2010-2011
M.TECH. (III SEMESTER) EXAMINATION
(ELECTRONICS ENGINEERING)
ARTIFICIAL NEURAL NETWORKS AND ITS APPLICATIONS
(EL – 745)

Maximum Marks: 75
Duration: Three Hours

Note:
(i) Answer any five questions.
(ii) All questions carry equal marks.
(iii) Notations and symbols carry their usual meanings.

1. (a) Explain the operation of Multi-Layer Perceptrons. Give the different (04)
Activation functions that are used.
(b) Determine the output for on MLP with the input X, and weight matrices of (04)
three layers given below. Assume unipolar sigmoidal non-linearity. How many
neurons are present in the output layer?

\[
X = \begin{bmatrix}
1 \\
-3 \\
0 \\
0
\end{bmatrix},
W_1 = \begin{bmatrix}
-1 & 4 & 0 & 2 \\
3 & 1 & -2 & 5 \\
-4 & 0 & 2 & 1
\end{bmatrix}
\]

\[
W_2 = \begin{bmatrix}
5 & 0 & -1 \\
2 & 3 & -2
\end{bmatrix},
W_3 = \begin{bmatrix}
4 & 1 \\
2 & 0 \\
-1 & 3
\end{bmatrix}
\]

(c) Design a 2-layer MLP for loading the input-output examples \( \{x_i, d_i\} \), (07)
i = 1, 2, 3, 4 given below.

| \( x_i \) | 0 | 1 | 2 | 3 |
| \( d_i \) | 1 | 3 | -1 | 0 |

2 (a) Let \( X_A \) and \( X_B \) be prototype vectors representing two clusters. Derive the linear (07)
decision surface for minimum distance classification.

(b) Implement the linear classifier obtained in part (a) using a McCulloch-Pitt’s (08)
neuron. Hence design a 5-input Majority function using one neuron.

3 (a) What are linearly separable functions? What is their significance in terms of (04)
Neural implementation?

(b) Determine whether the following sets of binary vectors are linearly separable (11)
from the remaining binary vectors of same length. If yes, then design a binary
neuron that separates them.

(i) \[ \{ [0 0 0 0], [1 0 1 0], [1 0 0 1], [1 0 0 0], [1 1 0 0] \} \]
(ii) \[ \{ [0 0 0 0], [0 0 1 1], [0 1 0 1], [1 0 0 1] \} \]
(iii) \[ \{ [0 0 0 1], [1 0 0 1], [1 1 0 1], [1 0 1 1] \} \]

Contd...
4 Implement the following logic functions with minimum number of neurons. 
   (i) \( f_1 = \Sigma (2) \) 
   (ii) \( f_2 = \Sigma (3,5,6,7) \) 
   (iii) \( f_3 = \Sigma (1,2,4,7) \) 
   (iv) \( f_4 = \Sigma (1,3,5) \) 
   (v) \( f_5 = \Sigma (1,2,3,4,5,6,7) \) 

5 (a) State Cover's theorem in qualitative terms. Hence solve the XOR problem by transforming into a high-dimensional space. 
   (b) Implement the XOR function using a Radial Basis Function Network. 

6 (a) Derive the Energy function of a Hopfield network of \( N \) neurons. How can you determine its stable states? 
   (b) Define Linear and Quadratic Programming problems in optimization. Solve an LPP to minimize the cost function \( f = x_1 + 3x_2 \), subject to the constraints \( 2x_1 + x_2 \leq 10, \quad x_1 \geq 0, \quad x_2 \geq 0 \) 

7 (a) How can you modify the Hopfield network circuit to implement negative weights? Derive its Energy function. 
   (b) Design a network to solve the given system of linear equations. What are the constraints on the coefficients \( w_1, w_2 \) and \( w_3 \)? 
      \[ w_1 x + w_3 y = 5 \] 
      \[ w_2 x + w_3 y = 3 \] 

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