NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY
FACULTY OF APPLIED SCIENCE
DEPARTMENT OF COMPUTER SCIENCE
JUNE EXAMINATIONS 2004

COURSE: NEURAL NETWORKS AND PDP
CODE: SCS 5202

INSTRUCTIONS TO CANDIDATES

This question paper consists of **section A** and **section B.**
Answer the question in **section A** and **any four (4)** questions in **section B**

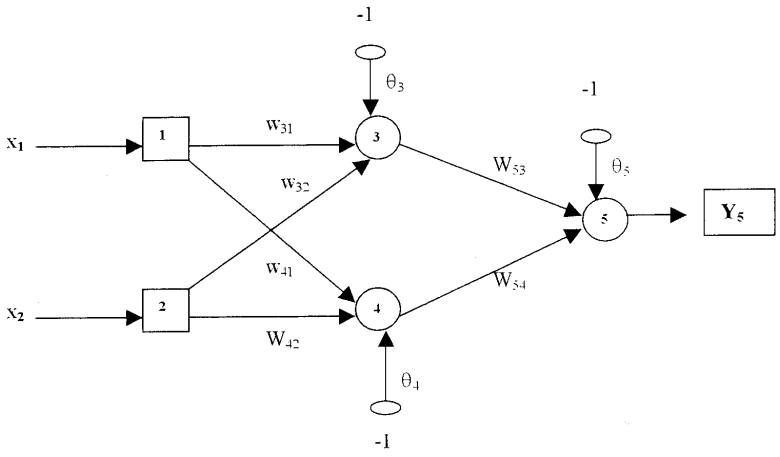
3 HOURS

SECTION A

QUESTION ONE

a) Derive the Backpropagation training algorithm. [10]

b) Consider the following three-layered back-propagation network. Suppose the network is required to perform logical operation Exclusive-Or. The initial weights and threshold levels are set randomly as follows: $w_{31} = 0.5$, $w_{41} = 0.9$, $w_{32} = 0.4$, $w_{42} = 1.0$, $w_{53} = -1.2$, $w_{54} = 1.1$, $\theta_3 = 0.8$, $\theta_4 = -0.1$, and $\theta_5 = 0.3$.



If the inputs x1 and x2 are equal to 1 and the desired output $Y_{d,5}$ is 0. Supposing that the network is trained based on the sigmoid function.

i) Calculate the actual outputs of neurons 3 and 4 in the hidden layer. [5]

ii) Determine the actual output of neuron 5 in the output layer and hence find the error **e** [4]

SECTION B

QUESTION TWO

a) Describe and outline the difference between **autoassociative** and **heteroassociative** types of memory. [5]

b) What is the bidirectional associative memory (BAM)? Using an example explain how the BAM works. [10]

c) Compare and contrast the BAM and Hopfield network models [5]

QUESTION THREE

a) How does an artificial neural network model the brain? [4]

b) Describe the two major classes of learning paradigms: **supervised** and **unsupervised** learning. What are the features that distinguish these two paradigms from each other. [10]

c) With reference to self Organising Map (SOM) neural networks explain the following terms:

i) Clustering [2]
ii) Euclidean distance [2]
iii) Prototype vectors [2]

QUESTION FOUR

a) Consider a multilayer feedforward network, all the neurons of which operate in their linear regions. Justify the statement that such a network is equivalent to a single layer feedforward network. **[4]**

b) A recurrent network has 3 source nodes, 2 hidden neurons, and 4 output neurons. Construct an architectural graph that would be descriptive of such a network. [6]

c) Write a C++ program to represent the network in b). It is sufficient to define the relevant classes and their relationships, without implementing the functions. [10]

QUESTION FIVE

a) What are the problems with using a perceptron as a biological model? [5]

b) Outline the learning algorithm in simple perceptron and hence demonstrate perceptron learning of the binary logic function AND. [10]

c) Why can the perceptron learn only linearly separable function? [5]

QUESTION SIX

a) Define the following terms

i)	Activation	[2]
ii)	Convergence	[2]
iii)	Learning rate	[2]
iv)	Gradient descent	[2]
v)	Momentum term	[2]
vi)	Threshold	[2]

b) Neural computing is becoming a major processing technique. Describe the advantages and disadvantages such a technique has over conventional processing techniques. [8]

QUESTION SEVEN

The activation function of a feed-forward **neural** network, denoted by **f**, is usually a sigmoid or a step function. Suppose, instead, that **f** is a linear function. (For simplicity, you may assume that **f** is the same linear function at each node.) What is the expressive power of the **neural** network in this case? You should answer this question in two steps:

a) Assume first that the network has only one hidden layer. For a given value of the weights W, write down equations for the activation of the units in the output layer as a function of W and the input layer I, without any explicit mention of the activation of the units in the hidden layer. Then show that there is a network with no hidden units that computes the same function as this two-layer network.

b) Now consider a network with an arbitrary number of hidden layers. Show that this network can also be reduced to an equivalent network with no hidden units.

From this analysis, what can you conclude about the expressive power of **neural networks** with linear activation functions? [20]

END OF QUESTION PAPER

GOOD LUCK