radars or "low" resolution radars, or some other fuzzy description of their resolution ability. Define the following fuzzy sets on the universe of radar image resolution as measures in meters:

$$\text{"High resolution} = \left\{\frac{1}{0.1} + \frac{0.9}{0.3} + \frac{0.5}{1} + \frac{0.2}{3} + \frac{0.1}{10} + \frac{0}{30}\right\}$$

$$\text{"Low resolution} = \left\{\frac{0}{0.1} + \frac{0.1}{0.3} + \frac{0.3}{1} + \frac{0.7}{3} + \frac{0.9}{10} + \frac{1}{30}\right\}.$$

Find membership function for the following linguistic phrases:

i) Not high resolution and not low resolution

ii) Low resolution or not very high resolution

iii) High resolution and not very, very high resolution.

[3]

5C. Using the inference approach, find the membership values for each of the triangular shapes (I,R,IR,E,T) for the triangle, $80^0, 75^0, 25^0$.

[2]

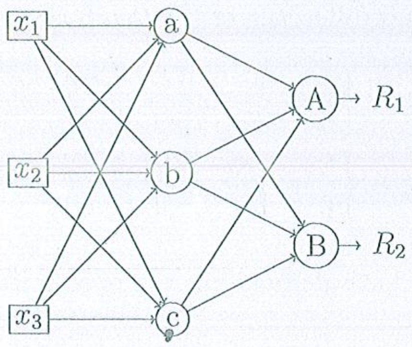

Figure: Q.5A

Table: Q.5A

Source to Hidden Layer Weights	Hidden to Output Layer Weights
$w_{a1} = 0.5$	$w_{Aa} = 0.25$
$w_{a2} = 0.2$	$w_{Ab} = 0.45$
$w_{a3} = 0.8$	$w_{Ac} = 0.15$
$w_{b1} = 0.4$	$w_{Ba} = 0.35$
$w_{b2} = 0.6$	$w_{Bb} = 0.65$
$w_{b3} = 0.4$	$w_{Bc} = 0.35$
$w_{c1} = 0.1$	
$w_{c2} = 0.3$	
$w_{c3} = 0.7$	

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MANIPAL INSTITUTE OF TECHNOLOGY

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SIXTH SEMESTER B.TECH (INFORMATION TECHNOLOGY / COMPUTER AND COMMUNICATION ENGINEERING) DEGREE END SEMESTER EXAMINATION-APRIL/MAY 2017

SUBJECT:PROGRAM ELECTIVE-II NEURAL NETWORKS AND FUZZY LOGIC (ICT 4012)

(REVISED CREDIT SYSTEM)

TIME: 3 HOURS | 27/04/2017 | MAX. MARKS: 50

Instructions to candidates

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

1A. For the data set given in Table Q.1A, design a polynomial learning machines whose inner product kernel is given by

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

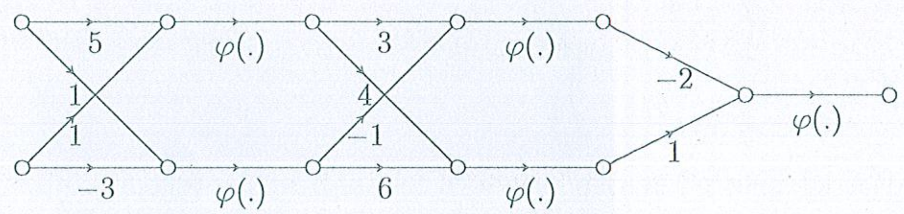
and compute the optimum margin of separation, ρ for this machine.

Table: Q.1A

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

[5]

1B. Figure Q.1B shows the signal-flow graph of a 2-2-2-1 feedforward network. The function $\varphi(.)$ denotes a logistic function. Write the input-output mapping defined by this network.



Q.1B

[3]

1C. What do you understand by the term *credit assignment problem*? Briefly explain two types of credit-assignment problems.

[2]

2A. Consider a fully connected feedforward 5-3-2-1 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 logistic function as the activation function. The logistic function is defined by

$$\varphi(x) = \frac{1}{1 + \exp(-x)}.$$

[5]

2B. Consider an exact solution of the XOR problem using an Radial Basis Function Network (RBFN) with four hidden units, with each radial-basis function center being determined by each piece of input data. The four possible input patterns are defined by (0,0), (0,1), (1,1), (1,0), which represents the cyclically ordered corners of a square. Construct the interpolation matrix Φ for the resulting RBFN. Hence compute the inverse matrix Φ^{-1}.

[3]

2C. Prove the given statement by contradiction, $((p \to q) \land p) \to q$.

