



ANSWER THE FOLLOWING QUESTIONS

Q1: a) State the difference between the following: (30 points)

- i- Crisp logic and Fuzzy logic. ii- Randomness and Fuzziness

b) Let the S-norm operator be:  $\frac{x+y-2xy}{1-xy}$  compute the corresponding T-norm operator.

Q2: A fuzzy model is given as follows: (35 points)

$R_1$ : IF X is A THEN Y is B

$R_2$ : IF Y is B THEN Z is C

The fuzzy mapping relations of the above rules are :

	y1	y2	y3	y4
x1	1	.3	.1	0
x2	.2	1	.6	.1
x3	0	.7	1	.2
x4	0	.1	.4	1

	z1	z2	z3	z4
y1	.8	1	.6	.2
y2	.2	0	.5	.8
y3	.1	.4	.9	.4
y4	.1	.2	.4	.8

If the input to the above fuzzy model is : X is slightly  $A^*$ , where :

$$A^* = \left\{ \frac{1}{x1} + \frac{0.7}{x2} + \frac{0.4}{x3} + \frac{0.1}{x4} \right\}. \text{ Find the fuzzy and crisp outputs of the model.}$$

Q3: A fuzzy rule-based model is constructed using the following two rules: (35 points)

R1: IF X is A and Y is B THEN Z is slightly C

R2: IF X is not very A and Y is fairly B THEN Z is very C

$$\text{Where: } A = \left\{ \frac{0.2}{x1} + \frac{0.5}{x2} + \frac{0.9}{x3} + \frac{1}{x4} + \frac{0.7}{x5} + \frac{0.3}{x6} \right\}$$

$$B = \left\{ \frac{1}{y1} + \frac{1}{y2} + \frac{0.9}{y3} + \frac{0.7}{y4} + \frac{0.4}{y5} + \frac{0.1}{y6} \right\}$$

$$C = \left\{ \frac{0.1}{z_1} + \frac{0.4}{z_2} + \frac{0.6}{z_3} + \frac{0.8}{z_4} + \frac{1}{z_5} + \frac{1}{z_6} \right\}$$

Let the input to the fuzzy model be of the following possibility distributions:

$$A^* = \left\{ \frac{1}{x_1} + \frac{0.8}{x_2} + \frac{0.6}{x_3} + \frac{0.45}{x_4} + \frac{0.25}{x_5} + \frac{0.15}{x_6} \right\}$$

$$B^* = \left\{ \frac{0.1}{y_1} + \frac{0.3}{y_2} + \frac{0.5}{y_3} + \frac{1}{y_4} + \frac{0.7}{y_5} + \frac{0.2}{y_6} \right\}$$

Assuming a fuzzy Mamdani model, get the following:

- The firing degree of each rule.
  - The output possibility distribution of the model.
  - If the output space  $C = \{100, 200, 300, 400, 500, 600\}$ , then obtain the final crisp output.
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