of classes, inheritance and polymorphism; process of object-oriented requirements specification, analysis and design; notations for object-oriented analysis and design; case studies and applications using some object oriented programming languages.

SESL ZG513 Network Security 4

SEHM ZG513 Network Security 4

SEWI ZG513 Network Security 4

SEWP ZG513 Network Security 4

This course examines issues related to network and information security. Topics include security concepts, security attacks and risks, security architectures, security policy management, security mechanisms, cryptography algorithms, security standards, security system interoperation and case studies of the current major security systems.

SESL ZG514 Data Warehousing 5

SEHM ZG514 Data Warehousing 5

SEWI ZG514 Data Warehousing 5

SEWP ZG514 Data Warehousing 5

Introduction, evolution of data warehousing; decision support systems; goals, benefit, and challenges of data warehousing; architecture; data warehouse information flows; software and hardware requirements; approaches to data warehouse design; creating and maintaining a data warehouse; Online Analytical Processing (OLAP) and multi-dimensional data, multi-dimensional modeling; view materialization; data marts; data warehouse metadata; data mining.

SEWI ZG520 Wireless & Mobile Communication 5

Signal propagation in a mobile environment, modulation, coding, equalization; first generation generation systems; multiple access techniques like FDMA, TDMA, CDMA, spread spectrum sytems; second & third generation systems, UMTS, IMT-2000; Wireless LAN, Wireless ATM and Mobile IP; emerging trends in Wireless & Mobile Communication.

SEWI ZG524 Real Time Operating Systems 5

SEWP ZG524 Real Time Operating Systems 5

Introduction to real-time systems, clock synchronization task assignment and scheduling, programming language with real-time support, ADA, real-time communication protocols, real-time database, fault tolerant techniques, reliability evaluation methods; case studies in real-time operating systems, simulation of real-time systems, embedded system programming.

SEWI ZG531 Pervasive Computing 4

Select application architectures; hardware aspects; human-machine interfacing; device technology: hardware, operating system issues; software aspects, java; device connectivity issues and protocols; security issues; device management issues and mechanisms; role of web; wap devices and architectures; voice-enabling techniques; PDAs and their operating systems; web application architectures; architectural issues and choices; smart card-based authentication mechanisms; applications; issues and mechanisms in WAP-enabling; access architectures; wearable computing architectures.

SESL ZG552 Software Testing Methodologies 4

SEMH ZG552 Software Testing Methodologies4

SEWI ZG552 Software Testing Methodologies 4

SEWP ZG552 Software Testing Methodologies4

Concepts and principles of software testing and quality assurance; software testing tools; functional, structural, integration and system testing techniques; software testing process and its management; evaluation of test effectiveness; testing specialized systems and applications; automated software testing; case studies.

SEWP ZG553 Real Time Systems 5

Real time software, Real time operating systems-scheduling, virtual memory issues and file systems, real time data bases, fault tolerance and exception handling techniques, reliability evaluation, data structures and algorithms for real time/embedded systems, programming languages, compilers and run time environment for real time/embedded systems, real time system design, real time communication and security, real time constraints and multi processing and distributed systems.

SEWI ZG582 Telecom Network Management 5

Network architecture and protocols; LAN, MAN and WANs; internetworking; network planning; network management concepts and standards; administrative, operational and fault management; security issues; remote network management.

SESL ZG622 Software Project Management 4

SEMH ZG622 Software Project Management 4

SEWI ZG622 Software Project Management 4

SEWP ZG622 Software Project Management 4

Managing a software development project, concepts, objects of a project, environment of a software project, system development life cycle, tools, review process; documentation in software program management, procedures, diagramming techniques, management; Planning and monitoring a software project, project planning, management tools, software project definitions, project management packages, project control; software project definition, classification, project sizes and methodologies, feasibility, requirements and start-up; programmer productivity; software planning, control tools, accelerated design; prototyping and role in software project management; software production and software project management; software system installation, managing testing requirements, test plans, alpha and beta systems; emerging directions in project management.

SESL ZG629T Dissertation 20

SEMH ZG629T Dissertation 20

SEWI ZG629T Dissertation 20

SEWP ZG629T Dissertation 20

A student registered in this course must take a topic in an area of professional interest drawn from the on the job work requirement which is simultaneously of direct relevance to the degree pursued by the student as well as to the employing / collaborating organization of the student and submit a comprehensive report at the end of the semester working under the overall supervision and guidance of a professional expert who will be deemed as the supervisor for evaluation of all components of the dissertation. Normally the Mentor of the student would be the Dissertation supervisor and in case Mentor is not approved as the supervisor, Mentor may play the role of additional supervisor. The final grades for dissertation are Non-letter grades namely Excellent, Good, Fair and Poor, which do not go into CGPA computation.

SESL ZG651 Software Architectures 5

SEMH ZG651 Software Architectures 5

SEWI ZG651 Software Architectures 5

SEWP ZG651 Software Architectures 5

Systems engineering and software architectures; Hatley-Pirbhai architectural template; architecture flow diagrams; requirements engineering and software architecture; architectural design processes; design post-processing; real-time architectures; architectural design patterns; software architecture and maintenance management; object oriented architectures; client-server architectures; forward engineering for object oriented and client-server architectures; emerging software architectures.

SESL ZG659 Technical Communication 4

SEMH ZG659 Technical Communication 4

SEWI ZG659 Technical Communication 4

SEWP ZG659 Technical Communication 4

Role and importance of communication; effectiveness in oral and written communication; technical reports; technical proposals; technical descriptions; definitions and classifications; business correspondence; precis writing; memorandum; notices, agenda and minutes; oral communication related to meetings, seminars, conferences, group discussions, etc.; use of modern communication aids.

SESL ZG661 Software Quality Management 4

SEMH ZG661 Software Quality Management 4

SEWI ZG661 Software Quality Management 4

SEWP ZG661 Software Quality Management 4

Software quality challenges and expectations; quality dilemma; software life cycle and link to quality; quality gates, formal reviews, system requirement reviews, preliminary design reviews, critical design reviews, test reviews; engineering reviews, walkthroughs, inspections, internal reviews; quality gate categories; technical environment and quality; planning for software quality, quality requirements for planning, quality needs, elements of quality planning, quality assessments during planning, software quality organization requirements; quality evaluation of software development process, process quality attributes, measuring software process quality; software process metrics; quality gate integrity; software product quality, standards and conventions, metrics; quality hierarchy, factors; quality assessment; quality evaluation techniques, reviews, walkthroughs, audit, inspections, analytical evaluation techniques; quality systems.

SEVI ZC132 Linear Algebra & Optimization 3

Vector and matrix algebra, systems of linear algebraic equations and their solutions; eigenvalues, eigenvectors and diagonalization of matrices; Formulation of linear programming problems, Simplex method, Big-M method, Two phase method, Sensitivity analysis, Revised and Dual Simplex Methods.

SEVI ZC142 Computer Programming 3

Elementary computer organization; introduction to Number Systems; Representation of integers, real numbers and characters on computers; concept of range and accuracy; Arithmetic Overflow; Algorithms and algorithm development; structured program development through step wise refinement. Introduction to C language; Functions; Recursion; Data structure & algorithms; File management & file handling; Problem solving using C.

SEVI ZC213 Probability & Statistics 3

Probability spaces; conditional probability and independence; random variables and probability distributions; marginal and conditional distributions; independent random variables; mathematical expectation; mean and variance; binomial, Poisson and normal distributions; sum of independent random variables; law of large numbers; central limit theorem (without proof); sampling distribution and test for mean using normal and student's t-distribution; test of hypothesis; correlation and linear regression.

SEVI ZC222 Advanced Programming Techniques 3

Dynamic memory management; low level processing; debugging techniques; symbolic debugging tools; visual programming environments; user interfaces; event driven programming; visual design methodologies; prototyping with visual programming aids; creating multi-threaded applications; other emergent advanced programming topics.

SEVI ZC252 Discrete Structures for Computer Science 3

Sets and relations; graphs and digraphs; trees, lists and their uses; partially ordered sets and lattices; Boolean algebras and Boolean expressions; semigroups and machines; codes and applications.

SEVI ZC261 Digital Electronics & Microprocessors 3

Binary logic gates; logic circuits; Boolean algebra and K-map simplification; number systems and codes; arithmetic logic units; flipflops; registers and counters; introduction to microprocessors; architecture; instruction set and programming; memory and I/O interfacing examples of system design.

SEVI ZC322 Database Management Systems 3

Introduction to Database Management Systems; File organization; Data Independence in databases; Data Models; Query processing systems; Database Design techniques; Concepts of security and integrity in databases; Distributed Databases; Applications using DBMS.

SEVI ZC332 Systems Programming 3

Batch processing Systems programs; operating characteristics and limitations; parallel processing of I/O and interrupt handling, multiprogramming; multiprocessing systems; design of system modules and interfaces; other selected topics.

SEVI ZC413 Computer Organization & Architecture 3

Overview of logic design; Instruction set architecture; Assembly language programming; Pipelining; Computer Arithmetic; Control unit; Memory hierarchy; virtual memory; Input and output systems; Interrupts and exception handling; Implementation issues; Case studies

SEVI ZC415 Data Structures & Algorithms 3

Introduction to software design principles, modularity, abstract data types, data structures and algorithms; analysis of algorithms; Linear data structures – stacks, arrays, lists queues and linked representations; Pre-fix, in-fix and post-fix expressions; Recursion; Set operations; Hashing and hash functions; Binary and other trees, traversal algorithms, Huffman codes; Search trees, priority queues, heaps and balanced trees; Sorting techniques; Graphs and digraphs; Algorithmic design techniques; Data structures for external storage, multi-way search and B-trees.

SEVI ZC416 Complier Design 3

Introduction to Progg. Languages and Compilers, Programming Language Features, Front End of a Compiler, Back End of a Compiler, Special aspects of compilers and runtime

SEVI ZC421 Computer Networks 3

Introduction, history and development of computer networks; Reference models; Physical Layer: theoretical basis, transmission media, types of transmission; MAC sub-layer: local area networks, FDDI; Data Link Layer: Sliding Window protocols, design aspects; Network Layer: routing algorithms, congestion control algorithms, internetworking; Transport Layer: Integrated Services Digital Network (ISDN), Asynchronous Transfer Mode (ATM) - reference models, service classes, switch design, LAN emulation; Application Layer protocols.

SEVI ZC422 Operating Systems 3

Introduction to operating systems; Various approaches to design of operating systems; Overview of hardware support for operating systems; Process management: process synchronization and mutual exclusion, interprocess communication, process scheduling; CPU scheduling approaches; Memory management: paging, segmentation, virtual memory, page replacement algorithms; File systems: design and implementation of file systems; input/output systems; device controllers and device drivers; Security and protection; Case studies on design and implementation of operating system modules.

SEVI ZC424 Software Development for Portable Devices 3

Introduction to mobile computing and emerging mobile application and hardware platforms; Developing and assessing mobile applications; Software lifecycle for mobile application – design and architecture, development – tools, techniques, frameworks, deployment; Human factors and emerging human computer interfaces (tangible, immersive, attentive, gesture, zero-input); Select application domains such as pervasive health care, m-Health; Mobile web browsing, gaming and social networking.

SEVI ZC425 Data Mining 3

Data Mining – introduction, fundamental concepts; motivation and applications; role of data warehousing in data mining; challenges and issues in data mining; Knowledge Discovery in Databases (KDD); role of data mining in KDD; algorithms for data mining; tasks like decision-tree construction, finding association rules, sequencing, classification, and clustering; applications of neural networks and machine learning for tasks of classification and clustering.

SEVI ZC446 Data Storage Technologies & Networks 3

Storage Media and Technologies – Magnetic, Optical and Semiconductor media, techniques for read/write operations, issues and limitations. Usage and Access – Positioning in the memory hierarchy, Hardware and Software Design for access, Performance issues. Large Storages – Hard Disks, Networked Attached Storage, Scalability issues, Networking issues. Storage Architecture. - Storage Partitioning, Storage System Design, Caching, Legacy Systems. Storage Area Networks – Hardware and Software Components, Storage Clusters/Grids. Storage QoS – Performance, Reliability, and Security issues.

SEVI ZC461 Software Engineering 3

Software engineering concepts and methodology; formal requirements specification; estimation; software project planning; detailed design; techniques of design; productivity; documentation; programming languages styles, code review; tool,

integration and validation; software quality assurance; software maintenance; metrics, automated tools in software engineering.

SEVI ZC472 Computer Graphics 3

Generation of dots, lines, arcs and polygons; color graphics, shades and levels; image transformation, windowing and clipping; 2-D and 3-D graphics; data structures, algorithms and optimization methods; case studies using GKS, CORE, etc; graphic languages and compilers.

SEVI ZC473 Multimedia Computing 3

Introduction to multimedia; media & data streams; image, video & audio file formats; image & video processing, synthesis of sound signal; image coding & compression, video & audio codes, low bit rate video telephony; audio-visual integration, lip reading, face animation; augmented reality; multimedia search services, content based image & video indexing; access to multimedia, human-machine interfaces, spoken language interface; algorithm vs. architecture based approaches, multimedia processors, performance quantification; case studies, vision 2010.

SEVI ZG511 Design & Analysis of Algorithms 5

Design techniques such as divide-and-conquer, recursion, backtracking, branch-and-bound, simulation; Analysis in terms of average level and worst level efficiency; Relationship to appropriate data structures; Illustrations dealing with problems in computer science, graph theory and mathematics; Computational complexity and bounds; NP-hard and NP-complete problems.

SEVI ZG512 Object Oriented Analysis & Design 4

Object orientation concepts, theories and principles; fundamental concepts of the object model: classes, objects, methods and messages, encapsulation and inheritance, interface and implementation, reuse and extension of classes, inheritance and polymorphism; process of object-oriented requirements specification, analysis and design; notations for object-oriented analysis and design; case studies and applications using some object oriented programming languages.

SEVI ZG513 Network Security 4

This course examines issues related to network and information security. Topics include security concepts, security attacks and risks, security architectures, security policy management, security mechanisms, cryptography algorithms, security standards, security system interoperation and case studies of the current major security systems.

SEVI ZG514 Data Warehousing 5

Introduction, evolution of data warehousing; decision support systems; goals, benefit, and challenges of data warehousing; architecture; data warehouse information flows; software and hardware requirements; approaches to data warehouse design; creating and maintaining a data warehouse; Online Analytical Processing (OLAP) and multi-dimensional data, multi-dimensional modeling; view materialization; data marts; data warehouse metadata; data mining.

SEVI ZG524 Real Time Operating Systems 5

Introduction to real-time systems, clock synchronization task assignment and scheduling, programming language with real-time support, ADA, real-time communication protocols, real-time database, fault tolerant techniques, reliability evaluation methods; case studies in real-time operating systems, simulation of real-time systems, embedded system programming.

SEVI ZG527 Cloud Computing 5

Concurrency and distributed computing, message passing over the network, connectivity and failure models, local vs remote connectivity, distributed resource modeling, distributed data models; replication & consistency; virtualization; CPU virtualization, memory and storage virtualization, virtualized networks, computing over WAN and Internet; computing on the cloud, computing models, service models and service contracts, programming on the cloud; Cloud infrastructure, LAN vs Wan issue, resource scaling and resource provisions, performance models, scalability, performance measurement and enhancement techniques; cloud applications and infrastructure services.

SEVI ZG552 Software Testing Methodologies 4

Concepts and principles of software testing and quality assurance; software testing tools; functional, structural, integration and system testing techniques; software testing process and

its management; evaluation of test effectiveness; testing specialized systems and applications; automated software testing; case studies.

SEVI ZG622 Software Project Management 4

Managing a software development project, concepts, objects of a project, environment of a software project, system development life cycle, tools, review process; documentation in software program management, procedures, diagramming techniques, management; Planning and monitoring a software project, project planning, management tools, software project definitions, project management packages, project control; software project definition, classification, project sizes and methodologies, feasibility, requirements and start-up; programmer productivity; software planning, control tools, accelerated design; prototyping and role in software project management; software production and software project management; software system installation, managing testing requirements, test plans, alpha and beta systems; emerging directions in project management.

SEVI ZG629T Dissertation 20

A student registered in this course must take a topic in an area of professional interest drawn from the on the job work requirement which is simultaneously of direct relevance to the degree pursued by the student as well as to the employing / collaborating organization of the student and submit a comprehensive report at the end of the semester working under the overall supervision and guidance of a professional expert who will be deemed as the supervisor for evaluation of all components of the dissertation. Normally the Mentor of the student would be the Dissertation supervisor and in case Mentor is not approved as the supervisor, Mentor may play the role of additional supervisor. The final grades for dissertation are Non-letter grades namely Excellent, Good, Fair and Poor, which do not go into CGPA computation.

SEVI ZG651 Software Architectures 5

Systems engineering and software architectures; Hatley-Pirbhai architectural template; architecture flow diagrams; requirements engineering and software architecture; architectural design processes; design post-processing; real-time architectures; architectural design patterns; software architecture and maintenance management; object oriented architectures; client-server architectures; forward engineering for object oriented and client-server architectures; emerging software architectures.

SEYI ZC421 Computer Networks 3

Introduction, history and development of computer networks; Reference models; Physical Layer: theoretical basis, transmission media, types of transmission; MAC sub-layer: local area networks, FDDI; Data Link Layer: Sliding Window protocols, design aspects; Network Layer: routing algorithms, congestion control algorithms, internetworking; Transport Layer: Integrated Services Digital Network (ISDN), Asynchronous Transfer Mode (ATM) - reference models, service classes, switch design, LAN emulation; Application Layer protocols.

SEYI ZC425 Data Mining 3

Data Mining – introduction, fundamental concepts; motivation and applications; role of data warehousing in data mining; challenges and issues in data mining; Knowledge Discovery in Databases (KDD); role of data mining in KDD; algorithms for data mining; tasks like decision-tree construction, finding association rules, sequencing, classification, and clustering; applications of neural networks and machine learning for tasks of classification and clustering.

SEYI ZC473 Multimedia Computing 3

Introduction to multimedia; media & data streams; image, video & audio file formats; image & video processing, synthesis of sound signal; image coding & compression, video & audio codes, low bit rate video telephony; audio-visual integration, lip reading, face animation; augmented reality; multimedia search services, content based image & video indexing; access to multimedia, human-machine interfaces, spoken language interface; algorithm vs. architecture based approaches, multimedia processors, performance quantification; case studies, vision 2010.

SEYI ZG512 Object Oriented Analysis and Design 4

Object orientation concepts, theories and principles; fundamental concepts of the object model: classes, objects, methods and messages, encapsulation and inheritance, interface and implementation, reuse and extension of classes, inheritance and polymorphism; process of object-oriented requirements specification, analysis and design; notations for object-oriented analysis and

design; case studies and applications using some object oriented programming languages.

SEYI ZG513 Network Security 4

This course examines issues related to network and information security. Topics include security concepts, security attacks and risks, security architectures, security policy management, security mechanisms, cryptography algorithms, security standards, security system interoperation and case studies of the current major security systems.

SEYI ZG518 Database Design and Applications 5

DBMS architecture; Data models: Network model, Hierarchical model and Relational model; Database design & optimization; Query processing & Query optimization; Transaction Processing; Concurrency control; Recovery; Security & protection; Introduction to Object Oriented data model & Multimedia Databases.

SEYI ZG519 Data Structures & Algorithms Design 5

Introduction to Abstract Data Types, Data structures and Algorithms; Analysis of Algorithms – Time and Space Complexity, Complexity Notation, Solving Recurrence Relations.; Divide-and-Conquer as a Design Technique; Recursion – Design of Recursive Functions / Procedures, Tail Recursion, Conversion of Recursive Functions to Iterative Form. Linear data structures – Lists, Access Restricted Lists (Stacks and Queues) – Implementation using Arrays and Linked Lists; Searching and Order Queries. Sorting – Sorting Algorithms (Online vs. Offline, In-memory vs. External, In-space vs. Out-of-space, QuickSort and Randomization). Unordered Collections: Hashtables (Separate Chaining vs. Open Addressing, Probing, Rehashing). Binary Trees – Tree Traversals. Partially Ordered Collections: Search Trees and Height Balanced Search Trees, Heaps and Priority Queues. Algorithm Design: Greedy Algorithms and Dynamic Programming. Graphs and Graph Algorithms: Representation schemes, Problems on Directed Graphs (Reachability and Strong Connectivity, Traversals, Transitive Closure. Directed Acyclic Graphs - Topological Sorting), Problems on Weighted Graphs (Shortest Paths. Spanning Trees). Introduction to Complexity Classes (P and NP) and NP-completeness. NP-Hard problems. Designing Algorithms for Hard Problems – Back tracking, Branch-and-Bound, and Approximation Algorithms.

SEYI ZG527 Cloud Computing 5

Concurrency and distributed computing, message passing over the network, connectivity and failure models, local vs remote connectivity, distributed resource modeling, distributed data models; replication & consistency; virtualization; CPU virtualization, memory and storage virtualization, virtualized networks, computing over WAN and Internet; computing on the cloud, computing models, service models and service contracts, programming on the cloud; Cloud infrastructure, LAN vs Wan issue, resource scaling and resource provisions, performance models, scalability, performance measurement and enhancement techniques; cloud applications and infrastructure services.

SEYI ZG552 Software Testing Methodologies 4

Concepts and principles of software testing and quality assurance; software testing tools; functional, structural, integration and system testing techniques; software testing process and its management; evaluation of test effectiveness; testing specialized systems and applications; automated software testing; case studies.

SEYI ZG622 Software Project Management 4

Managing a software development project, concepts, objects of a project, environment of a software project, system development life cycle, tools, review process; documentation in software program management, procedures, diagramming techniques, management; Planning and monitoring a software project, project planning, management tools, software project definitions, project management packages, project control; software project definition, classification, project sizes and methodologies, feasibility, requirements and start-up; programmer productivity; software planning, control tools, accelerated design; prototyping and role in software project management; software production and software project management; software system installation, managing testing requirements, test plans, alpha and beta systems; emerging directions in project management.

SEYI ZG623 Advanced Operating Systems 5

Overview of advanced operating systems: motivation for their design, and various types of advanced operating systems; Distributed

operating systems: architecture of distributed systems, theoretical foundation of distributed systems, deadlock detection/resolution, agreement protocols, file systems, distributed shared memory, scheduling, fault tolerance and recovery; Multiprocessor operating systems: multiprocessor system architectures, multiprocessor operating system design issues, threads, process synchronization, process scheduling and memory management; Data base operating systems: introduction, concurrency control: theoretical and algorithmic aspects; Case Study: Amoeba and Mach.

SEYI ZG629T Dissertation 20

A student registered in this course must take a topic in an area of professional interest drawn from the on the job work requirement which is simultaneously of direct relevance to the degree pursued by the student as well as to the employing / collaborating organization of the student and submit a comprehensive report at the end of the semester working under the overall supervision and guidance of a professional expert who will be deemed as the supervisor for evaluation of all components of the dissertation. Normally the Mentor of the student would be the Dissertation supervisor and in case Mentor is not approved as the supervisor, Mentor may play the role of additional supervisor. The final grades for dissertation are Non-letter grades namely Excellent, Good, Fair and Poor, which do not go into CGPA computation.

SEYI ZG651 Software Architectures 5

Systems engineering and software architectures; Hatley-Pirbhai architectural template; architecture flow diagrams; requirements engineering and software architecture; architectural design processes; design post-processing; real-time architectures; architectural design patterns; software architecture and maintenance management; object oriented architectures; client-server architectures; forward engineering for object oriented and client-server architectures; emerging software architectures.

SE* ZC415 Data Mining 3

Data Mining – introduction, fundamental concepts; motivation and applications; role of data warehousing in data mining; challenges and issues in data mining; Knowledge Discovery in Databases (KDD); role of data mining in KDD; algorithms for data mining; tasks like decision-tree construction, finding association rules, sequencing, classification, and clustering; applications of neural networks and machine learning for tasks of classification and clustering.

SE* ZC422 Parallel Computing 3

Introduction to parallel computing; Models of parallel computers; Interconnection networks, basic communication operations; Introduction to parallel algorithms; Parallel programming paradigms; issues in implementing algorithms on parallel computers; Parallel programming with message passing interface; Performance analysis; Scalability analysis; Basic design techniques for parallel algorithms; Parallel algorithms for selected topics like sorting, searching and merging, matrix algebra, graphs, discrete optimization problems and computational geometry.

SE* ZC424 Software for Embedded Systems 3

Real-time and Embedded Systems; Software issues in Embedded Systems; Software Development Process; Requirements Analysis– Use Cases, Identification and Analysis of use cases, Use Case Diagrams. Design – Architectural Design, Design Patterns, Detailed Design. Implementation – Languages, Compilers, Runtime Environments and Operating Systems for embedded software. Testing – Methodologies, Test Cases.

SE* ZC446 Data Storage Technologies & Networks 3

Storage Media and Technologies – Magnetic, Optical and Semiconductor media, techniques for read/write operations, issues and limitations. Usage and Access – Positioning in the memory hierarchy, Hardware and Software Design for access, Performance issues. Large Storages – Hard Disks, Networked Attached Storage, Scalability issues, Networking issues. Storage Architecture. - Storage Partitioning, Storage System Design, Caching, Legacy Systems. Storage Area Networks – Hardware and Software Components, Storage Clusters/Grids. Storage QoS – Performance, Reliability, and Security issues.

SE* ZC462 Network Programming 3

Overview of computer networks; inter-process communication; network programming; socket interface; client-server computing model: design issues, concurrency in server and clients; external

data representation; remote procedure calls; network file systems; distributed systems design.

SE* ZC463 Cryptography 3

Objectives of cryptography; ciphers – block and stream; mathematical foundations – modular arithmetic, finite fields, discrete logarithm, primality algorithms; RSA; digital signatures; interactive proofs; zero–knowledge proofs; probabilistic algorithms; pseudo-randomness.

SE* ZC473 Multimedia Computing 3

Introduction to multimedia; media & data streams; image, video & audio file formats; image & video processing, synthesis of sound signal; image coding & compression, video & audio codes, low bit rate video telephony; audio-visual integration, lip reading, face animation; augmented reality; multimedia search services, content based image & video indexing; access to multimedia, human-machine interfaces, spoken language interface; algorithm vs. architecture based approaches, multimedia processors, performance quantification; case studies, vision 2010.

