Ryerson University

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

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

Lab #:	1	Lab Title:	Introduction to Basic Lab Equiptment, Tools, and DC Measurements

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Section #:	10
Submission date and time:	Tuesday July 12, 6pm
Due date and time:	Tuesday July 12, 6pm

Document submission for Part I:

- A completed and signed "COVER PAGE – **Part I**" has to be included with your submission. The report will not be graded if the signed cover page is not included.
- Your completed handwritten pages of **Section 4.0** should be scanned (via a scanner or phone images), together with the required MultiSIM images. **Note:** *MultiSIM results must be generated using the Department's licensed version of MultiSIM, and the captured screenshots should show your name (at the center-top) and the timestamp (at the bottom-right corner of your screen).*
- Collate and create a *.pdf* or *.docx* file of the above, and upload it via D2L **any time prior to the start of your scheduled lab**. Upload instructions are provided on D2L.

Zero marks will be assigned for the entire lab if this Part I is not submitted prior to your scheduled lab.

**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.*

2.0 OBJECTIVES

- To introduce use of MultiSIM circuit simulation tool for capturing and analyzing circuits,
- To familiarize with the operation of basic electrical equipment such as a DC Power Supply (PS) and Digital Multimeter (DMM).
- To construct and test basic electrical circuits using a Breadboard device,
- To properly use a Digital Multimeter (DMM) to measure DC voltage, current and resistance.
- To learn the Standard Resistor Color-Code scheme necessary to read resistor values and tolerances.

3.0 REQUIRED LAB EQUIPMENT & PARTS

- Digital Multimeter (DMM) and Power Supply (PS)
- ELE202 Lab Kit: various components, breadboard, wires and jumpers.

4.0 PRE-LAB: ASSIGNMENT

(a) Use the Standard Resistor Colour-Code Chart in **Figure 1.0f** to: **(i)** determine the numerical value, tolerance and acceptable resistance range for each colour-coded resistor listed in **Table 1.0a**, and **(ii)** identify the corresponding 4-band colour codes of each resistor value listed in **Table 1.0b**. (Note: 1 kΩ = 1x10³Ω = 1000 Ω)

Lab workspace

$R_1 = 12\times10^0\Omega = 12.00\Omega \pm 2\%$, $12.00\Omega - 2\% = 11.76\Omega$, $12.00\Omega + 2\% = 12.24\Omega$

Resistor	Color of Bands 1st band	2nd band	3rd band	4th band	Color Code Value	Tolerance (%)	Range of Acceptable Values Minimum	Maximum
1	Brown	Red	Black	Red	12.00Ω	± 2%	11.76Ω	12.24Ω
2	Green	Violet	Yellow	Gold	570.00kΩ	± 5%	541.50kΩ	598.50kΩ
3	Blue	Red	Red	Gold	6.20kΩ	± 5%	5.89kΩ	6.51kΩ
4	Yellow	Violet	Orange	Silver	47.00kΩ	± 10%	42.30kΩ	51.70kΩ

$R_2 = 57\times10^4\Omega = 570.00k\Omega \pm 5\%$, $570.00k\Omega - 5\% = 541.50k\Omega$, $57.00k\Omega + 5\% = 598.50k\Omega$

Table 1.0a

$R_3 = 62\times10^2\Omega = 6.20k\Omega \pm 5\%$, $6.20k\Omega - 5\% = 5.89k\Omega$, $6.20k\Omega + 5\% = 6.51k\Omega$

$R_4 = 47\times10^3 = 47.00k\Omega \pm 10\%$, $47.00k\Omega - 10\% = 42.30k\Omega$, $47.00k\Omega + 10\% = 51.70k\Omega$

Resistor Value	Colour of Bands 1st band	2nd band	3rd band	4th band
100 Ω ± 2%	Brown	Black	Brown	Red
680 Ω ± 5%	Blue	Gray	Brown	Gold
3.3 kΩ ± 5%	Orange	orange	Red	Gold
47 kΩ ± 2%	yellow	Violet	Orange	Red

