

BITS, Pilani – Dubai
Dubai International Academic City, Dubai

IV Year (EEE/CS/EIE)
First Semester, 2010-2011

Comprehensive Examination

Course No: EA C482
Date: 21.12.2010
Duration: 3 Hours

Course Title: Fuzzy Logic and Applications
Weightage: 40%
Max. Marks: 80

Note: Answer Parts A and B on separate answer books.

Answer the questions (with parts) in the sequential order.
Use graph sheet for PART-A Q3 and Q4(b).

PART – A

1.a) Define the following operations on fuzzy sets: union, intersection, complement and power of a fuzzy set [4M]

b) In computer networking there is an imprecise relationship between the level of use of a network communication bandwidth and latency experienced in peer-to-peer communications. Let X be a fuzzy set of use levels (in terms of the percentage of full bandwidth used) and Y be a fuzzy set of latencies (in milliseconds) with the following membership functions:

$$X = \left\{ \frac{0.2}{10} + \frac{0.5}{20} + \frac{0.8}{40} + \frac{1.0}{60} + \frac{0.6}{80} + \frac{0.1}{100} \right\}, Y = \left\{ \frac{0.3}{0.5} + \frac{0.6}{1} + \frac{0.9}{1.5} + \frac{1.0}{4} + \frac{0.6}{8} + \frac{0.3}{20} \right\}$$

(i) Find the Cartesian product represented by the relation $R = X \times Y$

Now, suppose we have a second fuzzy set of bandwidth usage given by

$$Z = \left\{ \frac{0.3}{10} + \frac{0.6}{20} + \frac{0.7}{40} + \frac{0.9}{60} + \frac{1}{80} + \frac{0.5}{100} \right\}$$

Find $S = Z_{6 \times 6} \circ R_{6 \times 6}$ using

(ii) max-min composition and (iii) max-product composition

[6M]

2. a) Following linguistic terms are defined on the universe $Y = \{1, 2, 3, 4, 5\}$

$$Small = \left\{ \frac{1}{1} + \frac{0.8}{2} + \frac{0.6}{3} + \frac{0.4}{4} + \frac{0.2}{5} \right\}; Large = \left\{ \frac{0.2}{1} + \frac{0.4}{2} + \frac{0.6}{3} + \frac{0.8}{4} + \frac{1}{5} \right\}$$

Obtain the fuzzy sets for the following linguistic terms with hedges

(i) very very small or very very large

(ii) Intensely large

[6M]

b) Write only the expression for multiple conjunctive antecedents and multiple disjunctive antecedents. [4M]

P.T.O

3. Two membership functions A and B are shown below in Figure 3.1. Find the defuzzified output for the logical union of the 2 membership functions. (use graph paper)
 i) Centroid Method (using integration), ii) Weighted Average Method iii) Mean Max Membership Method [10M]