SE* ZC481 Computer Networks 3

Introduction, history and development of computer networks; Reference models; Physical Layer: theoretical basis, transmission media, types of transmission; MAC sub-layer: local area networks, FDDI; Data Link Layer: Sliding Window protocols, design aspects; Network Layer: routing algorithms, congestion control algorithms, internetworking; Transport Layer: Integrated Services Digital Network (ISDN), Asynchronous Transfer Mode (ATM) - reference models, service classes, switch design, LAN emulation; Application Layer protocols.

SE* ZG512 Object Oriented Analysis & Design 4

Object orientation concepts, theories and principles; fundamental concepts of the object model: classes, objects, methods and messages, encapsulation and inheritance, interface and implementation, reuse and extension of classes, inheritance and polymorphism; process of object-oriented requirements specification, analysis and design; notations for object-oriented analysis and design; case studies and applications using some object oriented programming languages.

SE* ZG513 Network Security 4

This course examines issues related to network and information security. Topics include security concepts, security attacks and risks, security architectures, security policy management, security mechanisms, cryptography algorithms, security standards, security system interoperation and case studies of the current major security systems.

SE* ZG515 Data Warehousing 5

Introduction, evolution of data warehousing; decision support systems; goals, benefit, and challenges of data warehousing; architecture; data warehouse information flows; software and hardware requirements; approaches to data warehouse design; creating and maintaining a data warehouse; Online Analytical Processing (OLAP) and multi-dimensional data, multi-dimensional modeling; view materialization; data marts; data warehouse metadata; data mining.

SE* ZG516 Computer Organization & Software Systems 5

Programmer model of CPU; Basic concept of buses and interrupts; Memory subsystem organization; I/O organization; Concept of assembler, linker & loader; Types of operating systems; Concept of process; OS functions: Process scheduling, Memory management, I/O management and related issues.

SE* ZG517 Usability Engineering 5

Usability-driven approach to Information Design; software usability bridge& its critical components; Iterative & evaluation of a two-level approach of UCID (User-Centered Information Design); five key principles of UCID; getting UCID into organization ; Benefits of implementing UCID; key features of UCID;UCID process & analysis; traditional processes for information development & their limitations; Managing UCID; role of usability engineers; preparing the usability plan; implementing a metrics program in typical UCID projects; key contributors; goal setting for software usability & information quality; critical design goals; designing the information architecture ;designing the specifications & prototypes; evaluating prototypes; two-level design activities; designing software labels; designing effective messages; designing online support elements & printed support elements; achieving information design goals; online search & navigation; evaluating information; two-level evaluation; approach achieving information design goals for improved software usability; testing information & validating; quality indicators;

retrievability; implementation techniques & issues ;Application of Usability Engineering in typical live projects to validate improved software usability.

SE* ZG518 Database Design & Applications 5

DBMS architecture; Data models: Network model, Hierarchical model and Relational model; Database design & optimization; Query processing & Query optimization; Transaction Processing; Concurrency control; Recovery; Security & protection; Introduction to Object Oriented data model & Multimedia Databases.

SE* ZG519 Data Structures & Algorithms Design 5

Introduction to Abstract Data Types, Data structures and Algorithms; Analysis of Algorithms – Time and Space Complexity, Complexity Notation, Solving Recurrence Relations.; Divide-and-Conquer as a Design Technique; Recursion – Design of Recursive Functions / Procedures, Tail Recursion, Conversion of Recursive Functions to Iterative Form. Linear data structures – Lists, Access Restricted Lists (Stacks and Queues) – Implementation using Arrays and Linked Lists; Searching and Order Queries. Sorting – Sorting Algorithms (Online vs. Offline, In-memory vs. External, In-space vs. Out-of-space, QuickSort and Randomization). Unordered Collections: Hashtables (Separate Chaining vs. Open Addressing, Probing, Rehashing). Binary Trees – Tree Traversals. Partially Ordered Collections: Search Trees and Height Balanced Search Trees, Heaps and Priority Queues. Algorithm Design: Greedy Algorithms and Dynamic Programming. Graphs and Graph Algorithms: Representation schemes, Problems on Directed Graphs (Reachability and Strong Connectivity, Traversals, Transitive Closure. Directed Acyclic Graphs - Topological Sorting), Problems on Weighted Graphs (Shortest Paths. Spanning Trees). Introduction to Complexity Classes (P and NP) and NP-completeness. NP-Hard problems. Designing Algorithms for Hard Problems – Back tracking, Branch-and-Bound, and Approximation Algorithms.

SE* ZG520 Wireless & Mobile Communication 5

Signal propagation in a mobile environment, modulation, coding, equalization; first generation generation systems; multiple access techniques like FDMA, TDMA, CDMA, spread spectrum sytems; second & third generation systems, UMTS, IMT-2000; Wireless LAN, Wireless ATM and Mobile IP; emerging trends in Wireless & Mobile Communication.

SE* ZG521 Advanced Data Mining 4

Topics beyond conventional record data mining. Mining complex data structures. Tree/graph mining, sequence mining, web/text data mining, stream data mining, spatiotemporal data mining, mining multi-variate time series data, high-dimensional data clustering, and mining social networking sites. Mining data from multiple relations (Multi-relational Data Mining). Privacy preserving Data Mining. Distributed computing solutions for data intensive data mining.

SE* ZG524 Real Time Operating Systems 5

Introduction to real-time systems, clock synchronization task assignment and scheduling, programming language with real-time support, ADA, real-time communication protocols, real-time database, fault tolerant techniques, reliability evaluation methods; case studies in real-time operating systems, simulation of real-time systems, embedded system programming.

SE* ZG525 Advanced Computer Networks 5

Topics in advanced networking – Quality of Service in IP networks, IPv6, Wireless and Mobile Networks, Carrier Technologies (Frame Relay, FDDI, ISDN, ATM), Peer-to-Peer Networks and Overlays, Routing and QoS Issues in Optical Networks.

SE* ZG526 Embedded System Design 4

Introduction to embedded systems; embedded architectures: Architectures and programming of icrocontrollers and DSPs. Embedded applications and technologies; power issues in system design; introduction to software and hardware co-design.

SE* ZG527 Cloud Computing 5

Concurrency and distributed computing, message passing over the network, connectivity and failure models, local vs remote connectivity, distributed resource modeling, distributed data models; replication & consistency; virtualization; CPU virtualization, memory and storage virtualization, virtualized networks, computing over WAN and Internet; computing on the cloud, computing models, service models and service contracts, programming on the cloud; Cloud infrastructure, LAN vs Wan issue, resource scaling and resource provisions, performance

models, scalability, performance measurement and enhancement techniques; cloud applications and infrastructure services.

SE* ZG531 Pervasive Computing 4

Select application architectures; hardware aspects; human-machine interfacing; device technology: hardware, operating system issues; software aspects, java; device connectivity issues and protocols; security issues; device management issues and mechanisms; role of web; wap devices and architectures; voice-enabling techniques; PDAs and their operating systems; web application architectures; architectural issues and choices; smart card-based authentication mechanisms; applications; issues and mechanisms in WAP-enabling; access architectures; wearable computing architectures.

SE* ZG551 Advanced Compilation Techniques 5

Generic Code Optimization Techniques - loop optimization, inlining, and other transformations. Impact of architectures on code generation and optimization: RISC architectures, VLIW architectures, special-purpose architectures. Architecture- specific code optimizations – register allocation, instruction scheduling. Code Optimizations under real-time / embedded constraints – cacheless / diskless memory models, bounded time responses. Garbage Collection Techniques. Virtual Machines and Just-in-Time Compilation techniques - HotSpot-like optimizations. Implementation of exception handling, concurrency, and generic jumps (like call/cc).

SE* ZG552 Software Testing Methodologies 4

Concepts and principles of software testing and quality assurance; software testing tools; functional, structural, integration and system testing techniques; software testing process and its management; evaluation of test effectiveness; testing specialized systems and applications; automated software testing; case studies.

SE* ZG553 Real Time Systems 5

Real time software, Real time operating systems-scheduling, virtual memory issues and file systems, real time data bases, fault tolerance and exception handling techniques, reliability evaluation, data structures and algorithms for real time/embedded systems, programming languages, compilers and run time environment for real time/embedded systems, real time system design, real time communication and security, real time constraints and multi processing and distributed systems.

SE* ZG562 Software Engineering & Management 5

Current concepts, methods, techniques, and tools of the software engineering process; software process models; process definition and assessment; software measurement and metrics; project planning, estimation and control; requirements analysis and specification, design methods; quality assurance and testing; configuration management; process improvement; case studies and project work.

SE* ZG573 Digital Signal Processing 3

Introduction; design of analog filters; design of digital filters: (IIR and FIR); structures for the realization of digital filters; random signals and random processes; linear estimation and prediction; Wiener filters; DSP processor architecture; DSP algorithms for different applications.

SE* ZG582 Telecom Network Management 5

Network architecture and protocols; LAN, MAN and WANs; internetworking; network planning; network management concepts and standards; administrative, operational and fault management; security issues; remote network management.

SE* ZG622 Software Project Management 4

Managing a software development project, concepts, objects of a project, environment of a software project, system development life cycle, tools, review process; documentation in software program management, procedures, diagramming techniques, management; Planning and monitoring a software project, project planning, management tools, software project definitions, project management packages, project control; software project definition, classification, project sizes and methodologies, feasibility, requirements and start-up; programmer productivity; software planning, control tools, accelerated design; prototyping and role in software project management; software production and software project management; software system installation, managing testing requirements, test plans, alpha and beta systems; emerging directions in project management.

SE* ZG623 Advanced Operating Systems 5

Overview of advanced operating systems: motivation for their design, and various types of advanced operating systems; Distributed operating systems: architecture of distributed systems, theoretical foundation of distributed systems, deadlock detection/resolution, agreement protocols, file systems, distributed shared memory, scheduling, fault tolerance and recovery; Multiprocessor operating systems: multiprocessor system architectures, multiprocessor operating system design issues, threads, process synchronization, process scheduling and memory management; Data base operating systems: introduction, concurrency control: theoretical and algorithmic aspects; Case Study: Amoeba and Mach.

SE* ZG626 Hardware Software Co-Design 5

FPGA and ASIC based design, Low-Power Techniques in RT Embedded Systems On-chip networking. Hardware Software partitioning and scheduling, Co-simulation, synthesis and verifications, Architecture mapping, HW-SW Interfaces and Re-configurable computing.

SE* ZG641 Management Information & Decision Support Systems 5

Data & information; characteristics of information; components of management information systems; information flows; design and maintenance of management information systems; decision support systems.

SE* ZG651 Software Architectures 5

Systems engineering and software architectures; Hatley-Pirbhai architectural template; architecture flow diagrams; requirements engineering and software architecture; architectural design processes; design post-processing; real-time architectures; architectural design patterns; software architecture and maintenance management; object oriented architectures; client-server architectures; forward engineering for object oriented and client-server architectures; emerging software architectures.

SE* ZG652 Software Maintenance Management 4

Issues in software maintenance, conceptual issues, scale of effort issues, organizational issues, productivity techniques issues, problem area issues; application systems; maintenance effort; impact of development tools and organizational controls; problems of maintenance; software evolution and maintenance; change management; impact analysis; system release planning; corrective maintenance; adaptive maintenance; perfective maintenance; reengineering source code, restructuring code, maintainability, flexibility, reusability, reliability, efficiency, reengineering tools; software testing & maintenance testing; system release and configuration management; managing the software maintenance process.

SE* ZG659 Technical Communication 4

Role and importance of communication; effectiveness in oral and written communication; technical reports; technical proposals; technical descriptions; definitions and classifications; business correspondence; precis writing; memorandum; notices, agenda and minutes; oral communication related to meetings, seminars, conferences, group discussions, etc.; use of modern communication aids.

SE* ZG661 Software Quality Management 4

Software quality challenges and expectations; quality dilemma; software life cycle and link to quality; quality gates, formal reviews, system requirement reviews, preliminary design reviews, critical design reviews, test reviews; engineering reviews, walkthroughs, inspections, internal reviews; quality gate categories; technical environment and quality; planning for software quality, quality requirements for planning, quality needs, elements of quality planning, quality assessments during planning, software quality organization requirements; quality evaluation of software development process, process quality attributes, measuring software process quality; software process metrics; quality gate integrity; software product quality, standards and conventions, metrics; quality hierarchy, factors; quality assessment; quality evaluation techniques, reviews, walkthroughs, audit, inspections, analytical evaluation techniques; quality systems.

SS ZC446 Data Storage Technologies & Networks 3

Storage Media and Technologies – Magnetic, Optical and Semiconductor media, techniques for read/write operations, issues and limitations. Usage and Access – Positioning in the memory hierarchy, Hardware and Software Design for access, Performance issues. Large Storages – Hard Disks, Networked Attached Storage,

Scalability issues, Networking issues. Storage Architecture. - Storage Partitioning, Storage System Design, Caching, Legacy Systems. Storage Area Networks – Hardware and Software Components, Storage Clusters/Grids. Storage QoS – Performance, Reliability, and Security issues.

SS ZC451 Internetworking Technologies 3

Introduction to internetworking concepts; the internet architecture; goals and key issued related to internet working technologies; design aspects; HTTP and other relevant protocols; agent technology and tools relevant to the internet; techniques of data compression; voice, video, and interactive video-on-demand over the internet; multimedia operating systems and their impact; multimedia networking; mobile computing; internet security, case studies.

SS ZC463 Cryptography 3

Objectives of cryptography; ciphers – block and stream; mathematical foundations – modular arithmetic, finite fields, discrete logarithm, primality algorithms; RSA; digital signatures; interactive proofs; zero–knowledge proofs; probabilistic algorithms; pseudo-randomness.

SS ZG513 Network Security 4

This course examines issues related to network and information security. Topics include security concepts, security attacks and risks, security architectures, security policy management, security mechanisms, cryptography algorithms, security standards, security system interoperation and case studies of the current major security systems.

SS ZG514 Object Oriented Analysis and Design 4

Object orientation concepts, theories and principles; fundamental concepts of the object model: classes, objects, methods and messages, encapsulation and inheritance, interface and implementation, reuse and extension of classes, inheritance and polymorphism; process of object-oriented requirements specification, analysis and design; notations for object-oriented analysis and design; case studies and applications using some object oriented programming languages.

SS ZG515 Data Warehousing 5

Introduction, evolution of data warehousing; decision support systems; goals, benefit, and challenges of data warehousing; architecture; data warehouse information flows; software and hardware requirements; approaches to data warehouse design; creating and maintaining a data warehouse; Online Analytical Processing (OLAP) and multi-dimensional data, multi-dimensional modeling; view materialization; data marts; data warehouse metadata; data mining.

SS ZG516 Computer Organization & Software Systems 5

Programmer model of CPU; Basic concept of buses and interrupts; Memory subsystem organization; I/O organization; Concept of assembler, linker & loader; Types of operating systems; Concept of process; OS functions: Process scheduling, Memory management, I/O management and related issues.

SS ZG518 Database Design & Applications 5

DBMS architecture; Data models: Network model, Hierarchical model and Relational model; Database design & optimization; Query processing & Query optimization; Transaction Processing; Concurrency control; Recovery; Security & protection; Introduction to Object Oriented data model & Multimedia Databases.

SS ZG519 Data Structures & Algorithm Design 5

Introduction to Abstract Data Types, Data structures and Algorithms; Analysis of Algorithms – Time and Space Complexity, Complexity Notation, Solving Recurrence Relations.; Divide-and-Conquer as a Design Technique; Recursion – Design of Recursive Functions / Procedures, Tail Recursion, Conversion of Recursive Functions to Iterative Form. Linear data structures – Lists, Access Restricted Lists (Stacks and Queues) – Implementation using Arrays and Linked Lists; Searching and Order Queries. Sorting – Sorting Algorithms (Online vs. Offline, In-memory vs. External, In-space vs. Out-of-space, QuickSort and Randomization). Unordered Collections: Hashtables (Separate Chaining vs. Open Addressing, Probing, Rehashing). Binary Trees – Tree Traversals. Partially Ordered Collections: Search Trees and Height Balanced Search Trees, Heaps and Priority Queues. Algorithm Design: Greedy Algorithms and Dynamic Programming. Graphs and Graph Algorithms: Representation schemes, Problems on Directed Graphs (Reachability and Strong Connectivity, Traversals, Transitive Closure. Directed Acyclic Graphs - Topological Sorting), Problems on Weighted

Graphs (Shortest Paths. Spanning Trees). Introduction to Complexity Classes (P and NP) and NP-completeness. NP-Hard problems. Designing Algorithms for Hard Problems – Back tracking, Branch-and-Bound, and Approximation Algorithms.

SS ZG520 Wireless & Mobile Communication 5

Signal propagation in a mobile environment, modulation, coding, equalization; first generation generation systems; multiple access techniques like FDMA, TDMA, CDMA, spread spectrum sytems; second & third generation systems, UMTS, IMT-2000; Wireless LAN, Wireless ATM and Mobile IP; emerging trends in Wireless & Mobile Communication.

SS ZG521 Advanced Data Mining 4

Topics beyond conventional record data mining. Mining complex data structures. Tree/graph mining, sequence mining, web/text data mining, stream data mining, spatiotemporal data mining, mining multi-variate time series data, high-dimensional data clustering, and mining social networking sites. Mining data from multiple relations (Multi-relational Data Mining). Privacy preserving Data Mining. Distributed computing solutions for data intensive data mining.

SS ZG525 Advanced Computer Networks 5

Topics in advanced networking – Quality of Service in IP networks, IPv6, Wireless and Mobile Networks, Carrier Technologies (Frame Relay, FDDI, ISDN, ATM), Peer-to-Peer Networks and Overlays, Routing and QoS Issues in Optical Networks.

SS ZG526 Distributed Computing 5

Course description to be developed.

SS ZG527 Cloud Computing 5

Concurrency and distributed computing, message passing over the network, connectivity and failure models, local vs remote connectivity, distributed resource modeling, distributed data models; replication & consistency; virtualization; CPU virtualization, memory and storage virtualization, virtualized networks, computing over WAN and Internet; computing on the cloud, computing models, service models and service contracts, programming on the cloud; Cloud infrastructure, LAN vs Wan issue, resource scaling and resource provisions, performance models, scalability, performance measurement and enhancement techniques; cloud applications and infrastructure services.

SS ZG531 Pervasive Computing 4

Select application architectures; hardware aspects; human-machine interfacing; device technology: hardware, operating system issues; software aspects, java; device connectivity issues and protocols; security issues; device management issues and mechanisms; role of web; wap devices and architectures; voice-enabling techniques; PDAs and their operating systems; web application architectures; architectural issues and choices; smart card-based authentication mechanisms; applications; issues and mechanisms in WAP-enabling; access architectures; wearable computing architectures.

SS ZG536 Advanced Statistical Techniques for Analytics 4

Course description to be developed.

SS ZG537 Information Retrieval 4

Course description to be developed.

SS ZG538 Infrastructure Management 4

Course description to be developed.

SS ZG547 Usability Engineering 5

Usability-driven approach to Information Design; software usability bridge& its critical components; Iterative & evaluation of a two-level approach of UCID (User-Centered Information Design); five key principles of UCID; getting UCID into organization ; Benefits of implementing UCID; key features of UCID;UCID process & analysis; traditional processes for information development & their limitations; Managing UCID; role of usability engineers; preparing the usability plan; implementing a metrics program in typical UCID projects; key contributors; goal setting for software usability & information quality; critical design goals; designing the information architecture ;designing the specifications & prototypes; evaluating prototypes; two-level design activities; designing software labels; designing effective messages; designing online support elements & printed support elements; achieving information design goals; online search & navigation; evaluating information; two-level evaluation; approach achieving information design goals for improved software usability; testing information & validating; quality indicators; retrievability; implementation techniques & issues

;Application of Usability Engineering in typical live projects to validate improved software usability .

SS ZG548 Advanced Data Mining 4

Topics beyond conventional record data mining. Mining complex data structures. Tree/graph mining, sequence mining, web/text data mining, stream data mining, spatiotemporal data mining, mining multi-variate time series data, high-dimensional data clustering, and mining social networking sites. Mining data from multiple relations (Multi-relational Data Mining). Privacy preserving Data Mining. Distributed computing solutions for data intensive data mining.

SS ZG552 Software Testing Methodologies 4

Concepts and principles of software testing and quality assurance; software testing tools; functional, structural, integration and system testing techniques; software testing process and its management; evaluation of test effectiveness; testing specialized systems and applications; automated software testing; case studies.

SS ZG554 Distributed Data Systems 5

Distributed File Systems - File System Models; Replication and Synchronization - Caching; Failure & Recovery; File System Security. Distributed Databases - Distributed Data Sources and Updates; Database Connectivity; Concurrency Control and Distribution mechanism; Distributed indexing schemes. Database security. Data on the Web - Web as a distributed data repository. Data Collection and Use Crawlers, Search Engines, and Indexing Schemes. Information Retrieval Techniques. Data Exchange - Hierarchical Data Models, XML, and query languages. Semi-structured / Unstructured data - querying and synchronization. Pervasive Data - Data distribution and access for non-computing devices, small computing devices, embedded computing devices and sensory devices.

SS ZG562 Software Engineering & Management 5

Current concepts, methods, techniques, and tools of the software engineering process; software process models; process definition and assessment; software measurement and metrics; project planning, estimation and control; requirements analysis and specification, design methods; quality assurance and testing; configuration management; process improvement; case studies and project work.

SS G566 Secure Software Engineering 5

Best practices for designing secure systems, software engineering principles for designing secure systems, criteria for designing secure systems; analysis of system properties and verification of program correctness; use of formal methods and verification for security; tools for verification of security properties; techniques for software protection (such as code obfuscation, tamper-proofing and watermarking) and their limitations; analysis of software based attacks (and defenses), timing attacks and leakage of information, and type safety.

SS ZG582 Telecom Network Management 5

Network architecture and protocols; LAN, MAN and WANs; internetworking; network planning; network management concepts and standards; administrative, operational and fault management; security issues; remote network management.

SS ZG622 Software Project Management 4

Managing a software development project, concepts, objects of a project, environment of a software project, system development life cycle, tools, review process; documentation in software program management, procedures, diagramming techniques, management; Planning and monitoring a software project, project planning, management tools, software project definitions, project management packages, project control; software project definition, classification, project sizes and methodologies, feasibility, requirements and start-up; programmer productivity; software planning, control tools, accelerated design; prototyping and role in software project management; software production and software project management; software system installation, managing testing requirements, test plans, alpha and beta systems; emerging directions in project management.

SS ZG626 Hardware Software Co-Design 5

FPGA and ASIC based design, Low-Power Techniques in RT Embedded Systems On-chip networking. Hardware Software partitioning and scheduling, Co-simulation, synthesis and verifications, Architecture mapping, HW-SW Interfaces and Re-configurable computing.

SS ZG652 Software Maintenance Management 4

Issues in software maintenance, conceptual issues, scale of effort issues, organizational

issues, productivity techniques issues, problem area issues; application systems; maintenance effort; impact of development tools and organizational controls; problems of maintenance; software evolution and maintenance; change management; impact analysis; system release planning; corrective maintenance; adaptive maintenance; perfective maintenance; reengineering source code, restructuring code, maintainability, flexibility, reusability, reliability, efficiency, reengineering tools; software testing & maintenance testing; system release and configuration management; managing the software maintenance process.

SS ZG653 Software Architectures 5

Systems engineering and software architectures; Hatley-Pirbhai architectural template; architecture flow diagrams; requirements engineering and software architecture; architectural design processes; design post-processing; real-time architectures; architectural design patterns; software architecture and maintenance management; object oriented architectures; client-server architectures; forward engineering for object oriented and client-server architectures; emerging software architectures.

SS ZG656 Networked Embedded Applications 4

Networked embedded systems, Clock synchronization, Protocol mechanisms protocol performance, CAN Bus architecture, USB Architecture, Embedded Internet, Distributed computing, Use of Java in building networked systems, Reliability & Fault Tolerance etc. Mission-critical distributed real-time applications, e.g., military, air traffic control; Prototyping benchmark applications, e.g. simulated air traffic visualization, radar display; Networking: TCP/IP, distributed objects; Embedded system programming and middleware: I/O, analog / digital conversion, DSP, runtime monitoring of CPU, processes, network equipment; Modeling distributed real-time systems; Quality of service maintenance.

SS ZG661 Software Quality Management 4

Software quality challenges and expectations; quality dilemma; software life cycle and link to quality; quality gates, formal reviews, system requirement reviews, preliminary design reviews, critical design reviews, test reviews; engineering reviews, walkthroughs, inspections, internal reviews; quality gate categories; technical environment and quality; planning for software quality, quality requirements for planning, quality needs, elements of quality planning, quality assessments during planning, software quality organization requirements; quality evaluation of software development process, process quality attributes, measuring software process quality; software process metrics; quality gate integrity; software product quality, standards and conventions, metrics; quality hierarchy, factors; quality assessment; quality evaluation techniques, reviews, walkthroughs, audit, inspections, analytical evaluation techniques; quality systems.

ST* ZG511 Matrix Methods in Civil Engineering 5

Matrix techniques; basic equations of solid mechanics; variational methods; finite difference and finite element methods; applications to structural mechanics, soil and rock mechanics, fluid mechanics, and hydraulic structures.

ST* ZG513 Advanced Computational Techniques 4

Interpolation, Polynomial Interpolation, Lagrange, Newton's Interpolation, Numerical integration, Wilson θ Method, Newmark's Method, Gauss and Hermitian Quadrature, Quadrature rules for multiple integrals, Large system of linear simultaneous equations, Direct and iterative algorithms based on Gauss elimination, Gauss Seidel method and symmetric banded equations, storage schemes – skyline, band solver, frontal solver, Cholesky decomposition, Non-linear system of equations, Eigen value problems, Forward iteration, Inverse iteration, Jacobi, Given's method, Transformation of generalized Eigen value problem to standard form, Vector iteration method, Initial and boundary value problems, Solution of first and second order differential equations using Euler, modified Euler, and Runge-Kutta methods, Finite difference operators.

ST* ZG514 Structural Optimization 4

Introduction, Engineering Optimization Problems, Optimal problem formulation, Single-variable optimization algorithms, Bracketing methods, Region Elimination methods, Gradient-based methods, Multivariable optimization algorithms, Evolutionary optimization methods, Simplex Search method, Hooke-Jeeves pattern search method, Powell's conjugate direction method, Cauchy's method, Newton's method, Conjugate

Gradient method, Constrained Optimization algorithms, Kuhun-Tucker conditions, Transformation methods, Direct search for constrained minimization, Feasible Direction Method, Specialized algorithms, Integer Programming, Geometric Programming, Nontraditional optimization Algorithms, Genetic algorithms, Simulated Annealing, Structural Optimization, Methods of optimal design of structural elements, minimum weight design of truss members, optimum reinforced design of R.C. C. Slabs and beams, Optimization to the design of structures such as multi-storey buildings, water tank, shell roofs, folded plates.

