Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY
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SIXTH SEMESTER B.TECH (E & C) DEGREE END SEMESTER EXAMINATION – April/May 2017
SUBJECT: SOFT COMPUTING TECHNIQUES (ECE - 4033)

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

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

1A. It is required to approximate a nonlinear function $y = x^2$ by using a 2-layer perceptron network. Train the network for one step using back propagation algorithm. Use 2 unipolar continuous neurons in the hidden layer and one linear neuron in the output layer. The input to the network is, $z = -1$.The bias input is -1 for each layer. Take η=λ=1.The initial weights of the hidden and output layers are respectively:

$$V^t = \begin{bmatrix} -1 & 0.2 \\ -0.6 & 0.8 \end{bmatrix}, W^t = [0.3 \quad 1 \quad 0]$$

1B. For the given data, perform network training using perceptron learning rule with discrete bipolar neurons till desired output is achieved:
$W^{1t} = [0 \quad 1 \quad 0], (X_1^t = [2 \quad 1 \quad -1], d_1 = -1), (X_2^t = [0 \quad -1 \quad -1], d_2 = 1), c = 1.$

1C. A probabilistic neuron has an activation function given by:

$O = +1, with\ probability\ p(v)$

$O = -1, with\ probability\ 1 - p(v)$ where $p(v) = \frac{1}{1+e^{-v/T}}$ with *T=1* and *v= net.*

Using this neuron model, find the output of a network for the following dataset:

$$W^t = \begin{bmatrix} -1 & -0.5 \\ -0.2 & 0.8 \end{bmatrix}, X^t = [2 \quad 3]$$

(5+3+2)

2A. The mean and variance of the height and weight of 4 male and 4 female subjects are given in Table.Q2A. Design a Bayes Classifier for gender classification and find the output of the classifier for a test subject whose height is 6 feet tall and weighing 130lbs.

2B. Design a Linear Discriminant classifier using Template matching to recognize the alphabets C, I, T. Use 3×3 pixel matrix to represent the patterns. Find the most likely and least likely misclassifications for each alphabet. Draw the classifier diagram.

2C. Fig Q2C shows the cost matrix and the performance of 2 classifier models. Compute the cost of classification in both cases and compare them.

(5+3+2)

3A. Design a discrete Hopfield auto associative memory to store 4-bit patterns' a', 'b' shown in Fig.Q.3A. Use bipolar discrete neurons to perform async update with the initial pattern c (Fig.Q3A) and find the energy at each step. Comment on the result.

3B. Design a spatio temporal memory network using bipolar discrete neurons to store the following sequence:$S^0 = [-1 \quad -1 \quad -1]^t \rightarrow S^1 = [-1 \quad 1 \quad 1]^t \rightarrow S^2 = [1 \quad -1 \quad 1]^t$.
Test the memory performance for both forward and backward pass.

3C. Draw the network architecture for a BAM (Bidirectional Associative memory) and write the expression for storage of patterns.

(5+3+2)

4A. Design a 3-rule based fuzzy system to simulate the nonlinear function given by:

$$y = 1 - x, -1 \leq x \leq 0$$
$$= 1 + x, \quad 0 \leq x \leq 1$$

Use Mamadani minimum implication for interpreting fuzzy IF-THEN rules, min for t-norm and max for union. Test the output of the system for x=0.25, -0.75 using centre average defuzzification.

4B. Find the fuzzy composition for the following relations using max-min composition. Show each step.

$$R_1 = \begin{bmatrix} 0.1 & 0.2 \\ 0.01 & 0.4 \\ 1 & 0.6 \end{bmatrix}, \quad R_2 = \begin{bmatrix} 1 & 0.5 \\ 0.2 & 0.6 \end{bmatrix}$$

Is it commutative? Justify the answer with proof.

4C. Find whether algebraic sum, algebraic product and Sugeno complement form an associated class or not.

(5+3+2)

5A. Consider a 2-input 1-output fuzzy system that is constructed from the following 3 rules:

If x1 is A1 and x2 is A2, Then y is A2
If x1 is A2 and x2 is A1, Then y is A1
Where A1, A2 are fuzzy sets with membership functions:

$\mu_{A1}(u) = 1 - |u|, if \ -1 \leq u \leq 1$ $\quad$ $\mu_{A2}(u) = 1 - |u-1|, if \ 0 \leq u \leq 2$
$= 0$ otherwise $\quad$ $= 0$ otherwise

If the input to the fuzzy system is [x1*, x2*] = [0.2, 0.5], use singleton fuzzifier to determine the output of the fuzzy system y* in the following case:

i) Minimum inference engine and center average defuzzifier
ii) Product inference engine and center average defuzzifier

5B. Draw the flowchart for the Genetic Algorithm (GA). With examples, briefly explain the various steps involved in implementing GA.

5C. Find the membership function for the fuzzy composite term, "*intensely small or not very medium*", given that the fuzzy sets, $small = \left[\frac{1}{1} + \frac{0.5}{2} + \frac{0.1}{3}\right], medium = \left[\frac{0.2}{1} + \frac{1}{2} + \frac{0.2}{3}\right]$. Use basic fuzzy operations wherever required.

(5+3+2)

Table. Q2A

Gender	mean (height)	variance (height)	mean (weight)	variance (weight)
male	5.855	3.5033e-02	176.25	1.2292e+02
female	5.4175	9.7225e-02	132.5	5.5833e+02

Fig.Q2C

Cost matrix

-1	1
1	-1

Classifier performance

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

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

Fig.Q3A