COLLEGE OF ENGINEERING
SUNY POLYTECHNIC INSTITUTE

ECE 260

Name:_____

Date:_____

Laboratory 2 – Ohm's Law

Purpose: The purpose of this lab is to become familiar with calculations related to Ohm's law. This will include calculations of voltage and power. You will collect and record data from simulation as well as from building your own circuits.

Equipment Required

- Breadboard and power supply
- FLUKE Hand-held Digital Multimeter (DMM)
- Various resistors (or similar)
  - 330 Ω resistor
  - 1.6kΩ resistor
  - 3.6 kΩ resistor
- Potentiometer

Learning Objectives

1. Become familiar with Ohm's Law
2. Build and analyze circuit using a simulation program
3. Build and analyze a circuit you built

Procedure

1) Analyze a circuit that demonstrates Ohm's Law

Ohm's Law relates the current flowing through and the voltage across the conductor. It is a basic law in electricity. Mathematically, the voltage is directly proportional to the current flowing. This relationship is V = IR, where V is the voltage across the conductor, I is the current flowing through the conductor and R is the resistance of the conductor. We can arrange Ohm's law to solve for an unknown quantity, given the other two quantities. Specifically, V=IR, I=V/R, R=V/I.

One of the applications of Ohm's law includes the design of fuses and circuit breakers. A typical circuit breaker or fuse is rated by the maximum current allowed to pass through it. A designer would use Ohm's law to determine the rating appropriate for a given electronic device, based on the resistance of the device and the power supplied to the device. Ohm's law can be used in the calculation of electric power, P. Here the power is defined as P=VI. Applying Ohm's law to this equation allows us to express the power in terms of the current and resistance, $P=I^2R$ or in terms of the voltage and the resistance, $P=V^2/R$.

a) Calculations using Ohm's Law

Here we will analyze a circuit using Ohm's Law. Calculate the current flowing through a resistor for the resistance values and voltage values given below.

Table 1

	R=330Ω	R=1.6kΩ	R=3.6kΩ
Supply Voltage (V)	Calculated I (mA)	Calculated I (mA)	Calculated I (mA)
1			
2.5			
3.25			
4.5			
5			

b) Simulate Ohm's Law (you must provide a copy of your simulation in your report)

Using Multisim, you will simulate a circuit with a 330Ω resistor and vary the voltage from 1V to 5V and record the current in each case. Repeat this process with a 1.6kΩ and 3.6kΩ resistors.

- Access Multisim Live from your laptop
- Build a simple circuit with a power DC variable power supply in series with a resistor.
- Set the resistor value to 330Ω and click and modify the power supply voltage to 1V
    - Insert a multimeter in series with the circuit and set it to measure current (they are along the right side of the window).
    - Also be sure to insert a Ground into your circuit.
- Click **Run** to simulate the circuit and record the current value in the table below.
- Click **Stop** to halt simulation before you make changes to the circuit
- Repeat this experiment with the different supply voltages and different resistor values and record your results in the table below.

Table 2

	R=330Ω	R=1.6kΩ	R=3.6kΩ
Supply Voltage (V)	Calculated I (mA)	Calculated I (mA)	Calculated I (mA)
1			
2.5			
3.25			
4.5			
5			

c) Measuring the current

In this section you will use a breadboard to verify Ohm's Law by creating an actual circuit on the bread board

- Connect a single resistor between the variable DC power supply and Ground.
- Configure the DMM to measure current
- Place a DMM, used to measure current, between the resistor and Ground. You will need to break the circuit apart to place the DMM properly
- Measure the current for each of the three resistors for varying voltage values
- Fill in the table below.

Table 3

	R=330Ω	R=1.6kΩ	R=3.6kΩ
Supply Voltage (V)	Measured I (mA)	Measured I (mA)	Measured I (mA)
1			
2.5			
3.25			
4.5			
5			

d) Finding Resistance of a Potentiometer

In this section you will use a breadboard to verify Ohm's Law by creating an actual circuit on the breadboard

A potentiometer is a resistor that can have its resistive value changed manually. For this section, you will use the 1kΩ potentiometer on the breadboard to place an unknown, random resistance into the circuit. By applying a known voltage and measuring the current through the potentiometer, you can calculate the resistance.

