UTHM
Universiti Tun Hussein Onn Malaysia

UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2014/2015

COURSE NAME	:	INTELLIGENT CONTROL SYSTEM
COURSE CODE	:	BEH 41803
PROGRAMME	:	BACHELOR OF ELECTRONIC ENGINEERING WITH HONOURS
EXAMINATION DATE	:	JUNE 2015 / JULY 2015
DURATION	:	3 HOURS
INSTRUCTION	:	ANSWER **ALL** QUESTIONS.

THIS QUESTION PAPER CONSISTS OF **SIX (6)** PAGES

Q1 (a) Compare neural network and fuzzy logic according to the structure.

(7 marks)

(b) Deduce four (4) the potential advantages of neural network for intelligent control.

(4 marks)

(c) Analyze the neural network working mechanism.

(4 marks)

(d) Outline why neural network must be trained before applying to solve the problem.

(2 marks)

(e) Discuss the importance of input and output variables in designing fuzzy control system.

(2 marks)

(f) Write each fuzzy set operation.

(6 marks)

Q2 Sugeno fuzzy control system is applied to control robot manipulator in the presence of fixed obstacle as shown in **Figure Q2(a)**. The controller has two inputs and one output. The inputs are the observation angle (θ_{obs}) and distance (d_{obs}) toward the obstacle. The output is the repulsive angle (θ_{rep}). Suppose that the arm can perceive an obstacle in a direction inside the interval $[-90^o \quad 90^o]$. The membership function is represented by seven fuzzy subsets: Zero (Z), Positive Small (PS), Positive Medium (PM), Positive Big (PM), Negative Small (NS), Negative Medium (NM), and Negative Big (NB) as shown in **Figure Q2(b)**. The arm can detect an obstacle from a distance of 30 cm. The membership function is expressed by three fuzzy subsets: Small (S), Medium (M), and Large (L) as shown in **Figure Q2(c)**. While the repulsive angle universe of discourse is $[-100^o \quad 100^0]$ by seven fuzzy subset: Zero (Z), Positive Small (PS), Positive Medium (PM), Positive Large (PL), Negative Small (NS), Negative Medium (NM), and Negative Large (NL) as shown in **Figure Q2(d)**. Rule tabulation related to input output of fuzzy control system is shown in **Table Q2**. Rules have max method and defuzzification is done using Weighted Average (WA).
Investigate the crisp value of the fuzzy control system output for $\theta_{obs} = -34^o$ and $d_{obs} = 20\ cm$.

(25 marks)

Q3 Multi Input Single Output (MISO) Mamdani Fuzzy logic control is applied to control the speed of the DC Motor. The controller has two inputs and one output. The input variables are error (e) and delta error (de), while the output variable is the motor input voltage (V). The controller inputs and output variables have five triangular fuzzy subsets, they are Negative (N), Negative Small (NS), Zero (Z), Positive Small (PS), and Positive (P). The range of five subsets as the following:

e ---- N[-4, -3, -2], NS[-3, -2, -1], Z[-3, 0, 3], PS[1, 2, 3], P[2, 3, 4]
de ---- N[-6, -3, 0], NS[-3, -2, -1], Z[-1, 0, 1], PS[1, 2, 3], P[0, 3, 6]

V ---- N[-10, -6, -2], NS[-6, -4, -2], Z[-2.5, 0, 2.5], PS[2, 4, 6], P[2, 6, 10]

Rule tabulation of this controller is shown in **Table Q3**. If error (e) is -2.5 and delta error (de) is -2.5:

(a) Develop the possible rule fire based on max-min method.

(5 marks)

(b) Determine each rule quantification.

(16 marks)

(c) Illustrate the clipping of the rule quantification result.

(2 marks)

(d) Estimate the real value of V using Centre of Area (COA) method.

