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(60.75º). 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) Given $x(t) = 5t + ln(2t)$.
   Find the first derivative with respect to time t of $x(t)$
   Find the second derivative with respect to time t of $x(t)$
   Find $x'(6)$
   Find $x''(6)$.
   Answer: $5 + 1/t;\ -1/t^2;\ 5.167;\ -0.02778$

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.

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

Answer:
0.2905
19.6905
1.0857

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.

Answer: 18.7350

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
Answer: (0.0013968)*t^4+(0.084127)*t^3+(-7.5063)*t^2+(155.254)*t+200

b) Find the location at t=11 s.
Answer: 1131 m

c) Estimate the velocity of the aircraft at 17.5 seconds.
Answer: -0.2309 m/s

d) Estimate the acceleration of the aircraft at 17.5 seconds.
Answer: -1.0460 m/s^2

e) At what time does the aircraft come to rest?
Answer: 17.30 s (This answer is not correct. So, use a 2nd order polynomial for location vs time with last three data points)

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. Take A=[2 3 4 5] as an example.
Answer: 14

11) Write a program to accept a 2-dimensional matrix and determine whether it is a sparse matrix. A sparse matrix could be considered to be a 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

$$7\frac{dy}{dt}+3y=4\ ,\ \ y(0)=2$$

Also find $y(5)$ and $\frac{dy}{dt}(5)$.

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

17) Solve

$$\frac{d^2y}{dx^2}+2\frac{dy}{dx}+5=x^2\ ,\ \ y(0)=5,\frac{dy}{dx}(0)=7$$

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

$$\frac{d^2y}{dx^2}=5x(30-x),\ \ y(0)=5,y(30)=7$$

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 a row vector.

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 n^{th} 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.

$$f(x) = x^2/4 - x^4/8 + x^6/12 - x^8/16 + ...$$

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 . . .] up to *n* terms. Do not use MATLAB sum command. Solve for *n*=10.

27) Write a program using a for loop that deletes the m^{th} 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. You can use MATLAB shortcut for making the output vector to be of length *n*-1.

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

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

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

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

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

30) You may be surprised to know that there is no exact expression for the perimeter of an ellipse, equivalent to that of the perimeter of a circle which is simply given as $C = 2\pi r$, where C is the circumference, and r is the radius of a circle. The length of mthe inor axis, $a = 3$ and the length of major axes $b = 11$ is given.
   a) Find the approximate value of the perimeter of the ellipse using the formula below
   $$p = 2\pi\sqrt{\frac{a^2 + b^2}{2}}$$
   Answer: 50.6566
   b) The exact perimeter of an ellipse is given by
   $$p = 2a\pi\left(1 - \sum_{i=1}^{\infty} \frac{(2i)!^2}{(2^i \times i!)^4} \frac{X^{2i}}{2i - 1}\right)$$
   where X is the eccentricity of the ellipse and is given by
   $$X = \frac{\sqrt{b^2 - a^2}}{a}$$
   Find the approximate value of the perimeter using $10, 25,$ and 40 terms of the series.
   Answer: 47.862, 47.669, 47.655