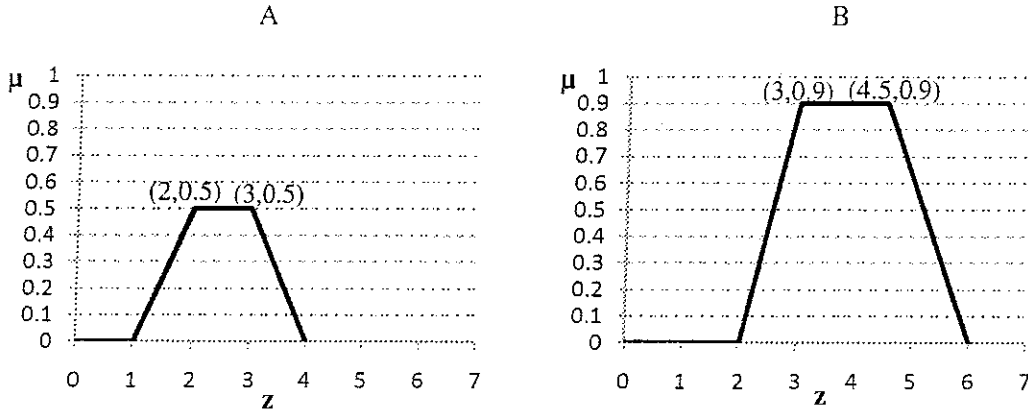


Figure 3.1

4. a) Draw the functional block diagram of fuzzy logic controller. [2M]
 b) A fuzzy cruise controller is used to maintain a vehicle at a desired speed. It consists of two fuzzy inputs, Speed Difference and Acceleration, and one fuzzy output, Throttle Control. The fuzzy sets characterizing Speed Difference, Acceleration, and Throttle Control are shown in Figures 4.1 – 4.3. The Rule Table is shown in Table 4.1. Obtain the induced decision table for Speed Difference = 30 and Acceleration = 80. (use graph paper) [8M]

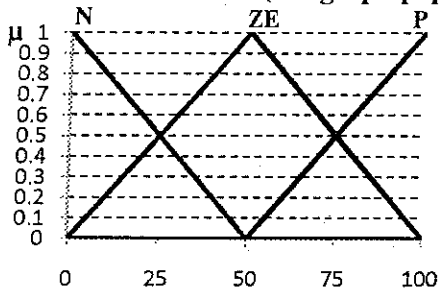


Figure 4.1 Speed Difference

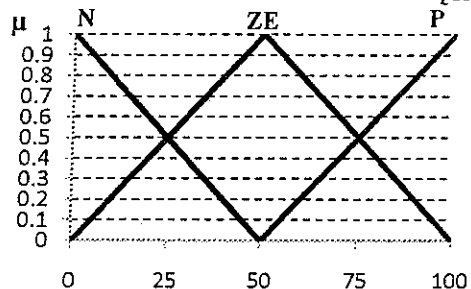


Figure 4.2 Acceleration

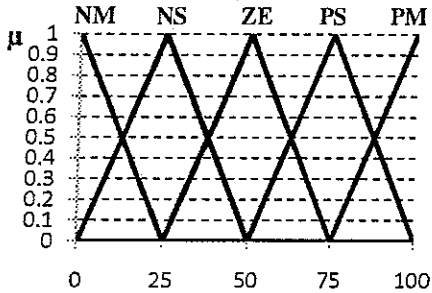


Figure 4.3 Throttle Control

Table 4.1 Rule Table

Acceleration	Speed Difference		
	N	ZE	P
N	PM	PS	PS
ZE	PS	ZE	NS
P	NS	NS	NB

P.T.O

PART – B

1. Explain activation functions of binary step function, binary sigmoid and bipolar sigmoid as per the following formats
 - (i) Name of the activation function
 - (ii) Graphical representation and
 - (iii) Mathematical Equations [3M]

2. Draw the architecture of the following networks
 - (i) Single layer feed forward network and
 - (ii) Multilayer feed forward network [4M]

3. List any three applications of neural networks [3M]

4. A Kohonen self organizing map is shown in Figure 8.1 along with the weights.
 - (i) Using the square of the Euclidean distance, find the cluster unit C_j that is closest to the input vector (0.3, 0.4).
 - (ii) Using a learning rate of 0.3, find the new weights for unit C_j
 - (iii) Find the new weights for C_{j-1} and C_{j+1} , if they are allowed to learn.

