Lab 3: Measuring Voltage and Current

Background:

Measuring voltage and measuring current involve different steps. To measure voltage across two points in a circuit, all you need to do is attach your voltmeter's positive lead (usually red) to the point you want the voltage of, and attach is negative lead (usually black) to the point you want to use as the reference. No disruption of the circuit needs to be done. An ideal voltmeter will have infinite resistance and thus, zero conductance. They are open circuits. Real voltmeters will have some conductance to them. For this experiment, we will treat our voltmeters as ideal.

An ideal ammeter (current meter) is the opposite of an ideal voltmeter. An ideal ammeter behaves as a short circuit, or a zero-ohm connection. We will treat our ammeters in this experiment as ideal.

Measuring current through a circuit element involves more that attaching two leads to a circuit. To make a current measurement, you must first sever a connection in the path of the current you would like to measure. This step cannot be overlooked. The ammeter should then be hooked up so that the meter short circuits (reconnects) the two points that were severed. This ensures the original current you were trying to measure (and temporarily cut off) all flows through the ammeter. You can watch this video for a more visual tutorial watch this video: www.youtube.com/watch?v=7lwZkl0yBqA

Polarity does matter when attaching both voltmeter and ammeter leads. Red terminals are positive and black terminals are negative. The ammeter measures current according to passive sign convention. This means that if positive current flows into its positive terminal and out the negative, this registers as a positive number of amps. Positive current flowing into the negative and out the positive registers as a negative number of amps.

Objectives:

- Hook up voltmeters to measure voltage
- Hook up ammeters to measure current
- Use Excel formulas to perform calculations so that input parameters can easily be changed to obtain new output parameters

Required LabVolt Virtual Equipment Modules and Recommended Placement:

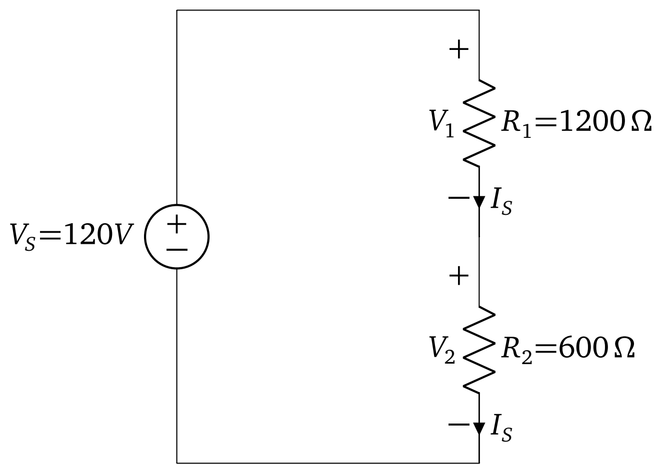
- 8821: Power Supply (bottom left)
- 9062: Data Acquisition Interface (center)
- 8311: Resistive Load (left center)

1 Prelab:

1. Read through this entire lab assignment.
2. Create all of the required Excel tables that perform the required calculations.

2 Part A Procedure:

1. Create a new Excel document and examine the schematic in Figure 1. Do all of the following steps



2. **Create an Input Variables table:**
On the first worksheet of the Excel file, create a table for your input variables with names in one cell (e.g. R_1), its *value* in the cell to the right (e.g. 1200). Your input variables are V_S, R_1, and R_2. In the cells storing values, do not include any other text than the number's digits, otherwise, Excel will interpret the cell as text and give it a numerical value of zero, and the value cannot be used in formulas. For instance, you should enter "1200" (do not include quotes). Do not enter "1.2k" or "1200ohms". A nearby cell should contain your units along with any engineering prefixes (if any).

3. **Create an Output Variables table:**
Your output variables are I_S, V_1, and V_2. In the same worksheet, create a nearby table for these variables' labels and values.

4. Use spreadsheet formulas to calculate all of your output variable values based on your input variable values. This should be done so that if any of your 3 input variables are changed in your spreadsheet, your output variables will change accordingly. With all of the values in Figure 1, you should calculate V_2 as 40.000V for Part A and 17.143V for Part B (rounded to the nearest mV). Changing V_S to 100V should make V_2 change to 14.286V for Part B. Set V_S back to 120V.