- Connect a potentiometer in series with a 5V source with a break in the circuit between the voltage source and one side of the potentiometer. Connect the other side of the potentiometer to ground.

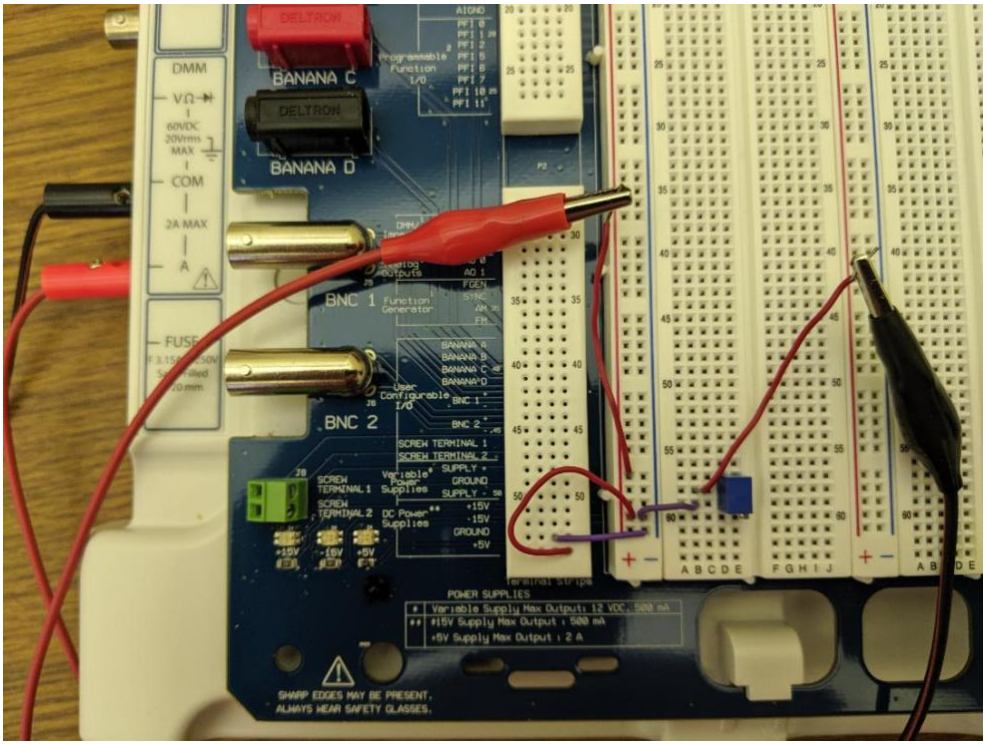

Figure 1: Image of circuit

- Turn the 1kΩ potentiometer to a new position (by turning the small screw)
    - If your using the Digital Boxes, use the potentiometer on the box
- Set the measurement mode to DC current on your DMM and use Ohm's law to calculate the resistance of the potentiometer, knowing that 5V is being applied.

What is the measured current?_____

What is the calculated resistance?_____

- Change the circuit configuration by disconnecting the potentiometer from the circuit. You can do this by disconnecting the wire between the 5V power supply and the potentiometer and the wire between the potentiometer and ground.

- Set the DMM to measure resistance with a range set to 5kΩ and measure the resistance of the potentiometer. ***Be sure to turn off the board when wiring and turn it back on when done.***

What is the measured value of the potentiometer?_____

Did the measured value match the calculated resistance value? Why or why not?

_____

_____

_____

e) Finding Resistance of an Unknown Resistor

You will use the breadboard to experiment with Ohm's law and confirm the value of a resistor compared to its color code specification.

- Randomly select a resistor from the white resistor bucket and wire it into your breadboard. See figures below.

