EELE 250 Circuits, Devices, and Motors

Lab #1: EE Basic lab instruments

Scope:

- Use a multimeter to measure resistance, DC voltage, and current
- Investigate the prototype-board (breadboard)
- Use a signal generator to create a sinusoidal voltage
- Use an oscilloscope to observe an AC voltage waveform

Home preparation:

- Obtain the lab component kit and buy a breadboard from the ECE Stockroom located in room 622 Cobleigh Hall.
- Obtain a lab notebook as indicated in the Lab Cover Sheet. (Print your name and contact information inside the front cover along with the grading table.) Leave at least the first 2 pages of the notebook for a Table of Contents. Sequentially number notebook pages. Plan to put all lab procedures and lab results in your notebook. (Provide enough information to repeat the experiment step-by-step.)
- Pre-lab assignments, if any, will be graded at the beginning of each lab.

Laboratory experiment:

In this experiment you investigate the basic circuit lab instruments. Your lab instructor will lead you through proper handling and equipment use procedures as well as general lab experiment expectations. During the lab period you should be able to find the answers to each of the questions below.

<u>Please answer the questions using complete sentences written in your lab notebook.</u>

1. Who is your lab instructor/TA? How and when can you contact him/her outside of lab?

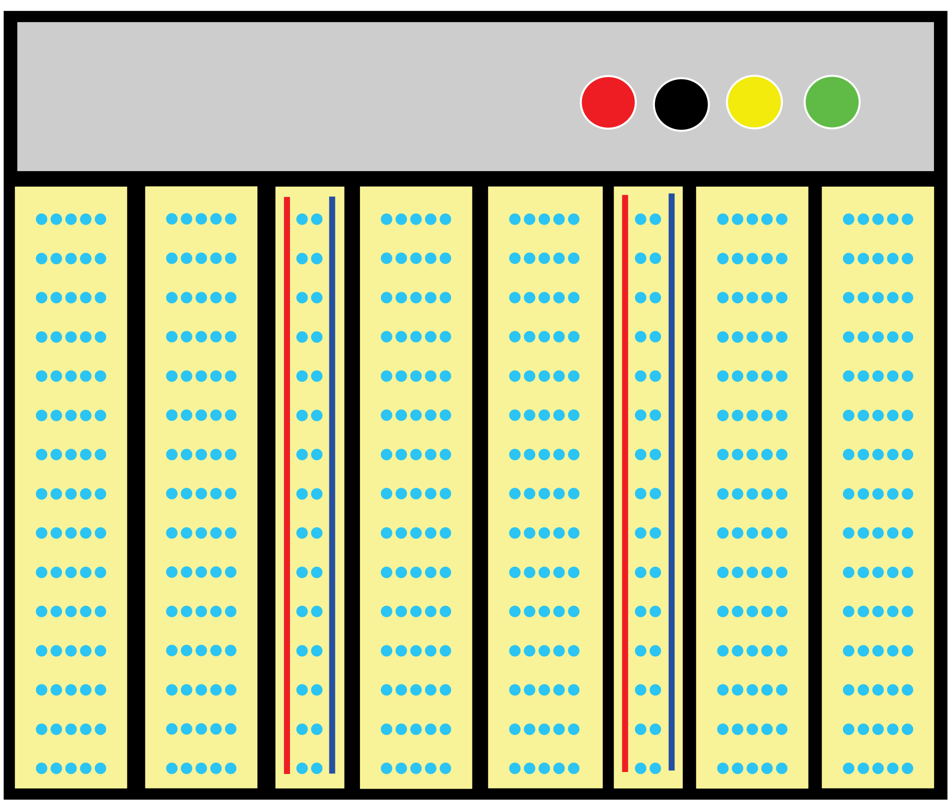
2. The following questions pertain to the **multimeter** provided at your lab station.
    a. What DC electrical parameters can be measured with the meter?
    b. Who is the manufacturer? What is the model and serial number?
    c. What is the largest resistance the meter can measure?
    d. What is the largest DC voltage the meter can measure?

e. What is the largest DC current the meter can measure?
f. What does the digital display indicate when a parameter being measured is larger than the scale setting?
g. What does the digital display indicate when a parameter being measured is much smaller than the scale setting?

