

**BIRLA INSTITUTE OF TECHNOLOGY, MESRA, RANCHI  
(MID SEMESTER EXAMINATION)**

**CLASS: IMSC  
BRANCH: MATHEMATICS**

**SEMESTER : V/ADD  
SESSION : MO/2025**

**SUBJECT: MA303R1 FUZZY LOGIC**

**TIME: 02 Hours**

**FULL MARKS: 25**

**INSTRUCTIONS:**

1. The question paper contains 5 questions each of 5 marks and total 25 marks.
2. Attempt all questions.
3. The missing data, if any, may be assumed suitably.
4. Tables/Data handbook/Graph paper etc., if applicable, will be supplied to the candidates

- |  |       | CO    | BL    |       |     |     |       |     |     |       |     |     |  |       |       |       |       |     |     |     |       |     |     |     |     |   |       |
|--|-------|-------|-------|-------|-----|-----|-------|-----|-----|-------|-----|-----|--|-------|-------|-------|-------|-----|-----|-----|-------|-----|-----|-----|-----|---|-------|
| Q.1(a) Differentiate between a fuzzy set and crisp set.  | [2]   | 1     | 1,2,3 |       |     |     |       |     |     |       |     |     |  |       |       |       |       |     |     |     |       |     |     |     |     |   |       |
| Q.1(b) Consider fuzzy sets A and B such that:<br>$A = \{(1,.2), (2,.5), (3,.8), (4,0), (5,.7), (6,.3), (7,1), (8,0)\}$<br>$B = \{(1,1), (2,.2), (3,.3), (4,.4), (5,.5), (6,.6), (7,0), (8,.1)\}$<br>Verify De Morgans law.   | [3]   | 1     | 1,2,3 |       |     |     |       |     |     |       |     |     |  |       |       |       |       |     |     |     |       |     |     |     |     |   |       |
| Q.2(a) $\tilde{A}$ and $\tilde{B}$ be two fuzzy sets defined on the universal set X. Show that $ \tilde{A}  +  \tilde{B}  =  \tilde{A} \cup \tilde{B}  +  \tilde{A} \cap \tilde{B} $ .   | [2]   | 1     | 1,2,3 |       |     |     |       |     |     |       |     |     |  |       |       |       |       |     |     |     |       |     |     |     |     |   |       |
| Q.2(b) Let $X = \{1,2,\dots,10\}$ . Determine cardinalities and relative cardinalities of the following fuzzy sets.<br>$B = \{(2,.8), (4,0.5), (5,0.6), (7,1)\}$<br>Is the set convex ?.   | [3]   | 1     | 1,2,3 |       |     |     |       |     |     |       |     |     |  |       |       |       |       |     |     |     |       |     |     |     |     |   |       |
| Q.3(a) Let $A = \{1/1.0 + 2/0.8 + 3/0.6 + 4/0.2\}$ defined on $X = \{1,2,3,4\}$ . Find all its $\alpha$ -cut sets. Show that A can be expressed in terms of the family composed of all its $\alpha$ -cuts.   | [2]   | 2     | 1,2,3 |       |     |     |       |     |     |       |     |     |  |       |       |       |       |     |     |     |       |     |     |     |     |   |       |
| Q.3(b) Consider the fuzzy matrices R and S defined by the following relational matrices as<br>$R =$ <table border="1" style="display: inline-table; border-collapse: collapse; text-align: center;"> <tr><td></td><td><math>Y_1</math></td><td><math>Y_2</math></td></tr> <tr><td><math>X_1</math></td><td>0.1</td><td>0.5</td></tr> <tr><td><math>X_2</math></td><td>0.6</td><td>0.8</td></tr> <tr><td><math>X_3</math></td><td>0.9</td><td>0.2</td></tr> </table> $S =$ <table border="1" style="display: inline-table; border-collapse: collapse; text-align: center;"> <tr><td></td><td><math>Z_1</math></td><td><math>Z_2</math></td><td><math>Z_3</math></td></tr> <tr><td><math>Y_1</math></td><td>0.7</td><td>0.3</td><td>0.8</td></tr> <tr><td><math>Y_2</math></td><td>0.6</td><td>0.7</td><td>0.9</td></tr> </table> Apply max-min composition to find ROS. |       | $Y_1$ | $Y_2$ | $X_1$ | 0.1 | 0.5 | $X_2$ | 0.6 | 0.8 | $X_3$ | 0.9 | 0.2 |  | $Z_1$ | $Z_2$ | $Z_3$ | $Y_1$ | 0.7 | 0.3 | 0.8 | $Y_2$ | 0.6 | 0.7 | 0.9 | [3] | 2 | 1,2,3 |
|  | $Y_1$ | $Y_2$ |       |       |     |     |       |     |     |       |     |     |  |       |       |       |       |     |     |     |       |     |     |     |     |   |       |
| $X_1$  | 0.1   | 0.5   |       |       |     |     |       |     |     |       |     |     |  |       |       |       |       |     |     |     |       |     |     |     |     |   |       |
| $X_2$  | 0.6   | 0.8   |       |       |     |     |       |     |     |       |     |     |  |       |       |       |       |     |     |     |       |     |     |     |     |   |       |
| $X_3$  | 0.9   | 0.2   |       |       |     |     |       |     |     |       |     |     |  |       |       |       |       |     |     |     |       |     |     |     |     |   |       |
|  | $Z_1$ | $Z_2$ | $Z_3$ |       |     |     |       |     |     |       |     |     |  |       |       |       |       |     |     |     |       |     |     |     |     |   |       |
| $Y_1$  | 0.7   | 0.3   | 0.8   |       |     |     |       |     |     |       |     |     |  |       |       |       |       |     |     |     |       |     |     |     |     |   |       |
| $Y_2$  | 0.6   | 0.7   | 0.9   |       |     |     |       |     |     |       |     |     |  |       |       |       |       |     |     |     |       |     |     |     |     |   |       |
| Q.4(a) Define Fuzzy Cartesian Product.   | [2]   | 2     | 1,2,3 |       |     |     |       |     |     |       |     |     |  |       |       |       |       |     |     |     |       |     |     |     |     |   |       |
| Q.4(b) Let $A = \{(w_1,0.3), (w_2,0.8), (w_3,0.5)\}$ and $B = \{(y_1,0.4), (y_2,0.5)\}$ be two fuzzy sets defined on the universes of discourse $X = \{w_1, w_2, w_3\}$ and $Y = \{y_1, y_2\}$ respectively. Find the fuzzy cartesian product $A \times B$ .   | [3]   | 2     | 1,2,3 |       |     |     |       |     |     |       |     |     |  |       |       |       |       |     |     |     |       |     |     |     |     |   |       |
| Q.5(a) Determine which fuzzy set, defined by the following function is a fuzzy number or not.<br>$\tilde{B}(x) = \begin{cases} x, & 0 \leq x \leq 1 \\ 0, & \text{otherwise} \end{cases}$  | [2]   | 3     |       |       |     |     |       |     |     |       |     |     |  |       |       |       |       |     |     |     |       |     |     |     |     |   |       |
| Q.5(b) Consider a triangular fuzzy number $A = (1,3,5)$ , represent it in form of membership function. Find its alpha cut. Also find its inverse.  | [3]   | 3     |       |       |     |     |       |     |     |       |     |     |  |       |       |       |       |     |     |     |       |     |     |     |     |   |       |