AE-813

M.A./M.Sc. (Final)
Term End Examination, 2016-17

MATHEMATICS

Optional

Paper - IX

Fuzzy Sets and Their Applications

Time : Three Hours] [*Maximum Marks* : 100
[*Minimum Pass Marks* : 36

Note : Answer any **five** questions. All questions carry equal marks.

1. (*a*) Show that sum and difference of two convex fuzzy sets are convex.

(*b*) Explain why we need fuzzy set theory.

2. (*a*) Explain interval-valued fuzzy sets, fuzzy sets of type-2 and L-fuzzy sets.

(*b*) Let $\tilde{A}_i \in F(x)$ for all $i \in I$, where I is an index set. Then show that

$$\bigcup_{i \in I} \alpha \tilde{A}_i \subseteq \alpha \left(\bigcup_{i \in I} \tilde{A}_i \right)$$

3. (*a*) Explain Zadeh's extension principle.

(*b*) Let $\tilde{A}$ and $\tilde{B}$ are fuzzy numbers with triangular shape in a fuzzy equation, as

$$\tilde{A}(x) = \begin{cases} 0, & \text{for} \quad x \le 3, x > 5 \\ x - 3, & \text{for} \quad 3 < x < 4 \\ 5 - x, & \text{for} \quad 4 < x < 5 \end{cases}$$

$$\tilde{B}(x) = \begin{cases} 0, & \text{for} \quad x \le 12, x > 32 \\ (x - 12)/8, & \text{for} \quad 12 < x \le 20 \\ (32 - x)/12, & \text{for} \quad 20 < x \le 32 \end{cases}$$

Find the solution of the equation $\tilde{A} \,.\, X = \tilde{B}$.

4. (*a*) Determine a transitive closure of the relation

$$\tilde{R} = \begin{bmatrix} 0.4 & 1.0 & 0.5 \\ 0.2 & 0.0 & 0.7 \\ 1.0 & 0.7 & 0.4 \end{bmatrix}$$

(*b*) Explain the following terms :

(*i*) Fuzzy relation

(*ii*) Max-Min composition

(*iii*) Binary relation

5. (*a*) Let a given finite body of evidence (G, m) be nested then for all $A, B \in P(X)$. Show that

(*i*) $\text{bel}(\tilde{A} \cap \tilde{B}) = \min[\text{bel}(\tilde{A}), \text{bel}(\tilde{B})]$

(*ii*) $\text{pl}(\tilde{A} \cup \tilde{B}) = \max[\text{pl}(\tilde{A}), \text{pl}(\tilde{B})]$

(*b*) Explain the following terms :

(*i*) Fuzzy measure

(*ii*) Possibility distribution

6. (*a*) State and prove De-Morgan Law.

(*b*) Show that

$$(p \Rightarrow q) \Leftrightarrow (\neg p \vee q)$$

is tautology.

7. (*a*) Explain the type of fuzzy connectives.

(*b*) Explain fuzzy quantifiers.

8. (*a*) Explain approximate reasoning and fuzzy language with example.

(*b*) For the function $f(a) = \log(1 + a)$, $a \in [0, 1]$ find the pseudo inverse and fuzzy complement.

9. (*a*) Write basic assumption in a fuzzy control system design.

(*b*) Explain fuzzy controllers and fuzzy automation operator.

10. Solve the following fuzzy linear programming problem :

Max $Z = 0.5x_1 + 0.2x_2$

such that $x_1 + x_2 \leq B_1$

$2x_1 + x_2 \leq B_2$

$x_1, x_2 \geq 0$

where $$B_1(x) = \begin{cases} 1 & ; \text{ for } x \leq 300 \\ \dfrac{400 - x}{100} & ; \text{ for } 300 < x \leq 400 \\ 0 & ; \text{ for } x > 400 \end{cases}$$

and $$B_2(x) = \begin{cases} 1 & ; \text{ for } x \leq 400 \\ \dfrac{500 - x}{100} & ; \text{ for } 400 < x \leq 500 \\ 0 & ; \text{ for } x > 500 \end{cases}$$

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