ECE401 – Perspectives in Electrical and Computer Engineering

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Learning to Build and Measure Resistive Circuits

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LAB Section: 05

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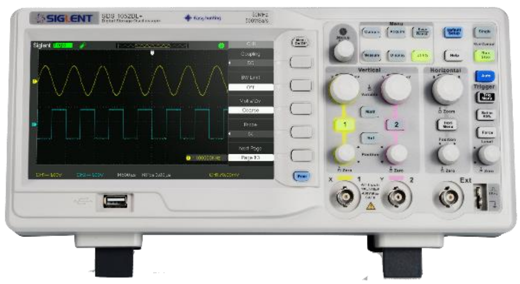
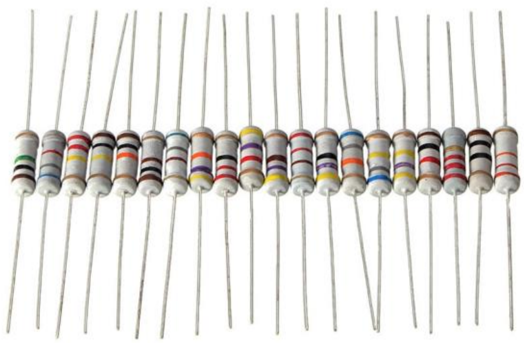
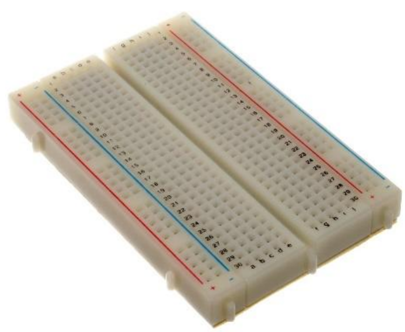
Introduction:

Lab 3 is titled "Learning to Build and Measure Resistive Circuits" and its objective is just that. For this lab, I arranged many different resistances in many different configurations and then measured the voltage drop across each resistor. A second part of this lab is to plot a sinusoidal waveform from a function generator with an oscilloscope.

Equipment List:

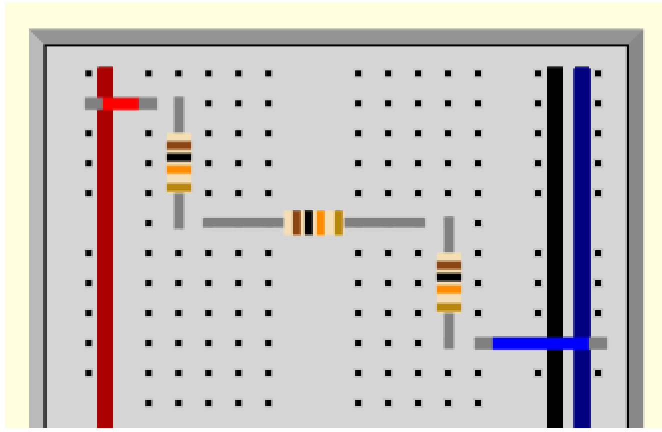
Equipment	Image	Description
Oscilloscope		An oscilloscope provides a graph of voltage in relation to time. This allows the observer to see how the voltage changes over time. This is most useful when dealing with periodic waveforms. An oscilloscope can give a graphical user interface to a waveform produced by a function generator.
DC Power Supply		A device that transforms the A.C. input (~120 V) into a D.C. output. The output is independent from changes of load, temperature, and A.C. Supply.
Benchtop Digital Multimeter		An electronic instrument used to measure electric voltage, current and resistivity. Multimeters provide the ability to measure different electrical signals as opposed to using individual meters.

Assorted Resistances		A collection of resistances that are used to alter the voltage across or the current through a circuit.
Breadboard		A reusable base for prototyping electronics. Components can be plugged into board and conductive rails can carry current from component to component.
Test Leads		A pair of wires connected to conductive clips to temporarily join electrical equipment. They are used in conjunction with a DMM to measure electrical signals

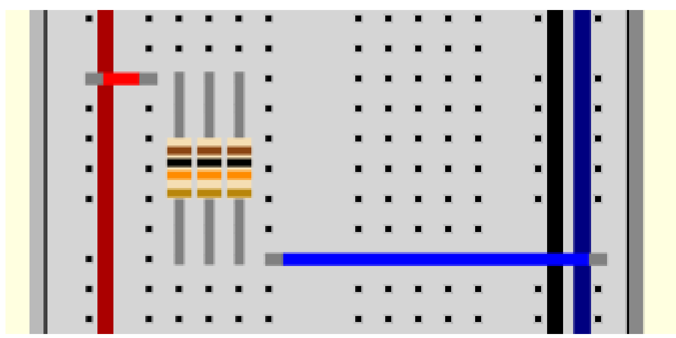
<u>Procedure:</u>

First, I will explain the steps in measuring voltage drop across resistances in series and parallel circuits.

1. I turned on the Digital Multimeter and inserted both leads into the correct plugs (black to black and red to red).
2. I then took 3 10kΩ resistors and placed them on the breadboard in this configuration:



3. Next, I attached each lead coming from the power supply to the power rails on the breadboard and turned the power supply.
4. Tune the power supply to 15.0V.
5. Using the leads from the DMM, record the voltage drop across each resistor. This is done by inserting each lead into the breadboard on either side of the resistor you are trying to measure.
6. Change R_2 and R_3 to 20kΩ and 30kΩ and remeasure the voltage drop across each.
7. With the same circuit configuration, raise the voltage on the power supply to 20.0V, and remeasure voltage drop.
8. Then lower the voltage to 7.5V and remeasure voltage drop.
9. Turn power supply off and remove all resistors and test leads.
10. Configure breadboard and 3 10kΩ resistors into a closed parallel circuit. How I configured this is:



11. Turn power supply back on measure the voltage.
12. Change R_2 and R_3 to 20kΩ and 30kΩ and remeasure the voltage drop.
13. Add R_4 of 1MΩ in parallel to the other resistors and measure voltage.
14. Raise the voltage on the power supply to 20.0V and remeasure voltage.
15. Lower the voltage to 7.5V and remeasure voltage.
16. Turn off power supply and DMM.
17. Unplug all resistors and test leads from the breadboard.

