Ryerson University

Department of Electrical, Computer, & Biomedical Engineering
Faculty of Engineering & Architectural Science

ELE 202
Electric Circuit Analysis
LAB COVER PAGE for Part II submission.

Lab #:	2	**Lab Title:**	Basic concepts, Relationships and Laws of Electrical Circuits.

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(* Note: remove the first 4 digits from your student ID)

Section #:	22
Submission date and time:	Feb 4, 2022, 9:30 am
Due date and time:	Feb 4, 2022, 4pm

Document submission for Part II:

- A completed and signed "COVER PAGE – **Part II**" has to be included with your submission, a copy of which is available on D2L. The report will not be graded if the signed cover page is not included.
- Scan your completed pages of **Section 5.0** and **Section 6.0** (via a scanner or phone images), together with any required In-Lab Oscilloscope screen-shot images.
- Collate and create a .pdf or .docx file of the above, and upload it via D2L **by 11.59 p.m. on the same day** your lab is scheduled. *Late submissions will not be graded.*

**By signing above, you attest that you have contributed to this submission and confirm that all work you have contributed to this submission is your own work. Any suspicion of copying or plagiarism in this work will result in an investigation of Academic Misconduct and may result in a "0" on the work, an "F" in the course, or possibly more severe penalties, as well as a Disciplinary Notice on your academic record under the Student Code of Academic Conduct, which can be found online at: www.ryerson.ca/senate/current/pol60.pdf.*

5.0 IN-LAB Experiment (*Virtual*): IMPEMENTATION & MEASUREMENTS

Please use **Multisim** to simulate & complete the following (*virtual version*)

(a) *I-V* Characteristics of Ohmic Resistor using a simple D.C. Circuit

1. From your lab kit, select 2.2 kΩ and 3.3 kΩ resistors (color-coded values). Use the DMM to measure their actual values. List the measured values in **Table 2.4**.

2. Build and connect the circuit of **Figure 2.0a** with **R** = 2.2 kΩ on the breadboard.
   Note 1: *When using the DMM as a Voltmeter, connect the DMM* ***in parallel*** *with the resistor as shown in the Figure 2.0b.* Note 2: *When using the DMM as an Ammeter, you must connect it* ***in series*** *with the resistor you need to measure the current passing through it as shown in the Figure 2.0b.*

3. Use the red and **black** "banana" cables (*available in the Lab room*) to connect the "+" and "-" terminals of the power supply to the RED and GREEN binding terminals on your breadboard, respectively. Turn ON the power supply.

4. Vary the power-supply source voltage, **E** such that the voltage across the resistor has the voltage, V_R values as listed in **Table 2.4** [*refer to the* ***Pre-Lab 4(a)***]. Use the Voltmeter to monitor the V_R voltage. Measure and record the corresponding current (I_R) values in **Table 2.4a**.

5. Turn OFF the power supply. Replace the 2.2kΩ resistor in circuit of **Figure 2.0a** with 3.3kΩ resistor. Repeat the above **Step 4,** and list your results in **Table 2.4b**.

6. Turn OFF the power supply.

- Copy and paste a screenshot showing your MultiSIM readings on each circuit. Include the MultiSIM circuit file (**.ms14**) of each circuit in your Post-Lab submission. **[4 marks]**

Simulation value of R = 2.2kΩ					
V_R (Volts)	3V	6V	9V	12V	15V
I_R (mA) **as measured** (*using Multisim*)	1.364mA	2.727mA	4.091mA	5.455mA	6.818mA
I_R (mA) **as calculated** in Pre-Lab (*Theory*)	1.364mA	2.727mA	4.091mA	5.455mA	6.818mA
Deviation (%) = 100.(measured - calculated)/(calculated)	0%	0%	0%	0%	0%

Table 2.4a: Experimental (*using Multisim*) results of the Simple DC Circuit in Figure 2.0 with **R** = 2.2 kΩ **[4 marks]**

Simulation value of **R** = 3.3kΩ					
V_R (Volts)	**3V**	**6V**	**9V**	**12V**	**15V**
I_R (mA) **as measured** (*using Multisim*)	0.909mA	1.818mA	2.727mA	3.636mA	4.545mA
I_R (mA) **as calculated** in Pre-Lab (*Theory*)	0.909mA	1.818mA	2.727mA	3.636 mA	4.545mA
Deviation (%) = 100.(measured - calculated)/(calculated)	0%	0 %	0 %	0 %	0 %

