Reg. No.										

MANIPAL INSTITUTE OF TECHNOLOGY

A Constituent Institute of Manipal University, Manipal

SEVENTH SEMESTER B.TECH (IT & CCE) DEGREE MAKE UP EXAMINATION-JAN 2017
SUBJECT:ELECIVE-III NEURAL NETWORKS AND FUZZY LOGIC (ICT 421)
(REVISED CREDIT SYSTEM)

TIME: 3 HOURS **–/01/2017** **MAX. MARKS: 50**

Instructions to candidates

- Answer any **FIVE FULL** questions. All questions carry equal marks.
- Missing data if any, may be suitably assumed.

1A. Describe Hebbian learning. Specifically

i) Characteristics of Hebbian synapse

ii) Synaptic enhancement and depression

iii) Mathematical models of Hebbian modification.

[5]

1B. Write summary of the perceptron convergence algorithm. [3]

1C. A neuron has an activation function $\varphi(v)$ defined by the logistic function, which is given by $\varphi(v) = 1/(1 + e^{-av})$, where v is the induced local field, and the slope parameter a is available for adjustment. Let $x_1, x_2, \ldots, x_m$ denote the input signals applied to the source nodes of the neuron, and b denote the bias. For convenience of presentation, we would like to absorb the slope parameter a in the induced local field v by writing

$$\varphi(v) = \frac{1}{1 + e^{-v}}.$$

How would you modify the inputs $x_1, x_2, \ldots, x_m$ to produce the same output as before? Justify your answer.

[2]

2A. Consider a fully connected feedforward 5-4-3 network. Construct an architectural graph for this network. Apply back-propagation algorithm to this network, and write the relation for each synaptic weight after one iteration of the back-propagation algorithm. Assume that each neuron in the network uses hyperbolic tangent function as the activation function. The hyperbolic tangent function is defined by

$$\varphi(v) = a \tanh(bv), \quad (a, b) > 0.$$

[5]

2B. Design of a neural network using back-propagation algorithm is more of a art than science in the sense that many factors involved in the design are the results of one's own personal experience. Describe various heuristics for making the back-propagation algorithm perform better. [3]

Table: Q.3A

Input Vector, x	Desired Response, d
$(-1, -1)$	-1
$(-1, +1)$	$+1$
$(+1, -1)$	$+1$
$(+1, +1)$	-1

2C. With a neat diagram, explain about a radial basis function network. [2]

3A. For the data set given in Table Q.3A, design a polynomial learning machines whose inner product kernel is given by

$$K(\mathrm{x}, \mathrm{x}_i) = (1 + \mathrm{x}^T \mathrm{x}_i)^2.$$

[5]

3B. Describe the generic approach for designing a support vector machine for pattern recognition. [3]

3C. The opeartion of the Bayes classifier for the Gaussian environment is analogous to that of the perceptron in that they are both linear classifiers. However, there are some subtle and important difference between them. Briefly discuss those differences. [2]

4A. The following raw data were determined in a pairwise comparison of new premium car preferences in a poll of 100 people. When it was compared with a Porsche (P), 79 of those polled preferred a BMW (B), 85 preferred a Mercedes (M), 59 preferred a Lexus (L), and 67 preferred an Infinity (I). When a BMW was compared, the preferences were 21-P, 23-M, 37-L, and 45-I. When a Mercedes was compared, the preferences were 15-P, 77-B, 35-L, and 48-I. When a Lexus was compared, the preferences were 41-P, 63-B, 65-M, and 51-L. Finally, when an Infinity was compared, the preferences were 33-P, 55-B, 52-M, and 49-L. Using rank ordering, plot the membership function for "most preferred car". [5]

4B. We want to compare the strength of two types of concrete. Four concrete masonry units (CMUs) from each type of concrete are stressed until they fail. The lowest stress at failure of a CMU is denoted 1, and the highest stress at failure is denoted 4, so the CMUs are rank ordered by failure stress, that is, $X = \{1, 2, 3, 4\}$. Since "failure" of CMUs is fuzzy, the membership value for a specific CMU represents the judgement that the CMU really failed. The following fuzzy sets represents the failure estimates for the two different concrete types:

$$A = \left\{ \frac{0.15}{1} + \frac{0.25}{2} + \frac{0.6}{3} + \frac{0.9}{4} \right\}$$

$$B = \left\{ \frac{0.2}{1} + \frac{0.3}{2} + \frac{0.5}{3} + \frac{0.8}{4} \right\}.$$

Calculate the union, intersection, and the difference for the two concrete types. [3]

4C. Consider two fuzzy relations R and S, which are given by

$$R = \begin{bmatrix} 1 & 0.8 & 0.6 & 0.2 & 0 \\ 0.8 & 1 & 0.8 & 0.6 & 0 \\ 0.6 & 0.8 & 1 & 0.8 & 0.6 \\ 0.2 & 0.6 & 0.8 & 1 & 0.8 \\ 0 & 0.2 & 0.6 & 0.8 & 1 \end{bmatrix} S = \begin{bmatrix} 1 & 0.6 & 0.4 & 0.2 & 0 \\ 0.6 & 1 & 0.6 & 0.4 & 0 \\ 0.4 & 0.6 & 1 & 0.6 & 0.4 \\ 0.2 & 0.4 & 0.6 & 1 & 0.6 \\ 0 & 0.2 & 0.4 & 0.6 & 1 \end{bmatrix}.$$

Compute $T = R \circ S$ using max-product composition.

