Roll No.												

PRESIDENCY UNIVERSITY

BENGALURU

End - term Examinations – December 2025

Date: 10- 12- 2025 **Time:** 1.00pm to 04.00pm

School: SOE	**Program:** ECE	
Course Code : ECE3030	**Course Name :** Fuzzy Logic and It's Engineering Applications	
Semester: V	**Max Marks**: 100	**Weightage**: 50%

CO - Levels	CO1	CO2	CO3	CO4	CO5	CO6
Marks	20	16	14	14	16	20

Instructions:

(i) Read all questions carefully and answer accordingly.

(ii) Do not write anything on the question paper other than roll number.

Part A

Answer ALL the Questions. Each question carries 2marks. **10Q x 2M=20M**

1	Fuzzy set theory is the backbone for fuzzy logic. What is the range of membership in any Fuzzy set.	**2 Marks**	**L2**	**CO2**
2	Draw any two standard membership functions, in context to fuzzy logic.	**2 Marks**	**L2**	**CO2**
3	CON(DIL A) = _____ ; DIL(CON A) = _____	**2 Marks**	**L2**	**CO2**
4	What does defuzzification mean in fuzzy clustering	**2 Marks**	**L2**	**CO5**
5	Write a fuzzy rule with two antecedents and one consequent	**2 Marks**	**L2**	**CO3**
6	Hard c Means is one of the methods used for the classification of data. If the first row of Hard 2-partition is [0 0 1 1 0 0 1], Find it's second row.	**2 Marks**	**L3**	**CO5**
7	Apply the maximum membership method to harden the partition matrix $U = \begin{bmatrix} 0.991 & 0.986 & 0.993 & 0 \\ 0.009 & 0.014 & 0.007 & 1 \end{bmatrix}$	**2 Marks**	**L3**	**CO5**
8	What is the purpose of using fuzzy equivalence relations	**2 Marks**	**L2**	**CO4**
9	What is the role of a fuzzy similarity matrix in classification	**2 Marks**	**L1**	**CO4**
10	Give a brief note on Takagi–Sugeno type fuzzy inference in fuzzy logic control system.	**2 Marks**	**L1**	**CO3**

Part B

Answer the Questions **Total 80 Marks.**

11.	**a.**	Fuzzy sets A and B are defined over the Universe of discourse $X = (1,2,3,4,5,6)$; Membership functions are given by $\mu_A(x) = 2^{-x}$; $\mu_B(x) = x^{-2}$; Illustrate the basic operations of Union, Intersection and complement for the membership functions.	**10 Marks**	**L2**	**CO1**
	b.	Apply fuzzy logic principles to prove DeMorgan's theorems for both union and intersection.	**10 Marks**	**L2**	**CO1**

or

12.	**a.**	Two fuzzy sets A and B, both defined on X, are as follows: $\mu(x_i)$ | x_1 | x_2 | x_3 | x_4 | x_5 | x_6 A | 0.1 | 0.7 | 0.8 | 1 | 0.7 | 0.1 B | 1 | 0.9 | 0.5 | 0.2 | 0.1 | 0 Express the following λ-cut sets using Zadeh's notation: $(i)\ (A \cup B)_{0.8}$ (ii) $(A \cap B)_{0.6}$ (iii) $\overline{(A \cap B)}_{0.8}$ (iv) $\overline{(A \cup B)}_{0.6}$	**10 Marks**	**L2**	**CO1**
	b.	Calculate (a) A X B (b) A U B (c) B X A and (d) A ∩ B given that A = {0.7/a + 0.3/b + 0.4/c + 0.9/d} B = {0.6/a + 0.5/b + 0.4/c + 0.7/d}	**10 Marks**	**L2**	**CO1**

13.	**a.**	The following raw data were determined in a pairwise comparison of new premium mobile phone preferences in poll of 100 people. When it was compared with Samsung (S), 79 of polled preferred Nokia(N), 85 preferred Apple (A), 59 preferred OnePlus(P) and 67 preferred LG(L). When a Nokia was compared, the preferences were 21-S, 23-A,37-P and 45-L. When Apple was compared, the preferences were 15-N, 77-S,35-P and 48-L. When a OnePlus was compared, the preferences were 41-S, 63-N,65-A and 51-L. Finally, When LG was compared, the preferences were 33-S, 55-N,52-P and 49-A. Using Rank ordering, plot the Membership function for the most preferred Mobile phone.	**10 Marks**	**L3**	**CO2**
	b	Suppose we are evaluating a new invention to determine its commercial potential. Two metrics 'uniqueness' and 'market size' are used to make the decisions regarding the innovation of the idea. For uniqueness, X={1, 2, 3, 4,5, 6}, and for market size Y={1, 2, 3, 4, 5, 6}. Given the fuzzy sets, $A = medium\ uniqueness = \left\{\frac{0}{1} + \frac{0.6}{2} + \frac{1}{3} + \frac{0.2}{4} + \frac{0.3}{5} + \frac{0.2}{6}\right\}$ $B = medium\ market\ size = \left\{\frac{0}{1} + \frac{0.4}{2} + \frac{1}{3} + \frac{0.8}{4} + \frac{0.3}{5} + \frac{0}{6}\right\}$ $C = diffuse\ market\ size = \left\{\frac{0.3}{1} + \frac{0.5}{2} + \frac{0.6}{3} + \frac{0.6}{4} + \frac{0.5}{5} + \frac{0.3}{6}\right\}$. Determine the implication relation using Zadeh's implication	**10 Marks**	**L3**	**CO3**