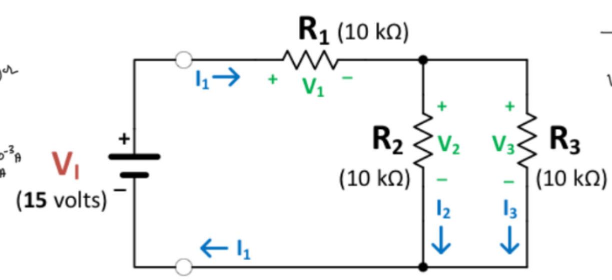
Table 1.0b

(b) The simple DC circuit in **Figure 2.0** is powered by a **15 volts** DC battery input-source (**V_I**) which will cause currents to flow through the resistors, **R_1**, **R_2** and **R_3** as illustrated. When current flows through a resistor, it creates a voltage across the resistor as governed by the **Ohm's Law** expression, **$V = I.R$**. The **Kirchhoff's Current Law** (KCL) states that the sum of all currents entering (or leaving) a node is zero. Therefore, $I_1 + (-I_2) + (-I_3) = 0$, resulting in $I_1 = I_2 + I_3$.

Even though the basic circuit laws may not be fully covered in class as yet, you may use the above circuit law expressions to determine the missing values in **Table 2.0**. Show your analysis on the below workspace provided. **Note:** 1 **mA** = $1\text{x}10^{-3}$**A** = 0.001A; and 1 **kΩ** = $1\text{x}10^{3}$**Ω** = 1000**Ω**

$I = 1mA$
$R = 5k\Omega$
$V = (1\times10^{-3})^{A}(5\times10^{3})^{\Omega}$
$V = 5V$
$R = 5k\Omega$
$I = \frac{V}{R} = \frac{5V}{5k\Omega} = \frac{5}{5\times10^{3}} = 1\times10^{-3}A = 1mA$

IR



$V_2 = I_2 R_2$
$V_2 = (0.5)^{mA}(10)^{k\Omega}$
$V = 5V$
$V_3 = I_3 R_3$

Figure 2.0: Simple D.C. circuit for voltage and current measurements

Pre- Lab workspace

V_1	V_2	V_3	I_1	I_2	I_3
10 volts	5volts	5 volts	1mA	0.5 mA	0.5mA

Table 2.0

$I_2 = V_2/R_2 = 5V/10k\Omega = 0.5mA$
$V_1 = I_1 \times R_1 = 1mA \times 10\ k\Omega = 10$ volts
$V_2 = I_1 \times R_2 = 1mA \times 5\ k\Omega = 5$ volts
$I_1 = V_1/R_1 = 10V/10k\Omega = 1mA$

What relationship exists between voltages V_2 and V_3? and between currents, I_2 and I_3? Why?

The relationship that exist between the voltages V_2 and V_3 and the currents I_2 and I_3 is that they are equal. This is because resistors R_2 and R_3 are parallel so $R_2 = R_3$, and therefore the current will also be the same. In terms of the resisters $R_2 = R_3$, and therefore the current will also be the same. In terms of the resistors R_2 and R_3 being parallel and of the same 10 kΩ value, its combined value is split in half. Also according to (KCL) $I_1 = I_2 + I_3$ and which is why the currents were equal as well.

Was the voltage relationship $V_I = V_1 + (V_2$ or $V_3)$ established? If so, why would it be the case?

Yes the voltage relationship was established because of the KCL which states that
$V_I = V_1 + (V_2$ or $V_3)$
which was proved with the $V_{rise} = V_{drop}$
$V_I = V_1 + V_2 = 10V + 5V = \underline{15V}$ or $V_I = V_1 + V_3 = 10V + 5V = \underline{15V}$

If the resistor, R_1 is replaced with a wire (i.e. make $R_1 = 0\ \Omega$), intuitively what might the resultant value of the voltage, V_3 be? Explain.

