MURANG'A UNIVERSITY OF TECHNOLOGY

SCHOOL OF ENGINEERING

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING

UNIVERSITY ORDINARY EXAMINATION

2018/2019 ACADEMIC YEAR

FIRST YEAR **FIRST** SEMESTER EXAMINATION FOR, MASTER OF TECHNOLOGY IN ELECTRICAL AND ELECTRONICS ENGINEERING

EET 602 – COMPUTATIONAL INTELLIGENCE IN ENGINEERING

DURATION: 3 HOURS

DATE: 18/12/2018

TIME: 9 – 12 P.M.

Instructions to candidates:

1. Answer any four questions.
2. Mobile phones are not allowed in the examination room.
3. You are not allowed to write on this examination question paper.

ANSWER ANY FOUR QUESTIONS

QUESTION ONE (25 MARKS)

a) Define an expert system and hence name its basic elements (5marks)

b) The computer is a major component of Artificial Intelligence (AI). Name the components that make AI attractive in comparison with Human Intelligence (5marks)

c) Briefly describe the learning methods in Artificial Neural Networks and Hence show its advantages over the conventional Digital computer (5marks)

d) Define defuzzification and hence describe the implementation of Centre of Area (COA) method (5marks)

e) Define the main component of all genetic Algorithm (GA). Explain the reasons why GA belongs to the class of AI methods known as "weak methods" (5marks)

QUESTION TWO (25 MARKS)

a) The knowledge in an expert system is often organized in the form of a set of IF …. THEN production Rules. Given an Engineering control system with variables X, Y and Z as parameters, Describe a matrix with 9 Rules and show how they are compiled using IF…. THEN RULES. (5marks)

b) Fuzzy logic has been widely applied in electric drive systems. Consider the fuzzy speed control system where the input signals are E and dE while the output signal is DU. Assuming triangular Membership functions of each signal which has only positive variables such as zero, positive small, positive medium, and positive big. Discuss how a fuzzy set defined by these variable can be used to design the fuzzy controller.(6marks)

c) An aircraft landing control requires that the desired downward velocity is proportional to the square of the height. Thus at higher altitudes a large downward velocity is required. As the height diminishes, the down velocity gets smaller and smaller. As the height becomes vanishingly small the down velocity also goes to zero. In this way the aircraft will descend from the altitude but will touch down very gently to avoid damage. The membership values for height, velocity and control force and indicated in Fig 1a, Fig 1b and Fig 1c.

The simulations may be done using the formulae below;

$$h_1 = h_0 + v_0$$
$$v_1 = v_0 + f_0$$

Assuming the following data; initial height, h_0=1000 metres, initial velocity, v_o=20m/s and control f_o to be computed from the initial conditions.

Using the information above;

i. Develop an FAM table of height against velocity (6marks)

ii. Conduct a simulation of the final descent and landing approach of the aircraft for two cycles using the centroid method (8marks)

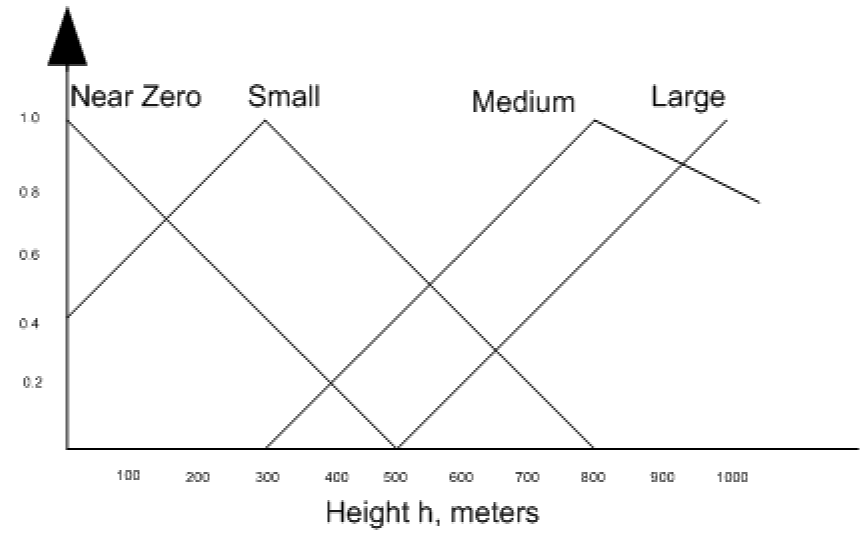
Near Zero
Small
Medium
Large
1.0
0.8
0.6
0.4
0.2
100 200 300 400 500 600 700 800 900 1000
Height h, meters

