

BITS, Pilani – Dubai
Dubai International Academic City, Dubai

IV Year (ALL)
Second Semester, 2009-2010

Comprehensive Examination

Course No: EA C482
Date: 19nd May 2010
Duration: 3 Hours

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

(Answer Parts A and B on separate answer books.)

(Answer the questions in the sequential order.)

(Answer all the parts of a question together.)

PART – A

1. In the speed control of a DC shunt motor system the Series Resistance R_{se} , Armature Current (I_a) and Speed (N) are expressed in terms of fuzzy sets given below. Find the relation between Resistance (R_{se}) and Speed (N) using relations computed in part a and part b, using max-product composition. **[4M]**

$$R_{se} = \{0.3/30 + 0.7/60 + 1/100 + 0.2/120\}$$

$$I_a = \{0.4/40 + 0.6/60 + 1.0/80 + 0.5/100\} \text{ and}$$

$$N = \{0.2/500 + 0.6/1000 + 1.0/1500 + 0.1/1800\}$$

a) Find the Fuzzy Cartesian product (R) of the Series Resistance (R_{se}) and Armature Current (I_a) **[4M]**

b) Find the Fuzzy Cartesian product (S) of the Armature Current (I_a) and Speed (N) **[4M]**

2. A BAM network (with bipolar input vectors and bipolar target codes) is used to recognize two letters A and C represented using a 5x3 grid. (* represents 1 and empty space -1)

	*	
*		*
*	*	*
*		*
*		*

	*	*
*		
*		
*		
	*	*

(a) Letter A \rightarrow target code (-1, 1)

(b) Letter C \rightarrow target code (1, 1)

a) Find the total weight matrix **[4M]**

b) Obtain the response of the net with A and C as the input. **[4M]**

c) Test the response of the net when it is presented with an noisy version of target code [0 1] **[4M]**

3. a) Outline the steps involved in the Hebb Learning Algorithm for ANN. [4M]
 b) Determine the weights and bias to classify the 2-dimensional input patterns (letters 'E' and 'F') represented in a 3x3 grid using the Hebb algorithm. Assume bipolar inputs and targets, with initial weights and bias as 0 (zero). [4M]
 c) Also draw the diagram for the neural network, for the given input pattern along with the weights. [2M]

(a)

*	*	*
*	*	
*	*	*

(b)

*	*	*
*	*	
*		

(a) Letter E → target code (1)

(b) Letter F → target code (-1)

(* represent 1 and empty space -1)

PART – B

4. a) A process control systems involves the monitoring of two linguistic parameters temperature (range from 134 to 138 F) and pressure (400 to 900 psi). The parameters are characterized by linguistic values having the following membership functions

i) High Temperature = { 0/134 + 0.4/135 + 0.6/136 + 0.8/137 + 1.0/138 }

ii) High Pressure = { 0/400 + 0.2/600 + 0.4/700 + 0.6/800 + 1.0/900 }

Find the membership functions for the following

i) Very Very High Temperature

ii) Dilation of High Temperature.

iii) Intensification of High Pressure.

[3x2M]

- b) For the fuzzy sets A, B, C defined on $U = \{ 1, 2, 3, 4, 5, 6 \}$ as

$A = \{ 0.1/1 + 0.3/2 + 0.5/3 + 0.6/4 + 0.4/5 + 0.2/6 \}$

$B = \{ 0.2/2 + 0.6/3 + 0.8/4 + 0.9/5 + 0.95/6 \}$

$C = \{ 0.9/1 + 0.8/2 + 0.7/3 + 0.4/4 + 0.5/5 \}$

Verify that the following properties hold

i) Distributive law (any one)

ii) Identity Law (for fuzzy set A only)

[4M]

[2M]

5. Develop an ADALINE network to realize the OR Boolean function (as shown in the truth table below) using bipolar inputs and bipolar targets. The initial value of weights w_1 , w_2 and bias are 0 (zero), and the learning parameter α is 0.2

x_1	x_2	Target (t)
1	1	1
1	-1	1
-1	1	1
-1	-1	-1

- a) Find the total error in the first epoch, using the inputs in the same order as shown in the truth table. [8M]