(2 marks)

Q4 Three layer Momentum Backpropagation (MOBP) neural network is shown in **Figure Q4** has initial weights (w) and delta weights (dw) as below:
Hidden layer weights (w) and delta weight (dw):

$$w_1 = 0.2,\ w_2 = 0.3,\ w_3 = -0.1,\ w_4 = 0.24,\ w_5 = -0.2,\ w_6 = 0.22,$$
$$w_7 = -0.31,\ w_8 = -0.15$$
$$\Delta w_1 = 0.1,\ \Delta w_2 = 0.15,\ \Delta w_3 = -0.21,\ \Delta w_4 = 0.4,\ \Delta w_5 = -0.32,$$
$$\Delta w_6 = 0.2,\ \Delta w_7 = -0.1,\ \Delta w_8 = 0.5$$

Output layer weight and delta weight:

$$w_9 = -0.25,\ w_{10} = 0.35,\ w_{11} = -0.21,\ w_{12} = 0.41$$
$$\Delta w_9 = -0.5,\ \Delta w_{10} = 0.2,\ \Delta w_{11} = -0.4,\ \Delta w_{12} = 0.3$$

Learning rate, activation function for hidden layer and output layer and momentum values are:

$$\eta = 75,\ f(net) = \frac{1}{1+e^{net}} \text{ and } \alpha = 0.5$$

Train the network for one iteration for given values are $x_1 = 0, x_2 = 1, target\ (t) = 1$. Update the weights and justify if it converges.

(25 marks)

- END OF QUESTION –

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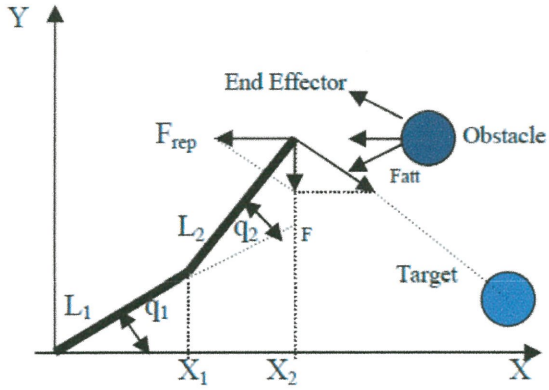

FIGURE Q2(a)

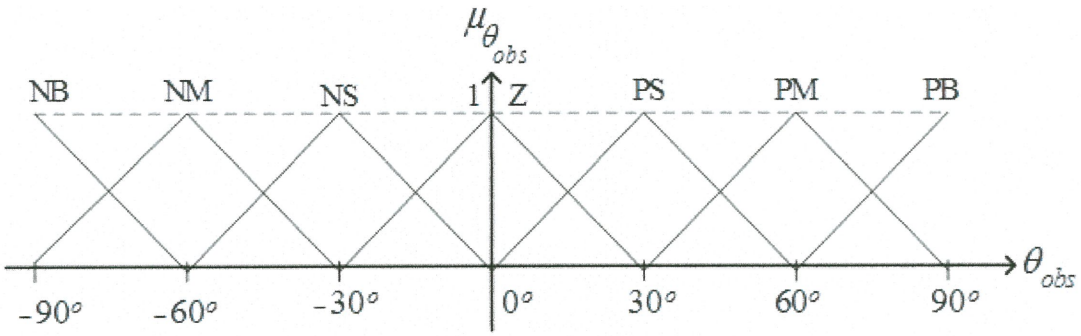

FIGURE Q2(b)

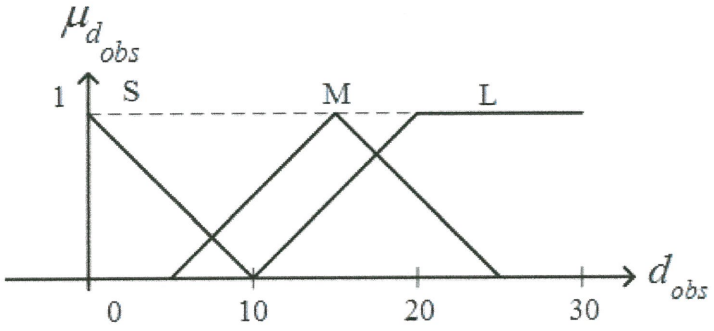

FIGURE Q2(c)