The resultant value of the voltage V_3 would be 15V

$V = I_2 \times R_2$
$= 15 = \frac{I_2 \times 10k}{10k}$
$I_2 = 0.0015A$

$V = I_2 \times R_2$
$= (0.0015)^{A}(10000)^{k\Omega}$
$= 15V$

$V_3 = (1.5)_{mA}(10)_{k\Omega} = 15V$

(c) The circuit in **Figure 2.1** is a simple voltage-divider configuration that uses two resistors in series to create an output voltage, V_O which is a fraction of the input voltage, V_I. The basic circuit laws dictate that the circuit current, **I** and the resultant voltage division output, V_O of this basic circuit configuration can be expressed as:

$$I = \frac{V_I}{R_X + R_Y} = \frac{V_O}{R_Y} \qquad V_O = \left[\frac{R_Y}{R_Y + R_X}\right] \cdot V_I$$

If the input voltage, V_I = **15** volts, and resistors R_X = **10** kΩ and R_Y = **5.0** kΩ, find the values of the output voltage, V_O and the circuit current, **I** by using the above expressions. Record the results in **Table 2.1**.

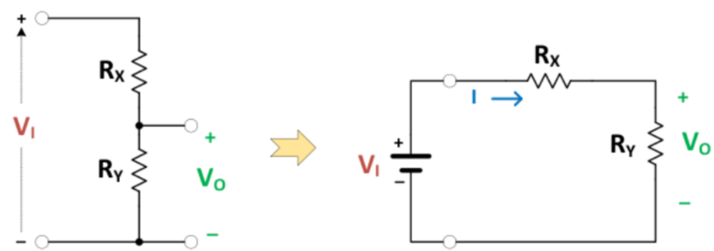


Figure 2.1: Simple voltage-divider circuit

Pre- Lab workspace

V_O	I
5volts	1mA

Table 2.1

$V_o = \frac{R_y}{R_y + R_x}$

$= \frac{5k\Omega}{10k\Omega + 5k\Omega}$

$= 5V$

$I = \frac{V_I}{R_x + R_y}$ or $\frac{V_O}{R_y}$

$= \frac{15V}{10k\Omega + 5k\Omega}$ $= 1mA$

$= 1mA$

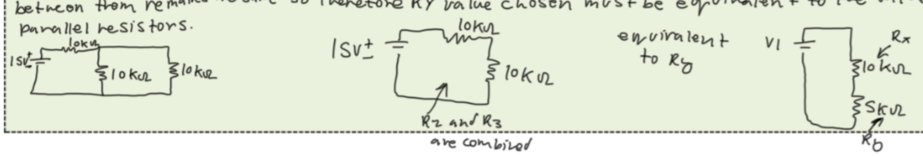
For the resistor values selected for circuits in **Figure 2.0** and **Figure 2.1**, and comparing your results in **Table 2.0** with those in **Table 2.1**, answer the following questions:

(i) Why would the value of $I = I_1$ and $V_O = V_3$ (or V_2)? Explain.

These values will stay the same because both figure 2.0 and 2.1 have the same setup. The first resistor Rx will be 10kΩ and an output of 15V and Ry basically replicates R2 and R3 10kΩ resistors in parallel.

(ii) Would it be reasonable to conclude that resistor, R_Y value chosen must be equivalent to the value of parallel resistors, R_2 and R_3 combined? Why?

Ry will be equal to the reciprocal of (1/R2 + 1/R3) as they are in parallel and computing it will give us 5kΩ which is the value of Ry. Also since R2 and R3 are in parallel the potential difference between them remains the same so therefore RY value chosen must be equivalent to the value of parallel resistors.



(d) Practice Exercise for MultiSIM simulation: At this point, the student should have already downloaded and installed the licenced version of MultiSIM software, and become familiar with the basic use of this simulation tool to construct and test simple electrical circuits. As was noted earlier, student should "*Refer to the MultiSIM software download procedures, related FAQs and video tutorials on the course website (D2L) to get acquainted with proper use of this simulation tool, and become proficient at it.*"

On MultiSIM, construct and simulate the practice circuit in **Figure 3.0** using the values shown. Measure the voltages, V_Y (across R_3) and V_Z (across R_5) and current, I_X (through R_4) as shown.

