UNIVERSITI TUN HUSSEIN ONN MALAYSIA

FINAL EXAMINATION
SEMESTER I
SESSION 2012/2013

COURSE NAME	:	FUZZY CONTROL SYSTEM
COURSE CODE	:	BEX 44203
PROGRAMME	:	BEE
EXAMINATION DATE	:	JANUARY 2013
DURATION	:	2 HOURS 30 MINUTES
INSTRUCTION	:	ANSWER **FOUR (4)** QUESTIONS ONLY

THIS QUESTION PAPER CONSISTS OF **SEVEN (7)** PAGES

Q1 Fuzzy control system is applied to control a room temperature by controlling the air conditioner compressor. The type of fuzzy control system is Mamdani. Fuzzy control system has two inputs: temperature of the room and target, and output is command in percent of compressor speed. Temperature, target and command have triangular membership function. Temperature and target have five (5) fuzzy sets; they are too-cold, cold, warm, hot and too-hot. Command has fuzzy set are cool, no-change and heat. Rule tabulation and fuzzy sets graph of each variables are represented in Table Q1 and Figure Q1. If temperature and target values are -3.75^{0}C and 8.75^{0}C respectively:

(a) Create the possible rule fire based on min-max method related with temperature and target value.

(4 marks)

(b) Determine each rule quantification.

(18 marks)

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

(1 marks)

(d) Calculate the crisp value of command using COG defuzzyfication.

(2 marks)

Q2 A Sugeno type of MISO fuzzy control system is applied for a cruise control system that is called a fuzzy cruise control system. A fuzzy cruise control system has a function to maintain a constant vehicle speed in spite of neverending changes in road grade, wind resistance, and other variables. The controller does this by comparing the commanded speed with the actual speed. The difference between commanded and actual speed is error. Then, the change in error is the difference in error from one sample period to the next. The speed of the vehicle is controlled through controlling the throttle angle. Error (e) and change in error (de) as input variables have three fuzzy sets, they are Negative, Zero, and Positive respectively. While, throttle angle as output variable has five fuzzy sets, they are Large Negative, Negative, Zero, Positive, and Large Positive. Rule tabulation and fuzzy sets graph of each variables are represented in Table Q2 and Figure Q2. If error (*e*) and change in error (*de*) value are 2.5 and -3.0 respectively:

(a) Create the possible rule fire based on max method related with *e* and *de* value.

(4 marks)

(b) Determine each rule quantification.

(18 marks)

(c) Draw the clipping of the rule quantification result

(1 marks)

(d) Calculate the crisp value of throttle angle using COG defuzzyfication.

(2 marks)

Q3 (a) Draw a fuzzy controller block and briefly explain each element of the block.

(8 marks)

(b) Explain each of fuzzy set operation.

(6 marks)

(c) Differentiate between Mamdani and Sugeno fuzzy type.

(5 marks)

(d) Explain what are Fuzzy Control System (FLC) and its main difference with a conventional control.

(6 marks)

Q4 (a) Differentiate between neural network and computer.

(5 marks)

(b) Compare learning type of neural network.

(5 marks)

(c) Explain what is the meaning of neural network training or learning.

(5 marks)

(d) Explain why neural network must be trained before it is applied to solve a problem.

(5 marks)

(e) Differentiate between neural network and fuzzy logic.

(5 marks)

Q5 Develop weights updating formulation for first iteration of MOBP neural network as shown in Figure Q5. Where η is network learning rate, α is momentum, network weights and weight increments are $w_1, w_2, \cdots, w_{12}$ and $\Delta w_1, \Delta w_2, \cdots, \Delta w_{12}$ respectively. Input variables are $x_1, x_2, \cdots, x_7$ and output variable is y. Learning target is t. Activation functions for hidden layer and output layer neurons are $f(net) = \frac{1}{1+e^{-net}}$, while input layer neurons have linear activation function.

