ENSC 180: Introduction to Engineering Analysis

Assignment 5

Due: 6.00 p.m., March 7, 2018

Note: *MATLAB codes should include definition of all variables; headings to identify the program structure plan; and appropriate captions and labels for tables and figures. Submit a .pdf report documenting your inputs and outputs in addition to a separate zip-file containing all M-files. Marks will be deducted for solutions that are unrealistic/impractical (as future engineers student should learn to think practically) and poorly documented.*

1. Write a MATLAB code to find the eigenvalues and eigenvectors of a 3x3 real symmetric matrix. The program should ask a user to enter the 3x3 matrix and output each eigenvalue and the corresponding eigenvector. You are not allowed to use any MATLAB built-in functions except *roots*. Using [A]= [4 3 1;3 7 -1; 1 -1 9] check the accuracy of your code by comparing with the eigenvalues and eigenvectors obtained from the MATLAB *eig* command. (25 marks)

2.

(a) An eigenvalue problem is defined by the matrix equation, $[K]-\omega^2[M]= \{0\}$, where K is a real symmetric square matrix and [M] is a diagonal square matrix (same order as [A]) with real positive elements. Given [A]= [4 3 1; 3 7 -1;1 -1 9] and [M]= [1 0 0;0 2 0;0 0 3], find the eigenvalues ω and the corresponding eigenvectors using MATLAB. (10 marks).

(b) *magic* is a MATLAB command that can be used to create a special square matrix. It has the property that the sums of the columns are the same, as are the sums of the rows. Create a 6x6 magic matrix and using MATLAB commands find the sum of each column, sum of each row and the sum of diagonals. Are these equal? (10 marks)

(c) Create a 4x4 magic matrix *A*. Use MATLAB to assemble a new matrix, B $=\begin{bmatrix} A & 2A \\ A^2 & A+2 \end{bmatrix}$ and check whether the sum of all rows, columns and diagonals of B is the same by using MATLAB. (10 marks)

3. At time *t=0*, the engine of a rocket shuts down and it has reached a height of 500m and rising at a velocity 125 m/s. Thereafter, the rocket is moving under the action of gravity and its height, *h*, is expressed as a function of *t*.

$$h(t)=-4.9t^2+125t+500$$

Using MATLAB symbolic calculations, find the velocity and acceleration of the rocket as a function of time. Plot the height, velocity and acceleration in a single figure using different colours and find the time to hit the ground using MATLAB built-in functions. (15 marks).

4. A Fibonacci sequence is composed of elements created by adding the two previous elements. The simplest Fibonacci sequence is 1,1,2,3,5,8,13,21……. Fibonacci sequences have many examples in nature (e.g., the shell of the chambered nautilus grows in accordance with a Fibonacci sequence). Write a MATLAB code to generate a Fibonacci sequence and prompt a user to enter the first two numbers and the total number of elements in the sequence. Your code should be able to plot the numbers in a polar plot using the element number as the angle and the value of the element as the radius. Show 3 sample polar plots generated by Fibonacci sequences. Check the ratio of two adjacent numbers of a Fibonacci sequence. Do you see any trend as the sequence grows? (30 marks).