# UNIVERSITI TUN HUSSEIN ONN MALAYSIA

# FINAL EXAMINATION
## SEMESTER II
## SESSION 2009/10

COURSE NAME        : FUZZY CONTROL SYSTEM

COURSE CODE         : BER 4233

PROGRAMME          : 4BER

EXAMINATION DATE   : APRIL/MAY 2010

DURATION             : 2 ½ HOURS

INSTRUCTION         : ANSWER FOUR (4) QUESTIONS ONLY

**Q1**    (a)    Create equation of equality, union, intersection and compliment for fuzzy set A and B with universe of discourse U.

(7 marks)

(b)    Describe the step of Mamdani Fuzzy Inference.

(8 marks)

(c)    Describe the two senses of the term Fuzzy Logic.

(5 marks)

(d)    Differentiate two methods of neural network learning algorithm.

(5 marks)

**Q2**    A fuzzy control system has table rules as shown in Table Q2 and membership as triangular function.

(a)    Develop the active rules related with error is 2.5 and differential error is -1.25, if Universe discourse for each variable is
Error: NB [-6,-4,-2], N [-4,-3,-2], NS [-3,-2,-1], Z [-2,0,2], PS [1,2,3],
      P [2,3,4], PB [2,4,6]
Differential error: NB [-6,-5,-4], N [-5,-3,-1], NS [-2,-1,0], Z [-1,0,1],
      PS [0,1,2], P [1,3,5], PB [4,5,6]
Output: NB [-8,-6,-4], N [-6,-4,-2], NS [-4,-2,0], Z [-2,0,2], PS [0,2,4],
      P [2,4,6], PB [4,6,8]

(5 marks)

(b)    Calculate the inference process from Q2(a)

(17 marks)

(c)    Calculate output crisp using COG method of Defuzzification

(3 marks)

**Q3**    A multilayer neural network is represented in Figure Q3. The network is trained using Backpropagation learning algorithm with weights initial condition as below: $w_1 = 0.01$, $w_2 = -0.01$, $w_3 = 0.11$, $w_4 = 0.21$, $w_5 = -0.11$, $w_6 = -0.2$, $w_7 = -0.15$, $w_8 = 0.31$, $\Delta w_1 = 0.1$, $\Delta w_2 = -0.02$, $\Delta w_3 = 0.01$, $\Delta w_4 = -0.11$, $\Delta w_5 = 0.0$, $\Delta w_6 = -0.011$, $\Delta w_7 = -0.05$, $\Delta w_8 = 0.01$

Activation function for hidden and output layer is $f(net) = \dfrac{1}{1 + e^{-net}}$, learning rate of network is A $\eta = 0.5$.

Neural network is used to evaluate AND GATE for input $x_1 = 1$, $x_2 = 1$, $x_3 = 1$, and target $t = 1$.

(a) Determine the value of each weight after one iteration

(22 marks)

(b) Calculate and draw MSE graph

(3 marks)

**Q4** (a) Explain what neural network is and how it work.

(6 marks)

(b) Describe the brief history of neural network.

(11 marks)

(c) Explain why neural network must train before apply to solve the problem.

(4 marks)

(d) Explain the potential advantages of neural network for intelligent control.

(4 marks)

Q5. (a) Develop weights updating formulation for first iteration of neural network shown in Figure Q5. Where $\eta$ is network learning rate, $\alpha$ is momentum, and network weights increment are $\Delta w_1, \Delta w_2, \cdots, \Delta w_{12}$.

(20 marks)

(b) Draw the block diagram of Fuzzy Gain Scheduling and Fuzzy PID auto tuner.

(4.7 marks)

Q6 (a) Describe the relationship between Fuzzy System and Neural Network

(5 marks)

(c) Draw the graph of membership function below for universe of discourse [2 14]

$$\mu(x) = \begin{cases} 0 & x < 2 \\ \dfrac{1}{4}(x-2) & 2 < x < 5 \\ \dfrac{1}{12}(x-5) + 0.75 & 5 < x < 8 \\ \dfrac{1}{8}(8-x) + 1 & 8 < x < 12 \\ \dfrac{1}{4}(12-x) + 0.5 & 12 < x < 14 \\ 0 & x > 14 \end{cases}$$

