Math 365 **Homework 1** **Due Sep. 7, 2016**
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A few notes:

- NCM="Numerical Computing in MATLAB ", the textbook for the course.
- This homework is designed to get you comfortable with using the MATLAB environment and with the format for turning in homework. The remaining homework sets will focus more on numerical methods and their applications to applied problems.
- Remember you have to work in teams of two on the homework assignments and final project. Please find a team member on your own. If you are having trouble doing so, send me an e-mail and I will try to assist.
- The completed homework assignment should be turned into your shared dropbox folder in a subfolder labeled "HW1". All work answer and code should be self-contained in one PDF file with the name "`HW1_<YourMainFolderName>.pdf`". All MATLAB code (M-files) for the problems should also be put in the folder so that I may run it to produce the results you present.
- Please see the Homework "Format" section on the course webpage for formatting your write-up. I highly suggest using the `publish` feature of MATLAB and the example file available on the course webpage.

1. (**Simple arithmetic expressions**) Compute the surface area of a torus whose inner radius is $r = 2.21$ and whose outer radius is $R = 4.36$. Use the formula

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

   Include the computed solution in the work you turn in so that it I can easily find it..

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 plot illustrating how the energy of an earthquake depends on the magnitude from $M = 1$ to $M = 9$. Use the `semilogy` function to create the plot and make sure you add labels and a title. Turn in the code you used to create the plot.

3. (**Simple vectorization**) Create two arrays **x** and **y**, whose entries are defined as

$$\begin{aligned} x_i &= i, \quad i = 1, 2, 3, 4, 5. \\ y_j &= 5 - 2j, \quad j = -2, -1, 0, 1, 2. \end{aligned}$$

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

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

Second, "vectorize" this statement so that no for loop is used at all. This should require one line of MATLAB code. Include the output in your written work from both techniques and verify that they are the same.

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.

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

$$f(x) = \cos(2x) \qquad g(x) = e^x \qquad h(x) = g(f(g(x)))$$

   (a) Plot the function over the domain $[-3, 3]$. Use the Matlab command MATLAB 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) Compute $h(4.3)$ and include this in your write-up.

5. (**Loading data from a file, simple statistics, and using 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`.

6. (**Generating sequences of numbers with a for loop**) Let

$$A = \begin{bmatrix} 1 & 1 \\ 1 & 0 \end{bmatrix} \quad \text{and} \quad X_1 = \begin{bmatrix} 1 & 0 \\ 0 & 1 \end{bmatrix}$$

   (a) Compute $X_{k+1} = AX_k$, for $k = 1, 2, \ldots, 5$ using a **for** loop and report the results for each k in the work you turn in.

   (b) The sequence of numbers that are being generated have a special name. What is it?

   (c) Compute X_{30} using a for loop and report this value in your report (do not include the values $X_2, \ldots, X_{29}$ for this part).

7. (**Quadratic formula**) NCM, problem 1.38. Make sure you investigate the output of the `roots([a b c])` thoroughly. This is best done by setting the output equal to a variable, say `x`, and then investigating `x(1)` and `x(2)`. Make sure you compute the accurate root given the formula $x_1 x_2 = c/a$ in the book.