Table 2.4b: Experimental results (*using Multisim*) of the Simple DC Circuit in Figure 2.0 with **R** = 3.3 kΩ **[4 marks]**

(b) Series Resistors Circuit - KVL

1. Using $\mathbf{R_1}$ =3.3 kΩ, $\mathbf{R_2}$ = 2.2 kΩ and $\mathbf{R_3}$ = 1.0 kΩ, construct on your breadboard the series circuit shown in **Figure 2.1**.

2. Turn ON the power supply. Adjust to set the source voltage, **E** to **15 V**. Measure the current **I** and the voltages V_{ab}, V_{bc}, and V_{cd}. Record the values in **Table 2.5**. Note: *Make sure the DMM is set to the right function before using it as Voltmeter or Ammeter, and accordingly connected to the circuit.*

3. Turn OFF the power supply.

4. **Design Problem Circuit**: Implement on your breadboard the re-designed circuit of **Figure 2.1** of Pre-Lab section [**4(b)(iii)**] using the standard-resistance value(s) that you had determined for $\mathbf{R_1}$, $\mathbf{R_2}$ and $\mathbf{R_3}$ to meet the requirements.

   4.0.1 Turn ON the power supply. Set the source voltage, **E** to **15 V**.

   4.0.2 Measure the current, **I** and the voltages across resistors $\mathbf{R_1}$ (=V_{ab}), $\mathbf{R_2}$ (= V_{bc}) and $\mathbf{R_3}$ (=V_{cd}), and record the results in **Table 2.6**.

   4.0.3 Turn OFF the power supply.

Copy and paste a screenshot showing your MultiSIM readings on each circuit. Include the MultiSIM circuit file (**.ms14**) of each circuit in your Post-Lab submission. **[5 marks]**

V_E	I (mA)	V_{ab} (Volts)	V_{bc} (Volts)	V_{cd} (Volts)	$\Sigma V = (V_{ab} + V_{bc} + V_{cd})$
15V	2.308mA	7.615V	5.077V	2.308v	7.615v+5.077v+ 2.308v = 15V

Table 2.5: Experimental (*using Multisim*) results of the Series Circuit of Figure 2.1 **[5 marks]**

Design values used =>	**R1** = 1kΩ ?	**R2** = 1kΩ ?	**R3** = 1kΩ ?		
V_E	I (mA)	V_{ab} (Volts)	V_{bc} (Volts)	V_{cd} (Volts)
15V	5mA	5V	5V	5V

Table 2.6: Experimental (*using Multisim*) results of the ***re-designed*** Series Circuit in Figure 2.1
[5 marks]