5. **Use the LabVolt simulator to obtain measured values:**

(a) Go to http://lvsim.labvolt.com/ and drag/drop the three modules listed under Required LabVolt Virtual Equipment Modules and Recommended Placement.

(b) Assemble the circuit in Figure 1.

   i. Use the variable DC voltage source (terminals 7 and N) for your voltage source.

   ii. Use the Resistive Load module for your resistors. Use the left-most resistor bank for R_1 and activate the 1200Ω resistor. Use the center bank for R_2 and activate the 600Ω resistor.

   iii. It is recommended that you take advantage of LVSIM's wire color choices. There are 3 nodes in each this lab's 2 circuits. Chose a different wire color for each node. This will be especially helpful in Part B. Suggestions are below.

   - V_S+: red
   - V_S-: grey (black is normally used, but it does not show up with black background)
   - Center node: choose one color that is easy to discern from the other 2

   iv. Attach your E1 voltmeter to the Power Supply's terminals 8 (positive) and N (negative).

   v. Set up one of the meters to continuously measure E1. Make sure it is in DC mode.

   vi. Turn on your main power and adjust the Power Supply's large dial to until E1 reads *exactly* 120.0V. To get finer control of the dial, you can move your mouse cursor further away from the center of the dial.

(c) Hook up your I1 ammeter to measure I_S. This is a series circuit, so the same current flows through all elements.

(d) Hook up your voltmeters E2 and E3 to measure V_1 and V_2, respectively.

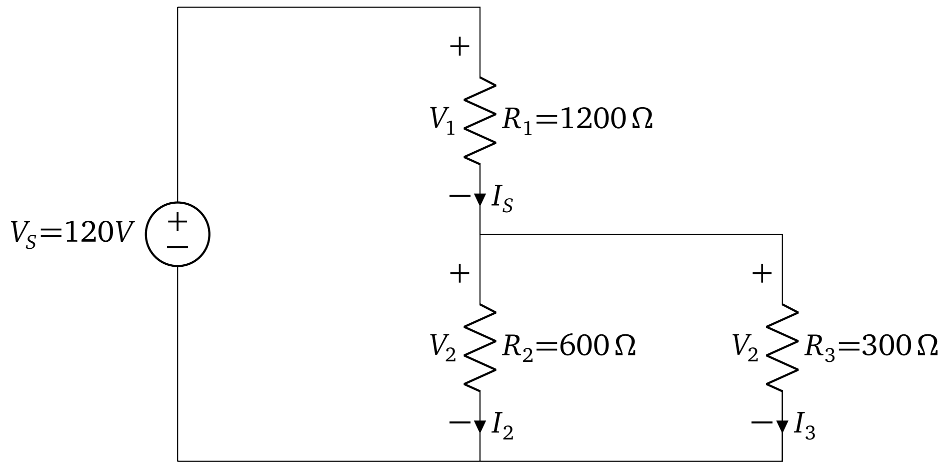
(e) Set up your LVSIM meters to continuously monitor the E1, E2, E3, and I1 values.

(f) Record your output variables' values in your Excel sheet.

6. Create a new column in your Output Variables table and compare your LVSIM results to your Excel-calculated results using percent error. Look up the formula for percent error, if need be. Use the Excel values as the theoretical and the LSVIM values as the measured values.

3 Part B Procedure:

1. Create or use a second worksheet within the same Excel file from Part A. For this part of the lab, use the circuit in Figure 2.



2. Repeat the Part A steps with the Part B schematic. This time, there will be some differences in procedure.
   (a) There will be one additional input variable (R_3) and two additional output variables (I_2 and I_3).
   (b) Use LVSIM meter I2 and I3 to measure I_2 and I_3, respectively. Note that hooking up 3 ammeters is much more complicated than hooking up only one. It is recommended that you hook up your voltmeters last, as they are easiest to attach.
   (c) Record all of your output variables' measurements and compare them to your Excel calculations with percent error.

4 Deliverables:

1. Turn in your Excel file (extension must be **.xlsx**) with both worksheets to this lab's D2L folder. There should be percent error calculations for all output variables for both Part A and Part B.

2. Save your Part B **.LVSIMWeb** file. This will save you time when doing next week's lab.