North South University

Department of Electrical & Computer Engineering

LAB REPORT

Course Name: EEE141L

Section: 08

Lab No: 04

Lab Name: Delta-Wye Conversion

Experiment Date: 03 July, 2022

Report Submission Date: 16 July, 2022

Group Number: 04

Faculty Name: **Syeda Sarita Hassan(SSH1)**

Lab Instructor: **Naziza Mehzabin Hossain**	Score
Student Name & ID: **Mosroor Mofiz Arman(1921079642)** **Nasim Anzum Promise(2022655642)** **Muhammad Raiyan Alam(1831100642)** **Sumit Kumar Kar(2021646642)**	
Remarks:	

Experiment Name:

Delta-wye Conversion.

Objectives:

(1) We have to perform Delta-wye Conversion.

(2) We have to verify the results with measured data.

(3) We have to solve a complex circuit using Delta-wye Conversion.

List of Equipment:

(1) Bread Board

(2) DMM

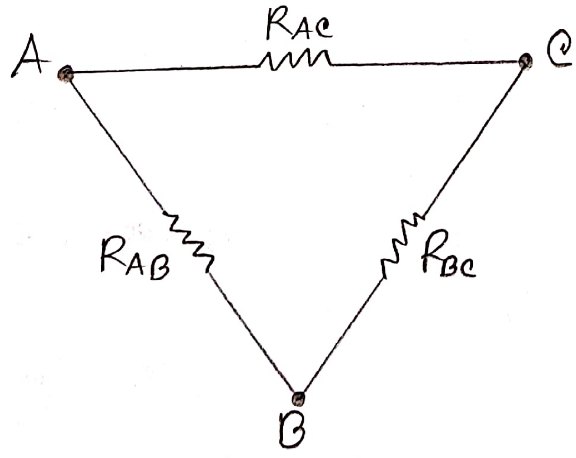
(3) $5 \times 15K\Omega$ resistor

(4) $3 \times 5K\Omega$ resistor

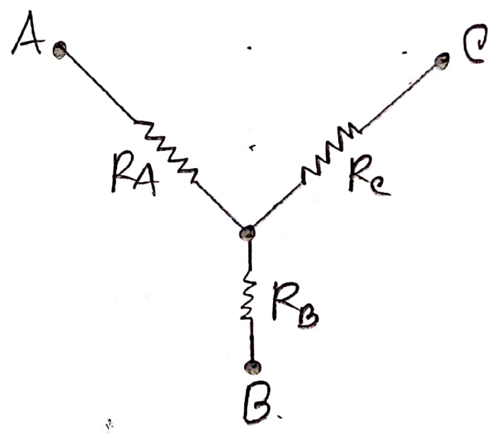
(5) DC power source.

Theory:

Delta-wye conversion: The delta-wye transformation is an extra technique for transforming certain resistors combinations that can not be handled by the series and parallel equations. It is possible to convert a delta network into a functionally equivalent wye network and it is also possible to convert a wye network into a functionally equivalent delta network. "Functionally equivalent" means that the overall electrical behavior of the converted network is identical to the overall electrical behavior of the original network.



Delta (Δ) Network



wye (Y) Network

Delta and wye networks are seen frequently in 3 phase AC systems, but even then they are usually balanced networks such as all resistors equal in value and conversion from one to other need not involve such complex calculations.

Equations for transforming a delta network into a wye network:

$$R_1 = \frac{R_b R_c}{R_a + R_b + R_c}, \quad R_2 = \frac{R_a . R_c}{R_a + R_b + R_c}, \quad R_3 = \frac{R_a . R_b}{R_a + R_b + R_c}$$

Equations for transforming a wye network into a delta network:

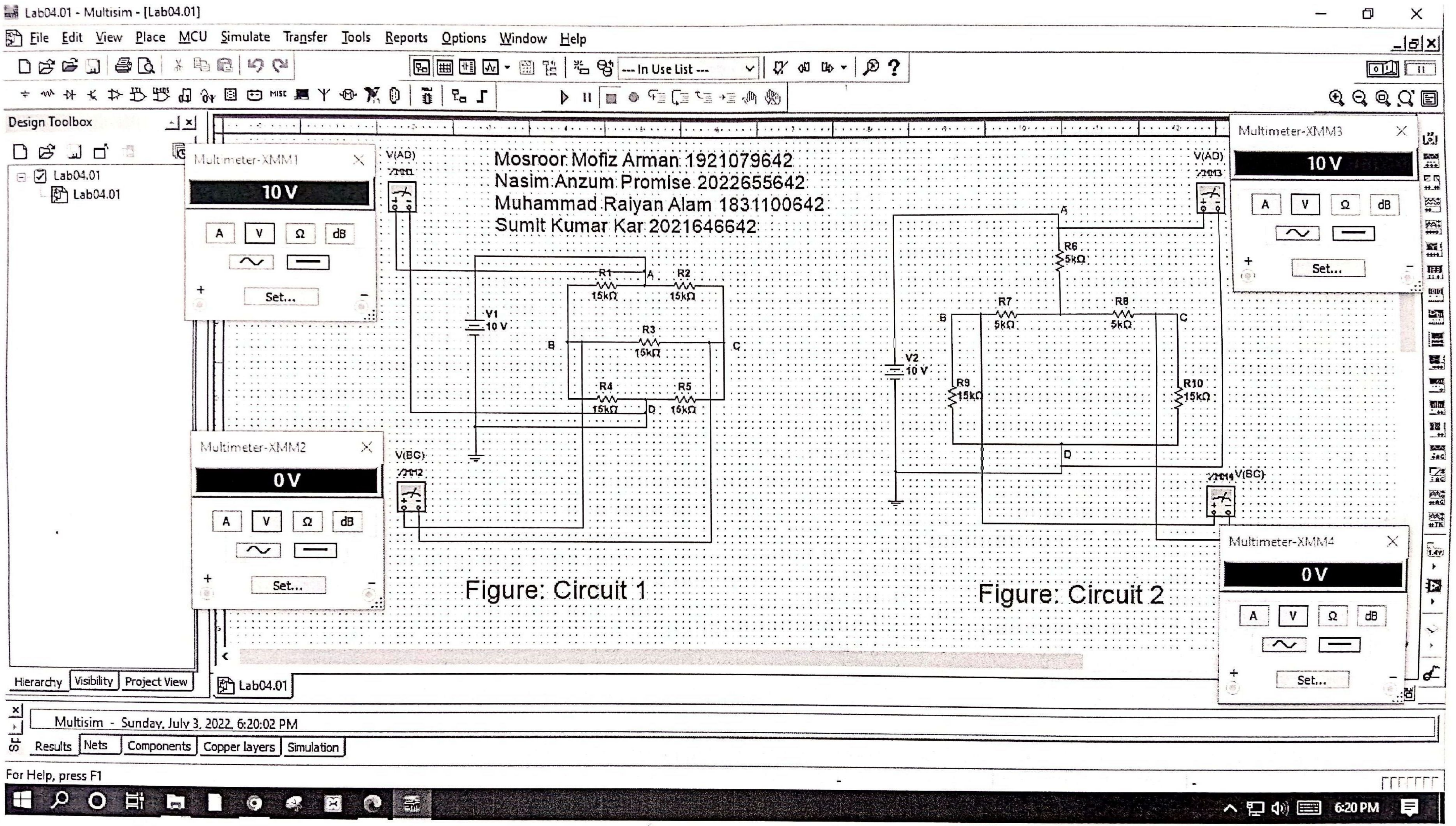
$$R_a = \frac{R_1 R_2 + R_2 R_3 + R_3 R_1}{R_1}$$

