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 **PRESIDENCY UNIVERSITY**

  **Bengaluru**

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| **End - Term Examinations – JANUARY 2025** |
| **Date:** 17 – 01- 2025 **Time:** 9:30 am – 12:30 pm |

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

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| **CO - Levels** | **CO1** | **CO2** | **CO3** | **CO4** |
| **Marks** | **14** | **14** | **36** | **36** |

**Instructions:**

1. *Read all questions carefully and answer accordingly.*
2. *Do not write anything on the question paper other than roll number.*

**Part A**

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| **Answer ALL the Questions. Each question carries 2marks. 10Q x 2M=20M** |
| **1** | From your intuition Draw membership curves in the universe of “speed of the Car” for Slow ; Medium ; Fast | **2 Marks** | **L1** | **CO1** |
| **2** | Fuzzy set A is given as $A = \left\{\frac{.5}{1}+\frac{.4}{2}+\frac{.3}{3}+\frac{.9}{4}+\frac{.5}{5}\right\}$. Find Crossover points and Height | **2 Marks** | **L1** | **CO1** |
| **3** | Write the Zadeh’s implication relation for the statement IF x is A, THEN y is B else C | **2 Marks** | **L1** | **CO2** |
| **4** | Membership function is given as $μ\_{A}\left(x\right)= 3^{-x}; x=1,2,3 $. Find$ λ cut set A\_{0^{+}}$  | **2 Marks** | **L1** | **CO2** |
| **5** | It is necessary to identify the value of c that gives the number of clusters in the data for the analysis at hand. This problem is known as \_\_\_\_\_\_\_\_\_\_\_\_\_ | **2 Marks** | **L1** | **CO3** |
| **6** | Consider the partition matrix U given below and harden it using *maximum membership method.* $U= \left[\begin{array}{c}0.991 0.986 0.993 0\\0.009 0.014 0.007 1\end{array}\right]$  | **2 Marks** | **L1** | **CO3** |
| **7** | FCM algorithm needs weighting parameter $m^{'}$ to find the cluster centre. Consider two points $x\_{1}=\{1, 3\}$; $x\_{2}=\{1.5, 3\}$. Compute the cluster centre for the cluster [0.993 1] in Fuzzy 2-partition with $m^{'} $= 2 | **2 Marks** | **L1** | **CO3** |
| **8** | List out two basic assumptions that are commonly made whenever a fuzzy rule based control policy is selected. | **2 Marks** | **L1** | **CO4** |
| **9** | Illustrate a fuzzy rule with two antecedents and one consequent using Mamdani graphical inference method. | **2 Marks** | **L1** | **CO4** |
| **10** | Control systems are some times divided into two classes. Mention these control systems with examples.  | **2 Marks** | **L1** | **CO4** |