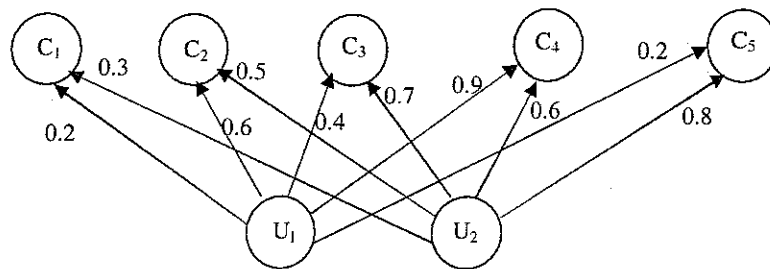


Figure 8.1

[10M]

5. For the back propagation network shown in Figure 9.1, find the new weights when the net in the following figure is given with the input pattern (1,0) and target output is 1. Use a learning rate of $\alpha = 0.3$ and binary sigmoid activation function. Assume Steepness parameter (σ) in sigmoidal activation as 1. (All calculations must be approximated to 4 decimal places.) [20M]

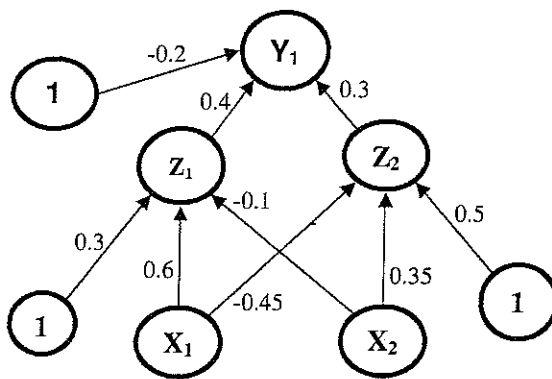


Figure 9.1

$$V_{01} = 0.3 \quad W_{01} = -0.2$$

$$V_{02} = 0.5$$

$$V_{11} = 0.6 \quad W_{11} = 0.4$$

$$V_{21} = -0.1$$

$$V_{12} = -0.45 \quad W_{21} = 0.3$$

$$V_{22} = 0.35$$



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IV Year (EEE/CS/EIE)
First Semester, 2010-2011

Test 2 (Open Book)

Course No: EA C482
Date: 07th Nov 2010
Duration: 50 minutes

Course Title: Fuzzy Logic and Applications
Weightage: 20%
Max. Marks. 40

(Answer the questions in the sequential order)

(Answer all the parts of a question together)

(This question paper has 2 pages and 2 questions. Use Graph Sheet for Q1)

1. A Mamdani type fuzzy logic controller is used for controlling the printer drum which is driven by a brushless DC motor. The fuzzy controller monitors the rotational angle θ (degrees) and the rate of change in rotational angle $\dot{\theta}$ (rad/s) of the printer drum and decides the motor control voltage V (volts), so that the motor can be controlled to run at constant speed or fixed position.

The input fuzzy variables θ and $\dot{\theta}$ are partitioned into 3 fuzzy sets Negative (N), Zero (Z) and Positive (P), whereas the output fuzzy variable has 5 fuzzy sets Negative Big (NB), Negative (N), Zero (Z), Positive (P) and Positive Big (PB), all of which are triangular membership functions with characteristics described below.

For θ $\mu_N = (\theta; -10, -10, 0)$, $\mu_Z = (\theta; -10, 0, 10)$, $\mu_P = (\theta; 0, 10, 10)$

For $\dot{\theta}$ $\mu_N = (\dot{\theta}; -300, -300, 0)$, $\mu_Z = (\dot{\theta}; -300, 0, 300)$, $\mu_P = (\dot{\theta}; 0, 300, 300)$

For V $\mu_{NB} = (V; -20, -20, -10)$, $\mu_N = (V; -20, -10, 0)$, $\mu_Z = (V; -10, 0, 10)$,