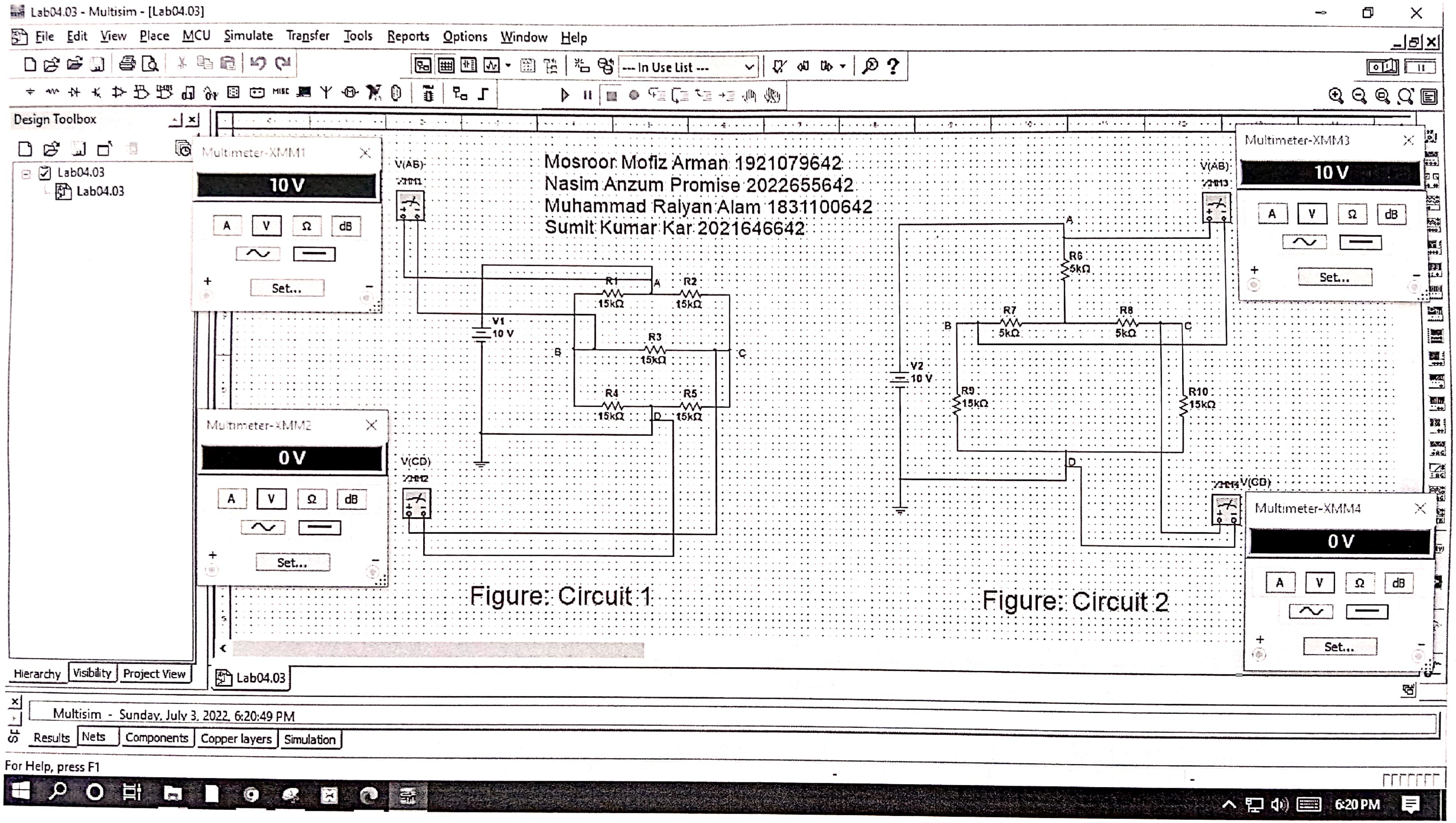
$$R_b = \frac{R_1 R_2 + R_2 R_3 + R_3 R_1}{R_2}$$