ST* ZG521 Topics in Structural Engineering 5

Introduction to structural optimization, application to simple structures such as trusses, and simple frames; Theory of plates and its applications in Civil Engineering; folded plate design; theory and design of shell structures specifically with application in structures covering large area.

ST* ZG522 Structural Health Assessment and Rehabilitation 4

Introduction, Overview of present repair, retrofitting, and strengthening practices, Distress identification, Repair management, Causes of deterioration and durability aspects, Holistic models of Deterioration of RCC, Durability Aspects, Intrinsic and Extrinsic causes an stages of Distress, Condition Survey and Non-destructive Evaluation, Classes of Damages and Repair Classification, Structural Analysis and Design, Reserve Strength, Evaluation of Building Configuration, Repair materials and their selection, Rehabilitation and Retrofitting Methods, Analysis and Design of Externally FRP and ECC Strengthened Structures, Retrofitting using External Unbonded Post-tensioning and Near Surface Mounted FRP Rebars, Durability Based Design of FRP Reinforced/Strengthened Bridge Girders, Case Study Problems.

ST* ZG523 Advanced Concrete Technology 4

Components of Concrete, chemical properties of cement & cementitious paste, properties of aggregates; chemistry of admixtures: mineral, chemical; effect of concrete composition on properties of fresh concrete and hardened concrete; Durability of concrete and its relation with concrete composition; Techniques for non-destructive evaluations (NDE) of concrete; Concrete mix design; Special concrete, Concrete with alkali activated binder.

ST* ZG524 Advanced Concrete Structural Design 5

Design of indeterminate beams and frames; Design of beam-column joints, Design of flat slabs, Analysis of slab using yield-line theory; Design of circular slabs; Design of beams curved in plan, Design of Folded plates and cylindrical shells, Design of Water Tanks.

ST* ZG532 Advanced Soil Mechanics 4

Modern concept of soil structure and its application in explaining its behaviour; effects of seepage on equilibrium of ideal soil; mechanics of drainage; theories of elastic subgrade reaction; theories of semi infinite elastic soils; vibration problems.

ST* ZG533 Advanced Composite Materials for Structures 4

Introduction and History of FRP, Overview of Composite materials, Physical and Mechanical Properties and Test methods, Design of RC Structures reinforced with FRP Bars, Flexural Strengthening of RC Beams, Shear Strengthening of Beams, Flexural Strengthening of Slabs, Strengthening of Axially and Eccentrically Loaded Columns, Seismic Retrofit of Columns.

ST* ZG551 Dynamics of structures 4

Free and forced Vibration Analysis of SDOF system, Response to general dynamic loadings, Numerical evaluation of dynamic response, Effect of damping; Free and forced vibration of undamped and damped multi degree of freedom systems; Modeling for multi degree of freedom systems; Equation of motions, Evaluation of natural frequencies and mode shapes, orthogonality conditions, Modal analysis and modal combination rules, Numerical evaluation of dynamic response for multi degree of freedom, time history analysis; support excited vibration, analysis of non-linear systems, Free and forced vibration analysis of continuous systems, Random vibrations, Stochastic response; Vibration isolation, vibration absorber and tuned mass damper; Evaluation of wind, blast, wave loading and other dynamic forces on structure; Modeling and dynamic analysis of buildings, bridges, water tank, liquid storage tanks, stack like structure, machine foundations etc.

ST* ZG552 Advanced Structural Mechanics and Stability 4

Analysis of stress and strain in three dimension domain, deviatoric stress and strain; stress and strain invariants, compatibility conditions, equilibrium equations; stress-strain relations for anisotropic, orthotropic and isotropic elastic materials; yield criterion; plastic potential and flow rules. Problems on plane stress and plain strain conditions, Airy stress function; Axi-symmetric problems; torsion of prismatic bars, circular and non-circular sections; thin-walled sections, membrane and sand-heap analogies, concept of stability of structures and examples of instability. Stability of structures with one and two degree of freedom, buckling of columns; beam-columns and simple frames, lateral torsion buckling of beams; and introduction to postbuckling of plates.

ST* ZG553 Theory of Plates and Shells 4

Analysis procedure and the basic theory of plates and shells; Different kinds of plates such as rectangular, circular, and elliptical; Different kinds of shell structures such as shell of revolution: spherical shells, cylindrical shells and special shell structures; Principles and applications of bending of plates, membrane theory, bending of shells, and stability of plates and shells; Kirchoff theory, Reissner-Mindlin-Naghadi type theories, rectangular plates-solution by double Fourier series, membrane theory of shells, and case study on plates and shells using numerical tools.

ST* ZG554 Advanced Structural Design 4

Practical design problems on analysis and design of multistoried and industrial buildings, chimney, retaining wall, water tank, towers, etc using both the steel and concrete materials. Modeling of structures subjected to various load (DL, LL, WL, EQ etc.) combinations, structural analysis, design, and detailing of specific advanced concrete and steel structures.

ST* ZG610 Computer Aided Analysis and Design in Civil Engineering 5

Computer languages; CAD, graphics; database management system; knowledge base expert system; development of preprocessor and post processor with graphic interface; analysis and design, optimization techniques, genetic algorithms, software development for analysis and design, interfacing.

ST* ZG612 Advanced steel Structures 4

Steel properties; high strength steels, structural behaviour, analysis and design; loads and environmental effects; load and resistant factor design (LRFD); column and beams; connections; member under combined loads; bracing requirements; composite members; plastic analysis and design; tall steel buildings, detailing in steel structures.

ST* ZG613 Advanced concrete Structures 4

Materials; high strength concrete, flexure analysis and design; shear and diagonal tension; bond and anchorage; serviceability; torsion; columns; joints; indeterminate beams and frames; yield line analysis; strip method for slabs; composite construction; footing and foundations; concrete building system; concrete tall buildings, detailing in concrete structures.

ST* ZG614 Prestressed Concrete Structures 4

Effect of prestressing; source of prestress, prestressing steel; concrete for construction; elastic flexure analysis, flexural strength; partial prestressing; flexural design based on concrete stress limits; tension profile; flexural design based on load balancing; losses due to prestress; shear diagonal tension and web reinforcement; bond stress, transfer and development length, anchorage zone design, deflections.

ST* ZG615 Earthquake Engineering 4

Single and multi degree freedom system; seismic risk, causes and effects of earthquakes; seismicity, determination of site characteristics; design earthquakes; earthquake resistant design philosophy; seismic response; earthquake resistant design of structures; detailing for earthquake resistance in concrete and steel structures.

ST* ZG616 Bridge Engineering 4

Purpose of bridge; classification of bridges; characteristics of each bridge; loads stresses and combinations; design of RC bridges; design of non-composite and composite bridges; prestressed bridge; continuous spans, box girders, long span bridges; substructure design for bridges.

ST* ZG617 Advanced Structural Analysis 4

Flexibility Method; stiffness method; beam curved in plan; two dimensional and three dimensional analysis of structures; shear deformations, shear

wall analysis; interactive software development for analysis of structures.

ST* ZG618 Design of Multi-Storey Structures 4

Loads and stresses; building frames; framing systems, bracing of multistorey building frames; diaphragms; shear walls and cover; tube structure, approximate analysis and preliminary design; frame analysis; design loading, wind effects and response, earthquake response of structures.

ST* ZG619 Finite element analysis 5

Fundamentals of Finite Element Method (FEM); basic formulations of FEM; assembly of elements, solution techniques; 2D and 3D problems; review of the isoparametric elements; thin and thick plate elements; introduction to shell formulations; use of newly developed elements; mixed finite element method; material and geometric nonlinear problems; application of FEM to civil engineering problems, programming FEM.

ST* ZG620 Advanced Foundation Engineering 4

Types of foundations, capacity and settlement of foundations, soil properties, design considerations, discrete method for analysis, design of shallow and deep foundations, failure in foundations, remedial measures, case studies of foundations.

ST* ZG621 Fluid Dynamics 5

Mechanics of turbulent flow; semi-empirical expressions; statistical concepts; stability theory;flow of non-Newtonian fluids; stationary and moving shock waves; Prandtl-Mayer expressions; two and three dimensional subsonic and supersonic flow; methods of characteristics; small perturbation theory and similarity rules.

ST* ZG622 Soil-Structure-Interaction 4

Importance of soil-structure interaction, basic theories, types of interaction problems, numerical modelling, experimental and field investigations, prediction of failure mechanism, economic considerations.

ST* ZG623 Ground Improvement Techniques 4

Requirements for ground improvement, various techniques of improvement, water table lowering, ground freezing, electro-osmosis, compaction, tamping, use of explosives, vibratory probes, thermal treatment, addition of lime, cement and bitumen, gravel and sand columns, preloading techniques, reinforced earth, soil replacement techniques.

ST* ZG631 Selected Topics in Soil Mechanics and Geotechnical Engineering 4

Formation of soil & soil deposits, subsurface exploration, collapsible soils identification treatment & design consideration, review of casting expansion models in soil, treatment of weak soil, numerical modelling, fracture propagation & fracture energy, fluid infiltered materials, modern trends.

ST* ZG641 Theory of Elasticity and Plasticity 5

Basic equations of theory of elasticity; elementary elasticity problems in two and three dimensions; theories of plastic flow; problems in plastic flow of ideally plastic and strain hardening materials; theory of metal forming processes.

STPWG ZG511 Matrix Methods in Civil Engineering 5

Matrix techniques; basic equations of solid mechanics; variational methods; finite difference and finite element methods; applications to structural mechanics, soil and rock mechanics, fluid mechanics, and hydraulic structures.

STPWG ZG513 Advanced Computational Techniques 4

Interpolation, Polynomial Interpolation, Lagrange, Newton's Interpolation, Numerical integration, Wilson θ Method, Newmark's Method, Gauss and Hermitian Quadrature, Quadrature rules for multiple integrals, Large system of linear simultaneous equations, Direct and iterative algorithms based on Gauss elimination, Gauss Seidel method and symmetric banded equations, storage schemes – skyline, band solver, frontal solver, Cholesky decomposition, Non-linear system of equations, Eigen value problems, Forward iteration, Inverse iteration, Jacobi, Given's method, Transformation of generalized Eigen value problem to standard form, Vector iteration method, Initial and boundary value problems, Solution of first and second order differential equations using Euler, modified Euler, and Runge-Kutta methods, Finite difference operators.

STPWG ZG514 Structural Optimization 4

Introduction, Engineering Optimization Problems, Optimal problem formulation, Single-variable optimization algorithms, Bracketing methods, Region Elimination methods, Gradient-based

methods, Multivariable optimization algorithms, Evolutionary optimization methods, Simplex Search method, Hooke-Jeeves pattern search method, Powell's conjugate direction method, Cauchy's method, Newton's method, Conjugate Gradient method, Constrained Optimization algorithms, Kuhun-Tucker conditions, Transformation methods, Direct search for constrained minimization, Feasible Direction Method, Specialized algorithms, Integer Programming, Geometric Programming, Nontraditional optimization Algorithms, Genetic algorithms, Simulated Annealing, Structural Optimization, Methods of optimal design of structural elements, minimum weight design of truss members, optimum reinforced design of R.C. C. Slabs and beams, Optimization to the design of structures such as multi-storey buildings, water tank, shell roofs, folded plates.

STPWG ZG521 Topics in Structural Engineering 5

Introduction to structural optimization, application to simple structures such as trusses, and simple frames; Theory of plates and its applications in Civil Engineering; folded plate design; theory and design of shell structures specifically with application in structures covering large area.

STPWG ZG522 Structural Health Assessment and Rehabilitation 4

Introduction, Overview of present repair, retrofitting, and strengthening practices, Distress identification, Repair management, Causes of deterioration and durability aspects, Holistic models of Deterioration of RCC, Durability Aspects, Intrinsic and Extrinsic causes an stages of Distress, Condition Survey and Non-destructive Evaluation, Classes of Damages and Repair Classification, Structural Analysis and Design, Reserve Strength, Evaluation of Building Configuration, Repair materials and their selection, Rehabilitation and Retrofitting Methods, Analysis and Design of Externally FRP and ECC Strengthened Structures, Retrofitting using External Unbonded Post-tensioning and Near Surface Mounted FRP Rebars, Durability Based Design of FRP Reinforced/Strengthened Bridge Girders, Case Study Problems.

STPWG ZG523 Advanced Concrete Technology 4

Components of Concrete, chemical properties of cement & cementitious paste, properties of aggregates; chemistry of admixtures: mineral, chemical; effect of concrete composition on properties of fresh concrete and hardened concrete; Durability of concrete and its relation with concrete composition; Techniques for non-destructive evaluations (NDE) of concrete; Concrete mix design; Special concrete, Concrete with alkali activated binder.

STPWG ZG524 Advanced Concrete Structural Design 5

Design of indeterminate beams and frames; Design of beam-column joints, Design of flat slabs, Analysis of slab using yield-line theory; Design of circular slabs; Design of beams curved in plan, Design of Folded plates and cylindrical shells, Design of Water Tanks.

STPWG ZG532 Advanced Soil Mechanics 4

Modern concept of soil structure and its application in explaining its behaviour; effects of seepage on equilibrium of ideal soil; mechanics of drainage; theories of elastic subgrade reaction; theories of semi infinite elastic soils; vibration problems.

STPWG ZG533 Advanced Composite Materials for Structures 4

Introduction and History of FRP, Overview of Composite materials, Physical and Mechanical Properties and Test methods, Design of RC Structures reinforced with FRP Bars, Flexural Strengthening of RC Beams, Shear Strengthening of Beams, Flexural Strengthening of Slabs, Strengthening of Axially and Eccentrically Loaded Columns, Seismic Retrofit of Columns.

STPWG ZG551 Dynamics of structures 4

Free and forced Vibration Analysis of SDOF system, Response to general dynamic loadings, Numerical evaluation of dynamic response, Effect of damping; Free and forced vibration of undamped and damped multi degree of freedom systems; Modeling for multi degree of freedom systems; Equation of motions, Evaluation of natural frequencies and mode shapes, orthogonality conditions, Modal analysis and modal combination rules, Numerical evaluation of dynamic response for multi degree of freedom, time history analysis; support excited vibration,

analysis of non-linear systems, Free and forced vibration analysis of continuous systems, Random vibrations, Stochastic response; Vibration isolation, vibration absorber and tuned mass damper; Evaluation of wind, blast, wave loading and other dynamic forces on structure; Modeling and dynamic analysis of buildings, bridges, water tank, liquid storage tanks, stack like structure, machine foundations etc.

STPWG ZG552 Advanced Structural Mechanics and Stability 4

Analysis of stress and strain in three dimension domain, deviatoric stress and strain; stress and strain invariants, compatibility conditions, equilibrium equations; stress-strain relations for anisotropic, orthotropic and isotropic elastic materials; yield criterion; plastic potential and flow rules. Problems on plane stress and plain strain conditions, Airy stress function; Axi-symmetric problems; torsion of prismatic bars, circular and non-circular sections; thin-walled sections, membrane and sand-heap analogies, concept of stability of structures and examples of instability. Stability of structures with one and two degree of freedom, buckling of columns; beam-columns and simple frames, lateral torsion buckling of beams; and introduction to postbuckling of plates.

STPWG ZG553 Theory of Plates and Shells 4

Analysis procedure and the basic theory of plates and shells; Different kinds of plates such as rectangular, circular, and elliptical; Different kinds of shell structures such as shell of revolution: spherical shells, cylindrical shells and special shell structures; Principles and applications of bending of plates, membrane theory, bending of shells, and stability of plates and shells; Kirchoff theory, Reissner-Mindlin-Naghadi type theories, rectangular plates-solution by double Fourier series, membrane theory of shells, and case study on plates and shells using numerical tools.

STPWG ZG554 Advanced Structural Design 4

Practical design problems on analysis and design of multistoried and industrial buildings, chimney, retaining wall, water tank, towers, etc using both the steel and concrete materials. Modeling of structures subjected to various load (DL, LL, WL, EQ etc.) combinations, structural analysis, design, and detailing of specific advanced concrete and steel structures.

STPWG ZG610 Computer Aided Analysis and Design in Civil Engineering 5

Computer languages; CAD, graphics; database management system; knowledge base expert system; development of preprocessor and post processor with graphic interface; analysis and design, optimization techniques, genetic algorithms, software development for analysis and design, interfacing.

STPWG ZG612 Advanced steel Structures 4

Steel properties; high strength steels, structural behaviour, analysis and design; loads and environmental effects; load and resistant factor design (LRFD); column and beams; connections; member under combined loads; bracing requirements; composite members; plastic analysis and design; tall steel buildings, detailing in steel structures.

STPWG ZG613 Advanced concrete Structures 4

Materials; high strength concrete, flexure analysis and design; shear and diagonal tension; bond and anchorage; serviceability; torsion; columns; joints; indeterminate beams and frames; yield line analysis; strip method for slabs; composite construction; footing and foundations; concrete building system; concrete tall buildings, detailing in concrete structures.

STPWG ZG614 Prestressed Concrete Structures 4

Effect of prestressing; source of prestress, prestressing steel; concrete for construction; elastic flexure analysis, flexural strength; partial prestressing; flexural design based on concrete stress limits; tension profile; flexural design based on load balancing; losses due to prestress; shear diagonal tension and web reinforcement; bond stress, transfer and development length, anchorage zone design, deflections.

STPWG ZG615 Earthquake Engineering 4

Single and multi degree freedom system; seismic risk, causes and effects of earthquakes; seismicity, determination of site characteristics; design earthquakes; earthquake resistant design philosophy; seismic response; earthquake resistant design of structures; detailing for earthquake resistance in concrete and steel structures.

STPWG ZG616 Bridge Engineering 4

Purpose of bridge; classification of bridges; characteristics of each bridge; loads stresses and combinations; design of RC bridges; design of non-composite and composite bridges; prestressed bridge; continuous spans, box girders, long span bridges; substructure design for bridges.

STPWG ZG617 Advanced Structural Analysis 4

Flexibility Method; stiffness method; beam curved in plan; two dimensional and three dimensional analysis of structures; shear deformations, shear wall analysis; interactive software development for analysis of structures.

STPWG ZG618 Design of Multi-Storey Structures 4

Loads and stresses; building frames; framing systems, bracing of multistorey building frames; diaphragms; shear walls and cover; tube structure, approximate analysis and preliminary design; frame analysis; design loading, wind effects and response, earthquake response of structures.

STPWG ZG619 Finite element analysis 5

Fundamentals of Finite Element Method (FEM); basic formulations of FEM; assembly of elements, solution techniques; 2D and 3D problems; review of the isoparametric elements; thin and thick plate elements; introduction to shell formulations; use of newly developed elements; mixed finite element method; material and geometric nonlinear problems; application of FEM to civil engineering problems, programming FEM.

STPWG ZG620 Advanced Foundation Engineering 4

Types of foundations, capacity and settlement of foundations, soil properties, design considerations, discrete method for analysis, design of shallow and deep foundations, failure in foundations, remedial measures, case studies of foundations.

STPWG ZG621 Fluid Dynamics 5

Mechanics of turbulent flow; semi-empirical expressions; statistical concepts; stability theory;flow of non-Newtonian fluids; stationary and moving shock waves; Prandtl-Mayer expressions; two and three dimensional subsonic and supersonic flow; methods of characteristics; small perturbation theory and similarity rules.

STPWG ZG622 Soil-Structure-Interaction 4

Importance of soil-structure interaction, basic theories, types of interaction problems, numerical modelling, experimental and field investigations, prediction of failure mechanism, economic considerations.

STPWG ZG623 Ground Improvement Techniques 4

Requirements for ground improvement, various techniques of improvement, water table lowering, ground freezing, electro-osmosis, compaction, tamping, use of explosives, vibratory probes, thermal treatment, addition of lime, cement and bitumen, gravel and sand columns, preloading techniques, reinforced earth, soil replacement techniques.

STPWG ZG631 Selected Topics in Soil Mechanics and Geotechnical Engineering 4

Formation of soil & soil deposits, subsurface exploration, collapsible soils identification treatment & design consideration, review of casting expansion models in soil, treatment of weak soil, numerical modelling, fracture propagation & fracture energy, fluid infiltered materials, modern trends.

STPWG ZG641 Theory of Elasticity and Plasticity 5

Basic equations of theory of elasticity; elementary elasticity problems in two and three dimensions; theories of plastic flow; problems in plastic flow of ideally plastic and strain hardening materials; theory of metal forming processes.

TA ZC163 Computer Programming 4

Basic Computing Steps and Flow Charting (Assignment, Sequencing, Conditionals, Iteration). Programming Constructs – Expressions, Statements, Conditionals, Iterators/Loops, Functions/ Procedures; Data Types – Primitive Types, Tuples, Choices (Unions or Enumerations), Lists/Arrays, Pointers and Dynamically Allocated Data. Input output and Files. Laboratory Component: Programming Exercises involving development and testing of iterative and procedural programs using bounded and unbounded iterations, function composition, random access lists, sequential access lists, dynamically allocated lists, and file access.

TA ZC164 Computer Programming 4

Basic Computing Steps and Flow Charting (Assignment, Sequencing, Conditionals, Iteration). Programming Constructs – Expressions, Statements, Conditionals, Iterators/Loops, Functions/ Procedures; Data Types – Primitive Types, Tuples, Choices (Unions or Enumerations), Lists/Arrays, Pointers and Dynamically Allocated Data. Input output and Files. Laboratory Component: Programming Exercises involving development and testing of iterative and procedural programs using bounded and unbounded iterations, function composition, random access lists, sequential access lists, dynamically allocated lists, and file access.

TA ZC142 Computer Programming 3

Elementary computer organization; introduction to Number Systems; Representation of integers, real numbers and characters on computers; concept of range and accuracy; Arithmetic Overflow; Algorithms and algorithm development; structured program development through step wise refinement. Introduction to C language; Functions; Recursion; Data structure & algorithms; File management & file handling; Problem solving using C.

TA ZC232 Engineering Measurements 3

Performance characteristics of measuring instruments, measurement methods for mechanical, electrical, radiant, chemical, magnetic and thermal energy variables. Emphasis in this course shall be on the operation and use of instruments.

TA ZC312 Technical Report Writing 3

Elements of effective writing; art of condensation; business letter writing; memos; formal reports; technical proposals; conducting, and participating, meetings; agenda and minutes; strategies for writing technical descriptions, definitions, and classifications; oral presentation; use of graphic and audio- visual aids; editing.

TE* ZG511 Soil Mechanics for Highway Engineering 4

Origin and classification of soils; physicochemical properties, index properties of soil, IS classification of soils and their applications in roads, airfields and embankments, Stresses within a soil, effective stress principle, Soil - water systems - capillarity, flow, Darcy's law, permeability, and tests for its determination, Stresses due to applied load, Stress analysis for embankments and pavements, Compressibility and consolidation characteristics, over consolidation ratio, determination of coefficients of consolidation and secondary compression (creep), consolidation under construction loading, Shear Strength and Mohr Coulomb strength criterion, direct and triaxial shear tests, drained, consolidated undrained and undrained tests, strength of loose and dense sands, NC and OC soils, dilation, pore pressures, Skempton's coefficients. Compaction characteristics, water content – dry unit weight relationships, OMC, maximum dry unit weight, field compaction, quality control, etc. Analysis and design of highway embankment, Characterization of ground, site investigations, methods of drilling, sampling, in situ test - SPT, CPT, plate load and dynamic tests, in-situ permeability and groundwater level, etc., Earth Pressure Theories, Selection and design of earth retaining structures

TE* ZG512 Soil Exploration and Field Techniques 4

Necessity and Importance of soil exploration, Method of sub surface exploration Test pits, Trenches, Wash boring, Percussion drilling , Rotary drilling, Factors affecting the selection of a suitable method of boring. Extent of boring, Factors controlling spacing and depth of bore holes, Spacing and depth of various Civil engineering structures. Indirect method of exploration, Seismic method, Electrical resistivity, Resistivity sounding and profiling, Different method of stabilization of the bore holes, their relative merits and demerits. Different method of ground water observation: Time lag in observation, sampling of ground water. Source of disturbance and their influence. Type of sampler, Principle of design of sampler, Representative and undisturbed sampling in various types of soils. Surface sampling, Amount of sampling, Boring and sampling record, Preservation and shipment of sample, preparation of bore log. Penetration tests, Standard penetration tests, Dynamic cone penetration tests with and without bentonite slurry, Static cone penetration tests, Pressure meter, Dilatometer, factors affecting the penetration tests. Various corrections in the test results. Interpretation of test result for design and determination of modulus of deformation. Small size penetrometers, Plate load test, Field CBR, Dynamic cone penetrometer for CBR evaluation.

Various corrections, empirical correlations and interpretation of test result for design in transportation engineering.

TE* ZG513 Reinforced Soil Structures for Transportation Engineering 4

Introduction and need for geosynthetics, Types, functions, properties and testing of geosynthetics, Strength analysis of reinforced soil, different types of soil retaining structure, Design codes for reinforced soil retaining walls, External and internal stability of reinforced soil retaining walls, Bearing capacity of footings resting on reinforced soil, Geo-synthetics in flexible pavements, geosynthetics application and design for Separation, Filtration, drainage, erosion control, barrier in highway engineering, Reinforced slope, Design and Construction of Geosynthetic Reinforced Embankments on Soft Subsoils, Other methods of reinforcement like soil nailing, rock bolting, stone columns etc., Practical case studies of reinforced soil structures, Applications of Geocell, PVD, Jute Geotextile and Coir Geotextile in transportation engineering, case studies.

