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APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

Eighth Semester B.Tech Degree (R, S) Examination May 2024 (2019 Scheme)

Course Code: CST454

Course Name: FUZZY SET THEORY AND APPLICATIONS

Max. Marks: 100 **Duration: 3 Hours**

PART A

Answer all questions, each carries 3 marks.

		Marks
1	Explain how fuzzy sets are different from crisp sets with the help of a proper example and figure.	(3)
2	Illustrate any three operations on fuzzy relations with example.	(3)
3	Differentiate between fuzzy tolerance and equivalence relations. Also specify how a fuzzy tolerance relation can be converted into equivalence relation.	(3)
4	Define Dilation, Concentration and Intensification on fuzzy sets with proper example and figure.	(3)
5	Using your own intuition and your own definitions of the universe of discourse, plot fuzzy membership functions for "liquid level in the tank" as very small, small, empty, full and very full.	(3)
6	Differentiate the following: a) Convex and non-convex fuzzy set b) Normal and subnormal fuzzy set	(3)
7	Prove that the proposition $((P \vee Q) \wedge \bar{P}) \rightarrow Q$ is a tautology.	(3)
8	Differentiate between Sugeno and Tsukamoto methods of graphical inferences.	(3)
9	Differentiate between hard c-means and soft c-means clustering.	(3)
10	Explain how fuzzy databases are different from relational databases.	(3)

PART B

Answer any one full question from each module, each carries 14 marks.

Module I

11 a) The amount of "total suspended solids" (TSS) in a river vary with the seasons, as do the flows. For example, in the summer when the flows are lowest, the TSS can be the highest. (7)

$$\underset{\sim}{A} = \left\{ \frac{0.15}{\text{winter}} + \frac{0.33}{\text{spring}} + \frac{0.52}{\text{summer}} + \frac{0.25}{\text{fall}} \right\}$$

$$\underset{\sim}{B} = \left\{ \frac{0.1}{\text{winter}} + \frac{0.55}{\text{spring}} + \frac{0.9}{\text{summer}} + \frac{0.2}{\text{fall}} \right\}$$

For the two particular rivers shown here, find

(a) $\underset{\sim}{A} \cup \underset{\sim}{B}$, (b) $\underset{\sim}{A} \cap \underset{\sim}{B}$, (c) $\overline{\underset{\sim}{A}}$, (d) $\underset{\sim}{A} | \underset{\sim}{B}$, (e) $\overline{\underset{\sim}{A} \cup \underset{\sim}{B}}$, (f) $\overline{\underset{\sim}{A} \cap \underset{\sim}{B}}$

b) Explain excluded middle axioms. Illustrate how this property differs for fuzzy sets and crisp sets. (7)

OR

12 a) In soil mechanics, the stability and strength of a soil is largely dependent on how well a soil is gradiated (soil particle size) and how well a soil is compacted. Suppose X is a fuzzy set defined on a universe of soil gradations, poor, moderate, and uniform represented as $X=\{x_1, x_2, x_3\}$and Y is a fuzzy set defined on a universe of three levels of compaction, low, medium and high represented as $Y=\{y_1, y_2, y_3\}$. A "poorly gradiated soil" is defined as (9)

$$\underset{\sim}{A} = \left\{ \frac{0.9}{x_1} + \frac{0.4}{x_2} + \frac{0.0}{x_3} \right\}$$

and a "well compacted soil" is defined as

$$\underset{\sim}{B} = \left\{ \frac{0.1}{y_1} + \frac{0.7}{y_2} + \frac{1}{y_3} \right\}$$

(a) Find the relation, $\underset{\sim}{R} = \underset{\sim}{A} \times \underset{\sim}{B}$, using a Cartesian product.

Let a "sufficiently gradiated soil" is defined as

$$\underset{\sim}{C} = \left\{ \frac{0.3}{x_1} + \frac{1.0}{x_2} + \frac{0.2}{x_3} \right\}$$

(b) Find $\underset{\sim}{C} \circ \underset{\sim}{R}$ using max-min composition.

(c) Find $\underset{\sim}{C} \circ \underset{\sim}{R}$ using max -product composition.

b) Show that the composition operation on two fuzzy relations are not commutative. (5)

Module II

13 a) A College has performed three tests Test1, Test2 and Test3 for the selection of employees. The quality of employees has been evaluated as being one of three conditions C = {Excellent, Fair, poor}. The table summarizes the results of the employees for three cities. Find the similarity relation R among the three tests using cosine amplitude method. (7)

	$Test_1$	$Test_2$	$Test_3$
$C_1(Poor)$	0.6	0.3	0.1
$C_2(Fair)$	0.5	0.5	0.4
$C_3(Excellent)$	0.0	0.2	0.6

b) Show that any λ-cut relation (for $\lambda > 0$) of a fuzzy tolerance relation results in a crisp tolerance relation. (7)

OR

14 a) Two fuzzy sets A and B, defined on X, are as follows: (6)