		(i) IF x is *medium uniqueness* THEN y is *medium market size* ELSE y is *diffuse market size*. (ii) IF x is *medium uniqueness* and *medium market size* THEN y is *diffuse market size*			

or

14.	**a.**	For controlling the motor two fuzzy sets A and B are defined as A = "motor speed OK" $= \left\{\frac{.5}{20}+\frac{.4}{30}+\frac{.3}{40}+\frac{1}{50}+\frac{.5}{60}\right\}$; B = "*motor voltage nominal*" $= \left\{\frac{.1}{1}+\frac{.3}{2}+\frac{.8}{3}+\frac{.1}{4}+\frac{.7}{5}\right\}$ Using Zadeh's implication, find the fuzzy relation for the rules, i) If "motor speed is OK", THEN "motor voltage is nominal". ii) If "motor speed is not OK", THEN "motor voltage is not nominal".	**10 Marks**	**L3**	**CO3**
	b	Three variables of interest in power Transistors are the amount of current that can be switched, the voltage that can be switched and the cost. The following membership functions are developed: $Average\ current\ (in\ amperes) = I$ $= \left\{\frac{0.4}{0.8}+\frac{0.7}{0.9}+\frac{1}{1}+\frac{0.8}{1.1}+\frac{0.6}{1.2}\right\}$ $Average\ voltage\ (in\ volts) \quad = V$ $= \left\{\frac{0.4}{30}+\frac{0.7}{45}+\frac{1}{60}+\frac{0.8}{75}+\frac{0.6}{90}\right\}$ $Cost\ of\ a\ transistor\ (in\ rupees) \ = C \ = \left\{\frac{0.4}{0.5}+\frac{1}{0.6}+\frac{0.8}{0.7}\right\}$ (a)Find the fuzzy Cartesian product $P = V \times I$; $T = I \times C$. (b)Using max-min composition, find $E = P$ o T.	**10 Marks**	**L3**	**CO2**

15.	**a**	Five regions x_1, x_2, x_3, x_4 and x_5 have suffered damage due to recent floods. The five regions have to be classified according to their damage levels. The table below shows the damage in % for each of the five regions. Correlate (i) Cosine Amplitude Method and (ii) Max-Min Method to obtain the tolerance Relation R for the above data.	**10 Marks**	**L4**	**CO 4**

	x_1	x_2	x_3	x_4	x_5
No damage	0.3	0.2	0.1	0.7	0.4
Medium damage	0.6	0.4	0.6	0.2	0.6
Serious damage	0.1	0.4	0.3	0.1	0

	b	An IC manufacturing plant has decided to classify five machines into two classes: good investment and bad investment. The data points in our sample, $X = \{x_1, x_2, x_3, x_4, x_5\}$, are $x_1 = \{5, 20\}$; $x_2 = \{3.5, 35\}$; $x_3 = \{4, 25\}$; $x_4 = \{7, 10\}$; $x_5 = \{8, 22\}$. Apply	**10 Marks**	**L3**	**CO 5**

		Fuzzy c Means (FCM) algorithm to determine fuzzy 2-partition after one iterations, $U^{(1)}$. Use weighting parameter $m' = 2$ and criterion for convergence, $\varepsilon_L \leq 0.01$. Start with the initial 2-partition $U^{(0)} = \begin{bmatrix} 1 & 1 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 & 1 \end{bmatrix}$			

Or

16.	**a.**	To classify the data points using fuzzy relations, we need to find the associated fuzzy equivalence relation. Consider five data points in a universe, $X = \{x_1, x_2, x_3, x_4, x_5\}$ and the following fuzzy equivalence relation $R = \begin{bmatrix} 1 & 0.8 & 0.4 & 0.5 & 0.8 \\ 0.8 & 1 & 0.4 & 0.5 & 0.9 \\ 0.4 & 0.4 & 1 & 0.4 & 0.4 \\ 0.5 & 0.5 & 0.4 & 1 & 0.5 \\ 0.8 & 0.9 & 0.4 & 0.5 & 1 \end{bmatrix}$ Form the clusters for the five datapoints in X based on λ-cut relations for λ = 0.5, 0.8, 0.9, 1 and Illustrate with a classification diagram.	**10 Marks**	**L4**	**CO4**
	b	For the ultimate assignment of data to a particular class, the fuzzy partitions are converted to hard c partitions. The sample points are $x_1 = \{1, 3\}$; $x_2 = \{1.5, 3.2\}$; $x_3 = \{1.3, 2.8\}$; $x_4 = \{3, 1\}$. Consider the fuzzy c partition matrix U given below and harden it using Nearest centre classifier (minimum distance) method. Assume weighting parameter $m' = 2$ and criterion for convergence, $\varepsilon_L \leq 0.01$ $U = \begin{bmatrix} 0.991 & 0.986 & 0.007 & 0 \\ 0.009 & 0.014 & 0.993 & 1 \end{bmatrix}$	**10 Marks**	**L3**	**CO5**

17.	**a.**	Design a fuzzy logic Air conditioner controller to turn the dial Z to control the flow of warm/hot or cool/cold air based on change in room temperature, ΔT°C, and the rate of change of temperature $\frac{d\Delta T}{dt}$. Consider ΔT = 3°C and $\frac{d\Delta T}{dt}$ = -2°C/min. Assume appropriate membership functions for the input and output variables.	**20 Marks**	**L3**	**CO6**

Or

18.	**a.**	Considering the appropriate membership functions and fuzzy rules, design the the fuzzy logic controller for the Weather Montoring System to find the Expected rainfall for the Temperature = 40°F and the Wind speed = 40Kmph.	**10 Marks**	**L3**	**CO6**
	b	Considering the appropriate membership functions and fuzzy rules, design the the fuzzy logic controller for the Intelligent traffic light control system to find the Extention time required for the Medium Arrival =15 and the Queue size =10.	**10 Marks**	**L3**	**CO6**