Scope:
- Investigate the prototype-board (breadboard)
- Use multi-meters to measure resistance, DC voltage and current
- Use signal generator to create sinusoidal voltage
- Use oscilloscope to measure AC voltage

Home preparation:
- Obtain Lab Kit and breadboard from 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 exactly.)
- 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. At the end of the lab period you will be able to answer all the questions below.
Please answer the questions using complete sentences written in your lab notebook.

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 is the digital display reading when a parameter being measured is larger than the scale setting?
  g) What is the digital display reading when a parameter being measured is much smaller than the scale setting?

3) Set the multimeter to read resistance at the smallest setting. The following questions pertain to your breadboard.
  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. Draw 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 "holes" sharing a common node. Measure and record the resistance between "holes" that are electrically isolated.
  d) Are the banana jack receptors 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. Measure and record the source voltage using the multimeter. On the proper scale, the multimeter reading is more accurate that the source gage. Plan to always use the multimeter reading to verify DC power supply settings.
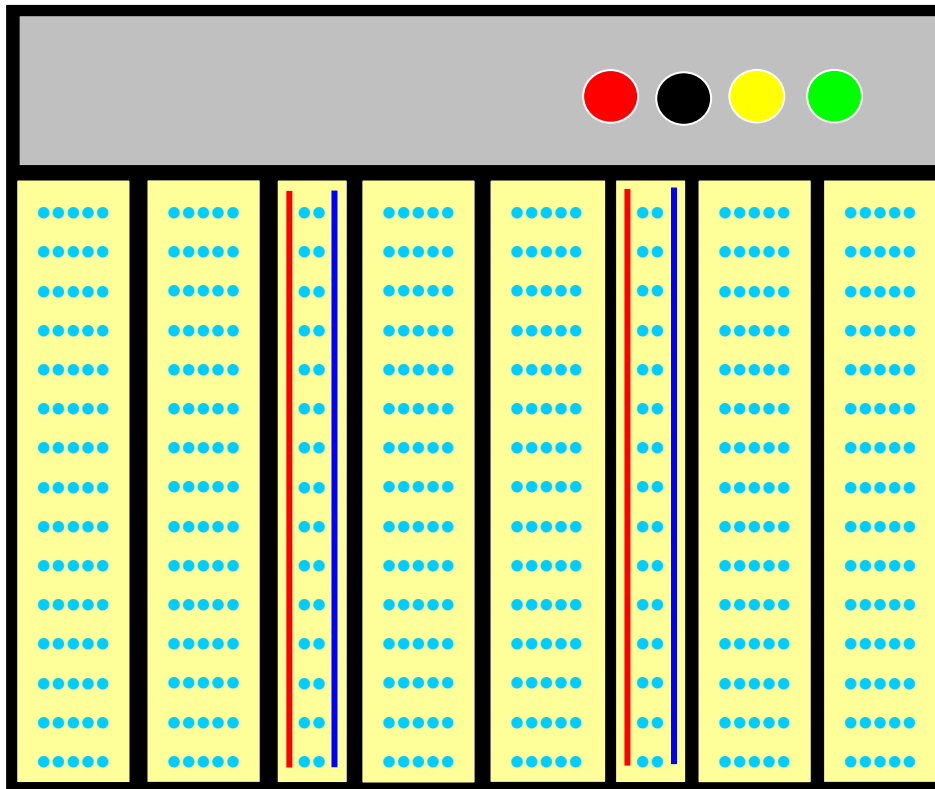
Figure 1.1: Breadboard Drawing

5) Choose a resistor from your lab kit and use the multimeter to measure the resistance. Apply a voltage of 5 V across the resistor and use the multimeter to measure the current through the resistor.
- 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 any 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 function generator and the scope's ground (black) clip to the generator black lead. Adjust the oscilloscope amplitude 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. Adjust the amplitude on the function generator to produce a 10 volt peak-to-peak sinusoid. Adjust the oscilloscope vertical scale to fill the CRT screen.

a) What is the o-scope (horizontal) time scale per division? A "division" is defined by the major grid on the screen.)
b) How many divisions does the signal take to complete one cycle?
c) Calculate the *period* of the waveform (horizontal time required for one cycle).
d) How are signal period and frequency in cycles per second related?
e) What is the o-scope (vertical) voltage scale per division?
f) How many divisions does the signal have from peak to peak?
g) Sketch in your notebook what you see on the o-scope CRT screen.
h) Knowing that a sinusoidal voltage can be represented as:

$$\mathbf{V_s(t) \ = V_m \ cos(\omega t + \theta) \ [V]}$$

(where $\omega = 2\pi f$ [radians/sec] is the radian frequency and f [Hz] is related to the period as indicated in (d); V_m is the voltage peak value; and θ is the phase shift in degrees),
write a mathematical expression for the voltage waveform.

(Notice the ratio relationship $\mathbf{\theta/360° = \tau/T}$ holds, where T is the period in seconds and τ is the phase shift time interval.)

Before leaving lab, show your notebook with recorded lab results to your instructor for grading. Turn off all equipment and return cables to their proper place. Leave your lab station clean and ready for other students to use. Thank you.