EE 2010 Circuit Analysis
Lab 01: A First Circuit

Lab Section: **Printed Name (Last, First):**

Learning Objectives:

- Establish a Multisim Online account
- Become familiar with the Multisim GUI and functions
- Build your first Multisim simulation
- Understand the proper operation of the DC Power Supply
- Understand the proper operation of the Multimeter
- Understand the operating characteristics of a solderless breadboard or "proto-board"
- Be able to identify a resistor from its color markings
- Be able to use these laboratory tools to build and measure electrical quantities of a simple circuit

IMPORTANT NOTE: This and future labs will employ *NI MultisimLive*, the On-Line version of Multisim. The advantages include: no download necessary, it runs on ALL web accessible devices (even your smart phone), and you have access to HUNDREDS of example circuits.

A. Before coming to lab:

1. Connect with Multisim

1.1 Go to: **the Multisim Website**

1.2 Select: "Signup"

1.3 Select: "Student"

1.4 Enter personal and University information

1.5 Add your name, major and other information relating to your role at WSU

2. Build a Circuit

2.1 Use the "Source," "resistor," and "ground" elements on the toolbar to build the (series) circuit shown below. Don't forget the ground.

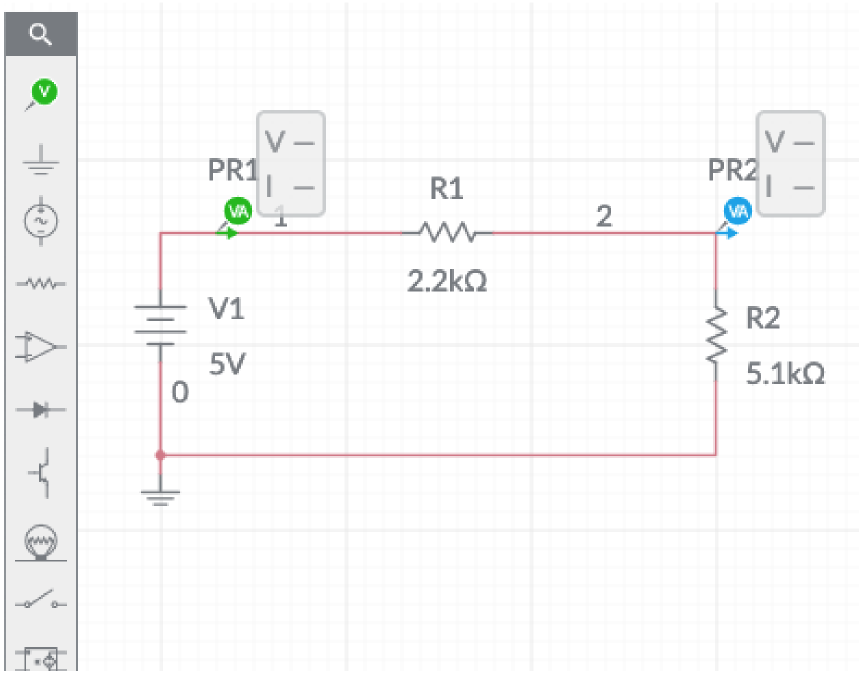

Figure 1: Voltage source with series resistor circuit schematic diagram

2.2 Click and move to place connecting "wires."

2.3 Set DC supply voltage to 5V.

2.4 Set the Resistor value to 2k Ω .

2.5 Add a voltage/current probe at node 2.

2.6 "Run" the simulation for a short time (since nothing changes in this circuit) by clicking on the ▷ symbol.

2.7 Use the design and measured quantities to verify $V = IR$.

2.8 Capture and download your schematic diagram file and submit it to the Pilot dropbox folder for Lab 01.

2.9 Explore "what ifs" by changing the values of R and V.

3. Explore Equipment Used in Lab

3.1 Read pages 1 – 46 of the Keysight E3631A Triple Output DC Power Supply user's guide

3.2 Read pages 1 – 42 of the TENMA Model 72-1020 OPERATING MANUAL

3.3 View **this description** of solderless breadboards

3.4 Interact with **this webpage** explaining resistor color codes

3.5 View **this document** on measuring resistances

3.6 Refer to this **web resource** on using a multimeter

3.7 Watch **this video** on measuring voltages and currents for a series resistor circuit.

3.8 Watch **this video** on measuring voltages and currents for a parallel resistor circuit.

3.9 Consider well the following *Trouble Shooting Hints* when something is NOT working in the Lab

(a) Be sure that the power is turned on.

