كلية الالكترونية
College of Electronic Techn

القسم: تحكم آلي
الفصل: السابع

أسئلة الامتحان النهائي لمادة: تحكم ذكي
رمز المادة: CT411

التاريخ: 14/ 03 /2022م
الزمن: ساعتان و نصف

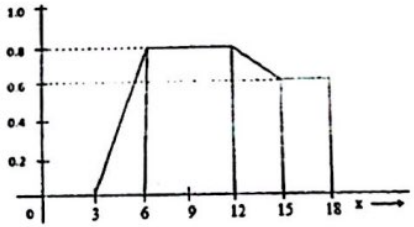
الفصل الدراسي : خريف/ 21-22

اسم الطالب: .....

رقم القيد .....

Answer the following questions:

Q1: For the following fuzzy set, find The crisp value which is obtained by CoG, MoM, SoM and LoM. {8 marks}

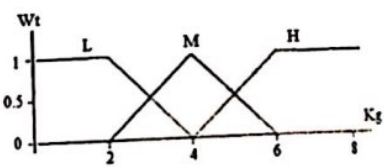


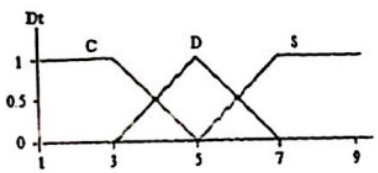
Q2: Let X={1,2,3,4,5} and Y={1,2,3,4,5}.The membership functions Small = {1/1+0.5/2+0/3+0.5/4+1/5}, Medium {0/1+0.5/2+1/3+0.5/4+0/5}, and Large = {0/1+0.2/2+0.5/3+0.8/4+1/5}. The rule-base of the fuzzy logic controller is:

1- If x is small Then y is medium
2- If x is medium Then y is large
3- If x is large Then y is small

Using the fuzzy graph model and max-min method; find the output y if the input:
$x^* = \{0/1+0.5/2+1/3+0.7/4+0.3/5\}$ {10 marks}

Q3: A controller in washing machine has two inputs; *Wt* is the weight of clothes (0-8 Kg) with linguistic variables {Light, Medium, Heavy}, and *Dt* is the amount of dirt {1-9} with linguistic variables {Clean, Dirty, Soiled}, the output Liq is the amount of cleaning liquid in mL {10-200}. The membership function distributions of the controller inputs are shown in the figure below.





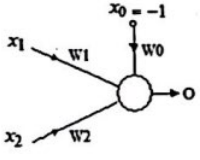
Based on ***Sugeno*** approach, the rule-base of the fuzzy logic controller is:

1- IF Wt is L AND Dt is C THEN Liq = 2 Wt + Dt.
2- IF Wt is M OR Dt is D THEN Liq = 6 Wt +7 Dt +10.
3- IF Wt is M AND Dt is S THEN Liq = 8 Wt +10 Dt −6.
4- IF Wt is H OR Dt is C THEN Liq = 14 Wt +16 Dt +3.
5- IF Wt is H AND Dt is D THEN Liq = 18 Wt +16 Dt + 15.

Find the Output Ø at Wt =4.5 Kg and Dt =4. {10 marks}

Liq

Q4: The shown Neural Network has α=0.2 and threshold value θ = 0.



This network will be trained to perform **AND** gate. Find the required weights W0, W1, and W2.

Write the results in the following table: {12 marks}

Epoch	Input			Desired output	Initial weights			Actual output	Error	Final weights		
	x0	*x1*	*x2*	t	*W0*	*W1*	*W2*	O	e	*W0*	*W1*	*W2*
1	-1	0	0	0	0.5	1	1					
	-1	0	1	0								
	-1	1	0	0								
	-1	1	1	1								
...	-1	0	0	0								
	-1	0	1	0								
	-1	1	0	0								
	-1	1	1	1								

Final Exam: CT411 (Intelligent Control)
Answers 14/03/2022

Q_1:

$A_1 = 3 \times 0.8 \times 0.5 = 1.2$ $\quad \bar{x}_1 = (3+6+6)/3 = 5$ (0.5)

$A_2 = 6 \times 0.8 = 4.8$ $\quad \bar{x}_2 = (6+12)/2 = 9$ (0.5)

$A_3 = 3 \times 0.6 = 1.8$ $\quad \bar{x}_3 = (12+15)/2 = 13.5$ (0.5)

$A_4 = 3 \times 0.2 \times 0.5 = 0.3$ $\quad \bar{x}_4 = (12+12+15)/3 = 13$ (0.5)

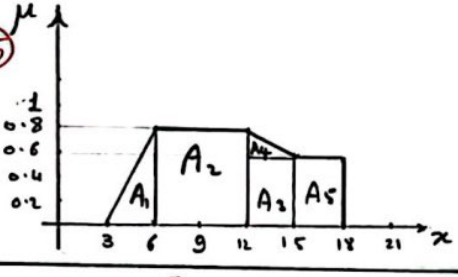
$A_5 = 3 \times 0.6 = 1.8$ $\quad \bar{x}_5 = (15+18)/2 = 16.5$ (0.5)

(COG) $x^* = \dfrac{1.2\times5 + 4.8\times9 + 1.8\times13.5 + 0.3\times13 + 1.8\times16.5}{1.2+4.8+1.8+0.3+1.8} = \dfrac{107.1}{9.9} = 10.82$ (2)

MOM ($x^* = \dfrac{12+6}{2} = 9$) (1.5)

SOM ($x^* = 6$) (1)

LOM ($x^* = 12$) (1)