$\mu_P = (V; 0, 10, 20)$, $\mu_{PB} = (V; 10, 20, 20)$

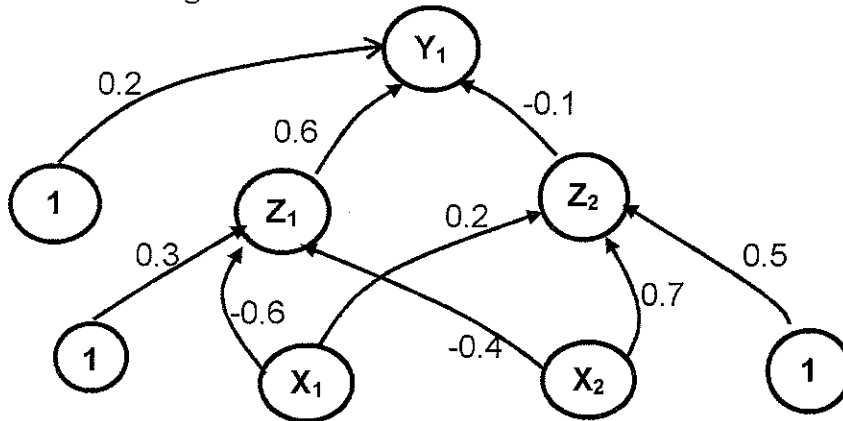
The fuzzy rule base is as follows

	$\dot{\theta}$		
θ	N	Z	P
N	PB	P	N
Z	P	Z	N
P	Z	Z	NB

If the value of rotational angle $\theta = 7.5^\circ$ and rate of change of rotational angle $\dot{\theta} = -120$ rad/s, find the defuzzified value of motor control voltage V , using centroid (integration) method. **[20M]**

P.T.O

2. For the neural network shown in figure below, determine the new weights using back propagation learning algorithm. The input pattern is (1, -1) and the target pattern is -1. Use a learning rate $\alpha = 0.2$. [20M]



$$v_{01} = 0.3, v_{11} = -0.6, v_{12} = 0.2, v_{21} = -0.4, v_{22} = 0.7, v_{02} = 0.5$$

$$w_{01} = 0.2, w_{11} = 0.6, w_{21} = -0.1$$

$$x_1 = 1, x_2 = -1, t = -1$$

$$\alpha = 0.2$$

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BITS, Pilani – Dubai
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IV Year (EEE/CS/EIE)
First Semester, 2010-2011

Test 1 (Closed Book)

Course No: EA C482
Date: 26th Sep 2010
Duration: 50 minutes

Course Title: Fuzzy Logic and Applications
Weightage: 25%
Max. Marks. 50

(Answer the questions in the sequential order)
(Answer all the parts of a question together)
(This question paper has 2 pages and 4 questions)

1. a) Differentiate between classical set and fuzzy set. (Give 2 differences and an example) (4M)
b) Draw the membership function of the following, along with the necessary expressions
i) Triangular Membership Function (4M)
ii) Trapezoidal Membership Function (4M)

2. For the fuzzy sets A, B defined on $U = \{2, 3, 4, 5, 6\}$ as

$$A = \left\{ \frac{0.1}{2} + \frac{0.6}{3} + \frac{0.4}{4} + \frac{0.3}{5} + \frac{0.8}{6} \right\}$$

$$B = \left\{ \frac{0.5}{2} + \frac{0.8}{3} + \frac{0.4}{4} + \frac{0.6}{5} + \frac{0.4}{6} \right\}$$

Find the following

- a) Complement of A, Complement of B (2M)
 - b) $A \cup B$, $A \cap B$ (2M+2M)
 - c) Difference $A - B$ and $B - A$ (2M+2M)
 - d) Verify De Morgan's Law $(A \cup B)' = A' \cap B'$ (2M)
3. The three variables of interest in MOSFET are the amount of current that can be switched, the voltage that can be switched and the cost. The following membership functions for the transistor was developed

$$\text{Current}(I) = \left\{ \frac{0.4}{0.8} + \frac{0.7}{0.9} + \frac{1}{1} + \frac{0.8}{1.1} + \frac{0.6}{1.2} \right\}$$

$$\text{Voltage}(V) = \left\{ \frac{0.2}{30} + \frac{0.8}{45} + \frac{1}{60} + \frac{0.9}{75} + \frac{0.7}{90} \right\}$$

$$\text{Cost}(C) = \left\{ \frac{0.4}{0.5} + \frac{1}{0.6} + \frac{0.5}{0.7} \right\}$$

