REVIEW PROGRAMMING
EML3041

Use any MATLAB functions available to you to do the problems, unless noted otherwise. For example, if you are solving a nonlinear equation, use the *solve* or *vpasolve* MATLAB command. Do one set at a time. First two are required, second one would be a check of intermediate competency, and the last one would be nice.

SET ONE

1) Find $\cos(60.75°)$. Note that the argument 60.75 is given in degrees.
   Answer: 0.4886

2) Find $\cos^{-1}(0.52)$ in degrees.
   Answer: 58.6677

3) Plot the volume of a spherical tank as a function of its radius as a **semi-log** plot. Use a range of radius of (0, 10). Show proper labels on the axes. Give the plot a suitable title.
   Hint: Volume of a spherical tank=$\frac{4}{3}\pi r^3$.

4) Subtract $\begin{bmatrix} 2 & 3 \\ 5.2 & 22 \\ 8 & 25 \end{bmatrix}$ from $\begin{bmatrix} 14 & 13 \\ 10.8 & -6 \\ 8 & -9 \end{bmatrix}$.

   Answer:
   ```
   12.0000   10.0000
    5.6000  -28.0000
         0  -34.0000
   ```

5) Find the first and second derivative with respect to time t of
   $x(t)=5t+ln(2t)$.
   Find $x'(6)$ and $x''(6)$.
   Answer: 5+1/t; 5.167; -0.02778

6) Solve the following nonlinear equation
   $3.993\times10^{-4} - 0.165x^2 + x^3 = 0$.
   Isolate the root between 0 and 0.11 by using loop and conditional statement.
   Answer: 0.062377

7) Solve the set of simultaneous linear equations using two methods: A\B to solve AX=B and inverse of A method to solve AX=B.

   $$\begin{bmatrix} 25 & 5 & 1 \\ 64 & 8 & 1 \\ 144 & 12 & 1 \end{bmatrix}\begin{bmatrix} a \\ b \\ c \end{bmatrix} = \begin{bmatrix} 106.8 \\ 177.2 \\ 279.2 \end{bmatrix}$$

8) Find the value of the area of a triangle of with sides of lengths 4, 10 and 12. The area of a triangle is given by

$$A = \sqrt{s(s-a)(s-b)(s-c)} \text{ where}$$

$$s = \frac{a+b+c}{2},$$

and *a, b, c* are the lengths of the three sides. The value of *s* should be calculated using MATLAB.

9) An aircraft position *x,* during an emergency landing exercise on a runway is timed as follows

t, s	0	5	10	17.5	25
x, m	200	800	1100	1200	1250

a) Find the 4th order interpolant to calculate location at any value of time

b) Find the location at t=11 s.

c) Estimate the velocity of the aircraft at 17.5 seconds.

d) Estimate the acceleration of the aircraft at 17.5 seconds.

e) At what time does the aircraft come to rest?

f) Plot velocity and acceleration as a function of time on the same graph till the time the aircraft comes to rest.

10) Write a program to find the sum of all elements of an array.

11) Write a program to accept a matrix and determine whether it is a sparse matrix. A sparse matrix is matrix that has more zero elements than nonzero elements.

12) Write a program to interchange the main diagonal elements of a square matrix with that of the secondary diagonal elements.

13) Write a program to accept a row vector, and find the second largest and second smallest elements in it.

SET TWO

14) Find $\int_{0.2}^{0.3} e^{2x} dx$ using the MATLAB command for integration.

Answer: 0.1651470514

15) Regress the (x,y) data pairs: (1,2), (2,5), (3,6), (4.5,9) to a first order polynomial. fprintf the polynomial. Find the value of y at $x=2.5$ from the first order polynomial you just found.

Answer: 1.9065*x+0.49533; 5.2617

16) Solve the following differential equation
$$7\frac{dy}{dt} + 3y = 4 , \quad y(0)=2$$
Also find $y(5)$ and $\frac{dy}{dt}(5)$.

Answer: 4/3 + 2/3 exp(- 3/7 x); 1.4115; -0.0335

17) Solve
$$\frac{d^2y}{dx^2} + 2\frac{dy}{dx} + 5 = x^2 , \quad y(0)=5, \frac{dy}{dx}(0) = 7$$
Also find $y(5)$ and $\frac{dy}{dx}(5)$.

Answer: 1/6 x^3 - 1/4 x^2 - 37/8 exp(-2 x) - 9/4 x + 77/8; 12.9581; 7.7504

18) Solve
$$\frac{d^2y}{dx^2} = 5x(30-x), \quad y(0)=5, y(30)=7$$
Also find $y(5)$ and $\frac{dy}{dx}(5)$.