To know your practice simulation of the circuit is done correctly, the measured results should show:

$$V_Y = 7.275 \text{ V}, \quad V_Z = 6.674 \text{ V} \quad \text{and} \quad I_X = 1.008 \text{ mA}$$

- Copy and paste a screenshot showing your MultiSIM readings on the circuit. Include the MultiSIM circuit file (**.ms14**) in your Pre-Lab submission.
- All screenshots should show your name printed on the center-top of the MultiSIM screen and the timestamp at the bottom-lower corner.

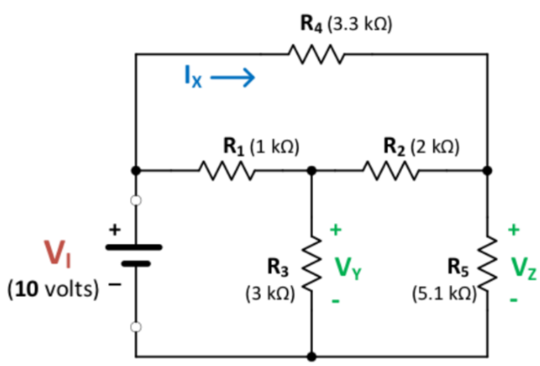


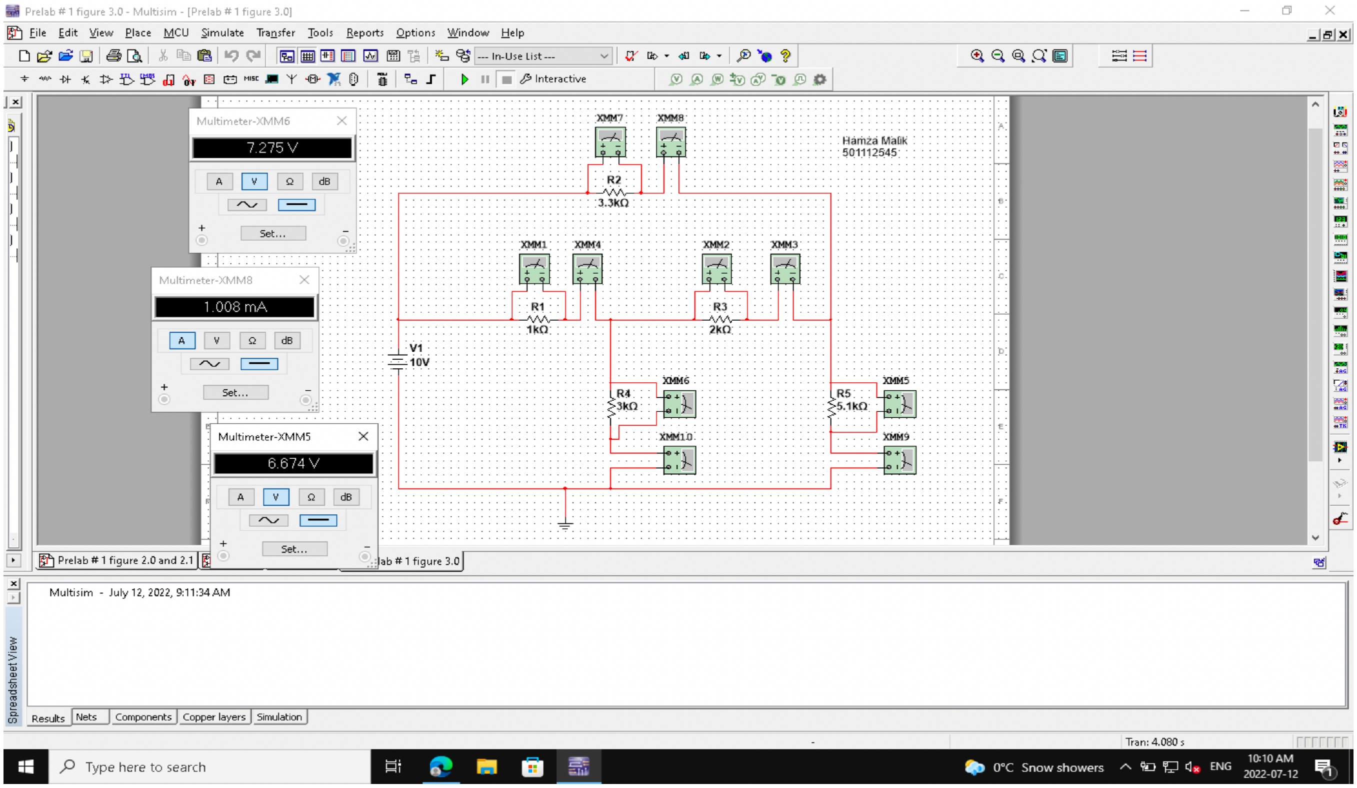
Figure 3.0: Practice circuit for MultiSIM tool