TE* ZG514 Advanced Concrete Technology in Transportation Engineering 4

Cements including blended cements, chemical and physical processes of hydration; concrete admixtures: pulverized fuel ash, ground granulated blast furnace slag, silica fume; effects on properties of concretes, mortars and grouts; methods of test; applications; mixer blends and blended cement; admixtures: Review of types and classification; chemical composition; origin and manufacture; actions and interactions; usage; effects on properties of concretes, mortars and grouts; methods of test; applications; Aggregates: Review of types; elementary mineralogy and petrology; aggregate prospecting; quarrying and gravel-winning practice; production of artificial aggregates; sampling and testing; effects on properties of concretes, mortars and grouts; Fresh concrete: Rheology of concentrated suspensions, pastes, mortars and concretes; workability, segregation and bleeding. Theory and principles governing the correct placing and compaction of concrete; Setting and hardening concrete: Plastic settlement and plastic shrinkage; exothermic characteristics; early age thermal movements; strength development; maturity, accelerated curing; assessment of safe stripping times; hot and cold weather concreting; Properties of hardened concrete: Strength; deformation under load; elasticity; creep; drying shrinkage and other volume changes. Thermal properties; Durability of concrete and concrete construction: Durability concept; pore structure and transport processes; reinforcement corrosion; fire resistance; frost damage; sulphate attack; alkali silica reaction; delayed ettringite formation; methods of providing durable concrete; short-term tests to assess long-term behaviour; Mix design: Review of methods and philosophies; mix design for special purposes; Special concretes: Lightweight concrete: autoclaved aerated concrete, no-fines concrete, lightweight aggregate concrete and foamed concrete. High strength concrete; refractory concrete; high density and radiation-shielding concrete; polymer concrete; fibre-reinforced concrete; mortars; renders; recycled concrete; Special processes and technology for particular types of structure: Sprayed concrete; underwater concrete; grouts, grouting and grouted concrete; mass concrete; slipform construction; pumped concrete; concrete for liquid retaining structures; vacuum process; concrete coatings and surface treatments; Ready-mixed concrete; Precast concrete; Concrete for roads and industrial floors

TE* ZG515 GIS Applications in Transportation Engineering 4

Remote sensing : Physics of remote sensing, Ideal remote sensing system, Remote sensing satellites and their data products, Sensors and orbital characteristics, Spectral reflectance curves, resolution and multi concept, FCC, Interpretation of remote sensing images. Digital image processing: Satellite image – characteristics and formats, Image histogram, Introduction to image rectification, Image enhancement, Land use and land cover classification system. Geographic information system (GIS) : Basic concept of geographic data, GIS and its components, Data acquisition, Raster and vector formats, Topography and data models, Spatial modelling, Data output, GIS applications. Global positioning system (GPS) : Introduction, Satellite navigation system, GPS- space segment, Control segment, User segment, GPS satellite signals, Receivers; Static, Kinematic and Differential GPS. Applications in Transportation Engineering: Intelligent Transport System, Urban Transport Planning, Accident Studies, Transport

System Management, Road Network Planning, Collecting Road Inventory

TE* ZG516 CAD Laboratory in Transportation Engineering 4

Basic AUTOCAD commands, exercises on earth work computations, cross sections of highways, exercises on packages like MX Roads to compute earth work, geometric design of highways, Exercises on HDM 4 package

TE* ZG517 Road Safety and Audit 4

Characteristics of accidents, accidents vs. crash, land use and road environment for safety, Multidisciplinary approach to planning for traffic safety and injury control; pre-crash and post-crash models; role of vehicle, roadway traffic, driver, and environment on road safety, crash and injuries.; accident analysis, conflict points at intersections, pedestrian safety, road safety improvement strategies; Road safety audit and analysis: Stages, aim and objectives, principles, process, roles and responsibility, Specific parameters, design standards, various stages of road safety audit, Road safety audit for rural roads, Checklists, Structuring of report. Steps in treatment of crash locations, diagnosing crash problem and solutions, accident report form, storing of data, using and interpreting crash data, identifying and prioritizing hazardous locations, condition and collision diagrams; Vulnerable road users: crashes related to pedestrian and bicyclists, their safety, provision for disabled; Crash reconstruction: understanding basic physics, calculation of speed for various skid, friction, drag, and acceleration scenarios; Engineering Measures: Speed humps and bumps, speed tables and cushions; Community awareness and education; Enforcement- Non-physical measures- physical measures; Road Safety Audit Case study.

TE* ZG518 Pavement Analysis and Design 4

Types of pavements, flexible, rigid and semi-rigid; components of pavement structure; stresses and strains in flexible and rigid pavements: layered systems, visco-elastic solutions; stresses and deflections in rigid pavements; computer programmes for analysis of stresses and deflections in rigid pavements; traffic loadings, load equivalency factors, traffic projections and analysis; material characterization as input to pavement design; flexible pavement design using IRC, AASHTO, MEPDG methods; Rigid pavement design using IRC, AASHTO, MEPDG, ACI and PCA methods; design of overlays; Considerations in pavement drainage design.

TE* ZG519 Pavement Evaluation Field Project 4

Structural condition, Functional Condition and Safety evaluation of pavements, Flexible and Rigid Pavement Rating and establishment of Pavement Condition Index, Case study, involving a failed pavement structure, to investigate the condition and suggest remedial measures, Use of HDM 4 software for establishing the best alternative remedy for the chosen case study.

TE* ZG520 Infrastructure Planning and Management 4

The goals and perspectives of planning; forecasting and design of alternatives; plan testing: economic, financial and environmental evaluation; the challenges of managing infrastructure; Information management and decision support system; Concepts of total quality management; Economics: life-cycle analysis and maintenance, Rehabilitation and Reconstruction (M.R & R) programming; Infrastructure management system (IMS) development and implementation; Rural Infrastructure Planning.

TE* ZG521 Environmental Impact Assessment 4

Environment and global problems; Framing Environmental issues; effects of infrastructure development on environment; prediction and assessment of environmental impacts of infrastructure projects: technical and procedural aspects, guidelines and legal aspects of environmental protection, impacts on air, water, soil and noise environment, valuation, strategic assessment, mathematical modeling for environmental processes; social impact assessment (SIA), dislocation/disruption impact of Infrastructure projects; Life Cycle Assessments (LCA) and risk analysis methodologies; mitigation of environmental impacts; case studies; environmental management plan (EMP), national and international certification and guidelines including ISO.

TE* ZG523 Transportation Systems Planning and Management 4

System and environment; sequential transportation systems planning: trip generation, trip distribution, modal split and traffic assignment. Transportation Systems Management (TSM) actions: traffic management techniques for

improving vehicular flow, preferential treatment for high occupancy modes, demand management technique for reduced traffic demand, staggered hours, vehicle restrictions; planning for pedestrians, parking planning; Methods of accident data collection and analysis.

TE* ZG524 Urban Mass Transit Planning, Operations and Management 4

Modes of public transportation and application pf each to urban travel needs; Comparison of transit modes and selection of technology and transit service; Estimating demand in transit planning studies and functional design of transit routes; Terminal design; Management and operation of transit systems, Model for operational management; Fleet and crew management; Terminal management; Fiscal management.

TE* ZG528 Selection of Construction Equipment and Modeling 4

Selection and application of construction and earth moving equipment; Productivity analysis of equipment operations; mathematical models for construction operations; Quality issues in construction process modeling.

TE* ZG534 Pavement Material Characterization 5

Soil properties for highway engineers: Origin, properties of soils, tests on soils, Aggregates: origin, classification, requirements, properties, importance of aggregate gradation; bituminous materials: origin, preparation, properties and tests, criterion for selection of different viscosity grades of bitumen, modified binders and bituminous emulsions, Bituminous mixture design: Marshall method of mixture design, SUPERPAVE procedure of mixture design; mechanical properties of bituminous mixtures: resilient modulus, dynamic modulus, visco-elastic and fatigue characteristics. Warm mix asphalt, micro-surfacing, slurry seal, dense bituminous Macadam and bituminous concrete Cement concrete pavement materials: requirements and design of concrete mixture for rigid pavement, IRC and IS specifications and tests, joints, filler and sealant materials.

TE* ZG535 Highway Geometric Design 4

Highway functional classification; route layout and selection, design controls and criteria: turning paths, driver performance, traffic characteristics; highway capacity; access control; safety; environment; Elements of design: sight distance, horizontal alignment, transition curves, super elevation and side friction; vertical alignment: - grades, crest and sag curves; highway cross-sectional elements and their design; at-grade Inter-sections – sight distance consideration and principles of design, channelization, mini roundabouts, layout of roundabouts, inter-changes: major and minor interchanges, entrance and exit ramps, acceleration and deceleration lanes, bicycle and pedestrian facility design; parking layout and design; terminal layout and design, geometric design for express ways.

TE* ZG536 Traffic Engineering and Safety 4

Road users and their characteristics; traffic studies- volume, speed, origin-destination (O-D) and delay studies; analysis and interpretations of traffic studies; traffic forecasting; capacity and level of service analysis; traffic characteristics at un-signalized and signalized intersections; design of signalized intersections, capacity and LOS of signalized intersections, actuated signal control, signal coordination; traffic controls: signs, markings, street furniture; traffic regulations; parking studies; nature of traffic problems and their solutions; traffic safety: accidents- data collection and analysis; causes and prevention.

TE* ZG537 Transportation Economics and Finance 4

Need for economic evaluation; concept of total transport cost; fixed and variable costs, elasticity of demand, marginal costs; value of travel time, accident costs; methods of economic evaluation; taxation in road transport, user charges: fees and tolls; highway legislation; investment policies and pricing, issues in financing and subsidy policy, public private partnership (PPP) options in transport sector: BOT, BOOT, BOLT; feasibility studies, identification and sharing of risks in PPP projects, operation and management agreements.

TE* ZG539 Introduction to Discrete Choice Theory 4

Introduction, element of choice process, individual preferences, behavioral choice rule, utility based choice theory; data collection techniques, stated preference (SP) survey, revealed preference (RP) survey, paradigms of choice data; discrete choice models, property of discrete choice models, Multinomial logit model; overview and structure, Nested logit model formulation; discriminant analysis, Naive Bayes classification, classification trees, classification using nearest neighbors;

application of fuzzy logic and artificial neural network in discrete choice modeling.

TE* ZG543 Traffic Flow Theory 4

Traffic flow elements: speed, volume and density and their relationships; time-space diagrams, controlled access concept, freeway concept, system performances, measures of effectiveness; mathematical modeling; probabilistic & stochastic models of traffic flow process, discrete and continuous modeling: headways, gaps and gap acceptance; macroscopic models; car-following model; queuing models; fundamentals & development of queuing processes; traffic simulation; intelligent transportation systems (ITS).

TE* ZG545 Airport Planning and Design 4

Air Transport-structure and organization; forecasting air travel demand: trend forecasts and analytical methods; air freight demand; airport system; characteristics of the aircraft; airport planning: site selection, layout plan, orientation and length of runway; airport capacity and configuration; geometric design of runway, taxiway and aprons; passenger terminal function, passenger and baggage flow, design concepts, analysis of flow through terminals, parking configurations and apron facilities; air cargo facilities-flow through cargo terminals, airport lighting; airport drainage; pavement design; airport access problem; environmental impact of airports.

TE* ZG546 Highway Construction Practices 4

Road planning and reconnaissance; right of way selection; fixing of alignment; road construction techniques: construction staking, clearing and grubbing of the road construction area; subgrade construction: excavation and filling, compaction, preparation of sub grade, quality control tests as per MORTH specifications; granular subbase and base course construction: gravel courses, WBM, WMM, stabilized soil subbases, use of geo-textiles and geo-grids; construction of bituminous layers; concrete pavement construction; field quality control ; road making machinery.

TE* ZG547 Pavement Failures, Evaluation and Rehabilitation 4

Pavement deterioration, distress and different types of failures, pavement surface condition deterioration such as slipperiness, unevenness, rutting, cracking; pot holes, etc., causes, effects, methods of measurement and treatment, use of modern equipment for pavement surface condition measurements, Analysis of data, interpretation. Structural deterioration of pavements: causes, effects, methods of treatment. Structural evaluation of flexible pavements by rebound deflection method, analysis of data, design of overlay, use of FWD and other methods for evaluation of flexible and rigid pavements and their application. Evaluation of new pavement materials, model studies, pavement testing under controlled conditions, accelerated testing and evaluation methods, Test track studies. Instrumentation for pavement testing.

TE* ZG548 Pavement Management Systems 4

Components of pavement management systems, pavement maintenance measures; pavement performance evaluation: general concepts, serviceability, pavement distress survey systems, performance evaluation and data collection using different equipment; evaluation of pavement distress modeling and safety; pavement performance prediction: concepts, modeling techniques, structural condition deterioration models, mechanistic and empirical models, HDM-IV models, comparison of different deterioration models, functional and structural condition deterioration models; ranking and optimization methodologies: Recent developments, economic optimization of pavement maintenance and rehabilitation.

TE* ZG549 Rural Road Technology 4

Network planning, accessibility and mobility; road alignment and survey; geometric design: cross-sectional elements, sight distance, horizontal and vertical alignments; road materials and use of marginal materials; pavement design, drainage, culverts and small bridges; construction and specifications; quality control in construction; pavement failures; maintenance; preparation of detailed project report (DPR); community participation in planning, design, construction and management.

TE* ZG616 Bridge Engineering 4

Purpose of bridge; classification of bridges; characteristics of each bridge; loads stresses and combinations; design of RC bridges; design of non-composite and composite bridges; prestressed bridge; continuous spans, box girders, long span bridges; substructure design for bridges.

TE* ZG619 Finite element analysis 5

Fundamentals of Finite Element Method (FEM); basic formulations of FEM; assembly of elements, solution techniques; 2D and 3D problems; review of the isoparametric elements; thin and thick plate elements; introduction to shell formulations; use of newly developed elements; mixed finite element method; material and geometric nonlinear problems; application of FEM to civil engineering problems, programming FEM.

TE* ZG623 Ground Improvement Techniques 4

Requirements for ground improvement, various techniques of improvement, lowering the water table, ground freezing, electro-osmosis, compaction, tamping, use of explosives, vibratory probes, thermal treatment, addition of lime, cement and bitumen, gravel and sand columns, preloading techniques, reinforced earth, soil replacement techniques, Modern methods of ground improvement with rubber tires, construction wastes, bio-cementation

TEPWG ZG511 Soil Mechanics for Highway Engineering 4

Origin and classification of soils; physicochemical properties, index properties of soil, IS classification of soils and their applications in roads, airfields and embankments, Stresses within a soil, effective stress principle, Soil - water systems - capillarity, flow, Darcy's law, permeability, and tests for its determination, Stresses due to applied load, Stress analysis for embankments and pavements, Compressibility and consolidation characteristics, over consolidation ratio, determination of coefficients of consolidation and secondary compression (creep), consolidation under construction loading, Shear Strength and Mohr Coulomb strength criterion, direct and triaxial shear tests, drained, consolidated undrained and undrained tests, strength of loose and dense sands, NC and OC soils, dilation, pore pressures, Skempton's coefficients. Compaction characteristics, water content – dry unit weight relationships, OMC, maximum dry unit weight, field compaction, quality control, etc. Analysis and design of highway embankment, Characterization of ground, site investigations, methods of drilling, sampling, in situ test - SPT, CPT, plate load and dynamic tests, in-situ permeability and groundwater level, etc., Earth Pressure Theories, Selection and design of earth retaining structures

TEPWG ZG512 Soil Exploration and Field Techniques 4

Necessity and Importance of soil exploration, Method of sub surface exploration Test pits, Trenches, Wash boring, Percussion drilling , Rotary drilling, Factors affecting the selection of a suitable method of boring. Extent of boring, Factors controlling spacing and depth of bore holes, Spacing and depth of various Civil engineering structures. Indirect method of exploration, Seismic method, Electrical resistivity, Resistivity sounding and profiling, Different method of stabilization of the bore holes, their relative merits and demerits. Different method of ground water observation: Time lag in observation, sampling of ground water. Source of disturbance and their influence. Type of sampler, Principle of design of sampler, Representative and undisturbed sampling in various types of soils. Surface sampling, Amount of sampling, Boring and sampling record, Preservation and shipment of sample, preparation of bore log. Penetration tests, Standard penetration tests, Dynamic cone penetration tests with and without bentonite slurry, Static cone penetration tests, Pressure meter, Dilatometer, factors affecting the penetration tests. Various corrections in the test results. Interpretation of test result for design and determination of modulus of deformation. Small size penetrometers, Plate load test, Field CBR, Dynamic cone penetrometer for CBR evaluation. Various corrections, empirical correlations and interpretation of test result for design in transportation engineering.

TEPWG ZG513 Reinforced Soil Structures for Transportation Engineering 4

Introduction and need for geosynthetics, Types, functions, properties and testing of geosynthetics, Strength analysis of reinforced soil, different types of soil retaining structure, Design codes for reinforced soil retaining walls, External and internal stability of reinforced soil retaining walls, Bearing capacity of footings resting on reinforced soil, Geo-synthetics in flexible pavements, geosynthetics application and design for Separation, Filtration, drainage, erosion control, barrier in highway engineering, Reinforced slope, Design and Construction of Geosynthetic Reinforced Embankments on Soft Subsoils, Other methods of reinforcement like soil nailing, rock bolting, stone columns etc., Practical case studies of reinforced soil structures, Applications of

Geocell, PVD, Jute Geotextile and Coir Geotextile in transportation engineering, case studies.

TEPWG ZG514 Advanced Concrete Technology in Transportation Engineering 4

Cements including blended cements, chemical and physical processes of hydration; concrete admixtures: pulverized fuel ash, ground granulated blast furnace slag, silica fume; effects on properties of concretes, mortars and grouts; methods of test; applications; mixer blends and blended cement; admixtures: Review of types and classification; chemical composition; origin and manufacture; actions and interactions; usage; effects on properties of concretes, mortars and grouts; methods of test; applications; Aggregates: Review of types; elementary mineralogy and petrology; aggregate prospecting; quarrying and gravel-winning practice; production of artificial aggregates; sampling and testing; effects on properties of concretes, mortars and grouts; Fresh concrete: Rheology of concentrated suspensions, pastes, mortars and concretes; workability, segregation and bleeding. Theory and principles governing the correct placing and compaction of concrete; Setting and hardening concrete: Plastic settlement and plastic shrinkage; exothermic characteristics; early age thermal movements; strength development; maturity, accelerated curing; assessment of safe stripping times; hot and cold weather concreting; Properties of hardened concrete: Strength; deformation under load; elasticity; creep; drying shrinkage and other volume changes. Thermal properties; Durability of concrete and concrete construction: Durability concept; pore structure and transport processes; reinforcement corrosion; fire resistance; frost damage; sulphate attack; alkali silica reaction; delayed ettringite formation; methods of providing durable concrete; short-term tests to assess long-term behaviour; Mix design: Review of methods and philosophies; mix design for special purposes; Special concretes: Lightweight concrete: autoclaved aerated concrete, no-fines concrete, lightweight aggregate concrete and foamed concrete. High strength concrete; refractory concrete; high density and radiation-shielding concrete; polymer concrete; fibre-reinforced concrete; mortars; renders; recycled concrete; Special processes and technology for particular types of structure: Sprayed concrete; underwater concrete; grouts, grouting and grouted concrete; mass concrete; slipform construction; pumped concrete; concrete for liquid retaining structures; vacuum process; concrete coatings and surface treatments; Ready-mixed concrete; Precast concrete; Concrete for roads and industrial floors

TEPWG ZG515 GIS Applications in Transportation Engineering 4

Remote sensing : Physics of remote sensing, Ideal remote sensing system, Remote sensing satellites and their data products, Sensors and orbital characteristics, Spectral reflectance curves, resolution and multi concept, FCC, Interpretation of remote sensing images. Digital image processing: Satellite image – characteristics and formats, Image histogram, Introduction to image rectification, Image enhancement, Land use and land cover classification system. Geographic information system (GIS) : Basic concept of geographic data, GIS and its components, Data acquisition, Raster and vector formats, Topography and data models, Spatial modelling, Data output, GIS applications. Global positioning system (GPS) : Introduction, Satellite navigation system, GPS- space segment, Control segment, User segment, GPS satellite signals, Receivers; Static, Kinematic and Differential GPS. Applications in Transportation Engineering: Intelligent Transport System, Urban Transport Planning, Accident Studies, Transport System Management, Road Network Planning, Collecting Road Inventory

TEPWG ZG516 CAD Laboratory in Transportation Engineering 4

Basic AUTOCAD commands, exercises on earth work computations, cross sections of highways, exercises on packages like MX Roads to compute earth work, geometric design of highways, Exercises on HDM 4 package

TEPWG ZG517 Road Safety and Audit 4

Characteristics of accidents, accidents vs. crash, land use and road environment for safety, Multidisciplinary approach to planning for traffic safety and injury control; pre-crash and post-crash models; role of vehicle, roadway traffic, driver, and environment on road safety, crash and injuries.; accident analysis, conflict points at intersections, pedestrian safety, road safety improvement strategies; Road safety audit and analysis: Stages, aim and objectives, principles, process, roles and responsibility, Specific

parameters, design standards, various stages of road safety audit, Road safety audit for rural roads, Checklists, Structuring of report. Steps in treatment of crash locations, diagnosing crash problem and solutions, accident report form, storing of data, using and interpreting crash data, identifying and prioritizing hazardous locations, condition and collision diagrams; Vulnerable road users: crashes related to pedestrian and bicyclists, their safety, provision for disabled; Crash reconstruction: understanding basic physics, calculation of speed for various skid, friction, drag, and acceleration scenarios; Engineering Measures: Speed humps and bumps, speed tables and cushions; Community awareness and education; Enforcement- Non-physical measures- physical measures; Road Safety Audit Case study.

TEPWG ZG518 Pavement Analysis and Design 4

Types of pavements, flexible, rigid and semi-rigid; components of pavement structure; stresses and strains in flexible and rigid pavements: layered systems, visco-elastic solutions; stresses and deflections in rigid pavements; computer programmes for analysis of stresses and deflections in rigid pavements; traffic loadings, load equivalency factors, traffic projections and analysis; material characterization as input to pavement design; flexible pavement design using IRC, AASHTO, MEPDG methods; Rigid pavement design using IRC, AASHTO, MEPDG, ACI and PCA methods; design of overlays; Considerations in pavement drainage design.

TEPWG ZG519 Pavement Evaluation Field Project 4

Structural condition, Functional Condition and Safety evaluation of pavements, Flexible and Rigid Pavement Rating and establishment of Pavement Condition Index, Case study, involving a failed pavement structure, to investigate the condition and suggest remedial measures, Use of HDM 4 software for establishing the best alternative remedy for the chosen case study.

TEPWG ZG520 Infrastructure Planning and Management 4

The goals and perspectives of planning; forecasting and design of alternatives; plan testing: economic, financial and environmental evaluation; the challenges of managing infrastructure; Information management and decision support system; Concepts of total quality management; Economics: life-cycle analysis and maintenance, Rehabilitation and Reconstruction (M.R & R) programming; Infrastructure management system (IMS) development and implementation; Rural Infrastructure Planning.

TEPWG ZG521 Environmental Impact Assessment 4

Environment and global problems; Framing Environmental issues; effects of infrastructure development on environment; prediction and assessment of environmental impacts of infrastructure projects: technical and procedural aspects, guidelines and legal aspects of environmental protection, impacts on air, water, soil and noise environment, valuation, strategic assessment, mathematical modeling for environmental processes; social impact assessment (SIA), dislocation/disruption impact of Infrastructure projects; Life Cycle Assessments (LCA) and risk analysis methodologies; mitigation of environmental impacts; case studies; environmental management plan (EMP), national and international certification and guidelines including ISO.

TEPWG ZG523 Transportation Systems Planning and Management 4

System and environment; sequential transportation systems planning: trip generation, trip distribution, modal split and traffic assignment. Transportation Systems Management (TSM) actions: traffic management techniques for improving vehicular flow, preferential treatment for high occupancy modes, demand management technique for reduced traffic demand, staggered hours, vehicle restrictions; planning for pedestrians, parking planning; Methods of accident data collection and analysis.

TEPWG ZG524 Urban Mass Transit Planning, Operations and Management 4

Modes of public transportation and application pf each to urban travel needs; Comparison of transit modes and selection of technology and transit service; Estimating demand in transit planning studies and functional design of transit routes; Terminal design; Management and operation of transit systems, Model for operational management; Fleet and crew management; Terminal management; Fiscal management.

TEPWG ZG528 Selection of Construction Equipment and Modeling 4

Selection and application of construction and earth moving equipment; Productivity analysis of equipment operations; mathematical models for construction operations; Quality issues in construction process modeling.

TEPWG ZG534 Pavement Material Characterization 5

Soil properties for highway engineers: Origin, properties of soils, tests on soils, Aggregates: origin, classification, requirements, properties, importance of aggregate gradation; bituminous materials: origin, preparation, properties and tests, criterion for selection of different viscosity grades of bitumen, modified binders and bituminous emulsions, Bituminous mixture design: Marshall method of mixture design, SUPERPAVE procedure of mixture design; mechanical properties of bituminous mixtures: resilient modulus, dynamic modulus, visco-elastic and fatigue characteristics. Warm mix asphalt, micro-surfacing, slurry seal, dense bituminous Macadam and bituminous concrete Cement concrete pavement materials: requirements and design of concrete mixture for rigid pavement, IRC and IS specifications and tests, joints, filler and sealant materials.

TEPWG ZG535 Highway Geometric Design 4

Highway functional classification; route layout and selection, design controls and criteria: turning paths, driver performance, traffic characteristics; highway capacity; access control; safety; environment; Elements of design: sight distance, horizontal alignment, transition curves, super elevation and side friction; vertical alignment: -grades, crest and sag curves; highway cross-sectional elements and their design; at-grade Inter-sections – sight distance consideration and principles of design, channelization, mini roundabouts, layout of roundabouts, inter-changes: major and minor interchanges, entrance and exit ramps, acceleration and deceleration lanes, bicycle and pedestrian facility design; parking layout and design; terminal layout and design, geometric design for express ways.

TEPWG ZG536 Traffic Engineering and Safety 4

Road users and their characteristics; traffic studies- volume, speed, origin-destination (O-D) and delay studies; analysis and interpretations of traffic studies; traffic forecasting; capacity and level of service analysis; traffic characteristics at un-signalized and signalized intersections; design of signalized intersections, capacity and LOS of signalized intersections, actuated signal control, signal coordination; traffic controls: signs, markings, street furniture; traffic regulations; parking studies; nature of traffic problems and their solutions; traffic safety: accidents- data collection and analysis; causes and prevention.

TEPWG ZG537 Transportation Economics and Finance 4

Need for economic evaluation; concept of total transport cost; fixed and variable costs, elasticity of demand, marginal costs; value of travel time, accident costs; methods of economic evaluation; taxation in road transport, user charges: fees and tolls; highway legislation; investment policies and pricing, issues in financing and subsidy policy, public private partnership (PPP) options in transport sector: BOT, BOOT, BOLT; feasibility studies, identification and sharing of risks in PPP projects, operation and management agreements.

TEPWG ZG539 Introduction to Discrete Choice Theory 4

Introduction, element of choice process, individual preferences, behavioral choice rule, utility based choice theory; data collection techniques, stated preference (SP) survey, revealed preference (RP) survey, paradigms of choice data; discrete choice models, property of discrete choice models, Multinomial logit model; overview and structure, Nested logit model formulation; discriminant analysis, Naive Bayes classification, classification trees, classification using nearest neighbors; application of fuzzy logic and artificial neural network in discrete choice modeling.

