4.3.1: Superposition

Overview:

In this lab, we will analyze, build, and test a circuit containing multiple sources. Except in special cases, multiple sources preclude the use of analysis techniques based entirely on circuit reduction approaches. We can, however, use circuit reduction techniques in conjunction with superposition to determine the response of a circuit with multiple sources.

It should be noted that alternate analysis techniques can be used to predict this circuit's response. The approach used to analyze the circuit does not, however, affect the actual circuit's behavior. Other lab assignments will use this same circuit, in conjunction with other analysis techniques. Please keep in mind that the circuit's physical behavior is not affected by the analysis technique used; the same measurement on the same circuit should provide the same result, regardless of the approach used to predict the response.

Before beginning this lab, you should be able to:

- Calculate circuit voltages, currents using circuit reduction techniques
- Use superposition techniques to determine circuit voltage, current responses in the presence of multiple sources

After completing this lab, you should be able to:

- Compare measured voltages and currents in an electrical circuit with predictions based on superposition techniques

This lab exercise requires:

- Analog Discovery module
- Digilent Analog Parts Kit
- Digital multimeter (optional)

Symbol Key:

DEMO — Demonstrate circuit operation to teaching assistant; teaching assistant should initial lab notebook and grade sheet, indicating that circuit operation is acceptable.

ANALYSIS — Analysis; include principle results of analysis in laboratory report.

SIM — Numerical simulation (using PSPICE or MATLAB as indicated); include results of MATLAB numerical analysis and/or simulation in laboratory report.

DATA — Record data in your lab notebook.

General Discussion:

This lab assignment concerns the circuit shown in Figure 1 below. Use V+ to apply the 5V voltage source and W1 to apply the 3V source. We wish to determine the voltage difference *V*.

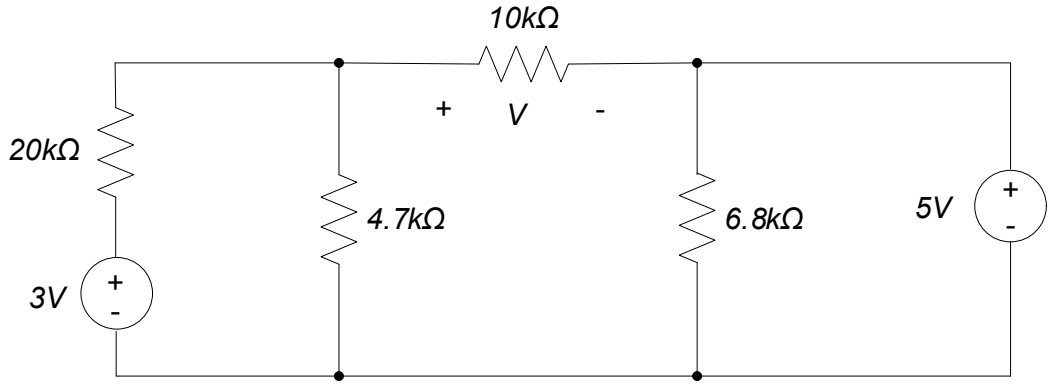

Figure 1. Circuit schematic.

Pre-lab:

ANALYSIS

Use superposition to predict the voltage *V* in the circuit of Figure 1. (e.g. determine the response of the voltage across the 10kΩ resistor resulting from the 3V source, determine the response of the voltage across the 10kΩ resistor resulting from the 5V source, and sum the results to obtain the total voltage across the 10kΩ resistor from both sources.)

Lab Procedures:

DATA

1. Choose the four resistors for the circuit of Figure 1. Record the actual resistance values.

DATA

2. Build the circuit of Figure 1, <u>with the 5V source replaced with a short circuit</u>. Measure the resulting voltage across the 10kΩ resistor.

DATA

3. Build the circuit of Figure 1, <u>with the 3V source replaced with a short circuit</u>. Measure the resulting voltage across the 10kΩ resistor.

DATA

4. Build the circuit of Figure 1, with <u>both</u> sources in place. Measure the resulting voltage across the 10kΩ resistor.

ANALYSIS

5. Calculate a percent difference between the sum of the voltages of step 2 and step 3 and the voltage measured in step 4. Comment on the agreement between the principle of superposition and your results.

ANALYSIS

6. Create a table summarizing the results of your pre-lab analysis and your experimental results. Your table should list, at a minimum:
   - The measured and expected voltage V due to the 3V source alone
   - The measured and expected voltage V due to the 5V source alone
   - The measured and expected voltage V due to both sources
   - The percent differences between the measured and expected values for the above three cases.