$\mu(x_i)$	x_1	x_2	x_3	x_4	x_5	x_6
$\underset{\sim}{A}$	0.1	0.7	0.8	1.0	0.7	0.1
$\underset{\sim}{B}$	1.0	0.9	0.5	0.2	0.1	0

Express the following λ-cut sets using Zadeh's notation:

(a) $(\bar{A})_{0.6}$ (b) $(B)_{0.5}$ (c) $(A \cup B)_{0.8}$ (d) $(A \cap B)_{0.6}$ (e) $(\bar{A} \cup A)_{0.7}$ (f) $(\overline{A \cap B})_{0.8}$

b) For steel design, the cross-sectional area to column-height ratio largely determines the susceptibility of the columns to buckling under axial loads. The normalized ratios are on the universe, X = {0, 1, 2, 3}. These ratios are characterized as "small" to "large": (8)

$$\text{"Small"} = \left\{\frac{1}{0} + \frac{0.9}{1} + \frac{0.8}{2} + \frac{0.7}{3}\right\}$$

$$\text{"Large"} = \left\{\frac{0}{0} + \frac{0.1}{1} + \frac{0.2}{2} + \frac{0.3}{3}\right\}$$

Calculate the membership functions for the following phrases:

(a) very small

(b) fairly small (= $[\text{small}]^{2/3}$)

(c) very, very large

(d) not fairly large and very, very small.

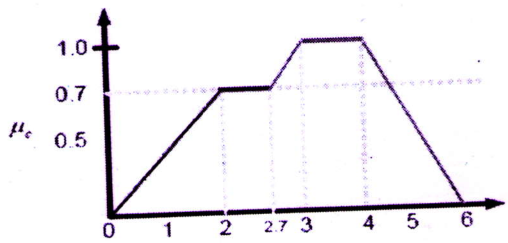
Module III

15 a) Using the inference approach, find the membership values for each of the triangular shapes (I, R, IR, E, T) for each of the following triangles: (8)

a) 55°, 65°, 60°

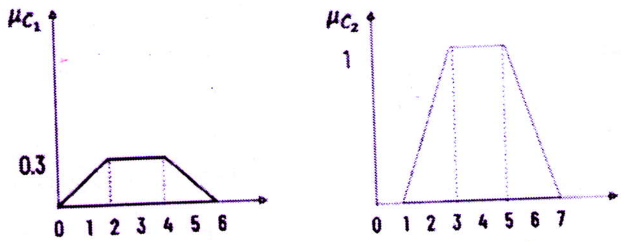
b) 120°, 50°, 10°

b) Find the defuzzified value for the following fuzzy set using Centroid method. (6)



OR

16 a) The results of two implication processes arc as shown in fig. Find the aggregated output and the defuzzified output using the (1) Centre of sums (2) Mean of maxima and (3) Weighted average methods. (7)



b) The following data was determined by the pairwise comparison of work preferences of 100 people: When it was compared with software(S), 72 persons polled preferred hardware (H), 65 of them preferred teaching (T), 55 of them preferred business (B) and 25 preferred textiles (TX). On comparison with hardware (H), the preferences were 42 for T, 66 for B and 35 for TX. When compared with teaching, the preferences were 38 for B and 25 for TX. On comparison with business, the preferences were 20 for TX. Using rank ordering, plot the membership function for the "most preferred work." (7)

Module IV

17 a) Illustrate Mamdani inference system with the help of a proper example. (14)

OR

18 a) Suppose we have a distillation process where the objective is to separate components of a mixture in the input stream. The universe for input variable (temperature) and output variable (distillate fractions) are given as: X = {175, 180, 185, 190}, Y= {89, 92, 95, 98}. Now we define fuzzy sets A and B on X and Y, respectively: (8)

$$\underset{\sim}{A} = \text{temperature of input steam is hot} = \left\{ \frac{0}{175} + \frac{0.7}{180} + \frac{1}{185} + \frac{0.4}{190} \right\}$$

$$\underset{\sim}{B} = \text{separation of mixture is good} = \left\{ \frac{0}{89} + \frac{0.5}{92} + \frac{0.8}{95} + \frac{1}{98} \right\}$$

a) Find relation for the proposition **IF "temperature is hot" THEN "separation of mixture is good".**

b) Another antecedent is given as

$$A' = \{\frac{1}{175} + \frac{0.8}{180} + \frac{0.5}{185} + \frac{0.2}{190}\}$$

Find the corresponding consequent B' using max-min composition.

b) Write short notes on fuzzy propositions. (6)

Module V

19 a) Explain a fuzzy logic control system with the help of block diagram and example. (7)

b) Explain fuzzy pattern recognition using multiple features. (7)

OR

20 a) Explain the process of classification by equivalence relations. (7)

b) Fuzzy neural networks are eminently suited for approximating fuzzy controllers and fuzzy expert systems. Justify your answer. (7)

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