TEPWG ZG543 Traffic Flow Theory 4

Traffic flow elements: speed, volume and density and their relationships; time-space diagrams, controlled access concept, freeway concept, system performances, measures of effectiveness; mathematical modeling; probabilistic & stochastic models of traffic flow process, discrete and continuous modeling: headways, gaps and gap acceptance; macroscopic models; car-following model; queuing models; fundamentals & development of queuing processes; traffic simulation; intelligent transportation systems (ITS).

TEPWG ZG545 Airport Planning and Design 4

Air Transport-structure and organization; forecasting air travel demand: trend forecasts and analytical methods; air freight demand; airport system; characteristics of the aircraft; airport planning: site selection, layout plan, orientation and length of runway; airport capacity and configuration; geometric design of runway, taxiway and aprons; passenger terminal function, passenger and baggage flow, design concepts, analysis of flow through terminals, parking configurations and apron facilities; air cargo facilities-flow through cargo terminals, airport lighting; airport drainage; pavement design; airport access problem; environmental impact of airports.

TEPWG ZG546 Highway Construction Practices 4

Road planning and reconnaissance; right of way selection; fixing of alignment; road construction techniques: construction staking, clearing and grubbing of the road construction area; subgrade construction: excavation and filling, compaction, preparation of sub grade, quality control tests as per MORTH specifications; granular subbase and base course construction: gravel courses, WBM, WMM, stabilized soil subbases, use of geo-textiles and geo-grids; construction of bituminous layers; concrete pavement construction; field quality control ; road making machinery.

TEPWG ZG547 Pavement Failures, Evaluation and Rehabilitation 4

Pavement deterioration, distress and different types of failures, pavement surface condition deterioration such as slipperiness, unevenness, rutting, cracking; pot holes, etc., causes, effects, methods of measurement and treatment, use of modern equipment for pavement surface condition measurements, Analysis of data, interpretation. Structural deterioration of pavements: causes, effects, methods of treatment. Structural evaluation of flexible pavements by rebound deflection method, analysis of data, design of overlay, use of FWD and other methods for evaluation of flexible and rigid pavements and their application. Evaluation of new pavement materials, model studies, pavement testing under controlled conditions, accelerated testing and evaluation methods, Test track studies. Instrumentation for pavement testing.

TEPWG ZG548 Pavement Management Systems 4

Components of pavement management systems, pavement maintenance measures; pavement performance evaluation: general concepts, serviceability, pavement distress survey systems, performance evaluation and data collection using different equipment; evaluation of pavement distress modeling and safety; pavement performance prediction: concepts, modeling techniques, structural condition deterioration models, mechanistic and empirical models, HDM-IV models, comparison of different deterioration models, functional and structural condition deterioration models; ranking and optimization methodologies: Recent developments, economic optimization of pavement maintenance and rehabilitation.

TEPWG ZG549 Rural Road Technology 4

Network planning, accessibility and mobility; road alignment and survey; geometric design: cross-sectional elements, sight distance, horizontal and vertical alignments; road materials and use of marginal materials; pavement design, drainage, culverts and small bridges; construction and specifications; quality control in construction; pavement failures; maintenance; preparation of detailed project report (DPR); community participation in planning, design, construction and management.

TEPWG ZG616 Bridge Engineering 4

Purpose of bridge; classification of bridges; characteristics of each bridge; loads stresses and combinations; design of RC bridges; design of non-composite and composite bridges; prestressed bridge; continuous spans, box girders, long span bridges; substructure design for bridges.

TEPWG ZG619 Finite element analysis 5

Fundamentals of Finite Element Method (FEM); basic formulations of FEM; assembly of elements, solution techniques; 2D and 3D problems; review of the isoparametric elements; thin and thick plate elements; introduction to shell formulations; use of newly developed elements; mixed finite element method; material and geometric nonlinear problems; application of FEM to civil engineering problems, programming FEM.

TEPWG ZG623 Ground Improvement Techniques 4

Requirements for ground improvement, various techniques of improvement, lowering the water table, ground freezing, electro-osmosis, compaction, tamping, use of explosives, vibratory probes, thermal treatment, addition of lime, cement and bitumen, gravel and sand columns, preloading techniques, reinforced earth, soil replacement techniques, Modern methods of ground improvement with rubber tires, construction wastes, bio-cementation

PART VIII

ADMINISTRATIVE STRUCTURE

BIRLA INSTITUTE OF TECHNOLOGY & SCIENCE, PILANI
ADMINISTRATIVE STRUCTURE

VICE-CHANCELLOR

Director, Pilani Campus	Director, K.K. Birla Goa Campus	Director, Hyderabad Campus	Director, Dubai Campus	Director, Off-Campus Programmes and Industry Engagement

Divisions												Departments	
Dean	**Dean**	**Associate Dean**	**Dean**	**Associate Dean**	**Dean**	**Dean**	**Dean**	**Dean**	**Dean**	**Dean**	**Dean**	**Head of the Department (HoD)**	
Administration	**Admissions**	**Academic Registration & Counselling**	**Instruction**	**Student Welfare**	**Academic Research**	**Sponsored Research and Consulting**	**Faculty Affairs**	**Academic and Resource Planning**	**Practice School**	**Work Integrated Learning Programmes**	**International Programmes and Collaboration**		
	Associate Deans Nucleus members	**Nucleus members**	**Nucleus members**	**Chief Warden Nucleus members**	**Associate Deans Nucleus members**	**Associate Deans Nucleus members**	**Associate Dean Nucleus member**	**Associate Deans Nucleus members**	**Associate Deans Nucleus members**	**Associate Deans Nucleus members**	**Associate Deans**		
Administration and Finance	Admissions Operation of Flexibilities (Transfer, Dual Degree, etc.)	Registration Planning & Operation Academic Records of Students Eligibility Transcripts, Provisional Certificates Counselling Academic Counselling Board	Timetable Teaching Allocation & Implementation Feedback & Monitoring Teaching Workshop	Hostels, NSS, Games & Athletics Student Activities Railway Concessions Scholarships & Aids Students Personal Files & Testimonials Student Discipline Recreational Activity Forum	Higher Degree Counselling Committee Doctoral Counselling Committee	Ideation Sponsored Research and Consultancy Interfacing with Agencies for Research	Faculty Recruitment, Performance Appraisal, Faculty Training & Development, Extension & Reappointment of Faculty	Academic Programs & Growth Curriculum Design & Implementation Pedagogic Practices Resource Estimation & Identification Resource Provisioning	Establishment of Stations Faculty Allocation Feedback & Monitoring Student Needs at PS Location Station Operation Student Assignment & Evaluation	Off-Campus Work Integrated Learning Programmes Operation of Centres Preparation and delivering of Courses Academic Monitoring Board Admissions, Registration & Students Records	International Collaborations Liasoning	Biological Sciences Chemical Engineering Chemistry Civil Computer Science & Information Systems Economics and Finance Electrical & Electronics Engineering Humanities and Social Sciences	Management Mathematics Mechanical Engineering Pharmacy Physics

Unit Chief	*Registrar (Unit Chief)*	*Unit Chief*	*Unit Chief*	*Unit Chief*	*Unit Chief*	*Unit Chief*	*Unit Chief*	*Unit Chief*
Computer Assisted Housekeeping	**General Administration**	**Information Processing Centre**	**Instrumentation**	**Placement**	**Publications & Media Relations**	**Software Development & Educational Technology**	**Estate Management**	**Centralised Purchases**
Nucleus members	**Nucleus members**	**Nucleus members**	**Faculty-in-Charge**	**Nucleus members**	**Faculty-in-Charges Nucleus members**	**Nucleus members**	**Nucleus members Estate Manager**	**Nucleus members**
Computerisation & Processing of Student Records Staff Records Budget preparation Accounts Alumni Records	Establishment Meetings Institute Records Award of Degrees/ Diplomas & Medals Medical, LTC, etc. Housing, Computer & Vehicle loan Scrutiny of Grades/ Reports Legal Affairs	Centralised Computer Facilities	Service & Maintenance of instruments EPABX Projection facilities Stage Light and Public Address System	Campus Interviews	All publications of the Institute Publicity through audio-visual and print media publications Media Relations Printing & Reprography	Software Research & Development Software Consultancy Identification and deployment of Educational Technologies e-learning technologies, course management etc. Video-conferencing	Electricity & Water Supply Campus Planning, Buildings' Construction, Maintenance	Central Purchase Central Inventory of equipments

ADMINISTRATIVE STRUCTURE

The Institute has a functional administrative structure (pages VIII-2, VIII-3 and VIII-4). Vice-Chancellor is the executive head of the Institute, including all its campuses. Further, each Campus has a Director who takes care of the day-to-day academic and administrative operations of the Campus.

Various activities and requirements arising out of innovative educational programmes have been grouped into functions and each functional Division is headed by a Dean and each Unit by a Chief. Similarly the departments are headed by the Head of the Department. There are also faculty members designated as Incharges of various activities such as Instruction, Registration, Practice School, etc.

For each Division and Unit, there are cohesive teams of faculty known as the nucleus to support the activities of the Division/Unit. The administrative officers are:

Dean: Head of a Division

Chief: Head of a Unit

Head: Head of a Department

Every faculty member of the Institute is administratively attached to a Department / Division / Unit or to offices like Vice-Chancellor's Office and Director's Office, Deputy Directors' Office, etc.

OFFICERS OF ACADEMIC ADMINISTRATION

Acting Vice-Chancellor

Prof. V.S. Rao

Director, Pilani Campus

Prof. Ashoke Kumar Sarkar

Director, K.K. Birla Goa Campus

Prof. Sasikumar Punnekkat

Director, Hyderabad Campus

Prof. V.S. Rao

Director, Dubai Campus

Prof. R.N. Saha

Director, Off-Campus Programmes and Industry Engagement

Prof. G. Sundar

Deputy Director, K.K. Birla Goa Campus

Prof. Ashwin Srinivasan

Registrar

Prof. M.M.S. Anand

Chief Financial Officer

Mr. Manoj Fitkariwala

DIVISIONS

ACADEMIC RESEARCH (Ph.D. Programme) DIVISION (ARD)

Dean, ARD

Prof. Sanjay Kumar Verma

Associate Deans, ARD

Dr. Hemant R. Jadhav, Pilani campus

Dr. Prasanta Kumar Das, K.K. Birla Goa campus

Prof. (Ms.) Vidya Rajesh, Hyderabad campus

Prof. (Ms.) Neeru Sood, Dubai campus

Nucleus, ARD

Pilani Campus:- Dr. Sharad Srivastava, Dr. Sunita Singhal, Dr. Navin Singh, Dr. Pawan K. Ajmera, Dr. Shilpi Garg

KK Birla Goa Campus:- Prof. Santonu Sarkar, Prof Rabi Narayan Panda, Prof. Saroj Baral, Dr. Angshuman Sarkar, Dr. Sukanta Mondal

ADMINISTRATION DIVISION

Dean, Administration

Prof. S.C. Sivasubramanian, Pilani Campus

Prof. D.M. Kulkarni, K.K. Birla Goa Campus

Prof. M.B. Srinivas, Hyderabad Campus

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Prof. Shanmugasundaram Balasubramaniam

Associate Deans, ARPD

Prof. Hitesh Datt Mathur, Pilani campus

Prof. Ranjan Dey, KK Birla Goa campus

Prof. P.K. Thiruvikraman, Hyderabad campus

Dr. Anand Kumar, Dubai campus

ADMISSIONS

Dean, Admissions

Prof. S. Gurunarayanan

Associate Deans, Admissions

Prof. Hari Om Bansal, Pilani campus

Prof. S D Manjare, KK Birla Goa campus

Prof. Chittaranjan Hota, Hyderabad campus

Prof. Thoppil George Thomas, Dubai Campus

Nucleus (Admissions)

Pilani Campus:- Prof. Sudeept Mohan, Dr. Rahul Singhal

KK Birla Goa Campus:- Dr. Gauranga Charan Samanta,Dr. Aswini Kumar Mishra,Dr. Vikas V. Choudhari

Dean, Admissions (Dubai Campus)

Prof. T.G. Thomas

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Dean, FAD

Prof. R. Mahesh

Associate Deans, FAD

Prof. Anshuman Dalvi, Pilani campus

Prof. Dhananjay M. Kulkarni, KK Birla Goa campus

Prof. Souri Banerjee, Hyderabad campus

Prof. Ramadoss Roopkumar, Dubai Campus

Nucleus, FAD

Dr. Sarvesh Satija

Dean, FAD (Dubai Campus)

Prof. R. Roop Kumar

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Prof. Niranjan Swain

Associate Deans, PSD

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Prof. K.R. Anupama, KK Birla Goa campus

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Prof. B. Muralidharan

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Prof. Sunil Bhand

Associate Deans, SRCD

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Prof. (Ms.) P. Yogeeswari, Hyderabad campus

Nucleus, SRCD

Dr. Vishal Saxena, Pilani Campus

Prof. P. Bhavana, KK Birla Goa Campus

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Associate Deans, WILPD

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Prof. G Venkiteswaran – Chennai off-campus centre

Prof. Raghunathan Ratabole – KK Birla Goa campus

Prof. Srinivasa Prakash Regalla, Hyderabad campus

Prof. Anil Kumar, Pilani campus

Chief Operations Officer

Mr. Rajiv Tandon

Nucleus, WILPD

Dr. Mukesh Kumar Rohil, Dr. Manojkumar Surajkaranji Soni

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Prof. Suman Kapur

Associate Deans, IPCD

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Prof. M. Srikanth, KK Birla Goa campus

Dr. P. Sankar Ganesh, Hyderabad campus

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Prof. (Ms.) Neena Goveas, KK Birla Goa campus

Prof. Morapakala Srinivas, Hyderabad campus

Dr. A. Somasundaram, Dubai campus

Nucleus, ARCD

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KK Birla Goa Campus:- Prof. Manjuri Kumar, Dr. Tincy L.Thomas,Dr. Varinder Singh, Dr. Reena Cheruvalath, Dr. Rashmi Chauhan, Dr. Mainak Banerjee, Dr. Amrita Chatterjee, Dr. Malabika Biswas, Dr. Kundan Kumar

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Prof. S. Gurunarayanan

Associate Deans, ID

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Prof. Aditya Prasad Koley, KK Birla Goa campus

Prof. A. Vasan, Hyderabad campus

Prof. K. Kumar, Dubai campus

Nucleus, ID

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STUDENT WELFARE DIVISION (SWD)

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Prof. Jagarlamudi Venkateswara Rao, KK Birla Goa Campus

Dr. Sandip S Deshmukh, Hyderabad Campus

Prof. Priti Bajpai, Dubai Campus

Nucleus, SWD

Pilani Campus:- Mr. Srinivas Reddy K.

KK Birla Goa Campus:- Dr. Anusuya Ganguly, Mr. Mahadev Gawas Prof. Vijayashree Nayak, Dr. Ethirajulu Senthamaria Kannan and all resident and non-resident wardens even though reporting elsewhere all resident and non-resident wardens even though reporting elsewhere.

Chief Warden

Prof. Shibashish Chowdhury

Wardens of Bhawans

Dr. Nitin Chaturvedi (Krishna Bhawan), Dr. Arun Jalan (Shankar Bhawan), Dr. Dipendu Bhunia (Ram Bhawan & Malviya Bhawan –D), Dr. Jitendra Singh Rathore (Vishwakarma Bhawan), Dr. V.S. Shekhawat (Srinivasa Ramanujan Bhawan), Dr. R. Raghunathan (Rana Pratap Bhawan), Dr. Rajesh Prasad Mishra (Ashok Bhawan), Prof. Surekha Bhanot (Meera Bhawan), Prof. Kusum Lata (Meera Bhawan), Dr. Sachin U Belgamwar (Malviya Bhawan – A, B, C), Dr. Sunil Kumar Dubey (Vyas Bhawan), Dr. Paritosh Shukla (Sir C.V. Raman Bhawan), Dr. Shuvendu N Patel (Bhagirath Bhawan)

Non-resident Wardens

Dr. Devendra Kumar (Krishna Bhawan), Dr. Bibhas Ranjan Sarkar (Shankar Bhawan), Dr. Ashish Tiwari (Vyas Bhawan), Dr. Srinivas Kota (Vishwakarma Bhawan), Dr. Murali Palla (Bhagirath Bhawan), Dr. Harikrishnan Gopinadhan Nair (Ashok Bhawan), Dr. Biswanath Layek (Malviya Bhawan), Dr. Paul Atish Tulsiram (Sir C.V. Raman Bhawan), Dr. Rajdeep Chowdhury (Srinivas Ramanujan Bhawan), Dr. Prabhat N Jha (Rana Pratap Bhawan), Prof. Ravi Kant Mittal (Day Scholar), Dr. Shamik Chakraborty (Ram Bhawan &

Malviya Bhawan -D), Dr. Sailaja Nandigama (Meera Bhawan), Prof. Devika (Meera Bhawan)

Physical Education

Dr. Pintu Modak (In-charge, Physical Education)

National Service Scheme

Dr. Anupam Singhal (Co-ordinator)

BITS ALUMNI AFFAIRS DIVISION

Chairman

Prof. Sasikumar Punnikkat

Pilani Campus

Faculty Members

Prof. Hari Om Bansal (Faculty-in-charge)

Student Members

Mr. Chaitanya Bhatla, Mr. Adnan Oquaish

KK Birla Goa Campus

Faculty Members

Dr. Veeky Baths (Faculty-in-charge)

Student Members

Tanmay Tiwari, Deepak Kumar, Samruddhi Bokade, Hitesh Varma, Monica Guntur, Srishti Sharma, Saksham Mehta, Jaivardhan Singh Chauhan, Shalini Ahuja, Prajakta Kolambkar, and Vishvesh Anikhindi.

Hyderabad Campus

Faculty Members

Prof. P N K Rao (Faculty In-charge), Dr. Balaji Gopalan, Dr. Phaneendra Kiran C.

Student Members

Mr.Nirmal, Ms.Deepthi

Dubai Campus

Faculty Member

Dr. Madiajagan (Faculty-in-charge)

UNITS

COMPUTER ASSISTED HOUSEKEEPING UNIT (CAHU)

Unit Chief, CAHU

Prof. S.C. Sivasubramanian

Nucleus, CAHU

Dr. Yashvardhan Sharma (Faculty in-charge, Payroll Processing)

CENTRALISED PURCHASES UNIT (CPU)

Unit Chief, CPU

Prof. N.V. Muralidhar Rao

Nucleus, CPU

Prof. Poonam Goyal, Dr. Sheth Pratik Nitinchandra, Prof. Ajay Kumar Sah, Dr. Rajeev Sakhuja

ESTATE MANAGEMENT UNIT (EMU)

Unit Chief, EMU

Dr. Anshuman

Estate Manager

Lt. Col. Ashok Kumar Bhataiya

GENERAL ADMINISTRATION UNIT (GAU)

Unit Chief, GAU

Prof. M.M.S. Anand

INFORMATION PROCESSING CENTRE UNIT (IPCU)

Unit Chief, IPCU

Prof. Janardan Prasad Misra

Nucleus (IPCU)

Dr. Vishal Gupta

INSTRUMENTATION UNIT (IU)

Unit Chief, IU

Prof. Surekha Bhanot

Faculty-in-Charge

Dr. Karunesh Kumar Gupta (Faculty In-charge, Projection Systems and Instrumentation Services)

PLACEMENT UNIT (PU)

Unit Chief, PU

Prof. Mani Sankar Dasgupta

Nucleus (PU)

Dr. Hare Krishna Mohanta

Placement Manager

Mr. Tabir Mishra

PUBLICATIONS AND MEDIA RELATIONS UNIT (PMRU)

Unit Chief, PMRU

Mr. Giridhar M Kunkur

Faculty-in-Charges

Prof. G.S. Chauhan – Publicity and Branding

Nucleus (PMRU)

Dr. Pushp Lata, Dr. Sushila Shekhawat

SOFTWARE DEVELOPMENT & EDUCATIONAL TECHNOLOGY UNIT (SDETU)

Unit Chief, SDETU

Prof. Rahul Banerjee

Nucleus (SDETU)

Prof. Rishikesh Vaidya, Dr. Virendra Singh Shekhawat (Faculty-in-Charge, Educational Technology Support), Mr. Avinash Gautam

ACCOUNTS & FINANCE SECTION

Head, Accounts & Finance

Shri Satyen Sharma

Manager, Finance

Shri V.N. Sharma

Manager, MIS

Shri Rahul Rastogi

SECURITY SECTION

Chief Security Officer

Mr. Kishore Singh

FACULTY-IN-CHARGES

Prof. R.P. Pareek, Medical Centre

Prof. Abhijit K Digalwar, Transport Services

Prof. Kuldip Singh Sangwan, Workshop

Prof. Poonam Goyal, Blossom Kids-Zone (BKZ)

Dr. Sarvesh Satija, Institute Functions

Mr. Giridhar M Kunkur, Library

Prof. Sangeeta Sharma, Societal Development

Dr. Jyoti, Centre for Entrepreneural Leadership

Dr. Virendra Singh Nirban-Reprography Section

DEPARTMENTS

Pilani Campus

Dr. Suresh Gupta, Head, Dept. of Chemical Engg.

Prof. Manoj Kumar, Head, Dept. of Civil Engg.

Prof. Anu Gupta, Head, Dept. of Electrical & Electronics Engg.

Prof. B. K. Rout, Head, Dept. of Mechanical Engg.

Dr. S. Murugesan, Head, Dept. of Pharmacy

Prof. Rahul Banerjee, Head, Dept. of Computer Science and Information Systems

Dr. Rajesh Mehrotra, Head, Dept. of Biological Sciences

Prof. Anil Kumar, Head, Dept. of Chemistry

Prof. A.K. Giri, Head, Dept. of Economics & Finance

Prof. Anil Kumar Bhat, Head, Dept. of Management

Prof. Chandra Shekhar, Head, Dept. of Mathematics

Prof. Debi Datt Pant, Head, Dept. of Physics

Prof. Gajendra Singh Chauhan, Head, Dept. of Humanities and Languages

K.K. Birla Goa Campus

Prof. Saibal Ganguly, Head, Dept. of Chemical Engineering.

Prof. M.K. Deshmukh, Head, Dept. of Electrical & Electronics Engineering and Electronics & Instrumentation

Dr. Shibu Clement, Head, Dept. of Mechanical Engineering..

Prof. Bharat M Deshpande, Head, Dept. of Computer Science and Information Systems

Prof. Judith Braganca,, Head, Dept. of Biological Sciences

Prof. Anjan Chattopadhyay, Head, Dept. of Chemistry

Prof. Aswini Kumar Mishra, Head, Dept. of Economics & Finance

Prof. Meenakshi Raman, Head, Dept. of Humanities & Social Sciences

Prof. Prasanna Kumar N, Head, Dept. of Mathematics

Dr. Toby Joseph, Head, Dept. of Physics

Hyderabad Campus

Dr. A. Ramesh Babu, Head, Dept. of Chemical Engineering.

Prof. Jagadeesh Anmala, Head, Dept. of Civil Engineering..

Prof. Y. Yoganandam, Head, Dept. of EEE

Prof. Y.V. Daseswara Rao, Head, Dept. of Mechanical Engineering.

Prof. Shrikant Yashwant Charde, Head, Dept. of Pharmacy

Prof. N.L. Bhanu Murthy, Head, Dept. of Computer Science and Information Systems

Prof. Suman Kapur, Head, Dept. of Biological Sciences

Dr. Anupam Bhattacharya, Head, Dept. of Chemistry

Prof. M.G. Prasuna, Head, Dept. Humanities and Social Sciences

Prof. Ramana Sonti, Head, Economics and Finance

Prof. Bivudutta Mishra, Head, Dept. of Mathematics

Dr. Arvinda N Raghavan, Head, Dept. of Physics

Dubai Campus

Dr. B.G. Prakash Kumar, Head, Dept. of Chemical Engg.

Dr. A. P. Singh, Acting Head, Dept. of Civil Engineering..

Dr. A.B.Chattopadhyay, Head, Dept. of Electrical & Electronics Engg.

Dr. R. Karthikeyan, Head, Dept. of Mechanical Engineering..

Dr. B. Vijaya Kumar, Head, Dept. of Computer Science

Dr. Gokhale Trupti Swarup, Head, Dept. of Biotechnology

Dr. Maneesha, Head, Dept. of General Sciences

Dr. A. Srinivasa Rao, Head, Dept. of Humanities and Social Sciences

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Prof. Kumar Neeraj Sachdev (Convenor), Prof. S. Gurunarayanan, Prof. B.K. Rout, Prof. Shibasish Chowdhury

Students Aid Fund (SAF)

Prof. Kumar Neeraj Sachdev (Convenor), Prof. S. Gurunarayanan, Prof. B.K. Rout, Prof. Shibasish Chowdhury, Mr. Sai Teja Kancharlapalli, Mr. Yerramsetti Shanmukh Tej, Mr. Priyank Gupta, Mr. Vishesh Sharma, Ms. Satya Priya Singh Deo

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International Students Advisor

Prof. Suman Kapur

Central Analytical Laboratory (CAL)

Head, Dept. of Pharmacy (Dr. S. Murugesan), Head, Dept. of Biological Sciences (Prof. Rajesh Mehrotra), Head, Dept. of Chemistry (Prof. Anil Kumar), Head, Dept. of Physics (Prof. D.D. Pant).

Technology Innovation Centre (TIC)

Prof. Anu Gupta.

Centre for Innovation, Incubation & Entrepreneurship (CIIE)

University wide Professor In-charge: Prof. Srinivas Krishnaswamy, K K Birla Goa Campus, **Faculty-In-Charge:** Dr. Jyoti Tikoria (Pilani

Campus), Prof. Srinivasa Rao (Dubai Campus), Prof Mridula Goel (K K Birla Goa Campus), Dr. Chandu Parimi (Hyderabad Campus)

Teaching Learning Centre (TLC)

University wide Professor In-charge: Prof. R.R Mishra, Pilani Campus, **Faculty-In-Charge:** Prof. Rajesh Mehrotra (Pilani Campus), Prof R Udayakumar (Dubai Campus), Dr. Varinder Singh (K K Birla Goa Campus), Prof. P K Thiruvikraman (Hyderabad Campus).