(b) Be sure the ground connections are common.

(c) Be sure the circuit you built is identical to that in the diagram. (Do a node-by-node check)

(d) Be sure that the supply voltages are correct.

(e) Be sure you are using the multimeter correctly to measure the voltage/resistance or the current.

(f) Be sure any multiple pin devices are correctly oriented.

If these have been carefully verified, it may be a chosen component has an incorrect value or doesn't work. It is also possible that the protoboard may have unwanted paths between nodes or that one of the bench lab instruments is not set correctly or working properly (although highly unlikely).

To find the problem, carefully trace the voltages through each circuit node and compare the signal to the expected signal. If there is a significant difference, use your engineering judgment to determine the cause or ask your lab assistant.

B. In Lab Procedures:

1. Setup

1.1 Acquire two resistors, $R_1 = 2.2\text{k}\,\Omega$ and $R_2 = 5.1\text{k}\,\Omega$ resistor.

1.2 Verify the resistor values via the color code:
R_1 band colors: ______________________________
R_2 band colors: ______________________________

1.3 Verify the resistor values via DMM measurement:
R_1 measured value: __________
R_2 measured value: __________

1.4 Explain the discrepancy: ____

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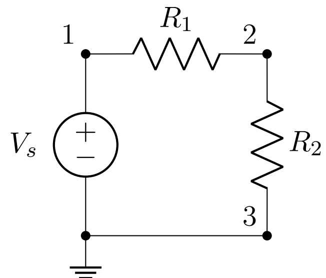
2. A Series Resistor Circuit

2.1 Build the (series) circuit shown below using the DC power supply as the source:



2.2 Measure the resistance from node 1 to node 3: $R_{1,3}$: __________

2.3 Remember to connect and energize the power source LAST – after the resistances are measured.

2.4 Set the supply voltage at 5V DC.

2.5 Measure the following voltages: $V_{1,3}$: __________, $V_{3,1}$: __________, $V_{1,2}$: __________, $V_{2,3}$: __________.

2.6 NOTE: IF YOU MEASURE CURRENT INCORRECTLY, YOU WILL DESTROY LAB EQUIPMENT.

2.7 Measure (be careful here) the current flowing through R_1: __________

2.8 Measure the current flowing through R_2: __________

2.9 Compare your answer to Ohm's law model $I = \frac{V_s}{R_{1,3}}$: ______________________________

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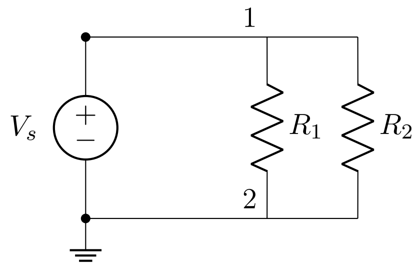
3. A Parllel Resistor Circuit

3.1 Build the modified (parallel) circuit shown below using the DC power supply as the source:



3.2 Measure the resistance from node 1 to node 2: $R_{1,2}$: ______________

3.3 Remember to connect and energize the power source LAST – after the resistances are measured.

3.4 Set the supply voltage at 5V DC.

3.5 Measure $V_{1,2}$: ______________

3.6 NOTE: IF YOU MEASURE CURRENT INCORRECTLY, YOU WILL DESTROY LAB EQUIPMENT.

3.7 Measure (be careful here) the current flowing through R_1: ______________

3.8 Measure the current flowing through R_2: ______________

3.9 Measure the current flowing through V_s: ______________

3.10 Compare your answer to Ohm's law model $I = \frac{V_s}{R_{1,2}}$: ______________________________________

Exercise your mind by exploring *what ifs*

Takeaways:

- Multisim is a reasonable simulation utility.
- The models for circuit elements and circuit quantities are **always wrong**, but hopefully close enough to be useful.
- Resistors in series add.
- Resistors in parallel have an equivalent lower than the minimum of any individual resistors.
- The voltage across series resistors add to the value of the supply.
- The current through series resistors is the same for each resistor.
- The voltage across parallel is the same for each resistor.
- The current through parallel resistors add to the value of the supply.