Lab #1: Simple DC Circuits

**Objectives**

The purpose of this lab is to analyze different, very simple DC circuits. The types of circuits that we analyzed focused on understanding the different effects resistors have on voltage and current, specifically when they are put in parallel, series, or a combination of the two.

**Procedures**

1.0 Laboratory Preparations

This part of the lab consisted only of collecting the required components for the lab. Interestingly, this part wasn’t easy for the class as the components were nearly all in the wrong place or were not there at all.

* 1. Current Divider

This part of the lab asked us to measure the voltage across each resistor and use those values to calculate the currents through those resistors. This circuit demonstrated resistors in parallel and the splitting effect it has on the current. It also asked us to do a KCL analysis at node A.

*V*bat

10 k

+

-

*v*2

5 k

2 k

100 

*v*1

+

-

+

*i*

**A**

Fig. 1. Parallel resistive circuit for KCL test.

-Voltage Measurements

V10k, V5k, V2k = +8.41 V

V­100 = .665 V

-Currents by theoretical Ohms and measured Voltages

I10k = 8.41V/10,000Ω =

.000841 Amps

I5k = 8.41V/ 5000Ω =

.001682 Amps

I2k = 8.41V/2000Ω =

.004205 Amps

I100 = 8.41/100 = .00665

-KCL

Node A: i10k + i5k + i2k­ – i100 = 0

i10k + i5k + i2k­ = i100

.000841 A + .001682 A + .004205 A = .006728 A

This result shows that the meter’s calculations were off by 1.2%. I think this can be accounted to the resistor’s values not being exactly correct and the meter not measuring perfectly.

* 1. Voltage Divider

This section of the lab asked us to measure the voltages across the resistors in a circuit modeled by fig. 2. This circuit demonstrated that voltage becomes split across the nodes across resistors in parallel. It also asked us to test the validity of KVL across the circuit.

Vbat

5 k

+

-

2 k

1 k

*i*

Fig. 2. Resistive voltage divider circuit for testing KVL.

-Voltage Measurements

Vs = 9.08 V

V5k = 5.71 V

V2k = 2.223 V

V1k = 1.138 V

-KVL

Vs = V5k + V2k + V1k

V5k + V2k + V1k =

5.71 V + 2.223 V + 1.138 V = 9.071V

(9.071/9.08) x 100 = .1

The KVL measured is .1% off from the theoretical value. This is a miniscule difference and definitely shows that KVL works in this circuit.

* 1. Current Measurement

This part of the lab asked us to get two random resistors and check their accuracy. The way this worked was, by measuring the voltage across the 100Ω resistor, we can get the current going through it. Then, we used that to get the actual resistance of the whole circuit by measuring the voltage across the whole circuit and using Ohm’s law. The only flaw in the original calculation that could lead to a larger error later is that the 100Ω resistor may not have been perfect. Finding the resistance in the whole series lets us subtract 100Ω from the calculated resistance. With that, we were able to compare the theoretical resistance and the calculated resistance to find both test resistors’ error.

-Voltage Measurements

Vc1 = Vc2 = 74.7 mV

Vs = 9.08 V

-Calculations

Ic = Vc/Rc = 74.7 mV/100Ω = .747 mA

Rs = Vs/Is = Vs/Ic = 9.08 V/.747 mA = 12,155.28 Ω

Rs – Rc = Rx = 12,055.28 Ω

-Error

Astonishingly, both of our resistors created the same voltage across Vc.

(12,055.28Ω/12kΩ) x 100 = .46

The resistors we were given had a theoretical value of 12,000Ω, but in reality had a resistance of about 12,055Ω. This is an error of .46%, way below the estimated ±10%.

This is only accurate if Rc << Rx because this allows the precision of the calculation to be greater. The resistors we were working with have an error of ±10%. In a 100Ω resistor, that’s a promise of ranging from 90-110Ω. That isn’t too much when the resistor that is in series with it is controlling most of the currant because it is about x120 the value of the test resistor. Measuring with a resistor that is of near theoretical value would cause both the test and unknown resistor to have a significant impact on the current of the circuit.

* 1. Wheatstone Bridge

This part of the lab asked us to build a circuit using a potentiometer in parallel with two resistors. The goal of this was to try and establish no voltage difference across the center pin of the potentiometer and the node in between R1 and R2. We were able to do this by measuring the voltage across the pin and the node and turning the potentiometer nob until the meter read 0mV.

-Resistor Values

R1 = 5kΩ

R2 = 10kΩ

Ra = 6.83kΩ

Rb = 13.14 kΩ

-Calculations

R1/R2 = Ra/Rb

*V*bat

*R*1

+

-

*v*g

+

*R*2

*R*a

*R*b

Fig. 4. DC Wheatstone bridge circuit using a potentiometer. The nulling voltage *v*g is measured using the voltmeter. At the desired null condition, *v*g = 0.

R1/R2 = 5kΩ/10kΩ = ½

Ra/Rb = 6.83kΩ/13.14 kΩ = .519

(.5/.519) x 100 = 3.9%

These results show a hilarious truth. They conclude that the resistors R1 and R2 are not perfect, that is to say if the calibration of the potentiometer was perfect. The truth is that most of the error most likely was due to human error. These were the worst results from all parts of the lab, and due to the fact that this is the only part of the lab that required the human touch, I believe that is the source of the larger than normal error.

**Executive Summary**

We are not sure what needs to be written here, so this is our best guess.

This lab introduced us to circuits with parallel resistors, in-series resistors, and potentiometers. This was also a lab that discussed and introduced the idea of imperfect components.

Parallel resistors show how currents split across different loads because of their equal voltages. Resistors in series show how voltage is split and compartmentalized across the nodes of each resistor in series. Potentiometers are useful in being able to adjust voltages in a circuit at will, with just a turn of a knob.

Calculating errors in this lab showed us how not all components are perfect, if any at all, and one should not expect them to.