ENEL101

Problem set 3

Chapter 4

Please read the file, "How to complete and upload the solution template" before you begin. Download assign3.m and fill it in and then upload the completed file on D2L drop box. Also download test_assign3.m and assign3_solutions.mat to test your answers as you go. Make sure your name and UCID are correctly filled out in the template file.

The questions are based on content from chapter 4 of the textbook "MATLAB, An introduction with applications". Assume that all the angles are in radians except where specifically noted.

Note for this assignment in Questions 8-10 you will need to understand how to use *for*, and *end*. Use

help for

to get information on how to use the **for** statement. You can also type

doc for

on the command line which opens the document file.

Do NOT use loops (e.g. *for*) for questions 1-7

1. Given a vector of samples $X1 = [-200, -190, \ldots, 10, 20]$, determine the sum of all of the elements of the vector $X1$.

2. Given a vector of samples $X2 = [-200, -190, \ldots, 10, 20]$, calculate a vector Y2 based on the function $y_i = 5x_i + 100$ where x_i is the ith element of $X2$ and y_i is the ith element of $Y2$. Make the function return $Q2 = \sum_i \sin(x_i)\cos(y_i)$.

3. Given vectors of samples $X3 = [0,1,\ldots,100]$ and $Y3 = [10,11,\ldots,110]$, calculate vector Z3 based on the function $z_i = \sin\left(\frac{\pi x_i}{180}\right) + 2\cos\left(\left(\frac{\pi}{180}\right)^2 x_i y_i\right)$. x_i, y_i and z_i are the i[th] elements of X3, Y3 and Z3 respectively.

4. Solve for X4 in the matrix equation $A\ X4 = Y4$ given

$$A = \begin{bmatrix} -4 & 3 & 1 \\ 5 & 6 & -2 \\ 2 & -5 & 4.5 \end{bmatrix} \text{ and } Y4 = \begin{bmatrix} -18.2 \\ -48.8 \\ 92.5 \end{bmatrix}$$

5. A rocket flying straight up measures the angle θ with the horizon at different heights, h. The measured values of θ and h are stored in two binary data files named Q5h.mat (contains a row vector of measured values of h) and Q5theta.mat (contains a row vector of measured values of θ). All angles are in degrees and height is given in km. Write a Matlab function that does the following:
    a. Reads the two binary data files and generates a row vector R whose elements are the estimates the radius of the earth at each data point using

$$R_i = \frac{h_i \cos(\theta_i)}{1 - \cos(\theta_i)}$$

    b. Outputs the average of all of the values of R.

6. The Matlab function rand() generates a random number between 0 and 1. Write a Matlab function that does the following:
    a. Given $M = 10{,}000$ generate M random numbers using rand(), and store them in a column vector of X.
    b. Computes the standard deviation (std) of the elements of X using

$$std = \sqrt{\frac{1}{M}\sum_{m=1}^{M}\left(X_m - \frac{1}{M}\sum_{n=1}^{M} X_n\right)^2}$$

and outputs the result. *Do NOT use Matlab's built-in functions std() or var() for this question.*

7. A digital magnetometer is a small low-power integrated circuit (IC) that measures the intensity of the earth's magnetic field and produces digital outputs that correspond to the magnetic field intensity along two or three axes of a local coordinate system. This electronic component is ubiquitously used in smartphones, GPS devices, vehicles, airplanes, etc. to produce accurate compass heading information.
The measured values of the earth's magnetic field (in nT) along the *x* and *y* axes of a magnetometer are provided in a binary data file named Q7xy.mat. The data file contains a 5 by 2 matrix named *Mdata*. Write a Matlab function that does the following:
    a. Reads the binary data file.
    b. Assigns the values of the 1st column of *Mdata* to row vector $X7$.
    c. Assigns the values of the 2nd column of *Mdata* to row vector $Y7$.
    d. Outputs a row vector $Z7$ whose elements are the estimates of the relative compass heading from

$$z_i = acrtan\left(\frac{y_i}{x_i}\right) \times \frac{180}{\pi}$$

Use *for* loops to answer questions 8-10.

8. Given N=10, determine the value of

$$Q = \sum_{n=5}^{N} \sum_{m=-3}^{n} \sin\left(\frac{nm}{10}\right)$$

9. Given M=11, determine the value of

$$Q = \sum_{m=0}^{M} \sum_{n=5}^{15} \sum_{k=n}^{20} (m+n+k)$$

10. Given K=12, determine the value of

$$Q = \sum_{k=5}^{K} k \sum_{m=5}^{k} m \sum_{n=-3}^{m} \cos(n+m)$$