(25 marks)

Q6 (a) A SDBP neural network is represented in Figure Q6. The networks have weights initial values are: $w_1 = 0.01$, $w_2 = -0.01$ and $w_3 = 0.11$. Activation function for hidden and output layer is $f(net) = \frac{1}{1+e^{-net}}$ with learning η is 0.6. Neural network is used to evaluate input $x_1 = 0.2$, $x_2 = 0.3$ and target $t = 0.15$. Determine the value of each weight and draw MSE for first iteration.

(20 marks)

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

(5 marks)

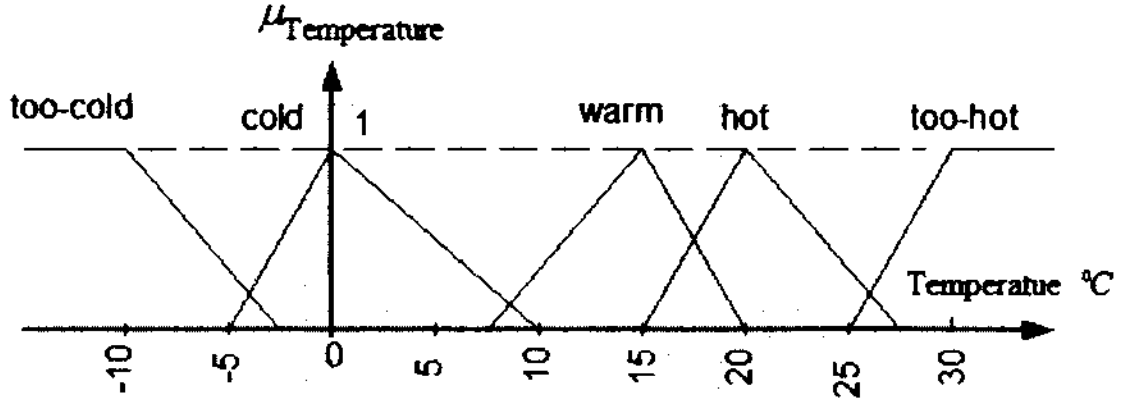
- END OF QUESTION -

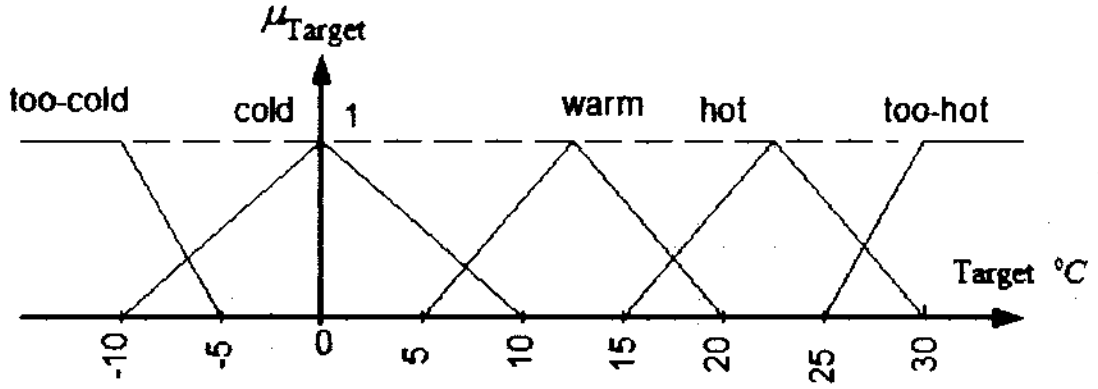
FINAL EXAMINATION

SEMESTER/SESSION	: I / 2012/2013	PROGRAMME	: BEE
COURSE	: FUZZY CONTROL SYSTEM	COURSE CODE	: BEX 44203

Table Q1

Command		Target				
		too-cold	cold	warm	hot	too-hot
Temperature	too-cold	no-change	heat	heat	heat	heat
	cold	cool	no-change	heat	heat	heat
	warm	cool	cool	no-change	heat	heat
	hot	cool	cool	cool	no-change	heat
	too-hot	cool	cool	cool	cool	no-change