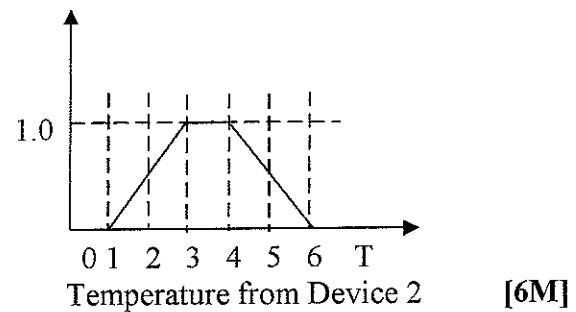
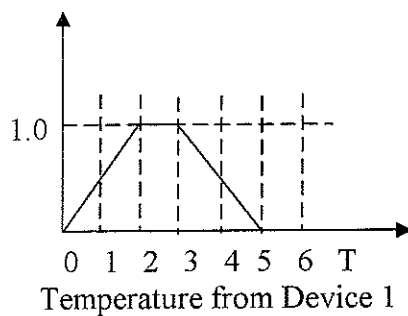
- b) The weights w_1 , w_2 and bias values after 6th epoch are 0.57, 0.64, and 0.50. Find the LMS error. [4M]

6. a) The mass (m) of an object is divided into 3 fuzzy sets Small Mass, Medium Mass and Large Mass. The Universe of Discourse of mass (m) is 0-500 kg. Triangular membership functions are used to represent the fuzzy sets Small, Medium and Large. The range of Small is 0-250 with membership value of 1 at 200kg, the range of Medium is 200-300 with a membership value of 1 at 250kg and the range of Large is 250-500 with membership value of 1 at 300kg respectively.

i) Draw the membership function diagram representing the fuzzy sets Small, Medium and Large [3M]

ii) Find the fuzzified value at a crisp value of 260 kg in the membership diagram [3M]

b) Due to the imprecise nature of measurement devices, the measured data will not be identical. To obtain the accurate value of the measured variable it is decided to take the union of the outputs and employ defuzzification method (Center of Sums). Shown below is the temperature output obtained from two such measurement devices. Find the defuzzified value of the temperature



7. Compare the Biological and Artificial Neural network based on the following aspects

a) Speed b) Processing c) Fault Tolerance d) Information storage e) Energy efficiency

[5 * 2M = 10]



BITS, Pilani – Dubai
Dubai International Academic City, Dubai

IV Year (ALL)
Second Semester, 2009-2010

Test 2 (Open Book)

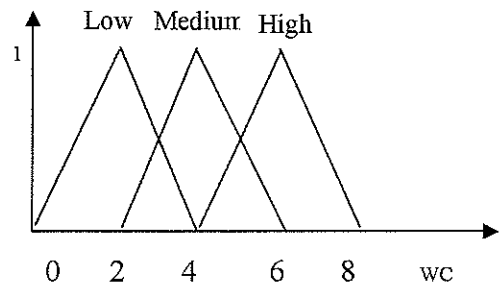
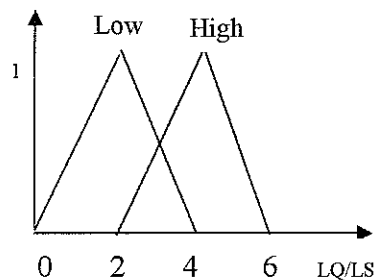
Course No: EA C482
Date: 08st Apr 2010
Duration: 50 minutes

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)

1. Consider a fuzzy logic based washing machine, which selects the Washing Cycle (WC) based on the Laundry Quantity (LQ) and Laundry Softness (LS).

The LQ and LS are fuzzy inputs, each of which is characterized by 2 triangular fuzzy sets viz. Low and High. The fuzzy output WC is characterized by 3 triangular fuzzy sets viz. Low, Medium and High



The fuzzy rule base is as follows

- i) if LQ is Low and LS is Low then WC is Low
- ii) if LQ is Low and LS is High then WC is Medium
- iii) if LQ is High and LS is Low then WC is Medium
- iv) if LQ is High and LS is High then WC is High

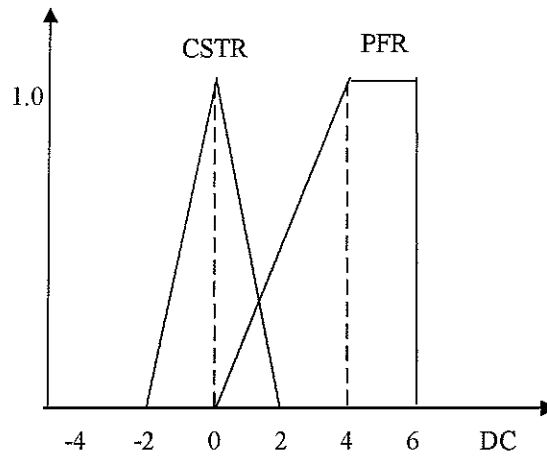
If the LQ is 2.3 and LS is 5.6, obtain the defuzzified value of the WC. (use max-min method for inference and Mean of Maxima method for defuzzification).

