Max marks:20,
Duration: 45 min,
[Hand written answers can be uploaded in any format]

21. Put the following into the appropriate group: [2 marks]

1. Baye's Classifier
2. SVM
3. Principal Component Analysis
4. Multi-layer Perceptron (Neural Network)
5. Mixture of Gaussian Clustering
6. kNN

Supervised	Unsupervised

22. Assume a linearly separable two class problem. Construct a neural network with minimum number of neurons. What activation function will be used in the output layer generally?[2 marks]

23. Draw a general neural network that consists of multiple layers and multiple outputs? What activation function will be used in the output layer generally? [2 marks]

24. Consider the following two multilayer perceptron, where all of the layers use linear activation functions. [2 marks]
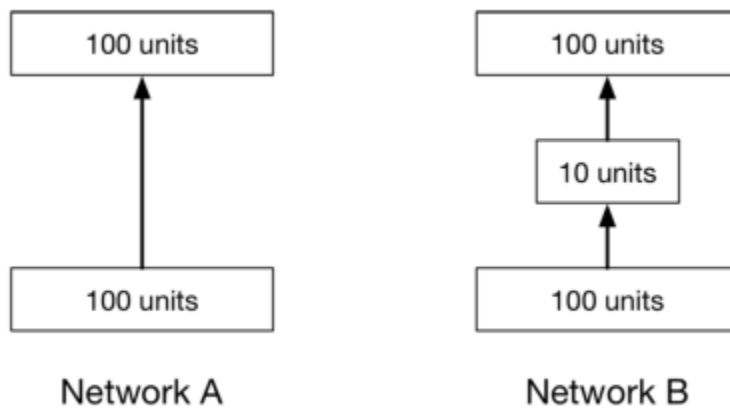
Network A

Network B

a) Give one advantage of Network A over Network B.
b) Give one advantage of Network B over Network A.

25. [2 marks]

Below is a diagram if a single artificial neuron (unit):

$$x_1$$
$$w_1$$
$$w_2$$
$$x_2$$
$$v$$
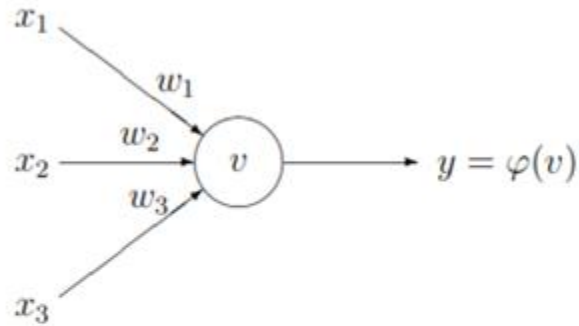$$y = \varphi(v)$$
$$w_3$$
$$x_3$$

Figure 1: Single unit with three inputs.

The node has three inputs $\mathbf{x} = (x_1, x_2, x_3)$ that receive only binary signals (either 0 or 1). How many different input patterns this node can receive? What if the node had four inputs? Five? Can you give a formula that computes the number of binary input patterns for a given number of inputs?

26. [2 marks]

$$x_1$$
$$w_1$$
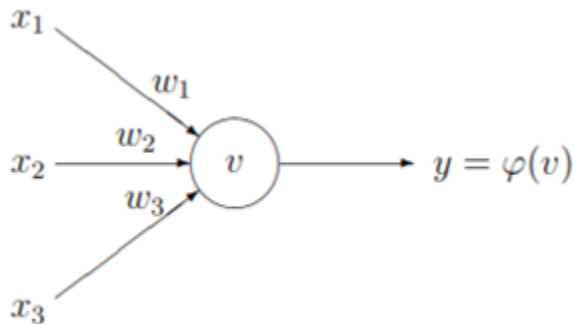$$w_2$$
$$x_2$$
$$v$$
$$y = \varphi(v)$$
$$w_3$$
$$x_3$$

Figure 1: Single unit with three inputs.

Consider the unit shown on Figure 1. Suppose that the weights corresponding to the three inputs have the following values:

$$
\begin{array}{rcr}
w_1 & = & 2 \\
w_2 & = & -4 \\
w_3 & = & 1
\end{array}
$$

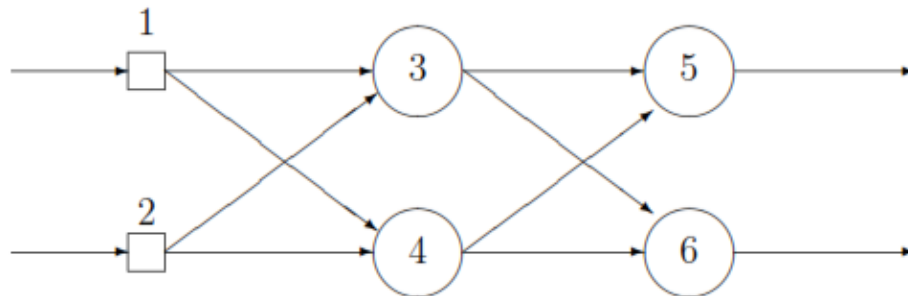and the activation of the unit is given by the step-function:

$$
\varphi(v) = \begin{cases} 1 & \text{if } v \geq 0 \\ 0 & \text{otherwise} \end{cases}
$$

Calculate what will be the output value y of the unit for each of the following input patterns:

