KISII UNIVERSITY
UNIVERSITY EXAMINATIONS
SPECIAL EXAMINATION
SECOND YEAR EXAMINATION FOR THE AWARD OF THE DEGREE OF BACHELOR OF SCIENCE RENEWABLE ENERGY/GEOPHYSICS & MINERALOGY
SECOND SEMESTER 2021/2022
(JULY, 2022)

PHRE 224: INTRODUCTION TO COMPUTER SIMULATIONS

STREAM: Y2 S2   **TIME: 2 HOURS**

DAY: WEDNESDAY, 8: 00 AM – 10.00 AM   DATE: 27/07/2022

INSTRUCTIONS:

1. *Do not write anything on this question paper.*
2. *Answer Question ONE (Compulsory) and any other TWO questions.*

QUESTION ONE [30 MARKS]

a)   Explain giving an example in each the following three categories of programing languages
   - i)   Machine language   [2marks]
   - ii)   Assembly language   [2marks]
   - iii)   High-level language   [2marks]

b)   Distinguish between a compiler and interpreter   [2marks]

c)   Name three primary windows in matlab   [3marks]

d)   Define the terms vector and matrix as used in matlab. [2marks]

e)   By use of an example, show how a 2x3 matrix is defined in matlab
                                                           [1marks]

f)   The following array of numbers is desired
   1.0000 1.5000 2.0000 2.5000 3.0000 3.5000 4.0000 4.5000 5.0000
   by assigning these to variable x show how this will be done in matlab
                                                           [1 mark]

g) Below is the output of a matlab code
    A =
            0 2 3
            4 2 6
            9 8 9
    Write the output of the following codes
    i)   >>A(3,2)   [1mark]
    ii)   >>A(:,3)   [1mark]
    iii)   >>A*A   [2marks]
    iv)   >>A.*A   [2marks]
h) Given the set of data X=2, 4, 5, 5, 1, 2, 4, 5, 8, 5; express it as a vector
    hence write a code that will output:
    i)   sum of elements of X   [1mark]
    ii)   mean of X   [1mark]
    iii)   Standard deviation of X   [1mark]
    iv)   number of elements in X   [1mark]
    v)   highest element in X   [1mark]
    (Note: Output values are not necessary)
i) What is the difference between a for loop and a while loop?   [2marks]

QUESTION TWO [20 MARKS]
a) Define function as used in matlab.   [1marks]
b) Name any three inbuilt functions in matlab   [3marks]
c) Below is a plot of two functions y1=sin(x) and y2=cos(x). Write down the
    code used to generate the plot.   [10 marks]

A plot of Sine and Cosine functions
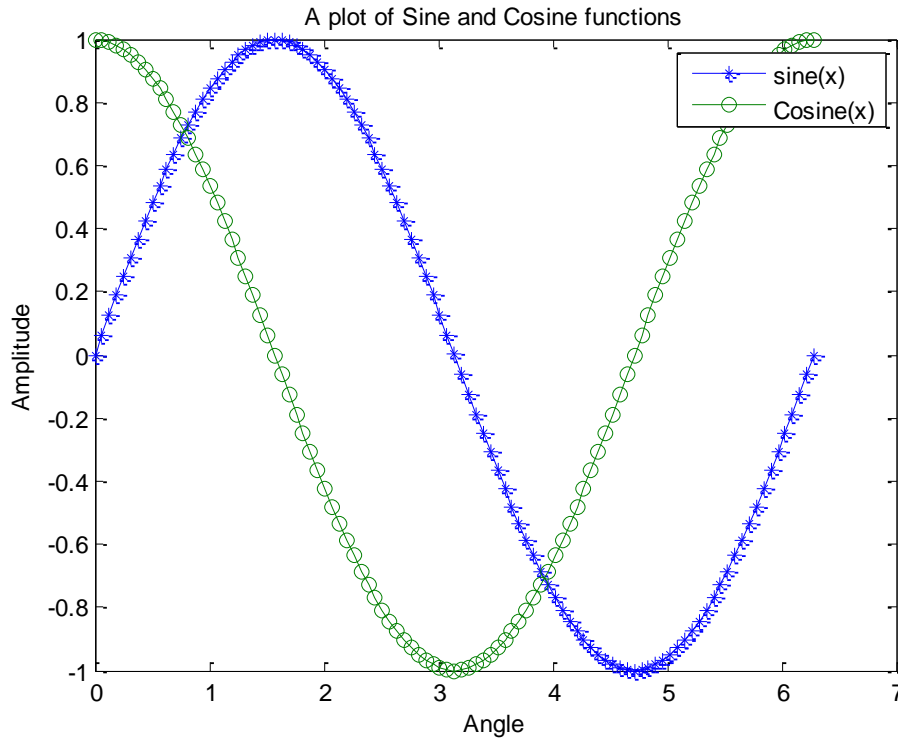
d) Develop an M-file function that is passed a numeric grade from 0 to 100 and returns a letter grade according to the scheme:

