



# BRAINWARE UNIVERSITY

**Term End Examination 2023**  
**Programme – M.Sc.(MATH)-2022**  
**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) For the fuzzy set A with the universe of discourse  $X = [-10,10]$  given as below:

$$A(x) = 0.1/1 + 0.5/2$$

Determine a fuzzy set B with using the “Extension Principle” for mapping function defined as below:

a)  $B(y) = 0.1/1 + 0.5/4$

b)  $B(y) = 0.5/1 + 0.1/4$

c)  $B(y) = 0.5/2 + 0.1/5$

d)  $B(y) = 0.1/2 + 0.5/5$

(ii) Choose the correct option

Which of the following is not a Fuzzy membership function?

a) Trapezoidal membership function

b) Triangular membership function

c) Gaussian membership function

d) Sinusoidal membership function

(iii) If a fuzzy set A with the universe of discourse  $X=\{1,2,3,4,5,6\}$  is defined as,

$$A = 0.2/1 \ 0.4/2 \ 0.6/3 \ 0.8/4 \ 1.0/5 \ 0.5/6$$

Tell what will be NOT (A)?

a)  $0.2/1 \ 0.0/2 \ 0.6/3 \ 0.0/4 \ 0.7/5 \ 0.0/6$

b)  $0.5/1 \ 0.4/2 \ 1.0/3 \ 0.8/4 \ 1.0/5 \ 0.5/6$

c)  $0.2/1 \ 0.4/2 \ 0.6/3 \ 0.8/4 \ 1.0/5 \ 0.5/6$

d)  $0.8/1 \ 0.6/2 \ 0.4/3 \ 0.2/4 \ 0.0/5 \ 0.5/6$

(iv) If R is fuzzy relation defined in the space  $X \times X$ , identify which of the following properties should be satisfied for R being a fuzzy equivalence relation?

a) Reflexivity

b) Symmetry

c) Transitivity

d) Reflexivity, Symmetry, and Transitivity

(v) The water is hot. Here the word hot can be represented by \_\_\_\_\_. Choose the correct option.

- a) Fuzzy Set
  - b) Crisp Set
  - c) Fuzzy & Crisp Set
  - d) De Morgan's set
- (vi) 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
- (vii) The composition of fuzzy relations holds identify which of the following properties?
- a) Monotonicity
  - b) Not Associativity
  - c) Distributivity over intersection
  - d) Weak Associativity over intersection

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

$$A = 0.1/x_1 + 0.3/x_2 + 0.7/x_3$$

$$B = 0.1/y_1 + 0.5/y_2 + 0.9/y_3$$

Identify what will be the diagonal values of  $R \cup \bar{R}$  ?

- 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
- (ix) Let two fuzzy sets  $A$  and  $B$  are defined for the universe of discourse  $X = \{1,2,3\}$  and  $Y = \{1,2,3\}$ , respectively as given below:

$$A = 0.2/1 + 0.5/2 + 1.0/3 \quad B = 0.1/1 + 1.0/2 + 0.5/3$$

Evaluate diagonal values of the implication relation matrix for the fuzzy rule interpreted as "A coupled with B"

using T-norm minimum operator?

- a) 0.1, 0.1, 0.1
  - b) 0.1, 0.5, 0.5
  - c) 0.5, 0.5, 0.5
  - d) None of These
- (x) Let fuzzy set  $B$  is defined with the universe of discourse  $X = \{1,2,3\}$  given as below.

$$B = 0.5/1 + 1.0/2 + 0.2/3$$

Determine the following will be the fuzzy set obtained by  $INT(B)$ ?

- a)  $0.50/1 + 0.00/2 + 0.20/3$
  - b)  $0.50/1 + 0.00/2 + 0.08/3$
  - c)  $0.50/1 + 1.00/2 + 0.20/3$
  - d)  $0.50/1 + 1.00/2 + 0.08/3$
- (xi) Determine the following is the formulation to find the membership value for the cylindrical extension in the space  $X \times Y$

of the one-dimensional fuzzy set  $A$  defined with the universe of discourse  $X$ ?

- a)  $\mu_{A'}(x) \quad \forall (x,y) \in X \times Y$
  - b)  $\mu_A(y) \quad \forall (x,y) \in X \times Y$
  - c)  $\mu_A(x) \quad \forall (x,y) \in X \times Y$
  - d)  $\mu_{A'}(y) \quad \forall (x,y) \in X \times Y$
- (xii) Choose the correct option

The room is warm. Here the word warm can be represented by \_\_\_\_\_

- a) Fuzzy Set
- b) Crisp Set

- c) Fuzzy & Crisp Set
- (xiii) Let  $A$  and  $B$  are two fuzzy sets defined over the universe of discourse  $X$ , identify what will be the formulation for T-norm bounded product operator?
- a)  $0 \vee (\mu_A(x) + \mu_B(x) - 1)$
- b)  $0 \wedge (\mu_A(x) + \mu_B(x) - 1)$
- c)  $0 \vee (\mu_A(x) + \mu_B(x) + 1)$
- d)  $0 \wedge (\mu_A(x) + \mu_B(x) + 1)$
- (xiv) Identify which of the following is the associativity property for the composition of fuzzy relations  $R, S$ , and  $T$ ?
- a)  $(R \circ S) \circ T = R \circ (S \circ T)$
- b)  $(R \circ S) \circ T = (R \circ S) \circ (R \circ T)$
- c)  $(R \circ S) \circ T \neq R \circ (S \circ T)$
- d) None of these
- (xv) Identify in which of the following statement is true
- a) For multivalent logic, it becomes difficult to make a precise statement with crisp binary values only.
- b) Fuzzy logic is a sub-set of classical logic
- c) In multivalent logic, truth is a matter of degree.
- d) All of this statements are true

