EE 220/220L Circuits I (Fall 2019)
Laboratory 1 Introduction to MATLAB®

Introduction

In engineering laboratories, a significant amount of work involves analyzing, modeling, and/or plotting signals and systems or data related to them. MATLAB® is a computer analysis/programming tool that is widely used in many engineering and science disciplines. MATLAB is available in the campus computer labs. This lab will acquaint you with using MATLAB for various computations as well as for basic plotting. There is a great wealth of materials available to enable you to learn MATLAB in hardcopy form as well as on-line.

Preliminary

Pay careful attention to the instructor's in-class demonstration and take notes in your logbook. Reviewing some of the MATLAB tutorials provided at the course web page (under the "Labs" link) is suggested. In particular, the tutorial by Kamen & Heck covers many of the basics. This laboratory is meant to help (i.e., force) you learn how to use the MATLAB program and "learn how to learn" about various MATLAB functions.

Laboratory

1. Start MATLAB. For example, on a computer in one of the campus computer labs, click the windows icon in the lower left corner, go to the "M" part of the list, click the down arrow/drop-down menu for MATLAB R201Xy, and select MATLAB R201Xy. [**Warning:** This program is very resource intensive (long load time).]

2. In the Command Window of MATLAB, define the variables *a*, *b*, *c*, and *d* as equal to 264, -19, -3+*j*10, and -9-*j*64, respectively. Then, perform the following calculations/operations:
   a. Multiply by pi the sum of *a* plus the square root of 180 divided by the absolute value of *b* raised to the 3.5 power, i.e., $\pi[a + (180)^{0.5}]/ |b|^{3.5}$.
   b. Calculate a complex variable *S* equal to the complex conjugate of *d* that is then divided by *c*, i.e., $S = d^*/c$.
   c. Find the real part, imaginary part, magnitude, and phase angle (both in radians and degrees) of *S*.
   d. Compute the result of the equation $e^{-0.012b}\tan(0.004a\pi)$

   Cut & paste the results from MATLAB into a computer-generated document (e.g., MS Word) and insert into your logbook. You may delete empty lines to save space. Clearly label as part 2.

3. In the Command Window of MATLAB, define a vector *R* containing the measured resistance values for some 680 Ω ± 10% resistors: 640, 692, 653, 733, and 698 Ω. Then, use MATLAB to calculate/determine some practical statistics for these resistance measurements:
   a. Determine the average of *R*.
   b. Determine the median of *R*.
   c. Determine the minimum of *R*.
   d. Determine the maximum of *R*.
   e. Determine the standard deviation of *R*.

Cut & paste the results from MATLAB into a computer-generated document (e.g., MS Word) and insert into your logbook. You may delete empty lines to save space. Clearly label as part 3.

4. Imagine that you have performed some experimental and analytical work on an RC circuit and need to analyze and visualize the results using MATLAB. Table 1 contains your experimental measurements of voltage versus time. Analytically, it is known that the voltage will obey an equation of the form $v(t) = V_0 e^{-t/\tau}$ (V) $t > 0$.

   a) Write an m-file to plot the experimental voltage versus time data points as **dots**. Make the horizontal (time) axis scale range from 0 to 10 s and the vertical (current) axis scale range from 0 to 10 V. Label the horizontal and vertical axes and title the plot "EE 220L Lab 1, part 4a, *your name*, *date*". Insert a legend in the upper right-hand corner of the graph. Put the *filename*, EE 220L Lab 1, part 4a, *your name*, & *date* in comment lines at top of the m-file. Cut & paste the m-file and figure from MATLAB into a computer-generated document and insert into your logbook.

   b) Next, write an m-file to plot the experimental voltage versus time data points as **dots** *and* to calculate & plot a continuous time function of form $v(t)$ that is a good fit to the experimental data (i.e., estimate/determine/guess the unknown constants V_0 and τ) as a **solid line** in steps of $\Delta t = 0.05$ s from 0 to 10 s. Keep same axes labels and scales as part a. Title the plot "EE 220L Lab 1, part 4b, *your name*, *date*". Insert a legend in the upper right-hand corner of the graph. Put the *filename*, EE 220L Lab 1, part 4b, *your name*, & *date* in comment lines at top of the m-file. Cut & paste the m-file and figure from MATLAB into a computer-generated document and insert into your logbook. List values for V_0 and τ (with units) below the figure in your logbook.

Table 1 Time and voltages data point for a first-order circuit.

***t* (s)**	***v* (V)**	***t* (s)**	***v* (V)**	***t* (s)**	***v* (V)**
0	8.8	2.5	4.5	7	1.5
0.4	7.7	3.1	4	7.5	1.3
0.75	7.2	3.8	3.4	8	1.2
1	6.8	4.25	3.0	8.5	1.1
1.25	6.4	5	2.5	9	1
1.6	5.9	5.8	2.1	9.5	0.9
2.1	5.2	6.5	1.7	9.8	0.8

Hints:

- See example m-file CT_plot_example.m at course webpage.
- V_0 is the initial current. I.e., $v(t = 0) = V_0$.
- τ is the time constant. It can be estimated by calculating $\tau_i = t_i / \ln[V_0 / v(t_i)]$ for a few experimental time & current data points and averaging. τ is somewhere between 1 and 6 s.