Course No.: CSE 2102
Course Title: Sessional based on CSE 2101
Experiment No. 2
Name of the Experiment: Design and implementation of single layer perceptron learning algorithm.

Course Outcomes: CO1
Learning Domain with Level: Cognitive (Applying, Analyzing, Evaluating & Creating)

The perceptron learning algorithm

1. Initialise weights and threshold
Define $w_i(t), (0 \leq i \leq n)$, to be the weight from input i at time t, and θ to be the threshold value in the output node. Set w_0 to be $-\theta$, the bias, and x_0 to be always 1.
Set $w_i(0)$ to small random values, thus initialising all the weights and the threshold.
2. Present input and desired output
Present input $x_0, x_1, x_2, \ldots, x_n$ and desired output $d(t)$
3. Calculate actual output

$$y(t) = f_h\left[\sum_{i=0}^{n} w_i(t)x_i(t)\right]$$

4. Adapt weights

$$\begin{aligned} \text{if correct} \quad & w_i(t+1) = w_i(t) \\ \text{if output 0, should be 1 (class A)} \quad & w_i(t+1) = w_i(t) + x_i(t) \\ \text{if output 1, should be 0 (class B)} \quad & w_i(t+1) = w_i(t) - x_i(t) \end{aligned}$$

We can modify step 4 in different way:
1st Way:

4. Adapt weights—modified version

$$\begin{aligned} \text{if correct} \quad & w_i(t+1) = w_i(t) \\ \text{if output 0, should be 1 (class A)} \quad & w_i(t+1) = w_i(t) + \eta x_i(t) \\ \text{if output 1, should be 0 (class B)} \quad & w_i(t+1) = w_i(t) - \eta x_i(t) \end{aligned}$$

where $0 \leq \eta \leq 1$, a positive gain term that controls the adaption rate.

2nd Way:

4. Adapt weights—Widrow-Hoff delta rule

$$\begin{aligned} \Delta &= d(t) - y(t) \\ w_i(t+1) &= w_i(t) + \eta \Delta x_i(t) \\ d(t) &= \begin{cases} +1, & \text{if input from class A} \\ 0, & \text{if input from class B} \end{cases} \end{aligned}$$

where $0 \leq \eta \leq 1$, a positive gain function that controls the adaption rate

Your task is to:

- **Design** three different programs for your designed dataset
- **Analyze** these program
- **Evaluate** the correctness of the program and the accuracy of these algorithm.
- **Apply** perceptron learning algorithm with Widrow-Hoff delta rule to solve AND problem.