BIRLA INSTITUTE OF TECHNOLOGY & SCIENCE, PILANI, HYDERABAD CAMPUS
FIRST SEMESTER 2022-2023
Mid-semester Examination
Course No: CE F 417, Time: 3:30-5:00 PM
Course Title: Application of AI in Civil Engineering
Date: 4.11.2022, Max. Marks: 25, Duration: 90 Minutes

1. Answer all five questions.
2. Answer each question on a fresh page.
3. The students shall not resort to any unfair means in attempting the exam. The consequences of adopting unfair means will be severe.

1. A business has investigated its manufacturing processes to produce minimal liquid, solid, and gaseous waste. A, B, and C are the sole items that the factory makes. Each unit of A, B, and C generates net profits of ₹75.0, ₹60.0, and ₹98.0 respectively. The table below illustrates how these three goods generate various quantities of waste. A maximum of 50,000 m^3/d of liquid waste, 9,000 kg/d of solid waste, and 7,000 m^3/d of gaseous waste may be produced daily. How many of each product should be manufactured to make the most profit? Use a linear programming framework to solve the issue. **(6 Marks)**

Waste Management Data			
Product	**Liquid Waste (m^3/unit)**	**Solid Waste (kg/unit)**	**Gaseous Waste (m^3/unit)**
A	2.0	1.0	0.5
B	1.5	1.2	2.0
C	2.6	0.9	1.0

2. Think about ways to group animals based on their shoulder heights and lengths in cm. Can a perceptron neural network model tell a WOLF, GOAT, and RABBIT apart? Acceptable starting points include assuming weights, biases, and learning parameter. Find the most appropriate threshold (if any), bias, and weights for possible classification. Comment if you can adjust the bias in the end or do bias translation in the end. **(5 Marks)**

#	Length (in cm)	Shoulder Height (in cm)	Animal	#	Length (in cm)	Shoulder Height (in cm)	Animal
1	99	61	Goat	6	35	22	Rabbit
2	180	83	Wolf	7	62	100	Goat
3	28	19	Rabbit	8	140	80	Wolf
4	97	60	Goat	9	34	21	Rabbit
5	120	70	Wolf	10	32	20	Rabbit

3. Suppose that we want to design an ADALINE network to distinguish between various categories of input vectors. Let us first try the categories listed below:

Category I: $p_1 = [1\ 1]^T\ and\ p_2 = [-1\ -1]^T$

Category II: $p_3 = [2\ 2]^T$.

i) Can an ADALINE network be designed to make such a distinction?

ii) If the answer to part (i) is yes, what set of weights and bias might be used?

Next, consider a different set of categories.

Category III: $p_1 = [1\ 1]^T\ and\ p_2 = [1\ -1]^T$

Category IV: $p_3 = [1\ 0]^T$.

iii) Can an ADALINE network be designed to make such a distinction?

iv) If the answer to part (iii) is yes, what set of weights and bias might be used?

v) Which other neural networks can do the distinction in the above two cases?

(5 Marks)

4. Consider the two classes of patterns that are shown in the Figure below. Class I represents vertical lines and Class II represents horizontal lines.
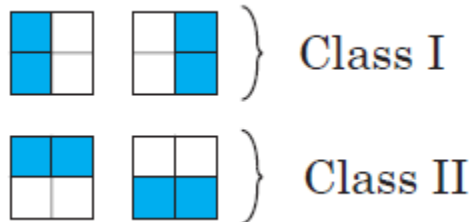
i) Are these categories linearly separable?

ii) Design a multilayer network to distinguish these categories. **(5 Marks)**

5. In chemical engineering, we have a natural gas stream that is mixed with an amine solution in an absorber. Suppose the selection of an appropriate analyzer to monitor the "sales gas" sour-gas concentration is important. This selection process can be complicated by the fact that one type of analyzer, say A, does not provide an average suitable pressure range but it does give a borderline value of instrument dead time; in contrast, another analyzer, say B, may give a good value of process dead time but a poor pressure range. Suppose for this problem we consider three analyzers: A, B, and C. Let

$$\underset{\sim}{P} = \left\{ \frac{0.7}{A} + \frac{0.3}{B} + \frac{0.9}{C} \right\}$$

represent the fuzzy set showing the pressure range suitability of analyzers A, B, and C (a membership of 0 is not suitable, and a value of 1 is excellent). Also, let

$$\underset{\sim}{OT} = \left\{ \frac{0.5}{A} + \frac{0.9}{B} + \frac{0.4}{C} \right\}$$

represent the fuzzy set showing the instrument dead time suitability of analyzers A, B, and C (again, 0 is not suitable and 1 is excellent). Find (i) the fuzzy set that shows the analyzers that are not suitable for pressure range and instrument dead time, (ii) the fuzzy set that shows which analyzer is most suitable in either category, (iii) the fuzzy set that shows which analyzer is suitable in both categories. **(4 Marks)**