University of California Merced
School of Engineering
Department of Electrical Engineering
ENGR 065 Circuit Theory

Lab #3 : Resistor Combinations, KCL, KVL, Voltage and Current Dividers, and Wheatstone-Bridge

Authors

Andre Martin

Luis Mora

Instructor

Ricardo Pinto de Castro

TA

Haoyu Li

Section

Wednesdays 9:00 am - 11:50 am

ENGR065-3L

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Objectives

- Verify KCL and KVL
- Measure the equivalent resistance of a resistive circuit.
- Measure the branch currents and node voltages.
- Use the Wheatstone bridge circuit to directly measure resistance.

Introduction:

In this lab, students will verify Kirchhoff's Current Law (KCL) and Kirchhoff's Voltage Law (KVL). This will be done by first, calculating the currents and voltages off given circuits using the KCL and KVL methods. Them, these theoretical calculations will be compared to the measured values of the actual circuit to show the laws put into practice. Lastly a Wheatstone bridge circuit will be constructed to directly measure a resistive value.

Procedure:

Part 1

Using the given electrical lab equipment, construct the circuit below (figure a) with R1 = 470Ω, R2 = 100Ω, and R1 = 100kΩ. Then fill out a data table with the values of each voltage node. Compare the values of the theoretical results and the measured values. Construct the second circuit below (figure b) and also fill out a data table for it to compare the results. Explain why the sum of the voltages sum up to the voltage source.

Part 2

Repeat the steps in part 1, but with different resistors. R1 = 470Ω, R2 = 680Ω, and R1 = 1kΩ

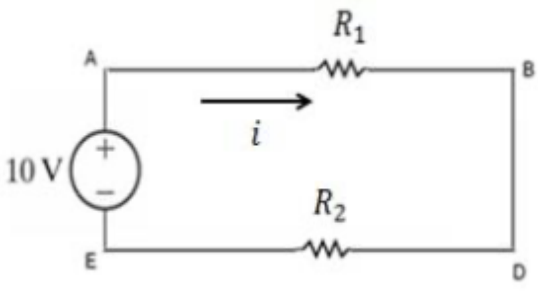


figure a

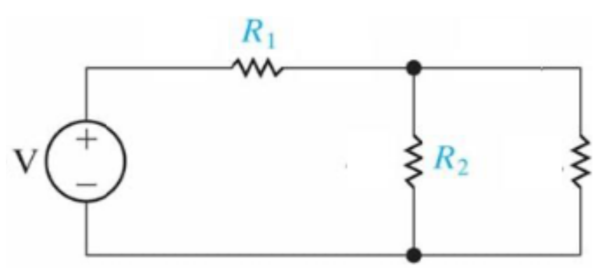


figure b

Part 3

Using a 5.6kΩ and a 10kΩ resistors, combine them in series and parallel to prove equivalent resistance.

Part 4

Use the ohmmeter to read your body's resistance and then try reading the resistance of a 10MΩ resistor. Observe what happens when grabbing the resistor's terminals while trying to read the resistance.

Part 5-6

Construct a Wheatstone bridge circuit with R1 = 3.3kΩ, R2 = 2.2kΩ, and Rx = 5.6kΩ. In this case Rx is a known value so that the formula Rx = (R2/R1)R3 can be proven. When constructed, adjust the potentiometer until the ammeter reads 0A, then measure the potentiometers resistance and enter it into the formula as R3.

Data and Measurements:

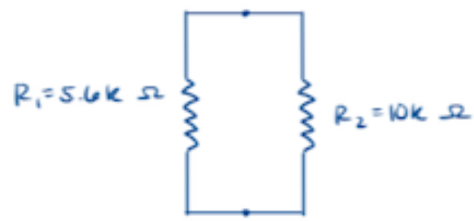
Part 1			
Column1	**Column2**	**Column3**	**Column4**
Variable	Theoretic	Measured	Δ
VAE	10V	9.98V	0.02
VAB	8.25 V	8.20V	0.05
VBD	0V	0V	0
VDE	1.75V	1.74V	0.01
i	17.5 mA	16.9 mA	0.6
Column1	**Column2**	**Column3**	**Column4**
Variable	Theoretic	Measured	Δ
IR1	17.5 mA	17.2 mA	0.3
IR2	17.75 mA	17.23 mA	0.5
IR3	1.7 mA	1.6 mA	0.1

Part 2			
Column1	Column2	Column3	Column4
Variable	Theoretic	Measured	Δ
VAE	10V	9.94V	0.06
VAB	4.09V	4.04V	0.05
VBD	0V	0V	0
VDE	5.91V	5.88V	0.03
i	8.7 mA	8.4 mA	0.3
Column1	Column2	Column3	Column4
Variable	Theoretic	Measured	Δ
IR1	17.5 mA	10.9 mA	6.6
IR2	17.75 mA	6.5 mA	11.25
IR3	0.017 mA	4.3 mA	4.29

Part 3

Circuit Schematic (Series)	

Theoretical equivalent resistance* =	$R_{eq} = 5.6k + 10k = 15.6k\,\Omega$
Measured equivalent resistance	$15.54k\ \Omega$

Circuit Schematic (Series)	
Theoretical equivalent resistance* =	$R_{eq} = \frac{(5.6k)(10k)}{5.6k+10k} = 3590\,\Omega$
Measured equivalent resistance	$3585\,\Omega$

Analysis

In Parts 1 & 2 the difference in the theoretical values to the measured values are very small, nearly negligible. This is more than likely due to the real life volt meters and ammeters. An ideal voltmeter would have a resistance of infinity and the ideal ammeter has no resistance. Disregarding the discrepancies, we can clearly verify that Kirchhoff's Voltage Law holds true, where all voltages equal zero, or the voltage drops equal the voltage source. Likewise, Kirchhoff's Current Law hold to be true as the current entering the nodes equal the summation of the currents leaving the node.

In Part 3, two resistive circuits were constructed, one in series and one in parallel. The theoretical calculations and actual measurements of the resistors were nearly identical. These results further proved the validity in using the method of making resistive equivalent circuits when analyzing complex circuits.

In Part 5-6, a Wheatstone bridge circuit was constructed. In the place of Rx, a known resistor was used to verify the technique of adjusting a potentiometer until reaching 0A on the ammeter. According to the results, the value of the potentiometers resistance effectively gave us Rx's resistance when using the formula.

Conclusion

All the objectives for this lab were thoroughly covered. From calculating theoretical values and then verifying the with real world measurements, Kirchhoff's Voltage and Current Laws were effectively verified. Along with KCL and KVL, the student was able to put in practice the Wheatstone bridge circuit and correctly calculate Rx.