1. Experiment number: 02.

2. Experiment name: Varification of Kirchoff's Voltage Law (KVL) and Kirchhoff's Current Law (KCL)

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5. Course Name: Introduction to Electrical Circuit Lab.

6. Section : M

7. Date of Submission: 15 June, 2024.

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1. Objectives of the experiment: The purpose of the experiment is to practically understand and verify Kirchoff's Voltage law (KVL) and Kirchhoff's Current Law (KCL). We will measure the voltage and current's in a circuit, compare these values with theoritical calculations, and compare the accuracy of KVL and KCL.

2. List of components and instruments;

(i) Resistors
(ii) Connecting wires
(iii) Trainer board
(iv) Avo meter or Multimeter
(v) DC source.

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3. Working principle:

Kirchhoff's Voltage Law (KVL): Kirchhoff's voltage law (KVL) states that the algebraic sum of all voltage in a closed loop or mesh in a circuit must equal zero. The principle is grounded in the law of conservation of energy, which asserts that energy can't be created or destroyed in an isolated system. Where traversing a closed loop in a circuit, the sum of electromotive forces (emf) and potential drops (voltage dropes) across resistors or other components must total zero.

Mathematically, KVL is expressed as:

$$\Sigma V = 0$$

Consider a simple loop with resistors R_1, R_2, R_3 and power supply with voltage V. The application of KVL would yield:

$$V - R_{R_1} - V_{R_2} - V_{R_3} = 0$$

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where $V_{R_1} = I.R_1$, $V_{R_2} = I.R_2$ and $V_{R_3} = IR_3$.

Kirchhoff's Current Law (KCL) : Kirchhoff's current law states that the algebric sum of currents entering a junction (or node) in a circuit must equal the sum of currents leaving the junction. The law is based on the principle of conseration of charge, implying that charge cannot accumalete at a node.

Mathematically, KCL is expressed as:

$$\Sigma I_{in} = \Sigma I_{out}$$

For example, if three currents I_1, I_2 and I_3 converge at a node and I_4 and I_5 leave the node, KCL states that:

$$I_1 + I_2 + I_3 = I_4 + I_5$$

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4. Data Table :

Kirchhoff's voltage law:

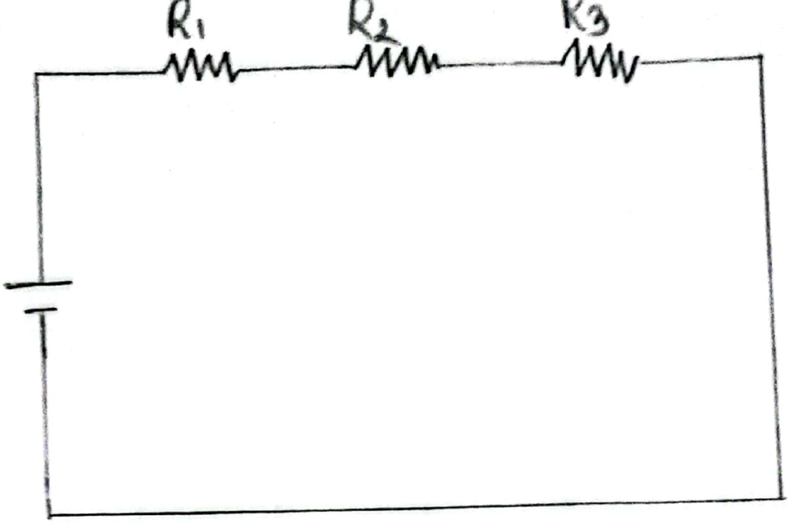

Fig: Series circuit for varification of KVL

10/06/24

No of obs.	R_1 kΩ	R_2 kΩ	R_3 kΩ	Source Voltage, E (V) CV	Source Voltage, E (V) MV	Voltage Across R_1, V_1 (V) CV	Voltage Across R_1, V_1 (V) MV	Voltage Across R_2, V_2 (V) CV	Voltage Across R_2, V_2 (V) MV	Voltage Across R_3, V_3 (V) CV	Voltage Across R_3, V_3 (V) MV	Total Voltage Drop = $V_1+V_2+V_3$ (V) CV	Total Voltage Drop = $V_1+V_2+V_3$ (V) MV	Error = $\frac{(MV-CV)}{CV}$ (%)
1	[illegible]	2.2	9.9	5.09	5.09	0.38	0.39	0.85	0.84	3.85	3.86	5.08	5.09	0.197
2	[illegible]	2.2	9.9	10.13	10.13	0.76	0.77	1.7	1.68	7.66	7.68	10.12	10.13	0.09
3														

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Kirchhoff's current law:

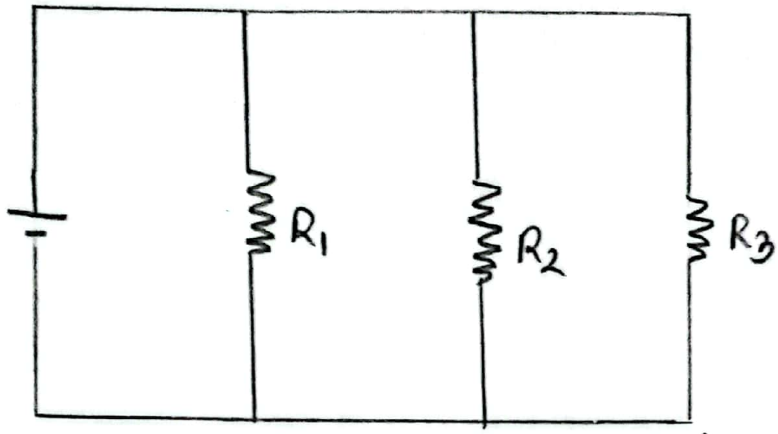

Fig2: Parallel circuit for varification of KCL

No of obs.	R_1	R_2	R_3	I		I_1		I_2		I_3		$I = I_1 + I_2 + I_3$		% Error = (mv-cv) ÷ cv
	kΩ	kΩ	kΩ	CA	MA	CA	MA	CA	MA	CA	MA	CA	MA	
1	9.9	2.2	1	7.77	7.91	0.5	0.5	2.27	2.27	4.99	5.11	7.76	7.88	2.83
2	9.9	2.2	1	16.4	15.66	1.06	1.02	4.86	4.65	10.69	10.14	16.63	15.82	4.87
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Calculation:

Kirchhoff's voltage Law (KVL):

In this series circuit we have used $R_1 = 0.984 K\Omega$

$R_2 = 2.2 K\Omega$ and $R_3 = 9.9 K\Omega$

Source Voltage, $E = 5.09 v$

Total Resistance, $R = R_1 + R_2 + R_3$

$= (0.984 + 2.2 + 9.9) K\Omega$

$= 13.084 K\Omega$

In measured voltage, we have found voltage accordingly for R_1 $v_1 = 0.39 v$, R_2 $v_2 = 0.84 v$

R_3 $v_3 = 3.86 v$

Here total voltage is $= v_1 + v_2 + v_3$

$= (0.39 + 0.84 + 3.86) v$

$= 5.09 v$

Here total voltage is equal to source voltage.

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Now for calculated value,

Total Resistance, $R = 13.084 \ k\Omega$

Source voltage, $V = 5.09V$

Current, $I = \frac{V}{R}$

$= \frac{5.09}{13.084 \times 10^3} A$

$= 3.89 \times 10^{-4} A$

Now for R_1 voltage, $V_1 = IR_1$

$= (3.89 \times 10^{-4} \times 0.984 \times 10^3) V$

$= 0.38V$

R_2 voltage, $V_2 = IR_2$

$= (3.89 \times 10^{-4} \times 2.2 \times 10^3) V$

$= 0.85 V$

R_3 voltage, $V_3 = (3.89 \times 10^{-4} \times 9.9 \times 10^3) V$

$= 3.85 V$

Total voltage, $V = V_1 + V_2 + V_3$

$= (0.38 + 0.85 + 3.85) V$

$= 5.08 V$

Error $= \frac{(5.09 - 5.08)}{5.08} \%$

$= 0.197\%$

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we did this for twice. 2nd time we have used source voltage with 10.13V.