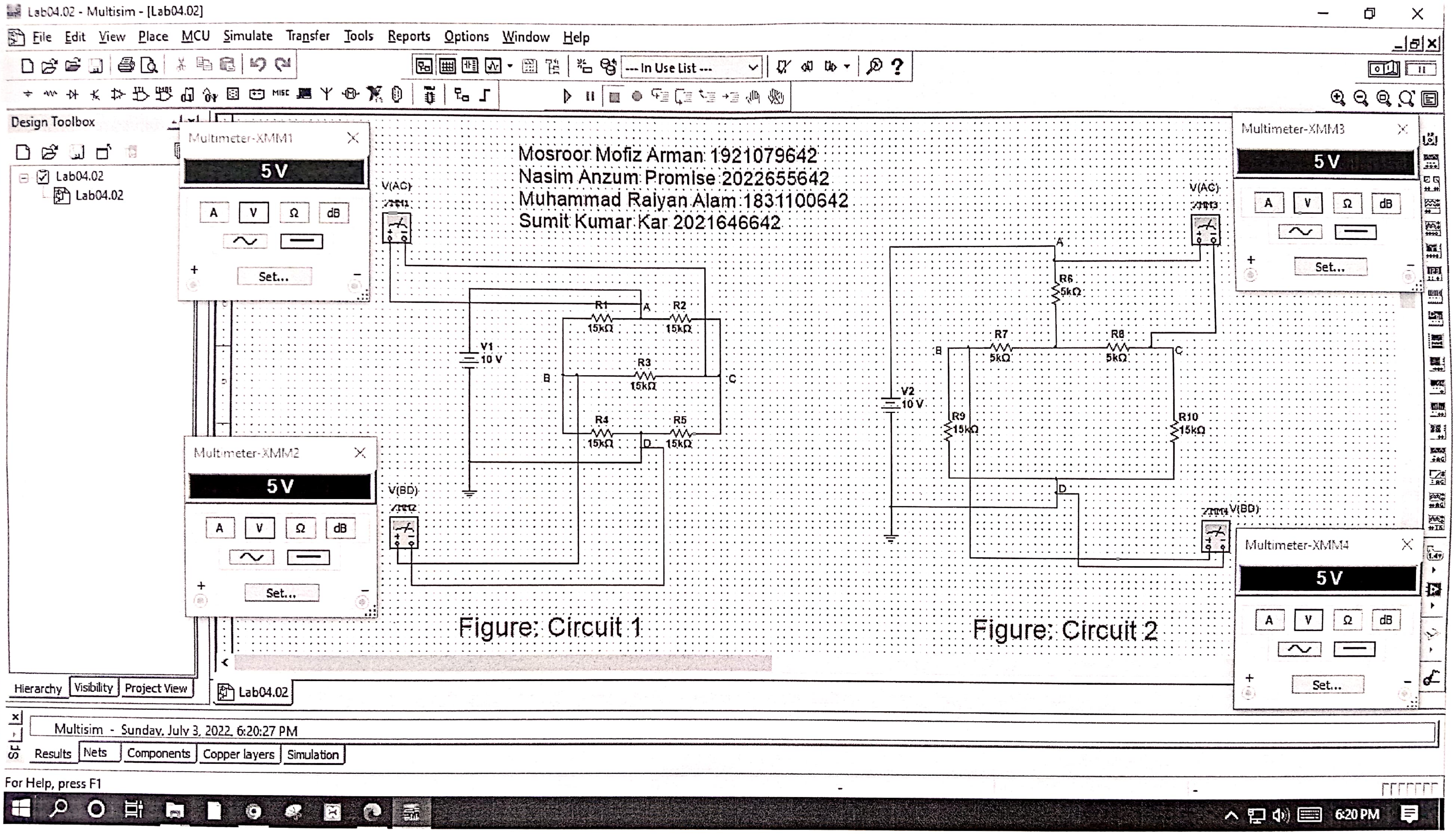
$$R_c = \frac{R_1 R_2 + R_2 R_3 + R_3 R_1}{R_3}$$

Transforming from delta network to wye

network introduces one additional node and transforming wye network to delta network removes one node.


Lab04.01 - Multisim - [Lab04.01]
File Edit View Place MCU Simulate Transfer Tools Reports Options Window Help
--- In Use List ---
Design Toolbox
Lab04.01
Lab04.01
Multimeter-XMM1
10 V
A V Ω dB
Set...
Mosroor Mofiz Arman 1921079642
Nasim Anzum Promise 2022655642
Muhammad Raiyan Alam 1831100642
Sumit Kumar Kar 2021646642
V(AD)
R1 15kΩ
R2 15kΩ
R3 15kΩ
R4 15kΩ
R5 15kΩ
V1 10 V
A
B
C
D
Multimeter-XMM2
0 V
Set...
V(BC)
Figure: Circuit 1
Multimeter-XMM3
10 V
Set...
R6 5kΩ
R7 5kΩ
R8 5kΩ
R9 15kΩ
R10 15kΩ
V2 10 V
Multimeter-XMM4
0 V
Set...
Figure: Circuit 2
Hierarchy Visibility Project View
Lab04.01
Multisim - Sunday, July 3, 2022, 6:20:02 PM
Results Nets Components Copper layers Simulation
For Help, press F1
6:20 PM