[15 Marks]

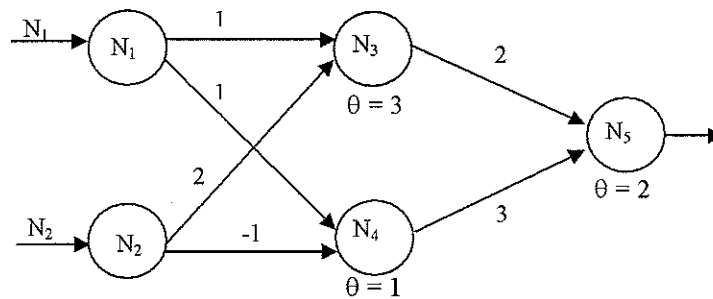
2. The difference in concentrations (DC) of inlet and outlet streams of CSTR and PFR are given with the membership values and show in the figure below. Find the most representative value (defuzzified value) for the union of CSTR and PFR (which has both the characteristics of CSTR and PFR for the fluidized bed design), using centroid method.

[10 Marks]

P.T.O



3. For 2 inputs x_1 and x_2 , realize the function $y = (x_1 \text{ AND } (\text{NOT } x_2))$ using the McCulloch-Pitt's neuron model. Initialization of weights and threshold values are to be chosen so that the neuron realizes the function. **[5 Marks]**
4. For the neural network shown McCulloch-Pitt net shown in figure.



- a) Define the response of neuron N_5 at time t in terms of the activations of the input neurons, N_1 and N_2 at the appropriate times. **[5 Marks]**
- b) Show the activation of N_5 at time $t=0$ that results from the input signal of $N_1 = 1$ and $N_2 = 0$. **[5 Marks]**
- (Assume that the firing of the neurons will take place at intervals of $t-2, t-1, t$)

♣ ♣ ♣ ♣ ♣

BITS, Pilani – Dubai
Dubai International Academic City, Dubai

IV Year (ALL)
Second Semester, 2009-2010

Test 1 (Closed Book)

Course No: EA C482
Date: 21st Feb 2010
Duration: 50 minutes

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

(Answer the questions in the sequential order)
(Answer all the parts of a question together)

1. For the fuzzy set A defined on $U = \{1, 2, 3, 4, 5, 6\}$ as
 $A = 0/1 + 0.1/2 + 0.35/3 + 0.4/4 + 0.55/5 + 0.6/6$,
 - a) Find the α -cut decomposition of A (2.0 marks)
 - b) Find the Fuzzy Cardinality of A (2.0 marks)
 - c) Find the Scalar Cardinality of A (1.0 marks)

2. For the fuzzy set A, B defined on $U = \{2, 3, 4, 5\}$ as
 $A = 1/2 + 0.5/3 + 0.3/4 + 0.2/5$, $B = 0.5/2 + 0.7/3 + 0.2/4 + 0.4/5$
Find the following
 - a) Complement of A, Complement of B (2.0 marks)
 - b) $A \cup B$ (2.0 marks)
 - c) $A \cap B$ (2.0 marks)
 - d) Difference $A - B$ and $B - A$ (2.0 marks)
 - e) Verify De Morgan's Law $(A \cap B)' = A' \cup B'$ (2.0 marks)

3. The relationship R between temperature and maximum operating frequency depends on various factors for a given electronic circuit. Let T be a temperature fuzzy set (in °F) and F represent frequency fuzzy set (in MHz) on the following universes of discourse.
 $T = \{-50, 0, 50\}$ and $F = \{8, 16, 25, 33\}$
The fuzzy Cartesian product of T and F results in the following relation R.

R	-50	0	50
8	0.2	0.7	1.0
16	0.4	0.7	0.8
25	0.6	0.8	0.6
33	0.9	0.8	0.4

P.T.O

The reliability of the electronic circuit is related to the maximum operating temperature and is expressed using a relation S which is the Cartesian product of Temperature T and Reliability Index $M = \{1, 2, 4\}$.

