

EE 101	Fall 2007	Date:	Lab Section #
Lab #5		Name:	
Introduction to MATLAB		<i>No Lab partners this time!</i>	

Abstract

NOTE: You need to have a free MSU computer account AND ECE printing permission BEFORE you arrive for this experiment!

After completing this experiment you should:

- (1) Be able to enter data into Matlab™,
- (2) Be able to create line graphs using Matlab,
- (3) Be able to create data sets representing sinusoidal signals using Matlab,
- (4) Be able to graph these data sets and create appropriate titles and axis labels,
- (5) Be able to copy Matlab graphs into a word processor to produce a technical document
- (6) Be more comfortable in describing sinusoids mathematically,
- (7) Have bolstered your understanding of the I-V characteristics of resistors and diodes.

Introduction and Theory

Matlab™ is a software package intended for use by engineers and scientists in solving complex problems. The name “Matlab” is short for “matrix lab,” since Matlab is very efficient at processing arrays and matrices of numbers. One generally interacts with Matlab by typing special words and symbols in a command window on the computer screen. Matlab contains commands and features for many specific applications, such as plotting (`plot` and `bar` are two such commands). Also, the user can readily create custom software routines for specialty needs. These user-created routines can be used in the same manner as the commercial routines provided with the Matlab package.

To find out about how to use Matlab, keep in mind that a help option is always available: to get help about any command, type `help <command>` and hit return. For example, `help plot` gives information about using the command `plot`. Fortunately, Matlab uses many familiar notations for its commands, such as `plot` to generate a graphical plot, `sin(x)` for the sine function, `pi` for the number π , etc.

Matlab has the ability to handle complex-valued numbers (`'a + jb'`) with the same ease as for real-valued numbers. It also can handle matrix-valued arrays in a similar manner as single values. For example, to multiply a matrix A times a vector B, simply write `A*B`. The appropriate combinations of rows and columns are handled correctly.

A few other useful Matlab commands are: `grid` to toggle grid lines on or off for a graph; `figure` to open a new plotting window so you can produce a new graph in a separate window without erasing the graph in the previous window; `hold` or `hold on` to hold the current plot so that a second plot can be written on top of the original graph; `hold off` releases this feature.

Another helpful feature is that Matlab keeps track of the history of commands you enter. After entering several Matlab commands, use the up or down arrow keys to see previous commands which can now be

edited and re-run by simply pressing the enter key. Remember chapter 6 of your EE 101 Note Set contains a Matlab tutorial.

Prelab

PL1. Calculate the period of a 60 Hz sinusoid. Show your work.

Instructor's initials_____

PL2. How long does it take a 60 Hz sinusoid to complete five full cycles? Show your work.

Instructor's initials_____

PL3. What is the value of a $2V_{pp}$, 60 Hz sine wave in both magnitude (in Volts) and phase (in degrees) at $t = 2.5$ ms if the waveform is assumed to start with zero phase at $t = 0$ seconds? Show your work.

Instructor's initials_____

Equipment

Computers and Matlab program in the ECE computer lab, room 625 Cobeigh Hall.

Procedures

P1. Launch the Matlab program using the desktop icon or the 'Start' menu. The program will open with several window panes.

Explore Matlab by typing the command `help` at the `>>` prompt in the command window, then for any of the topics listed, type `help <topic>`. It is not necessary to write the directory name preceding the topic of interest. Also try `help plot` and `help cos`. After you finish the exercises of procedures P2 through P10, feel free to type `help demo` and try out one or more of the available demonstrations.

P2. Using your measured diode data from Lab 4 (which you recorded in Table II of Lab 4), create vectors containing:

- the input voltage values (save under the variable V)
- the voltage drop across the resistor (save under the variable VR)
- the voltage drop across the diode (save under the variable VD)
- the current flowing through the circuit (save under the variable I)

→ Create a line graph of the current (y-axis) vs. the voltage drop across the resistor (x-axis).

→ Place an appropriate descriptive title on the graph. Also label the x and y axes with the proper quantity names and units.

P3. Create a new Microsoft Word document and copy the P2 graph from Matlab into the Word document. Underneath the graph write a brief description about what is shown. Does the I-V characteristic of the resistor match what you expected? Using your graph, approximate the resistance value of the resistor. Explain your calculation.

P4. Create a line graph of the current (y-axis) vs. the voltage drop across the diode (x-axis). Place an appropriate descriptive title on the graph. Also label the x and y axes with the proper quantity names and units.

P5. Copy the P4 graph from Matlab into the Word document. Underneath the graph write a brief description about what is shown. Does the I-V characteristic of the diode match what you expected? For a piecewise linear model of the diode, what seems to be a good estimate the diode's voltage drop when conducting?

P6. In this step you will use the ideal diode equation to plot the I-V characteristic of the 1N4005 (the diode used in lab 4) and compare it to the measured I-V characteristic.

→ Create a new vector called Vdiode containing the values from -2 to 0.7 in steps of 0.01. This new set of values will be used to create an I-V characteristic for the 1N4005.

→ Create a variable I_0 and set it equal to 76.9×10^{-12} . This is the value of I_0 in the equation given on page 35 of your note set. The value was taken from the SPICE model for the 1N4005.

→ Create the variable N and set it equal to 1.45. This is the value of the diode ideality factor as given on page 35 of your note set. The value was taken from the SPICE model for the 1N4005.

→ Create variables for the electronic charge and Boltzmann's constant as found on page 35 of the noteset.

→ Create a variable T and set it equal to 290. This is the assumed value of temperature in degrees Kelvin.

→ Using the ideal diode equation, create a new vector called Idiode containing the values of the diode current for voltages held in variable Vdiode. The equation is given on page 39 of the noteset. *The exponential function in MatLab is exp; try help exp in MatLab to learn more.*

→ Create a graph that contains both the measured I-V characteristic of the diode and that predicted using the ideal diode equation. Make certain to label your graph appropriately.

→ Copy this graph to your Word document. Underneath the graph write a brief description regarding what is shown.

→ Below the graph, comment on the agreement between the measured I-V characteristic and that predicted using the ideal diode equation.

P7. → Again in Matlab, create a cosine wave with frequency $f = 60$ Hz, and create a line plot of five cycles of this signal, with "volts" for the vertical scale and time in seconds for the horizontal scale. You need to think about how to specify the argument for the cosine function and how many points per waveform cycle is appropriate.

→ Be sure to label the graph and axes appropriately, and copy this plot into the Word document and give a written description.

P8. → Repeat P7, but with a *phase shift* of +30 degrees. This requires changing the argument to the cosine function. Be sure to account for degrees or radians when using the cosine function.

P9. → Now create one graph with both signals from P7 and P8 overlapped on the same graph. Choose different line styles for the two signals, keeping in mind that the printer in the lab is monochrome (colors won't show up). Label the graph and axes, then copy the plot into the Word document and give a written description.

P10. → Add a report title at the top of the first page, along with the date, class number and section, and your name. Check the graph sizes, page boundaries, and text wrapping so that the graphs and their corresponding descriptions fit on the proper pages without wasting space. Print this report and turn it in as your lab report for today.

MATLAB is a tool that you may find useful in your math and science courses – make use of this fantastic resource!