3. The following questions pertain to your **solderless breadboard**.

⇨ *Start by setting the multimeter to read resistance at its smallest setting.*

a. Use multimeter readings to determine which "holes" on your breadboard are connected and which are electrically isolated from each other.
b. Use the breadboard drawing shown in Figure 1.1 as a model for your bread board. Sketch a summary diagram in your notebook, and make lines connecting "holes" which are electrically connected. All "holes" that are electrically connected are said to share a common node.
c. Measure and record the resistance between several "holes" that share a common node. Measure and record the resistance between a few "holes" that are electrically isolated.
d. Are the banana jack receptacles mounted on your breadboard electrically connected to any of the "holes"?



4. The following questions pertain to the **power supply** provided at your lab station.
    a. Who is the manufacturer? What is the model and serial number?
    b. How many independent DC voltages can the supply provide, and what are the voltage ranges?
    c. Set voltage source “A” to 5 V using the control knob and the panel display. Measure and record the source voltage using the multimeter.

> *The multimeter reading is typically more accurate that the power supply’s panel gauge, so we always use the multimeter reading to verify DC power supply settings.*

5. Choose a **resistor** from your lab kit and use the multimeter to measure the resistance. Using the power supply, connect a voltage of 5 V across the resistor and use the multimeter to measure the *current* through the resistor.

> *Always turn off the power supply when you are changing connections. NOTE that while a voltage measurement can be made without interfering with the circuit itself, a <u>current</u> measurement requires the meter to be placed <u>in series with the circuit branch where the current is to be measured</u>.*

    a. Record the resistance and current values.
    b. Do the measurements confirm Ohm’s Law? Explain.
    c. Sketch the supply/resistor/meter circuit. Use +/- for voltage drops across each circuit element and → for current flow through each element in the circuit.
    d. How many *nodes* and *loops* are in the circuit?

6. Connect the **signal generator** “main out” to Channel 1 of the **oscilloscope**. Turn on the signal generator and use the control settings to produce a 1 kHz (1000 Hz) sinusoidal waveform. Using a BNC-to-alligator cable, hook the oscilloscope probe hook-tip onto the red lead from the signal generator and the scope's ground (black) clip to the generator black lead. Adjust the oscilloscope vertical gain knob and sweep rate knob until you see about one cycle of the sinusoidal waveform on the screen. If the signal scrolls across the display screen, set the trigger to Channel 1 and adjust the trigger level to get a stationary signal displayed.

    Now adjust the amplitude on the signal generator to produce a 10 volt *peak-to-peak* sinusoid. Adjust the oscilloscope vertical scale to fill the CRT screen.

a. Sketch in your notebook what you see on the oscilloscope display screen, including the waveform and the rectangular "grid" lines built into the screen.

b. What is the oscilloscope (horizontal) time scale per division? A "division" is defined by the small rectangular grid elements on the screen.

c. How many divisions does the signal take to complete one cycle?

d. Calculate the *period* of the waveform (horizontal time required for one cycle).

e. How are signal *period* and its *frequency* in Hz (cycles per second) related?

f. What is the o-scope (vertical) voltage scale per division?

g. How many divisions does the waveform span from peak to peak?

h. Knowing that a sinusoidal voltage can be represented mathematically as:

$$\mathbf{V_s(\mathit{t}) = V_m \cos(\omega \mathit{t} + \theta)}$$

where $\omega = 2\pi f$ is the *radian frequency* [radians/sec], f is the waveform frequency in cycles per second [Hz], $\mathbf{V_m}$ is the voltage peak value [volts], and θ is the relative phase shift [radians] with respect to where you define time zero, write the mathematical expression for the voltage waveform displayed on your scope.

Notice the ratio relationship $\theta/2\pi = \tau/T$ holds, where T is the period in seconds and τ is the time delay corresponding to the phase shift θ.

Before leaving lab, show your notebook with recorded lab results to your instructor for credit. Turn off all equipment and return cables to their proper place. Leave your lab station clean and ready for other students to use. **You do not leave until your TA checks and approves the condition of your lab station!**