The error was 0.09%.

Kirchhoff's current Law (KCL):

for measured value,

We have used $R_1 = 9.9k\Omega$, $R_2 = 2.2k\Omega$ and $R_3 = 1k\Omega$ as Resistors.

Measured current, $I^0 = 7.91$ A

For R_1, $I_1 = 0.5$ A

R_2, $I_2 = 2.27$ A

R_3, $I_3 = 5.11$ A

Total current, $I = I_1 + I_2 + I_3$

$= (0.5 + 2.27 + 5.11)$ A

$= 7.88$ A

for Calculated value,

Total Resistance, $R = (R_1^{-1} + R_2^{-1} + R_3^{-1})^{-1}$ kΩ

$= \{(9.9)^{-1} + (2.2)^{-1} + (1)^{-1}\}^{-1}$ kΩ

$= 642.857 \times 10^{-3}$ KΩ

Source Voltage, V = 5 V

Source current, $I^0 = \frac{V}{R} = \frac{5}{642.857}$ A

$= 7.7$ A

for, R_1 $I_1 = \frac{R}{R_1} I$

$= \left(\frac{642.857}{9.9 \times 10^3} \times 7.77\right)$ A

$= 0.5$ A

R_2 $I_2 = \left(\frac{642.857}{2.2 \times 10^3} \times 7.77\right)$ A

$= 2.27$ A

R_3 $I_3 = \left(\frac{642.857}{1 \times 10^3} \times 7.77\right)$ A

$= 4.99$ A

Total current leaving, $I = I_1 + I_2 + I_3$

$$= (0.5 + 2.27 + 4.11) A$$

$$= 7.76 \text{ A}$$

$$\text{Error} = \frac{7.88 - 7.76}{7.76} \%$$

$$= 2.83\%$$

We did this for twice. The second time source current was ~~8~~ 15.66 A. The error was 4.87%.

5. Result : The result of this experiment is too close with theoritical calculations and measured calculation. There are are some minor errors. If it is ignored the varification of ~~they~~ these law will be varified.

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6. Discussion: The experiment aimed to varify Kirchhoff's voltage Law (KVL) and kirchhoff's current Law (KCL) through practical measurements. While the results confirmed the law's applicability, minor discrepencies were observed due to various sources of error. It could be measurement inaccuracies, component Tolerances, connecting issues and lastly theoritical assumptions. As we tried to do this experiment with so much care. We had used high-precision instruments, selected tight-tolerence components, ensured secure connections for ignoring the minor error.

7. Conclusion: The experiment successfully varified Kirchhoff's Voltage Law and Kirchhoff's current Law (KCL). The result confirmed that sum of voltage in a closed loop equals zero

(KVL) and the sum of current at junction equals the sum of currents Leaving (KCL). Minor discrepencies were attributed to measurement inaccuracie component ~~tot~~ tolerence and connecting issues, high-lighting the importance of precise instruments and high quality components in circuit analysis.

8. Remarks: The experiment effectively confirmed Kirchhoff's voltage Law (KVL) and Kirchhoff's current Law (KCL)

9. Reference:

1. A.R. Hambley, "Electrical engineering: Principle and Applications", 7th edition

2. R.L. Boylested, "Introductory circuit analysis", 13th edition.

3. ~~Kirchho~~ "Kirchhoff's Law," Edumir Physics.

4. "Kirchhoff's law application: 2 Loop circuit Solving," Khan Academy.