Homework 1 - MATLAB Basics

Self-Study Exercises (Do not report these exercises):

1. Work on the following questions from the book "Applied Numerical Methods with MATLAB", 3rd edition, Chapra: 2.1, 2.2, 2.3, 2.4, 2.18.

Exercises to be reported:

1. The butterfly curve is given by the parametric equations below. Generate values of x and y for values of t from 0 to 100 with $\Delta t = 1/16$. Construct 2D plots of (a) x and y versus t and (b) y versus x. Use `subplot` to stack these 2 plots vertically and make the plot in (b) square. Include titles and axis labels on both plots and a legend for (a). For (a), employ a dotted line for y in order to distinguish it from x.

$$x = \sin(t)\left(e^{\cos t} - 2\cos 4t - \sin^5 \frac{t}{12}\right)$$

$$y = \cos(t)\left(e^{\cos t} - 2\cos 4t - \sin^5 \frac{t}{12}\right)$$

2. The butterfly curve given above can also be represented in polar coordinates as given below. Generate values of r for values of θ from 0 to 8π with $\Delta\theta = \pi/32$. Use the MATLAB function polar to generate the polar plot of the butterfly curve with a dashed red line. Employ the MATLAB Help to understand how to generate the plot.

$$r = e^{\sin\theta} - 2\cos(4\theta) - \sin^5\left(\frac{2\theta - \pi}{24}\right)$$

3. The sine function can be evaluated by the following infinite series:

$$\sin x = x - \frac{x^3}{3!} + \frac{x^5}{5!} - \cdots$$

Create an M-file to implement this formula so that it computes and displays the values of $\sin x$ as each term in the series is added. In other words, compute and display in sequence the values for:

$$\sin x = x$$
$$\sin x = x - \frac{x^3}{3!}$$
$$\sin x = x - \frac{x^3}{3!} + \frac{x^5}{5!}$$
$$\vdots$$

up to the order term of your choosing. For each of the preceding, compute and display the percent relative error as:

$$\%\text{error} = \frac{\text{true} - \text{series approximation}}{\text{true}} \times 100\%$$

As the test case, employ the program to compute sin(0.9) for up to and including eight terms— that is, up to the term $x^{15}/15!$. Plot the (percent relative error) versus (number of terms) graph. Don't forget to add labels to the axes and a title to your plot.

4. Develop a function function M-file that returns the difference between the passed function's maximum and minimum value given a range of the independent variable. In addition, have the function generate a plot of the function for the range. Test it for the following cases:
(a) $f(t) = 8e^{-0.25t} \sin(t - 2)$ from $t = 0$ to 6π.
(b) $f(x) = e^{4x} \sin(1/x)$ from $x = 0.01$ to 2.
(c) The built-in humps function from $x = 0$ to 2.

How to Submit Your Homework:

1. Each student should submit his/her own homework. You can discuss the questions with your friends, but you must write your own code. Group work is not allowed.

2. Write a detailed report, which includes explanations about each part in each question. Explain how your scripts and functions work, i.e., which parts of your functions/scripts accomplish which task and how it is accomplished. Include the outputs of your functions to your report. You can save a figure as a *.jpg image file using "File —> Save as" in the Figure window.

3. Don't forget to put detailed comments into your functions/scripts to explain what your code is doing. Also indicate the inputs and outputs in the comment section. (% sign is used to put comments in MATLAB)

4. Combine your report and MATLAB codes into a single file. Plots should go into the report. Name your zip file as "name_surname_studentnumber_hw_no.zip". For example, a student whose name is Ayşe Çalışkan and student number is 1234567 will name her file as: "ayse_caliskan_1234567_hw1.zip" for the first homework. Also, write your name, surname and student number as comments at the beginning of your codes.

5. To submit your homework, send your zip file to math2059Spring2018Hmw@gmail.com before the deadline.