Nucleus Members (Campus wise):

Pilani: Sudeept Mohan, Dr. Navneet Gupta, Dr. Sudersan Raman, Dr. Hari Nair

Dubai: Prof. Sankaram MV, Dr. Swarnalatha R, Dr. Geetha Kannan, Dr. Madiajagan M, Dr. Lajwanti Kishnani

K K Birla Goa Campus: Mr. Amol Deshpande, Dr. Anita Agrawal, Dr. Manoj Kumar Pandey, Dr. Reena Cheruvalath.

Hyderabad: Prof. Amit Kumar Gupta, Dr. Arvinda Raghavan, Dr. Aruna Malapati, Prof. N Rajesh

Committee for Combating Sexual Harassment Problems

Prof. (Ms.) Surekha Bhanot (Convenor), Prof. (Ms.) Poonam Goyal, Dr. (Ms.) Saumi Ray, Prof. Sanjay Kumar Verma, Dr. (Ms.) M. Kasturi, Prof Shibashish Choudhary (Nodal Officer).

Campus Planning & Maintenance Committee

Prof. Ajit Pratap Singh (Convenor), Dr. Anshuman, Lt. Col. A.K. Bhataiya, Prof. Kuldip Singh Sangwan.

House Allotment Committee

Prof. Anshuman (Convenor), Prof. A Dalvi, Shri R.C. Dagar

Visiting Faculty and Students Hostel (VFAST Hostel)

Prof. Virendra Singh Nirban

Recreational Activity Forum (RAF)

Prof. Kumar Neeraj Sachdev (Incharge), Mr. Garigipati Sai Srikanth, Mr. Bayireddy Leela Manas, Mr. Vishnu Sharma R K, Mr. Bandi Vishal, Ms. Vandana Jain, Mr. Vidya Sagar, Dr. Anubha Dadhich, Dr. Arun Kumar Vaish, Mr. Ashok Kumar Saini, Mr. Ashish Gupta

UGC Unit & UGC Liaison

Prof. Sanjay Kumar Verma (Nodal Officer)

Purchase Committee

Prof. N.V.M. Rao (Convenor), Prof. S.C. Sivasubramanian, Satyen Sharma.

Centre for Robotics & Intelligent Systems

Dr. Bijay Kumar Rout (Coordinator), Prof. Sudeept Mohan, Prof. R K Mittal (nucleus member) and Prof. N N Sharma (nucleus member)

Centre for Desert Development Technologies

Prof. Rajiv Gupta (Coordinator), Shri Gyanendra Singh, Shri Shiv N. Sanwal, Shri K. C. Sacheti, Shri Pradeep Bishnoi, Prof. Surekha Bhanot, Prof. Kuldip Singh Sangwan.

Centre for Materials Science & Technology

Prof. Mani Shankar Dasgupta

Centre for Renewable Energy and Environment Development (CREED)

Dr. Manojkumar Surajkaranji Soni (Coordinator), Dr. Hari Om Bansal, Dr. Hitesh Datt Mathur, Dr. Pratik N. Sheth, Dr. Rajneesh Kumar, Dr. Ravi Inder Singh.

Embedded Controller Application Centre

Prof. Surekha Bhanot (Coordinator), Prof. S. Gurunarayanan, Mr. Ashish Mishra.

Staff Association

Dr. Arun Kumar Vaish (President), Dr. Navin Singh (Vice President), Dr. Sunil Kumar Dubey (General Secretary), Dr. Virendra Singh Shekhawat (Joint Secretary), Dr. Chandra Shekhar (Treasurer), Dr. Niladri Sarkar (Member), Ms. Ruchika Sharma (Member)

Students Union

Mr Akhil Reddy Parvath Reddy (President) Mr. Rijul Dutta (General Secretary)

Auditors of the Institute

M/s. S.R. Batliboi & Co., LLP, Gurgaon (Statutory),

M/s. Aneja Associates, Mumbai (Internal).

BITS COOP

Prof. A. K. Sarkar (President), Prof. S.C. Sivasubramanian (Vice-President), Prof. Sanjay Kumar Verma (Secretary), Prof. M.M.S. Anand (Treasurer).

Medical Centre, VidyaVihar

Prof. Rajendra Prasad Pareek, (Physician & Medical Superintendent) and Dr. (Ms.) Sanjana R. Bhat (Gynecologist).

Other visiting doctors are: Dr. Sanjay Katewa (Dentist), Dr. H.S. Sankhla (ENT Specialist), Dr. R.P. Jajoo (Ayurvedic Physician), Dr. Diwakar Pathak (Homeopathic Specialist).Dr.Karan Beniwal (Pediatrician)

CERTAIN OTHER ORGANISATIONS IN PILANI

Birla Sarvajanik Hospital

Dr. R.K. Jain (CMO), Dr. P.K. Gupta, Dr. Sunil Shah, Dr. Prashant Singh, Dr. (Ms.) Rinku Singh, Dr. P.K. Jain, Dr. B. Pal Singh, Dr. Mool Singh (ENT, visit on Monday only), Dr.(Ms.) Sarita Sharma, Dr. Ramesh P. Jajoo (Ayurvedic Physician), Dr. Pooja Shah (ENT specialist), Dr. Hemant Sharma, Dr. Pawan Kumar, Dr. Jagdeep Ray (Plastic sergeon, visits on Wednesday only), Dr. Anil Sharma (Urologist, visit on Wednesday only).

Shri MahadeoSinghi Eye Hospital

Dr. P.K. Sehgal (CMO), Dr. Amitabh Chakraborty, Dr. G. B. Mathur, Dr. Basant Sharma (Dental Surgeon).

Birla Museum

Dr. V.N. Dhaulakhandi (Director)

Central Electronics Engineering Research Institute (CEERI)

Prof. Santanu Chaudhury

DISCIPLINE-WISE LIST OF FACULTY

Name	Designation	Campus
BIOLOGICAL SCIENCES		
Suman Kapur, Ph.D.	Sr. Professor	Hyderabad
S K Verma, Ph.D.	Professor	Pilani
Ashis Kumar Das, Ph.D.	Professor	Pilani
D J Shariff, Ph.D.	Professor	Dubai
Neeru Sood, Ph.D.	Professor	Dubai
S Swaminathan, Ph.D.	Professor	Hyderabad
Uma S Dubey, Ph.D.	Associate Professor	Pilani
Shibasish Chowdhury, Ph.D.	Associate Professor	Pilani
Jitendra Panwar, Ph.D.	Associate Professor	Pilani
Vishal Saxena, Ph.D.	Associate Professor	Pilani
Rajesh Mehrotra, Ph.D.	Associate Professor	Pilani
Sanjeev Kumar, Ph.D.	Associate Professor	Pilani
Lalita Gupta, Ph.D.	Associate Professor	Pilani
P R Deepa, Ph.D.	Associate Professor	Pilani
S Ramachandran, Ph.D.	Associate Professor	Dubai
Gokhale Trupti Swarup, Ph.D.	Associate Professor	Dubai
Utpal Roy, Ph.D	Associate Professor	Goa
Meenal Kowshik, Ph.D	Associate Professor	Goa
Judith Maria Braganca, Ph.D	Associate Professor	Goa
Srikanth Mutnuri, Ph.D.	Associate Professor	Goa
Dibakar Chakrabarty, Ph.D	Associate Professor	Goa
Vijayashree Nayak, Ph.D	Associate Professor	Goa
Vidya Rajesh, Ph.D.	Associate Professor	Hyderabad
Ramakrishna Vadrevu, Ph.D.	Associate Professor	Hyderabad
B Vani, Ph.D.	Assistant Professor	Pilani
Prabhat Nath Jha, Ph.D.	Assistant Professor	Pilani
Pankaj Kumar Sharma, Ph.D.	Assistant Professor	Pilani
Sandhya Mehrotra, Ph.D.	Assistant Professor	Pilani
Shilpi Garg, Ph.D.	Assistant Professor	Pilani
Rajdeep Chowdhury, Ph.D.	Assistant Professor	Pilani
Veeky Baths, Ph.D.	Assistant Professor	Goa
Anasuya Ganguly, Ph.D.	Assistant Professor	Goa
Sumit Biswas, Ph.D.	Assistant Professor	Goa
Angshuman Sarkar, Ph.D.	Assistant Professor	Goa
Malabika Biswas, Ph.D.	Assistant Professor	Goa
Sukanta Mondal, Ph.D.	Assistant Professor	Goa
Kundan Kumar, Ph.D.	Assistant Professor	Goa

Name	Designation	Campus
Indrani Talukdar, Ph.D.	Assistant Professor	Goa
Arnab Banerjee, Ph.D.	Assistant Professor	Goa
Raviprasad Aduri, Ph.D.	Assistant Professor	Goa
Jayati Ray Dutta, Ph.D.	Assistant Professor	Hyderabad
Kumar Pranav Narayan, Ph.D.	Assistant Professor	Hyderabad
P Shankar Ganesh, Ph.D.	Assistant Professor	Hyderabad
Sridev Mohapatra, Ph.D.	Assistant Professor	Hyderabad
K Naga Mohan, Ph.D.	Assistant Professor	Hyderabad
Debashree Bandyopadhyay, Ph.D.	Assistant Professor	Hyderabad
Sandhya Amol Marathe, Ph.D.	Visiting Assistant Professor	Pilani
Sudeshna Mukherjee, Ph.D.	Visiting Assistant Professor	Pilani
Ashish Kr Runthala, M.E.	Lecturer	Pilani
Manoj Kannan, M.E.	Visiting Lecturer	Dubai
CHEMICAL ENGINEERING		
Bandi Venkata Prasad, Ph.D.	Professor	Pilani
Sutapa Roy Ramanan, Ph.D.	Professor	Goa
Srinivas Krishnaswamy, Ph.D.	Professor	Goa
Saibal Ganguly, Ph.D..	Professor	Goa
Suresh Gupta, Ph.D.	Associate Professor	Pilani
Arvind Kumar Sharma, Ph.D.	Associate Professor	Pilani
B B Gulyani, Ph.D.	Associate Professor	Dubai
Sampatrao Dagu Manjare, Ph.D.	Associate Professor	Goa
Saroj S. Baral, Ph.D.	Associate Professor	Goa
I Sreedhar, Ph.D.	Associate Professor	Hyderabad
Srikanta Dinda, Ph.D.	Associate Professor	Hyderabad
Hare Krishna Mohanta, Ph.D.	Assistant Professor	Pilani
Sheth Pratik N, Ph.D.	Assistant Professor	Pilani
Smita Raghuvanshi, Ph.D.	Assistant Professor	Pilani
Priya Christina S, Ph.D.	Assistant Professor	Pilani
Amit Jain, Ph.D.	Assistant Professor	Pilani
Ajaya Kumar Pani, Ph.D.	Assistant Professor	Pilani
P Chattopadhyay, Ph.D.	Assistant Professor	Pilani
Banasri Roy, Ph.D.	Assistant Professor	Pilani
Sonal Mazumder, Ph.D.	Assistant Professor	Pilani
Raman Sharma, Ph.D.	Assistant Professor	Pilani
Srinivas Appari, Ph.D.	Assistant Professor	Pilani
B G Prakash Kumar, Ph.D.	Assistant Professor	Dubai
Nishant Harish Pandya, Ph.D.	Assistant Professor	Dubai
Eldhose Iype, Ph.D.	Assistant Professor	Dubai
Rajib Ghosh Chaudhuri, Ph.D	Assistant Professor	Dubai

Name	Designation	Campus
Manjuri Kumar, Ph.D.	Assistant Professor	Goa
Jegatha Nambi Krishnan Ph.D.	Assistant Professor	Goa
Asima Shaukat, Ph.D.	Assistant Professor	Goa
Dhanya Ram V. Ph.D.	Assistant Professor	Goa
Rajagopal Vellingiri, Ph.D.	Assistant Professor	Goa
D Purnima, Ph.D.	Assistant Professor	Hyderabad
Balaji Krishnamurthy, Ph.D.	Assistant Professor	Hyderabad
A Ramesh Babu, Ph.D.	Assistant Professor	Hyderabad
Karthik Chetan V, Ph.D.	Assistant Professor	Hyderabad
Asma Ahmed, Ph.D.	Assistant Professor	Hyderabad
Vikranth Kumar Surasani Ph.D.	Assistant Professor	Hyderabad
Subhajit Majumdar, M.E.	Lecturer	Pilani
Utkarsh Maheshwari, M.E.	Lecturer	Pilani
Vaishnavi T. Unde, M.E.	Lecturer	Goa
Surendran G., M.Tech.	Lecturer	Goa
Amol Deshpande, M.E.	Lecturer	Goa
Parul Sahu, M.Tech	Lecturer	Goa
Lakshmi Sirisha P, M.Tech	Lecturer	Hyderabad
K Santosh Sopanrao, M.E.	Lecturer (Off Campus)	Pilani
C H Ramesh Kumar, M.E.	Visiting Faculty	Pilani
CHEMISTRY		
V S Rao, Ph.D.	Sr. Professor	Hyderabad
G Sundar, Ph.D.	Sr. Professor	Hyderabad
S C Sivasubramanian, Ph.D.	Professor	Pilani
Subit Kumar Saha, Ph.D.	Professor	Pilani
Ram Kinkar Roy, Ph.D.	Professor	Pilani
Dalip Kumar, Ph.D.	Professor	Pilani
B Muralidharan, Ph.D.	Professor	Dubai
Sunil Bhand, Ph.D.	Professor	Goa
Aditya P. Koley, Ph.D.	Professor	Goa
N Rajesh, Ph.D.	Professor	Hyderabad
Saumi Ray, Ph.D.	Associate Professor	Pilani
Anil Kumar, Ph.D.	Associate Professor	Pilani
Ajay Kumar Sah , Ph.D.	Associate Professor	Pilani
Bharti Khungar, Ph.D.	Associate Professor	Pilani
I R Laskar, Ph.D.	Associate Professor	Pilani
Vijaya iIango, Ph.D.	Associate Professor	Dubai
Geetha Kannan, Ph.D.	Associate Professor	Dubai
Raghu Nath Behera, Ph.D.	Associate Professor	Goa
Narendra Nath Ghosh, Ph.D	Associate Professor	Goa

Name	Designation	Campus
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Ranjan Dey, Ph.D.	Associate Professor	Goa
Rabi Narayan Panda, Ph.D.	Associate Professor	Goa
P Bhavana, Ph.D.	Associate Professor	Goa
Halan Prakash, Ph.D.	Associate Professor	Goa
K Sumithra, Ph.D.	Associate Professor	Hyderabad
K V G Chandra Sekhar, Ph.D.	Associate Professor	Hyderabad
Jayanty Subbalakshmi, Ph.D.	Associate Professor	Hyderabad
R Krishnan, Ph.D.	Associate Professor	Hyderabad
Manab Chakravarty, Ph.D.	Associate Professor	Hyderabad
Madhushree Sarkar, Ph.D.	Assistant Professor	Pilani
Prashant U Manohar, Ph.D.	Assistant Professor	Pilani
Paritosh Shukla, Ph.D.	Assistant Professor	Pilani
Indresh Kumar, Ph.D.	Assistant Professor	Pilani
Surojit Pande, Ph.D.	Assistant Professor	Pilani
Rajeev Sakhuja, Ph.D.	Assistant Professor	Pilani
Shamik Chakraborty, Ph.D.	Assistant Professor	Pilani
Bibhas Ranjan Sarkar, Ph.D.	Assistant Professor	Pilani
R Rajan, Ph.D.	Assistant Professor	Dubai
F Rusal Raj, Ph.D.	Assistant Professor	Dubai
Tincy L. Thomas, Ph.D.	Assistant Professor	Goa
Rashmi Chauhan, Ph.D.	Assistant Professor	Goa
K P Jayadevan, Ph.D.	Assistant Professor	Goa
Mainak Banerjee, Ph.D.	Assistant Professor	Goa
Amrita Chatterjee, Ph.D.	Assistant Professor	Goa
Subhadeep Banerjee, Ph.D.	Assistant Professor	Goa
Venkatesan.S. Thimmakondu, Ph.D.	Assistant Professor	Goa
Anupam Bhattacharya, Ph.D.	Assistant Professor	Hyderabad
Balaji Gopalan, Ph.D.	Assistant Professor	Hyderabad
Ramakrishnan Ganesan, Ph.D.	Assistant Professor	Hyderabad
Subhas Ghosal, Ph.D.	Assistant Professor	Hyderabad
Amit Nag, Ph.D.	Assistant Professor	Hyderabad
Sounak Roy, Ph.D.	Assistant Professor	Hyderabad
Durba Roy, Ph.D.	Assistant Professor	Hyderabad
Siju C R, M.TECH.	Lecturer	Pilani
CIVIL ENGINEERING		
Ashoke Kumar Sarkar, Ph.D.	Senior Professor and Director	Pilani
Rajiv Gupta, Ph.D.	Senior Professor	Pilani
Ajit Pratap Singh, Ph.D.	Professor	Pilani*
S B Singh, Ph.D.	Professor	Pilani

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K Srinivasa Raju, Ph.D.	Professor	Hyderabad
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Manoj Kumar, Ph.D.	Associate Professor	Pilani
Ravi Kant Mittal, Ph.D.	Associate Professor	Pilani
V Vinayaka Ram, Ph.D.	Associate Professor	Hyderabad
A Vasan, Ph.D.	Associate Professor	Hyderabad
Anmala Jagadeesh, Ph.D.	Associate Professor	Hyderabad
Sridhar R, Ph.D.	Associate Professor	Hyderabad
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Anupam Singhal, Ph.D.	Assistant Professor	Pilani
Dipendu Bhunia, Ph.D.	Assistant Professor	Pilani
S N Patel, Ph.D.	Assistant Professor	Pilani
Shibani Khanra Jha, Ph.D.	Assistant Professor	Pilani
Amit Goel, Ph.D.	Assistant Professor	Pilani
Bahurudeen A, Ph.D.	Assistant Professor	Pilani
Prasanta Kumar Sahu, Ph.D.	Assistant Professor	Pilani
K Rajitha, Ph.D.	Assistant Professor	Hyderabad
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Chandu Parimi, Ph.D.	Assistant Professor	Hyderabad
Mohan S C, Ph.D.	Assistant Professor	Hyderabad
Anasua Guharay, Ph.D.	Assistant Professor	Hyderabad
Arkamitra Kar, Ph.D.	Assistant Professor	Hyderabad
Naveen James, Ph.D.	Assistant Professor	Hyderabad
Mahesh K Hamirwasia, M.E.	Assistant Professor (Off Campus)	Pilani
Muthukumar G, Ph.D.	Lecturer	Pilani
R Srinivas, M.E.	Lecturer	Pilani
Sri Kalyana Rama J, M.Tech.	Lecturer	Hyderabad
COMPUTER SCIENCE, INFORMATION SYSTEMS & SOFTWARE SYSTEMS		
Sasikumar Punnekkat, D.Phil	Sr. Professor & Director	Goa
Ashwin Srinivasan, Ph.D.	Sr. Professor	Goa
Janardan Prasad Misra, M.E.	Professor	Pilani
Sudeept Mohan, Ph.D.	Professor	Pilani
Navneet Goyal, Ph.D.	Professor	Pilani
Rahul Banerjee, Ph.D.	Professor	Pilani
S Balasubramaniam, M.S.	Professor	Pilani
S Vadivel, Ph.D.	Professor	Dubai
B Vijayakumar, Ph.D.	Professor	Dubai
Santonu Sarkar, Ph.D.	Professor	Goa
Chittaranjan Hota, Ph.D.	Professor	Hyderabad

Name	Designation	Campus
Mukesh Kumar Rohil, Ph.D.	Associate Professor	Pilani
Poonam Goyal, Ph.D.	Associate Professor	Pilani
Bharat M. Deshpande, Ph.D.	Associate Professor	Goa
Neena Goveas, Ph.D.	Associate Professor	Goa
Jagarlamudi Venkateswara Rao, Ph.D.	Associate Professor	Goa
R Gururaj, Ph.D.	Associate Professor	Hyderabad
N L Bhanu Murthy, Ph.D.	Associate Professor	Hyderabad
Anand Magadi Narasimhamurthy, Ph.D.	Associate Professor	Hyderabad
T Venkateswara Rao, M.TECH.	Associate Professor (Off Campus)	Pilani
H Viswanathan, M.TECH.	Associate Professor (Off Campus)	Pilani
K Venkatasubramanian, M.E.	Assistant Professor	Pilani
Yashvardhan Sharma, Ph.D.	Assistant Professor	Pilani
Haribabu K, Ph.D.	Assistant Professor	Pilani
V S Shekhawat, Ph.D.	Assistant Professor	Pilani
Vishal Gupta, Ph.D.	Assistant Professor	Pilani
Sundaresan Raman, Ph.D.	Assistant Professor	Pilani
S K Hafizul Islam, Ph.D.	Assistant Professor	Pilani
Abhishek Mishra, Ph.D.	Assistant Professor	Pilani
Lavika Goel, Ph.D.	Assistant Professor	Pilani
Shyamapada Mukherjee, Ph.D.	Assistant Professor	Pilani
Kuldeep Kumar, Ph.D.	Assistant Professor	Pilani
V Santhosh Kumar, Ph.D.	Assistant Professor	Dubai
Sujala D Shetty, Ph.D.	Assistant Professor	Dubai
M Madiajagan, Ph.D.	Assistant Professor	Dubai
Siddhaling Urologin, Ph.D.	Assistant Professor	Dubai
Lucy J Gudino, Ph.D.	Assistant Professor	Goa
K R Biju, Ph.D.	Assistant Professor	Goa
Sanjay Kumar Sahay, Ph.D.	Assistant Professor	Goa
Baskar A., Ph.D.	Assistant Professor	Goa
G Geetha Kumari, Ph.D.	Assistant Professor	Hyderabad
Aruna Malapati, Ph.D.	Assistant Professor	Hyderabad
Tathagata Ray, Ph.D.	Assistant Professor	Hyderabad
Ritu Arora, M.S.	Assistant Professor (Off Campus)	Pilani
Chandra Shekar R K, M.TECH.	Assistant Professor (Off Campus)	Pilani
Pradheep Kumar K, Ph.D.	Assistant Professor (Off Campus)	Pilani
Vineet Kumar Garg, M.E.	Assistant Professor (Off Campus)	Pilani
Nayan Khare, M.TECH.	Assistant Professor (Off Campus)	Pilani
Anita Ramachandran, M.TECH.	Assistant Professor (Off Campus)	Pilani
S Susila, Ph.D.	Senior Lecturer	Dubai
Susanna S Henry, M.E.	Senior Lecturer	Dubai

Name	Designation	Campus
Sunita Singhal, Ph.D.	Lecturer	Pilani
Mayuri A Digalwar, M.E.	Lecturer	Pilani
Vandana Agarwal, M.TECH.	Lecturer	Pilani
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R Mahesh, Ph.D.	Professor	Pilani
Rajendra Prasad Pareek, M.D.	Professor	Pilani
D Sriram, Ph.D.	Professor	Hyderabad
P Yogeeswari, Ph.D.	Professor	Hyderabad
H R Jadhav, Ph.D.	Associate Professor	Pilani
Sunil Kumar Dubey, Ph.D.	Assistant Professor	Pilani

Name	Designation	Campus
S Murugesan, Ph.D.	Assistant Professor	Pilani
Rajeev Taliyan, Ph.D.	Assistant Professor	Pilani
G Anil Bhanudas, Ph.D.	Assistant Professor	Pilani
Punna Rao Ravi, Ph.D.	Associate Professor	Hyderabad
A Sajeli Begum, Ph.D.	Associate Professor	Hyderabad
Shrikant Yashwant Charde Ph.D.	Associate Professor	Hyderabad
Paul Atish Tulshiram, Ph.D.	Assistant Professor	Pilani
Jindal Anil Brijbhushan, Ph.D.	Assistant Professor	Pilani
Deepak Chitkara, Ph.D.	Assistant Professor	Pilani
Anupama Mittal, Ph.D.	Assistant Professor	Pilani
Gautam Singhvi, Ph.D.	Assistant Professor	Pilani
Aniruddha Roy, Ph.D.	Assistant Professor	Pilani
V V Krishna Venuganti, Ph.D.	Assistant Professor	Hyderabad
Swati Biswas, Ph.D.	Assistant Professor	Hyderabad
Balaram Ghosh, Ph.D.	Assistant Professor	Hyderabad
Onkar Prakash Kulkarni, Ph.D.	Assistant Professor	Hyderabad
Arti Dhar, Ph.D.	Assistant Professor	Hyderabad
Bharathi R, M.E.	Assistant Professor (Off Campus)	Pilani
M M Pandey, M.TECH.	Lecturer	Pilani
Mahaveer Singh, M.PHARM.	Lecturer	Pilani
Priti Jain, M.PHARM.	Lecturer	Pilani
Archana Khosa Kakkar, M.PHARM.	Lecturer	Pilani
PHYSICS		
Rashmi Ranjan Mishra, Ph.D.	Professor	Pilani
D Bandyopadhyay, Ph.D.	Professor	Pilani
R Roopkumar, Ph.D.	Professor	Dubai
K.K. Singh, Ph.D.	Professor	Dubai
S Karthiyayini	Professor	Dubai
Arun V Kulkarni, Ph.D.	Professor	Goa
Souri Banerjee, Ph.D.	Professor	Hyderabad
Kusum Lata, Ph.D.	Associate Professor	Pilani
S N Karbelkar, Ph.D.	Associate Professor	Pilani
Anshuman Dalvi, Ph.D.	Associate Professor	Pilani
Rakesh Choubisa, Ph.D.	Associate Professor	Pilani
Raj Kumar Gupta, Ph.D.	Associate Professor	Pilani
Debi Datt Pant, Ph.D.	Associate Professor	Pilani
V Manjuladevi, Ph.D.	Associate Professor	Pilani
Sindhu S, Ph.D.	Associate Professor	Pilani
Kavita S. Jerath, Ph.D.	Associate Professor	Dubai
Nandakumar Patincharath, Ph.D.	Associate Professor	Goa

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Raghunath Ratabole, Ph.D.	Associate Professor	Goa
Gaurav Dar, Ph.D.	Associate Professor	Goa
Radhika Vathsan, Ph.D.	Associate Professor	Goa
Prasanta Kumar Das, Ph.D.	Associate Professor	Goa
PK Thiruvikraman, Ph.D.	Associate Professor	Hyderabad
Kannan Ramaswamy, Ph.D.	Associate Professor	Hyderabad
Gopala Krishna Koneru, M.TECH.	Associate Professor (Off Campus)	Pilani
Srijata Dey, Ph.D.	Assistant Professor	Pilani
Niladri Sarkar, Ph.D.	Assistant Professor	Pilani
Vaidya Rishikesh D, Ph.D.	Assistant Professor	Pilani
Navin Singh, Ph.D.	Assistant Professor	Pilani
Biswanath Layek, Ph.D.	Assistant Professor	Pilani
Madhukar Mishra, Ph.D.	Assistant Professor	Pilani
Kaushar Vaidya, Ph.D.	Assistant Professor	Pilani
Tapomoy Guha Sarkar, Ph.D.	Assistant Professor	Pilani
J N Bandyopadhyay, Ph.D.	Assistant Professor	Pilani
S Gangopadhyay, Ph.D.	Assistant Professor	Pilani
H Amol Ramdas Shilpa, Ph.D.	Assistant Professor	Pilani
G Amaranath, Ph.D.	Assistant Professor	Dubai
Deepak P N, Ph.D.	Assistant Professor	Goa
Toby Joseph, Ph.D.	Assistant Professor	Goa
Sunilkumar V, Ph.D.	Assistant Professor	Goa
Teny Theresa John, Ph.D.	Assistant Professor	Goa
Chandradew Sharma, Ph.D.	Assistant Professor	Goa
Ram Shankar Patel, Ph.D.	Assistant Professor	Goa
Tarun Kumar Jha, Ph.D.	Assistant Professor	Goa
Ethirajulu Senthamaria Kannan, Ph.D.	Assistant Professor	Goa
Kinjal Banerjjee, Ph.D.	Assistant Professor	Goa
Aravinda N Raghavan, Ph.D.	Assistant Professor	Hyderabad
B Hari Hara Venkataraman, Ph.D.	Assistant Professor	Hyderabad
Meenakshi Viswanathan, Ph.D.	Assistant Professor	Hyderabad
V Satya Narayana Murthy, Ph.D.	Assistant Professor	Hyderabad
Sashideep Gutti, Ph.D.	Assistant Professor	Hyderabad
K V S Shiv Chaitanya, Ph.D.	Assistant Professor	Hyderabad
Asrarul Haque, Ph.D.	Assistant Professor	Hyderabad
Rahul Nigam, Ph.D.	Assistant Professor	Hyderabad
Sarmistha Banik, Ph.D.	Assistant Professor	Hyderabad
Adonis Vasile Lupulescu, Ph.D.	Assistant Professor	Hyderabad
Gyanan, M.TECH.	Lecturer (Off Campus)	Pilani
Bulla Radhika, M.S.	Instructor (Off Campus)	Pilani

Name	Designation	Campus
OTHER ACADEMIC STAFF		
Giridhar M Kunkur, M.LIB.	Librarian	Pilani
Ishappa Bandi, M.PHIL.	Dy. Librarian	Pilani
Anuradha Voolapalli, Ph.D.	Dy. Librarian	Goa
M S Udayakumar	Dy Librarian	Hyderabad
Deepak Mehta, M.PHIL.	Assistant librarian	Pilani
Pintu Modak, Ph.D.	Sr. Physical Edu. Officer	Pilani
Bhavesh Verma, M.PHIL.	Physical Edu. Instructor	Pilani
Chandu Lamani, M.P.E.D.	Physical Education Instructor	Goa

***On deputation to BITS Pilani Dubai Campus**

SCIENTISTS / PROFESSIONALS PARTICIPATING IN SPECIFIC COLLABORATIVE PROGRAMMES:

The list of scientistis / professionals from industries / collaborating organizations who are currently involved and actively participating in running specific collaborative programmes is given below:

BITS-AVAYA PROGRAMME, Pune, Collaboration: M.Tech. Telecommunication and Software Engineering

Mr. Anirban Mookerjee, Ms. Aarti Rao, Mr Manish Mishra, Mr. Manish Kalbande, Mr Vikas Verma , Mr. Amar Khumbhar.

