Name : _____

Homework Project #0

This homework is designed to get you comfortable with using the Matlab environment and with the format for turning in homework.

Here are some guidelines on how you will turn in your homework.

- You will turn in your Matlab m-files all of your homework *electronically* via Dropbox folders that I will assign to you.
- To format your homework, you will use Matlab's Publish markup-language. These are basically formatting commands that can be easily entered into your Matlab scripts. I will then "publish" your homework to produce a PDF file, which I will grade electronically.
- Pay particular attention to the use of the `function` command for each problem, formatting of text, including text formatted using a Times Roman font, italics, bold face and hyperlinks, and the positioning of plots.
- You should publish your own work to make sure that every problem runs to completion. You will only get partial credit for problems that do not execute to completion.

Complete the following problems, using the format suggested by the online solutions (available on the course website). Your final published document should look as close to the solutions as possible. You only have to submit your m-file to your Dropbox folder, but you should also publish your file on your own to see that it is formatted correctly.

1. (**Simple arithmetic expressions; write scalar to a file**) Compute the surface area of a torus whose inner radius is $r = 3.21$ and whose outer radius is $R = 3.56$. Use the formula

   $$S = \pi^2 (R - r)(R + r)$$

   Write out your result to the file `torus.out`.

2. (**Plotting a simple relationship**) According to the Richter scale, the magnitude M of an earthquake is given by the formula

   $$M = \frac{2}{3} \log_{10} \frac{E}{E_0},$$

   where E is the energy released by the earthquake, and $E_0 = 10^{4.4}$ Joules is the energy of small reference earthquake. Use Matlab to create a plot illustrating how the energy of an earthquake depends on the magnitude. Plot the magnitude in the range from $M = 1$ to $M = 9$. Use the `semilogy` function to create the plot and make sure you add labels and a title.

3. (**Use constants and fprintf**) Suppose you took all the smartphones currently in use and laid them end-to-end around the Earth at the equator. How many times can you circle the earth with smartphones? Use the web to find relevant parameters for this problem. Choose useful variable names for each of the constants you use, and create a useful print statement to report your answer.

4. (**Simple vectorization; write array to a file**) Create two arrays **x** and **y**, whose entries are defined as

   $$\begin{aligned} x &= \begin{bmatrix} 1 & 2 & 3 & 4 & 5 \end{bmatrix} \\ y &= \begin{bmatrix} 2 & 4 & 6 & 8 & 10 \end{bmatrix} \end{aligned}$$

Then, compute the sum of these two vectors in two different ways. First, use a `for` loop to construct the vector **z** as

$$z_i = x_i + y_i, \quad i = 1, 2, 3, 4, 5.$$

Second, "vectorize" this statement as

$$\mathbf{z} = \mathbf{x} + \mathbf{y}$$

Use the function `write_file` to write your result to the file `z.out`.

This problem illustrates one of the most powerful features of Matlab. Many complicated expressions can be vectorized to create code that is faster and more compact than the equivalent version using loops required for other compiled languages.

5. (**Simple anonymous function handle; plotting**) Use *anonymous function handles* to define the functions

$$f(x) = \sin(x) \qquad g(x) = e^x \qquad h(x) = g(f(g(x)))$$

   (a) Plot the function $h(x)$ over the domain $[-3, 3]$. Use the Matlab command `linspace` to construct a sequence of 500 equally spaced points in the given domain.

   (b) Add a title, and axis labels to your plot.

   (c) Write the value of $h(4.3)$ to a file `h.out`.

6. Approximate π using continued fractions. A continued fraction approximation is an expression of the form

$$\pi = d_1 + \cfrac{1}{d_2 + \cfrac{1}{d_3 + \cfrac{1}{d_4 + \cfrac{1}{d_5 + \cdots}}}}$$

   The digits you will need to approximate π are given by

$$d = [3, 7, 15, 1, 292, 1, 1, 1, 2, 1, 3, 1, 14, 2, 1, 1, 2, 2, 2, 2, 1, 84].$$

   Use the `fprintf` statement to print your approximation, the value of π reported by Matlab's built-in π command, and the error you get in your approximation.

7. (**Continued fractions**) Use the *Online Encyclopedia of Integer Sequences* to find the integer sequence A003417 to approximate Euler's number e. Print your results as in Problem 6.

8. (**Loading data from a file; use fprintf**) For this problem, load the data file `heights.dat` from the course website. Compute the min, max, mean and standard deviation of the height data and report the results using `fprintf`.

9. (**Advanced Publishing options**) Try out some of the more advanced formatting commands by reproducing the text (including hyperlinks) from the homework solutions. Format the code in the template file so that it looks like the solutions in `hmwk0_sample.pdf`.