(c) Parallel Resistors Circuit - KCL

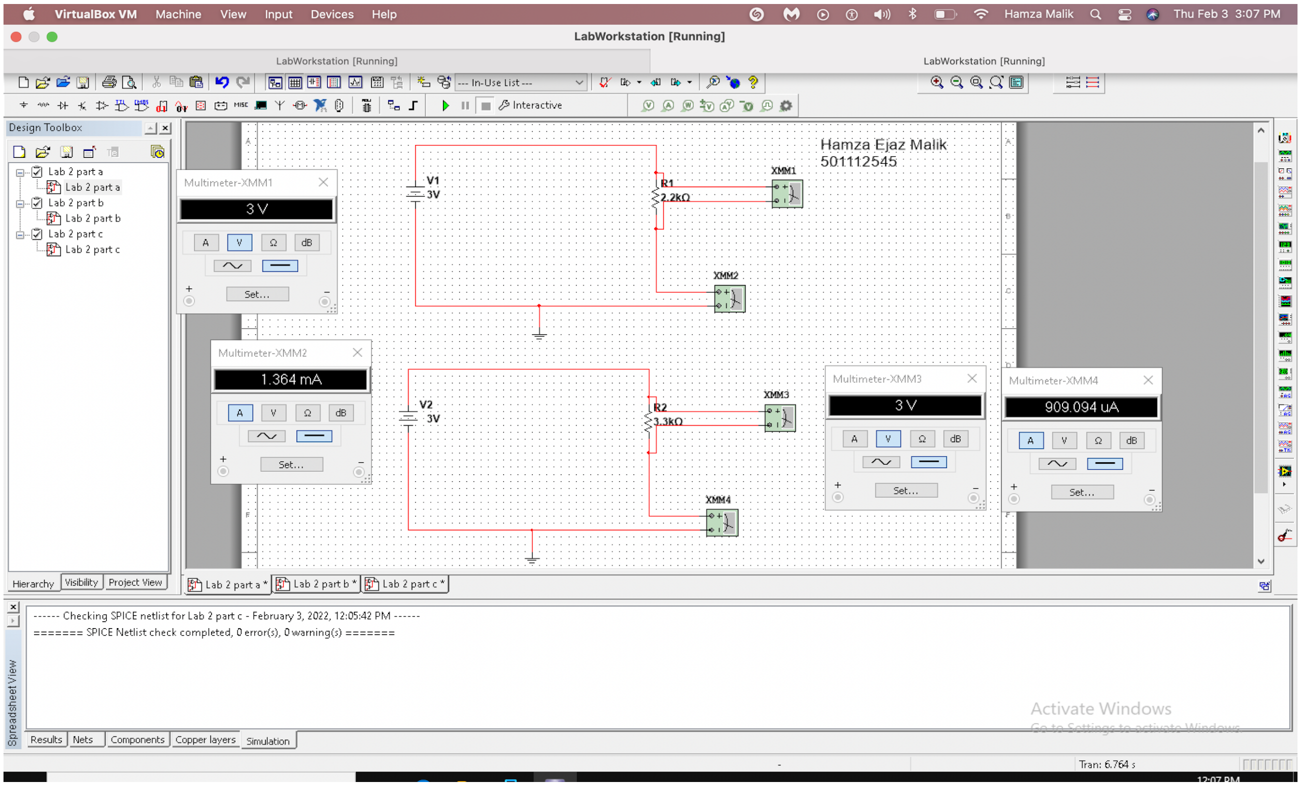
1. Using $\mathbf{R_1}$ = 3.3 kΩ, $\mathbf{R_2}$ = 2.2 kΩ and $\mathbf{R_3}$=1.0 kΩ, construct the parallel circuit shown in **Figure 2.2**.
2. Turn ON the power supply. Adjust the source voltage to **15V**.
3. Measure the currents **I, I_1, I_2 and I_3** as depicted in **Figure 2.2b**, and record your experimental results in **Table 2.7**. Note: *Make sure the DMM is set to the Ammeter function, and accordingly connected.*
4. Turn OFF the power supply.

- Copy and paste a screenshot showing your MultiSIM readings on each circuit. Include the MultiSIM circuit file (**.ms14**) of each circuit in your Post-Lab submission. **[5 marks]**