Pattern	P_1	P_2	P_3	P_4
x_1	1	0	1	1
x_2	0	1	0	1
x_3	0	1	1	1

27. [3 marks]

The following diagram represents a feed-forward neural network with one hidden layer:

A weight on connection between nodes i and j is denoted by w_{ij}, such as w_{13} is the weight on the connection between nodes 1 and 3. The following table lists all the weights in the network:

$w_{13} = -2$	$w_{35} = 1$
$w_{23} = 3$	$w_{45} = -1$
$w_{14} = 4$	$w_{36} = -1$
$w_{24} = -1$	$w_{46} = 1$

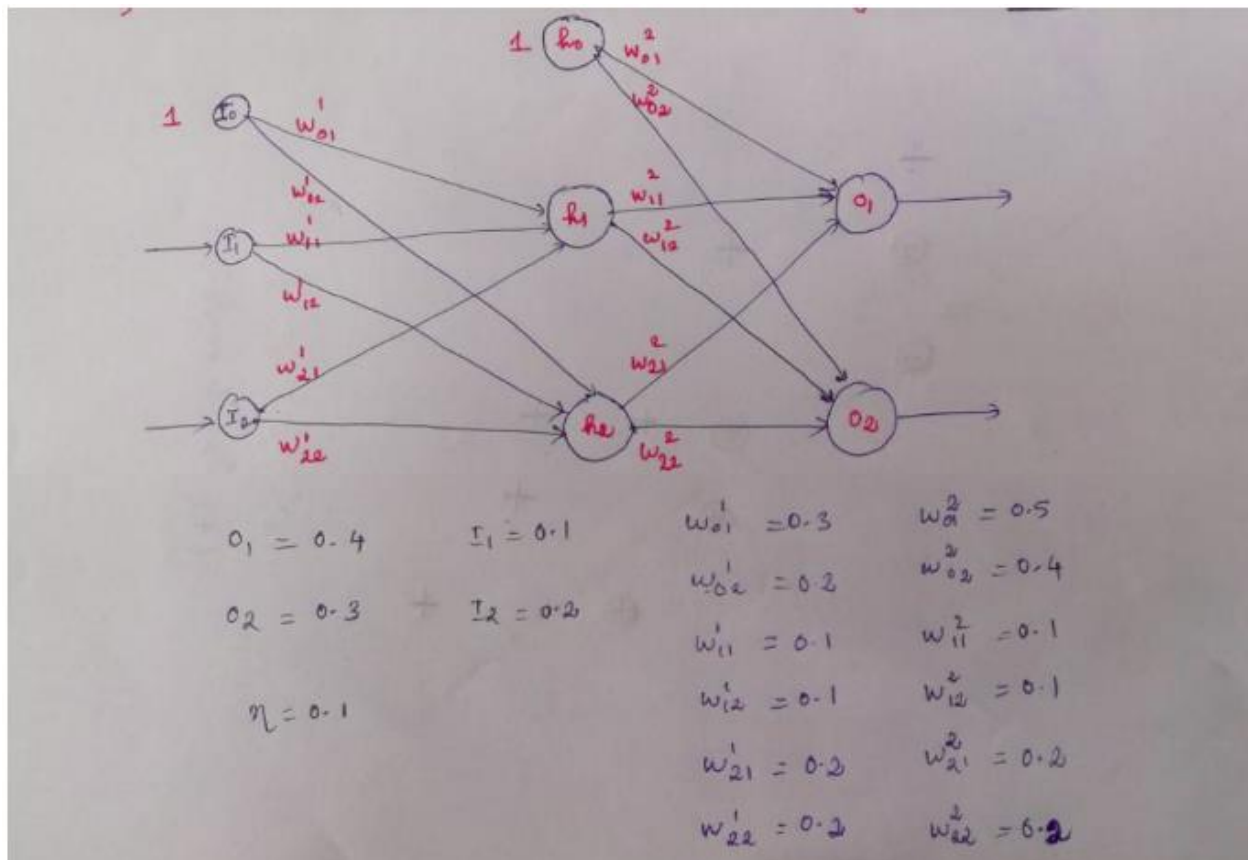Each of the nodes 3, 4, 5 and 6 uses the following activation function:

$$\varphi(v) = \begin{cases} 1 & \text{if } v \geq 0 \\ 0 & \text{otherwise} \end{cases}$$

where v denotes the weighted sum of a node. Each of the input nodes (1 and 2) can only receive binary values (either 0 or 1). Calculate the output of the network (y_5 and y_6) for each of the input patterns:

Pattern:	P_1	P_2	P_3	P_4
Node 1:	0	1	0	1
Node 2:	0	0	1	1

28. [5 marks]

Feed forward and back propagation algorithm: Update the weight vector using back propagation algorithm and sigmoid as the activation function (show first weight updation only)

$O_1 = 0.4$ $I_1 = 0.1$ $w_{o1}^1 = 0.3$ $w_{o1}^2 = 0.5$

$O_2 = 0.3$ $I_2 = 0.2$ $w_{o2}^1 = 0.2$ $w_{o2}^2 = 0.4$

$w_{11}^1 = 0.1$ $w_{11}^2 = 0.1$

$\eta = 0.1$ $w_{12}^1 = 0.1$ $w_{12}^2 = 0.1$

$w_{21}^1 = 0.2$ $w_{21}^2 = 0.2$

$w_{22}^1 = 0.2$ $w_{22}^2 = 0.2$

-----------------------------------End of the question paper---