

Birla Institute of Technology and Science-Pilani, Hyderabad campus
First Semester 2022-23; Mid Semester Examination
Course No CEF231; Course Title: Fluid Mechanics
Date 04.11.2022, Maximum Marks: 30, Duration: 90 Minutes

N.B: Do not round off the intermediate values; Underline your Answers with relevant units

1. The vertical gap (separated by two plane surfaces) is 0.034 m wide and contains liquid L (specific gravity and viscosity 0.96 and 1.96 N-s/m²). The plate of dimension 1.9 m × 1.9 m × 0.0019 m is placed in the middle of the vertical gap. The plate is pulled up with a velocity of 0.24 m/s. The weight of the plate is 92 N. Mass density of water and acceleration due to gravity is 1000 kg/m³ and 9.81 m/s². Compute shear resistance. [6]
2. A single-column manometer is attached to a pipe X containing liquid L1 (specific gravity 0.98) with manometric liquid of specific gravity 13.61 (Hg in this problem). The height of liquid L1 in the left limb (LL) above the interface (up to the centre of pipe X) is 0.5 m. The height of the manometric liquid in the right limb (RL) above the interface is 0.8 m. The ratio of the area of the reservoir to that of RL is 140. The specific weight of water is 9810 N/m³. Find pressure in pipe X. [6]
3. The vertical side of a tank has a rectangular opening of 6 m × 3 m (width and height) and is closed by a plate using six bolts (3 on top and three on bottom) of the opening. The location of the liquid surface (specific gravity 0.9) from the top edge of the opening is 4 m. The specific weight of water is 10000 N/m³. Compute tension force in each upper bolt and each lower bolt. [6]
4. Solid cone of diameter and height 0.62 m, 0.8 m of specific gravity 0.82 is floating in liquid of specific gravity of 0.98. Determine the metacentric height and verify the stability of the cone. Hint: the position of the cone is vertex downwards. [6]
5. (a) Stream function $\psi = 8xy$. The velocity vector is ten units, and its inclination angle with the X-axis is 160°. Identify the corresponding co-ordinates (x, y). [4]
(b) What is the difference between stream tube and streamline [2]

Birla Institute of Technology and Science-Pilani, Hyderabad campus
First Semester 2022-23; Comprehensive Examination
Course No CEF231; Course Title: Fluid Mechanics
Date 28.12.2022, Maximum Marks: 40, Duration: 180 Minutes

Instructions to be strictly followed

- **Mandatory to Underline the answers in the manuscript.**
- **Answer to be made in the same sequence;**
- **Do not round off intermediate Answers**
- **All Questions are compulsorily to be answered**

1. A reducing bend in a horizontal plane of 45° deflection angle is discharging $1.6 \text{ m}^3/\text{s}$ of liquid. Diameter and pressure at inlet are 0.80 m and 26 kPa. Outlet is of 0.40 m diameter and 3.2 m higher than inlet. Volume of liquid (mass density 1020 kg/m^3) in the bend is 2.64 m^3 . Friction loss is 31.5 % of kinetic energy at inlet. Correction factors for kinetic energy at inlet and outlet are 1.14 and 1.24 whereas for momentum, these respectively are 1.42 and 1.84. Acceleration due to gravity is 9.81 m/s^2 . Find out **intensity of pressure at outlet and horizontal force** exerted by the liquid on the bend. Hint: axis at inlet of pipe is horizontal. [3+3]
2. Inclined venturi meter of inlet and throat dimensions of 0.52 m, 0.26 m is carrying liquid and positioned upwards. Reading of differential U-tube manometer connected to inlet and to the throat, length of converging cone, coefficient of discharge, inclination of venturi meter with horizontal are found to be 0.52 m, 0.88 m, 0.94, 34° . Specific weight of liquid, specific gravity of mercury, specific gravity of liquid and acceleration due to gravity are 10.2 kN/m^3 , 13.6, 1, 10 m/s^2 . Estimate **discharge in venturi meter and pressure at throat** if pressure at inlet is 72 kPa. [3+3]
3. Compute **maximum discharge** of liquid through convergent divergent mouthpiece. Diameter and gauge pressure at venacontracta are 0.082 m and -14 m of liquid. Measured head over centre of mouthpiece is 3.2 m whereas identified head loss in the contraction and divergent portions are 6.2 % of head and 10.2 % of head. Also find out **diameter at outlet**. Acceleration due to gravity is 9.81 m/s^2 . [3+3]
4. Syphon in the form of pipe line of diameter and total length of 1.2 m and 1400 m is joined between two reservoirs 1 and 2 having liquid level difference of 10 m. Height of summit of the syphon over reservoir 1 liquid surface, acceptable absolute minimal pressure at the summit, friction factor, and atmospheric pressure head in m of liquid are 4 m, 0.0, 0.02, 10.2. $g = 9.81 \text{ m/s}^2$. Find

out **discharge of liquid and outlet leg length** of syphon taking into account entry, exit and friction losses. [3+3]

5. Pipe of diameter and length 0.32 m and 800 m is transmitting liquid. Pressure anomaly recorded is 3200 kPa. Assess the following: **discharge, frictional resistance, requisite power to take care of the flow in kilowatts, maximum point velocity, shear stress at 0.08 m from the wall, friction factor**. Specific gravity and viscosity of liquid are 1.24, 1.64 N-s/m². Mass density of water is 1000 kg/m³. Status of pipe is horizontal and laminar flow condition [1+1+1+1+1+1]

6. Each question carries two marks each. Answer in the same sequence

- (a) Liquid (specific gravity of 0.76 and viscosity 0.0054 N-s/m²) flows through an orifice meter with orifice opening of 34 % of pipe diameter. As an alternative, orifice meter is replaced with venturi meter with diameter of throat is equal to diameter of orifice opening. Experiments revealed that coefficient of discharge of orifice meter and venturi meter are 0.76 and 0.94. Estimate **ratio of head over orifice meter and venturi meter**. Hint: discharge remain constant.
- (b) A rectangular notch is fixed at bottom of the tank of area $4.23 \times 10^5 \text{ m}^2$. Time needed to change the liquid levels from 5.2 m to 1.6 m is 5200 seconds. Quantify **length of the notch**. $C_d = 0.68$ and $g = 9.81 \text{ m/s}^2$. End contractions and velocity of approach need not be considered.
- (c) In a Mach model law situation, ratio of bulk modulus of elasticity of liquid in prototype and model is 1.2. Ratio of mass density of liquid in prototype and model is 1.3. Compute **velocity ratio**. What is the **velocity in prototype** if velocity in model is 8 m/s. Fluid is same in model and prototype?
- (d) A vertical surface has projected area of 5.2 m² with centre of gravity from top surface as 5.6 m. Specific gravity of liquid is 0.82. Compute **pressure force**? Vertical surface is having clamp one side at centre of vertical edge and two bolts on opposite side with equal distance from the end. What is the **load carrying capacity of clamp and two bolts**?
- (e) Width of large orifice is 2.6 m. Head upto top of orifice, head upto bottom of orifice, coefficient of discharge (H_1, H_2, C_d) values are 4.8 m, 7.6 m, 0.67. Compute **discharge passing through large orifice**.