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 #:	1	**Lab Title:**	Introduction to Basic Lab Equipment, Tools, & DC Measurements

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

Section #:	5
Submission date and time:	19 / 5 / 2023 - 14:00
Due date and time:	19 / 5 / 2023 - 14:00

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 Experiments: IMPEMENTATION & MEASUREMENTS

(a) Resistance Measurement.

1. Select three **10** kΩ resistors from your Lab Kit and mark (or label) each one as $\mathbf{R_1}$, $\mathbf{R_2}$ and $\mathbf{R_3}$ respectively, so that each resistor can be correctly identified when later used in a circuit.

2. Turn ON the DMM multimeter and set it as an ***Ohmmeter*** by pressing the "**Ω**2W" function key on the instrument. Then, as illustrated in **Figure 5.0a**, directly measure the actual resistance value of each **10** kΩ resistor. Record yours results in **Table 3.0** in the appropriate column. Fill in the remaining columns later for Post-Lab work.

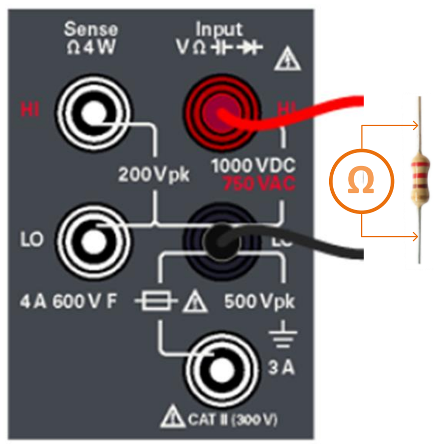


Figure 5.0a: DMM "Ohmmeter" Connection

	THEORETICAL			ACTUAL	ACTUAL DEVIATION
	Color Code (C.C.) value	Minimum value	Maximum value	Measured value	$\text{Dev.}\,\% = \frac{(\text{C.C. value} - \text{ACTUAL value}).100}{(\text{C.C. value})}$
$\mathbf{R_1}$	**10 kΩ**	9.8 k	10.2 k	10.022 k	0.22 %
$\mathbf{R_2}$	**10 kΩ**	9.8 k	10.2 k	9.888 k	1.12 %
$\mathbf{R_3}$	**10 kΩ**	9.8 k	10.2 k	9.888 k	1.12 %

Table 3.0: Actual vs Theoretical values of resistance

(b) Breadboard Implementation, and Voltage-Current Measurements:

Implementation of the Simple DC Circuit in Figure 2.0

1. Turn OFF the Power Supply (PS) and the DMM multimeter.

2. Follow proper breadboarding procedures to neatly construct the DC circuit in **Figure 2.0** on your breadboard using the three **10** kΩ resistors that were previously marked and identified as $\mathbf{R_1}$, $\mathbf{R_2}$ and $\mathbf{R_3}$. For convenience, connect a red wire from the **RED** binding terminal to one of a "red lined" horizontal node on the breadboard, and a green wire from the **GREEN** binding terminal to the "blue lined" common node. This way, the "**+**" side of the input DC voltage, $\mathbf{V_I}$ from the Power Supply can be securely connected to the **RED** terminal with a **banana** cable, and the "**-**" side of the input DC voltage from the Power Supply securely connected to the **GREEN** binding terminal using a second **banana** cable. ***Banana*** *cables are made available in the lab room.*

   Below **Figure 5.0b** shows a possible breadboard setup of the DC circuit in **Figure 2.0** to serve as a reference guide.

