Philadelphia University **Student Name:**

Faculty of Engineering **Student Number:**

Dept. of Computer Engineering

Second Exam, First Semester: 2015/2016

Course Title:	**Neural Networks and Fuzzy Logic**	**Date:**	27/12/2015
Course No:	**630514**	**Time Allowed:**	50 minutes
Lecturer:	Dr. Qadri Hamarsheh	**No. Of Pages:**	4

Information for candidates

1. *This exam paper contains 4 questions totaling 20 marks.*
2. *The marks for parts of question are shown in round brackets.*

Advices to candidates

1. *You should attempt all sub questions.*
2. *You should write your answers clearly.*

Basic notions: *The aims of the questions in this part are to evaluate the required minimal student knowledge and skills. Answers in the pass category represent the minimum understanding of basic concepts: different Learning Rules- Perceptron Learning Rule, backpropagation algorithm, Hopfield network, Bidirectional Associative Memory, Kohonen self-organizing map and their Matlab Implementation.*

Question 1 ***Multiple Choice*** ***(7 marks)***

Identify the choice that best completes the statement or answers the question.

1) Which of the following equations is the best description of the **Perceptron Learning Rule**?

a) $\Delta W_k = \eta y_k X$

b) $\Delta W_k = \eta\,(X - W_k)$

c) $\Delta W_k = \eta\,(d_k - y_k)X$

d) $\Delta W_j = \eta_j\,(X - W_j)$, **where** $\eta_j < \eta$ **and** $j \neq k$

Where X is the input vector, η is the learning rate, W_k is the weight vector, d_k is the target output, and y_k is the actual output for unit k.

2) In the backpropagation algorithm, how is the **error function** usually defined?

a) $\frac{1}{2}\sum_j (weight_j \times input_j)$ **for all inputs** j

b) $\frac{1}{2}\sum_j (target_j - output_j)^2$ **for all outputs** j

c) $\frac{1}{2}\sum_j (target_j - output_j)$ **for all outputs** j

d) None of above

3) A Hopfield network has **10** neurons. How many **adjustable parameters** does this network contain?

a) 45 **b) 90**

c) 100 **d) 1024**

4) Give the **equation** that can be used to convert the unipolar binary data (**x**) to bipolar binary data (**y**).

a) $\mathbf{y = 2x}$ **b)** $\mathbf{y = -2x - 1}$

c) $\mathbf{y = 2x + 1}$ **d)** $\mathbf{y = 2x - 1}$

5) If the associated pattern pairs $(\mathbf{x}, \mathbf{y})$ are different and if the model recalls a **y** given an **x** or vice versa, then it is termed as

a) **Auto correlator** **b)** **Auto-associative memory**

c) **Heteroassociative memory** **d)** **Double associative memory**

6) An advantage with **gradient descent** based methods, such as back propagation, is that they cannot get stuck in local minima.

a) **True** **b)** **False**

7) The second stage of back propagation training is _____

a) **initialization weights** **b)** **back propagation of errors**

c) **feed forward** **d)** **updating of weights and bias**

Question 2 ***(3 marks)***

Determine the **weight matrix** for an auto-associative, discrete Hopfield Network (as discussed in class) that has four neurons and has "**learned**" the patterns**.**

$$p_1 = \begin{bmatrix} 1 \\ 1 \\ -1 \\ -1 \end{bmatrix}, \qquad p_2 = \begin{bmatrix} 1 \\ -1 \\ 1 \\ -1 \end{bmatrix}$$

Solution

Familiar and Unfamiliar Problems Solving: *The aim of the questions in this part is to evaluate that the student has some basic knowledge of the key aspects of the lecture material and can attempt to solve familiar and unfamiliar problems different Learning Rules- Perceptron Learning Rule, backpropagation algorithm, Hopfield network, Bidirectional Associative Memory, Kohonen self-organizing map and their Matlab Implementation.*

Question 3 ***(4 marks)***

Explain **Bidirectional Associative Memory** training algorithm.

Solution

Question 4 *(6 marks)*

A **Kohonen self-organizing map** is used to cluster **four vectors**. Let the vectors to be clustered be

(1, 1, 0, 0); (0, 0, 0, 1); (1, 0, 0, 0); (0, 0, 1, 1)

The maximum number of **clusters** to be formed is

$$\mathbf{m = 2.}$$

Suppose the **learning rate** is

$$\boldsymbol{\alpha = 0.6,}$$

The neighborhood of node **J** is set so that only one cluster updates its weights at each step ($R = 0$).

Initial weight matrix:

$$\begin{bmatrix} 0.2 & 0.8 \\ 0.6 & 0.4 \\ 0.5 & 0.7 \\ 0.9 & 0.3 \end{bmatrix}$$

a) Calculate the updates in the weight matrix after training the network using the first vector, **(1, 1, 0, 0)** *(3 marks)*

b) Write a matlab program to *(3 marks)*

- Load these input vectors.
- Create a Self-Organizing Map.
- Train the Network.
- View the Network.
- Plot results using different SOM plots.

Solution

GOOD LUCK