

Laboratory Goals

- ❑ Familiarize students with the digital multimeter and the power supply
- ❑ Calculate voltage and current values for two circuits
- ❑ Construct resistive series and series-parallel circuits
- ❑ Measure the resistance, current, and voltage of resistive circuits
- ❑ Record results in the laboratory notebook

Pre-lab / lab reading

- ❑ *Student Reference Manual for Electronic Instrumentation Laboratories* by Stanley Wolf and Richard Smith, Copyright 1990.
- ❑ *Agilent User's Guides* published by Agilent Technologies, Copyright 2000. (Copies of these reference books are available in the lab, or at the website)
- ❑ Basic resistive networks, EECE 203 textbook

Equipment needed

- ❑ Lab notebook, pen
- ❑ Agilent E3631A Triple DC Power Supply
- ❑ Agilent 34401A Digital Multimeter
- ❑ 2 test leads, red, with banana/EZ Hook ends (located in your assigned equipment cabinet)
- ❑ 2 test leads, black, with banana/EZ Hook ends (located in your assigned equipment cabinet)

Parts needed

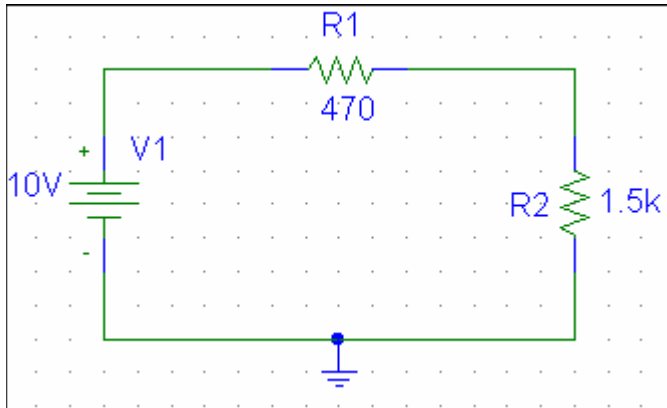
- ❑ Circuit breadboard
- ❑ Lab parts kit
- ❑ Resistor, 470 Ohms, $\frac{1}{4}$ W
- ❑ Resistor, 560 Ohms, $\frac{1}{4}$ W
- ❑ Resistor, 1.5k Ohms, $\frac{1}{4}$ W
- ❑ Resistor, 2.2k Ohms, $\frac{1}{4}$ W
- ❑ Brown jumper wires, 3 (U-shaped wires, found in the parts kit)

Lab safety concerns

- ❑ **Do not make voltage measurements while the multimeter is set for current measurements-you will blow the current limiting fuse!**
- ❑ Do not turn on the power supply until you have rechecked your circuit for correct wiring
- ❑ Do not allow the test leads connected to the power supply to touch each other

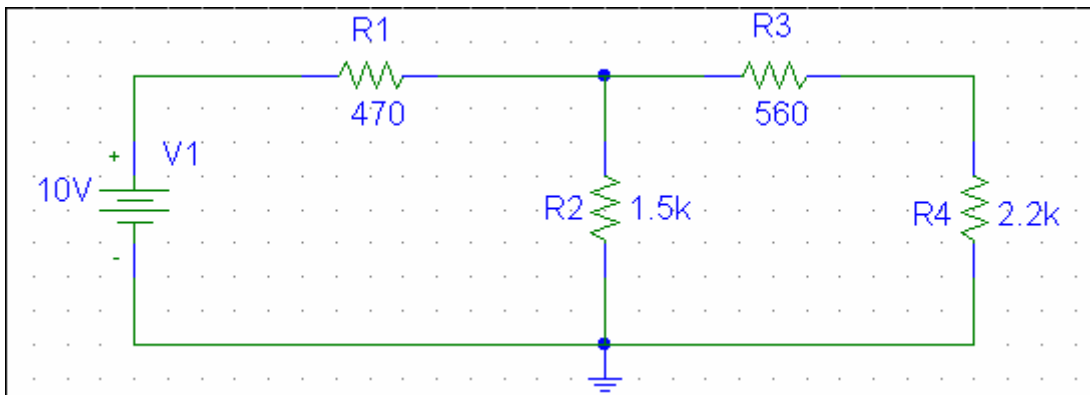
1. Pre-Lab Design Calculations

- Calculate I_{R1}/I_{R2} , V_{R1} , and V_{R2} for Circuit 1:



Circuit 1

- Next, Calculate I_{R1} , I_{R2} , I_{R3}/I_{R4} , V_{R1} , V_{R2} , V_{R3} , and V_{R4} for Circuit 2:



Circuit 2

- Create two tables in your lab notebook, with the headings shown below. (Be sure to make two columns under each resistance, current or voltage – one for the calculated value, and the other for measured values)