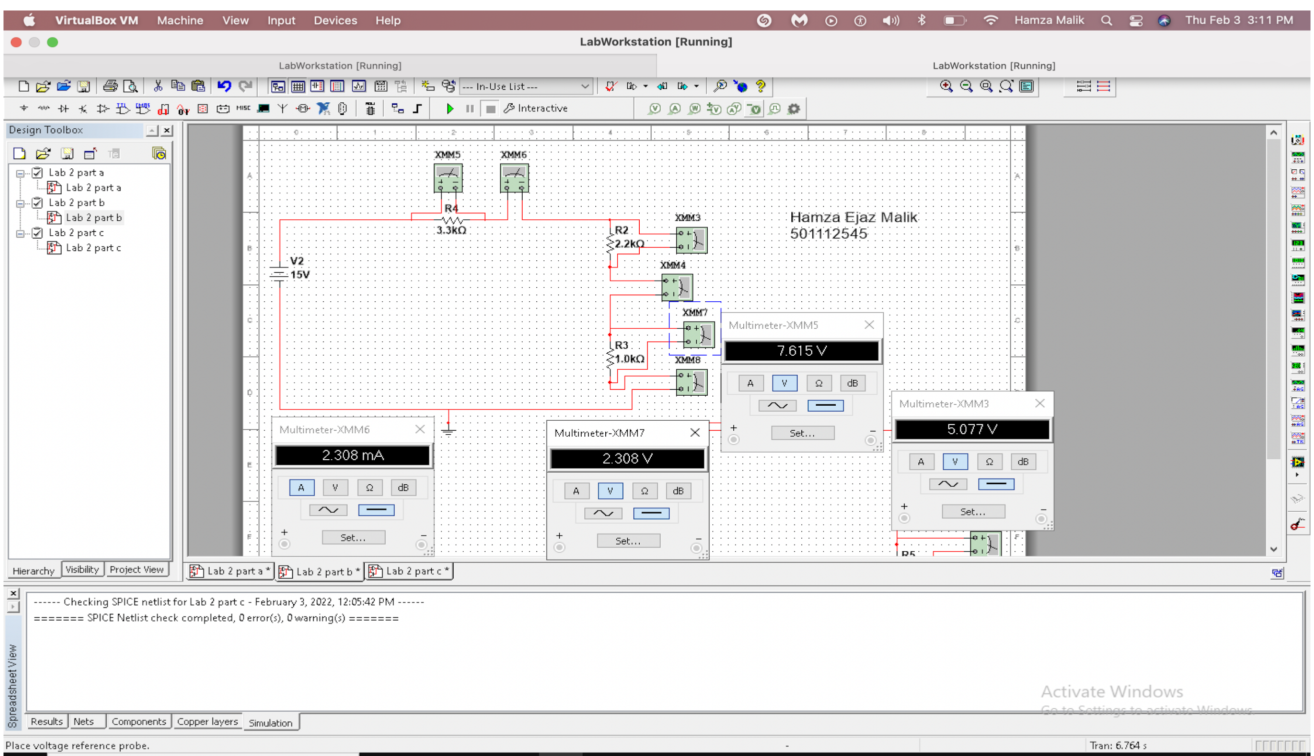
V_E	I (mA)	I_1 (mA)	I_2 (mA)	I_3 (mA)	$\Sigma I = (I_1 + I_2 + I_3)$
15V	26.364mA	4.545mA	6.818mA	15mA	26.363mA