**Part B**

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| **Answer the Questions Total 80 Marks.** |
| **11.** | **a.** | Fuzzy sets A and B are defined over the Universe of discourse $X=\left(1,2,3,4,5\right); $  Membership functions are given by  $μ\_{A}\left(x\right)=\left[\frac{1}{2x^{2}}\right]$  $ μ\_{B}\left(x\right)=\left[\frac{1}{2x+σ^{}}\right]$ $ σ=2; a$= 6Find (i) $\overline{A} ∪ \overline{B}$ (ii) $A ∪ \overline{B}$ (iii) $λ cut sets A\_{0.3}, B\_{0^{+}}$  | **10 Marks** | **L2** | **CO1** |
|  | **b.** | Defuzzfication to scalars popularly uses centroid method. Illustrate this method using suitable membership functions. | **10 Marks** | **L2** | **CO2** |
| **or** |
| **12.** | **a.** | Apply fuzzy logic principles to prove DeMorgan’s theorems for both union and intersection. | **10 Marks** | **L2** | **CO1** |
|  | **b.** | 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** |
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| **13.** | **a.** | Suppose we want to sample a complex signal from a demodulator circuit and classify into two sets. The sample points are $x\_{1}=\{1, 3\}$; $x\_{2}=\{1.5, 3.2)$; $x\_{3}=\{1.3, 2.8\}$; $x\_{4}=\{3, 1\}$. If the first row of your initial 2-partition is [1 0 0 0], apply Hard c Means (HCM) algorithm to find optimum Hard 2- partition, $U^{\*}$.  | **20 Marks** | **L3** | **CO3** |
| **or** |
| **14.** | **a.** | 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 $x\_{1}=\{5, 20\}$; $x\_{2}=\{3.5, 35)$; $x\_{3}=\{4, 25\}$; $x\_{4}=\left\{7, 10\right\}; x\_{5}=\{8, 22\}$. Apply Fuzzy c Means (FCM) algorithm to determine fuzzy 2-partition after two iterations, $U^{(2)}$. Use weighting parameter $m^{'}=2$ and criterion for convergence, $ε\_{L}\leq 0.01$. Start with the initial 2-partition $U^{(0)}= \left[\begin{array}{c}0 1 1 0 0\\1 0 0 1 1\end{array}\right]$ | **20 Marks** | **L3** | **CO3** |

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| **15.** | **a.** | For the ultimate assignment of data to a particular class, the fuzzy partitions are converted to hard c partitions. 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, $ε\_{L}\leq 0.01$ $U= \left[\begin{array}{c}0.991 0.986 0.007 0\\0.009 0.014 0.993 1\end{array}\right]$  | **10 Marks** | **L3** | **CO3** |
|  | **b.** | Fuzzy logic control is extensively used in many applications such as Washing machines, Traffic light control, weather monitoring etc. Mr. John is heading team in KELTRON to design a Intelligent traffic light control system using fuzzy logic. The team has decided to use two input variables, namely, Arrival and Queue and the output variable as Extention time. 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** | **L4** | **CO4** |
| **Or** |
| **16.** | **a.** | For All fuzzy equivalence relations, their λ-cuts are equivalent ordinary relations. Hence, 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$$R= \left[\begin{array}{c} 1 0.8 0.4 0.5 0.8\\0.8 1 0.4 0.5 0.9\\0.4 0.4 1 0.4 0.4\\0.5 0.5 0.4 1 0.5\\0.8 0.9 0.4 0.5 1\end{array}\right]$$ Form the clusters for the five datapoints in X based on λ-cut relations for λ = 0.5, 0.8, 0.9  | **10 Marks** | **L3** | **CO3** |
|  | **b.** | Explain the function of each block in a typical fuzzy logic control system with a neat block diagram and list out all six basic assumptions that are commonly made whenever a fuzzy rule based control policy is selected. | **10 Marks** | **L2** | **CO4** |

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| **17.** | **a.** | Design a fuzzy logic controller for the safe landing of the aircraft. Consider the two state variables height above the ground, *h* and the vertical velocity of the aircraft, *v*. The control output will be a force, that, when applied to the aircraft, will alter its height, *h*, and vertical velocity, *v*. Assume appropriate membership functions and fuzzy rules in the design. Compute the height, *h* and vertical velocity, *v* for at least 2 iterations. Consider the initial height = 1500ft and initial vertical velocity = -25 ft/sec. | **20 Marks** | **L4** | **CO4** |
| **Or** |
| **18.** | **a.** | Most control systems are more complex than we can deal with, mathematically. In this situation, fuzzy control can be developed, provided a knowledge base about the control process exists and formed into a number of fuzzy rules. 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, ∆T°C, and the rate of change of temperature $\frac{d∆T}{dt}$. Consider ∆T = 3°C and $\frac{d∆T}{dt}$ = -1°C/min. Assume appropriate membership functions for the input and output variables. | **20 Marks** | **L4** | **CO4** |

**\*\*\*\*\* BEST WISHES \*\*\*\*\***