1. (a) Explain the operation of McCulloch Pitt's neuron using the geometrical concept of a hyperplane in input space. 

(b) Derive a vector which is normal to a given hyperplane. 

(c) Design a network for XOR function implementation using McCulloch Pitt's neurons. 

2. (a) Explain the basic operation of a biological neuron using a simple diagram. What is the significance of synaptic strength? 

(b) How can you implement artificial neurons in electronic form? Give the limitations of various circuit configurations. 

3. (a) The discriminant function of a linear dichotomizer is given by \( g(x) = w^T x + b \), where \( x \) is the input vector and \( w, b \) are its parameters. Give the equation of the decision surface and show that the distance of a point \( x_i \) in the input/pattern space from the decision surface is given by \( g(x_i)/\|w\| \). 

(b) Inputs corresponding to two classes A and B, clustered around \( X_A \) and \( X_B \) are to be categorized on the basis of minimum distance criteria. Given that \( X_A = [0 2 -3 1]^T \), \( X_B = [1 -2 1 4]^T \) design a neural network to carry out the required dichotomy such that A and O to class B. 

4. Implement the following logic functions with minimum number of neurons: 

\( f_1 = \Sigma (1, 4, 5, 6, 12) \) 
\( f_2 = \Sigma (0, 1, 3, 4, 5, 6, 9, 12) \) 
\( f_3 = \Sigma (3, 5, 15) \) 
\( f_4 = \Sigma (0, 1, 5, 8) \) 

5. (a) Design a Radial Basis Function Network for strict interpolation of the given input-output examples \( \{ x_i, d_i \}, i = 1, 2, 3. \) 

\begin{tabular}{|c|c|c|c|} 
\hline
\( x_i \) & 0 & 1 & 3 \\
\hline
\( d_i \) & 2 & -1 & 0 \\
\hline
\end{tabular}
(b) Implement a NAND function of two inputs, using only one RBF neuron and a threshold unit.

6. (a) How are feedback neural networks different from feed forward neural networks?
(b) Design a 3-bit Analog – to – Digital converter by employing the Hopfield Neural Network topology.

7. Design a non-linear feedback neural circuit capable of solving the following system of linear equations:

\[
\begin{bmatrix}
2 & 1 \\
1 & 1
\end{bmatrix}
\begin{bmatrix}
V_1 \\
V_2
\end{bmatrix}
= 
\begin{bmatrix}
2 \\
1.5
\end{bmatrix}
\]