Simple resistive circuits: measurements and calculations.

We continue our study of oddly useless circuits as we practice our understanding of basic circuit analysis techniques and demonstrate that the calculations do indeed predict the behavior of real circuits built and measured in the lab.

In this lab we will look at examples from the three formal circuit analysis techniques: node-voltage, mesh-current, and superposition. For each circuit, we will analyze it using the appropriate technique, build it in lab, and then measure voltages and currents.

The analysis will require the most time, and can be done outside of lab. (Do not use precious lab time to do calculations.) Building the circuits will require the most time in lab. To save on lab time, it might be a good idea to build the first few the circuits on the breadboard before coming to lab. The measurements that on each circuit are quite simple and can be done with the multi-meter very quickly.

Note that the circuits use the same 5 or 6 resistors over. For the circuits that have multiple DC sources, be careful with the +/– connections. Ask your lab supervisor for assistance if you are unsure about hooking the sources into your circuits.

As always, when solving sets of simultaneous equations, it is not necessary to do all of the linear algebra by hand. While solving a 2x2 set of equations is not hard, you should use your calculator or an on-line solver (e.g. Wolfram Alpha) to handle sets that are 3x3 or bigger.

Reporting

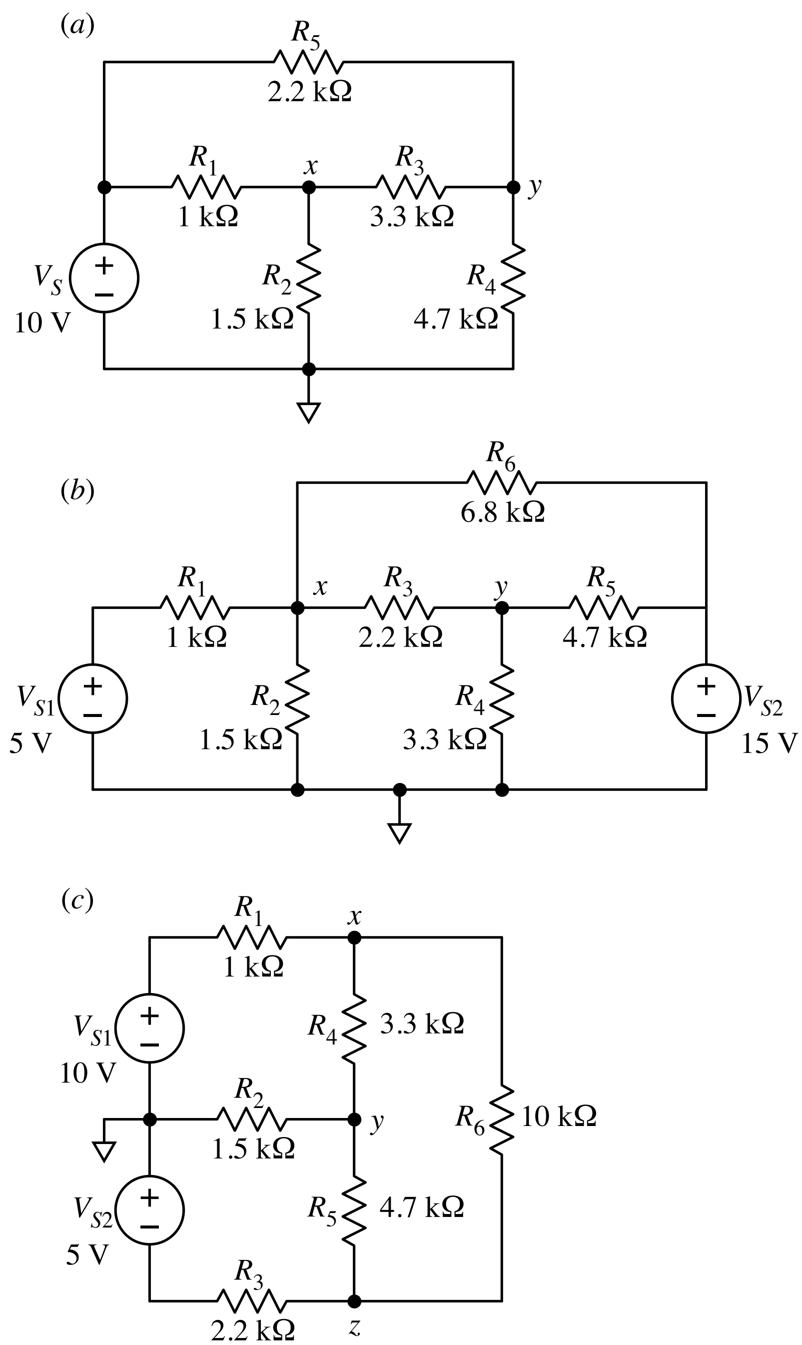
Prepare a report for the work done in this lab. Include the calculations and measurements, along with comparisons of the results. Check the schedule page for the due date.

