



UNIVERSITI TUN HUSSEIN ONN MALAYSIA

**FINAL EXAMINATION
SEMESTER I
SESSION 2009/10**

SUBJECT NAME : FUZZY CONTROL SYSTEM
SUBJECT CODE : BER 4233
COURSE : 4BER
EXAMINATION DATE : NOVEMBER 2009
DURATION : 2 ½ HOURS
INSTRUCTION : ANSWER 4 (FOUR) QUESTIONS ONLY

THIS PAPER CONSISTS OF 5 PAGES

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- Q1.** (a) List 6 design methodologies of fuzzy controller. (6 marks)
- (b) Draw the block diagram of the fuzzy supervisory controller for intelligent control. (10 marks)
- (c) Explain why input and output variables very important to know in designing fuzzy control system? (4 marks)
- (d) Describe what a neuro fuzzy system? (5 marks)
- Q2.** (a) Draw the fuzzy control system block. (4.5 marks)
- (b) Explain each element definition from Q2 (a). (8 marks)
- (c) Explain why input and output variables very important to know in designing fuzzy control system? (5 marks)
- (d) Explain what is neuro fuzzy system? (7.5 marks)
- Q3.** Calculate the MSE for two iterations of three layers neural network with three neurons in input layer and three neurons in hidden layer and one neuron in output layer. The inputs, target, learning rate and momentum are: $x_1 = 0.4$, $x_2 = -0.1$, $x_3 = -0.2$, $t = 0.1$, $\eta = 0.75$ and $\alpha = 0.5$ respectively. Initial weights value and weight increment (Δw) for all hidden layer neurons are -0.01 and 0 respectively. Initial weights value and weight increment for output layer neuron are 0.02 and 0 respectively. Activation function for hidden and output layer is $f(net) = net$. (25 marks)

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Q4. Fuzzy control system is applied for control the robot arm movement. Fuzzy control system type is MISO and each variable have five membership functions in triangular function. Each membership function names are N (negative), NS (negative small), Z (zero), PS (positive small), and P (positive) respectively. Maximum value of all quantification is 1. Universe discourse related with each variable name as the following:

- Error:
 - N: [-3, -2, -1]
 - NS: [-2, -1, 0]
 - Z: [-2, 0, 2]
 - PS: [0, 1, 2]
 - P: [1, 2, 3]
- Change in error:
 - N: [-6, -4, -2]
 - NS: [-4, -2, 0]
 - Z: [-2, 0, 2]
 - PS: [0, 2, 4]
 - P: [2, 4, 6]
- Output:
 - N: [-3, -2, -1]
 - NS: [-2, -1, 0]
 - Z: [-1, 0, 1]
 - PS: [0, 1, 2]
 - P: [1, 2, 3]

- (a) Create a table of Rule for the system. (10 marks)
- (b) Draw the membership function related for table of Rule Q4 (a). (12 marks)
- (c) Formulate all rules fire related with error is -1.5 and change in error is 4.5 (3 marks)

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- Q5. A fuzzy control system has triangular membership function and three membership functions below are firing:

IF error is zero AND change in error is positive big THEN output is positive

IF error is negative big AND change in error is positive big THEN output is negative big

IF error is negative AND change in error is positive big THEN output is zero

Evaluate implies fuzzy set using minimum criteria and the crisp output signal using centroid of gravity (COG) for change in error is 2.5 and error is -1.5 if universe discourse for zero error is $[-2, 0, 2]$, negative error is $[-3, -1.5, 0]$, negative big error is $[-4, -2.5, -1]$, positive big change in error is $[2.5, 4, 5.5]$, zero output is $[-4, 0, 4]$, positive output is $[2, 4, 6]$, and negative big output is $[-8, -6.5, -5]$.

(25 marks)

- Q6. A multilayer neural network is represented in Figure Q6. The network is trained using Backpropagation learning algorithm with initial condition as below:

$x_1 = 1, x_2 = 1, x_3 = 1, t = 1, \eta = 0.5, \alpha = 0.4, w_1 = 0.01, w_2 = -0.01, w_3 = 0.11,$
 $w_4 = 0.21, w_5 = -0.11, w_6 = -0.2, w_7 = -0.15, w_8 = 0.31, \Delta w_1 = -0.01, \Delta w_2 = 0.01,$
 $\Delta w_3 = 0.11, \Delta w_4 = -0.21, \Delta w_5 = -0.11, \Delta w_6 = 0.2, \Delta w_7 = -0.15, \Delta w_8 = -0.31$

Activation function for hidden and output layer is $f(net) = \frac{1}{1 + e^{-net}}$

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

(21.6 marks)

- (b) Calculate and draw MSE graph

(3.4 marks)

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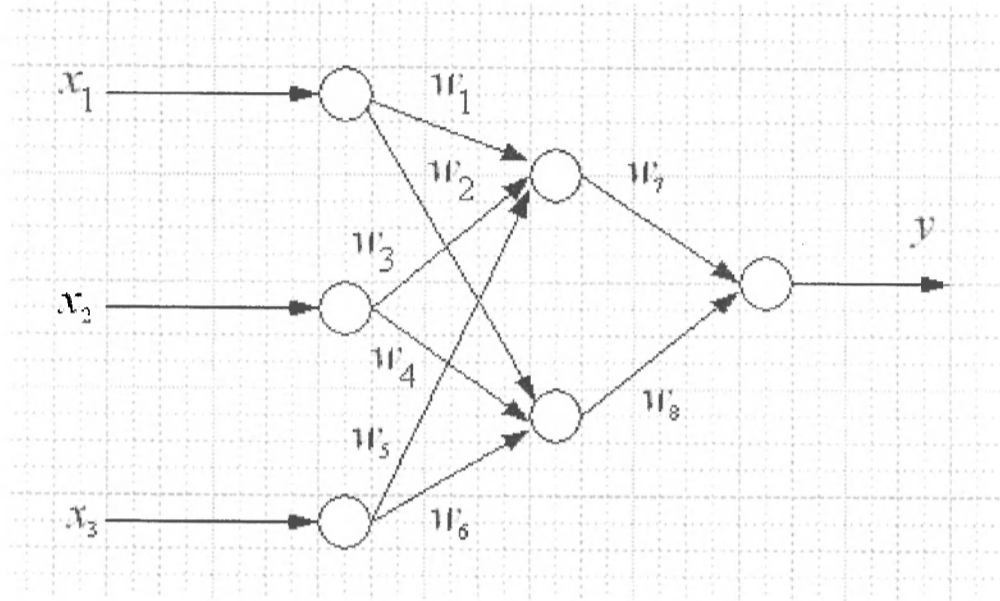


Figure Q6