University ☺f P☺rtland
Sch☺☺l ☺f Engineering

EE 271–Electrical Circuits Laboratory
Fall 2016

Lab Experiment #2: Simple Resistive Circuits

Simple Resistive Circuits

I. Objective

In this experiment, the students will design, build and/or experiment simple resistive electrical circuits to gain some experience in using Ohm's law, Kirchhoff's laws, and their extensions such as voltage and current divider principles to analyze circuits consisting of series- and parallel-connected resistors.

II. Procedure

PART 1: Voltage and Current Divider Principles

Part 1(a): Verification of the Voltage Divider Circuit

1(a)–Pre-lab Assignment: For the circuit shown in Fig. 1(a), using the voltage divider principle, provide a general equation for V_{out} and calculate its numerical value. Box your answer.

1(a)–Lab Experiment: Construct the circuit shown in Fig. 1(a). Using the handheld DMM in DC mode set to read resistance, measure and record the actual values of the resistors R_1 and R_2 used in your circuit in Table 1. Calculate the % error in each resistor value as follows:

$$\boxed{\%\text{ error in } R \text{ value} = \frac{R_{\text{theoretical}} - R_{\text{measured}}}{R_{\text{theoretical}}} \times 100}$$

Table 1. Resistor values and percentage errors. (Circuit in Figure 1(a).)

R_1 (kΩ) (theoretical)	R_1 (kΩ) (measured)	% error in R_1	R_2 (kΩ) (theoretical)	R_2 (kΩ) (measured)	% error in R_2

Provide the calculated percentage errors in the resistor values in Table 1. Measure and record the output voltage V_{out}. Also calculate the % error of the V_{out} value as follows:

$$\boxed{\%\text{ error in } V_{\text{out}} \text{ value} = \frac{V_{\text{out, prelab}} - V_{\text{out, measured}}}{V_{\text{out, prelab}}} \times 100}$$

Box your results. Comment on the differences between the theoretical and measured values.

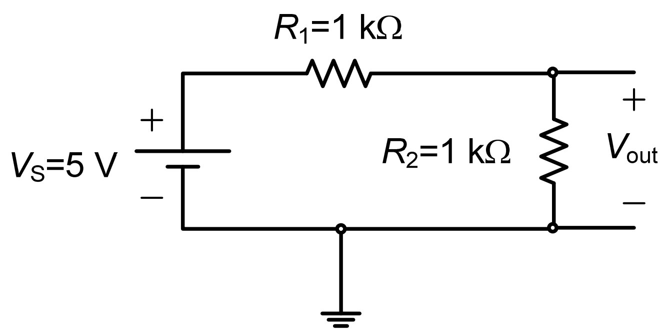

Figure 1(a). The voltage divider circuit.

Part 1(b): Verification of the Current Divider Principle

1(b)–Pre-lab Assignment: Connect a shunt resistor R_{shunt} across the R_2=1 kΩ resistance of Fig. 1(a), as shown in Fig. 1(b). Provide simplified general equations for currents I_2 and I_{shunt} flowing through the resistors R_2 and R_{shunt} and voltage V_{out} across R_2 and R_{shunt} in terms of V_S, R_1, R_2, and R_{shunt}. Using these equations, calculate the values of I_2 and I_{shunt} flowing through the resistors R_2 and R_{shunt} and the voltage V_{out} for three different values of R_{shunt} resistance which are 100 Ω, 1 kΩ, and 10 kΩ respectively. Present your calculated current and voltage values in a table as shown in Table 2.

Provide the following table in your lab notebook including the measurements and calculated values related to the circuit shown in Figure 2.

Table 2. Prelab values of R_{shunt}, I_2, I_{shunt}, and V_{out}. (Figure 1(b) circuit).

R_{shunt} (kΩ)	I_2 (mA)	I_{shunt} (mA)	V_{out} (V)
0.1			
1.0			
10.0			

1(b)–Lab Experiment: Construct the circuit shown in Fig. 1(b). Measure and record the actual values of the resistors R_1, R_2 and R_{shunt} used in your circuit in Table 2. Recalculate the values of currents I_2 and I_{shunt} and voltage V_{out} for three different cases using the measured values of the resistors R_1, R_2 and R_{shunt} (for three different R_{shunt} values) and provide your recalculated values in Table 3.

Table 3. Recalculated values of I_2, I_{shunt}, and V_{out} using actual R values.

R_1 (kΩ)	R_2 (kΩ)	R_{shunt} (kΩ)	I_2 (mA)	I_{shunt} (mA)	V_{out} (V)

Measure and record the values of the currents I_2 and I_{shunt} and the output voltage V_{out} for each R_{shunt} resistor connected across the R_2 resistance. Present your measured current and voltage values in a table as shown in Table 4.

Table 4. Measured values of R_{shunt}, I_2, I_{shunt}, and V_{out}. (Figure 1(b) circuit).