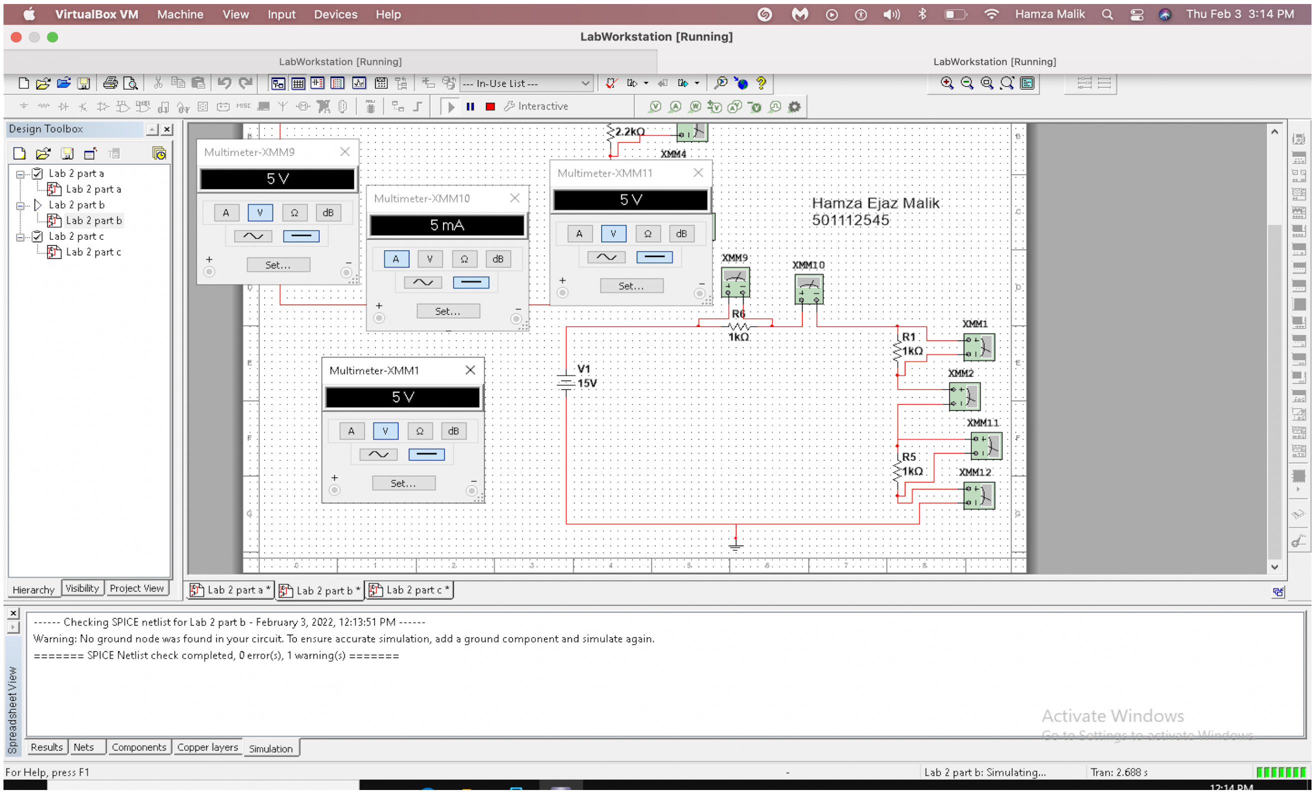
Table 2.7: Experimental (*using Multisim*) results of the Parallel Circuit in Figure 2.2 **[5 marks]**

