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SEVENTH SEMESTER B.TECH(IT) DEGREE MAKE UP EXAMINATION-JAN 2016
SUBJECT:PROGRAM ELECTIVE III-NEURAL NETWORKS & FUZZY LOGIC (ICT 421)
(REVISED CREDIT SYSTEM)

TIME:3 HOURS **03/01/2016** **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. Consider the following orthonormal sets of key patterns, applied to a correlation matrix memory:

$$\mathrm{x}_1 = [1,0,0,0]^T \qquad y_1 = [5,1,0]^T$$
$$\mathrm{x}_2 = [0,1,0,0]^T \qquad y_2 = [-2,1,6]^T$$
$$\mathrm{x}_3 = [0,0,1,0]^T \qquad y_3 = [-2,4,3]^T$$

i) Compute the memory matrix M

ii) The stimulus applied to the memory is a noisy version of the key pattern x_1 and given by $\mathrm{x} = [0.8, -0.15, 0.15, -0.20]^T$. Calculate the memory response y

iii) Show that the response y is closest to the stored pattern y_1 in a Euclidean sense.

1B. Figure Q.1B has no biases. Suppose that biases equal to -1 and +1 are applied to the top and bottom neurons of the first hidden layer, and biases equal to +1 and -2 are applied to the top and bottom neurons of the second hidden layer. Write the new form of input-output mapping defined by the network.

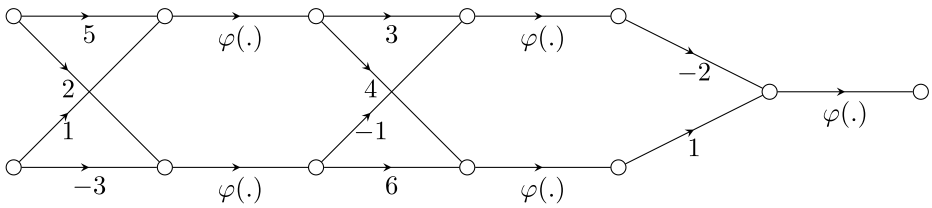

Figure: Q.1B

1C. With suitable graph, explain learning-rate annealing schedules.

[5+3+2]

2A. Formulate the classification conditions for Bayes classifier.

2B. A fully connected feedforward network has three source nodes, two hidden layers, one with three neurons and other with two neurons and one output neuron. Construct an architectural graph of this network. Apply back-propagation algorithm to this network and write the relation for each synaptic weight after one iteration of back-propagation algorithm.

2C. Solve XOR problem using multi-layer perceptron.

[5+3+2]

Table: Q.3A

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

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

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

.

3B. Formulate multi-dimensional interpolation problem in terms of radial basis functions. Also give the necessary and sufficient condition for its solution to exist.

3C. Obtain expression for updated synaptic weight using least-mean square algorithm.

[5+3+2]

4A. For the data shown in the accompanying table, show the first iteration in trying to compute the membership values for the input variables x_1, x_2, x_3 and x_4 in the output region R_1, R_2 and R_3. Use a $4 \times 3 \times 3$ neural networks with a random set of weights.

x_1	x_2	x_3	x_4	R_1	R_2	R_3
10	0	-4	2	0	1	0

4B. We have a full database containing articles from several popular news magazines like *Newsweek*, *Frontline*,*India Today* etc. We want to use fuzzy sets to access linguistic information from our database. Let us say that the user enters four words, w_1, w_2, w_3, and w_4. Also, let us say we have partitioned our database into two broad or general topics, T_1 and T_2. Table Q.4B illustrates the correlation between the words and the topics. For the two fuzzy sets (T_1 and T_2) determine the

Table: Q.4B

	T_1	T_2
w_1	0	0.9
w_2	0.3	0.7
w_3	0.5	0.1
w_4	0.8	0

membership for the following set operations

i) $T_1 \cup T_2$

ii) $T_1 \cap T_2$

iii) $T_1 | T_2$

iv) $\overline{T_1 \cup T_2}$

v) $\overline{T_1 \cap T_2}$

vi) $T_1 \cup \overline{T}_1$

4C. Use the fuzzy sets T_1 and T_2 from Q.4B to compute the following

i) $R = T_1 \times T_2$, and

ii) $R1 = R \circ R$ using max-product method.

[5+3+2]

5A. What do you mean by the term defuzzification of a fuzzy relation? For the fuzzy relation

$$R = \begin{bmatrix} 1 & 0.1 & 0 & 0.6 & 0.3 \\ 0.02 & 0.1 & 0.35 & 1 & 0.5 \\ 0.2 & 1 & 0.7 & 1 & 0 \\ 0.04 & 0.4 & 1 & 0.3 & 0 \end{bmatrix}$$

Find the λ-cut relation for the following values of λ:

i) $\lambda = 0^+$
ii) $\lambda = 0.1$
iii) $\lambda = 0.4$
iv) $\lambda = 0.7$, and
v) $\lambda = 0$.