Answer: - 5/12 x^4 + 25 x^3 - 168749/15 x + 5; -5.3380e+04; -9.5833e+03

19) Write a program to check if a given matrix is an identity matrix.

20) Write a program to find the frequency of odd numbers and even numbers in the input of a matrix.

21) Fibonacci developed a sequence 1, 1, 2, 3, 5, 8, 13, 21,… This sequence is developed by starting with numbers 1 and 1, and then the numbers following them are additions of previous two numbers, like 1+1=2, 1+2=3, 3+2=5, 5+3=8, 8+5=13 and so on. Write a function that generates the nth term of the sequence.

22) Write a program to calculate factorial value of a positive integer.

SET 3

23) A function $f(x)$ is defined below.
$$f(x) = x^2/4 - x^4/8 + x^6/12 - x^8/16 + \ldots\ldots$$
Use the first k terms of the series to calculate the value of the function in decimal format.
% k = number of terms in the series
% x = value of x in the series
- Using the for-end OR while-end loop to do the summation.
- Your program should work for any positive value of k.
- Only show the inputs and outputs with description using the *fprintf* command and suppress intermediate outputs.
- Test the program for $k=5$ and $x=1.2$.
  Answer: 0.3905

24) Calculate take home pay as per a new tax law for a person. A person's wage is based on a nominal rate of $9/hour. If the person works for more than 40 hours in a week, an extra compensation of $2.79/hour is given for the time worked over 40 hours. Under the new tax law, the person's
- income tax rate is 16.7% on the part of the gross income that is over $145/week, and the income tax is deducted from the gross pay,
- medicare tax rate is 2.72% on all gross income, and the medicare tax is deducted from the gross pay,
- social security tax rate is 7.28% on part of the gross income that is less than $100/week, and the social security tax is deducted from the gross pay.

Run the program to find the take home pay for two cases - someone working 10 hours/week and someone working 50 hours/week.

Answer: 10hrs/week: wage =90; incometax =0; medicaretax =2.4480; socialsecurity =6.5520; takehome=81.0000

50hrs/week: wage =477.9000; incometax =55.5943; medicaretax =12.9989; socialsecurity =7.2800; takehome =402.0268

SET 4

25) Write a program to display a multiplication table of 9 from 9×1 to 9×20

26) Write a program to sum the series $[\,9 + 99 + 999 + 9999\ldots]$ up to n terms. Do not use MATLAB sum command. Solve for $n=10$.

27) Write a program that deletes the mth element in a given row vector of length n and moves the elements accordingly to make a vector with n-1 elements. Do not use another vector to do this. Do not use any MATLAB shortcut to do this.

28) Given an infinite series for calculating the value of π by Ramanujan as follows:

$$\frac{1}{\pi} = \frac{2\sqrt{2}}{9801} \sum_{n=0}^{\infty} \frac{(4n)!(1103 + 26390n)}{(n!)^4 396^{4n}}.$$

Specifications: Use the first k terms of the series to calculate the value of π in decimal format.
% k = number of terms in the series
- Using the for-end OR while-end loop to do the summation for finding the value of π for a given value of k.
- Your program should work for any positive value of k.
- Only show the inputs and outputs with description using the *fprintf* and *disp* commands and suppress intermediate outputs.

Test the program for $k=5$.

Answer: 3.141592653589793

29) Given a function $f(x)$, the
a) exact mean $\bar{f}$ of the function in the interval (a, b) is given by

$$\boxed{\bar{f} = \frac{\displaystyle\int_a^b f(x)dx}{b - a}} \qquad (1)$$

b) approximate value of the mean $\bar{f}$ of the function in the interval (a, b) is given by

$$\boxed{\bar{f} \cong \frac{1}{n+1} \sum_{i=0}^{n} f(a + ih)} \qquad (2)$$

where
        n = number of equal segments in the domain (a, b)
        h = segment width, $(b-a)/n$

Specifications
- Input the following in four separate lines as assignment to variables, $f(x)=3e^{2x}$, $a=2.3$, $b=5.7$, $n=4$.

- *The program should also work with different inputs, that is, if I change the above four inputs in the four lines of your Mfile, the program should find the appropriate approximate and exact mean.*
- Find the approximate mean of the function as given by Equation (2). You need to use loop(s). You CANNOT use *sum* or *mean* or any such similar MATLAB functions. If you are unsure of what you cannot use, please raise your hand.
- Find the value of the exact mean of the function as defined by Equation (1) by using the MATLAB *int* function.

  Answer: exact=39362; approx=65559