Fig 1a

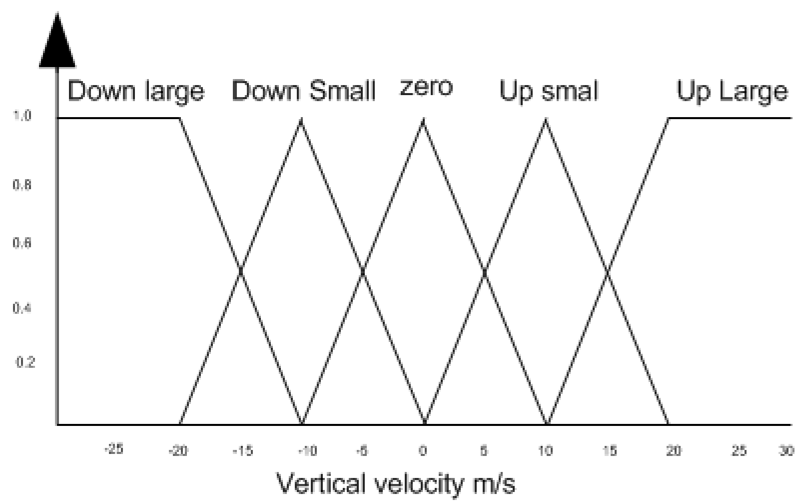
Down large
Down Small
zero
Up smal
Up Large
1.0
0.8
0.6
0.4
0.2
-25 -20 -15 -10 -5 0 5 10 15 20 25 30
Vertical velocity m/s

Fig.1b

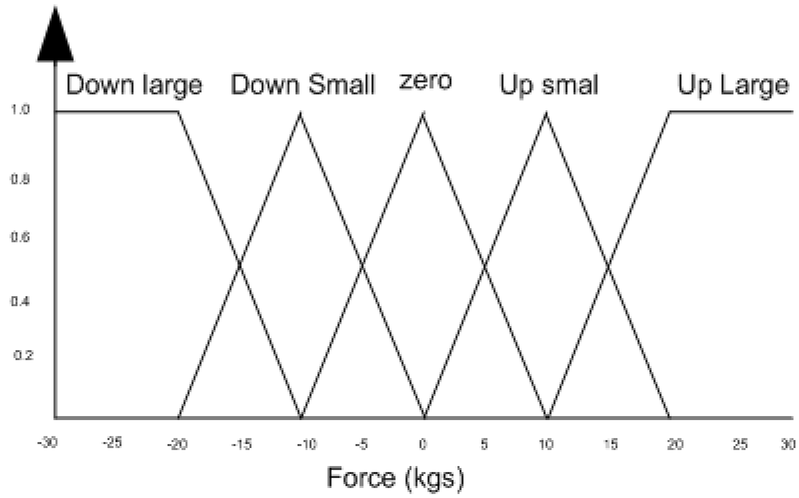

Fig.1c

QUESTION THREE (25 MARKS)

a) Define an artificial Neural Network (ANN) and then draw an Artificial Neural Network with linear activation function. Indicate an area of application of ANN in engineering systems and explain the reason sigmoid activation in the most preferred as an activation function (6marks)

b) Briefly explain why ANN are often characterized as fault tolerant (5marks)

c) A Neural Network made up of Four layers has the initial quasi random values that have been assigned to different weights connecting the path between the elements in the layers of the Network as in table 1

Table 1

$w^1_{11}=0.5$	$W^2_{11}=0.1$	$W^3_{11}=0.30$
$w^1_{12}=0.4$	$W^2_{12}=0.55$	$W^3_{12}=0.35$
$w^1_{13}=0.1$	$W^2_{13}=0.35$	$W^3_{21}=0.35$
$w^1_{21}=0.2$	$W^2_{21}=0.20$	$W^3_{22}=0.25$
$w^1_{22}=0.6$	$W^2_{22}=0.45$	$W^3_{31}=0.45$
$w^1_{23}=0.2$	$W^2_{23}=0.35$	$W^3_{32}=0.30$
	$W^2_{31}=0.25$	
	$W^2_{32}=0.15$	
	$W^2_{33}=0.60$	

The output equation is of the form;

$$O = \frac{1}{1 + e^{-[\sum x_i w_i - t]}}$$

Where O=Output of the threshold element using sigmoid function

x_i=Inputs to the threshold elements (i=1, 2….n)

w_i= weights attached to the inputs

t= threshold for the elements

Assuming the threshold value of t=0 initially and the first data points inputs for the neural network at x_1=0.05 and x_2=0.02

1. Draw the Neural Network to be trained (5marks)
2. Determine the outputs for the second, third and fourth layers (9marks)

QUESTION FOUR (25 MARKS)

a) Define a "fitness function" in Genetic algorithm and briefly explain how it is related to solving problems in Engineering systems (5marks)
b) Given two strings in Figure 3, describe the crossover operation as used in Random fashion of population location in Genetic Algorithms. Explain how mutation can take place in this case and what impact it has in finding the optimum solution to the given problem (8 marks)

1	0	0	0	1	0	1	0	0	1

0	1	0	1	0	1	0	1	1	0

Figure 3

c) An Electrical communication system has a fitness function

$$J = 1 + sinx$$

As shown in figure 4. Assuming that the solution space has 31 values and that each solution is represented by a five digit binary string ranging from 00000 to 11111.