Q_2:

$$R_1 = \begin{bmatrix}1\\0.5\\0\\0.5\\1\end{bmatrix} \circ \begin{bmatrix}0 & 0.5 & 1 & 0.5 & 0\end{bmatrix} = \begin{bmatrix}0 & 0.5 & 1 & 0.5 & 0\\0 & 0.5 & 0.5 & 0.5 & 0\\0 & 0 & 0 & 0 & 0\\0 & 0.5 & 0.5 & 0.5 & 0\\0 & 0.5 & 1 & 0.5 & 0\end{bmatrix}$$ (1)

$$R_2 = \begin{bmatrix}0\\0.5\\1\\0.5\\0\end{bmatrix} \circ \begin{bmatrix}0 & 0.2 & 0.5 & 0.8 & 1\end{bmatrix} = \begin{bmatrix}0 & 0 & 0 & 0 & 0\\0 & 0.2 & 0.5 & 0.5 & 0.5\\0 & 0.2 & 0.5 & 0.8 & 1\\0 & 0.2 & 0.5 & 0.5 & 0.5\\0 & 0 & 0 & 0 & 0\end{bmatrix}$$ (1)

$$R_3 = \begin{bmatrix}0\\0.2\\0.5\\0.8\\1\end{bmatrix} \circ \begin{bmatrix}1 & 0.5 & 0 & 0.5 & 1\end{bmatrix} = \begin{bmatrix}0 & 0 & 0 & 0 & 0\\0.2 & 0.2 & 0 & 0.2 & 0.2\\0.5 & 0.5 & 0 & 0.5 & 0.5\\0.8 & 0.5 & 0 & 0.5 & 0.8\\1 & 0.5 & 0 & 0.5 & 1\end{bmatrix}$$ (1)

$$R = R_1 \cup R_2 \cup R_3 = \begin{bmatrix} 0 & 0.5 & 1 & 0.5 & 0 \\ 0.2 & 0.5 & 0.5 & 0.5 & 0.5 \\ 0.5 & 0.5 & 0.5 & 0.8 & 1 \\ 0.8 & 0.5 & 0.5 & 0.5 & 0.8 \\ 1 & 0.5 & 1 & 0.5 & 1 \end{bmatrix}$$ (1)

max - min

$$y^* = \left(\begin{bmatrix} 0 & 0.5 & 1 & 0.7 & 0.3 \end{bmatrix} \circ \begin{bmatrix} 0 & 0.5 & 1 & 0.5 & 0 \\ 0.2 & 0.5 & 0.5 & 0.5 & 0.5 \\ 0.5 & 0.5 & 0.5 & 0.8 & 1 \\ 0.8 & 0.5 & 0.5 & 0.5 & 0.8 \\ 1 & 0.5 & 1 & 0.5 & 1 \end{bmatrix} \right)$$

$y^*(1,1) = \max(0, 0.2, 0.5, 0.7, 0.3) = 0.7$ (1)

$y^*(1,2) = \max(0, 0.5, 0.5, 0.5, 0.3) = 0.5$ (1)

$y^*(1,3) = \max(0, 0.5, 0.5, 0.5, 0.3) = 0.5$ (1)

$y^*(1,4) = \max(0, 0.5, 0.8, 0.5, 0.3) = 0.8$ (1)

$y^*(1,5) = \max(0, 0.5, 1, 0.7, 0.3) = 1$ (1)

$$y^* = \left\{ \frac{0.7}{1} + \frac{0.5}{2} + \frac{0.5}{3} + \frac{0.8}{4} + \frac{1}{5} \right\}$$ (1)

$$CoA(y) = \frac{0.7 \times 1 + 0.5 \times 2 + 0.5 \times 3 + 0.8 \times 4 + 1 \times 5}{0.7 + 0.5 + 0.5 + 0.8 + 1} = \frac{11.4}{3.5} = 3.26$$

Q_3:

$F_1 = 2 \times 4.5 + 4 = 13$ (0.5)

$F_2 = 6 \times 4.5 + 7 \times 4 + 10 = 65$ (0.5)

$F_3 = 8 \times 4.5 + 10 \times 4 - 6 = 70$ (0.5)

$F_4 = 14 \times 4.5 + 16 \times 4 + 3 = 130$ (0.5)

$F_5 = 18 \times 4.5 + 16 \times 4 + 15 = 160$ (0.5)

Q4:

Epoch	Inputs			Desired output	Initial weights				Actual output		Δw			Final weights			
	x_0	x_1	x_2	t_i	w_0	w_1	w_2	O'	O	e_i	Δw_0	Δw_1	Δw_2	w_0	w_1	w_2	
1	-1	0	0	0	0.5	1	1	-0.5	0	0	0	0	0	0.5	1	1	1.5
	-1	0	1	0	0.5	1	1	0.5	1	-1	0.2	0	-0.2	0.7	1	0.8	1.5
	-1	1	0	0	0.7	1	0.8	0.3	1	-1	0.2	-0.2	0	0.9	0.8	0.8	1.5
	-1	1	1	1	0.9	0.8	0.8	0.7	1	0	0	0	0	0.9	0.8	0.8	1.5
2	-1	0	0	0	0.9	0.8	0.8	-0.9	0	0	0	0	0	0.9	0.8	0.8	1.5
	-1	0	1	0	0.9	0.8	0.8	-0.1	0	0	0	0	0	0.9	0.8	0.8	1.5
	-1	1	0	0	0.9	0.8	0.8	-0.1	0	0	0	0	0	0.9	0.8	0.8	1.5
	-1	1	1	1	0.9	0.8	0.8	0.7	1	0	0	0	0	0.9	0.8	0.8	1.5

$W_0 = 0.9$
$W_1 = 0.8$
$W_2 = 0.8$

$$O' = w_0 x_0 + w_1 x_1 + w_2 x_2$$

$$\Delta w_i = \alpha (t_i - O_i) x_i = \alpha e_i x_i$$