Letter	Criteria
A	$70 \leq$ Numeric grade ≤ 100
B	$60 \leq$ Numeric grade <70
C	$50 \leq$ Numeric grade <60
D	$40 \leq$ Numeric grade <50
F	$0 \leq$ Numeric grade <40

The first line of the function should be

function grade = lettergrade(score)   [6marks]

QUESTION THREE [20 MARKS]

a) Use Gauss elimination to solve the following   [7marks]

$$10x_1 + 2x_2 - x_3 = 27$$

$$-3x_1 - 5x_2 + 2x_3 = -61.5$$

$$x_1 + x_2 + 6x_3 = -21.5$$

b) Below is a code to implement Naïve Gauss elimination method

```
1    function x = GaussNaive(A,b)
2    % x-Output solutions of the equations
3    % A-Matrix of coefficients
4    % b-Right hand solution as a column vector
```

```
5    %
6    [m,n] = size(A);
7    if m~=n, error('Matrix A must be square'); end
8    a = [A b];
9    nb = n+1;
10   for i = 1:n-1
11   for j = i+1:n
12   factor = a(j,i)/a(i,i);
13   a(j,i:nb) = a(j,i:nb)-factor*a(i,i:nb); end
14   end
15   x = zeros(n,1);
16   x(n) = a(n,nb)/a(n,n);
17   for j = n-1:-1:1
18   x(j) = (a(j,nb)-a(j,j+1:n)*x(j+1:n))/a(j,j);
19
```

i)   How will you call this function to solve the problem in (a) above.
ii)   Write down the outputs of lines 6, 8, 9, and 15   [4marks]
iii)   An attempt run this code failed. Identify the error   [1 mark]

c)   Newton Raphson method is an iterative method of finding the solution of an equation graphically. Its equation is given as

$$x_{i+1} = x_i - \frac{f(x_i)}{f'(x_i)}$$

Use this method to estimate the root of $f = \exp(-x) - x$ with 4 iterations. Use initial guess of x=0.5.   [4marks]

d)   A function to implement Newton Raphson method is given below. Explain what lines 11,14,15 and 18 does.   [4marks]

```
1.function [x1,Error]=NewtonRaphson(xin,fx,Iter,Error)
2. %OUTPUT:
3. % x1-Solution of the problem
4. % Error-Final error of the solution
5. % INPUT:
6. % xin-initial guess of the solution
7. % fx- function whose solution is to be determined, fx must be
8. symbolic
9. % Iter- Approximate number of iterations
10. % Error-Expected Minimum Error

11. dfx=diff(fx);
12. for i=1:Iter
13.     syms x
14.     x1=xin-(subs(fx,x,xin)/subs(dfx,x,xin));
15.     x1=double(x1);
16.     Er=((x1-xin))/x1*100;
17.if Er<=Error
```

```
18.break
18.end
20.    xin=x1;
21. end
22. end
```

QUESTION FOUR [20 MARKS]

a) From Tailor's series of expansion, derive **forward, backward and central difference** approximation methods for estimating first derivatives of functions.   [12marks]
b) Write down a matlab function that implements the above three approximation methods. The function should accept inputs of the function to be differentiated and the value of x at which the derivative is to be determined. Outputs of the function should be the first derivatives of the three methods.   [6marks]
c) You are to use the above function to find the derivative of the following function at x=0.5 using a step size of h=0.5.
$$f(x) = -0.1x^4 - 0.12x^3 - 0.5x^2 - 0.24x + 1.2$$
Show how you will call your Matlab function to find the derivative of this function.   [2marks]

QUESTION FIVE [20 MARKS]
a) What is a model?   [1 mark]
b) Discuss any three classifications of models   [6marks]
c) What is simulation?   [1 mark]
d) State four advantages of simulation   [4marks]
e) Explain the following classifications of numerical methods for simulation:
    i) Single-step method   [1mark]
    ii) Multistep method   [1mark]
f) Describe numerical integration of a function using trapezoidal rule and write a simple matlab function to implement the integration. [6marks]