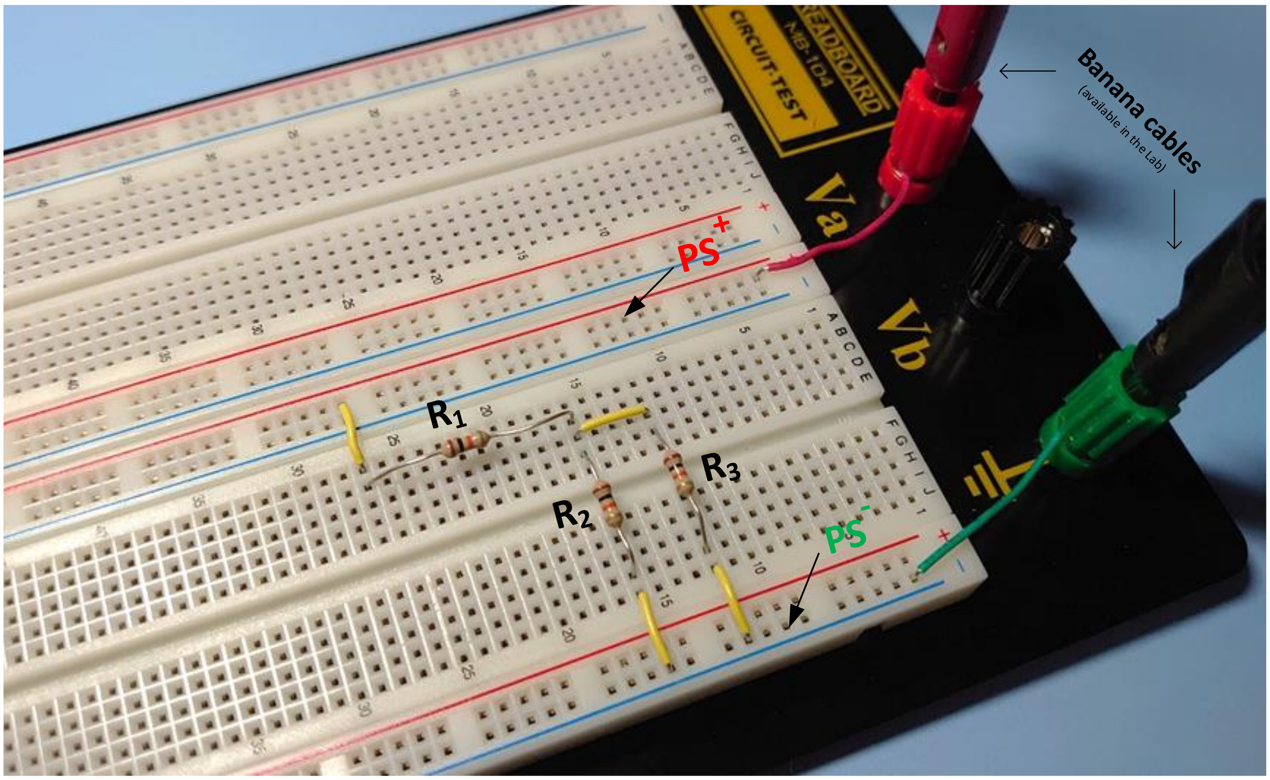
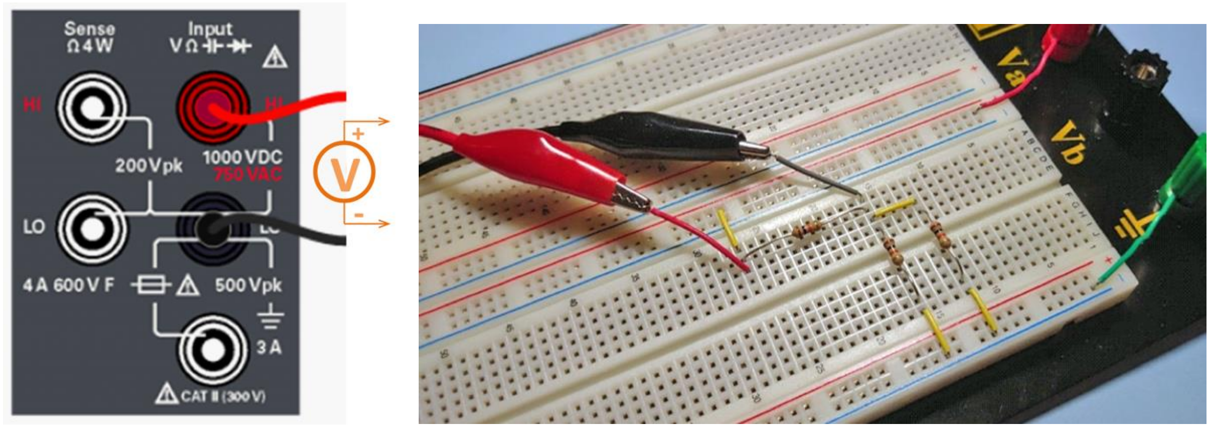


Figure 5.0b: Example of breadboard setup for the circuit in Figure 2.0.

3. Voltage Measurements: Turn ON the DMM multimeter and set it as a ***Voltmeter*** by pressing the "**DCV**" function key on the instrument. Connect the cable probes to the DMM as shown in **Figure 5.0c-(i)**.