(e) Use MultiSIM to:

(i) Construct and simulate the circuit of **Figure 2.0**, with V_I = **15** V and $R_1 = R_2 = R_3 =$ **10** kΩ. Measure the voltages V_1, V_2 and V_3; and currents I_1, I_2 and I_3. Record the results in below **Table 2.2**.

(ii) Construct and simulate the circuit of **Figure 2.1**, with V_I = **15** V, R_X = **10** kΩ and R_Y = **5** kΩ. Measure the voltage, V_O and current, **I**. Record the results in below **Table 2.3**.

- Copy and paste a screenshot showing your MultiSIM readings on each circuit. Include the MultiSIM circuit file (**.ms14**) of each circuit in your Pre-Lab submission.
- All screenshots should show your name printed on the center-top of the MultiSIM screen and the timestamp at the bottom-lower corner.


Prelab # 1 figure 3.0 - Multisim - [Prelab # 1 figure 3.0]
File Edit View Place MCU Simulate Transfer Tools Reports Options Window Help
Multimeter-XMM6
7.275 V
Multimeter-XMM8
1.008 mA
Multimeter-XMM5
6.674 V
Hamza Malik
501112545
XMM7
XMM8
R2
3.3kΩ
XMM1
XMM4
XMM2
XMM3
R1
1kΩ
R3
2kΩ
V1
10V
R4
3kΩ
XMM6
XMM10
R5
5.1kΩ
XMM5
XMM9
Prelab # 1 figure 2.0 and 2.1
Multisim - July 12, 2022, 9:11:34 AM
Results
Nets
Components
Copper layers
Simulation
Spreadsheet View
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Type here to search
0°C Snow showers
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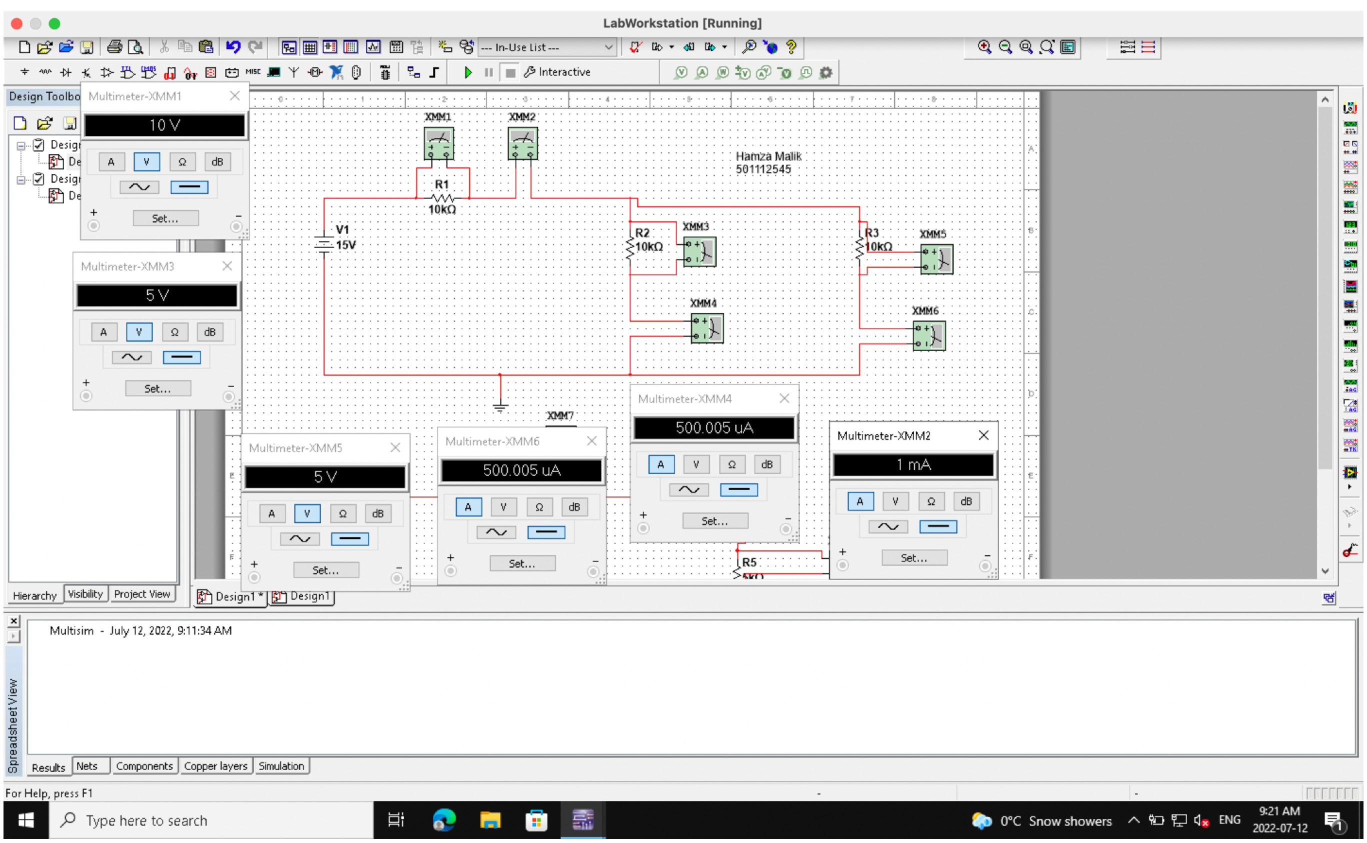
2022-07-12


