Roll No											

PRESIDENCY UNIVERSITY
BENGALURU

SET B

SCHOOL OF ENGINEERING
END TERM EXAMINATION - JAN 2024

Semester : Semester V -2021

Course Code : ECE3030

Course Name : Fuzzy Logic and Its Engineering Applications

Program : B.Tech.

Date : 09-JAN-2024
Time : 9:30AM - 12:30 PM
Max Marks : 100
Weightage : 50%

Instructions:
(i) Read all questions carefully and answer accordingly.
(ii) Question paper consists of 3 parts.
(iii) Scientific and non-programmable calculator are permitted.
(iv) Do not write any information on the question paper other than Roll Number.

PART A

ANSWER ALL THE QUESTIONS **5 X 2M = 10M**

1. Every linguistic variable will have a membership function. From your intuition draw membership curves in the universe of “Speed of a vehicle” for Low speed ; Medium speed and High speed.

(CO1) [Knowledge]

2. Using fuzzy operations on linguistic variables, we can generate linguistic hedges. Suppose Fuzzy set $A = \left\{\frac{.5}{1} + \frac{.4}{2} + \frac{.3}{3} + \frac{.9}{4} + \frac{.5}{5}\right\}$.
Apply concentration and dilation operations.

(CO2) [Knowledge]

3. Fuzzy c Means is popularly used for the clustering of data. If cluster 1 of Fuzzy 2-partition is [0.99 0.87 0.44 0.75 1 0.32 0.11], Find it’s second cluster.

(CO3) [Knowledge]

4. There are two poular methods, among many others, to defuzzify fuzzy partitions. The defuzzification may be required in the ultimate assignment of data. Consider the partition matrix U given below and harden it using *maximum membership method.*

$$U = \begin{bmatrix} 0.991 & 0.986 & 0.993 & 0 \\ 0.009 & 0.014 & 0.007 & 1 \end{bmatrix}$$

(CO3) [Knowledge]

5. The concept of control surface, or decision surface, is central in fuzzy control systems methodology. Describe the control surface with reference to fuzzy logic control system.

(CO4) [Knowledge]

PART B

ANSWER ALL THE QUESTIONS **5 X 10M = 50M**

6. An engineer is asked to develop a glass break detector/discriminator for use with residential alarm systems. The detector should be able to distinguish beween the breaking of a glass(a window) and a drinking glass. Membership functions for the window pane and the glass are given respectively as $\mu_A(x)$ *and* $\mu_B(x)$

$$\mu_A(x) = exp\left[\frac{-(x-a)^2}{2\sigma^2}\right]$$

$$\mu_B(x) = exp\left[\frac{-(x-b)^2}{2\sigma^2}\right]$$

$$X = (0,1,2,3,4,5,6,7,8,9,10); \sigma = 2; a = 4; b = 8$$

Illustrate the basic operations such that
(a) Window pane and glass are safe
(b) Either window pane or glass is safe
(c) Window pane is safe and (but) Glass is not safe

(CO1) [Comprehension]

7. Lamda cut sets are used in many applications such as classification and clustering of data. Determine the crisp λ-cut λ = 0.1 *j,* for *j = 0,1,2,3,4,5,* for the following fuzzy relation matrix R:

$$R = \begin{bmatrix} 0.2 & 0.7 & 0.4 & 1 \\ 1.0 & 0.9 & 0.5 & 0.1 \\ 0 & 0.8 & 1 & 0.6 \\ 0.2 & 0.5 & 1 & 0.3 \end{bmatrix}$$

(CO2) [Comprehension]

8. For research on the human visual system, it is sometimes necessary to characterize the strength of response to a visual stimulus based on a magnetic field measurement on electrical potential measurement. The inputs are defined on the universe X = [0, 50, 100, 150, 200] femtotesla, and outputs on the universe Y = [0, 50, 100, 150, 200] femtotesla. Consider the fuzzy sets

$$W = weak\ stimulus = \left\{\frac{1}{0} + \frac{0.9}{50} + \frac{0.3}{100} + \frac{0}{150} + \frac{0}{200}\right\}$$

$$M = medium\ stimulus = \left\{\frac{0}{0} + \frac{0.4}{50} + \frac{1}{100} + \frac{0.4}{150} + \frac{0}{200}\right\}$$

$$S = severe\ response = \left\{\frac{0}{0} + \frac{0}{50} + \frac{0.5}{100} + \frac{0.9}{150} + \frac{1}{200}\right\}$$

Determine the implication relation R using Zadeh's implication
IF "weak stimulus" THEN not "severe response";
Now, using a new antecedent(IF part) for the input M = medium stimuli and a max-min composition, Find another response on the Y universe to relate approximately to the new stimulus M. Comment on the response.

(CO2) [Comprehension]

9. 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 $m' = 2$ and criterion for convergence, $\varepsilon_L \leq 0.01$
Consider the coordinates x1=(1,3); x2=(1.5,3.2); x3=(1.3,2.8); x4=(3,1).

$$U = \begin{bmatrix} 0.991 & 0.986 & 0.007 & 0 \\ 0.009 & 0.014 & 0.993 & 1 \end{bmatrix}$$

(CO3) [Comprehension]

10. Fuzzy logic control is extensively used in many applications such as Washing machines, Traffic light control, weather monitoring etc. Mr. Kiran is heading a team in Samsung to design a Washing machine using fuzzy logic. The team has decided to use two input variables, namely, Dirtiness level and Load size and the output variable as Water amount. Considering the appropriate membership functions and fuzzy rules, design the the fuzzy logic controller for the washing machine to find the amount of water required for the Medium Dirtiness level =50 and the load size =6Kg.

(CO4) [Comprehension]

PART C

ANSWER ALL THE QUESTIONS **2 X 20M = 40M**

11. A problem in IC manufacturing management is to allocate four different job sites to two different teams. Let the job sites be designated as x_i and combined to give a universe, $X = \{x_1, x_2, x_3, x_4\}$. The following vectors give the locations of the four job sites:$x_1 = \{5, 5\}; x_2 = \{6, 8\}; x_3 = \{8, 10\}; x_4 = \{9, 12\}$. Apply Hard c Means (HCM) algorithm to determine optimum partition, U^* . Start with the initial Hard 2-partition

$$U^{(0)} = \begin{bmatrix} 1 & 1 & 0 & 0 \\ 0 & 0 & 1 & 1 \end{bmatrix}$$

(CO3) [Application]

12. Fuzzy control system provides the flexibility and reasonable accuracy in a typical application such as Aircraft landing control. Here, the desired downward velocity of the aircraft is proportional to the square of the height. As the height becomes vanishingly small, the downward velocity goes to zero. In this way , the aircraft will descend and will touch down very gently to avoid damage. 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 = 800ft and initial vertical velocity = -15 ft/sec.

(CO4) [Application]