

Kirchoff's Laws, Resistance, Series and Parallel

Ph 261 Lab 03

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1 Purpose

Apply Ohm's and Kirchoff's laws to real circuits. Simplify circuits using series and parallel combinations.

2 Prelab

Record the results of the following exercises in your lab journal.

1. Apply Kirchoff's voltage law to two loops in the circuit of figure 1.
2. Apply Kirchoff's current law to one node in the circuit.
3. Use the results of the previous two parts to calculate the current and voltage drop on each resistor in terms of V_0 and R .
4. The combination of all four resistors acts like a single resistor, $R_{eq} = V_0/I_0$. Find this "equivalent resistance" in terms of R .
5. Here is an alternative analysis of the circuit. In the following, fill in "serial" or "parallel" and then calculate the equivalent resistance.
 - (a) R_3 and R_4 are in Their combined resistance is $R_{34} =$
 - (b) R_{34} and R_2 are in Their combined resistance is $R_{234} =$
 - (c) R_{234} and R_1 are in Their combined resistance is $R_{eq} =$

6. The circuit drawn in figure 2 may look complicated, but it is easy to solve. Look carefully at the symmetry of the resistor arrangement. Use KCL and symmetry to find the currents in all of the resistors in terms of the current in the power supply, I_0 . Briefly explain how you used symmetry.

7. Assuming that the blue (dark) colored resistors have resistance R , and the yellow (light) colored resistors have resistance $2R$, find the voltage across each resistor in terms of I_0 .

8. Use KVL to find the currents and voltages in the resistors in terms of V_0 , eliminating I_0 . Also calculate the equivalent resistance of the cube in terms of R .

9. The circuit in figure 3 is identical to the cube, except that one connection is missing. Correct the diagram by adding one wire. Sketch in your lab journal.

3 Equipment Required

- 1 Digital Multimeter
- 1 DC Power Supply
- 1 Proto Board
- 6 Resistors, any value, R
- 6 Resistors of value $2R$

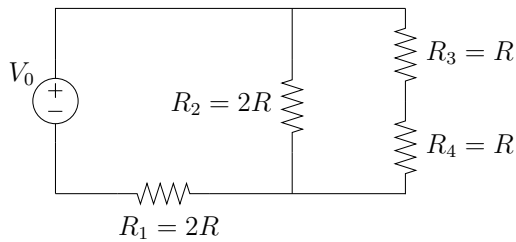


Figure 1: Circuit for parts 1-5 of the prelab and parts 3-5 of the procedure.

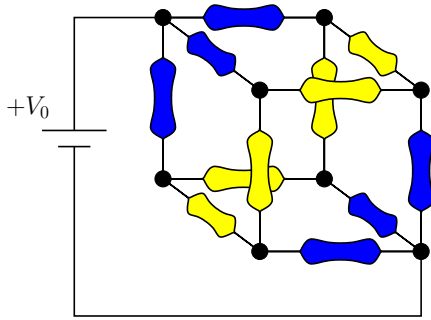


Figure 2: Circuit for parts 6-9 of the prelab and parts 6-10 of the procedure.

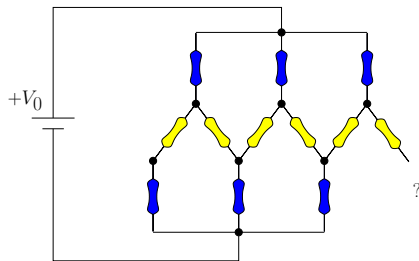


Figure 3: A “flattened” version of figure 2. This is *almost* right.

4 Procedure

1. Select six resistors with the same value R . It does not matter what R is, but record your

choice in the lab journal.¹ Measure all the R resistors to verify their values, and record them. Use only resistors that are within tolerance ($\pm 5\%$).

2. Select six resistors of value $2R$, and repeat step 1 with them.
3. Build the circuit shown in figure 1 on your proto board. Set the supply to 3V.
4. Make a table in your journal with three columns. Provide a row for each resistor. The first column will be the resistor name (R_1, R_2 , etc.). The second column will be labeled V_{calc} . Fill this with the expected voltage drop across each resistor, using the formulas you derived in the pre-lab.
5. Measure the voltage across each resistor, and enter these in the third column of your data table.
6. Build the circuit in figure 2, using R for the blue (dark) colored resistors, and $2R$ for the yellow (light) colored ones. The “flattened” version (figure 3, when completed) may be easier to lay out on the proto board.
7. Apply 3V. Measure the current through the supply. Work out the equivalent resistance from this information.
8. Measure the voltage across each of the 3 blue resistors at the $+V$ end of the cube.
9. Measure the voltage across each of the 6 yellow resistors.
10. Measure the voltage across each of the 3 blue resistors attached to the ground of the power supply.

5 Conclusion

Are your measured voltages and currents consistent with what you derived in the prelab? Are any differences consistent with the error introduced by imprecise resistor values?

¹Resistors above about 100 k Ω may introduce measurement errors with the DMM. You will be happier with moderate values of resistance.