LabWorkstation [Running]
Design Toolbo
Multimeter-XMM1
10 V
Multimeter-XMM3
5 V
XMM1
XMM2
R1
10kΩ
Hamza Malik
501112545
V1
15V
R2
10kΩ
XMM3
XMM4
R3
10kΩ
XMM5
XMM6
XMM7
Multimeter-XMM4
500.005 uA
Multimeter-XMM2
1 mA
Multimeter-XMM5
5 V
Multimeter-XMM6
500.005 uA
R5
Hierarchy
Visibility
Project View
Design1 *
Design1
Multisim - July 12, 2022, 9:11:34 AM
Results
Nets
Components
Copper layers
Simulation
Spreadsheet View
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0°C Snow showers
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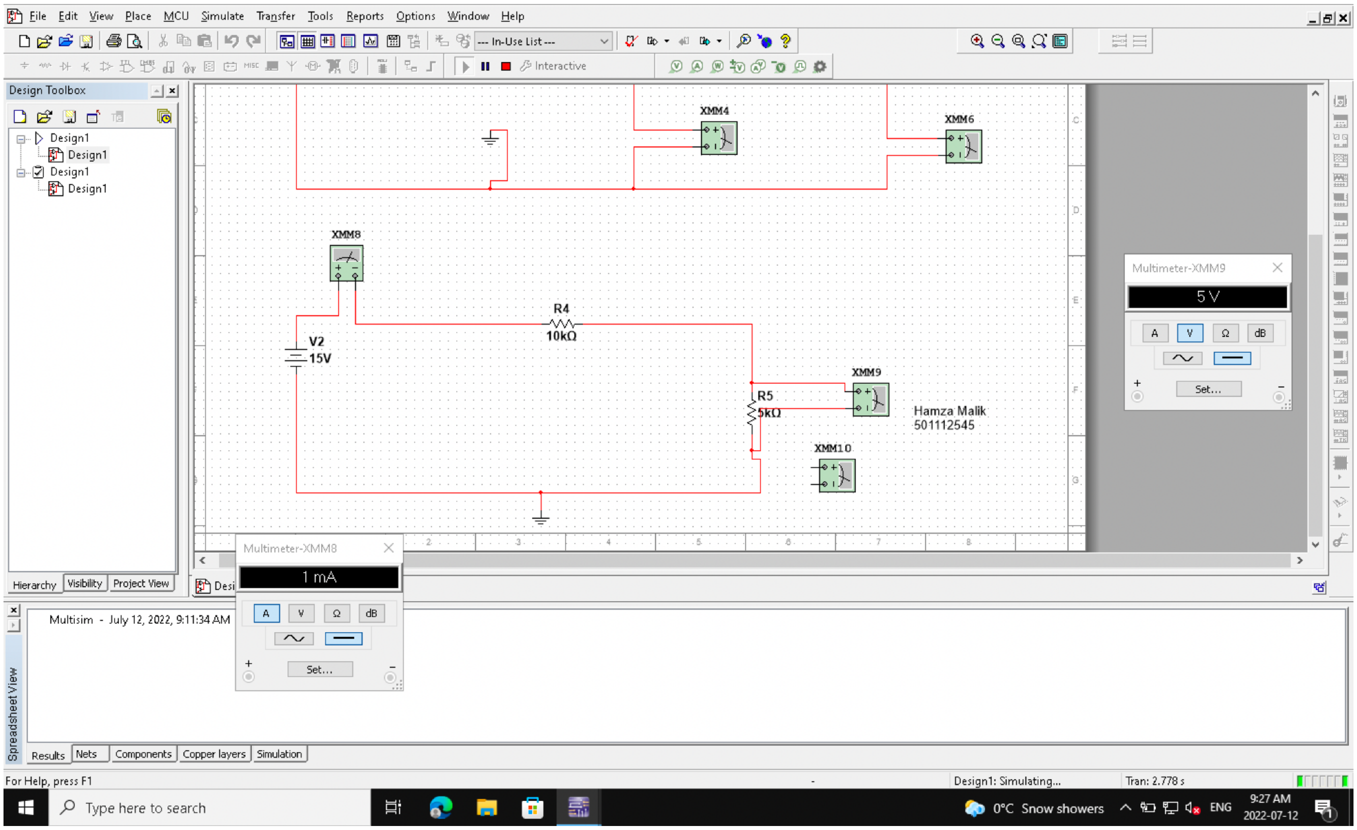
2022-07-12


XMM4
XMM6
XMM8
R4
10kΩ
V2
15V
XMM9
R5
5kΩ
Hamza Malik
501112545
XMM10
Multimeter-XMM9
5 V
Multimeter-XMM8
1 mA
Multisim - July 12, 2022, 9:11:34 AM
Design1: Simulating...
Tran: 2.778 s

Pre-Lab workspace

V_1	V_2	V_3	I_1	I_2	I_3
10V	10V	5V	1mA	500uA	500uA

Table 2.2

V_O	I
5V	1mA

Table 2.3

Compare your above simulation results with the respective theoretical ones from **Table 2.0** and **Table 2.1**, and comment.

The results from table 2.0 and table 2.1 as shown above are respectfully the same meaning that both the calculations done were relatively very accurate compared to the created multisim files.

Do these simulation results support your answers to the questions posed earlier in the Pre-Lab sections **4(b)** and **4(c)**? Explain.

Yes the results from the simulation for pre lab sections 4(b) and (c) support my answer