BOLD and Underline Word should be written with color pen. Use pencil margin, Page number with color pen, all drawing with pencil, table body with pencil but text will be ball pen, write both sides.

Experiment Name: Verification of Superposition Theorem.

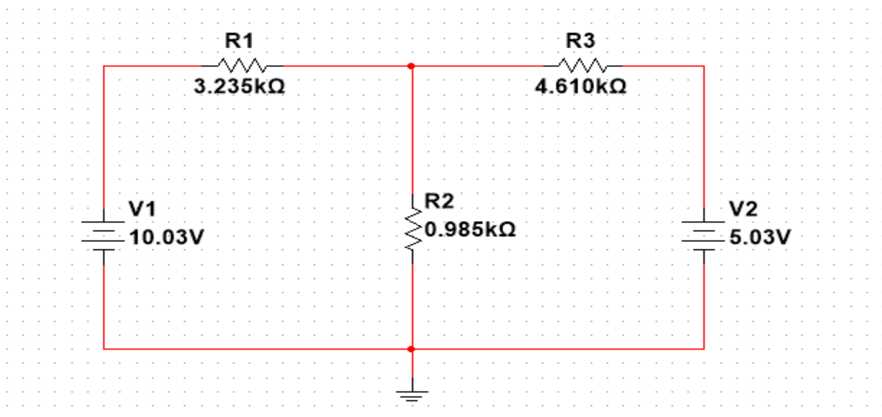
Objectives:

- To verify Superposition Theorem.

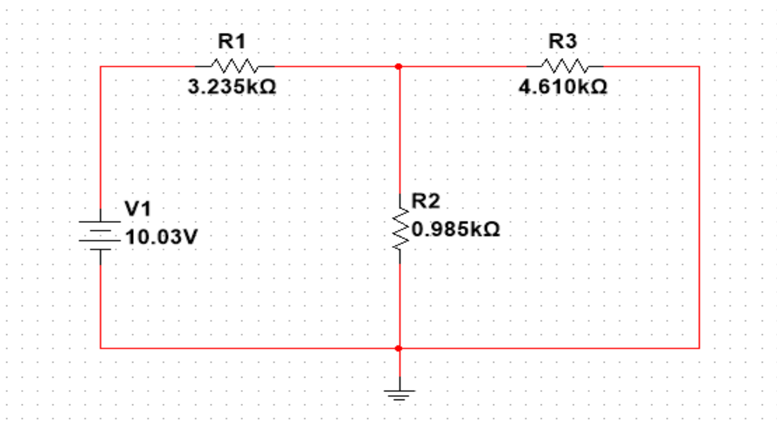
Apparatus:

- Breadboard
- Resistors (1x 3.3 kΩ, 1x 4.7 kΩ, 1x 1 kΩ)
- Digital Multimeter (DMM)
- DC Power Supply
- Wires

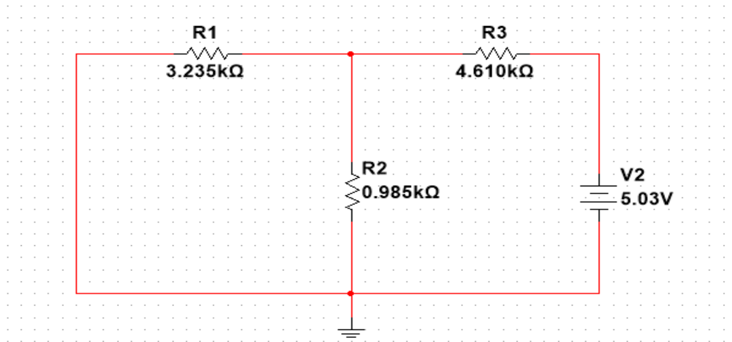
Circuit Diagram:



Circuit - 1



Circuit - 2



Circuit - 3

Data Table & Calculation:

Table - 1:

	I_2	I_2'	I_2''	$I_2' + I_2''$
Measured Data	2.780	2.040	0.740	2.780
Theoretical Data	2.761	2.043	0.719	2.762
Error	0.69%	0.15%	2.92%	0.65%

Table-2:

	V_{R_1}	V_{R_1}'	V_{R_1}''	$V_{R_1}' + V_{R_1}''$
Measured	7.300	8.010	-0.722	7.288
Theoretical	7.311	8.018	-0.708	7.310
Error	0.15%	0.10%	1.98%	0.30%

