Group 55 - Assignment 4 - Problem 1

Given are the two Fuzzy Control rules -

Rule 1 If x is A_1 and y is B_1 Then z is C_1

Rule 2 If x is A_2 and y is B_2 Then z is C_2

The membership functions for the Linguistic variables

$A_1, A_2, B_1, B_2, C_1, C_2$ are -

$$\mu_{A_1}(x) = \begin{cases} \frac{x-2}{3} & 2 \le x \le 5 \\ \frac{8-x}{3} & 5 \le x \le 8 \end{cases}$$

$$\mu_{A_2}(x) = \begin{cases} \frac{x-3}{3} & 3 \le x \le 6 \\ \frac{9-x}{3} & 6 \le x \le 9 \end{cases}$$

$$\mu_{B_1}(y) = \begin{cases} \frac{y-5}{3} & 5 \le y \le 8 \\ \frac{11-y}{3} & 8 \le y \le 11 \end{cases}$$

$$\mu_{B_2}(y) = \begin{cases} \frac{y-4}{3} & 4 \le y \le 7 \\ \frac{10-y}{3} & 7 \le y \le 10 \end{cases}$$

$$\mu_{C_1}(z) = \begin{cases} \frac{z-1}{3} & 1 \le z \le 4 \\ \frac{7-z}{3} & 4 \le z \le 7 \end{cases}$$

$$\mu_{C_2}(z) = \begin{cases} \frac{z-3}{3} & 3 \le z \le 6 \\ \frac{9-z}{3} & 6 \le z \le 9 \end{cases}$$
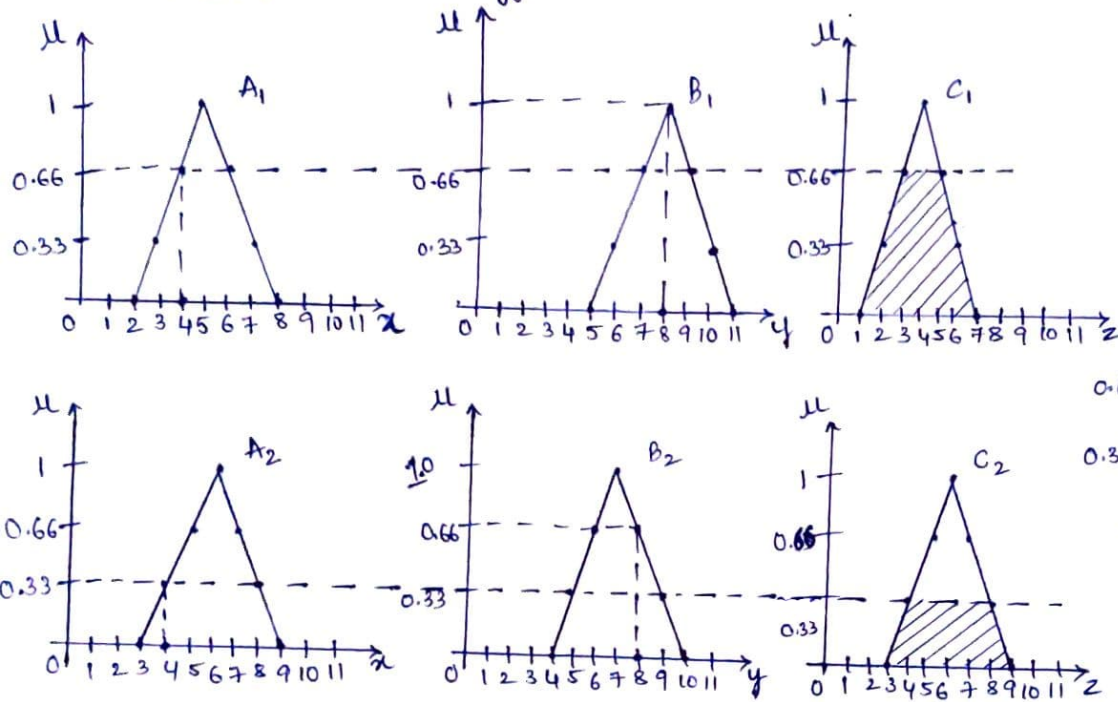
The sensor values at time t_i are given as $x_0(t_i) = 4$ & $y_0(t_i) = 8$ → ①

Using the membership functions given, below values are calculated - (by bringing every membership function onto the same scale [1, 11])

$x/y/z$	A_1	A_2	B_1	B_2	C_1	C_2
1	0	0	0	0	0	0
2	0	0	0	0	0.33	0
3	0.33	0	0	0	0.66	0
4	0.66	0.33	0	0	1	0.33
5	1	0.66	0	0.33	0.66	0.66
6	0.66	1	0.33	0.66	0.33	1
7	0.33	0.66	0.66	1	0	0.66
8	0	0.33	1	0.66	0	0.33
9	0	0	0.66	0.33	0	0
10	0	0	0.33	0	0	0
11	0	0	0	0	0	0

* Based on the calculated values from the table above, below are the plots - Here we have used Mamdani inferencing system [Max - Min inference method] &i,Mean of maximum (MOM) for the defuzzification strategy.

ii, Largest of maximum (LOM)

here using ① ⇒ $z_0(t_1) = 4$ & $y_0(t_1) = 8$.

A_1

1

0.66

0.33

0 1 2 3 4 5 6 7 8 9 10 11 x

B_1

1

0.66

0.33

0 1 2 3 4 5 6 7 8 9 10 11 y

C_1

1

0.66

0.33

0 1 2 3 4 5 6 7 8 9 10 11 z
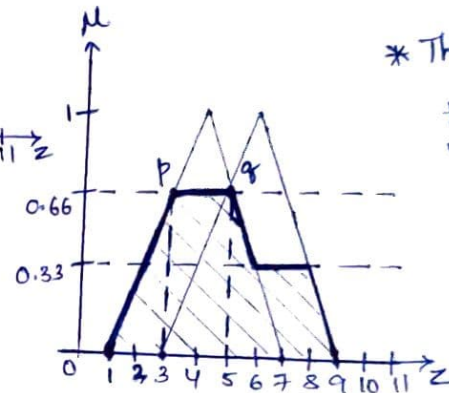
* The maximum value from the final o/p plot is "0.66" & this value is in the range of [3,5].

μ

0.66

0.33

P q

0 1 2 3 4 5 6 7 8 9 10 11 z

A_2

1

0.66

0.33

0 1 2 3 4 5 6 7 8 9 10 11 x

B_2

1.0

0.66

0.33

0 1 2 3 4 5 6 7 8 9 10 11 y

C_2

1

0.66

0.33

0 1 2 3 4 5 6 7 8 9 10 11 z

i, Mean of maximum (MOM) defuzzification

The maximum value = 0.66

& it is obtained in range = [3,5] ⇒ P=3, q=5

As per MOM strategy -

Value of the o/p = $\frac{P+q}{2}$ (mean values)

⇒ $z(t_1) = \frac{3+5}{2} = 4$

→ So, the value of control o/p at time t_1 using MOM = 4

ii, Largest of Maximum (LOM) defuzzification.

The maximum value = 0.66

& it is obtained in range = [3,5]

As per LOM strategy -

Value of the o/p = Largest in the o/p range. = 5

→ So, the value of control o/p at time t_1 using LOM. = 5