Now I will explain the process of formatting an oscilloscope to correctly view a sinusoidal waveform from a function generator.

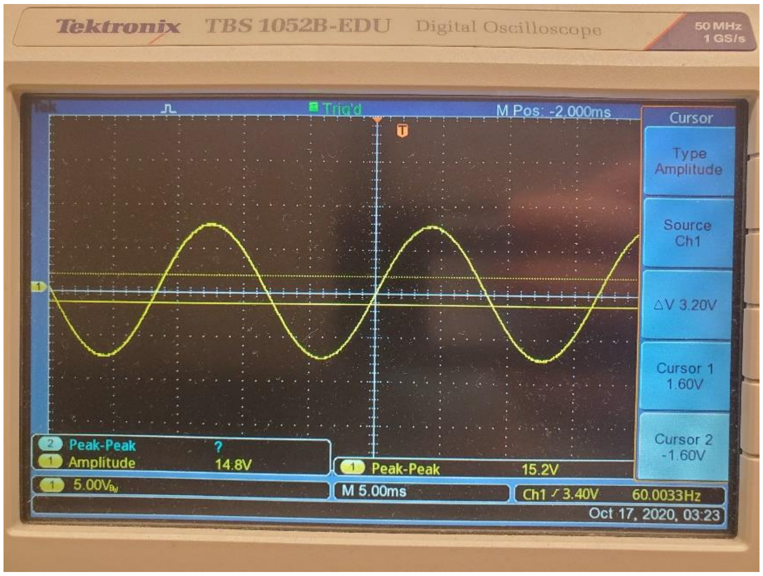
1. Plug coaxial cable into function generator and oscilloscope.

2. Turn on both the function generator and oscilloscope.
3. Tune the function generator to $15V_{ppk}$ and 60Hz.
4. Use the knobs and buttons on the oscilloscope to correctly view the waveform.
5. Next, I took a picture of the correctly viewed waveform with my phone for use in this lab report.
6. Lastly, I shut off the function generator and oscilloscope and unplugged the coaxial cable.

Results:

When measuring the voltage drop across a series circuit with three 10kΩ resistors, I measured V_{R1} = 4.96V, V_{R2} = 5.10V, and V_{R3} = 4.96V. When I changed R_2 and R_3 to 20kΩ and 30kΩ resistors, the new values were: V_{R1} = 2.494V, V_{R2} = 5.008V, and V_{R3} = 7.467V. When I raised the voltage on the power supply to 20V, the new values were: V_{R1} = 3.328V, V_{R2} = 6.681V, and V_{R3} = 9.967V. When I lowered the voltage to 7.5V, the new values were: V_{R1} = 1.248V, V_{R2} = 2.506V, and V_{R3} = 3.738V. After changing the circuit configuration to a parallel circuit with three 10kΩ resistors, I measured a voltage of 14.98V. When I changed R_2 and R_3 to 20kΩ and 30kΩ resistors, the voltage I measured was 14.98V again. When I added R_4 of 1MΩ in parallel to the other resistors, the voltage I measured was 14.97V.

The image I took of the output from the oscilloscope is below:



Discussion:

The values I measured while completing this lab are a little bit different from the values I calculated for the prelab. So, to account for this, I also calculated the percent error of each value. The equation I used was: $percent\ error = \frac{Calculated\ Value - Measured\ Value}{Calculated\ Value}$, where the calculated value is the value I found while completing the pre-lab and the measured value is the value I recorded while performing the lab. The percent error for all values is listed below:

Three 10kΩ resistors in series with an input voltage of 15V:

V_{R1} = 0.008, V_{R2} = -0.02, V_{R3} = 0.008

10kΩ, 20kΩ, 30kΩ resistors in series with an input voltage of 15V:

V_{R1} = 0.0024, V_{R2} = -0.0016, V_{R3} = 0.0044

10kΩ, 20kΩ, 30kΩ resistors in series with an input voltage of 20V:

V_{R1} = 0.0015, V_{R2} = -0.00225, V_{R3} = 0.0033

10kΩ, 20kΩ, 30kΩ resistors in series with an input voltage of 7.5V:

V_{R1} = 0.0016, V_{R2} = -0.0024, V_{R3} = 0.0032

Three 10kΩ resistors in parallel with an input voltage of 15V:

V = 0.00133

10kΩ, 20kΩ, 30kΩ resistors in parallel with an input voltage of 15V:

V = 0.00133

10kΩ, 20kΩ, 30kΩ, 1MΩ resistors in parallel with an input voltage of 15V:

V = 0.002

Conclusion:

I believe this lab was successful in teaching me to build and measure resistive circuits. The error I calculated in the section above this is most likely from both slight variations in the testing equipment and the resistance of wires which I had not accounted for in the pre-lab. The second part of this lab is to plot a sinusoidal waveform from a function generator with an oscilloscope. In the prelab for this part, I incorrectly potted both the amplitude and the period of the waveform. I feel as though I was able to complete this objective as well. I had never used any of the equipment that were used in this lab.