14502

BRAINWARE UNIVERSITY

Term End Examination 2024-2025
Programme – M.Sc.(MATH)-2024
Course Name – Fuzzy Logic
Course Code - MSCMC204
(Semester II)

Full Marks : 60 **Time : 2:30 Hours**

[The figure in the margin indicates full marks. Candidates are required to give their answers in their own words as far as practicable.]

Group-A

(Multiple Choice Type Question) 1 x 15=15

1. *Choose the correct alternative from the following :*

(i) Tell the system that should use fuzzy logic:

a) System with accurate information

b) System with granular (linguistic) information

c) System without any ambiguous information

d) Systems operating on bivalent logic

(ii) Using De Morgan's Law, identify the correct statement for fuzzy sets R, S, and T.

a) $\overline{R \cup S} \cap T = \bar{R} \cap \bar{S} \cup T$

b) $\overline{R \cup S} \cap T = \bar{R} \cup \bar{S} \cap T$

c) $\overline{R \cup S} \cap T = \bar{R} \cap \bar{S}$

d) $\overline{R \cup S} \cap T = \bar{R} \cap \bar{S} \cap T$

(iii) For the fuzzy sets R and S defined below:

R = {(10,0.7), (30,1.0)} and

S = {(13,0.9), (15,0.5)}.

Identify the membership value at $\delta\delta = 15$ for the distance set between R and S:

a) 0.1 b) 0.5

c) 0.9 d) 0.7

(iv) Let A and B are two fuzzy numbers with the universe of discourse $X \in [-10,10]$ as given below.

$A = 0.1/1 + 0.2/2 + 1.0/3$

$B = 0.3/5 + 1.0/10$

with the universe of discourse $X \in [-15,15]$, determine the membership function value for highest generic variable value obtained for C=A+B:

a) 0.6 b) 1.0

c) 0.9 d) 0.3

(v) For a fuzzy set A is given as below:

$A = 0.1/2 + 0.5/3 + 1.0/5$,

determine the membership function value at generic variable value x=3 of its complement after applying Sugeno's class of complement with λ=4.

a) 0.167 b) 0.667

c) 0.777 d) 0.766

(vi) Let us consider two fuzzy sets A and B with the universe of discourse X and Y, respectively defined as

$A = 0.1/x1 + 0.3/x2 + 0.7/x3$,

$B = 0.1/y1 + 0.5/y2 + 0.9/y3$.

For fuzzy relation matrix R between A and B, determine the diagonal values of R:

a) 0.1, 0.3, 0.3 b) 0.1, 0.3, 0.7

c) 0.9, 0.7, 0.7 d) 0.9, 0.7, 0.3

(vii) Let us consider two fuzzy sets A and B with the universe of discourse X and Y, respectively defined as

$A = 0.1/x1 + 0.3/x2 + 0.7/x3$,

$B = 0.1/y1 + 0.5/y2 + 0.9/y3$.

Identify the diagonal values of $R \cap \overline{R}$:

a) 0.1, 0.3, 0.3 b) 0.1, 0.3, 0.7

c) 0.9, 0.7, 0.7

d) 0.9, 0.7, 0.3

(viii) If R is fuzzy relation defined in the space X × X, identify the property that should be satisfied for R being a fuzzy equivalence relation:

a) Reflexivity

b) Symmetry

c) Transitivity

d) Reflexivity, Symmetry, and Transitivity

(ix) Identify the property for the composition of fuzzy relations holds

a) Monotonicity

b) Not Associativity

c) Distributivity over intersection

d) Weak Associativity over intersection

(x) Identify the correct option:

a) The contrast intensifier increases the membership value which are above 0.5.

b) The contrast intensifier diminishes the membership value which are above 0.5.

c) The contrast intensifier increases the membership value which are below 0.5.

d) None of These

(xi) Choose the correct option for a TSK fuzzy model:

a) The overall output is obtained via weighted average and increases time consuming process of defuzzification required in Mamdani fuzzy model.

b) The overall output is obtained via average and avoids time consuming process of defuzzification required in Mamdani fuzzy model.

c) The overall output is obtained via weighted average and avoids time consuming process of defuzzification required in Mamdani fuzzy model.

d) The overall output is obtained via average and increases time consuming process of defuzzification required in Mamdani fuzzy model.

(xii) A TSK fuzzy model with two rules is given as below.