R_{shunt} (kΩ)	I_2 (mA)	I_{shunt} (mA)	V_{out} (V)

Using the recalculated and measured values (given in Tables 3 and 4), calculate and present in a table (see Table 5) the percentage errors in the current and voltage values in each case and comment. Also, comment on what happens to the values of the two currents I_2 and I_{shunt} with respect to one another as R_{shunt} resistor increases? Why?

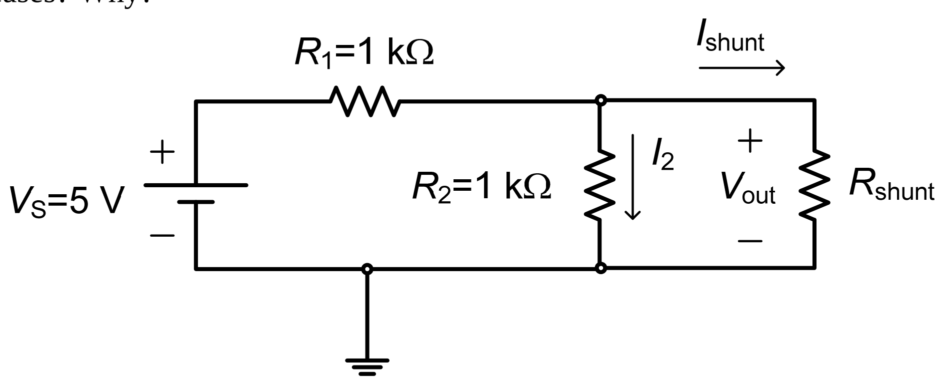

Figure 1(b). The current divider circuit.

Table 5. Percentage errors in measured values of I_2, I_{shunt}, and V_{out}.

R_{shunt} (kΩ)	% error in I_2	% error in I_{shunt}	% error in V_{out}

PART 2: Design of a Voltage Divider Circuit

2(a)–Pre-lab Assignment: Design a voltage divider circuit similar to the one shown in Fig. 2 to convert a fixed power supply voltage of 5 V to a voltage equal to 2 V. For the circuit, all you have available are four 1 kΩ resistors. Show the circuit you designed on paper. (Note: More than one circuit design is possible.)

2(b)–Lab Experiment: Test your designed circuit in the lab. Measure and record the value of the output voltage in the circuit and verify your design.

2(c)–Lab Experiment: Next, to investigate loading effect, use the voltage divider circuit designed in Part 2(a) to supply 2 V to an unknown resistive load (which will be provided in the lab). Connect the unknown resistive load across the output terminals of the voltage-divider circuit you designed and measure the voltage supplied to the unknown load in each circuit. Does your voltage divider circuit supply a 2 V voltage to the unknown load? If no, explain why.

2(d)–Lab Experiment: Measure the resistance of the unknown resistive load and redesign your voltage divider circuit accordingly so that your circuit takes the fixed 5 V voltage and supplies 2 V to the load. Again, as before, all you have are four 1 kΩ resistors. (Hint: If you design your voltage-divider circuit correctly, it only dissipates power when the load resistance is connected across it, otherwise, when the load is disconnected from the designed circuit, the power consumption in the voltage-divider circuit is zero.)

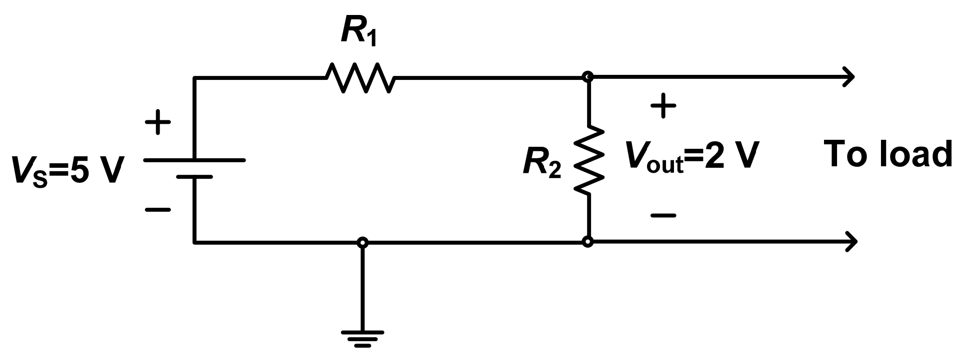

Figure 2. Voltage divider circuit.

III. Discussions & Conclusion

In this section, discuss the various aspects of Experiment #2 and make some conclusions. In your write-up, you should at least address the following questions:

1. What was the objective of this experiment and was the objective achieved?
2. Did any of your measurements have more than 5% error? What was your maximum % error?
3. What sources of error may have contributed to the differences between the theoretical values and the measured values?
4. Other comments relevant to this experiment.