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PG (CBCS)
M.Sc. Semester-IV Examination, 2023
MATHEMATICS
PAPER: MTM 402
(FUZZY MATHEMATICS WITH APPLICATIONS & SOFT COMPUTING)

Full Marks: 50 **Time: 2 Hours**

The figures in the right-hand margin indicate full marks.
Candidates are required to give their answers in their own words as far as practicable.

Write the answer for each unit in separate sheet

UNIT: 402.1
FUZZY MATHEMATICS WITH APPLICATIONS
F.M. - 20

1. Answer any **TWO** from the following questions: 2×2=4
   a) Determine the height and support for each of the following fuzzy sets that have Triangular Membership functions and Trapezoidal Membership functions. Draw the corresponding membership function for each case.
   b) What are the causes of uncertainty?
   c) State Bellman and Zadeh's principle.
   d) Let $f(x) = x^2 - 1$. Find $f(\tilde{A})$, where $\tilde{A} = \{(-2, 0.41), (-1,0.75), (0,1.0), (1,0.32), (2,0.96), (3,0.2)\}$.

2. Answer any **TWO** from the following questions: 2×4=8
   a) Prove that the fuzzy sets satisfy the distributive laws under standard fuzzy union and intersection.
   b) Consider the two fuzzy numbers $\tilde{A} = (5,7,10)$, $\tilde{B} = (0,3,9,13)$. Using addition, substruction and scalar multiplication rules for fuzzy numbers, determine the following: $2\tilde{A} + 3\tilde{B}, 2\tilde{A} - 3\tilde{B}$, $\tilde{A} + \tilde{B}$, $\tilde{A} - \tilde{B}$. Give an example of fuzzy set which is not convex. Determine whether the statement is true or false: α −cut of fuzzy set is also a fuzzy set. 2+1+1
   c) Show that fuzzy sets do not satisfied laws of contradiction and excluded middle. Is every fuzzy set a fuzzy number? Justify your answer. 3+1
   d) Explain the procedure to reduce the uncertainty from fuzzy multi-objective LPP.

(P.T.O.)

3. Answer any **ONE** from the following questions: 1×8=8

a) What do you mean by symmetric and non-symmetric fuzzy LPP?

Let the fuzzy LPP with fuzzy resources be

$$Maximize \quad z = 2x_1 + x_2$$

subject to

$$3x_1 + x_2 \lesssim \widetilde{13}$$
$$4x_1 + 3x_2 \gtrsim \widetilde{16}$$
$$x_1 + 2x_2 \lesssim \widetilde{10}$$
$$\text{and } x_1, x_2 \geq 0$$

and the tolerances as $p_1 = 2, p_2 = 4$ and $p_3 = 3$. Convert the fuzzy LPP to equivalent crisp parametric programming problem. 3+5

b) Consider the fuzzy set $\tilde{A}$, with the following membership functions given by

$$\mu_{\tilde{A}}(x) = \begin{cases} \dfrac{x-5}{5}, & 5 \leq x \leq 10 \\ -\dfrac{x-15}{5}, & 10 \leq x \leq 15 \\ 0, & \text{Otherwise} \end{cases}$$

i. Find $\tilde{A}^c$, the complement of $\tilde{A}$. Also, sketch the membership function of $\tilde{A}^c$.

ii. Find $\tilde{A}_{0.3}, \tilde{A}_{0.5}$ where $\tilde{A}_\alpha$ is the α −cut of the fuzzy set $\tilde{A}$.

iii. Determine support and height for the fuzzy set $\tilde{A}$. Is it normal?

iv. Is it Convex? Justify your answer. 2+2+2+2

[Internal Assessment- 05]

(P.T.O.)

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UNIT: 402.2

SOFT COMPUTING

F.M. - 20

4. Answer any **TWO** from the following questions: 2×2=4

a) Write the different features of soft computing.

b) Find the weights and threshold values of an ANN that should classify the following input/ output pairs

x_1	x_2	$x_1 \wedge x_2$
0	0	0
0	1	0
1	0	0
1	1	1

c) Perform one point crossover (at 3) for the following Chromosomes

$$x_1 = 1010101010$$
$$x_2 = 0101010101$$

Perform two-point crossover (at 2 and 5) for the following Chromosomes

$$y_1 = 1110110100$$
$$y_2 = 1000101000$$

d) How fuzzy logic differs from usual logic?

5. Answer any **TWO** from the following questions: 2×4=8

a) Let $X = \{1, 2, 3, 4\}$ and $Y = \{a, b, c\}$ be two universes of discourses. Also, let $\tilde{A} = \{(1, 0.2), (2, 0.5), (3, 0.7), (4, 1.0)\}$, $\tilde{B}$={(1,0.3),(2,0.4),(3,0.8),(4,0.7)} and $\tilde{C} = \{(a, 0.1), (b, 0.6), (c, 0.9)\}$. Determine the fuzzy relation of the following fuzzy rule "IF x is $\tilde{A}$ AND x is $\tilde{B}$ THEN y is $\tilde{C}$ ".

b) Explain Supervised leaning. Define max-min composition between two fuzzy relations. Suppose R and S be two fuzzy relations defined on $X \times Y$ and $Y \times Z$ respectively. Find the Max-Min composition of $R \circ S$, if $\begin{pmatrix} 0.44 & 0.86 & 0.00 & 0.36 \\ 0.93 & 0.50 & 0.80 & 0.49 \\ 0.90 & 0.16 & 0.77 & 0.62 \\ 0.91 & 0.00 & 0.80 & 0.91 \end{pmatrix}, \begin{pmatrix} 0.94 & 0.86 & 0.00 & 0.23 \\ 0.00 & 1.00 & 0.70 & 0.32 \\ 0.10 & 0.16 & 0.07 & 0.85 \\ 0.91 & 1.00 & 0.00 & 0.76 \end{pmatrix}$ are the matrix representation of R, S respectively.

c) Realise a Hebb net for the logical AND function with bipolar inputs and targets.

(P.T.O.)

d) Write a short note on mutation. What is the role and importance of mutation in Genetic Algorithms?

6. Answer any **ONE** from the following questions: 1×8=8

a) Realize the function XOR gate using McCulloch-Pitts neuron model.

b) Describe the binary coded GA procedure to maximize a real valued function $y = f(x_1, x_2)$ in $a \leq x_1, x_2 \leq b$.

[Internal Assessment- 05]

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