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 Electric Circuits

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

Section #:	11
Submission date and time:	2/2/2023 - 17:00
Due date and time:	2/2/2023 - 17:00

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: IMPEMENTATION & MEASUREMENTS

(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.

Color-coded value of **R** = 2.2kΩ => Actual measured value of **R** = _____ ?					
V_R (Volts)	**4V**	**6V**	**8V**	**10V**	**15V**
I_R (mA) **as measured**	1.84 mA	2.77 mA	3.696 mA	4.622 mA	6.956 mA
I_R (mA) **as calculated** in Pre-Lab using color-coded R value	1.82 mA	2.73 mA	3.64 mA	4.55 mA	6.82 mA
Deviation (%) = 100.(measured - calculated)/(calculated)	1.098	1.465	1.053	1.582	1.994

Table 2.4a: Experimental results of the Simple DC Circuit in Figure 2.0 with **R** = 2.2 kΩ

Color-coded value of **R** = 3.3kΩ => Actual measured value of **R** = _____ ?					
V_R (Volts)	**4V**	**6V**	**8V**	**10V**	**15V**
I_R (mA) **as measured**	1.242 mA	1.862 mA	2.483 mA	3.105 mA	4.664 mA
I_R (mA) **as calculated** in Pre-Lab using color-coded R value	1.21 mA	1.82 mA	2.42 mA	3.03 mA	4.55 mA
Deviation (%) = 100.(measured - calculated)/(calculated)	2.644	2.307	2.603	2.475	2.505

Table 2.4b: Experimental results of the Simple DC Circuit in Figure 2.0 with **R** = 3.3 kΩ

(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 $\mathbf{V_{ab}}$, $\mathbf{V_{bc}}$, and $\mathbf{V_{cd}}$. 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 $\mathbf{R_1}$ (=$\mathbf{V_{ab}}$), $\mathbf{R_2}$ (= $\mathbf{V_{bc}}$) and $\mathbf{R_3}$ (=$\mathbf{V_{cd}}$), and record the results in **Table 2.6**.

   4.0.3 Turn OFF the power supply.

$\mathbf{V_E}$	**I** (mA)	$\mathbf{V_{ab}}$ (Volts)	$\mathbf{V_{bc}}$ (Volts)	$\mathbf{V_{cd}}$ (Volts)	ΣV = ($\mathbf{V_{ab}} + \mathbf{V_{bc}} + \mathbf{V_{cd}}$)
15V	14.998 mA	7.579 mA	5.092 mA	2.326 mA	14.997 mA

Table 2.5: Experimental results of the Series Circuit of Figure 2.1

Design values used => $\mathbf{R_1}$ = 1k ?	$\mathbf{R_2}$ = 1k ?		$\mathbf{R_3}$ = 1k ?	
$\mathbf{V_E}$	**I** (mA)	$\mathbf{V_{ab}}$ (Volts)	$\mathbf{V_{bc}}$ (Volts)	$\mathbf{V_{cd}}$ (Volts)
15V	5 mA	5 mA	5 mA	5 mA

Table 2.6: Experimental results of the ***re-designed*** Series Circuit in Figure 2.1

(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**, $\mathbf{I_1}$, $\mathbf{I_2}$ **and** $\mathbf{I_3}$ 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.

V_E	I (mA)	I_1 (mA)	I_2 (mA)	I_3 (mA)	$\Sigma I = (I_1 + I_2 + I_3)$
15V	26.909 mA	4.6695 mA	6.9554 mA	15.276 mA	26.909 mA

Table 2.7: Experimental results of the Parallel Circuit in Figure 2.2

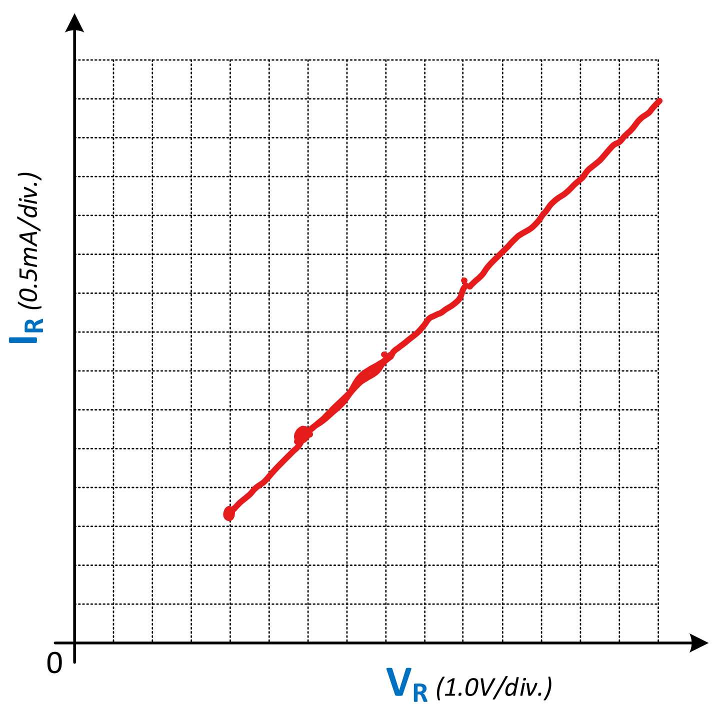
6.0 POST-LAB: OBSERVATIONS AND ANALYSIS OF RESULTS

1. Compare your theoretical values and MultiSIM simulation measurements listed in **Table 2.0** with the experimental values of **Table 2.4a** and **Table 2.4b**. Relate the actual deviation obtained to the resistance tolerance band of the resistor. Explain your observations.

workspace

Considering the values from table 2, Almost all values from the table have 0 deviation, whereas from tables 2.4 a and b there exists a deviation but it is well under the tolerance range.

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



workspace

Slope is approximately 0.46

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

workspace

My experimental data that is evident in table 2.7 clearly shows the validity of KVL as the total Voltage proves to be the sum of the Voltage passing through each resistor.

There are minute relative discrepancies from the pre-lab calculations to the actual experiment, this is due to the fact that the values of the resistors vary by a percentage and are not exact as labelled.

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

workspace

$\mathbf{P}_{R1}$ = 0.018 J

$\mathbf{P}_{R2}$ = 0.012 J

$\mathbf{P}_{R3}$ = 0.054 J

$\mathbf{P}_{VE}$ = 0.035 J

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

workspace

The experimental results and theoretical results are identical and go hand in hand with the data.

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

workspace

My experimental data that is evident in table 2.7 clearly shows the validity of KCL as the total current proves to be the sum of the currents passing through each resistor.

There are minute relative discrepancies from the pre-lab calculations to the actual experiment, this is due to the fact that the values of the resistors vary by a percentage and are not exact as labelled.

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.

workspace

P$_{R1}$ = 0.070 J

P$_{R2}$ = 0.1043 J

P$_{R3}$ = 0.229 J

P$_{VE}$ (source) = 0.403 J

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

As the Circuit only contains resistors, the power delivered by the source equals the sum of the power absorbed by each resistor in this circuit.