FINAL EXAMINATION

SEMESTER/SESSION : I / 2012/2013 PROGRAMME : BEE
COURSE : FUZZY CONTROL SYSTEM COURSE CODE : BEX 44203

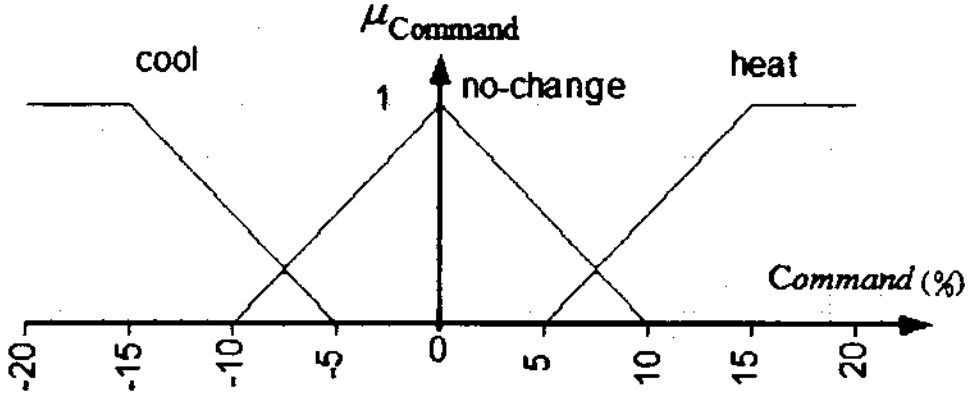
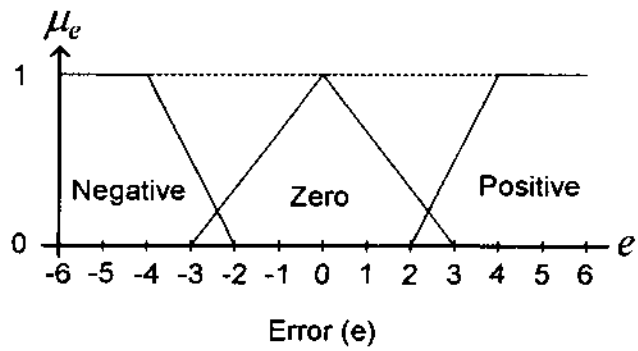


FIGURE Q1

Table Q2

Throttle angle		Change in error (de)		
		Negative	Zero	Positive
Error (e)	Negative	Large Negative	Negative	Zero
	Zero	Negative	Zero	Positive
	Positive	Zero	Positive	Large Positive