BITS – Bhaktivedanta Institute, Mumbai, Collaboration: M.Phil. Consciousness Studies

Dr. Ravi Gomatam, Dr. C. Unnikrishnan, Dr. S. K. Rohida, Dr. K. Samudravijaya, Dr. Laxmidhar Behera, Dr. S. Nagarkatti, Dr. P. K. Joshi, Dr. R. K. Shyamsunder, Mr. Greg Anderson, Kanwaljeet Kaur, Jayant Silva, Dr. Padmini Shetty, and Dr. K. P. Rajan

BITS - Bharat Forge Limited, Pune, Collaboration: B.Tech. Manufacturing Technology

Mr.Amit Kalyani, Mr.Raju Kalyani, Dr SV Bhave, Mr. G K Agarawal, ,Mr. Ajay Ingle, Mr Harish Deshpande, Mr. Anand Mahurkar, Mr. K Deshmukh, Mr. Srikant Madiwale; Mr Mukesh Ghogre and Dr Raj KumarRaj Kumar Singh.

BITS – Bombay Hospital, Mumbai, Collaboration: M.Phil. Hospital and Health Systems Management

Mr. B.K. Taparia, Dr. Rajkumar V. Patil, Dr. Rajesh Choumal, Dr. Rajkumar Choudhary, Dr. Sagar Sakle, Dr. Madhulika Jain, Dr. Inder Talwar, Dr. Sunila jaggi, Dr. Sujata Mehta, Dr. Asmitqa Sakle, Dr. P.M. Bhujang, Mr. Rajesh Kukreja, Ms. G.D. Koppikar, Dr. Maya Parihar Malhotra, Dr. D.B. Modi, Dr. Nina Desai, Dr. R. Goel

BITS - Christian Medical College, Vellore, Collaboration: M.Phil. Hospital and Health Systems Management

Dr. Abel Rajarathinam, Dr. Alfred Job Daniel, Prof. Allan John Dr. Anna Pulimood, Dr. Annabel D'Souza, Mrs. Annie Valsan, Dr. Balaji, Mr. Baskaran, Mr. Bijesh Kumar Yadav, Mr. Chellaswamy, Dr. Christianna Singh, Mr. Denzil Ranjitsingh, Mr. Ebenezer Sundarraj, Mrs. Esther Kezia James, Mrs. Florence, Mr. Francis, Dr. George M. Chandy, Dr. Gigi Chandy, Ms. Gowri, Ms. Grace, Dr. Henry Kirubakaran, Mr. Hugh Skeil, Mrs. Indhumathi, Dr. Jacob. T. John, Dr. Jasmine, Dr. Jayaprakash Muliyil, Mr. Jeyashankar, Dr. John C. Muthuswami, Dr. Joy Mammen, Dr. Joy Michael, Dr. Joyce Ponnaiya, Mr. Josam Titus, Dr. Joseph Kuruvilla, Mr. Joseph Selvaraj, Dr. J.V.Peter, Dr. K. R. John, Dr. O. C. Abraham, Ms. Lallu Joseph, Mr. Pinto, Dr. Pramila Lee, Mr. Prasanna Samuel, Dr. Prashantham, Dr. Prathap Tharyan, Dr. Rajesh, Mr. Ravishankar, Dr. Reginald Alex, Mr. Robby Priya Sundersingh, Mr. Samuel Abraham, Dr. Samuel N.J. David, Dr. Shyamkumar, Mrs. Sarala Stanley, Mr. Sezlian, Ms. Sonia Valas, Dr. Subramani, Mr. Sukumar Solomon, Dr. Sunil Chandy, Mr. Sunny Kuruvilla, Mr. T.S. Ravikumar, Ms. Tunny Sebastian, Sr. Valli Babu, Mr. Vijayakumar, Dr. Vinod Shah, Dr. Visalakshi

BITS–Cognizant Technology Solutions, Chennai, Collaboration: M.Tech. Software Engineering

Dr. Vinay Raj Menon, Mr. Vanamamalai Sridhar, Mr. A. Sridharan , Dr. M. J. Shankar Raman, Mr. G. Sridhar, Dr. V. Maheswari, Dr. S. Chelliah, Mr. S. Prabhu, Mr. Sreekumar Gopalan, Mr. Ravi Ramachandran, Dr. Christy A, Mr. C. Ramamurthy, Mr. Swaminath Vaidyanathan, Mr. Srikanth Chavali, Mr. Ganesh S, Mr. Rajesh C, Mr. Aravind A, Mr. Sathish N, Ms. Gayathri Viswanathan, Mr. Ramesh P, Mr. V.S. Vasan, Mr. Prakash Ramaswamy

BITS - Consultancy Development Centre, New Delhi, Collaboration: M.B.A. Consultancy Management

Mr. Deepak Agarwal, Mr. S.K. Lalwani, Mr. Suresh Kumar, Dr. A. K. Puri, Mr. K. K. Vohra, Mr. Sunil Soni, Dr. S.K. Laroiya, Prof. P.K. Jain.

CLUSTER PROGRAMME, Pune: M.Tech. Embedded Systems

Mr. Kiran H Dahimiwal; (Industry expert) ; Mr Ranjit Nair (Industry expert); Mr Rajendra Kurmadas (Industry expert); Dr Sandeep Agarwal, Mr. Mahadev Chougule , Mr Pawan

Gupta.; Ms Sneha Thombare, Mr Mukesh Ghogare

CLUSTER PROGRAMME, Pune: M.Tech. Design Engineering

Dr Raj Kumar Singh , Mr. Jitendra Divgi ,Mr Ravindra Birajdar, Mr. Vijay Tijare, Mr. Sarvesh Mahajan (Industry expert); Mr N K Joshi; Mr. Ayaz Khan, Mr Harish Deshpande; Mr Umesh Chavan; Dr Suhas Deshmukh; Mr Anand Mahulkar, Mr V N Kapatkar, Mr KW Deshmukh

BITS-Cybage India Limited, Pune, Collaboration: M.Tech. Software Engineering

Ms Deepthi Trivedi, Ms. Minal Raja; Mr. Sallaudian Shaikh, Mr Sunil Dhore,, Mr Manish Mishra, Mr. Sandeep Patil

BITS-Eaton Technolgies, Pune, Collaboration: M.Tech. Design Engineering, M.Tech Embedded Systems and B.S Engineering Design

Mr Sashawat Mitra, Ms. Nairita Dey; Mr Swapnil Wadkar, Mr Ayaz Khan, Mr. Mohan Kohnd, Mr Nitin Junarkar.

BITS-IGATE Ltd., Mumbai and Pune, Collaboration: M.Tech. Software Engineering

Mrs. Veena Deshpande, Ms Shamika Kulkarni, Mr Sachin Patankar, Mr Pravin Tekade; Ms Mahima Sharma, Mr Pramod Patwardhan; Mr Sameer Chimurkar, Ms. Seema Shah, Mr. Abhijeet Patankar, Mr. Parmanand Barik, Mr. Santosh Chobe, Mr. Rahul Patil, Mr Ashutosh Nivargi.Ms. Pradnya Kashikar, Mr. Sanjeev Pitambare,

BITS-JOHN DEEERE, Pune, Collaboration: M.Tech. Design Engineering

Ms Sarika Saini; Mr Lalit Ganwir , Mr. Sarvesh Mahajan; Mr. Ayaz Khan, Mr N K Joshi, Mr Sandeep Wankhade; Mr Swapnil Wadkar, Mr Wallace Jocob.

BITS - JSW Steel Ltd., Vijayanagar, Collaboration: B.Tech. Process Engineering

Dr. V. K. Nowal, Mr. H. R. Lal, Mr. Pankaj LOchan, Mr. Achutha Raghava, Dr. Ramakrishna, Mr. Upendra Kumar, Mr. , Pankaj Gupta, Mr. Shakeel Ahmed Maniyar, Prof. Jeevargi Phakirappa, Dr. Rameshwar Sah, Mr. Satish Kumar , Dabbiru, Ms. Triveni Kakimani, Dr. Mallikarjunrao Panabaka, Ms. Uma Devi, Dr Sarbendu Sanyal, Dr. Manjini , Sambandam, Dr. Jitendra Mohapatra, Mr. Sharanappa Kalshetty, Dr. Ravi Kishore, Mr. L Vinay, Mr. Suresh , Basabareddy , Mr. Mrunmaya Pasupalak ,Mr. Chaitanya Ayyagari , Dr. Ravi Kishore , Mr. Vijaya Sekhar , Mr. P K , Tripathi, Prof. Pavan Kumar , Mr. Siddalingagouda, Mr. Irshad Ali , Mr. Venkatesan J, Mr. Ratnakar Bonda

BITS-Kirloskar Oil Engines Ltd., Kagal, Collaboration: B.Tech. Manufacturing Technology

Mr. Krishna Gawade, Mr. Vikram Dalvi, Mr. Nitin Junarkar, Mr. Ashish Patil, Mr. Harish Deshpande, Mr. Sunil Kardikar, Mr. Bhimsen Shinde; Mr. Amar Bhandare, Mr. Yogesh Danekar, Mr. Mahadev Chougule.

BITS – L V Prasad Eye Institute, Hyderabad, Collaboration: B.Optom. Optometry

Dr Gullapalli N Rao, Prof. D Balasubramanian, Dr G Chandra Sekhar, Dr Taraprasad Das, Dr Prashant, Dr Avinash Pathangey, Prof. P K Sai Prakash, Dr Savitri Sharma, Dr Vanita Pathak-Ray, Dr Anil K Mandal, Dr Virender S Sangwan, Dr Archana Bhargava , Dr Annie Mathai, Dr Somasheila Murthy, Dr Subhadra Jalali, Dr Praveen V Krishna, Dr Ramesha Kekunnaya, Dr Shrikant R Bharadwaj, Dr Srinivas Marmamula, Dr Vijaya Kumari Gothwal, Mr Vijay Kumar Y, Mr Srikanth M, Mr Deepak Kumar, Dr Beula Christy , Mr Jachin D Williams, Dr Subhabrata Chakrabarti, Mr Hasnat Ali, Mr Ghanshyam Singh, Mr Rajesh L, Mrs Vijaya L Ramam, Dr Rohit Khanna, Mr Srikanth D, Dr Padmaja K Rani, Ms. Snigdha, Ms Shailaja P Reddy, Mr Anjaneyulu, Dr Premnandhini Satgunam, Dr Charanya Ramachandran, Dr Srinivasa L Varadharajan, Mr Ganesh J, Dr Dilip Kumar Mishra, Dr Joveeta Joseph, Mr Yashwanth Goud M, Mr Praveen Kumar B, Mr Vinay Kumar N. Ms Yamuna, Ms Geetha Sravani, Ms Rebecca Sumalini, Ms Lakshmi Nair

BITS– Madras Medical Mission, Chennai, Collaboration: B.S. Physician Assistant

Prof. (Dr). Philomena Mariados, Dr.Mir Mahdi Ali, Dr. Thankam Rama Varma,Dr. S. Rajan, Dr. Benjamin Ninan, Dr. Mullasari Ajit, Dr. J. Ezhilan, Dr. Anusha Rohit, Dr. Ulhas Pandurangi, Dr. Kanagarajan, Dr. Latchumana Dhas, Dr. S. Selva Kumar, Dr. Ramani

Devairakkam, Dr. Kundavi, Dr.Malar, Dr.Lakshmi Dr. V.S. Manoharan, Dr.Sadullah Basha, Dr.Kishore.S, Mr.Felix Emmanuel, Ms.Vanitha.M,Dr. Nageswara Rao, Dr.Parthasarathy, Ms.Jacinth Martha Ebenezer.R.

BITS – R. L. Institute of Nautical Science, Madurai, Collaboration: B.Tech. Marine Engineering and B.Tech. Nautical Technology

Dr R Lakshmipathy, Mr R Ramkumar, Mr M Subramanian, Mr C Chandrasekaran, Mr.R.Muthukrishnan, Capt. Vivek Scudder, Mr Ananda Das, Mr Uma Maheswaran, Mr Chidambararaj C, Mr M Kumarasamy, Mr C P Sachithananatham, Mr.N.Manoj Kumar, Mrs Reen Golda, Mr Balasubramanian G, Mr Nagarajan R, Mr Rajendran R, Mr Mr Karanthamalai K, Mr Baskaran A, Mr Pulandiran K, Mr Vidya Poornachari D K, Mr M Muhundharajan, Mr S Paramasivam, Mr R R Jothikrishnan, Mr Nandeeswaran S, Mr Ramasamy R, Mr Suresh Babu R S, Mr Robert G, Mr K Palpandi, Mr Venkatasubramanian G, Mr.Boopathy Rajan G, Mr.T.Madalai Manikandan, Dr.R.Suganya, Dr.S.Pugalanthi, Mr.S.Pandikumar, Mrs.R.Suganthi Hepzhiba, Ms.Janaki, Mr V Prabhakar, Mr Vasudevan K, Mr Senthilkumar S, Mrs.N.G.Asha, Mr Ramasamy R, Mr.Lakshmanan, Mr.Porcheziyan, Mr Muthukamatchi M, Mr.P.Paulpandi

BITS – Sankara Nethralaya, Chennai, Collaboration: B.Optom. Optometry, M.Phil. Optometry

Dr. S. S. Badrinath, Prof. Jay M Enoch, Dr. S Baskaran, Dr. Lingam Gopal, Dr. T. S. Surendran, Dr. S. Meenakshi, Dr. Ronnie George, Dr. R Krishna Kumar, Dr L Vijaya, Dr Prema Padmanabhan, Dr. H N Madhavan, Dr. Vasanthi Badrinath, Dr. K. Lily Theresa, Dr. Sulochana K N, Dr. J Biswas, Dr. N. Ankayarkani, Dr. S. Krishna Kumar, Dr. R R Sudhir, Dr.S Pramod Bhende, Dr Muna Bhende, Dr. P S Rajesh, Dr K C Anand, Dr Smitha Parveen, Dr R Srikanth, Dr Rajiv Raman, Dr Manish Pandey, Dr Jayamuruga Pandian,Dr M Rajeswari,Ms A Rashima,Ms H Jameel Rizwana,Ms N Anuradha,Mr S Viswanathan,Ms Gella laxmi,Ms M Revathy,Ms K P Mohana,Ms S Ramya, Mr R Banukumar,Ms R Monica,Ms N P Leelaapriaya,Ms A Vijayalakshmi,Ms S Rajini,Ms N Kalpa, Ms R Indhusree, Dr. P P Santanam, Prof. S Veeraraghavan, Dr. S Ramaswamy, Dr Deepa Balendran, Dr Sumathi Narayanan, Prof. S Seshasayee,Dr R Anbalagan,Dr Revathy Ravindran,Prof. N Pichaimuthu,Ms G Vasanth,Dr K Ambujam,Ms Sabiha N JamalMr B Vijaya Kumar,Dr Rani Balasubramanian, Ms Sheela Evangeline,Ms Varuna Kumaran,Mr M Shankar,Dr M B Sudharsanam, Dr J Subbulakshmi, Dr Bharathi,Ms Gomathy Iyer,Mr Naresh Kumar,Mr R Bhuvana Sundar, Dr J Narayanan, Dr Nivedita Chatterjee ,Dr Dorein Gracis.

BITS – SAP Labs, Bangalore, Collaboration: M.Tech. Software Engineering

Prof. Naveen N C, Prof. Madhu B. K, Dr. Sasirekha, Prof. DV Ashoka, Prof. Ajay Misra, Prof.Raghavan.P, Prof.Raghavendra, Mr. Srevats Subromaniam Laxman, Mr. Kavi Arasu, Mr. Bhaskar Kalyansundaram, Mr.Kallol Pal, Mr. Sateesh Kavuri, Mr. Naved Ahmed, Mr. Badari Nath, Mr. Rohit Pathak, Ms. Zoya Kapoor, Mr. Nithin B Krishana, Mr.Nagendra Kumar, Mrs.Tabassum Ara, Mr. Nithin B Krishana,Mr. Ajit Ashok Joshi, Mrs Anitha N Murthy, Mrs. Jayashree Raju

BITS-SKF India Limited, Pune: M.Tech. Design Engineering

Ms Anjali Byce, Ms.Dhara Shah, Mr. N.K Joshi, Mr V N Kapatkar, Mr. Amol Shinde, Mr. Ayaz Khan, Mr. CVSR Subamanyam, Mr. Sandeep Wankhade.

BITS-TACO India Ltd., Pune, Collaboration: B.Tech. Manufacturing Technology

Mr. Kanchan Kr. Biswas, Mr Vikas Yadav,, Mr. Balesh Ropia, Mr. Anand Mahurkar, Mr. Sandeep Wankhade ; Mr Nitin Junarkar;

BITS-TATA MOTOR, PUNE : M.Tech Automatic Engineering

Mr Syshant Routray, Ms Trupti W, Ms. Deepali Khairnar, Dr Benu Madhav, Dr Ganesh Soni, Mr Sarvesh Mahajan, Mr. Amol Shinde

BITS-Tata Technologies, Pune, Collaboration: M.Tech. Automotive Engineering

Mr. Subhendu Ghosh, Mr. Aditya Roy choudhary; Mr. C. Surendra Nath, Mr. Istaqi Khan; Ms Anumeha Jain; Mr. Indranil Bhattacharya.

BITS – Tolani Maritime Institute, Induri, Collaboration: B.Tech. Marine Engineering and B.Tech. Nautical Technology

Mr. Rohet Tolani, Dr. Sujata Naik, Dr. B. K. Saxena, Capt R. K. Razdan, Capt. Subhash Deshpande, Capt. Krishnamurthy N Iyer, Dr. Sanjeet Kanungo,Dr. D.D. Mundhra, Cdr (retd) S Dasgupta, Capt. Manoj Hirkane, Dr. Bani Upmanyu, Ms. Anjali V Deshpande, Mr. Sachin M Vyavahare, Mr. Wallace Jacob, Mrs. Unnati N Chaudhari, Mrs. Vandana M Shinde, Dr. Vinod Kumar Mangwani, Mrs. Puja P Awachat, Mrs. Gauri M Kulkarni, Mrs. Nilima C Joshi, Mr. Ganesh B Ingle, Mr. Mukesh J Umbarkar, Mr. Sanjay B Dabadgaonkar, Dr. Dhiren P Dave, Mr. Laxman S Tikore, Mr. G.B. Jadhav, Mr. Kailash A Mehendale, Mr. Gajjan Singh, Mr. Ajit G Shedge, Cdr (Retd) Lakhbir Singh, Cdr (Retd). S P Singh, Mr. Subhash Ghosh, Mrs. Sujata A Male, Mrs. Pratibha V Ghatkamble,Mr. Mohammad Abrar Zaheer, Mr.Irayya D Swami,Mr. Vaibhav Karlekar,Mr.Nandkumar Mehta,Mr. Moreshwar Narkhede, Mr. Shishir kumar Srivastava, Cdr (Retd) Krishnankutty, Mr. Arun Mahajan, Mr. Naresh Kumar Mishra, Mr. Shailendra Kumar, Mr. Upinderjeet Singh, Mr. Premkumar Ramrakhiani, Mr. Sankar K Subramanian, Mr. Shishir Dutt, Mr. Sunil Kumar Panda, Cdr (Retd)Bhaskar Walimbe, Mr. Anirudh Kumar, Mr. Sudhir C. Sindagi, Mr.Ajit Singh Aidhen, Mr. Jitendra Singh Pal, Mr.Prabhakar B Shidhaye, Dr. Rajendra Prasad, Mr.Satyavan K Ghorpade,Mr.Bhagwan Singh, Mr. Rakesh Kumar Ganotra, , Col. (Retd) G. P. Krishnamurthy,Mr. Anand L Tappu, Mr. N. K. Joshi, Mr. H. K. Deshpande, Dr. Nitin D Junnarkar, Mr. Anand Pandya, Mr. Gopal M Mohadikar, Mr. C. V. S. R. Subrahmanyam, Mr. Ayaz J Khan, Mr. Amol S Shinde, Mr. Shrikant Madiwale, Mrs. Supriya S Bhagat, Mr.Amol Ratnakar Tatke, Mr. Ankush Lahu Pawar, Mr. Prasad Ramesh Deshpande,Mr. Somnath Nirali, Cdr (Retd) Niranjan Pal, Capt. K Govindrajan, Capt. I. Banerji, Capt. Abhijeet A Avate, Capt.Deepak Sabharwal, Capt. V B Sathaye, Cmde (Retd) Hari A Gokhale, Capt. Sarfaraz J Lakdawala, Mr. Rajendra Shrivastava,Mr.Deepchand Dhankher, Mr. Mahendra Singh Masani.

BITS – Tech Mahindra, Hyderabad, Collaboration: M.Tech Software Engineering

Mr. N Krishna Murthy, Dr YVK Ravi Kumar, Ms. S V Menaja, Mr. K Vamsi Krishna, Mr G Anil Kumar, Mr K Srinivas, Ms. D Sandhya Rani, Mr STVSS Yadunandan, Mr. K G Krishna, Ms Radhika B.

BITS-Tech Mahindra Limited, Pune, Mumbai, Bangalore, Hyderabad, Chennai, Noida, Collaboration: M.Tech. Software Engineering and M.Tech. Telecommunications and Software Engineering

Mr. Sujit Baksi, Mr. L Ravichandran, Mr. Rakesh Soni, Col.(retd) PK Sharma, Mr. Uday Vartak, Mr. Ved Prakash Nirbhay, Mr. Prakash Devan, Mr. Rajendra Kembhavi, Mr. Sanjeev Parida, Ms. Gargi Banerjee, Col.(retd) Surendra Patnaik, Mr. Saurabh Agrawal, Mr. Abhishek Kumar, Mr. Saravanan Mariappan, Mr. Sindhu Rajendra, Mr. Nagraj Vaidya, Mr. P.V. Mathew, Ms. Dheepti Amritha, Mr. Vijay Kumar, Mr. Riyaz Mulla, Ms. Vaishali Phatak, Ms Sunaina Shrivatsava; Ms Rajpreet Kaur, Mr. Abhishek Kumar; Mr. N.S.T. Sai, Ms. Elizabeth Zachariah, Mr. Varun T, Ms. Sucharita Palepu, Mr. Raju Wadalkar, Mr. Ravi Jain, Ms. Pradyna Kashikar, Mr. Parag Mahajani, Ms. Yogeshri. Gaidhani, Dr. K Samudravijaya, Ms.Chetna Khairnar, Ms. Prachi Harkare

BITS-Wipro Infotech, Bangalore, Chennai, Hyderabad, Mumbai, Gurgaon and Mysore, Collaboration: M.Tech. Systems Engineering, M.Tech. Software Engineering and B.Tech. Information Systems.

Mr.Ajay Narayanan, Ms.Anchal Tripathi, Ms. Ashif Banu Abdul Razak, Ms. P.Monica Prisulla, Ms. Pinky Paresh Bhatt, Ms. Puhpanjali Patnaik.

