CMPE 110 Laboratory Exercise 2

Ohm's Law

Andrei Tumbar
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Lab Section: 05
Instructor: Mark Byers
TA: Rickie Yeung
Tommy Li

Lecture Section: 01
Professor: Dr. Soldavini

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Abstract

Understanding Ohm's Law as well as Kirchoff's loop laws is important and vital when designing circuits. This labratory exercise exposes the relationship between voltage, current, and resistance in both a parallel and series configuration. A powersupply supplied a variable voltage across 3 resistors, two in parrallel and the third in series. An effective resistance was calculated and compared to a measured resistance. Potential drop across resistors was measured at every integer voltage from 2-5V. A Voltage vs. Current graph was generated illustrating the linear relationship between the two variables for ohmic resistors. This exercise proves Kirchoff's loop laws and Ohm's law.

Design Methodology

The three smallest resistors were determined. Resistors were named R_1, R_2, and R_3 in order by increasing resistance. The actual resistance was measured using the multimeter's ohmeter function (See table 1).

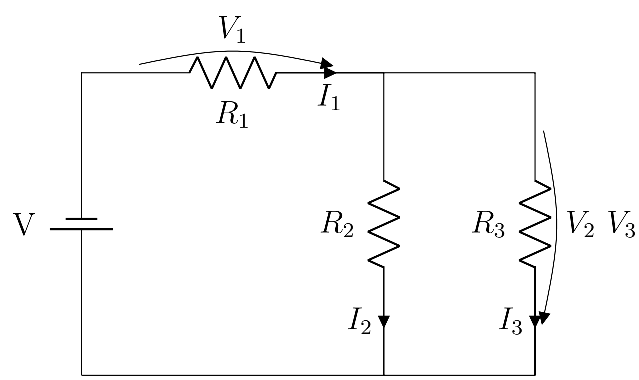

Figure 1: Circuit configuration given R_1, R_2, and R_3 have accending resistances.

A circuit was wired on a breadboard such that R_2 and R_3 were placed in parallel to each other and in series to R_1. Figure 1 shows an example circuit in the correct configuration. With the power supply voltage set to 5V, potential drop across R_1 and R_2 was taken. This step was repeated for 2V, 3V, and 4V across the power supply.
Current through all three resistors was measured at a 5V total potential. An effective resistance for the entire circuit was calculated. First the two parallel branches were combined through equation 1:

$$R_{eq} = \frac{1}{\sum \frac{1}{R_i}} \tag{1}$$

Resistance of R_1 was added to the value about yielding a total effective resistance of the circuit.
Finally, current through R_3 was measured from 2-5V at 1V intervals from the power supply and recorded. Using this data, a graph was generated for Voltage vs. Current through R_3.

Results and Analysis

Resistance

Table 1 contains measured resistance for each resistor. Rated resistance and tolerance are also shown.

Table 1: Measurements taken for all three resistors.

	Banded Values		Measured Values
	Rated Resistance (Ω)	Rated Tolerance (%)	Actual Resistance (Ω)
R_1	330	$\pm$ 5	328.00
R_2	3330	$\pm$ 5	3396.00
R_3	5600	$\pm$ 5	5598.80

Measured resistance in R_1 R_2 and R_3 showed great accuracy to that of the rated resistance.

Voltage

Table 2 shows the data taken for the voltage drop across R_1 and R_2 for varying powersupply voltage from 2V to 5V.

Table 2: Voltage measured across R_1 and R_2.

	V_{PS}	V_{R_1}	V_{R_2}
˜2V	1.997	0.268	1.728
˜3V	2.997	0.402	2.592
˜4V	3.998	0.536	3.457
˜5V	4.999	0.670	4.320

As expected, the voltage across R_1 and R_2 scale proportionally to the voltage across the power supply.

Current

Current through any of the three resistors yielded very low numbers because the effective resistance was so high. Effective resistance came out to be 2441.84Ω calculated from:

$$R_{eq} = R_1 + \frac{1}{\frac{1}{R_2} + \frac{1}{R_3}} = 2441.84\Omega \tag{2}$$

Table 3: Voltage measured across R_1 and R_2.

I_1 (mA)	I_2 (mA)	I_3 (mA)
2.00	1.27	0.77

Results

Table 4 was generated by measuring the current through R_3 and the power supply at every 1V interval from 2-5V. The last column was generated by applying Ohm's Law $V = IR$.

Table 4: Table to test captions and labels

Voltage (V)	$\mathrm{V_{PS}}$ (V)	$\mathrm{V_{R_3}}$ (V)	$\mathrm{I_{PS}}$ (mA)	$\mathrm{I_{R_3}}$ (mA)	$\mathrm{R_3}$ (Ω)
2	1.997	1.728	0.815	0.308	5616.88
3	2.997	2.592	1.220	0.463	5593.95
4	3.998	3.475	1.630	0.617	5607.78
5	4.999	4.320	2.040	0.771	5603.11

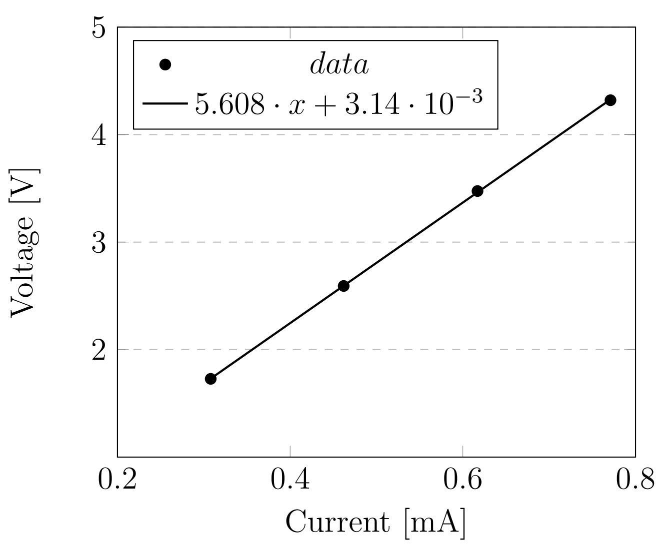

Figure 2: Voltage over R_3 vs Current through R_3

Figure 2 displays the data from table 4 for I_{R_3} on the X-axis and V_{R_3} on the Y-axis. The slope in figure 2 represents the resistance of R_3 in $k\Omega$ because according to Ohm's Law $R = \frac{V}{I}$.

Conclusion

This laboratory exercise was to expose the relationship between voltage, current, and resistance in both a parallel and series circuit using Kirchoffs loop laws and Ohms Law. Using the power supply, varying voltages were applied across three resistors, two in parallel and the third in series. Using the multimeter, the resistance, current, and voltage was taken across the power supply and resistors for 2, 3, 4, and 5 volts. R_1, R_2, and R_3 showed great accuracy to their banded resistances compared to their actual measured resistances from the multimeter. The voltage across R_1 and R_2 were proportional to the voltage across the power supply, proving Kirchoffs voltage loop law. Because the linear regression closely correlated to the data, Ohms Law is proven. This exercise was effective in proving both Kirchoffs loop laws and Ohms Law.