ENEL101

Problem set 6

M File Programming

Important Notes:

- This assignment is about writing user defined functions for applications. The questions are based on content from chapters 8 and 9 of the textbook "Matlab, An introduction with applications".
- Complete this assignment by filling in the template file, assign6.m, with your Matlab function files.
- The function files will be tested by the auto-tester using randomly generated data.
- Do NOT make any plots in your code.

Make sure your final submission runs without syntax error. As usual, template files that do not run without syntax error will be rejected by the auto-marker, and you will have to visit Chris in person to demo your code and get the marks.

Q1. Write a function that finds the magnitude of the roots of an input polynomial and outputs the magnitude of the roots that fall within a user specified range of values LOW and HIGH. The input polynomial p is entered as a row vector of coefficients as shown in the example on pp.262-3 of the textbook.

The polynomial $y = -0.001x^4 + 0.051x^3 - 0.76x^2 + 3.8x - 1.4$ is entered as $p = [-0.001, 0.051, -0.76, 3.8, -1.4]$. The magnitude of the roots are: $29.6177, 10.8776, 10.8776, 0.3995$. Now suppose the range is given as say LOW=9 and HIGH=11, then the second and third roots $[10.8776, 10.8776]$ will be output.

Q2. Write a function that accepts the vector of data points T and h as input arguments and determines a linear equation in the form of $T = mh + b$ that best fits the data. Then output the magnitude of the error between the data points and the linear regression curve, denoted by the vector of e. Use the Matlab `polyfit()` and `polyval()` functions. The input arguments are the boiling temperature of water T at various altitudes h as in

***h* (meters)**	0	608	1520	2280	3040	6384	7904
***T* (Celsius)**	100.00	98.88	95.00	92.22	90.00	81.11	75.55

Q3. Write a function that accepts the vector of data points N and t as input arguments and determines the best exponential equation in the form of $N = be^{mt}$ that best fits the data, using the Matlab `polyfit()` function. Then output 1x2 vector $[b\ m]$. The input arguments are the number of bacteria N measured at different times t as

***t* (min)**	10	20	30	40	50
N	38,000	60,000	250,000	500,000	1000,000

Q4. Write a function named that accepts the integration limits of A and B as input arguments and outputs the integral of $h(x) = \sin(x)\exp\left(-x^2\right)x^3$. Use the Matlab `quad()` function for this. That is the function does the following

$$Z = \int_A^B \sin(x)\exp\left(-x^2\right)x^3 dx$$

Q5. The following wind tunnel data shows the aerodynamic drag force on a car, F_D, as a function of the car velocity, v.

$v(km/hr)$	20	40	60	80	100	120	140	160
$F_D\left(N\right)$	10	50	109	180	300	420	565	771

Write a function that accepts an arbitrary value for v and output the corresponding interpolated value of F_D. Use Matlab function `interp1()` with the 'spline' method for the interpolation.

Q6. An RLC circuit with an alternating voltage source is assumed. The source voltage v_s is given by $v_s = v_m \sin(\omega_d t)$, where $\omega_d = 2\pi f_d$ in which f_d is the driving frequency. The normalized amplitude of the current, I, in this circuit is given by

$$I = \frac{1}{\sqrt{R^2 + \left(\omega_d L - \frac{1}{\omega_d C}\right)^2}}$$

where R (Ω), L (H), and C (F) are the resistance of the resistor, the capacitance of the capacitor, and the inductance of the inductor, respectively. Write a function named that accepts R, L, and C as input arguments and finds the natural frequency of the circuit (the frequency at which I is maximum). The natural frequency of f_0 (Hz) is the output argument. Use Matlab's `fminbnd()` for this application and search over $0.5/\sqrt{LC} < \omega_d < 1.5/\sqrt{LC}$. Note that minimizing $-I$ is equivalent to maximizing I.

Q7. The sudden outbreak of an insect population can be modelled by the equation

$$\frac{d\,N}{d\,t} = RN\left(1 - \frac{N}{C}\right) - \frac{r\,N^2}{N_c^2 + N^2}$$

where N is the number of insects, R is an intrinsic growth rate, and C is the carrying capacity of the local environment. The first term is a population growth model and the second term represents the effects of bird predation, which becomes significant when the population reaches a critical size N_c and has a maximum value of r. Solve for Nat time $t = 50$ days for $R = 0.55$ per day, $N(0) = 1000, C = 10^4, N_c = 10^4$, and $r = 10^4$ per day. Use `ode45()`. Note: you must make your anonymous function a function of both t and N even though t doesn't appear explicitly in the differential equation.