EE 110
Introduction to Engineering & Laboratory Experience
Lab manual credit: Dr. Saeid Rahimi
Lab 0: Course Introduction

The primary goal of the one-unit EE110 course is to serve as a small window to allow the freshman electrical engineering students view the main categories of topics that they will encounter in the next few years of their electrical engineering studies at Sonoma State University. These topics include concepts of Ohm’s law, DC and AC signals, diodes and LEDs, transistor, operational amplifiers and 555 timers. In addition, students are given an opportunity to learn basics of microcontrollers and a few simple applications. In order to achieve this goal, each topic is presented in a very simple fashion without in-depth discussion of the foundations and theories of operation. Our experience indicates that by a cursory treatment of various topics in electronics, students will experience a “flavor” for each topic and show a strong interest in one or more of the subjects. Students are required to build a final project based on what they have learned in this course. The project is not intended to be original and students can use a vast number of in-print and online resources available to them. It is required that the students present the projects at the end of the course and submit a comprehensive written document describing the operation of their project.

The experiments in this course are essentially divided into four parts based on the type of equipment utilized in the experiments:

a. Standard laboratory equipment
b. Introduction to electronic components and basic circuit laws
c. Arduino based microcontroller
d. Exploratory design project

Multisim is an easy-to-use simulation application which is available on department laboratory computers. Students are encouraged to use the application for drawing circuits for their reports. Multisim is a powerful simulation software and will be encouraged to explore to utilize its capabilities in this course. Students may wish to use other online simulation software applications that are available for free. Circuits.IO is an example. The use of simulation software in this course is not mandatory. However, students are required to include computer-generated circuit diagrams in their reports.

In the first lab (Lab 0), students are also given some advice on how to navigate through the department of engineering science websites. In particular, the 4-year road map for completion of the Electrical Engineering degree program is discussed. Additionally, the course syllabus will be discussed in some detail. The laboratory procedures including safety considerations, laboratory notebook, requirements for lab reports, attendance and final project will be discussed.
A brief introduction to the equipment used in this laboratory will be given below:

1. Power Supply or Battery

2. Digital Multimeter

3. Keysight Oscilloscope

4. Digilent Discovery Scope (DS): These small and portable instruments will be loaned to students during the semester. The DS will help students carry measurements outside the laboratory (at home). DS units will be connected to students’ laptops, which will be used as input devices for writing codes and for monitoring the controls and results. The DS will be distributed among students in the beginning of lab 1, and the Arduino experiments will begin in lab 7. Students are urged to order their Arduino kits, a multimeter, lab books and the text, Arduino for Dummies, immediately. It will be assumed that students will have the necessary tools (at the latest) for lab 2.
1. DC Measurements

Electronic instruments and circuits are made up of individual and integrated electronic components. In this laboratory you will become familiar with some individual analog electronic components: switches, resistors, capacitors, diodes, and transistors. The picture below shows images of these components. In particular pay attention to the number of wires (legs, pins, leads) coming out of these devices. Generally the simple devices (resistors, capacitors, inductors, diodes) have two pins. Transistors and integrated circuits (ICs) have more than two pins. All electronic components are made up of one or more of the following materials: Conductors, semiconductors, semi-insulators, and insulators.

The electronic symbols for identifying some of these components are illustrated below. Each of these components has a specific function in a circuit. Today we will test the operation of traditional laboratory instruments. The functions and properties of the various components will be covered in the future sessions. Let us first talk about resistors which are the most basic component used in electronics. The resistance of resistors are measured in Ohms and the amount of electric current (I) going through them depends on their resistance (R) and the applied voltage (V). The relationship among I, R and V is expressed by Ohm’s law. The units of I, R, and V are Ohms, Amperes, and Volts, respectively.

1. Ohm's Law

Ohm's law states that the voltage drop across a resistor has a linear relationship to the current flowing through the resistor. Graphically this linear relationship is represented by a line when the current through the resistor is plotted against the voltage across it. This graph is termed I-V characteristic of the device. A linear I-V graph indicates that the resistance of the device remains constant over a wide range of currents and voltages. For many electronic devices the resistance is not a constant and varies with the applied voltage and current. These devices possess non-linear I-V characteristics. However, the slope of the curve at any given point determines the resistance of the device for that particular current and voltage.
A power supply is a device that provides the energy required to power up a circuit. In this section we will experiment with DC (Direct Current) power supplies. In this lab we will experiment with the Agilent E3630A power supply. The device output will be displayed on its front screen. However, multimeters are commonly used for measurement of basic electrical resistance, voltage, and current. Your station is equipped with a Fluke 179 multimeter. In this lab we will use both instruments. In order to become familiar with the use and accuracy of the DC power supply, try the following procedure.

**Assignment A:**

1. Set the function on Agilent E3630A to +6V. Adjust the voltage to 4.5 Volts. Measure the voltage using the provided multimeters. Write down the results. Make sure you turn the output power on.
2. Set the function to +20V. Adjust the voltage to +8 volts. Measure the voltage and record the result.
3. Set the function to -20V. Adjust the voltage to -10 volts. Measure the voltage and record the result.

**Ohm’s Law**

Ohms law describes the relationship between voltage and current in a linear device: \( V = I \times R \). Voltage difference is sometimes referred to as the voltage drop or potential difference. For a given voltage \( V \), the current \( I \) is determined by the resistance \( R \).

**DC Signal and DC Sources**

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3. Set the function to -20V. Adjust the voltage to -10 volts. Measure the voltage and record the result.
2. AC Signals

The goal of this part of the experiment is to make students familiar with the basic operation of function generators and oscilloscopes and introduce the concepts of frequency, period, and amplitude. Students will learn to use the function generator to output ac signals and view them using oscilloscope. Consequently, students will measure frequency, period and amplitude using the oscilloscope. This part of the experiment is conducted mostly in a free style, exploring a wide range of frequencies and other parameters. The output of the function generator is directly connected to one of the inputs (channels) of the oscilloscope. Students are required to carefully draw the waveform in their lab books as observed on the scope screen to scale. A more detailed description of traditional function generators and oscilloscopes, and the AC signals and oscilloscope function of the DS will be given in lab 3.

![Waveform Diagram]

Your instructor will describe the concepts of signal period (frequency), and amplitude as illustrated in figure below, and will outline the measurement parameters.