

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 $\cos(60.75^\circ)$. 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

$$3.993 \times 10^{-4} - 0.165x^2 + x^3 = 0.$$

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: $A \setminus B$ 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/s²

- 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

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

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

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

17) Solve

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

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

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

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.

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

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 $[9 + 99 + 999 + 9999 \dots]$ 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

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

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

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

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 the minor 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