Part A: $2.2k\Omega$ & $3.3\ k\Omega$ Simple DC Circuits

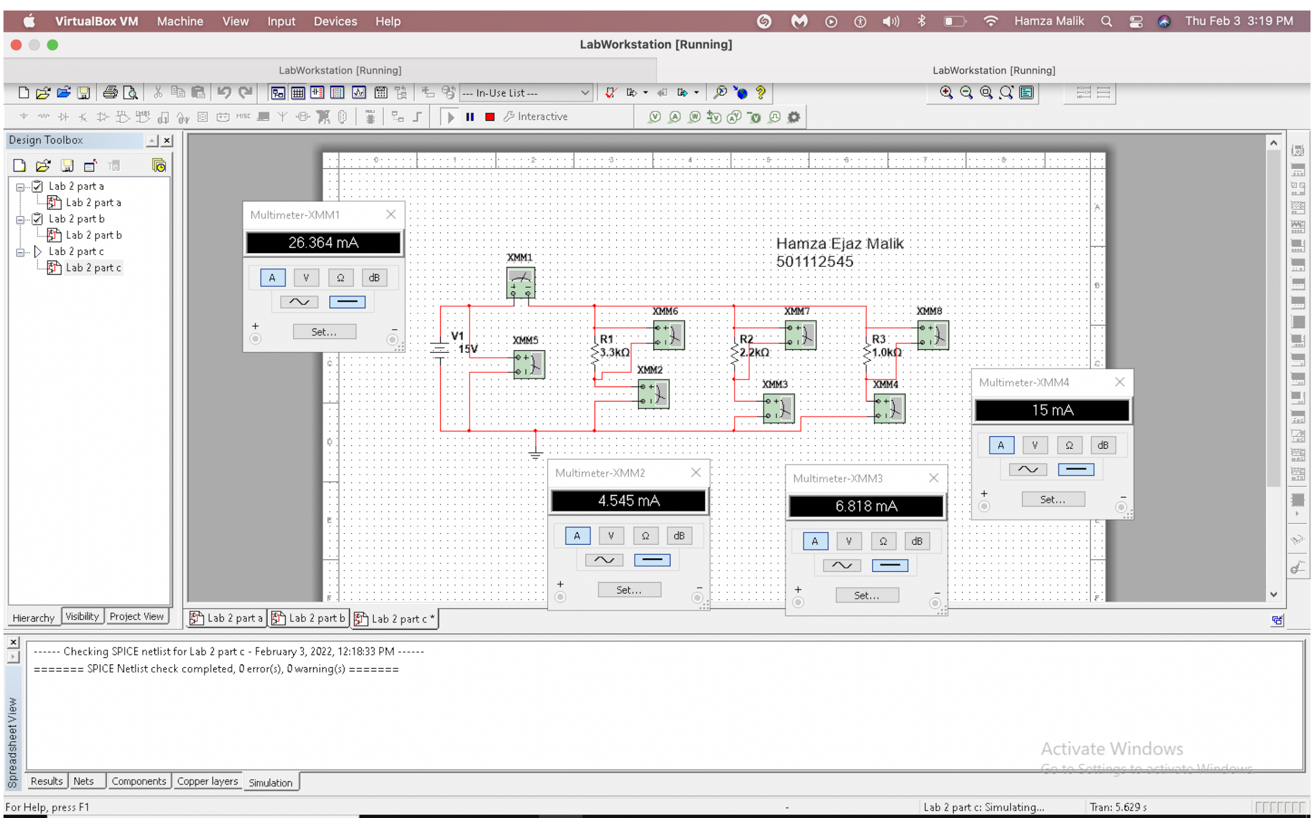


Part B: Series Resistor Circuits - KVL





Part C: Parallel Resistor Circuits - KCL



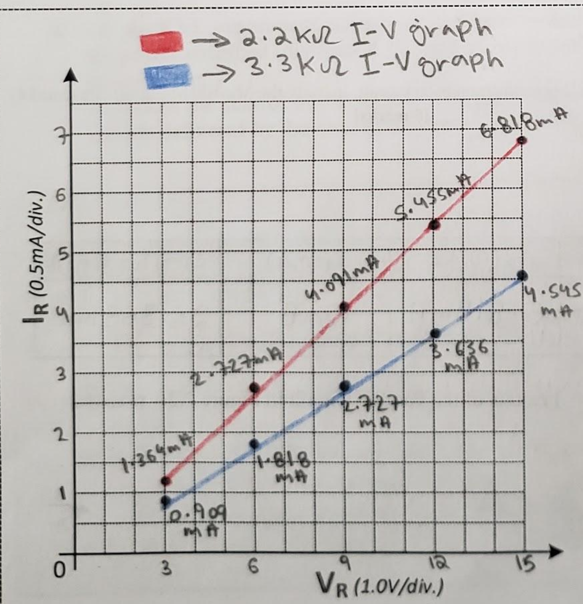
6.0 POST-LAB: OBSERVATIONS AND ANALYSIS OF RESULTS

1. Compare your theoretical values from **Table 2.0** and lab experimental values (*using MultiSIM simulation tool*) of **Table 2.4a** and **Table 2.4b**. Explain your observations. **[2 marks]**

Workspace

Comparing my theoretical values and the lab experimental values, they were exactly the same with 0% deviation. This basically verifies the ohm's law $I = \frac{V}{R}$ as we get the experimental values for the corresponding value of the current.

2. Use the below Graph to plot the ***I-V*** characteristics **for each resistor** using the measured values listed in **Table 2.4a and Table 2.4b**, respectively. Then:-
   (a) For the measured values plotted, estimate the slope of each ***I-V*** graph and determine the resistance from the slope. Compare these values with your actual used resistance values of 2.2 kΩ and 3.3 kΩ. Explain any discrepancies. **[1.5 marks]**
   (b) Is the ***I-V*** characteristics of each resistor consistent with the Ohm's law? Explain. **[1 marks]**



Graph - [2 marks]

Workspace

a) For 2.2kΩ graph the

$$\text{Slope} = \frac{y_2 - y_1}{x_2 - x_1} = \frac{6.818 - 1.364}{15 - 3}$$
$$= 0.455$$

For 3.3kΩ graph the

$$\text{Slope} = \frac{y_2 - y_1}{x_2 - x_1} = \frac{4.545 - 0.909}{15 - 3}$$
$$= 0.303$$

When comparing the values of our resistors with the calculated slope, they are different because the resistance were measured with $R = V/I$ meaning the to find R, which basically gives us the inverse of the slope.

b) $R = \frac{V}{I} = \frac{15V}{6.818mA} = 2.2k\Omega$

$R = \frac{V}{I} = \frac{15V}{4.545mA} = 3.3k\Omega$

∴ yes the I-V characteristics of each resistor consistent with ohm's law, as R can be found using ohm's law $R = \frac{V}{I}$ as shown above.

