ENSC 180: Introduction to Engineering Analysis

Assignment 7

Due: 6.00 p.m., April 4, 2018

Note: *MATLAB codes should include definition of all variables; headings to identify the program structure plan; and appropriate captions and labels for tables and figures. Submit a .pdf report documenting your inputs and outputs in addition to a separate zip-file containing all M-files. Marks will be deducted for solutions that are unrealistic/impractical (as future engineers student should learn to think practically) and poorly documented.*

1. Solve the following without the use of for/while loops. The solution should not be entered manually but as a result of an algorithm. The following vector and matrix are provided: V = 3:4:133; M = [0 2 0; 8 0 3; 0 0 5].

   (a) Add 3 to the non-zero elements of M that are also smaller than 5; (b) Add 2 to all elements of V that are divisible by 7; (c) Return a numeric vector of all elements of V containing the digit 7; and (d) Prompt a user for two numbers and create a vector v1 of length 30 with equal spacing, starting with the given numbers. Create a new vector v2 containing the sums of every two consecutive elements of v1 (e.g., if given vector is v1=1,2,3,4,…, the new sequence should be v2=3,5,7,…). (20 marks)

2. Consider a 5m long aluminum wire carrying a current of 8.4A. The radius of the wire is 2mm. Assume that the wire has a constant resistance with temperature, while the other parameters are following: density: 2.6989 g/cc, melting point: 660.37 °C, electrical resistivity: 0.0026548 mΩ-cm, T_0 = 20 °C; specific heat: C=0.215 Cal/(g*K). Use the following basic equations making use of appropriate units: Power=I^2R; Energy(t)=∫Power*dt; T=T_0+dT; dT=Energy(t)/(m*C); m=V*density; R=resistivity*l/A

   a) Using MATLAB, plot the temperature profile of the wire for 2 hours assuming no loss of heat to the air.

   b) Check if the wire reaches its melting point within 2 hrs and indicate the result as an output.

   c) What is the maximum current that can be passed through the wire within 2 hrs. without reaching its melting point? (20 marks)

3. Plot the function, y= (2*x^4-x^2+x-1)/(x^2-2) and its first and second derivatives in one figure and in that order. The range of is x -3 to 3, and y is -200 to 200. In your plots, identify all local maxima and minima, inflection points, and vertical asymptotes of the function and its derivatives by using red circles for all local maxima, blue circles for all local minima, and all inflection points in green. Vertical asymptotes should be indicated with a black ‘x’ on the x axis. All graphs with appropriate highlights must be plotted together at once. Please include appropriate titles, axes labels and legends in the plot. (15 marks)

4. Consider the dataset given below and fit a cubic spline curve using MATLAB. Show the data set and the spline in a single figure. Show a 9^{th} order polynomial fit using *polyfit* in the same plot. Comment on the two curves. (15 marks)

x	805	825	845	865	885	905	925	945	965	985
y	0.710	0.763	0.907	1.336	2.169	1.598	0.916	0.672	0.615	0.606

5. The data set below describes a cross-section of an air foil where the points (X, Yu) define the upper surface of the air foil, and the points (X, Yl) define the lower surface.

X	Yu	Yl
0	0	0
0.005	0.0102	-0.0052
0.0075	0.0134	-0.0064
0.0125	0.017	-0.0063
0.025	0.025	-0.0064
0.05	0.0376	-0.006
0.1	0.0563	-0.0045
0.2	0.0812	-0.0016
0.3	0.0962	0.001
0.4	0.1035	0.0036
0.5	0.1033	0.007
0.6	0.095	0.0121
0.7	0.0802	0.017
0.8	0.0597	0.0199
0.9	0.034	0.0178
1.0	0	0

(a) Use MATLAB to draw the air foil by fitting cubic splines separately to each of the lower and upper surfaces and then plotting the results in a single figure. To make it look like an air foil you will probably need to resize the plot window.

(b) Redo (a) but use global polynomial interpolation provided by MATLAB for each surface instead of splines. Try up to 4 different degrees of polynomials between 1 and n-1 (e.g. 4^{th}, 8^{th}, 12^{th}, 15^{th}) and comment on your results. Generally, a n-1 polynomial will give a best fit in terms of least squares. Does it provide the best result in this case? (15 marks)

6. The following equation describes the motion of a certain mass connected to a spring, with no friction:

$$3\ddot{y} + 75y = f(t)$$

where $f(t)$ is an applied force. Suppose the applied force is sinusoidal with a frequency of ω rad/s and an amplitude of 10 N: $f(t) = 10\sin(\omega t)$.

Suppose that the initial conditions are $y(0) = \dot{y}(0)=0$. Plot $y(t)$ for $0 \leq t \leq 20$ s. Do this for the following three cases, $\omega = 1$ rad/s $\omega = 5$ rad/s and $\omega = 10$ rad/s. Compare the results of these cases. <u>Note: use *ode45* solver to solve this problem. (15 marks)</u>