Mech 221: Computer Lab 1

Hand in the solutions to the three questions in the lab at the *end* of the lab.

Question 1: Defining functions and plotting

In this question, you will review how to define and plot functions in MATLAB. Hand in the last plot you make in the sequence of instructions below.

- Create a vector `x` of length 11 containing values between 0 and 1 using the `linspace` command as follows. The vector `x` corresponds to the end points of 10 equally spaced subintervals of [0,1].

  ```
  >> x = linspace(0,1,11)
  ```

- Now we will map these points to the function $f(x) = x^2$ and store the values in the vector `y`. Enter the following command:

  ```
  >> y = x.^2
  ```

  Don't forget the "dot" in the command above, which tells MATLAB to take the square of each entry. The command `y= x.*x` also works, but `x*x` will give an error message (it tries to use matrix multiplication and the dimensions of the vector `x` do not allow this).

- We now have defined our function on the interval. Now let's plot it!

  ```
  >> plot(x,y)
  ```

  You should now have a window on your screen that contains a plot of $y = x^2$ from $x = 0$ to $x = 1$.

- Now we will plot another function, $y = \sin(x)$ from $x = 0$ to $x = 2\pi$, using 50 points. Enter the following

  ```
  >> clear all;
  >> x = linspace(0,2*pi,50);
  >> y = sin(x);
  >> plot(x,y);
  ```

Take note of what you see in the plot window.

- Plot the following function on the given interval (Use 21 points i.e. 20 intervals on the x-axis). *Hand this plot as Question #1 for the lab.*

$$f(x) = e^{-x^2}, \quad 0 \leq x \leq 1$$

Note: the MATLAB command for the exponential function, e^x, is `exp(x)`

Question 2: Trapezoidal Method and the Gaussian

MATLAB has a built-in function that approximates an integral using the Trapezoidal Method, called `trapz`. Typing in the command `>> trapz(x,y)` will approximate the integral of the function `y` with respect to `x`, where `x` and `y` are data vectors of equal length.

Hand in answers to the following questions as Question #2 for the lab

(a) Use the `trapz` command to estimate $I = \int_0^1 e^{-x^2} dx$ using 20 intervals (You can use the data from Question #1). What is the approximate value you obtain?

(b) By increasing the value of N, get the value of I accurate to 4 decimal places. What N is required for that accuracy and what is the accurate value?

Question 3: Introduction to .m files and Simpsons Rule

.m files are a very useful MATLAB tool. To solve large problems it is impractical for the programmer to continuously input commands into MATLAB. ".m files" allow for the programmer to write all the sequence of commands to be executed. This is known as a "script". Once written, the script can be run in MATLAB.

Hand in a print-out of the .m file you create below, and the estimate of the integral $\int_0^\pi x \sin x dx$ using Simpsons Rule with $N = 20$ subintervals as your answer to Question #3.

- Create a new m.file (File → New → M-File). If you cannot get the pull-down menu in "File", try first clicking on the Command Window.

- Using your pre-lab, write the code required to integrate $f(x) = x \sin(x)$ on the interval $0 \leq x \leq \pi$, using Simpson's Rule on $N = 20$ intervals.

- Save the file in the same directory as your Current Directory with the name “simpsonsrule.m”. Be sure to add the “.m” extension.

- Go to the MATLAB command window and enter `>> simpsonsrule`. If no errors appear, your code will have been executed and all your data saved in the workspace. If you are having trouble with errors, take note of where the error is occurring in your m.file (MATLAB will tell you) and attempt to debug the problem. When your code runs without errors, check that it is computing the correct quantities by comparing to the exact value of the integral or approximate values computed with `trapz`.

- What value did your Simpsons Rule code give you for the approximate value of the integral? Write down the answer and submit a print-out of your Simpsons Rule code.