Lab04.03 - Multisim - [Lab04.03]
File Edit View Place MCU Simulate Transfer Tools Reports Options Window Help
--- In Use List ---
Design Toolbox
Lab04.03
Lab04.03
Multimeter-XMM1
10 V
A V Ω dB
Set...
Mosroor Mofiz Arman 1921079642
Nasim Anzum Promise 2022655642
Muhammad Raiyan Alam 1831100642
Sumit Kumar Kar 2021646642
V(AB)
XMM1
R1 15kΩ
R2 15kΩ
R3 15kΩ
R4 15kΩ
R5 15kΩ
V1 10 V
A
B
C
D
Multimeter-XMM2
0 V
A V Ω dB
Set...
V(CD)
XMM2
Figure: Circuit 1
V(AB)
XMM3
Multimeter-XMM3
10 V
A V Ω dB
Set...
R6 5kΩ
R7 5kΩ
R8 5kΩ
R9 15kΩ
R10 15kΩ
V2 10 V
A
B
C
D
V(CD)
XMM4
Multimeter-XMM4
0 V
A V Ω dB
Set...
Figure: Circuit 2
Hierarchy Visibility Project View
Lab04.03
Multisim - Sunday, July 3, 2022, 6:20:49 PM
Results Nets Components Copper layers Simulation
For Help, press F1
6:20 PM


Lab04.02 - Multisim - [Lab04.02]
File Edit View Place MCU Simulate Transfer Tools Reports Options Window Help
--- In Use List ---
Design Toolbox
Lab04.02
Multimeter-XMM1
5 V
Mosroor Mofiz Arman 1921079642
Nasim Anzum Promise 2022655642
Muhammad Raiyan Alam 1831100642
Sumit Kumar Kar 2021646642
V(AC)
R1 15kΩ
R2 15kΩ
R3 15kΩ
R4 15kΩ
R5 15kΩ
V1 10 V
V(BD)
Multimeter-XMM2
5 V
Figure: Circuit 1
Multimeter-XMM3
5 V
R6 5kΩ
R7 5kΩ
R8 5kΩ
R9 15kΩ
R10 15kΩ
V2 10 V
Multimeter-XMM4
5 V
Figure: Circuit 2
Hierarchy Visibility Project View
Lab04.02
Multisim - Sunday, July 3, 2022, 6:20:27 PM
Results Nets Components Copper layers Simulation
For Help, press F1
6:20 PM

North South University

Department of Electrical and Computer Engineering

EEE141L/ETE141L

List of Equipment

- Bread Board
- DMM
- 5 x 15kΩ resistor
- 3 x 5 kΩ resistor
- DC power source

Procedure

1. Measure the resistor values with DMM and note down in Table 1.
2. Setup the circuit as shown in the circuit 1
3. Measure the voltage V_{AD} , V_{BD}, V_{CD} (D is the reference node) and note down in Table 2
4. Measure the voltage V_{AB} , V_{BC}, V_{AC} and note down in Table 2.
5. Setup Circuit 2.
6. Measure the voltage V_{AD} , V_{BD}, V_{CD} (D is the reference node) and note down in Table 2
7. Measure the voltage V_{AB} , V_{BC}, V_{AC} and note down in Table 2

Data Collection for Lab 4:

Group No. 04
Instructor's Signature Waziz

Table 1:

Theoretical R	Measured R, Ω	% Error
15k	14.76, 14.88, 14.67, 14.77, 14.80	1.6%, 0.8%, 2.2%, 1.5%, 1.33%
5k	4.88, 4.87, 4.79	2.4%, 2.6%, 4.2%

North South University

Department of Electrical and Computer Engineering

EEE141L/ETE141L

Table 2:

Readings	Circuit 1	Circuit 2	% Error
V_{AD}	10.07V	10.07V	0%
V_{BD}	5.00V	5.09V	1.8%
V_{CD}	5.04V	5.05V	0.19%
V_{AB}	5.04V	5V	0.19%
V_{BC}	0V	0V	0%
V_{AC}	5.02V	5.02V	0%

Report:

1. The resistors in Circuit 1 are in series or in parallel combination?
2. What technique would you use to find the equivalent resistance?
3. Perform Delta-Wye conversion for ΔABC $(upper\ portion)$ of circuit 1. Show all your steps to find the equivalent resistance R1, R2, R3 from Ra, Rb, Rc.
1. Redraw the equivalent the circuit after applying the Delta-Wye conversion for ΔABC. Is it same as circuit 2?
2. Calculate Req.
3. Calculate the voltage of R1, R2, R3.
4. Calculate V_{AB} , V_{BC}, V_{AC} and V_{AD} , V_{BD}, V_{CD}. Do your calculated values match the measured values for circuit 2? Find the % Error.
5. Using Table 2, analyze whether Circuit 2 is equivalent to Circuit 1? Was Delta-Wye conversion successful?

A

Questions and Answers:

(1) Answer: The resistors in circuit-1 are neither in series nor in parallel combination.

(2) Answer: I would use Delta-wye conversion techniques to find the equivalent resistance.

(3) Answer: From measurements,

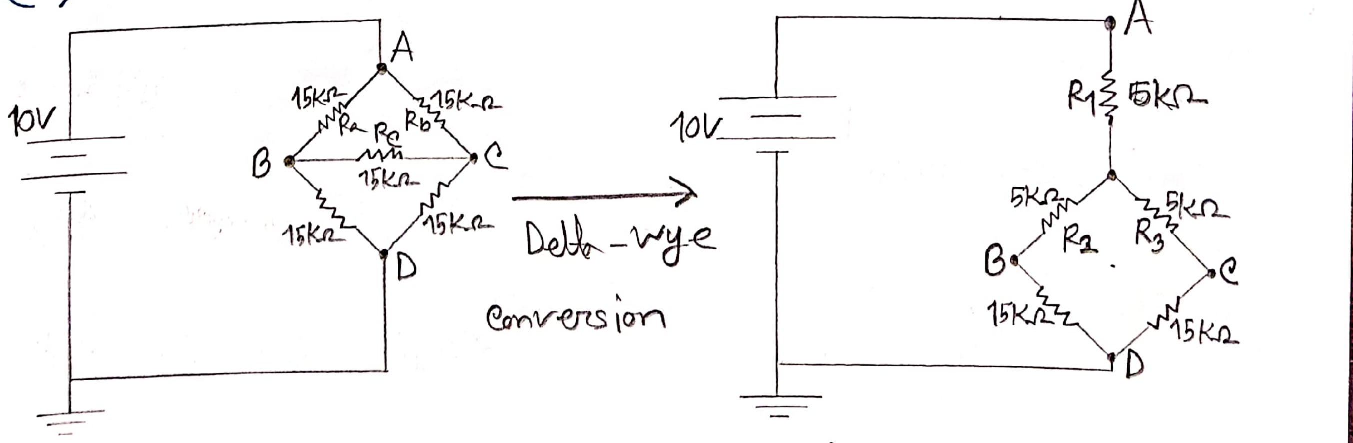
$R_a = 14.76\ K\Omega$, $R_b = 14.88\ K\Omega$, $R_c = 14.67\ K\Omega$

$$\therefore R_1 = \frac{R_b R_c}{R_a + R_b + R_c} = \frac{14.88 \cdot 14.67}{14.76 + 14.88 + 14.67} = 4.93\ K\Omega$$

$$\therefore R_2 = \frac{R_a . R_c}{R_a + R_b + R_c} = \frac{14.76 \cdot 14.67}{14.76 + 14.88 + 14.67} = 4.89\ K\Omega$$

$$\therefore R_3 = \frac{R_a . R_b}{R_a + R_b + R_c} = \frac{14.76 \cdot 14.88}{14.76 + 14.88 + 14.67} = 4.96\ K\Omega$$

(4) Answer:



After redrawing the equivalent circuit and applying the Delta-wye conversation for ΔABC everything is exactly same expect the values of individual resistances of the Delta-wye schematics. Thus, it is same as circuit-2.