BITS-Wipro Technologies, Bangalore, Chennai, Hyderabad, Kolkata, Pune and Kochi, Collaboration: M.Tech. Software Engineering, M.Tech. Microelectronics and B.Tech. Information Systems

Mr. P B Kotur, Mr. Udaya Prakash, Dr. Sricharan Srinivasan, Mr. Santosh Sridhar, Dr. Akash Sondhi, Mr. Mukesh Verma, Ms. Rajani Satheesan.

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Prof. V.S. Rao, Acting Vice-Chancellor

Shri B.K. Birla

Shri Sidharth Birla

Smt. Manjushree Khaitan

Shri Hemant Kumar

Prof. D. Balasubramanian

Dr. Santanu Chaudhury

Dr. S.K. Chopra

Shri Tridib Kumar Das

Prof. Asis Datta

Shri Ashish Dhawan

Prof. L.K. Maheshwari

Shri Enrico Malerba

Shri V.S. Pandey

Shri Raju Reddy

Prof. M.M.S. Anand (Registrar)
Non-member Secretary

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Chairman (Vice-Chancellor)

Prof. V.S. Rao (Sr. PROF), Acting

Vice-Chairman (Director, Pilani Campus)

Prof. Ashoke Kumar Sarkar (Sr. PROF)

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Dubai Campus

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Prof. Poonam Goyal
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Prof. T. Venkateswara Rao, Hyderabad
Prof. H. Viswanathan, Bangalore
Prof. Satya Sudhakar Yedlapalli, Bangalore

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Prof. Narendra Nath Ghosh
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Prof. Anand Magadi Narasimhamurthy
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Prof. Punna Rao Ravi
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Prof. Vijaya Ilango
Prof. Kavita Sunil Jerath
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Prof. Anu Gupta (ASOP)
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Prof. Adhir Baran Chattopadhyay (PROF)
Prof. Trupti Swarup Gokhale (ASOP)
Prof. Ram Karthikeyan (PROF)
Dr. B.G. Prakash Kumar (ASTP)
Prof. A. Srinivasa Rao (ASOP)
Prof. B. Vijayakumar (PROF)

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Dr. Phaneendra Kiran C (ASTP), Hyderabad Campus
Dr. Lucy J. Gudino (ASTP), K.K. Birla Goa Campus
Dr. Jyoti (ASTP), Pilani Campus
Dr. Angshuman Sarkar (ASTP), K.K. Birla Goa Campus
Dr. Meenakshi Viswanathan (ASTP), Hyderabad Campus

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Shri Giridhar M. Kunkur, Pilani Campus
Shri R. Sivakumar, Dubai Campus

Workshop Superintendent

Shri G.J. Desai, K.K. Birla Goa Campus

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Prof. Thoppil George Thomas (PROF), Dubai Campus

Placement Officer

Prof. Mani Sankar Dasgupta (PROF)

Student Members

Shri Akshith Reddy Saddi, 2013B3A7673P
Shri Yashoraj Tyagi, 2013A8PS287G
Shri Himanshu Bagga, 2013B4A7864H
Shri Rishav Jalan,, 2013A7TS183U

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1. Prof. Niranjan Swain, Hyderabad Campus
2. Prof. B. Muralidharan, Dubai Campus

Dean, ARD

Prof. Sanjay Kumar Verma

Associate Dean, ARCD:

Prof. Bijay Kumar Rout (Pilani Campus)

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Chairman: Associate Dean, SWD Prof. Kumar Neeraj Sachdev **Chief Warden:** Prof. Shibasish Chowdhury **Faculty Members (2):** Dr. Gajendra Singh Chauhan Dr. Saumi Ray **Student Member (1):** Mr. Keshav Venkatraman ID No. 2012A4PS211P	**Chairman: Associate Dean, SWD** Prof. Jagarlamudi Venkateswara Rao **Chief Warden:** Dr. Ramesha C.K. **Faculty Members (2)** Prof. Tarkeshwar Singh Prof. Radhika Vathsan **Student Member (1):** Mr. Bittu N. ID No. 2012B5A3514G
III. Hyderabad Campus	**IV. Dubai Campus**
Chairman: Associate Dean, SWD Prof. Sandip Shridharrao Deshmukh **Chief Warden:** Dr. Kumar Pranav Narayan **Faculty Members (2):** Prof. Punna Rao Ravi Dr. Aruna Malapati **Student Member (1):** Mr. Ch Sai Chaitanya Reddy ID No. 2012A4PS353H	**Chairman: Dean, SWD** Prof. Priti Bajpai **Chief Warden:** Dr. Santosh Kumar Vasudevan **Faculty Members (2):** Dr. Rusal Raj Dr. Sujala D. Shetty **Student Member (1):** Ms. Shreya Jain ID No. 2013A7PS064U

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5.	Computer Science & Information Systems	Dr. Sundaresan Raman
6.	Off-Campus Work-Integrated Learning Programmes	Dr. Manojkumar Surajkaranji Soni
7.	Economics & Finance	Prof. N.V. Muralidhar Rao
8.	Electrical & Electronics Engineering & Instrumentation	Dr. Pawan Kamalkishor Ajmera
9.	Humanities and Social Sciences	Dr. Dinesh Yadav
10.	Mathematics	Dr. Shivi Agarwal
11.	Mechanical Engineering	Dr. Amol M. Marathe
12.	Management	Dr. Satendra Kumar Sharma
13.	Pharmacy	Dr. Rajeev Taliyan
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8.	Mathematics	Dr. Amit Setia
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10.	Physics	Dr. Teny Theresa John

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3.	Chemical Engineering	Prof. Srikanth Dinda
4.	Chemistry	Dr. Durba Roy
5.	Computer Science & Information Systems	Prof. Ananda Magadi Narasimhamurthy
6.	Economics and Finance	Dr. Suddatta Banerjee
7.	Electrical & Electronics Engineering	Dr. Souvik Kundu
8.	Humanities and Social Sciences	Prof. Sunny Jose Gosman
9.	Mathematics	Dr. Sumit Kumar Viswakarma
10.	Mechanical Engineering	Dr. N Jalaiah
11.	Pharmacy	Prof. Punna Rao Ravi
12.	Physics	Dr. V Satyanarayana Murthy

Shri M.S. Udayakumar (Deputy Librarian) - Chairman of the Library Committee

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2.	Chemical Engineering	Dr. Nishant Harishbhai Pandya
3.	Computer Science	Dr. Siddhaling Urolagin
4.	Electrical & Electronics Engineering, Electronics and Instrumentation Engineering and Electronics and Communication Engineering	Dr. Raja Muthalagu
5.	General Sciences	Dr. Suhel Ahmed Khan
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Associate Dean, Academic Registration & Counselling Division

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3. Prof. Vidya Rajesh, Hyderabad Campus
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2. Prof. Anjan Chattopadhyay, K.K. Birla Goa Campus
3. Prof. Amit Kumar Gupta, Hyderabad Campus
4. Prof. R. Udayakumar, Dubai Campus

Convenorship rotates amongst these members depending on the item to be discussed

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Dean (Admissions), Pilani Campus

Special Invitees:

Dean, (AR), Pilani Campus

Dean, (WILP), Pilani Campus

Dean, (Academics/Admission), Dubai Campus

ACADEMIC CALENDAR FOR PILANI CAMPUS

SOME IMPORTANT DATES

2016

JULY

S	M	T	W	T	F	S
31					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30

AUGUST

S	M	T	W	T	F	S
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31			

SEPTEMBER

S	M	T	W	T	F	S
		1	2	1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	

OCTOBER

S	M	T	W	T	F	S
30	31					1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29

NOVEMBER

S	M	T	W	T	F	S
		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30			

DECEMBER

S	M	T	W	T	F	S
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	31

2017

JANUARY

S	M	T	W	T	F	S
1	2	3	4	5	6	7
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15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				

FEBRUARY

S	M	T	W	T	F	S
			1	2	3	4
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12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28				

MARCH

S	M	T	W	T	F	S
			1	2	3	4
5	6	7	8	9	10	11
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19	20	21	22	23	24	25
26	27	28	29	30	31	

APRIL

S	M	T	W	T	F	S
30						1
2	3	4	5	6	7	8
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16	17	18	19	20	21	22
23	24	25	26	27	28	29

MAY

S	M	T	W	T	F	S
	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31			

JUNE

S	M	T	W	T	F	S
				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	

HOLIDAYS AND RECESS

First Semester 2016-2017

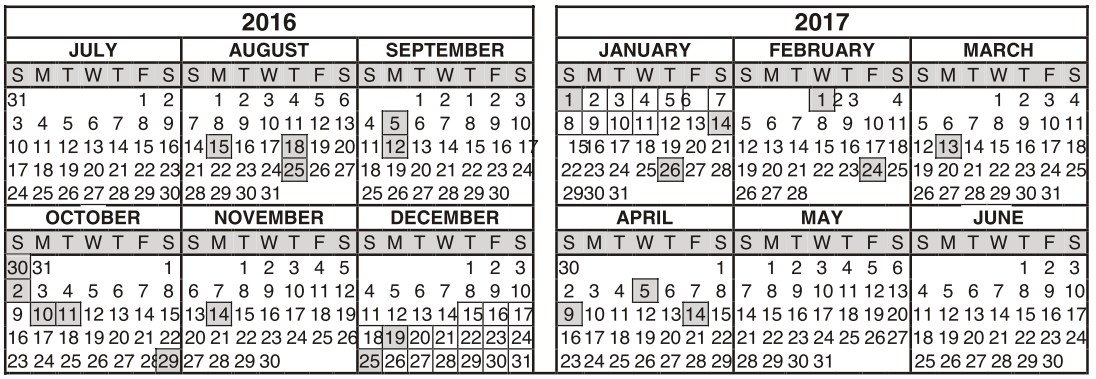
July 4, 2016 (M)	Registration for Practice School II
July 4, 2016 (M)	Practice School II begins
July 29 (F)	Admission to Higher Degree and Doctoral Programmes
July 30 (S)	Admission to Integrated First Degree Programme
July 31 (Su)	Freshmen Orientation Programme
August 1 (M)	First Semester begins
August 1 (M)	Registration for all students
August 2 (T)	Class-work begins
August 15 (M)	Independence Day (H)
August 17 (W)	Last day for substitution of courses
August 18 (Th)	Raksha Bandhan (H)
August 19 (F)	Last day for submission of Application for Merit-Cum Need Scholarship
August 25 (Th)	Janmashtami (H)
September 12 (M)	Eid- ul-Zuha (H)
October 2 (Su)	Mahatma Gandhi's Birthday (H)
October 3 (M) to 8 (S)	Mid-Semester Test (Class work Suspended)
October 7 (F)	Monday's Timetable to be followed
October 10(M) -11 (T)	Dussehra (H)
October 12 (W)	Last day for withdrawal from courses
October 17 (M)	Last day for returning evaluated answerscripts of Mid-Semester Test
October 20 (Th)-23 (Su)	OASIS-2016
October 26 (W)	Last day for Mid-Semester Grading
October 30 (Su) - 31(M)	Diwali (H)
November 4 (F)	Monday's Timetable to be followed
November 14 (M)	Guru Nanak's Birthday (H)
November 26 (S)	Thursday's Timetable to be followed
November 26 (S)	Last day of Pre-comprehensive marks display
November 29 (T)	Last day for class work
December 1 (Th)	Comprehensive Examination begins
December 14 (W)	Practice School II ends
December 14 (W)	Comprehensive Examination ends
December 14 (W)	First Semester ends
December 15 (Th) to January 11 (W), 2017	Recess
December 25 (Su)	Christmas (H)
January 1, 2017 (Su)	New Year (H)

Second Semester 2016-2017

January12, 2017 (Th)	Second Semester begins
January 12 (Th)	Registration for all students
January 12 (Th)	Registration for Practice School II
January 12 (Th)	Practice School II begins
January 13 (F)	Class-work begins
January 14 (S)	Makar Sankranti (H)
January 26 (Th)	Republic Day (H)
January 28 (S)	Last day for substitution of courses
January 28 (S)	Last day for submission of Application for Merit-Cum Need Scholarship
February 1 (W)	Basant Panchmi and Founder's Day (H)
February 24 (F)	Shivratri (H)
March 6 (M) to 11(S)	Mid-Semester Test (Class work Suspended)
March 12(Su) -13(M)	Holi (H)
March 18 (S)	Last day for withdrawal from courses
March 21 (T)	Last day for returning evaluated answerscripts of Mid-Semester Test
March 23 (Th) - 26(Su)	APOGEE
March 25 (S)	Last day for Mid-Semester Grading
April 5 (W)	Ram Navami (H)
April 9 (Su)	Mahavir Jayanti (H)
April 14 (F)	Dr. Ambedkar Jayanti (H)
April 16 (Su)	Registration for Practice School I
May 2 (T)	Last day for class work
May 3 (W)	Comprehensive Examination begins
May 16 (T)	Comprehensive Examination ends
May 16 (T)	Second Semester ends
May 19 (F)	Summer Vacation begins
May 22 (M)	Summer Term begins
May 22 (M)	Practice School I begins
June 17 (S)	Practice School II ends
July 15 (S)	Practice School I ends
July 15 (S)	Summer Term ends
July 17 (M)	Summer Vacation ends

ACADEMIC CALENDAR FOR K. K. BIRLA GOA CAMPUS

SOME IMPORTANT DATES



HOLIDAYS AND RECESS

First Semester 2016-2017

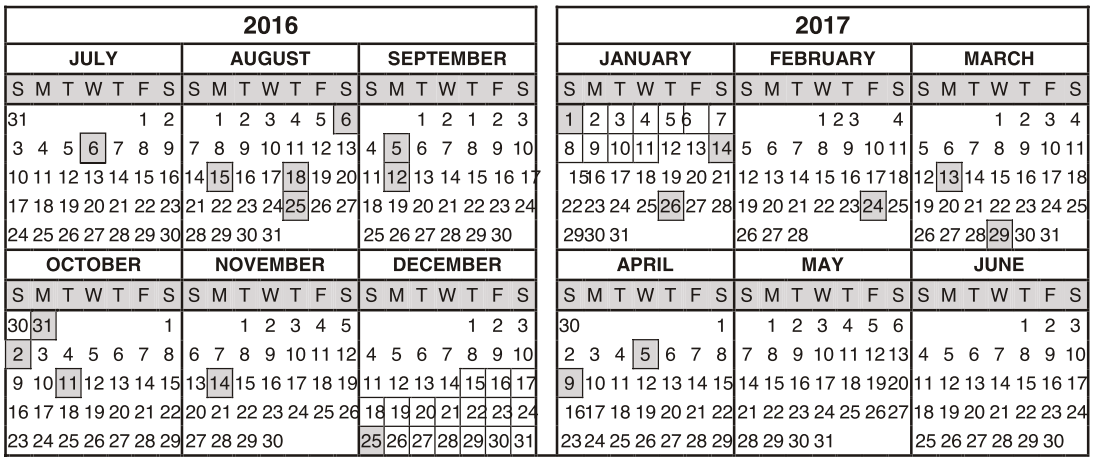
July 4, 2016 (M)	Registration for Practice School II
July 4, 2016 (M)	Practice School II begins
July 29 (F)	Admission to Higher Degree and Doctoral Programmes
July 30 (S)	Admission to Integrated First Degree Programme
July 31 (Su)	Freshmen Orientation Programme
August 1 (M)	First Semester begins
August 1 (M)	Registration for all students
August 2 (T)	Class-work begins
August 15 (M)	Independence Day (H)
August 17 (W)	Last day for substitution of courses
August 18 (Th)	Raksha Bandhan (H)
August 19 (F)	Last day for submission of Application for Merit-Cum Need Scholarship
August 25 (Th)	Janmashtami (H)
September 5 (M)	Ganesh Chaturthi(H)
September 12(M)	Eid- ul-Zuha (H)
September 19(M) -23(F)	Test I Series
October 1 (S)	Last day for returning evaluated answerscripts of Test 1
October 2 (Su)	Mahatma Gandhi's Birthday (H)
October 5 (W)	Monday's Timetable to be followed
October 10 (M)	Last day for withdrawal from courses
October 10(M) - 11(T)	Dussehra (H)
October 24(M) - 28(F)	Test II Series
October 29 (S)	Diwali (H)
October 30 (Su)	Diwali (H)
November 5(S)	Last day of returning evaluated answer scripts of Test- II
November 9(W)	Monday's Timetable to be followed
November 10(Th)	Last day of Mid-Semester Grading
November 14 (M)	Guru Nanak's Birthday (H)
November 26 (S)	Last day of Pre-comprehensive marks display
November 29 (T)	Last day for class work
December 1 (Th)	Comprehensive Examination begins
December 14 (W)	Practice School II ends
December 14 (W)	Comprehensive Examination ends
December 14 (W)	First Semester ends
December 15 (Th) to January 11 (W), 2017	Recess
December 19 (M)	Goa Liberation Day(H)
December 25 (Su)	Christmas (H)
January 1, 2017 (Su)	New Year (H)

Second Semester 2016-2017

January12, 2017 (Th)	Second Semester begins
January 12 (Th)	Registration for all students
January 12 (Th)	Registration for Practice School II
January 12 (Th)	Practice School II begins
January 13 (F)	Class-work begins
January 14 (S)	Makar Sankranti (H)
January 26 (Th)	Republic Day (H)
January 28 (S)	Last day for substitution of courses
January 28 (S)	Last day for submission of Application for Merit-Cum Need Scholarshi
January 31 (T)	Wednesday's Timetable to be followed
February 1 (W)	Basant Panchmi and Founder's Day (H)
February 20(M) to 25(S)	Test I Series
February 24 (F)	Shivratri (H)
March 4(S)	Last day of returning evaluated answer scripts of Test- I
March 13(M)	Holi (H)
March 18 (S)	Last day for withdrawal from courses
March 27(M) - 31(F)	Test II Series
April 5 (W)	Ram Navami (H)
April 8(S)	Last day of returning evaluated answer scripts of Test- II
April 9 (Su)	Mahavir Jayanti (H)
April 11 (T)	Friday's Timetable to be followed
April 13 (Th)	Last day of Mid-Semester Grading
April 14 (F)	Good Friday(H)
April 16 (Su)	Registration for Practice School I
April 29(S)	Last day of Pre-comprehensive marks display
May 2 (T)	Last day for class work
May 3 (W)	Comprehensive Examination begins
May 16 (T)	Comprehensive Examination ends
May 16 (T)	Second Semester ends
May 19 (F)	Summer Vacation begins
May 22 (M)	Summer Term begins
May 22 (M)	Practice School I begins
June 17 (S)	Practice School II ends
July 15 (S)	Practice School I ends
July 15 (S)	Summer Term ends
July 17 (M)	Summer Vacation ends

ACADEMIC CALENDAR FOR HYDERABAD CAMPUS

SOME IMPORTANT DATES



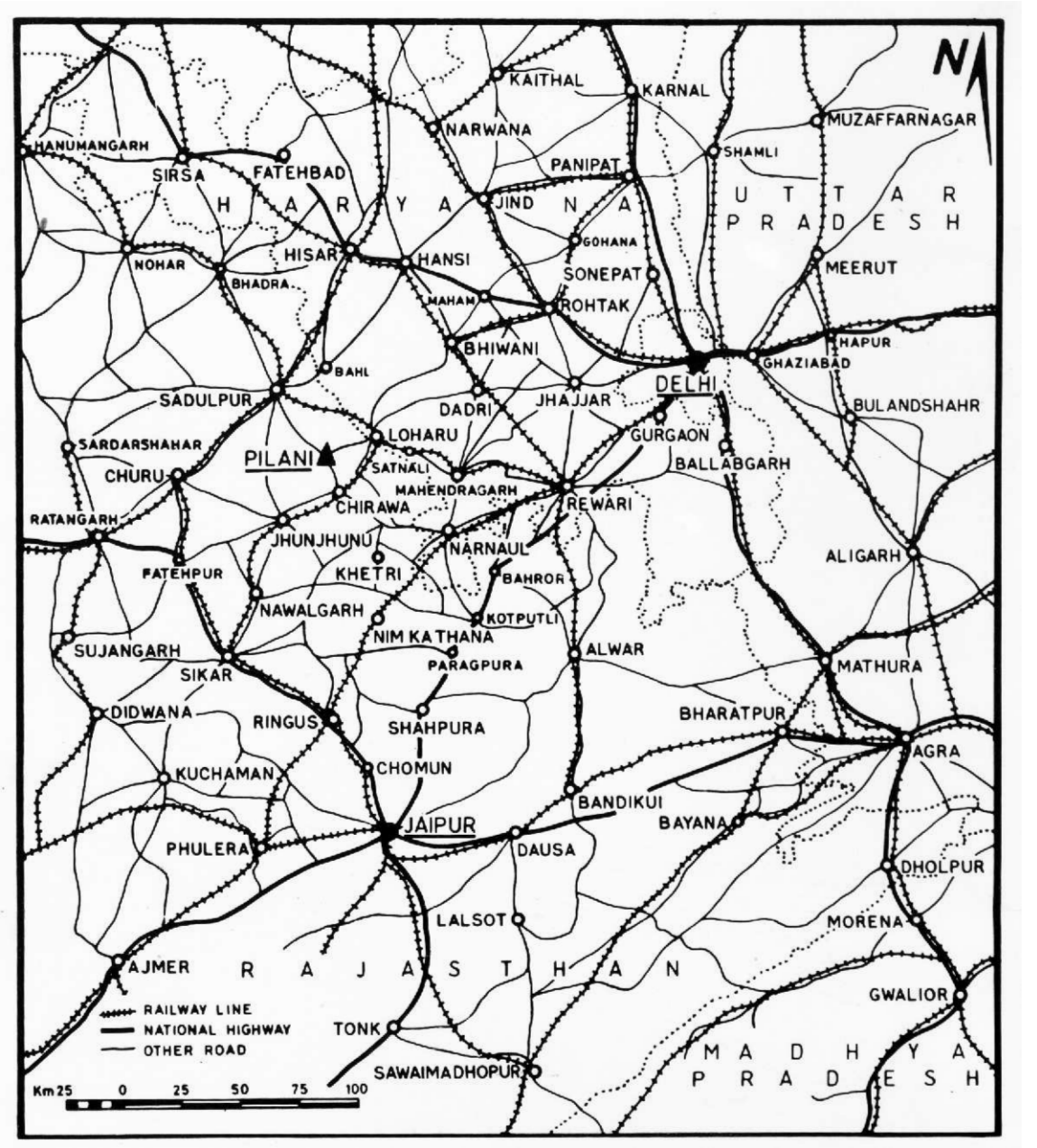
HOLIDAYS AND RECESS

First Semester 2016-2017

July 4, 2016 (M)	Registration for Practice School II
July 4, 2016 (M)	Practice School II begins
July 6, 2016 (W)	Ramzan (Eid-ul-Fitr) (H)
July 29 (F)	Admission to Higher Degree and Doctoral Programmes
July 30 (S)	Admission to Integrated First Degree Programme
July 31 (Su)	Freshmen Orientation Programme
August 1 (M)	First Semester begins
August 1 (M)	Registration for all students
August 2 (T)	Class-work begins
August 15 (M)	Independence Day (H)
August 17 (W)	Last day for substitution of courses
August 18 (Th)	Raksha Bandhan (H)
August 19 (F)	Last day for submission of Application for Merit-Cum Need Scholarship
August 25 (Th)	Janmashtami (H)
August 31 (W)	Monday's Timetable to be followed
September 5 (M)	Ganesh Chaturthi (H)
September 8(Th)-13(T)	Test-I Series (Class Work Suspended)
September 12 (M)	Bakrid (Eid-ul-Zuha) (H)
September 20 (T)	Monday's Timetable to be followed
September 20 (T)	Last day for returning evaluated answer scripts of Test I
September 28 (W)	Monday's Timetable to be followed
October 2 (Su)	Mahatma Gandhi's Birthday (H)
October 10 (M)	Last day for withdrawal from courses
October 11 (T)	Dussehra (H)
October 14 (F)–15(Su)	ATMOS 2016 (Class work remains suspended)
October 21 (F) - 25 (T)	Test-II Series (Class Work Suspended)
October 26 (W)	Last day for Mid-Semester Grading
October 31 (M)	Diwali (H)
November 2 (W)	Last day for returning evaluated answer scripts of Test II
November 2 (W)	Monday's Timetable to be followed
November 14 (M)	Guru Nanak's Birthday (H)
November 26 (S)	Last day of Pre-comprehensive marks display
November 29 (T)\	Last day for class work
December 1 (Th)	Comprehensive Examination begins
December 14 (W)	Practice School II ends
December 14 (W)	Comprehensive Examination ends
December 14 (W)	First Semester ends
December 15 (Th) to January 11 (W), 2017	Recess
December 25 (Su)	Christmas (H)
January 1, 2017 (Su)	New Year (H)

Second Semester 2016-2017

January12, 2017 (Th)	Second Semester begins
January 12 (Th)	Registration for all students
January 12 (Th)	Registration for Practice School II
January 12 (Th)	Practice School II begins
January 13 (F)	Class-work begins
January 14 (S)	Makar Sankranti (H)
January 26 (Th)	Republic Day (H)
January 26 (Th)- 29(Su)	ARENA 2017
January 28 (S)	Last day for substitution of courses
January 28 (S)	Last day for submission of Application for Merit-Cum Need Scholarship
February 23 (Th) - 28(T)	Test-I Series (Class Work Suspended)
February 24 (F)	Shivratri (H)
March 8 (W)	Last day for returning evaluated answer scripts of Test I
March 13(M)	Holi (H)
March 17 (F) -19 (Su)	PEARL 2017 (Class Work Suspended)
March 18 (S)	Last day for withdrawal from courses
March 25 (S)	Last day for Mid-Semester Grading
March 29 (W)	Ugadi/Hyderabad Campus Foundation Day (H)
March 31 (F) - April 4(T)	Test-II Series (Class Work Suspended)
April 5 (W)	Ram Navami (H)
April 9 (Su)	Mahavir Jayanti (H)
April 12 (W)	Last day for returning evaluated answer scripts of Test II
April 16 (Su)	Registration for Practice School I
May 2 (T)	Last day for class work
May 3 (W)	Comprehensive Examination begins
May 16 (T)	Comprehensive Examination ends
May 16 (T)	Second Semester ends
May 19 (F)	Summer Vacation begins
May 22 (M)	Summer Term begins
May 22 (M)	Practice School I begins
June 17 (S)	Practice School II ends
July 15 (S)	Practice School I ends
July 15 (S)	Summer Term ends
July 17 (M)	Summer Vacation ends



ROUTE TO PILANI