3. For the KVL experiment, how well did your experimental results of **Table 2.5** conform to the Kirchhoff's Voltage Law? Explain. **[1.5 marks]**
Compare the experimental results (*using Multisim*) of **Table 2.5** with your theoretical Pre-Lab values shown in **Table 2.1**, and explain reason(s) for any relative discrepancies/deviations observed. **[1.5 marks]**

Workspace

The experiment results of table 2.5 conforms to KVL as I was able to get to Vab + Vbc + Vcd with the help of constant 2.308mA and the resistors and adding everything up together was equal to VE which is 15V. Comparing the experimental results to the theoretical pre lab values they were both the same with 0% deviation. Any relative discrepancies/deviation which could have occured were in the process of rounding during the pre lab.

4. For the KVL experiment, using your measured voltages and currents of **Table 2.5**, calculate the power absorbed (dissipated) by **each** series resistor, and the total power delivered by the input-source. **[3.5 marks]**
How does the sum of power absorbed by the resistances in this series circuit compare to the amount delivered by the source? Explain. **[1 marks]**

workspace

P_{R1} = IV = (2.308mA)×(7.615V) = 17.57mW

17.57+11.72+5.33 = 34.62mW

P_{R2} = IV = (2.308mA)×(5.077V) = 11.72mW

P_{R3} = IV = (2.308mA)×(2.308V) = 5.33 mW

P_{VE} = IV = (2.308mA)×(15V) = 34.62mW

Its due to the fact that they are both the same with 0% deviation. 15V is used to find PVE which is sum of voltages of KVL, along with current being constant throught. Therefore the resistors will provide us will the exact same PVE value.

5. For the KVL "**Design Problem**" experiment, do your results in **Table 2.6** confirm the design requirements of $V_{ab} = V_{bc} = V_{cd} = 5V$; and the current $I \leq 5mA$? How do these experimental results (*using Multisim*) compare to your theoretical Pre-Lab values of **Table 2.2**. Explain reason(s) for any discrepancies/deviations. **[1.5 marks]**

Workspace

Yes my results confirm the design requirements as I was able to get Vab = Vbc = Vcd = 5V and current = 5mA. Comparing experimental results and theoretical prelab values, I got the exact same results with 0% deviation, with the help of KVL and ohms law. Any discrepancies could be in error of rounding as it can sometimes be far off, while during the prelab

6. For the KCL experiment, how well did your experimental results of **Table 2.7** conform to the Kirchhoff's Current Law? Explain. **[1.5 marks]**
Compare the experimental results (*using Multisim*) of **Table 2.7** with your theoretical Pre-Lab values shown in **Table 2.3**, and explain reason(s) for any relative discrepancies/deviations observed. **[1.5 marks]**

Workspace

The experimental results of table 2.7 conform to the KCL as I was able to get to I which was 26.364mA with $I_1 + I_2 + I_3$ which in this case was
4.545mA + 6.818mA + 15mA = 26.363mA.
Comparing the experimental results and the theoretical prelab values both were exactly the same with 0% deviation confirming kcl law. If any discrepancies/deviations were to occur it would most likely be due to rounding errors.

7. For the KCL experiment, using your measured voltages and currents of **Table 2.7**, calculate the power absorbed (dissipated) by **each** series resistor, and the total power delivered by the input-source. **[3.5 marks]**

Workspace

$P_{R_1} = IV = (4.545mA)(15V) = 68.175mW$

$P_{R_2} = IV = (6.818mA)(15V) = 102.27mW$

$P_{R_3} = IV = (15mA)(15V) = 225mW$

P_{V_E} (source) $= IV = (26.363mA)(15V) = 395.445mW$

$P = 68.175mW + 102.27mW + 225mW = 395.445mW$

How does the sum of power absorbed by the resistances in this series circuit compare to the amount delivered by the source? Explain. **[1 marks]**

Its due to the fact that they are both the exact same with 0% deviation cause of KCl. The sum of the currents helps us ~~get~~ to Pve and having the consistant voltage of 15V throughout, we end up getting the same value.