P.T.O

- a) Find the Cartesian product $P = V \times I$ (3M)
- b) Find the Cartesian product $T = I \times C$ (3M)
- c) Using the max-min composition find $E = P \circ T$ (3M)
- d) Using the max-product composition find $E = P \circ T$ (3M)

4. a) Plot the fuzzy triangular membership functions for linguistic variable “Weight of people”(w), whose ranges are given below (5M)

- Very Light - $0 \leq w \leq 30$
- Light - $30 \leq w \leq 40$
- Average - $40 \leq w \leq 50$
- Heavy - $50 \leq w \leq 60$
- Very Heavy - $60 \leq w \leq 70$

b) Using your intuition and knowledge how you will introduce overlapping in the membership functions for the above problem. Draw necessary diagram for overlapping and also mention the ranges. (5M)

c) Consider linguistic variable defined by

$$\mu_{Old}(x) = \begin{cases} 0 & 0 \leq x < 50 \\ \left[1 + \frac{x-50}{5}\right]^{-2} & 50 \leq x \leq 100 \end{cases}$$

Form the fuzzy set representation for linguistic variable “Old”. Suppose the above term is modified with hedge “Very”, then find the new fuzzy set for the modified linguistic variable “Very Old”. Use increments of 10 for x. (2M+2M)



BITS, PILANI – DUBAI
FIRST SEMESTER 2010 – 2011
FOURTH YEAR (EEE/CS/EIE)
QUIZ 2

A

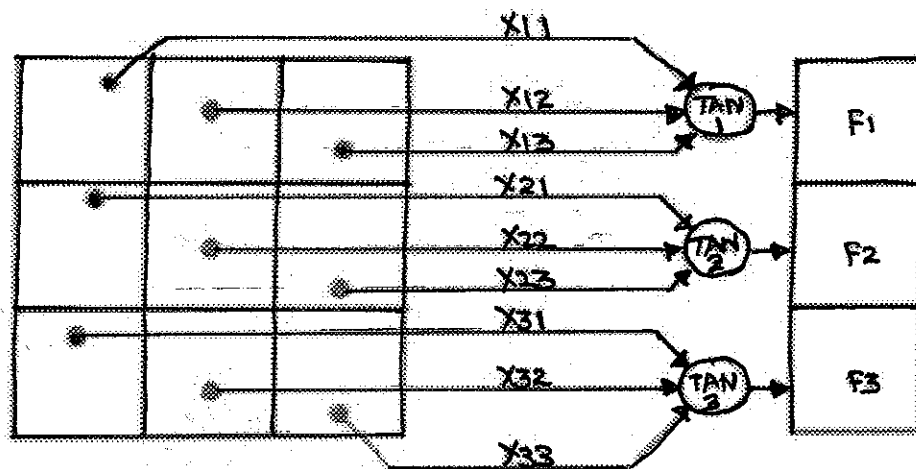
Course Code: EA C482
 Course Title: Fuzzy Logic and Applications
 Duration: 20 minutes

Date: 29.11.10
 Max Marks: 14
 Weightage: 7%

Name: ID No: Sec / Prog:

Instructions: Write your answers in the blank space provided after each question. You may use the reverse side if necessary.

1. The neural network shown in figure is [1M]



- (a) a single layer feed-forward neural network
- (b) a Back propagation neural network
- (c) a BAM neural network

Ans :

2. Which of the following is true for ANN? [1M]
 (i) On average, neural networks have higher computational rates than conventional computers
 (ii) Neural networks learn by example
 (iii) Neural networks mimic the way the human brain works

- (a) Both (i) and (ii) are true
- (b) Both (ii) and (iii) are true
- (c) All of them are true

Ans :

3. Which of the following is true for ANN? [1M]
 (i) The training time depends on the size of the network.
 (ii) Neural networks can be simulated on a conventional computer..
 (iii) Artificial neurons are identical in operation to biological ones.