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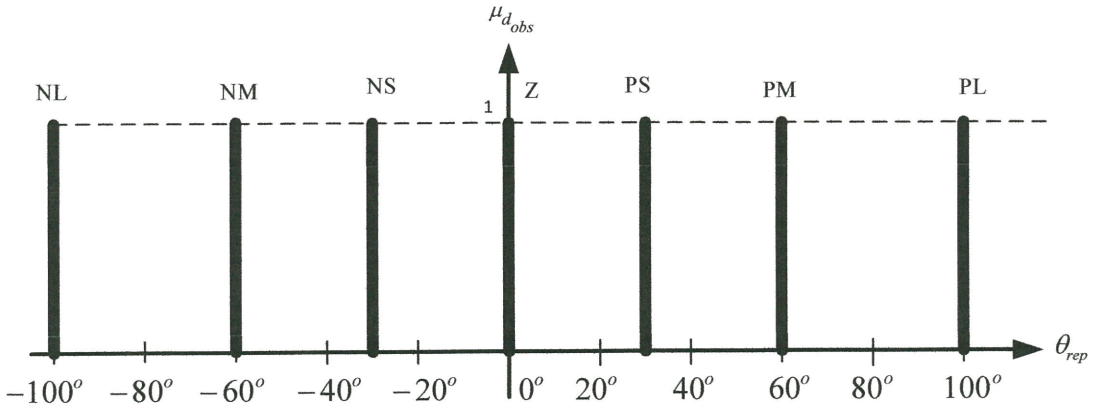

FIGURE Q2(d)

Table Q2

θ_{rep}		θ_{obs}						
		NB	NM	NS	Z	PS	PM	PB
d_{obs}	S	PM	PS	PL	NL	NL	NM	NS
	M	PS	PM	PL	NL	NM	NS	NS
	L	Z	PS	PM	NM	NS	NS	Z

Table Q3

V		de				
		N	NS	Z	PS	P
e	N	NS	N	N	N	N
	NS	NS	NS	N	N	N
	Z	Z	Z	Z	PS	PS
	PS	PS	PS	P	P	P
	P	P	P	P	P	P

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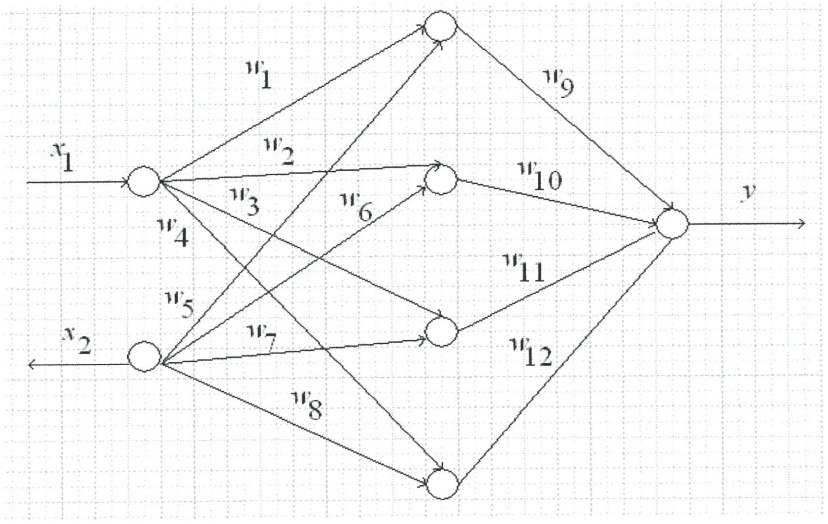

FIGURE Q4