(15 marks)
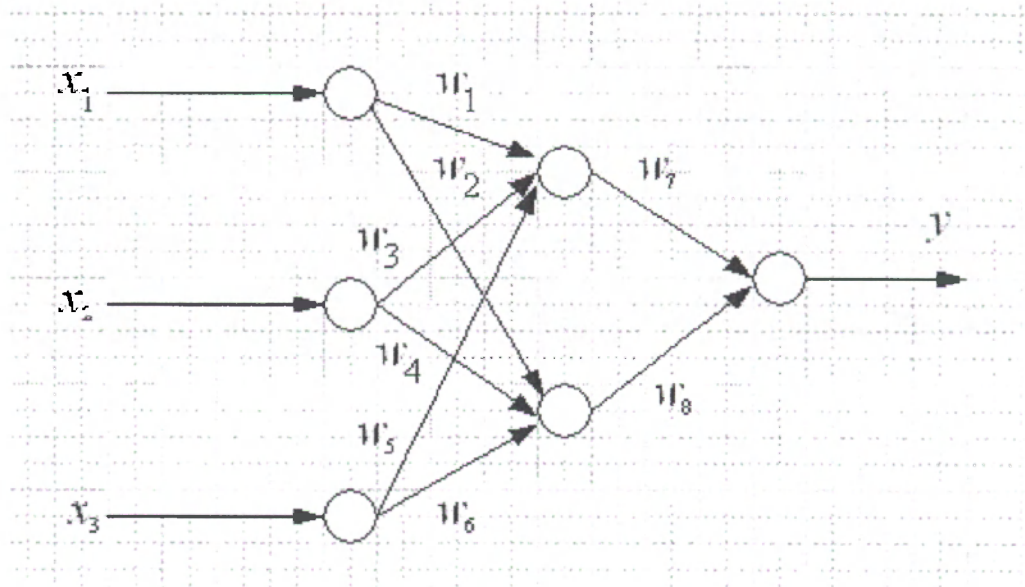
(c)　　Describe the definition of neuro fuzzy system.

(5 marks)

### Tabel Q2: Rule tabulation

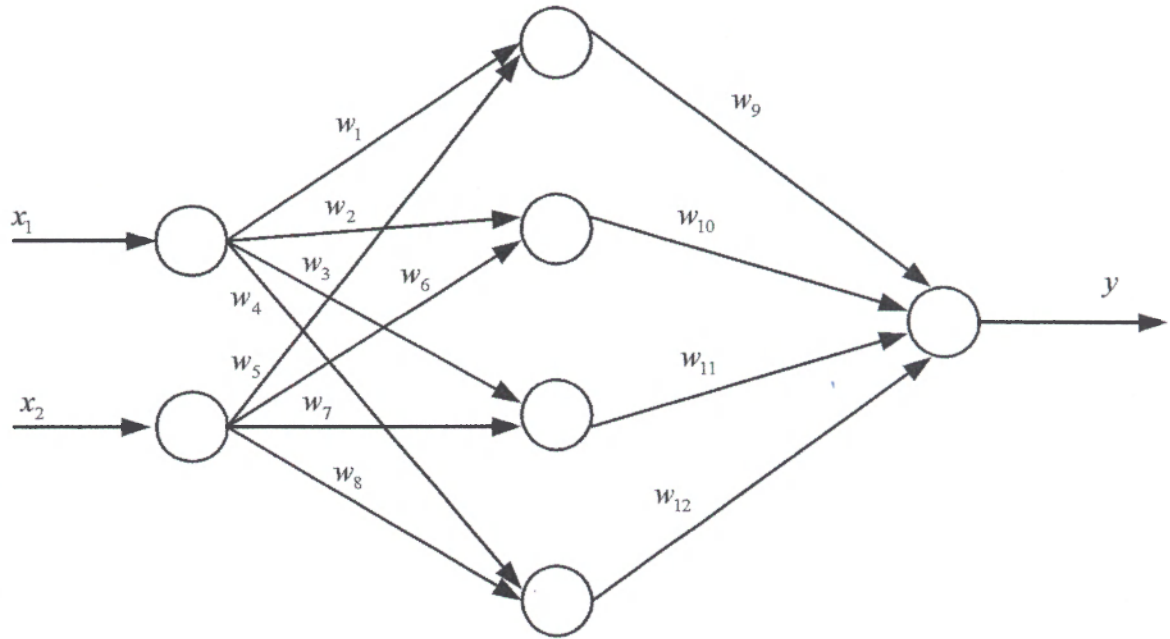| u | | e | | | | | | |
|---|---|---|---|---|---|---|---|---|
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| de | NB | NB | NB | NB | N | Z | P | PB |
| | N | NB | NB | NB | N | PS | P | PB |
| | NS | NB | NB | N | NS | PS | P | PB |
| | Z | NB | N | NS | Z | PS | P | PB |
| | PS | NB | N | NS | PS | P | PB | PB |
| | P | NB | N | NS | P | PB | PB | PB |
| | PB | NB | N | Z | P | PB | PB | PB |



**Figure Q3**

**Figure Q5**