Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY

MANIPAL

A Constituent Institution of Manipal University

VI SEMESTER B.TECH. (MECHATRONICS ENGINEERING)

END SEMESTER EXAMINATIONS, JUNE 2017

SUBJECT: INTELLIGENT CONTROLLERS [MTE 4005]

REVISED CREDIT SYSTEM

Time: 3 Hours MAX. MARKS: 50

Instructions to Candidates:

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

1A. Consider a 2 input one output fuzzy system that is constructed from the following rules. **4**

a) IF x_1 is A_1 and x_2 is A_2 THEN y is A_1.

b) IF x_1 is A_2 and x_2 is A_1 THEN y is A_2 where A_1 and A_2 are fuzzy sets in R with membership function

$$\mu_{A1}(u) = \begin{cases} 1 - |u|, & if \ -1 \le u \le 1 \\ 0, & otherwise \end{cases} \qquad \mu_{A2}(u) = \begin{cases} 1 - |u-1|, & if \ 0 \le u \le 2 \\ 0, & otherwise \end{cases}$$

Suppose that the input to the fuzzy system is $(x_1^*, x_2^*) = (0.5, 0.3)$ and use singleton fuzzifier. Determine the output fuzzy set and y^* using Product Inference Engine and center average defuzzifier.

1B. Differentiate between ANN and Biological Neuron. **3**

1C. The figure-1C represents feedforward neural network. **3**

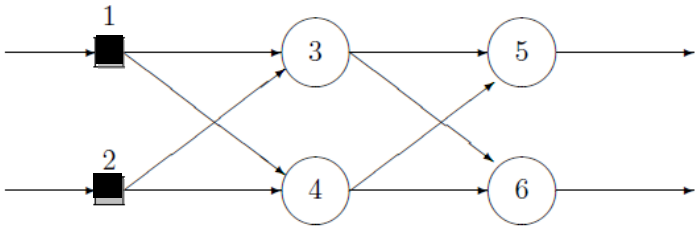

Figure 1C

A weight on connection between nodes i and j is denoted by w_{ij} , such as w_{13} is the weight on the connection between nodes 1 and 3.

The table-1C lists all the weights in the network:

$w_{13} = -2$ $w_{23} = 3$	$w_{35} = 1$ $w_{45} = -1$
$w_{14} = 4$ $w_{24} = -1$	$w_{36} = -1$ $w_{46} = 1$

Table 1C

Each of the nodes 3, 4, 5 and 6 uses the following activation function:

$$\varphi(v) = \begin{cases} 1 & \text{if } v \geq 0 \\ 0 & \text{otherwise} \end{cases}$$

where v denotes the weighted sum of a node. Each of the input nodes (1 and 2) can only receive binary values (either 0 or 1). Calculate the output of the network (y5 and y6) for the input pattern: P = [node 1, node 2] = [0,1]

2A. Perform two iterations of Widrow-Hoff Learning rule for the following data given: **4**

$$X_1 = \begin{bmatrix} 1 \\ -2 \\ 0 \\ -1 \end{bmatrix} \quad X_2 = \begin{bmatrix} 0 \\ 1.5 \\ -0.5 \\ -1 \end{bmatrix} \quad W^1 = \begin{bmatrix} 1 \\ -1 \\ 0 \\ 0.5 \end{bmatrix}$$

The desired responses for X_1 and X_2 are d_1= -1 and d_2= -1 respectively. Consider

c =1 and λ = 1.

2B. Design a minimum distance classifier with three classes using the following training data: **6**

Class 1: $\begin{bmatrix} -2.0 \\ -1.0 \end{bmatrix}, \begin{bmatrix} -2.0 \\ -3.0 \end{bmatrix}$ Class 2: $\begin{bmatrix} -2.0 \\ 1.0 \end{bmatrix}, \begin{bmatrix} -2.0 \\ 3.0 \end{bmatrix}$ Class 3: $\begin{bmatrix} 2.0 \\ 1.0 \end{bmatrix}, \begin{bmatrix} 2.0 \\ -1.0 \end{bmatrix}$

3A. Given two fuzzy sets **2**

$$A = \frac{0.4}{p} + \frac{0.25}{q} + \frac{0}{r} + \frac{0.8}{s} + \frac{1}{t} \qquad B = \frac{0}{p} + \frac{0.3}{q} + \frac{0.8}{r} + \frac{0.4}{s} + \frac{0.4}{t}$$

Determine the following:

i) Fuzzy intersection of A and $B_{0.25}$ using Yager class with w = 2.

ii) Projection of cartesian product of (A & B) on A, where Cartesian product is given by Q(AxB) = min(A,B)

3B. Explain “Linguistic Variable” with suitable example. Describe the significance of “Linguistic Hedges” ? **4**

3C. Let U= {1,2,3,4}; V={1,2,3}. Suppose x ε U is inversely proportional to y ε V. This can be formulated as a fuzzy IF-THEN rule given by “IF x is tall THEN y is short”. **4**

When Tall = $\frac{0}{1} + \frac{0.1}{2} + \frac{0.5}{3} + \frac{1}{4}$

Short = $\frac{1}{1} + \frac{0.5}{2} + \frac{0.1}{3}$. Perform Dienes- Rescher implication to interpret this rule.

4A. Compare Fuzzy Systems and Neural Network. **3**

4B. Perform single step error-back propagation of a multilayer perceptron network for the given data. Use η=1, λ=1 and both the layers are unipolar continuous. **7**

$$Z = \begin{bmatrix} -1 \\ 2 \\ -1 \end{bmatrix} \qquad V^t = \begin{bmatrix} 2 & 0 & 3 \\ 1 & 3 & 1 \end{bmatrix} \qquad W^t = \begin{bmatrix} 0 & 1 & 1 \\ 1 & 0 & 1 \end{bmatrix} \qquad d = \begin{bmatrix} 0 \\ 1 \end{bmatrix}$$

5A. Describe the three types of associative memory with suitable examples. **5**

5B. Design an auto-associative memory to store the following patterns: $S_1 = [-1\ 1\ 1\ 1]^t$ and $S_2 = [1\ -1\ -1\ 1]^t$ **3**

5C. Describe the significance and role of genetic algorithm in artificial intelligence. **2**

Table of S-Norm and T-Norm:

S-Norm	T-Norm
$S_w(a,b) = \min[1,(a^w + b^w)^{1/w}]$	$t_w(a,b) = 1 - \min[1,((1-a)^w + (1-b)^w)^{1/w}]$