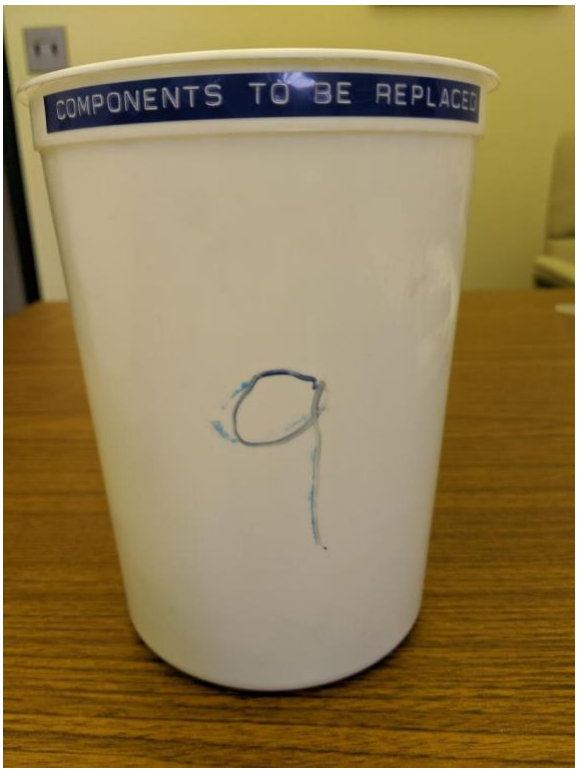

Figure 2

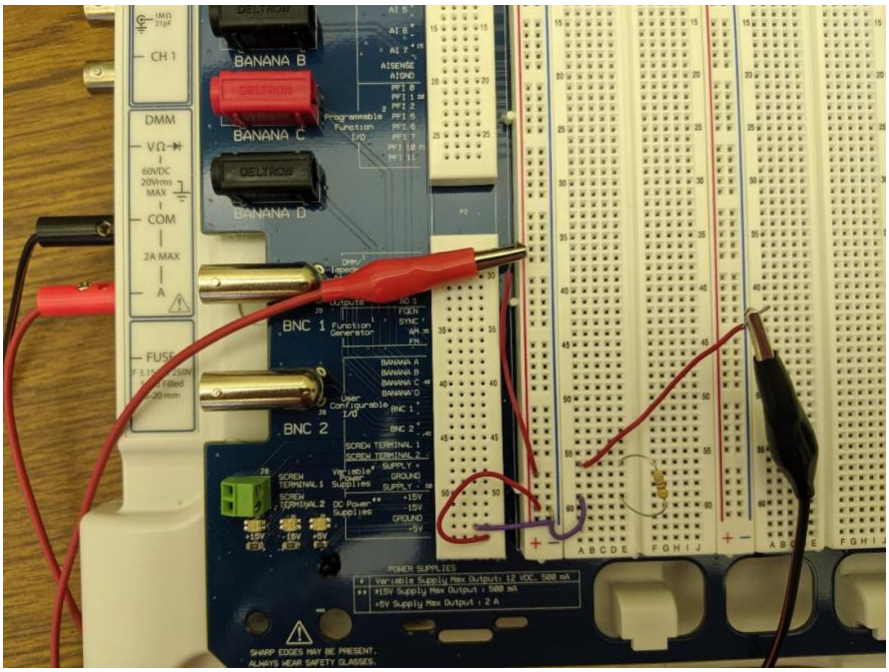

Figure 3

- Measure the current through the circuit using the DMM similar to what you did in the previous section
- Use Ohm's law to calculate the resistance of the resistor, knowing that 5V is being applied across the resistor.

What is the measured current?_____

What is the calculated resistance?_____

Confirm the resistance using the color code and the DMM. According to the color code, what resistance should the resistor demonstrate?