5B. Embedded systems are often supplied 120 V AC for power. A "power supply" is required to convert this to a useful voltage (quite often +5 V DC). Some power supply design employ a technique called "switching". This technique generates the appropriate voltages by storing and releasing the energy between inductors and capacitors. This problem characterizes two linguistic variables, high and low voltage, on the voltage range of 0 to 200 V AC:

$$\text{"High"} = \left\{ \frac{0}{0} + \frac{0}{25} + \frac{0}{50} + \frac{0.1}{75} + \frac{0.2}{100} + \frac{0.4}{125} + \frac{0.6}{150} + \frac{0.8}{175} + \frac{1}{200} \right\}$$

$$\text{"Medium"} = \left\{ \frac{0.2}{0} + \frac{0.4}{25} + \frac{0.6}{50} + \frac{0.8}{75} + \frac{1}{100} + \frac{0.8}{125} + \frac{0.6}{150} + \frac{0.4}{175} + \frac{0.2}{200} \right\}$$

Find the membership functions for the following phrases:

(i) Not very high
(ii) Slightly medium and very high
(iii) Very, very high or very, very medium.

5C. Using the inference approach, find the membership values for each of the triangular shapes (I,R,IR,E,T) for each of the following triangles:

(i) $45^0, 75^0, 60^0$
(ii) $120^0, 50^0, 10^0$.

[5+3+2]

6A. In metallurgy, materials are made with mixtures of various metals and other elements to achieve certain desirable properties. In a particular preparation of steel, three elements, namely iron, manganese and carbon are mixed in two different proportions. The samples obtained from these two different proportions are placed on a normalized scale, as shown in Figure Q.6A and are represented as fuzzy sets A_1 and A_2. You are interested in finding some sort of "average" steel proportion. For the logical union of the membership function shown you are required to find the defuzzified quantity. Calculate the defuzzified value, z^* using the following methods:

(i) Center of sums, which is defined as $z^* = \frac{\int_Z z \sum_{k=1}^{n} \mu_{A_k}(z)dz}{\int_z \sum_{k=1}^{n} \mu_{A_k}(z)dz}$
(ii) Center of largest area, which is defined as $z^* = \frac{\int \mu_{A_k}(z)zdz}{\int \mu_{A_k}(z)dz}$

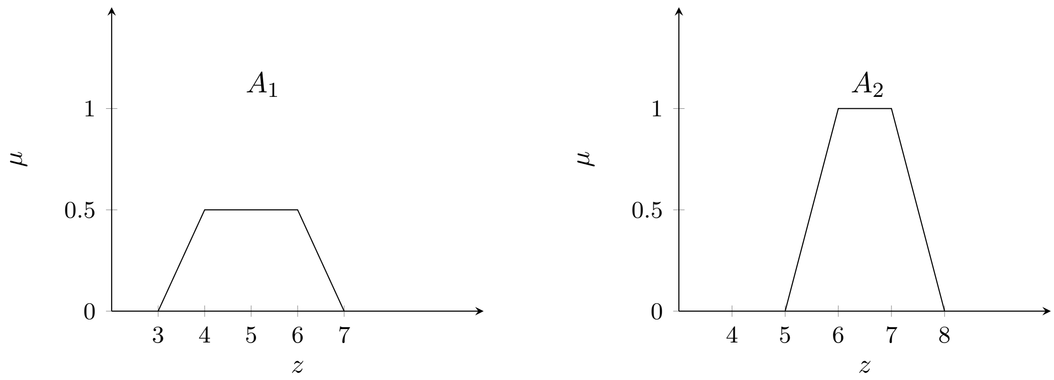

Figure: Q.6A

6B. You are asked to develop a controller to regulate the temperature of a room. Knowledge of the system allows you to construct a simple rule of thumb: when the temperature is HOT then cool room down by turning the fan at the fast speed, or, expressed in rule form, IF temperature is HOT, THEN fan should turn FAST. Fuzzy sets for hot temperature and fast fan speed is given below:

$$H = \text{“hot”} = \left\{ \frac{0}{60} + \frac{0.1}{70} + \frac{0.7}{80} + \frac{0.9}{90} + \frac{1}{100} \right\}$$

represents universe X in ${}^0F$, and

$$F = \text{“fast”} = \left\{ \frac{0}{0} + \frac{0.2}{1} + \frac{0.5}{2} + \frac{0.9}{3} + \frac{1}{4} \right\}$$

represents universe Y in 1000 rpm

i) From these two fuzzy sets construct a relation for the rule using classical implication.

ii) Suppose a new rule uses a slightly different temperature, say “moderately hot,” and is expressed by the fuzzy membership function

$$H' = \left\{ \frac{0}{60} + \frac{0.2}{70} + \frac{1}{80} + \frac{1}{90} + \frac{1}{100} \right\}$$

Using max-min composition, find the resulting fuzzy fan speed.

6C. Consider fuzzy sets from Q.6B and construct a relation for the rule, “IF temperature is HOT or moderately HOT, THEN fan should turn FAST” using Mamdani implication (i.e $\mu_R = min(\mu_H, \mu_F)$).

[5+3+2]