FINAL EXAMINATION

SEMESTER/SESSION	: I / 2012/2013	PROGRAMME	: BEE
COURSE	: FUZZY CONTROL SYSTEM	COURSE CODE	: BEX 44203

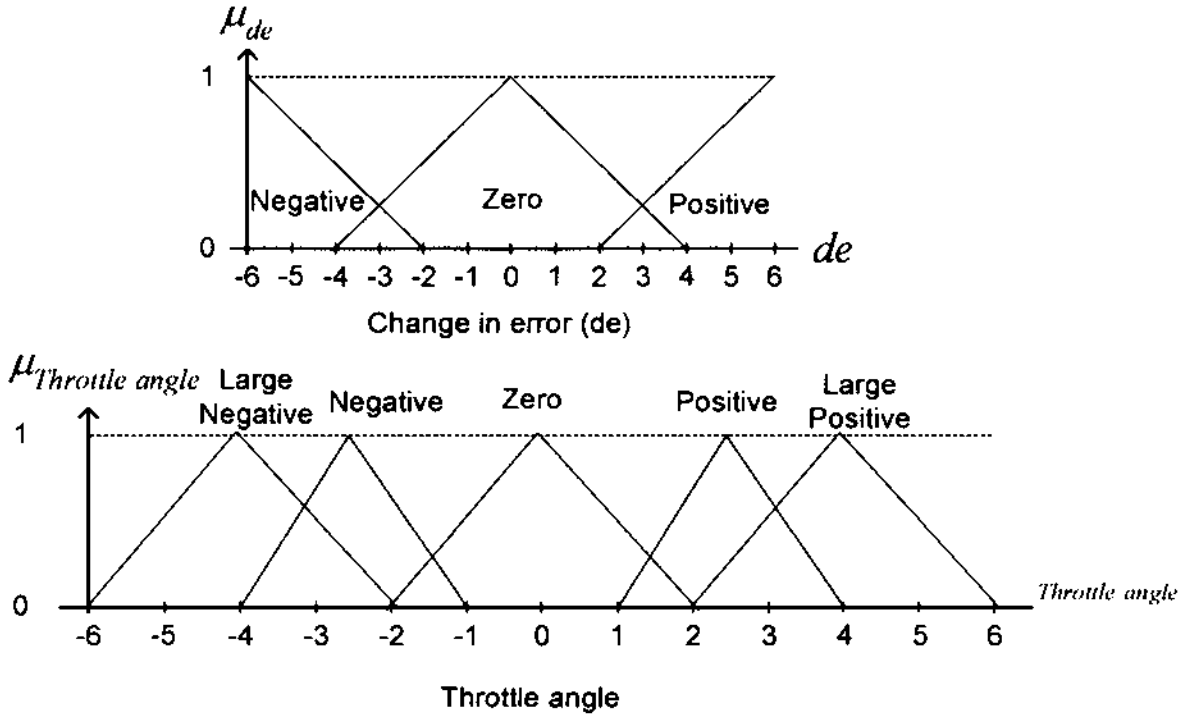


FIGURE Q2

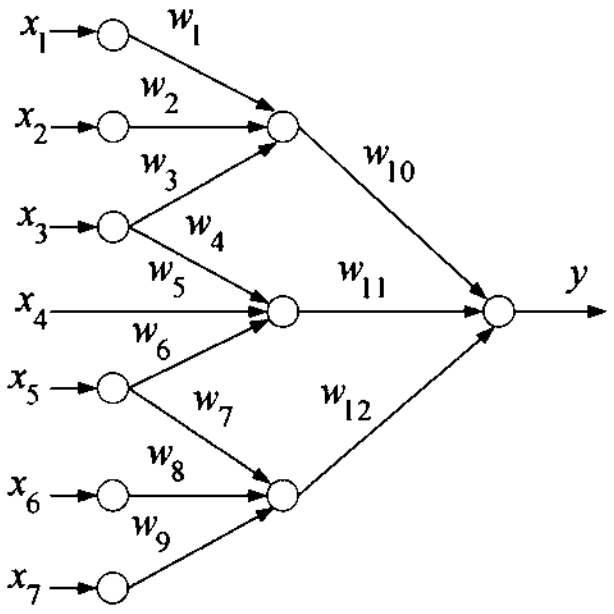


FIGURE Q5

FINAL EXAMINATION

SEMESTER/SESSION	: 1 / 2012/2013	PROGRAMME	: BEE
COURSE	: FUZZY CONTROL SYSTEM	COURSE CODE	: BEX 44203

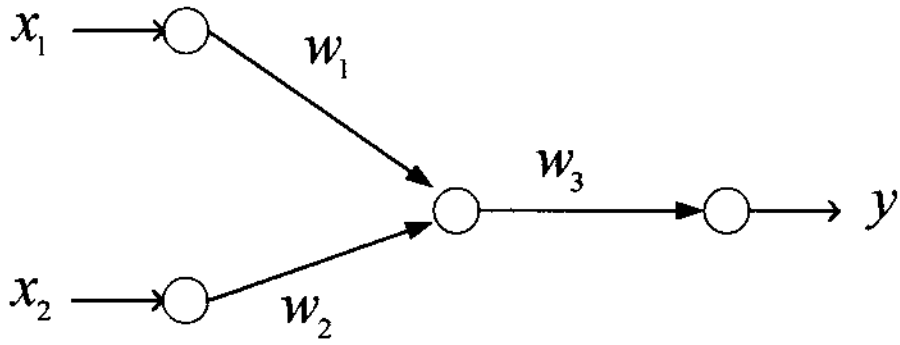


FIGURE Q6