1. Write a script which performs the following operations (in sequence)

a) creates a 20x40 array, A, in which each element (or entry) in rows 1 through 10 is assigned the value 1 and each element in rows 11 through 20 is assigned the value 2;

b) creates a new 20x40 array, B, which is the same as A except row 11 for which B(11,j) =1/j, for 1<j<40;

c) creates a new 20x41 array, C, which is the same as B for columns 1 through 40 but also includes a column 41 in which all elements are assigned the value 3;

d) creates a new 20x41 array, P, which is the same as C except the first ten entries on the main diagonal for which is P(i,i) = 2 * C(i,i) for 1<i<10;

e) creates a new 20x41 array, Q, which is the same as P except the (1,2) entry for which Q(1,2) is assigned the value 7;

f) creates a new 20x41 array, R, in which each element is the square of the corresponding element in Q- for example, R(1,2) will be assigned the value 49;

g) creates a scalar "bigsum" which is the sum of all the elements (820 in total) of the array.

2. A 6x6 matrix is given below. Write a code such that it holds the nonzero values of the matrix as a vector.

$$U = \begin{bmatrix} 3 & 5 & 0 & 0 & 2 & 1 \\ 0 & 9 & 0 & 0 & 0 & 6 \\ 0 & 0 & 5 & 0 & 0 & 0 \\ 9 & 8 & 4 & 5 & 2 & 6 \\ 0 & 0 & 0 & 0 & 0 & 0 \\ 3 & 5 & 0 & 0 & 0 & 0 \end{bmatrix}$$

Hint: You have to use two "for" loops to search the row and columns of U matrix and one "if" conditional to check whether the values are different than zero.

The output of this code should be:

$$F = \begin{bmatrix} 3 & 5 & 2 & 1 & 9 & 6 & 5 & 9 & 8 & 4 & 5 & 2 & 6 & 3 & 5 \end{bmatrix}$$

3. Solve the system of nonlinear equations of Lab 5 using "for" loop. Perform 5 iterations, the nonlinear equations are given below:

$$\delta_1^2 + \delta_2^2 + 6\delta_2 - 0.1809 = 0$$
$$\delta_1^2 + \delta_2^2 + 8\delta_2 - 0.1280 = 0$$

4. Write a script code that solves the linear equations given below by using Gauss-Elimination:

$$\begin{aligned} 2x_2 + x_3 &= -8 \\ x_1 - 2x_2 - 3x_3 &= 0 \\ -x_1 + x_2 + 2x_3 &= 3. \end{aligned}$$

Hint: You can swap the rows if necessary.

5. Write a script that will use the random number generator *rand* to determine the following:

a) The number of random numbers it takes before a number between 0.8 and 0.85 occurs.

b) The number of random numbers it takes to add up to 20 (or more).

c) The number of random numbers it takes before the mean of those numbers is within 0.01 of 0.5.

6.

a) Write a MATLAB function that takes n ,matrix size, as input and returns a n x n matrix that takes random number between – n and n at diagonals and random number betwen -1 and 1 for the rest.

b) Write a script that takes output of function in part a and check whether the matrix is diagonally dominant or not. Your code should print a message as “The matrix is diagonally dominant” or “The matrix is not diagonally dominant”.

7. The first lines of the following code in MATLAB generate an independent variable X and a dependent variable Y. Y is a linear function of X with some random error added. (Random error is generated with the *rand* command in MATLAB.) If you are curious about this or any other built-in functions in MATLAB, always use help menu. Size is a command that is used to determine the row or column size of any matrix.

a) You are now going to write a code for determining the Gauss-Legendre polynomial expression for interpolation between the x and y using these data points, and plot the obtained function between 0 and 16 in MATLAB. The following lines of code should provide you with a start to writing this code. Complete the code below.

```
clear all
x=0:8:16;
y=3+0.5*x+rand(1,size(x,2));
coun=0;
for i=0.0:0.1:max(x); %this is the x value at which you estimate the polynomials value
sum=0;
        for
            for
                if
                    prod=
                end
            end
            sum=
        end
    coun=coun+1;
    xnew(coun,1)=i;
    xnew(coun,2)=sum;
end
```

b) Plot the polynomial function you obtained between x values of 0 and 16. Use the plot command in MATLAB. Try what `xlabel('blank')` and `ylabel('blank')` does. Replace them with proper labels for your axes. You have three points. What is the order of polynomial you plotted?

8. You are going to write a code that integrate the following function using Simpson 1/3 rules by dividing the curve into n subintervals.

$$\int_0^5 (5x - x^2)\, dx$$

a) The following code writes function to use for integration. Is the code is right ? If not , correct it.

```
function [ output] = fx(x)
clear all
clc
output=5x-x^2;
end
```

b) Complete the following code that divides the curve into n subinterval (starting from n=4) and increase n value until the relative error (Lab 2) is less than 5 %.

```
clear all
clc

val=(5*25/2-125/3); % integral value of function
tol=0.05;
error=1;
n=2;
while error > 0.05

n=...;  % increase the number of equal subintervals
dx=....; %step size
sum=0;
for i=1:n/2 %number of intervals

    % write x values in terms of i,lower and upper boundary values
    x1=....;
    x3=....;
    x2=...;
    %add interval integration value to sum
    sum=sum+....;
end
%calculate error
error=....;
end
n
```

9.

a) Write a MATLAB function that is supposed to evaluate the following function:

$$f(x)=\begin{cases} x^3 & 0\le x<1 \\ 2-\dfrac{x^2}{5} & 1\le x<2 \\ x+x^2 & 2\le x \end{cases}$$

Note that, if x is smaller than 0, your code should print a message as *"x is smaller than 0, function is not defined!"*

b) Write a MATLAB script that finds the following integral using Trapezoidal Rule that calls f(x) from the MATLAB function that you written in Part (a):

$$\int_0^3 f(x)\,dx$$

Hint: Use step size (h) as 0.05.

References:

- Otto, S. R., Denier, J. P. An Introduction to Programming and Numerical Methods in MATLAB, Springer, 2005
- MIT Open Course Material, Numerical Computation for Mechanical Engineers Exercises, MIT, 2012