### Group-B

(Short Answer Type Questions)

3 x 5=15

2. Define Fuzzy Singleton with proper example. (3)
3. Write the norms of Sugeno's class of complement (3)
4.  $A$  and  $B$  are two crisp sets given as below with universe of discourse  $X$  and  $Y$ , respectively. Show that a relation i.e. first element is greater than the second element in  $A \times B$  is the subset of  $A \times B$ . (3)
- $A = \{1,2,3,4\}$   
 $B = \{2,3,4\}$
5. Explain Larsen Fuzzy Model using Max-Min Composition Single Rule with Single Antecedent (Fuzzy Input) (3)
6. Let  $A$  and  $B$  are two fuzzy sets given as below. (3)
- Evaluate the union of  $A$  and  $B$  for the universe of discourse  $X = \{1, 2,3,4\}$ .
- $A = 0.7/1 + 0.5/2 + 0.1/3 + 0.6/4$   $B = 0.8/2 + 0.3/3$

OR

- A fuzzy set  $A$  is given below for a universe of discourse  $X$ . (3)
- Evaluate the support, Core and crossover for the given set.
- $A = \{(4,0), (5,0.1), (6,0.5), (7,0.3), (9,0.9), (10,1), (11,0.5), (12,1), (13,0)\}$

**Group-C**

(Long Answer Type Questions)

5 x 6=30

7. Discuss Larsen Fuzzy Model using Max-Min Composition Multiple Rules with multiple Antecedent (Fuzzy Input) (5)
8. Let there are three fuzzy set A, B and C In the universe of discourse X, Y and Z are given as below. (5)

$$X = \{x_1, x_2, x_3\} : Y = \{y_1, y_2, y_3, y_4\} : Z = \{z_1, z_2\}$$

Let two fuzzy relations  $R_1(x,y)$  and  $R_2(y,z)$  ,are defined on the space  $X \times Y$  and  $Y \times Z$  respectively define as below.

$R_1(x,y)$ =" x is related to y"

$R_2(y,z)$ =" y is related to z"

$$R_1(x,y) = \begin{matrix} & y_1 & y_2 & y_3 & y_4 \\ \begin{matrix} x_1 \\ x_2 \\ x_3 \end{matrix} & \begin{bmatrix} 0.7 & 0.6 & 0.3 & 0.4 \\ 0.9 & 0.4 & 0.2 & 0.7 \\ 0.1 & 0.9 & 0.5 & 0.6 \end{bmatrix} \end{matrix} \quad R_2(y,z) = \begin{matrix} & z_1 & z_2 \\ \begin{matrix} y_1 \\ y_2 \\ y_3 \\ y_4 \end{matrix} & \begin{bmatrix} 0.6 & 0.7 \\ 0.9 & 0.3 \\ 0.4 & 0.8 \\ 0.2 & 0.5 \end{bmatrix} \end{matrix}$$

Find the max-product composition of  $R_1$  and  $R_2$

9. Define Normalization of a fuzzy set A (5)

A subnormal fuzzy set A is given for a universe of discourse X. Evaluate the normalized fuzzy set A'.

Where  $A = \{(5,0.1), (6,0.4), (7,0.5), (8,0.8), (9,0.7), (10,0.3), (11,0.5), (12,0.7), (13,0.6), (14,0.5), (15,0.5)\}$

10. A linguistic variable "Bright" on the universe of discourses (5)

$X = \{1, 2, 3, 4, 5\}$  is defined as,

$$\text{Bright} = 1.0/1 + 0.8/2 + 0.6/3 + 0.4/4 + 0.2/5$$

Evaluate the following:

i. Very Bright

ii. Very Very Bright:

iii. More or Less Bright

11. Evaluate and plot the distances  $d(A, B)$ ,  $d(A, C)$  and  $d(B, C)$  for fuzzy sets A, B and C given below with the universe of discourse  $X =$  (5)

$(1,2,3,4,5,6,7,8)$ .

$$A = \{(2, 0.7), (3,0.3), (4,0.9), (5,1.0)\}$$

$$B = \{(1,0.2), (2,0.4), (3,1.0)\}$$

$$C = \{(5,0.3), (6,0.8), (7,1.0), (8,0.5)\}$$

12. Let us consider two fuzzy sets A and B with the universe of discourse X and Y, respectively defined as (5)

$$A = 0.2/x_1 + 0.4/x_2 + 0.5/x_3$$

$$B = 0.5/y_1 + 0.1/y_2 + 0.7/y_3$$

If a fuzzy relation R defined on space  $X \times Y$  is,

$$R = \begin{matrix} & \begin{matrix} y_1 & y_2 & y_3 \end{matrix} \\ \begin{matrix} x_1 \\ x_2 \\ x_3 \end{matrix} & \begin{bmatrix} 0.2 & 0.1 & 0.2 \\ 0.4 & 0.1 & 0.4 \\ 0.5 & 0.1 & 0.5 \end{bmatrix} \end{matrix}$$

Justify the "Idempotency" property the fuzzy relation R

OR

The fuzzy relation R defined over X is given below (5)

$$R = \begin{matrix} & \begin{matrix} x_1 & x_2 & x_3 & x_4 \end{matrix} \\ \begin{matrix} x_1 \\ x_2 \\ x_3 \\ x_4 \end{matrix} & \begin{bmatrix} 1.0 & 0.9 & 0.6 & 0.2 \\ 0.9 & 1.0 & 0.7 & 0.3 \\ 0.6 & 0.7 & 1.0 & 0.9 \\ 0.2 & 0.3 & 0.9 & 1.0 \end{bmatrix} \end{matrix}$$

Justify that R is a fuzzy tolerance relation

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