_____

_____

_____

Use the digital multimeter directly to measure the resistance of the component

- Change the circuit configuration to the following

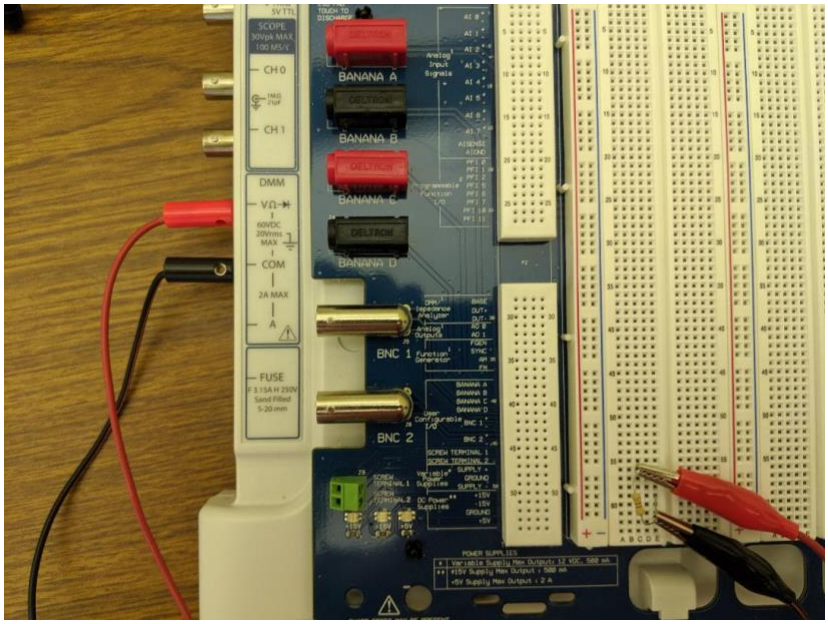

Figure 4

- Set the DMM to measure resistance and measure the resistance of the component
    - If the reading is over, increase the **Range**. Make sure to turn off the protoboard while measuring resistance and turn it back on when done.

What is the measured resistance value of the component?_____

Do the calculated and measured resistance values fall within the color code range? Why or why not?

_____

_____

_____

f) Investigate Non-linear and Negative Resistance Components

Most resistance components follow Ohm's law. There are some that do not. These are referred to as non-linear resistors and negative resistance components. However, most resistors are linear which means the ratio between the current and the voltage is constant. If a component is non-linear, such as thermistors and photoresistors vary their resistance according to an increase in temperature and light respectively. Another type of non-linear component is the varistor. The resistance of a varistor will increase as the voltage increases.

Components can have negative resistance as well. Voltage increases across components with negative resistance. A fluorescent lamp has negative resistance. An increase in voltage leads to a decrease in current since R is negative.

Describe the difference between regular (ohmic) resistors and non-linear/negative components. How would the presence of a non-linear or negative component change how you might analyze the circuit?

_____

_____

_____

_____

Conclusion

These questions will help you review and interpret the concepts learned in this lab.

In your own words, describe Ohm's law. Give two instances from the real world or from your educational career in which it would be used.

What is the current of the circuit?

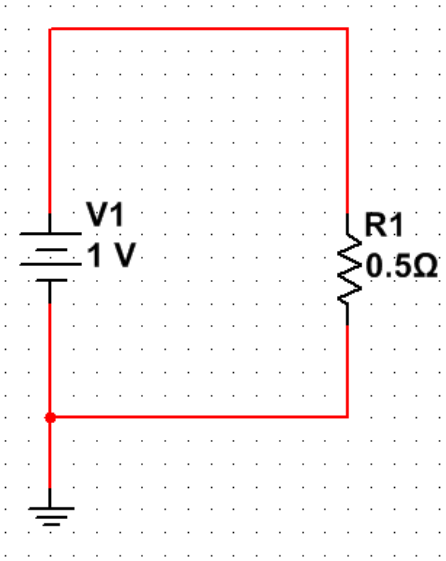

Figure 5

A. 1 Volts
B. 5 Amps
C. 5 Amps
D. 2 Amps

The watt (W) is the unit for electrical power, where P = I x V. Express the watt in terms of ohms (Ω), amperes (A), and/or volts (V):

A. $W = V^2 \times \Omega$
B. $W = A^2 \times \Omega$
C. $W = A \times V \times \Omega$
D. $W = \Omega / A \times V$

Were your observations from the simulated circuit in the Simulate step consistent with your calculations from the Exercise step? If not, why do you think that is?

Record any observations from your experiments in relation with Ohm's law that you have not yet noted. Reference your calculations from the exercise and your results from the Simulate and Experiment steps.