- (a) All of them are true.
- (b) Only (ii) is true.
- (c) Both (i) and (ii) are true.

Ans :

4. What are the advantages of ANN over conventional computers? [1M]
(i) They have the ability to learn by example
(ii) They are more fault tolerant
(iii) They are more suited for real time operation due to their high computational rates

- (a) Both (i) and (ii) are true
(b) Both (i) and (iii) are true
(c) All of them are true

Ans :

5. What is the significance of using learning rate and momentum factor in a back propagation neural network? [2M]

6. List out any 4 activation functions used in neural networks. [2M]

7. How to select the number of nodes in a hidden layer for a back propagation NN? (Write only key point) [2M]

8. Explain in brief about global minima and local minima in a back propagation NN? [2M]

9. Differentiate between supervised and unsupervised learning in ANN? [2M]



BITS, PILANI – DUBAI
FIRST SEMESTER 2010 – 2011
FOURTH YEAR (EEE/CS/EIE)
QUIZ 1

A

Course Code: EA C482
Course Title: Fuzzy Logic and Applications
Duration: 20 minutes

Date: 18.10.10
Max Marks: 16
Weightage: 8%

Name: ID No: Sec / Prog:

Instructions: Write your answers in the blank space provided after each question. You may use the reverse side if necessary.

1. Assume that the concept of 'young' is represented by a fuzzy set **Young** whose membership function is given by **Young = FuzzyTrapeziod[0, 0, 25, 40]**. The concept of **Old** is represented by a fuzzy set **Old = FuzzyTrapeziod[50, 65, 100, 100]**. Sketch the graphical representation of fuzzy set representing the concept of **Middle-Ages** which is defined as **neither young nor old**. Assume Universe of discourse of Age is [0,100] [3M]

2. What are the 2 types of Fuzzy Inference Systems? **(OBJECTIVE TYPE)** [1M]
- a. Model-Type and System-Type
 - b. Momfred-Type and Semigi-Type
 - c. Mamdani-Type and Sugeno-Type
 - d. Mihni-Type and Sujgani-Type
- Ans :

3. What is Fuzzy Inference System? **(OBJECTIVE TYPE)** [1M]
- a. The process of formulating the mapping from a given input to an output using fuzzy logic.
 - b. Changing the output value to match the input value to give it an equal balance
 - c. Having a larger output value than the input.
 - d. Having a smaller output value that the input.
- Ans :

4. What is another name for Fuzzy Inference System? **(OBJECTIVE TYPE)** [1M]
- a. Fuzzy Expert System
 - b. Fuzzy Modeling
 - c. Fuzzy Controller.
 - d. All of the above.
- Ans :

P.T.O

5. What is the purpose of aggregation? **(OBJECTIVE TYPE)** [1M]
- a. To gather all the different fuzzy sets outputs and combine them into a single fuzzy set outputs
 - b. To gather all the possible inputs and use the average to gain an output
 - c. To gather all the different fuzzy sets outputs and average them out to get a single value.
 - d. To subtract all the output fuzzy set values from the input values. **Ans :**

6. Differentiate between Mamdani and Sugeno FLCs? **(2 Key differences)** [2M]

7. Differentiate between conventional controller and fuzzy controller? **(2 Key differences)** [2M]

8. Differentiate between PI like and PD like FLCs? **(2 Key differences)** [2M]

9. Write **any 2** methods employed for the membership value assignment to fuzzy variables? [1M]

10. For the given fuzzy set A on the Universe of discourse $X = [0, 5]$, with membership function $\mu_A(x) = \frac{2x}{x+5}$, find the value of x for the crossover point? [2M]