The value of J in equation 1 is therefore 11.6^o (0.201rad). If the population has four members, spinning a coin (heads=1, tail=0) produced the following initial population

00101 11110 00001 00011

Determine the offspring from the initial generation to the second generation (12marks)

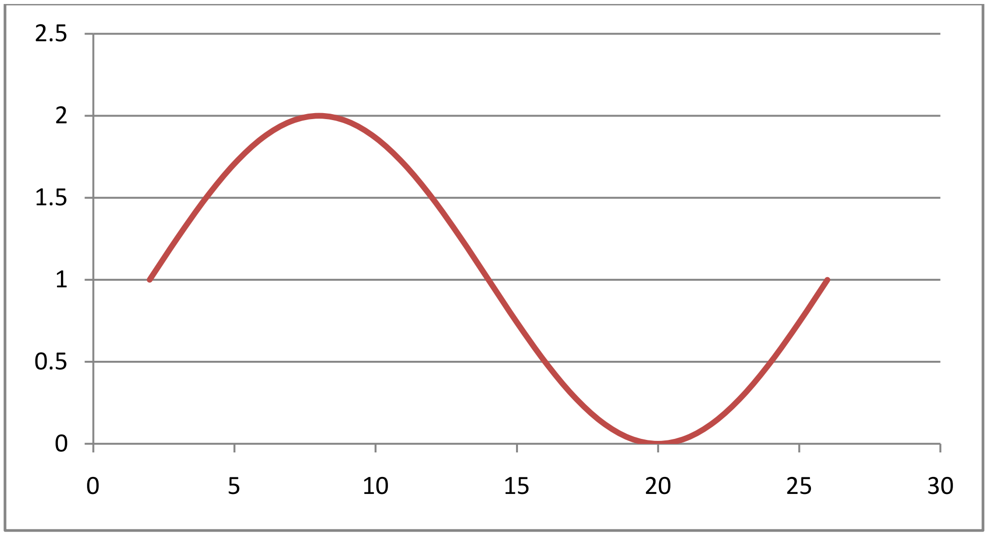

Figure 4.

QUESTION FIVE (25 MARKS)

a) A constant force F, acts on a body with mass, m moving on a smooth surface at velocity, v. the effective power of this force will be EP=F(V) sin θ. using the partitioning for the input variable θ, as shown in Fig G5a and partitioning for the output variable ,EP, as shown in Q5b and the following three simple rules;
   1. If Z(zero) is then ME(Most Efficient)
   2. If NS(negative small or PS (Positive Small) then NE(Not Efficient)
   3. PB (Positive Big) or NB(Negative Big) then NME (Negative Most Efficient such as breaking)

Conduct a graphical simulation and plot the results on a graph of EP versus θ. Show the method associated with exact solution of the problem at Hand. (12.5 marks)

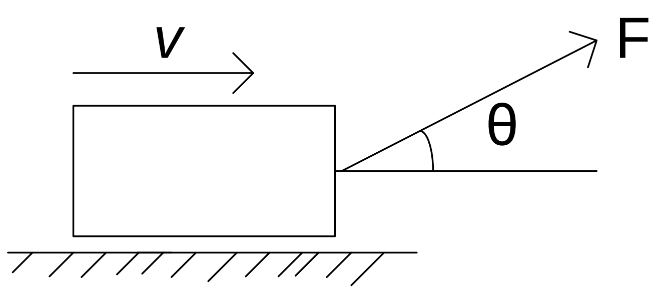

Fig 5a

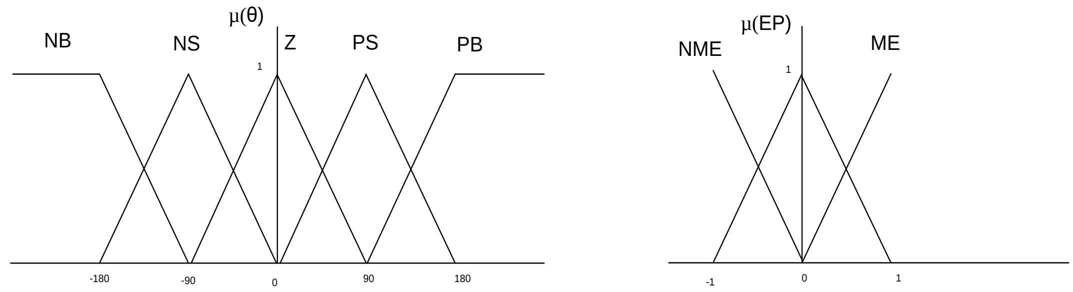

Fig 5b

b) Using the data shown in the accompanying Table 2, show the first iteration in trying to compute the membership values for the input variables X_1, X_2 and X_3 in the output regions R_1 and R_2. Assume a random set of weights for your neural network.

Table 2

X_1	X_2	X_3	R_1	R_2
1.0	0.5	2.3	1.0	0.0

i. Use a 3x3x1 Neural Network
ii. Use a 3x3x2 Neural Network
iii. Explain the apparent difference in Results when using (i) and (ii) (12.5marks)