# EE 220/220L Circuits I (Fall 2017)
# 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. Review some of the MATLAB tutorials provided at the course web page (under the "Labs" link). In particular, print-out and review the tutorial by Kamen & Heck which covers much 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. To start MATLAB on a computer in one of the campus computer labs, click the following series of commands: Start → All Programs → DEPT → ECE → MATLAB → MATLAB R201Xy. [**Warning:** This program is very resource intensive (long load time).]

2. In Command Window of MATLAB, define the variables *a*, *b*, *c*, and *d* as equal to 114, -121, -3+*j*10, and 9-*j*24, respectively. Then, perform the following calculations/operations:
   a. Multiply by pi the sum of *b* plus the square root of 240 divided by the absolute value of *a* raised to the 1.25 power, i.e., $\pi[b + (240)^{0.5}]/ |a|^{1.25}$.
   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 330 Ω ± 10% resistors: 326, 314, 333, 342, 330, 341 and 319 Ω. Then, make the following calculations of some practical statistics for the 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. Write an m-file to plot the time and voltage data points contained in Table 1 as **dots**. On the same graph, calculate a continuous time function of the form $v(t) = V_0\, e^{-t/\tau}$ (V) that is a good fit to the data, i.e., determine unknown constants $V_0$ and $\tau$ by trial-and-error (see hints). Plot the analytic function $v(t)$ as a **solid line** in steps of $\Delta t = 0.05\,\text{s}$ from $0 \le t \le 10\,\text{s}$. Make the vertical axis scale $0 \le V \le 10\,\text{V}$. Label the horizontal and vertical axes and title the plot "EE 220L Lab 1, part 4, *your name*, *date*". Insert a legend in the upper right hand corner of the graph. Put *filename*, EE 220L Lab 1, part 4, *your name*, & *date* in comment lines at the top of your m-file. Cut & paste the m-file and figure from MATLAB into a computer-generated document and insert into your logbook. List your values of $V_0$ and $\tau$ (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 | 8.9 | 2.5 | 4.5 | 7 | 1.5 |
| 0.4 | 7.8 | 3.1 | 3.9 | 7.5 | 1.3 |
| 0.75 | 7.1 | 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 | 2.0 | 9.5 | 0.9 |
| 2.1 | 5.2 | 6.5 | 1.8 | 9.8 | 0.8 |

Hints:

- See example m-file CT_plot_example.m at course webpage.
- Plot the experimental data points first. Then, estimate/determine/guess values for the constant coefficients $V_0$ and $\tau$ for $v(t)$.
- The initial voltage is $v(t = 0) = V_0$.
- $\tau$ is a decay coefficient with a value somewhere between 1 and 6 s.