S	1	2	4
-50	1	0.8	0.6
0	0.7	1	0.7
50	0.5	0.6	1

Find the relationship between Frequency F and Reliability Index M , using

a) max-min composition (3.0 marks)

b) max-product composition (3.0 marks)

c) max-average composition (4.0 marks)

(Write the expression for each type of composition with at least 1 solution step.)



BITS, PILANI – DUBAI
SECOND SEMESTER 2009 – 2010
FOURTH YEAR
QUIZ 2

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

Date: 04.05.10
Max Marks: 14
Weightage: 7%

Name: ID No: Sec / Prog:

Instructions: Write your answers in the blank space provided after each question..

1) Give the weight updation rule for MADALINE Neural network. **[2 M]**

2) If the net input to an output neuron is 0.64, calculate its output when the activation function is a) binary sigmoidal b) bipolar sigmoidal **[1M + 1M]**

3) Identify the type of learning adopted in
a) Perceptron NN **[1M]**

b) Hebb NN **[1M]**

[PTO]

4) A single layer 2 input 1 output perceptron neural network, with bipolar inputs, and bipolar output, is used to realise the boolean AND function. The weights w_1 , w_2 and bias are 1, 1, 1 respectively.

a) Draw the decision boundary diagram, showing the equation of the boundary. [1M]

b) Discuss on linear separability for part-a [2M]

5) For a single layer NN with binary inputs, bipolar targets, without bias and threshold value = 0.

a) Will the network converge? [1M]

b) Justify the answer in part -a in a sentence or two [1M]

[PTO]

6) A BAM network (with bipolar input vectors and bipolar target codes) is used to recognize two letters L and C represented using a 3x2 grid. Find the total information stored in the synapses with 2 inputs [3M]

(a)		(b)	
*		*	*
*		*	
*	*	*	*

(a) Letter L \rightarrow target code (-1, 1)

(b) Letter C \rightarrow target code (1, 1)



BITS, PILANI – DUBAI
SECOND SEMESTER 2009 – 2010
FOURTH YEAR
QUIZ 1

Version A

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

Date: 10.03.10
Max Marks: 16
Weightage: 8%

Name: **ID No:** **Sec / Prog:**

Instructions: Write your answers in the blank space provided after each question..

1. R is a fuzzy relation on $U \times V$ where $U = \{a, b, c\}$, $V = \{p, q, r\}$. Draw the Sagittal diagram for the relation R.

	p	q	r
a	1.0	0.4	0.5
b	0.3	0.0	0.7
c	0.6	0.8	0.2

[2 mark]

2. R is a BFR on U, where $U = \{1, 2, 3, 4\}$.

	0.3	0.3	0.5	1.0
R =	0.4	1.0	0.1	0.6
	0.5	0.4	0.9	0.4
	0.8	0.7	0.2	0.4

- a. Write any one membership grade $R(x,y)$ which satisfies the reflexive property.
[1 marks]

- b. Write any one membership grade $R(x,y)$ which satisfies the symmetric property..
[1 marks]

[PTO]

3. List down all the possible projections and the corresponding domains of a Ternary Fuzzy Relation T on $A \times B \times C$

[2 marks]

4. R, a BFR on $U \times V$, where $U = \{ a, b \}$ and $V = \{ x, y, z \}$, is given by
 $R = 0.5/(a, x) + 0.1/(a, y) + 0.9/(a, z) + 0.3/(b, x) + 0.8/(b, y) + 0.2/(b, z)$
Find projections R_1 and R_2

[1.0 + 1.0 mark]

5. For a fuzzy relation R on $U \times V \times W \times X$, write the expression for projection R_{234}

[2 mark]

6. For a fuzzy relation R on $U \times V \times W \times X$, write the expression for cylindrical extension R_{23} ¹⁴

[2 mark]

[PTO]

7. For a fuzzy relation R on $U \times V \times W \times X$, write the expression for cylindrical closure of the projections R_1 , R_{23} , R_{134} [2 marks]

8. Find out whether the given relation R on $U = \{a, b, c\}$ satisfies transitive property.

$$R = \begin{matrix} & 0.2 & 0.5 & 0.4 \\ \begin{matrix} a \\ b \\ c \end{matrix} & \begin{pmatrix} 0.0 & 0.5 & 0.3 \\ 0.0 & 0.5 & 0.4 \end{pmatrix} \end{matrix}$$

[2 mark]

