**EXPERIMENT NO .10**

**AIM:** Implementation of Single Layer Perceptron Training algorithm for given example dataset.

**Implementation:**

import numpy as np

# Sigmoid Activation Function & Derivative

def sigmoid(x):

    return 1 / (1 + np.exp(-x))

def sigmoid\_derivative(x):

    return x \* (1 - x)  # Derivative of sigmoid

# Define XOR Dataset

X = np.array([[0, 0], [0, 1], [1, 0], [1, 1]])  # Inputs

y = np.array([[0], [1], [1], [0]])  # XOR outputs

# Initialize Weights & Biases

np.random.seed(1)

input\_neurons = 2

hidden\_neurons = 2

output\_neurons = 1

W1 = np.random.uniform(-1, 1, (input\_neurons, hidden\_neurons))  # Weights (Input → Hidden)

b1 = np.zeros((1, hidden\_neurons))  # Bias for Hidden Layer

W2 = np.random.uniform(-1, 1, (hidden\_neurons, output\_neurons))  # Weights (Hidden → Output)

b2 = np.zeros((1, output\_neurons))  # Bias for Output Layer

learning\_rate = 0.5

epochs = 10000

# Training Loop

for epoch in range(epochs):

    # Forward Propagation

    hidden\_input = np.dot(X, W1) + b1

    hidden\_output = sigmoid(hidden\_input)

    final\_input = np.dot(hidden\_output, W2) + b2

    y\_pred = sigmoid(final\_input)

    # Compute Error

    error = y - y\_pred

# Backpropagation

    d\_y\_pred = error \* sigmoid\_derivative(y\_pred)  # Derivative of loss w.r.t output

    d\_hidden = d\_y\_pred.dot(W2.T) \* sigmoid\_derivative(hidden\_output)  # Hidden layer error

    # Update Weights and Biases

    W2 += hidden\_output.T.dot(d\_y\_pred) \* learning\_rate

    b2 += np.sum(d\_y\_pred, axis=0, keepdims=True) \* learning\_rate

    W1 += X.T.dot(d\_hidden) \* learning\_rate

    b1 += np.sum(d\_hidden, axis=0, keepdims=True) \* learning\_rate

    # Print Error

    if epoch % 1000 == 0:

        print(f"Epoch {epoch} - Error: {np.mean(np.abs(error))}")

# Testing

print("\nFinal Predictions:")

print(y\_pred.round())

Epoch 0 - Error: 0.4993115461156098

Epoch 1000 - Error: 0.14014506815954345

Epoch 2000 - Error: 0.05327964300268032

Epoch 3000 - Error: 0.03780967281606503

Epoch 4000 - Error: 0.030679375964888487

Epoch 5000 - Error: 0.026405146117187903

Epoch 6000 - Error: 0.023492200189944003

Epoch 7000 - Error: 0.021348885711484702

Epoch 8000 - Error: 0.019689247027391152

Epoch 9000 - Error: 0.018356376355077773

Final Predictions:

[[0.]

[1.]

[1.]

[0.]]