FACULTY OF ELECTRICAL & ELECTRONICS ENGINEERING

TEST 2

COURSE	**:**	**INTELLIGENT CONTROL**
COURSE CODE	**:**	**BEE4333**
LECTURER	**:**	**DR. DWI PEBRIANTI**
		DR. NOR MANIHA ABDUL GHANI
DATE	**:**	**26 MAY 2016**
DURATION	**:**	**1 HOUR 30 MINUTES**
SESSION/SEMESTER	**:**	**SESSION 2015/2016 SEMESTER II**
PROGRAM	**:**	**BEE**

NAME: ____

STUDENT ID: ____

NRIC: ____

INSTRUCTIONS TO CANDIDATES

1. This question paper consists of **TWO (2)** questions. Answer **ALL** questions.
2. All the calculations and assumptions must be clearly stated.
3. Write your answers in the exam booklet provided.

DO NOT TURN THIS PAGE UNTIL YOU ARE TOLD TO DO SO

This examination paper consists of **FIVE (5)** printed pages including front page

QUESTION 1

Consider the neural network model as shown in **Figure 1** with the following assumptions:

- S1 is a sigmoid activation function and S2 is a hyperbolic tangent function such that S1: $f(x) = \dfrac{1}{1+e^{-x}}$ and S2: $f(x) = \dfrac{e^{x} - e^{-x}}{e^{x} + e^{-x}}$ and the neurons shown as “/” are linear.

- Assume the weights between the layers *i* and *j* (w_{ji}) have an initial value of 0.3 and the weights between the layers *j* and *k* (w_{kj}) have initial value of 0.2.

- Assume the learning rate, $\eta = 0.4$ and momentum, $\alpha = 0.9$.

- The inputs are given as follows: $x1=1, x2=1, x3=0$.

- Assume the following notations: net_j for input of neuron *j*, O_j for output of neuron *j* and net_k for input of neuron *k*, O_k for output of neuron *k* (e.g $net_{k=2}$ for input of neuron $k=2$)

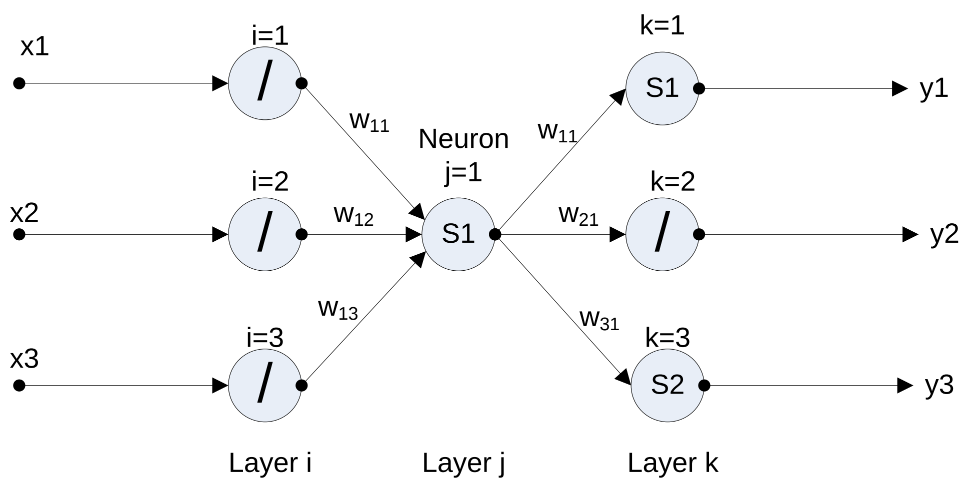

Figure 1

Answer the following questions:

a) Calculate the value of each of the outputs. *(y1, y2, y3).*

[8 Marks]

b) Suppose the backpropagation algorithm is used to adapt the weights of the neural network, **derive the equation** of the weights adaptation between the layers *j* and *k* (Δw_{kj}) **[in this case *j=1* and *k=2*] based on output *y2***.

Given:

$$\Delta w_{kj} = \eta \delta_k O_j$$

$$\Delta w_{kj}(t+1) = \Delta w_{kj} + \alpha \Delta w_{kj}(t)$$

$$w_{kj}(t+1) = w_{kj} + \Delta w_{kj}(t+1)$$

where O_j is the output of neuron *j*, η is the learning rate and δ_k is the error signal between layers *k* and *j* such that:

$$\delta_k = O_k(1 - O_k)(E_k)$$

$$\delta_j = O_j(1 - O_j) \sum \delta_k W_{kj}$$

and where E_k is the error between the neural network output (*y*) and the target (t), such that:

$$E_k = \frac{1}{2}(t - y)^2$$

[6 Marks]

c) Based on the assumptions as given, calculate next value of weight at the branch (*k=2 and j=1*) assuming the **target, t_2=0.**

[8 marks]

d) Suppose hidden layer neuron, *j=1* is changed to hyperbolic function, *S2*:

$f(x) = \dfrac{e^x - e^{-x}}{e^x + e^{-x}}$, and neuron, *k=2* is maintained linear function,

Repeat (a) to **calculate the output, *y2*.**

[3 Marks]

QUESTION 2

(a) Genetic Algorithm (GA) is a part of evolutionary computing that was invented by John Holland.

(i) Draw the GA cycle of reproduction.

[2 Marks]

(ii) Base on (i), explain the working principle of GA.

[3 Marks]

(b) Genetic algorithm (GA) can be used to solve a simple mathematical problem. Consider a mathematical function as shown below:

$$a + 2b + 3c + 4d = 30$$

Genetic algorithm is used to find the appropriate values of parameter *a*, *b*, *c* and *d*. The chromosome can be represented as:

a	b	c	d

To speed up the computation, these **4 (FOUR)** parameters are restricted to have integer values between *0* and *30*.

The initial populations are listed in Table 2.1

Table 2.1 Initial Population

Population Number	[a b c d]
1	[12 05 23 08]
2	[01 21 18 03]
3	[10 04 13 14]
4	[20 01 10 06]

(i) The fitness function is given by

$$f(x) = a + 2b + 3c + 4d - 30$$

Calculate the fitness value for each population listed in **Table 2.1**. Arrange from the fittest individual to the less fit individual.

[5 Marks]

(ii) For the **1st generation** do the following:

a) Cross the fittest two individuals using one-point crossover at the middle point.

[4 Marks]

b) Suppose the mutation rate, $\rho_m = 10\%$, calculate the number of mutations by applying the equation below:

$$n_m = \rho_m \times n_g \times n_p$$

where n_m, ρ_m, n_g, n_p are number of mutations, mutation rate, number of gene in individual and number of populations, respectively.

[2 Marks]

c) Number of mutations obtained from (ii-b) is a number of gene that can be mutated. The number that will be mutated is generated randomly. Suppose that the generated random number is **12** and **18**, define which individuals that will be mutated.

[2 Marks]

d) Mutate the gene of individuals obtained in (ii-c) with the equation below:

$$m_g = \rho_m \times v_g$$

where m_g, ρ_m, v_g are new mutated value, mutation rate and value of original gene, respectively.

[2 Marks]

(iii) Calculate the fitness value for each new population obtained in (ii). (**Note** : **FOUR (4)** new population will be generated from (iii)). Evaluate the performance after the **FIRST (1st)** generation.

[5 Marks]

[CO3, PO2, C4]