- Turn ON the Power Supply (PS) and set its voltage value to **15 volts** (to serve as your $\mathbf{V_I}$ input source). Use the probes to measure $\mathbf{V_1}$ (across $\mathbf{R_1}$), $\mathbf{V_2}$ (across $\mathbf{R_2}$) and $\mathbf{V_3}$ (across $\mathbf{R_3}$) *one at a time*. Example of the voltage measurement of $\mathbf{V_1}$ across resistor, $\mathbf{R_1}$ is illustrated in **Figure 5.0c-(ii)**. Record your measured values in **Table 4.0**.

- Turn OFF the Power Supply (PS) and DMM.

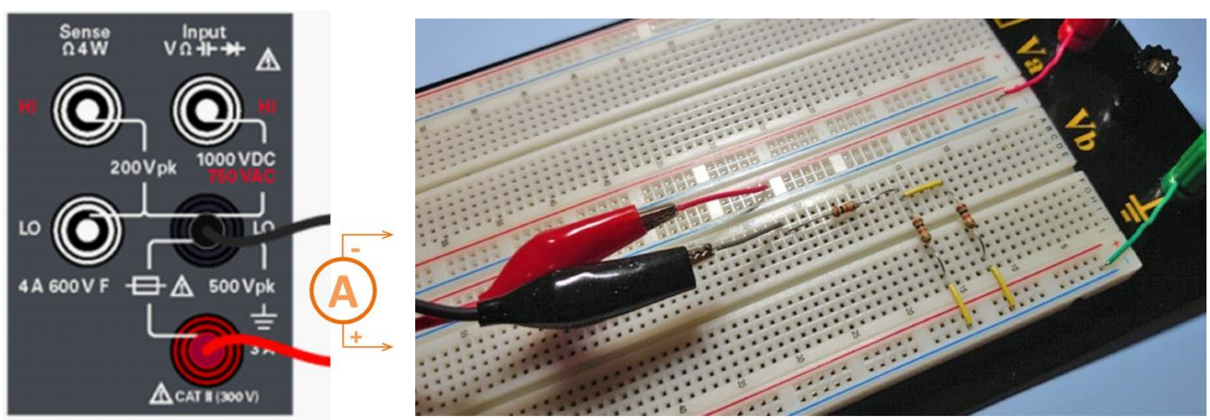


(i) DMM Voltmeter Configuration **(ii)** Example of how to take voltage across resistor R_1, with the DMM

Figure 5.0c: DMM Voltmeter Connections

4. Current Measurements: Connect the cable probes to the DMM as shown in **Figure 5.0d-(i)**. Turn ON the DMM multimeter and set it as an ***Ammeter*** by pressing the "**DCI**" function key on the instrument.

- To measure current, I_1 (through $\mathbf{R_1}$), break the circuit to insert the ***Ammeter*** in series with $\mathbf{R_1}$. Example of the ***Ammeter*** connected in series with $\mathbf{R_1}$ is shown in **Figure 5.0d-(ii)**. **Note**: Be very careful when using the ***Ammeter*** feature of the multimeter. If the ***Ammeter*** is not placed in series with the resistor and the probe leads are placed across the resistor instead, then you can burn out the multimeter's fuse and/or damage the instrument.
- Turn ON the Power Supply (PS) and set its voltage value back to **15 volts** for the $\mathbf{V_I}$ input source. Record your ***Ammeter*** measured value of the current in **Table 4.0**.
- Turn OFF the Power Supply (PS)**.** Then, disconnect the ***Ammeter*** and restore the original wire connection in place.
- Follow the above procedures to measure current, I_2 (through $\mathbf{R_2}$). Repeat the same to measure current, I_3 (through $\mathbf{R_3}$). Record the ***Ammeter*** measured values of the respective currents in **Table 4.0**.
- Turn OFF the Power Supply (PS) and the DMM.



(i) DMM Ammeter Configuration **(ii)** Example of how to measure current through resistor R_1, with the DMM

Figure 5.0d: DMM Ammeter Connections

V_1	V_2	V_3	I_1	I_2	I_3
10.0047 mV	4.9936 mV	4.9935 mV	0.30652 mA	1.5292 mA	1.5295 mA

Table 4.0: Measured values for the circuit in Figure 2.0

Implementation of the Voltage-Divider circuit in Figure 2.1

1. Turn OFF the Power Supply (PS) and the DMM multimeter.

2. Modify your existing breadboard circuit in **Figure 2.0** to construct the voltage-divider circuit in **Figure 2.1**, as follows:

    - Leave resistor, $\mathbf{R_1}$ (**10** kΩ) from the previous circuit in place to serve as the required value for resistor $\mathbf{R_X}$ (**10** kΩ) of the voltage-divider circuit in **Figure 2.1**.
    - Remove resistor, $\mathbf{R_3}$ from the previous circuit.
    - Select **5.1** kΩ from your Kit for the resistor value for $\mathbf{R_Y}$. (Note: *For the Pre-Lab analysis, a **5.0** kΩ value was used for the resistor, $\mathbf{R_Y}$. However, in practice the closet standard value resistor available to use is **5.1** kΩ.*)
    - Replace resistor, $\mathbf{R_2}$ (10 kΩ) in the previous circuit with the **5.1** kΩ resistor to serve as the required resistor, $\mathbf{R_Y}$ of the voltage-divider circuit in **Figure 2.1**.

3. Turn ON the Power Supply (PS) and set its voltage value to **15 volts** for your $\mathbf{V_I}$ input source.

4. Turn ON the DMM multimeter and set it as a ***Voltmeter*** by pressing the **DCV** function key on the instrument, and connect the cable probes as was shown in **Figure 5.0c-(i)**. Measure the voltage, $\mathbf{V_O}$ across resistor, $\mathbf{R_Y}$. Record the measured value in **Table 4.1**.

5. Turn OFF the Power Supply (PS).

6. Set the DMM multimeter as an ***Ammeter*** by pressing the **DCI** function key on the instrument, and connect the cable probes as was shown in **Figure 5.0d-(i)**.

7. Insert the ***Ammeter*** in series with resistor, $\mathbf{R_X}$ [as was illustrated in **Figure 5.0d-(ii)**] to measure the current, **I** through it.

8. Turn ON the Power Supply (PS) and set its voltage value to **15V** for your $\mathbf{V_I}$ input source.

9. Record the measured value of the current, **I** in **Table 4.1**.

10. Turn OFF the Power Supply (PS) and the DMM multimeter.

$\mathbf{V_O}$	**I**
5108.89 mV	0.00986 mA

Table 4.1: Measured values for the circuit in Figure 2.1

6.0 POST-LAB: OBSERVATIONS AND ANALYSIS OF RESULTS

(a) Resistance Measurements

Workspace

From your observation of the results in **Table 3.0**:

- Was the actual value of each of the three **10** k**Ω** resistors within the expected maximum-minimum resistance range? Stated differently, was the "**Dev.%**" of each resistor within its specified $\pm$ 5% tolerance? If not, what might be the reason(s) for the discrepancy?

  Yes, All the 3 resistors used in this experiment were under the specified Tolerance level.

- Even though the same **10** kΩ color-code valued resistors were selected, the actual measured resistances of these three **10** kΩ resistors are not expected to be same. Is that what you have observed? If so, why should that be the case?

  The values of all the three resistors were not the same but were very close to each other. As in the approximate mean of all such values would be our Theoretical value.

(b) Voltage-Current Measurements

Workspace

With reference to the "Simple DC Circuit" in **Figure 2.0**:

Explain how your measurement results in **Table 4.0** compare to the corresponding theoretical values in **Table 2.0** and MultiSIM simulation values in **Table 2.2**? Explain possible causes of any discrepancies.

My measurements in Table 4, table 2 and table 2.2 were coherent and there wasn't much of discrepancy. The variation in values from the MultiSim simulation, and the Theoretical values were coherent with each other whereas there was differenced with the actual experiment values.

The possible reasons for this could be the fact that the simulation considered the value of resistors to be exact and without any errors whereas in the actual experiment, the actual values of the resistors were a mere approximation within the ranges of the tolerance level.

The impending discrepancies weren't large, for they were quite small and could be approximated as theoretical values.

Did the experimental results in **Table 4.0** confirm the Kirchhoff's Current Law expression: $I_1 = I_2 + I_3$ provided earlier? Explain?

Yes, through the experiment, we had validated the Kirchhoff's Current Law expression on current being the sum of its constituent parts. Thus, verifying that the total current in the circuit is the sum of all the current flow in the circuit.

From your measurement results in **Table 4.0**, calculate the resistance value of R_1 (= V_1/I_1), R_2 (=V_2/I_2) and R_3 (= V_3/I_3) => R_1 = 10.02 k, R_2 = 9.82 k; and R_3 = 9.82 k.

Are these values expected to be the same as the corresponding *directly* measured resistance values in **Table 3.0**.? Why?

Yes, the values expected are to be the same as directly measuring the resistance of the resistors. This is because we are calculating the resistance of the individual resistor from the information, we know on how much current passes between the resistor and what potential difference exists in them.