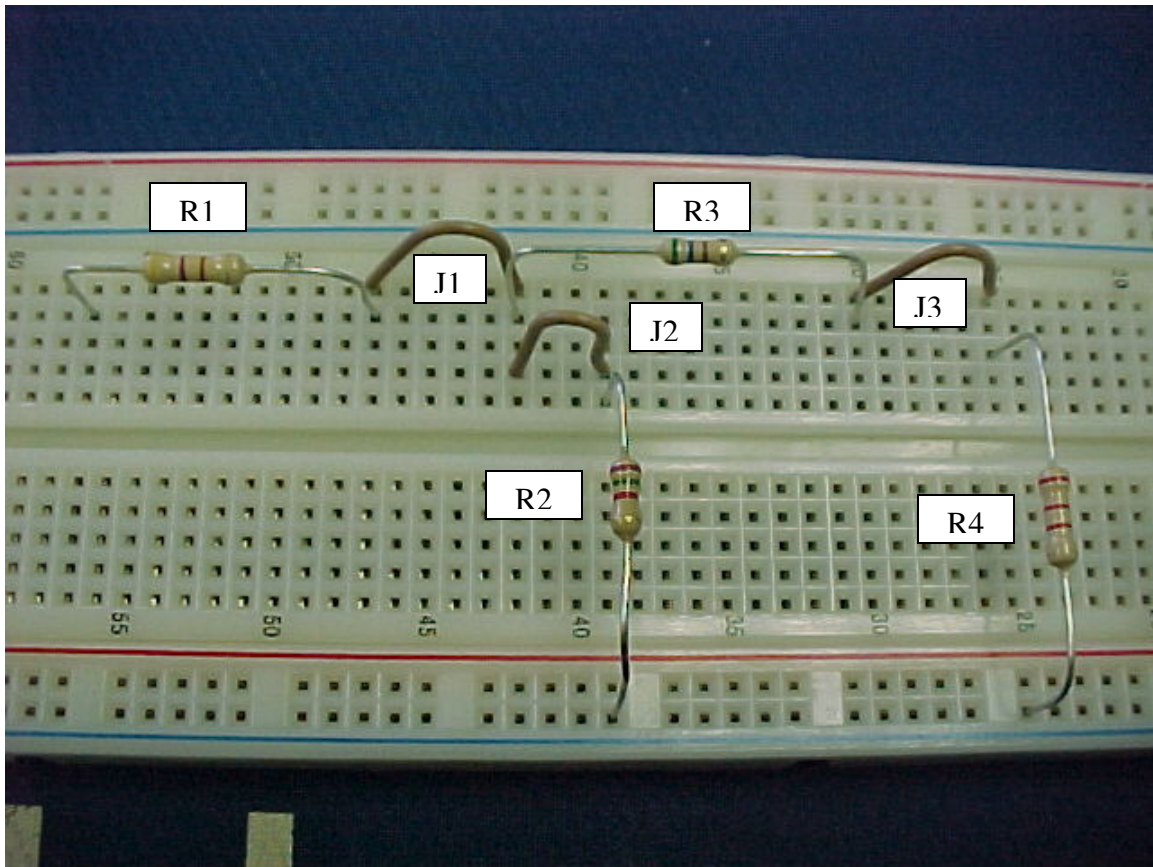
Circuit #1	V_{in}	R1	R2	I_{R1}/I_{R2}	V_{R1}	V_{R2}
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Circuit #2	V_{in}	R1	R2	R3	R4	I_{R1}	I_{R2}	I_{R3}/I_{R4}	V_{R1}	V_{R2}	V_{R3}	V_{R4}
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- Copy the calculated values for circuits 1 and 2 into the tables

2. Circuits 1 and 2 Construction

- Build the circuit exactly as shown below (bend the brown jumper wires as shown; these wires are later removed for resistance and current measurements). Resistors are found in the resistor cabinet.



Circuits 1 and 2

3. Resistance and Voltage Measurement using the Multimeter

- Locate the Agilent 34401A Digital Multimeter
- Press the white **Power** button to turn on the multimeter
- Confirm that the gray **Terminals** button is out (i.e., the front terminals are active)
 - Note that there are two sets of identical terminals in the front and back of the multimeter. The rear terminals have probes already plugged in and are typically set for voltage and resistance measurements. *We will use the front terminals for today's lab, so the button is out*

- Connect a pair of red and black test leads to the multimeter as shown below for resistance and voltage measurements:

The Digital Multimeter set for Resistance and Voltage Measurements

- Press the white **Ω 2W** button to select the resistance measurement mode
- Briefly clip the two test leads together (The multimeter reads approximately zero Ohms. *Always test the probes before relying on them!*)
- To make resistance measurements with the multimeter:
 - Remove the jumper wire (J3) from between R3 and R4
 - Clip the red test lead to either of the legs of resistor R1
 - Clip the black test lead to the other leg of R1
 - Record the resistance value shown on the multimeter in your lab notebook (e.g., 471.92 Ohms will read as **.471.92KOHMS**)
 - Unclip the two test leads from R1 and repeat the measurement for the other 3 resistors
 - Unclip the two test leads from the last resistor measured, and set them aside
- Locate the Agilent E3631A Triple DC Power Supply
- Press the white **Power** button to turn on the power supply
- To set the power supply to +10VDC:
 - Press the **Output On/Off** button to enable the power supply output
 - Press the **+25V** button to select the +/- 25V power supply
 - Turn the **ADJUST** dial clockwise until the display shows “10.00V”
 - Press the **Output On/Off** button to disable the power supply output

- Connect the second pair of red and black test leads between the power supply and the circuit as shown below:

The Power Supply Connected to the Circuit

- Press the power supply's **Output On/Off** button to provide power to the circuit
- To take DC voltage measurements of R1 and R2 with the multimeter:
 - Press the **DC V** button to select the DC voltage measurement mode
 - Clip the **red** test lead from the multimeter to one leg of R1
 - Clip the **black** test lead from the multimeter to the other leg of R1
 - Record the voltage drop VR1 in your table (a negative voltage means that you have the probes reversed from the correct polarity-change them!)
 - Repeat the voltage measurement for R2
- Measure the circuit input voltage by connecting the multimeter test leads to the same points where the power supply is connected to the circuit. Record the value
- Press the **Output On/Off** button to disable the power supply output
- Unclip the multimeter test leads from the circuit
- Reinstall jumper wire J3 to complete circuit 2
- Press the power supply's **Output On/Off** button to provide power to the circuit
- Take voltage measurements of the resistors in circuit 2 using the same procedure as above (be sure to include R1 and R2, since the voltages are different from those in circuit 1)
- Measure the circuit input voltage for circuit 2, and record the value
- Press the **Output On/Off** button to disable the power supply output
- Unclip the multimeter test leads from the circuit

4. Current Measurement using the Multimeter

- ❑ **Do not make voltage measurements while the multimeter is set for current measurements-you will blow the current limiting fuse!**
- ❑ To make DC current measurements with the multimeter:
 - Remove the **red** test lead from the **V Ω** input on the front panel
 - Connect the **red** test lead to the **I** input (below the black test lead connection)
 - Press the blue **Shift** button, followed by the **DC I** button
- ❑ Remove jumper wire (J3)
- ❑ Remove jumper wire (J2)
- ❑ Clip the **red** test lead of the multimeter to the left leg of R3
- ❑ Clip the **black** test lead of the multimeter to the top leg of R2 (the multimeter is now ready to measure the series current for circuit 1)
- ❑ Press the power supply's **Output On/Off** button to provide power to the circuit
- ❑ Record the current shown on the multimeter for IR1/IR2 of circuit 1
- ❑ Press the **Output On/Off** button to disable the power supply output
- ❑ Reinstall jumper wire (J3)
- ❑ Press the power supply's **Output On/Off** button to provide power to the circuit
- ❑ Record the current shown on the multimeter for IR2 of circuit 2
- ❑ Press the **Output On/Off** button to disable the power supply output
- ❑ Unclip the multimeter test leads from the circuit
- ❑ Reinstall jumper wire (J2)
- ❑ Remove jumper wire (J1)
- ❑ Clip the **red** test lead of the multimeter to the right leg of R1
- ❑ Clip the **black** test lead of the multimeter to the left leg of R3
- ❑ Press the power supply's **Output On/Off** button to provide power to the circuit
- ❑ Record the current shown on the multimeter for IR1 of circuit 2
- ❑ Press the **Output On/Off** button to disable the power supply output
- ❑ Unclip the multimeter test leads from the circuit
- ❑ Reinstall jumper wire (J1)
- ❑ Remove jumper wire (J3)
- ❑ Clip the **red** test lead of the multimeter to the right leg of R3
- ❑ Clip the **black** test lead of the multimeter to the top leg of R4
- ❑ Press the power supply's **Output On/Off** button to provide power to the circuit
- ❑ Record the current shown on the multimeter for IR3/IR4 of circuit 2

- ❑ Press the **Output On/Off** button to disable the power supply output

- ❑ After all the measurements are recorded, disconnect the test leads from the circuit and turn off the equipment. You are done!

Before leaving the lab, take a few minutes to make sure all equipment and test leads are returned to your cabinet, and then lock it. Return the cabinet key to your T.A. Pick up any loose parts on the workstation table, and wipe off any eraser shavings, or other debris with a paper towel. Dispose of the paper towel and debris in the wastebasket.

4. Analysis

Write a summary report for this lab. Be sure to also include the following topics:

Compare theoretical vs. measured values. Are there differences? If so, Why?

Explain any difficulties you had with this lab. (Please include suggestions to improve the lab, if you have them).