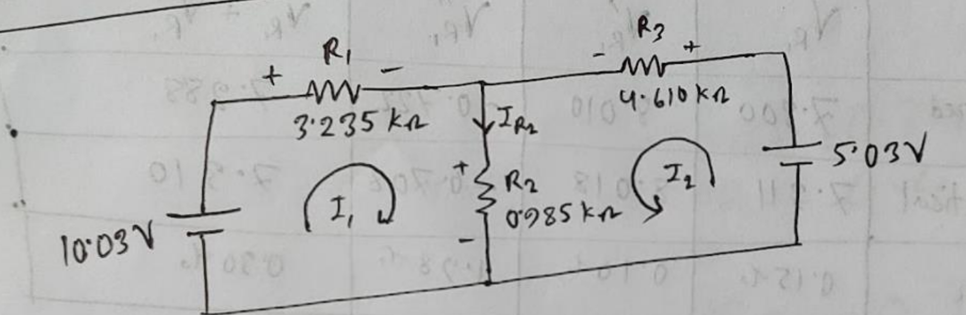
Table-3

	V_{R_2}	V_{R_2}'	V_{R_2}''	$V_{R_2}' + V_{R_2}''$
Measured	2.728	2.013	0.723	2.736
Theoretical	2.720	2.012	0.708	2.720
Error	0.29%	0.05%	2.12%	0.59%

Table-4:

	V_{R_3}	V'_{R_3}	V''_{R_3}	$V'_{R_3} + V''_{R_3}$
Measured	2.375	-2.014	4.410	2.396
Theoretical	2.310	-2.012	4.322	2.310
Error	2.81%	0.10%	2.04%	3.72%

From Circuit-1:



From Loop-1:

$$10.03 - 3.235\,I_1 - 0.985\,(I_1 + I_2) = 0$$

$$\Rightarrow 10.03 - 3.235\,I_1 - 0.985\,I_1 - 0.985\,I_2 = 0$$

$$\Rightarrow -4.22\,I_1 - 0.985\,I_2 = -10.03$$

$$4.22\,I_1 + 0.985\,I_2 = 10.03 \quad \text{.. (i)}$$

From Loop-2:

$$5.03 - 4.610 I_2 - 0.985 (I_1 + I_2) = 0$$

$$\Rightarrow 5.03 - 4.610 I_2 - 0.985 I_1 - 0.985 I_2 = 0$$

$$\Rightarrow -0.985 I_1 - 5.595 I_2 = -5.03$$

$$\therefore 0.985 I_1 + 5.595 I_2 = 5.03 \quad \cdots (ii)$$

Using Calculator:

$$I_1 = 2.260 \text{ mA}$$

$$I_2 = 0.501 \text{ mA}$$

$$\therefore I_{R_2} = (2.260 + 0.501) \text{ mA}$$

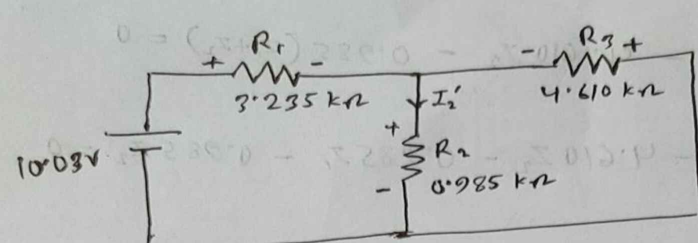
$$= 2.761 \text{ mA}$$

$$\therefore V_{R_1} = 2.260 \times 3.235 = 7.311 \text{ V}$$

$$\therefore V_{R_2} = 2.761 \times 0.985 = 2.720 \text{ V}$$

$$\therefore V_{R_3} = 0.501 \times 4.610 = 2.310 \text{ V}$$

From Circuit-2:



$$R_T = R_1 + (R_2 \parallel R_3)$$

$$= R_1 + \left(\left(\frac{1}{0.985} + \frac{1}{4.610} \right)^{-1} \right)$$

$$= R_1 + 0.812$$

$$= 3.235 + 0.812$$

$$= 4.047 \text{ k}\Omega$$

$$\therefore I_s = \frac{10.03}{4.047} = 2.478 \text{ mA}$$

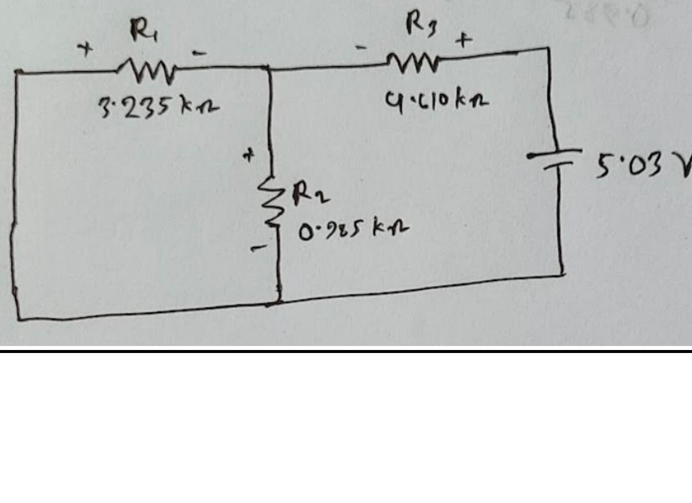
$$\therefore V'_{R_1} = \frac{3.235}{4.047} \times 10.03 = 8.018 \text{ V}$$

$$\therefore V'_{R_2} = \frac{0.812}{4.047} \times 10.03 = 2.012 \text{ V}$$

$$\therefore V'_{R_3} = -V'_{R_2} = -2.012 \text{ V}$$

$$\therefore I'_2 = \frac{0.812}{0.985} \times 2.478 = 2.043 \text{ mA}$$

From Circuit - 3:



$$R_T = R_3 + (R_1 \parallel R_2)$$

$$= R_3 + \left(\left(\frac{1}{3.235} + \frac{1}{0.985}\right)^{-1}\right)$$

$$= R_3 + 0.755$$

$$= 4.610 + 0.755$$

$$= 5.365 \text{ k}\Omega$$

$$\therefore I_s = \frac{5.03}{5.365} = 0.938 \text{ mA}$$

$$\therefore V''_{R_3} = \frac{4.610}{5.365} \times 5.03 = 4.322 \text{ V}$$

$$\therefore V''_{R_2} = \frac{0.755}{5.365} \times 5.03 = 0.708 \text{ V}$$

$$\therefore V''_{R_1} = -V''_{R_2} = -0.708 \text{ V}$$

$$\therefore I''_2 = \frac{0.755}{0.985} \times 0.938 = 0.719 \text{ mA}$$

Error Calculation:

$$I_2 = \left|\frac{2.761 - 2.780}{2.761}\right| \times 100\%$$

$$= 0.69\%$$

$$V_{R_1} = \left| \frac{7.311 - 7.300}{7.311} \right| \times 100\%$$

$$= 0.15\%$$

$$V_{R_2} = \left| \frac{2.720 - 2.728}{2.720} \right| \times 100\%$$

$$= 0.29\%$$

$$V_{R_3} = \left| \frac{2.310 - 2.375}{2.310} \right| \times 100\%$$

$$= 2.81\%$$

And so on......

Graph:

N/A

Result Analysis:

We measured the current I2 when two sources were connected and when only one source was connected at a time. After measuring, we found the value of I2 is the same as the algebraic sum of I_2' and I_2''. That means our circuit followed the superposition theorem.

Questions and Answers:

01. Superposition Theorem:

The current through, or voltage across, any element of a network is equal to the algebraic sum of the currents or voltages produced independently by each source.

In other words, this theorem allows us to find a solution for a current or voltage using *only one source at a time.* Once we have the solution for each source, we can combine the results to obtain the total solution.

02. Already showed in Data Table Section.

03...

In our experiment circuit, we found I_2 was 2.78 mA when two sources were connected. We found I_2' of 2.04 mA when we removed the second source. After reconnecting the second source and removing the first source, we found I_2'' of 0.74 mA. Now if we add I_2' and I_2'', we find 2.04 + 0.74 = 2.78 mA, the same current as the first case.

For VR_1,
$VR_1' + VR_1'' = 8.01\ V + (-0.722\ V) = 7.288\ V = 7.30\ V = VR_1$
(Approximately Same)

For VR_2,
$VR_2' + VR_2'' = 2.013\ V + 0.723\ V = 2.736\ V = 0.728\ V = VR_2$
(Approximately Same)

For VR_3,
$VR_3' + VR_3'' = -2.014\ V + 4.410\ V = 2.396\ V = 2.375\ V = VR_3$
(Approximately Same)

Hence, our circuit completely followed the superposition theorem. This little margin of error happens due to wire resistance and many other environments.

04. Already showed in Data Table Section.

Discussion:

After completing this experiment, we successfully verify the Superposition Theorem. That means we can now find a solution for a current or voltage using only one source at a time. We need to combine the result to find the final solution. In this experiment, we don't face any severe difficulty. We encountered a problem with DC Power Supply; it was changing continuously. After some tries, we fixed it and took a steady voltage output. Finally, we completed the experiment within the time.

Attachment:

01. Signed Data Table.

02. Simulation using Multisim.