(5) Answer: From measurements,

$R_1 = 4.88K\Omega$, $R_2 = 4.87K\Omega$, $R_3 = 4.79K\Omega$

and $R_4 = 14.77K\Omega$, $R_5 = 14.80K\Omega$

Let, $R_L = R_2 + R_4 = (4.87 + 14.77) = 19.64K\Omega$

$R_R = R_3 + R_5 = (4.79 + 14.80) = 19.59K\Omega$

$$\therefore R_p = \frac{1}{\frac{1}{R_L} + \frac{1}{R_R}} = \frac{1}{\frac{1}{19.64} + \frac{1}{19.59}} = 9.81K\Omega$$

Again, R_1 and R_p are in series combination.

$\therefore R_{eq} = R_1 + R_p = (4.88 + 9.81) = 14.69K\Omega$

(6) Answer: From measurements,

$R_1 = 4.88K\Omega$

From (5), $R_p = 9.81K\Omega$ and given, $V_s = 10V$

Using voltage dividing rule,

$$V_{R_1} = \frac{V_s}{R_1 + R_p} \times R_1 = \frac{10}{4.88 + 9.81} \times 4.88 = 3.3V$$

Now, $$V_{S_1} = \frac{V_s}{R_1 + R_p} \times R_p = \frac{10}{4.88 + 9.81} \times 9.81 = 6.68V$$

$$\therefore V_{R_2} = \frac{V_{S1}}{R_2 + R_4} \times R_2 = \frac{6.68}{4.87 + 14.77} \times 4.87 = 1.66V$$

$$\therefore V_{R_3} = \frac{V_{S1}}{R_3 + R_5} \times R_3 = \frac{6.68}{4.79 + 14.80} \times 4.79 = 1.63V$$

(7) Answer: Here,

$V_{AB} = V_{R_1} + V_{R_2} = (3.3 + 1.66)V = 4.96V$

$V_{BC} = V_{R_2} - V_{R_3} = (1.66 - 1.63)V = 0.03V$

$V_{AC} = V_{R_1} + V_{R_3} = (3.3 + 1.63)V = 4.93V.$

$V_{BD} = E - V_{R_1} - V_{R_2} = (10 - 3.3 - 1.66)V = 5.04V$

$\cancel{V_{AD} = V_{AB} + V_{BC} + V_{BD} = (}$

$V_{AD} = V_{AB} + V_{BC} + V_{BD} = (4.96 + 0.03 + 5.04)V = 10.03V.$

$V_{CD} = E - V_{R_1} - V_{R_3} = (10 - 3.3 - 1.63)V = 5.07V$

We know,

$$\%\ \text{Error} = \frac{|\text{Theoretical} - \text{Experimental}|}{\text{Theoretical}} \times 100\%.$$

Therefore, Circuit-2:

Reading	Theoretical	Experimental	% Error
V_{AD}.	10.03V	10.07V	$\frac{\lvert 10.03 - 10.07 \rvert}{10.03} \times 100\% = 0.4\%$
V_{BD}	5.04V	5.09V	$\frac{\lvert 5.04 - 5.09 \rvert}{5.04} \times 100\% = 0.992\%$
V_{CD}	5.07V	5.05V	$\frac{\lvert 5.07 - 5.05 \rvert}{5.07} \times 100\% = 0.4\%$
V_{AB}	4.96V	5V	$\frac{\lvert 4.96 - 5 \rvert}{4.96} \times 100\% = 0.8\%$
V_{BC}	0.03V	0V	$\frac{\lvert 0.03 - 0 \rvert}{0.03} \times 100\% = 100\%$
V_{AC}	4.93V	5.02V	$\frac{\lvert 4.93 - 5.02 \rvert}{4.93} \times 100\% = 1.83\%$

(8) Answer: Table: 02:

Reading	Circuit-1	Circuit-2	% Error	Was Delta-wye conversion successful or not?
V_{AD}	10.07V	10.07V	0%	Yes, accurate
V_{BD}	5.00V	5.09V	1.8%	~~No~~ Yes
V_{CD}	5.04V	5.05V	0.19%	Yes
V_{AB}	5.04V	5V	0.19%	Yes
V_{BC}	0V	0V	0%	Yes, accurate
V_{AC}	5.02V	5.02V	0%	Yes, accurate

As Delta-wye conversion ~~yeit~~ yielded the same circuit as circuit 2. Therefore, circuit 1 and circuit 2 are totally equivalent. Thus, we can say for sure Delta-wye ~~conv~~ conversion was successful.

Result analysis & Discussion:

From Table-1,

% Error of

$$R_a = \frac{|\text{Practical value} - \text{theoretical value}|}{\text{Theoretical value}} \times 100\%$$

$$= \frac{|14.76 - 15|}{15} \times 100\% = 1.6\%$$

$$R_b = \frac{|14.88 - 15|}{15} \times 100\% = 0.8\%$$

$$R_c = \frac{|14.67 - 15|}{15} \times 100\% = 2.2\%$$

$$R_{BD} = \frac{|14.77 - 15|}{15} \times 100\% = 1.5\%$$

$$R_{CD} = \frac{|14.80 - 15|}{15} \times 100\% = 1.33\%$$

$$R_1 = \frac{|4.88 - 5|}{5} \times 100\% = 2.4\%$$

$$R_2 = \frac{|4.87 - 5|}{5} \times 100\% = 2.6\%$$

$$R_3 = \frac{|4.79 - 5|}{5} \times 100\% = 4.2\%$$

From Table-2,

% Error of

$$V_{AD} = \frac{|circuit1 - circuit2|}{circuit1} \times 100\%$$

$$= \frac{|10.07 - 10.07|}{10.07} \times 100\% = 0\%$$

$$V_{BD} = \frac{|5.00 - 5.09|}{5.00} \times 100\% = 1.8\%$$

$$V_{CD} = \frac{|5.04 - 5.05|}{5.04} \times 100\% = 0.19\%$$

$$V_{AB} = \frac{|5.04 - 5.00|}{5.04} \times 100\% = 0.19\%$$

$$V_{BC} = \frac{|0 - 0|}{0} \times 100\% = 0\%$$

$$V_{AC} = \frac{|5.02 - 5.02|}{5.02} \times 100\% = 0\%$$

From the experiment, we learned about Delta- wye conversion that helped us to solve the circuits which couldn't be series or parallel and to calculate its equivalent value circuits. In the conversion of delta-wye, some terminals of wye and delta circuit have identical values. Although the Delta and wye have the same total resistance. They still have individual but different resistors. Moreover, this is a useful technique in circuit analysis in transforming a circuit to reduce in simplier circuit but of course the resistance will be constant before transformation.

In the experiment, we were provided eight

26

resistors and could determine the value of the resistors by color coding. The first five resistors were 15KΩ and the second three resistors were 5KΩ. We were also provided with a digital multimeter (DMM) to measure the current and voltage of the resistors. First, we took all resistors and inserted them on the breadboard. Then we measured the resistor's resistance values using DMM and wrote the values in Table-01. We calculated the percentage error between the theoretical and experimental values of the resistors. Then we made an application of delta network with those resistors like four 15KΩ resistors using the DC power supply as a voltage

Source and set that on 10V. After that we measured the voltages between the nodes and filled table-02 with the measured values. Therefore, we did the same process for circuit-02 with three 15KΩ resistors and two 5KΩ resistors. and filled table-01 and table-02 with the measured values. Then we calculated the percentage error between two circuits and completed our experiment.

The experimental and theoretical data are almost same. It has flaws present in the real world, which could be coming from tolerance equipment in accuracy and loss of connections.

During the experiment, provided breadboard was not good and we faced some problems measuring voltage using DMM. Even then, we experimented properly.

Table of Contributions:

Mosroor Mofiz Arman	1921079642
Nasim Anzum Promise	2022655642
Muhammad Raiyan Alam	1831100642
Sumit Kumar Kar	2021646642

All the group members contributed equally.