[2]

3A. In network computing many applications involve communication between two separate systems interconnected via a network. Two metrics of interest during the interaction of these client-and-server systems are the "response" on the system where the user resides (client) and the "load" on the remote system (server). Let X represent the universe of response, $X = \{1,2,3,4,5\}$, and Y, the universe of load, $Y = \{1,2,3,4\}$, where lower numbers correspond to "faster response" and "lighter load," respectivel. Now let us define two fuzzy variables A and B representing "average response" and "medium load" where

$$A = \left\{\frac{0.2}{1} + \frac{0.5}{2} + \frac{1}{3} + \frac{0.3}{4} + \frac{0}{5}\right\} \text{ and } B = \left\{\frac{0}{1} + \frac{0.7}{2} + \frac{0.4}{3} + \frac{0.1}{4}\right\}.$$

i) Find the implication $A \to B$, using classical approach.

ii) Now, what "degree of load" would be associated with a new fuzzy set A' denoting "quick response"? Let

$$A' = \left\{\frac{0.9}{1} + \frac{0.7}{2} + \frac{0.3}{3} + \frac{0.1}{4} + \frac{0}{5}\right\}.$$

Using max-product composition, find $B' = A' \circ R$. What might this "degree of load" be called?

[5]

3B. How does learning curves gets generated for studying performance of neural networks? Explain various types of information that can be inferred from the learning curve. [3]

3C. What do you understand by the term *indicator function*? Write a functional in terms of indicator function for the optimal hyperplane for non-separable patterns using support vector machine.

[2]

4A. Two companies bid for a contract. A committee has to review the estimates of those companies and give reports to its chairperson. The reviewed reports are evaluated on a non-dimensional scale and assigned a weighted score that is represented by a fuzzy membership function, as illustrated by the two fuzzy sets B_1 and B_2, in Fig. Q.4A. The chairperson is interested in the lowest bid, as well as a metric to measure the combined "best" score. For the logical union of the membership function shown we want to find the defuzzified quantity. Use centroid method to calculate the defuzzified value, z^*. [5]

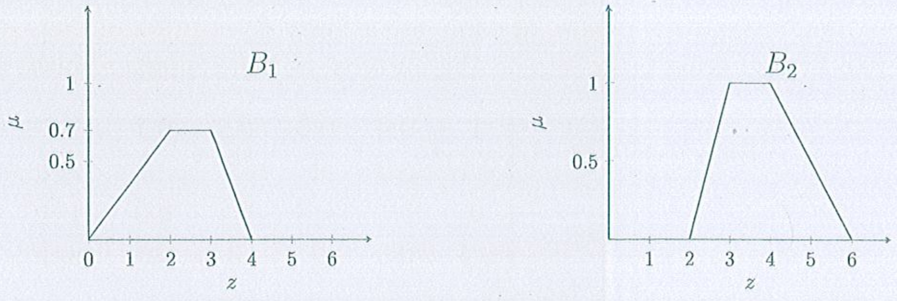


Figure: Q.4A

4B. The Froude number, F_R, is used to calculate whether flow in a channel is subcritical, critical, or supercritical, and is given by the expression, $F_R = v/\sqrt{gD}$, where v is the velocity of the flow, D is the channel depth, and g is the gravitational constant. In a channel with a constant depth, F_R is a maximum when the flow is high, and F_R is minimum when the flow is low. Suppose the flow velocity is given on a universe of non-dimensional velocities, $X = \{0,20,40,60,80,100\}$. For the two flows given below, find the union, intersection, and difference of the two flows.

$$Flow_1 = \left\{\frac{1}{0} + \frac{0.8}{20} + \frac{0.65}{40} + \frac{0.45}{60} + \frac{0.3}{80} + \frac{0.1}{100}\right\}$$
$$Flow_2 = \left\{\frac{0}{0} + \frac{0.45}{20} + \frac{0.6}{40} + \frac{0.8}{60} + \frac{0.95}{80} + \frac{1.0}{100}\right\}.$$

[3]

4C. Two fuzzy sets A and B, both defined on X, are as follows: Express the following λ-cut

$\mu(x_i)$	x_1	x_2	x_3	x_4	x_5	x_6
A	0.1	0.6	0.8	0.9	0.7	0.1
B	0.9	0.7	0.5	0.2	0.1	0

sets using Zadeh's notation:

i) $(A \cup B)_{0.7}$

ii) $(A \cap B)_{0.6}$.

[2]

5A. For the data shown in accompanying table, show the first iteration of back propagation algorithm in trying to compute the membership values for the input variables x_1, x_2 and x_3 in the output region R_1 and R_2. Use the network shown in Fig. Q.5A. The weights used in Fig. Q.5A is given in Table Q.5A.

x_1	x_2	x_3	R_1	R_2
1.0	0.5	2.3	0.0	1.0

[5]

5B. With respect to imaging radars when we speak of "resolution," we are referring to the "fitness" of our ability to distinguish closely spaced targets. We may have "high" resolution