[2]

5A. The calculation of an elastic structure depends on knowing the material properties of the structure as well as its support conditions. Suppose we have an elastic structure, such as a bar of known material, with properties like wave speed (C), modulus of elasticity (E), and cross-sectional area (A). However, the support stiffness is not well known; hence the fundamental natural frequency of the system is not precise either. Define two fuzzy sets

$$K = \text{“support stiffness”} \quad \text{in kilogram per square meter}$$

, and

$$f_1 = \text{“first natural frequency of the system”} \quad \text{in Hertz with}$$

membership functions

$$K = \left\{ \frac{0}{1e+3} + \frac{0.2}{1e+4} + \frac{0.5}{1e+5} + \frac{0.8}{5e+5} + \frac{1}{1e+6} + \frac{0.8}{5e+6} + \frac{0.2}{1e+7} \right\}$$
$$f_1 = \left\{ \frac{0}{100} + \frac{0}{200} + \frac{0.2}{500} + \frac{0.5}{800} + \frac{1}{1000} + \frac{0.8}{2000} + \frac{0.2}{5000} \right\}$$

i) Using the proposition, IF x is K, THEN y is f_1, find this relation using Mamdani implication for $K \to f_1$

ii) Define another antecedent, say $K' =$ “damaged support,”

$$K' = \left\{ \frac{0}{1e+3} + \frac{0.8}{1e+4} + \frac{0.1}{1e+5} \right\}.$$

Find the system's fundamental first natural frequency due to the change in support condition using max-min composition.

[3]

5B. In a problem related to the computer tracking of soil particles as they move under stress, the program displays desired particles on the screen. Particles can be small and large. Due to segmentation problems in computer imaging, the particles can become too large and obscure particles of interest or become to small and be obscured. To solve this problem linguistically, suppose we define the following atomic terms on a scale of size [0, 50] in units of mm^2:

$$\text{“}Large\text{”}' = \left\{ \frac{0}{0} + \frac{0.1}{10} + \frac{0.3}{20} + \frac{0.5}{30} + \frac{0.6}{40} + \frac{0.7}{50} + \right\}$$
$$\text{“}Small\text{”}' = \left\{ \frac{1}{0} + \frac{0.8}{10} + \frac{0.5}{20} + \frac{0.3}{30} + \frac{0.1}{40} + \frac{0}{50} + \right\}$$

For these atomic terms find the membership functions for the following phrases:

(i) Very small or very large

(ii) Not small and not large

(iii) Large or not small.

[3]

5C. Using the inference approach, find the membership values for each of the triangular shapes (I,R,IR,E,T) for the triangle, $90^0, 65^0, 25^0$.

[2]

6A. A landfill is the cheapest method of solid waste treatment and disposal. Once disposed into a landfill, solid waste can be a major source of energy due to its potential to produce methane. However, all the solid waste disposed cannot generate methane at the same rate and in the same quantities. Based on its biodegradability, solid waste is classified into three distinct groups, namely: rapidly biodegradable, moderately biodegradable, and slowly biodegradable. Design of a landfill gas extraction system is based on gas production through the first two groups; both have different gas production patterns. The data collected from experiments and experiences are presented by the sets A_1 and A_2 as shown in Figure Q.6A, where A_1 and A_2 are defined as the fuzzy sets rapidly biodegradable and slowly biodegradable, respectively in units of years. In order to properly design the gas extraction system we need a single representative gas production value. Calculate the defuzzified value, z^* using centroid methods.

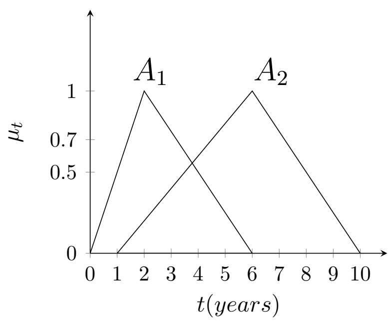

Figure: Q.6A

[5]

6B. Determine the λ-cut relations for $\lambda = \{0, 0.1, 0.2, 0.4, 0.7, 0^+\}$, for the following fuzzy relation matrix R:

$$R = \begin{bmatrix} 1 & 0.8 & 0.4 & 0.5 & 0.8 \\ 0.8 & 1 & 0.4 & 0.5 & 0.9 \\ 0.4 & 0.4 & 1 & 0.4 & 0.4 \\ 0.5 & 0.5 & 0.4 & 1 & 0.5 \\ 0.8 & 0.9 & 0.4 & 0.5 & 1 \end{bmatrix}.$$

[3]

6C. Prove the following statement by contradiction.

$$((P \to \overline{Q}) \wedge (Q \vee \overline{R}) \wedge (R \wedge \overline{S})) \to \overline{P}$$

[2]