Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY

MANIPAL

(A constituent unit of MAHE, Manipal)

SECOND SEMESTER M.TECH. (OE) DEGREE END SEMESTER EXAMINATION

JUNE 2019

SUBJECT: NEURAL NETWORKS AND FUZZY LOGIC (ECE - 5248)

TIME: 3 HOURS **MAX. MARKS: 50**

Instructions to candidates

- Answer **ALL** questions.
- Missing data may be suitably assumed.

1A. The weight matrix of the spatio temporal memory is given by:

$$W^t = \begin{bmatrix} -1 & 3 & -1 & -1 & -1 \\ -1 & -1 & -1 & -1 & 3 \\ -1 & -1 & 3 & -1 & -1 \\ -1 & 3 & -1 & -1 & -1 \\ 3 & -1 & -1 & 3 & 1 \end{bmatrix}$$

Knowing that a vector $s^{1t} = [-1 \quad 1 \quad -1 \quad -1 \quad 1]$ belongs to a sequence, find the remaining vectors of the sequence.

1B. A network with 2 linear neurons with λ=1 responds with outputs 0.9 and 0.1 respectively. Find the input vector. The weight vector, $W^t = \begin{bmatrix} 0.5 & -0.8 \\ 1 & 0.2 \end{bmatrix}$.

1C. Perform 2 steps of Hebbian learning rule for the following training dataset:

$$X_1 = \begin{bmatrix} 1 \\ 0.5 \end{bmatrix}, X_2 = \begin{bmatrix} -1 \\ 0.5 \end{bmatrix},$$

The initial weight vector is $W^{1t} = [1 \quad -1]$ and c=0.5. Use unipolar discrete neurons.

(5+3+2)

2A. It is required to simulate the non-linear function $y = x^2$ using back propagation algorithm. Perform one step back propagation by considering 2 unipolar continuous neurons in the first layer and one linear neuron in the second layer with an input of x=0.5. Assume the initial weights to be one in both layers. Take η , λ =1 and augmented input to be equal to -1.

2B. Perform two steps of delta learning rule on the following dataset:

$$\left(\mathbf{x}_1 = \begin{bmatrix} 2 \\ 0 \\ -1 \end{bmatrix}, \quad d_1 = -1 \right), \quad \left(\mathbf{x}_2 = \begin{bmatrix} 1 \\ -2 \\ -1 \end{bmatrix}, \quad d_2 = 1 \right)$$

The initial weight is $W^t = [1 \quad 0 \quad 1]$. Assume η=λ=0.5. Use bipolar continuous neurons.

2C. i) Show whether the Yager fuzzy complement is involutive (Hint: if c[c (a)]=a for all a ϵ [0, 1]

ii) Determine the equilibrium of Sugeno fuzzy complement (Hint: Equilibrium is defined as c (a)=a for all a ϵ [0, 1]]

(5+3+2)

3A. The initial weight matrix of a Kohenen's feature map is given by:

$$W^t = \begin{bmatrix} 1 & 0.1 & 0.5 \\ 0.1 & 0.8 & 0.3 \\ 0.7 & 0.5 & 0.2 \\ 0.3 & 0.1 & 0.7 \\ 0.3 & 0.5 & 1 \end{bmatrix}$$

Perform one step training for the input x1 = $[0.3\ 1\ 0.8]^t$. Assume α=0.5, R=1. Use Euclidian distance metric for winner selection**.**

3B. Find whether the following form an associated class or not:

i) Einstein sum, Einstein product and Yager complement.

ii) Max, min and Sugeno complement.

3C. For the classifier models M1 and M2, Compute the precision and percentage accuracy.

Model M_1	PREDICTED CLASS		
		+	-
ACTUAL CLASS	+	150	40
	-	60	250

Model M_2	PREDICTED CLASS		
		+	-
ACTUAL CLASS	+	250	45
	-	5	200

(5+3+2)

4A. i) Consider the following fuzzy relation defined on U1×U2×U3 where U1 = {a, b, c}, U2={s, t}

U3={x, y}:

$$Q = 0.3/b,t,x + 0.01/a,s,x + 1/b,s,y + 0.9/b,t,y + 0.4/a,t,y + 0.6/c,s,y$$

Compute the projections of Q on U1×U3. Also Compute the cylindrical extension of the projections to U1×U2×U3 and prove that $Q \subseteq Q_E$

ii) Given two fuzzy sets

$$A = \left(\frac{1}{0} + \frac{0.5}{1} + \frac{0.1}{2} + \frac{0.5}{3} + \frac{0.1}{4}\right)\ B = \left(\frac{0.2}{0} + \frac{0.4}{1} + \frac{1}{2} + \frac{0.6}{3} + \frac{0.2}{4}\right)$$

Use modus tollens to determine A' by considering Mamadani min implication for A→B and interpret your result with B' =very very B.

4B. With the help of flowchart, briefly explain the various steps involved in implementing Genetic Algorithm.

4C. Consider the following fuzzy relations:

$$Q1 = \begin{pmatrix} 0.2 & 1 & 1 \\ 0.8 & 0.5 & 0.6 \\ 0.7 & 1 & 0.3 \end{pmatrix}\ Q2 = \begin{pmatrix} 1 & 1 & 0.8 \\ 0.5 & 0.1 & 0.7 \\ 0.9 & 0.04 & 0.2 \end{pmatrix}$$

Perform Q1 o Q2 by max-min composition.

(5+3+2)

5A. Design a simple fuzzy rule based system to simulate a non-linear function Y=Sin X, where *X* is defined in the universe [-90 90] and *Y* is defined in the universe [-1 1]. Use Mamadani minimum implication with min for t-norm operator and max for s-norm operator. Use centre average defuzzifier and test by applying the following fuzzy singletons: *X* = 0, 45 and -90.

5B. The confusion matrix for a classifier is shown in **Fig. 5B**. Determine sensitivity, specificity Precision, Recall, F-measure and accuracy for the classifier.

5C. Determine Fuzzy AND with p = 0.5, given that the fuzzy set $A = \frac{1}{1} + \frac{0.3}{2} + \frac{0.6}{3} + \frac{0.8}{4} + \frac{0.1}{5}$ and $B = \frac{0.2}{1} + \frac{0.5}{2} + \frac{0.7}{3} + \frac{0.9}{4} + \frac{1}{5}$

(5+3+2)

		Predicted class	
		POSITIVE	**NEGATIVE**
Actual class	**TRUE**	**180 (a)**	**30 (b)**
	FALSE	**20 (c)**	**170 (d)**

Fig. 5B