Phys234, 2018, Problem set #5: Due Monday March 12, 8pm

Question 1: Question 1 will be given at the start of the lab.

Question 2:

Find the four roots of the following non-linear system of equations:

$$y = x^2 + x - 20$$
$$y^2 = x + 12$$

You have to use the `newtonSys.m` function that I showed in class, so do not forget to hand in your user defined m-file that contains the evaluation of the Jacobian and functions. In the building of your answer you may want to print various results and use different initial conditions. But for the final file you submit, make sure that it only prints out the answer for your four roots. Submit your solution as function m-file called `ps5q2.m` that follows the format of the file given below.

```
function ps5q2
% ID: xxxxxxx, name
% Solution to question 2, problem set 5
%
... % initialization, etc.

% Get 1st root
x_root1 = ...  % your operations to get root (2-element column vector)

% Get 2nd root
x_root2 = ...  % your operations to get root (2-element column vector)

% Get 3rd root
x_root3 = ...  % your operations to get root (2-element column vector)

% Get 4th root
x_root4 = ...  % your operations to get root (2-element column vector)

% print out of the answer
fprintf('The first root is \n')
fprintf('x = %15.12f\n', x_root1(1) )
fprintf('y = %15.12f\n\n', x_root1(2) )
fprintf('The second root is \n')
fprintf('x = %15.12f\n', x_root2(1) )
fprintf('y = %15.12f\n\n', x_root2(2) )
fprintf('The third root is \n')
fprintf('x = %15.12f\n', x_root3(1) )
fprintf('y = %15.12f\n\n', x_root3(2) )
fprintf('The forth root is \n')
fprintf('x = %15.12f\n', x_root4(1) )
fprintf('y = %15.12f\n\n', x_root4(2) )

end
```

Question 3:

The following table gives the density of glycerin (ρ, in kg/m^3) at different temperatures (T, in degrees Celcius).

Temperature (degrees C)	density (kg/m^3)
0	1276.03
10	1270.11
20	1264.02
30	1258.09
40	1252.01
50	1244.96

Use the `linefit.m` function that I showed in class to get a the best line fit (in a least squares sense) of the density of glycerin as a function of temperature. Plot a comparison of the data and your line fit on the same axes. Don't forget to label your axes and include a legend. Submit your answer in a function file `ps5q3.m` that prints the coefficients of the line fit and plots the graph.

Question 4: Question 4 will be given at the start of the lab.

Question 5:

The function $y = c_1 \exp(c_2 x)$ can be transformed into a linear relationship $v = d_1 x + d_2$. Write a function `c=expFit(x,y)` that executes this transformation and calls `linefit.m` to find the best fit values of c_1, c_2 for a given set of data points (x, y). To test your function, write a `ps5q5.m` function which produces a print-out the the best fit values of c_1 and c_2 for the following data points:

i	1	2	3	4	5
x	1.0000	2.5000	4.0000	5.5000	7.0000
y	2.2851	1.4176	0.8794	0.5455	0.3384

Your function `ps5q5.m` should also produce a plot of the data and the curve fit on the same axes. Don't forget to label your axes and include a legend.

Question 6:

The following table shows a series of 19 earthquakes that occurred near a subduction zone, the location of which are tabulated in terms of a horizontal distance and depth with respect to specific geographic point. The depth (variable y) is approximately proportional to the horizontal distance (variable x), showing that the earthquakes are indeed associated with the subducting plate and that the angle of subduction is approximately constant with depth. The data file (earthquake.dat) can be downloaded from the eclass webpage.

earthquake	horizontal distance (km) x	depth (km) y
102292B	49	17.0
102292G	34	19.9
020293D	55	25.1
102492B	83	25.7
102492K	55	27.4
102592A	75	27.9
011890B	95	29.1
052892A	116	35.3
041190B	70	36.7
011490B	93	43.9
062592C	81	44.4
110191B	116	44.8
022589A	121	45.1
011288A	125	47.1
112189A	128	47.8
121688D	129	48.8
051489A	143	51.5
101088D	143	54.6
090789B	116	55.5

a) Find the best fitting straight line (in a least square sense) to this data set. Write a m-file function (named `ps5q6a.m`) that, when executed, prints out the value of the slope and intercept and produces a graph showing both the data points and the least square fit. Include axis labels and a legend on your plot.

b) If the error in the determination of the depth of each earthquake is proportional to the depth and given by $\sigma_i = y_i/20$, find the best fitting straight line weighted by these errors. Write an m-file function (named `ps5q6b.m`) that, when executed, prints out the value of the slope and intercept and produces a graph showing 1) the data points; 2) the least square fit without error weighting; 3) the least square fit with error weighting. Include axis labels and a legend on your plot.