Node-voltage

For the circuits shown in Fig. 1, use the node-voltage method to calculate the voltages at the indicated nodes with respect to ground. In lab, build each circuit and use the voltmeter to measure the indicated node voltages. Show that your calculations and measurements are consistent.

As a challenge, you can try doing the calculations for the circuit (c) twice. Once with the ground as shown. Then repeat with the ground moved to the other side of V_{S2} (i.e. between V_{S2} and R_3.)

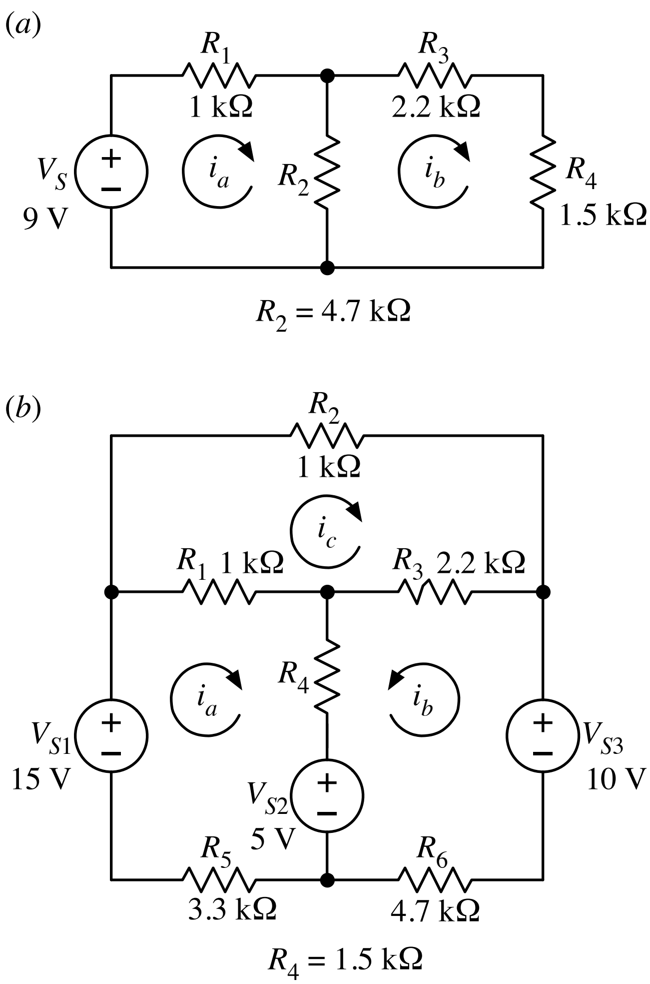
Figure 1.



Mesh-current

For the circuits shown in Fig. 2, use the mesh-current method to calculate the indicated mesh currents. In lab, build each circuit and use the multimeter to measure all of the resistor currents. (Use the ammeter or use the voltmeter + Ohm's Law). Show that the measured resistor currents are consistent with the calculated mesh currents. Note: Circuit (b) requires three positive sources — you will need to use one source from the second power supply available on the lab bench.

Figure 2.



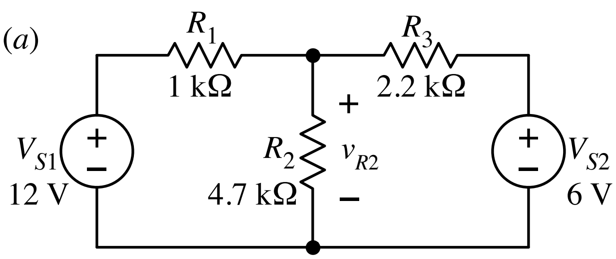
Superposition

Analyze the circuits in Fig. 3 using the superposition method to find the indicated voltage in part (a) and the current in part (b). In lab, build each circuit and measure the requested quantity. Again, you will need to use the extra power supply to get the third positive DC voltages for part (b).

Then show that superposition works in the lab. For circuit (a), measure v_{R2} with V_{S1} active (V_{S1} = 12 V) but with V_{S2} de-activated. (Turn the voltage to down to 0 V. Or remove the leads for V_{S2} and replace with a short circuit.) Then do the other partial measurement with V_{S2} active (= 6 V) and V_{S1} deactivated. Show that the two partial measurements of v_{R2} add up to the measured value of v_{R2} when both sources were active.

Do the same with circuit (b), except that there will be three partial measurements of the resistor current. Show that the three partial measurements add up to the current measured when all sources were active.

Figure 3. (*a*)



(*b*)