RULE 1: *IF* "x *is LOLL*" *AND* "y *is HIGH*" *THEN* "$z = y + 3$"

RULE 2: *IF* "x *is HIGH*" *AND* "y *is LOLL*" *THEN* "$z = x + 5$"

The input membership functions are defined as follows:

$x(LOLL) = triangle\ (x; [1,3,5])$

$x(HIGH) = triangle\ (x; [2,4,6])$

$y(LOW) = triangle\ (y; [0,2,4])$

$y(HIGH) = triangle\ (y; [6,8,10])$

For crisp inputs $x = 2$ and $y = 1$,

Evaluate the firing strength using max- product composition:

a) 0.50
b) 0.20
c) 0.25
d) None of these

(xiii) A TSK fuzzy model with two rules is given as below.

RULE 1: *IF* "x *is LOLL*" *AND* "y *is HIGH*" *THEN* "$z = y + 3$"

RULE 2: *IF* "x *is HIGH*" *AND* "y *is LOLL*" *THEN* "$z = x + 5$"

The input membership functions are defined as follows:

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$y(LOW) = triangle\ (y; [0,2,4])$

$y(HIGH) = triangle\ (y; [6,8,10])$

For crisp inputs $x = 5$ and $y = 1$

Evaluate aggregated weighted output using max-min composition:

a) 4
b) 10
c) 0.50
d) 0.25

(xiv) Choose the correct option. Fuzzy logic is

a) Used to respond to questions in a human like way
b) A new programming language used to program animation
c) The result of fuzzy thinking
d) A term that indicates logical values greater than one

(xv) Choose the correct option. $A \cup (A \cap B) = A$ represents

a) Law of excluded middle

b) Law of absorption

c) Demorgans law

d) Law of contradiction

Group-B

(Short Answer Type Questions) 3 x 5=15

2. Define convex set and convex fuzzy set. (3)

3. Define scalar cardinality of a fuzzy set with an example. (3)

4. For Fuzzy sets A and B defined on X, show that, $\overline{A \cup B} = \bar{A} \cap \bar{B}$. (3)

5. Calculate using arithmetic operations: (3)

i) $\frac{[4,10]}{[1,2]}$,

ii) $[3,4] \times [2,2]$.

iii) $\frac{[-1,1]}{[-2,-\frac{1}{2}]}$

6. Let $X = \{0,1,2,\ldots,10\}$ and $A(x) = \frac{x}{x+4}$. Evaluate its height, core, support. (3)

OR

If a fuzzy complement C is defined by, $C(a) = \frac{1-a}{1+\lambda a}, \lambda \geq 0$ evaluate the equilibrium point. (3)

Group-C

(Long Answer Type Questions) 5 x 6=30

7. Let M be the fuzzy set of middle aged persons defined by, (5)

$$M: X \to [0,1]$$

where $X = \{0,1,2, \ldots, 100\}$

$$M(x) = \begin{cases} 0; x \leq 20 \text{ or } x \geq 60 \\ \frac{x-20}{15}; 20 \leq x \leq 35 \\ \frac{60-x}{15}; 45 \leq x \leq 60 \\ 1; 35 \leq x \leq 45. \end{cases}$$

Then evaluate $^{0.8}M$ and ^{0+}M.

8. Let $C: [0,1] \to [0,1]$ be defined by, $C(a) = \frac{1}{2}(1 + cos\pi a)$. Show that C is a continuous fuzzy complement but not involutive. (5)

9. Write the definition of aggregation operation on n fuzzy sets. (5)

10. For the following fuzzy numbers, A and B evaluate A + B where, (5)

$$A(x) = \begin{cases} 0; x \leq -1, x \geq 3 \\ \frac{x+1}{2}; -1 \leq x \leq 1 \\ \frac{3-x}{2}; 1 \leq x \leq 3, \end{cases}$$

$$B(x) = \begin{cases} 0; x \leq -1, x \geq 5 \\ \frac{x-1}{2}; 1 \leq x \leq 3 \\ \frac{5-x}{2}; 3 \leq x \leq 5. \end{cases}$$

11. Let $E(x) = \begin{cases} 1; & x = 5 \\ 0; & otherwise. \end{cases}$ (5)

Then explain that it is not a fuzzy number.

12. Justify that a fuzzy set A on $\mathbb{R}$ is convex only if $A(\lambda x_1 + (1-\lambda)x_2) \geq \min(A(x_1), A(x_2)), \forall x_1, x_2 \in \mathbb{R}$. (5)

OR

Justify that, for any Fuzzy sets A and B defined on X, $A \cup (A \cap B) = A$. (5)

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