UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER II
SESSION 2012/2013

COURSE NAME	: FUZZY CONTROL SYSTEM
COURSE CODE	: BER 4233 / BEX 44203
PROGRAMME	: 4 BEE
EXAMINATION DATE	: JUNE 2013
DURATION	: 3 HOURS
INSTRUCTION	: ANSWER **ALL** QUESTIONS

THIS QUESTION PAPER CONSISTS OF **FOUR (4)** PAGES

Q1 Fuzzy control system is applied to control arm robot gripper position through control the input voltage of the motor. Motor has function as an actuator of robot gripper. The type of fuzzy control system is Mamdani. Fuzzy control system has two inputs: error (e) and change in error (Δe), and output is the input voltage of the motor. Error, change in error and input voltage of the motor have same fuzzy sets as in Figure Q1. Rule tabulation of fuzzy control system is represented in Table Q1. If error (e) and change in error (Δe) values are -1.5 and 2.2 respectively:

(a) Create the possible rule fire based on max-max method related with error (e) and change in error (Δe) value

(4 marks)

(b) Evaluate each rule quantification

(24 marks)

(c) Draw the clipping of the rule quantification result

(1 mark)

(d) Evaluate the crisp value of throttle angle using weighted average defuzzyfication

(1 mark)

Q2 A Takagi-Sugeno (T-S) fuzzy model is derived from nonlinear equation below:

$$\begin{cases} \dot{x}_1 = x_2 \\ \dot{x}_2 = x_1^2 + 2x_2^2 + u \end{cases}$$

Assumed that $x_1 \in [0.5, 3.5]$ and $x_2 \in [-1, 4]$, x_1 and x_2 are nonlinear terms in the equations. As a premise, assumed that $x_1 = z_1$ and $x_2 = z_2$. T-S fuzzy model have rules with max method and have fuzzy set Positive, Negative, Small and Big. Evaluate value of $\dot{x}_1$ and $\dot{x}_2$ (defuzzification) for $x_1 = z_1 = 2.75$ and $x_2 = z_2 = 0.25$.

(a) Construct the membership function graph

(5 marks)

(b) Evaluate the quantification based on values of $x_1 = z_1$ and $x_2 = z_2$

(12 marks)

(c) Produce inference based on rule result.

(12 marks)

(d) Produce the defuzzification result.

(1 mark)

Q3 (a) A SDBP neural network is represented in Figure Q3. The initial weights of the networks are: $w_1 = 0.01$, $w_2 = -0.01$ and $w_3 = 0.11$. Activation function for hidden layer and output layer is $f(net) = \frac{1}{1 + e^{-net}}$ with a learning rate (η) at 0.6. Neural network is used to evaluate input $x_1 = 0.2$, $x_2 = 0.3$ and target $t = 0.15$. Evaluate the value of each weight and draw MSE for first iteration.

(20 marks)

(b) Outline the step to implement neural network control.

(5 marks)

Q4 (a) Outline fuzzification, rule base, inference mechanism, and defuzzification.

(4 marks)

(b) Draw block of Adaptive Neuro Fuzzy Inference System (ANFIS).

(1 mark)

(c) Explain six (6) fuzzy inference system considerations related to neuro fuzzy.

(6 marks)

(d) Analyze the program below, explain its mistake and make the correction.

```
1.  load mgdata.dat;
2.  t = mgdata(:,1);
3.  x = mgdata(:,2);
4.  plot(t,x)
5.     for t=118:1117,
6.        Data(t-117,:)=[x(t-18) x(t-12) x(t-6) x(t) x(t+6)];
7.     end
8.  trnData=Data(1:500, :);
9.  chkData=Data(501:end, :);
10. genfis1 = fismat (trnData);
11. plotmf(fismat, 'input')
```

(4 marks)

- END OF QUESTION –