

EE101 Laboratory 2

(SP03)

Name _____

Date _____

Partner's name _____

Instructional Objectives (at the end of this lab you should be able to:)

- Understand simple circuit diagrams.
- Create circuits on the prototype board by following simple circuit diagrams.
- Connect from the lab power supply to the prototype board to create desired voltage(s).
- Measure dc voltages using a multimeter.
- Understand Ohm's Law and Kirchhoff's voltage law.
- Measure dc currents using a multimeter and understand Kirchhoff's current law.

Description and Background

Engineers and technicians frequently use circuit diagrams to show how components and voltage sources are interconnected. Understanding circuit diagrams others have written, and writing your own circuit diagrams so that others may understand them, is clearly an essential skill for communicating specific technical information in electrical and computer engineering.

Voltages and currents have polarity and magnitude. For example, “-5 V” indicates a negative polarity, a magnitude of 5 and units of volts (V). The expression “+3 mA” indicates a 3 milliamperere current with a positive polarity.

The term **circuit node** refers to any point in a circuit where two or more elements (or branches) are joined together. A **circuit loop** is any closed path starting at a node in an electrical circuit, which when traversed requires passing through a sequence of circuit branches and which comes back to the circuit node of the beginning—without the path crossing itself. A circuit can have many circuit loops, some of which intersect or share branches and others that do not.

One of the fundamental rules for electrical engineers is Ohm's Law, named for Georg Simon Ohm (1789-1854). Ohm discovered a linear relationship between voltage and current in many circuit elements:

$$\mathbf{V = I R}$$

where V is voltage (volts), I is current (amps), and R is the resistance of the circuit element that we now measure in the unit of ohms. Another way of interpreting Ohm's Law is that the resistance R is the voltage across the component divided by the current through it.

Two other very important rules for understanding electrical circuits are known as Kirchhoff's Laws, named after Gustav Robert Kirchhoff (1824-1887), who did experiments with electricity in the mid-1800s.

Kirchhoff's voltage law: the sum of the voltages around a circuit loop must equal zero, when following a consistent measurement direction of voltages for each element around the loop.

Kirchhoff's current law: the sum of all currents into a circuit node must equal zero. In other words, the total current flowing into a node must equal the current flowing out of that node.

Voltage and current measurements use two wires from the multimeter; this gives two choices of how the wires are connected in a circuit (black wire here, or red wire here?). Being attentive to this choice will give correct polarity (positive or negative current or voltage). It helps to be consistent: you are encouraged to use the red wire for the positive polarity and the black wire for the negative polarity.

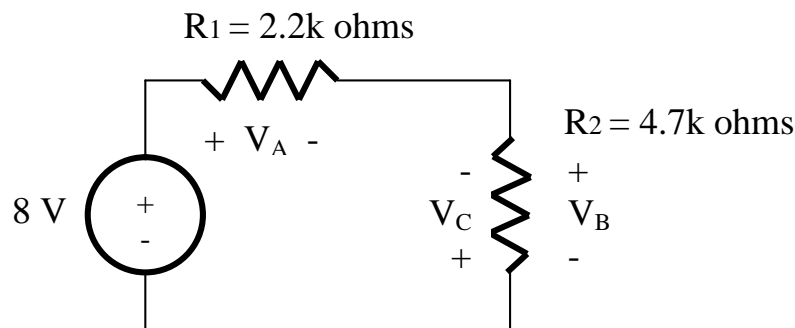
Equipment

Your own circuit prototype board, your own lab kit containing resistors and alligator clips, your own resistor color code chart; and the bench DC power supply, multimeter, and banana cables furnished in the lab.

Procedures

P1. Construct the circuit shown below on your prototype board. Use the bench DC power supply for the voltage source, using the multimeter to set the supply voltage accurately to 8 volts.

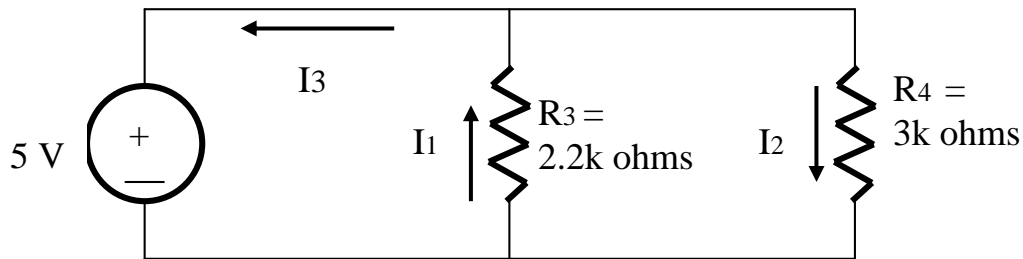
Measure voltages V_A , V_B , and V_C and record them on the figure (pay strict attention to the proper polarities). Also for each of these three measured voltages, show clearly on the figure where the red and black wires from the multimeter were connected.



P2. Using the voltages you measured in P1, show two examples of Kirchhoff's voltage law: one expression using your measurements for V_A , V_B , and the 8 V power supply, and another expression using your measurements for V_A , V_C , and the 8 V power supply. Explain the reason for any discrepancy in your measurements.

P3. Construct the circuit shown below on your prototype board. Use the lab power supply for the voltage source and use the multimeter to set the voltage accurately to 5 volts. Measure currents I_1 , I_2 , and I_3 following the polarities shown in the figure and record your measurements on the figure next to each of these current labels. The meter must be placed *in series* with the circuit branch you are trying to measure, which means you have to think carefully about how to separate the desired branch and place the meter into the circuit.

Also for each of these three measured currents, sketch on the figure how the multimeter was connected into your circuit, including identifying clearly where the red and black wires were attached.



P4. Using the currents you measured in P3, show an example of Kirchoff's current law for one of the circuit nodes and explain how this law applies to your measurements.

P5. Answer the questions in the table below. *Carefully* check for units and proper abbreviations.

- | | | |
|----|--|-------|
| 1. | 725 mV is how many volts? | _____ |
| 2. | 10.5 A is how many mA? | _____ |
| 3. | What is the sum of 650 mV and 1.2 V (in volts)? | _____ |
| 4. | 0.075 μA is how many mA? | _____ |
| 5. | What is the sum of 0.25 mA and 0.05 μA (in mA)? | _____ |
| 6. | Express 2.2 mA in terms of A. | _____ |
| 7. | What is the sum of 2400 V and 30,500 mV (in V)? | _____ |
| 8. | How many circuit loops are in the P1 circuit? | _____ |
| 9. | How many circuit loops are in the P3 circuit? | _____ |