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MIT WORLD PEACE UNIVERSITY | PUNE
TECHNOLOGY, RESEARCH, SOCIAL INNOVATION & PARTNERSHIPS

F. Y. B. Tech Academic Year 2020-21

Trimester:I **Subject:** Basics of Electrical and Electronics Engineering

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Roll No: 109054 **Batch: I3**

Experiment No:7

Name of the Experiment: Verification of Kirchhoff's current law (KCL) and Kirchhoff's voltage law (KVL)

Performed on: 11th February 2022

Submitted on: 13th February 2022

Aim: Verification of Kirchhoff's current law (KCL) and Kirchhoff's voltage law (KVL)

Objectives

- To get the idea of analysing the circuits
- To solve the electrical circuit theoretically
- To verify practical and theoretical value

Components and equipment required

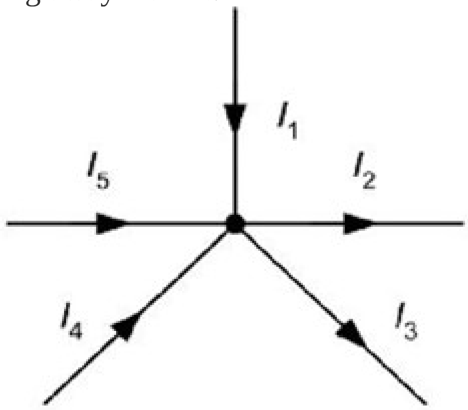
Components	**Specification**
DC Ammeters	0 – 1 A (3 No.)
DC Voltmeter	0 - 20 V (1 No.)
Circuit board	Same as shown in Fig.3
DC Power supply	0 – 15 V (2 No.)

Theory

A German physicist Gustav Kirchhoff developed two laws enabling easy analysis of an interconnection of any number of circuit elements. The first law deals with the flow of current and is popularly known as **Kirchhoff's Current Law (**KCL) while the second one deals with the voltage drop in a closed network and is known as **Kirchhoff's Voltage Law** (KVL).

A. Kirchhoff's current law

It states that, at any moment, the algebraic sum of currents flowing through a point (or junction) in a network is Zero or in any electrical network, the algebraic sum of the currents meeting at a point (or junction) is Zero. This law is also known as Point Law. In other words, the sum of the currents flowing towards a point is equal to the sum of those flowing away from it.



$$I_1 - I_2 - I_3 + I_4 + I_5 = 0$$

Convention:
Current flowing towards the junction is positive (+)
Current flowing away from the junction is negative (−)

Fig. 1: Kirchoff's current law

In Fig.1, currents I_1, I_4 and I_5 are flowing towards the node, are considered as positive. At the same time, currents I_2 and I_3 are leaving the junction, are considered as negative. As per KCL, sum of all the currents is zero. That means sum of currents entering the node and sum of currents leaving the node is equal.

B. Kirchhoff's voltage law

It states that, in any closed loop (mesh), the algebraic sum of the EMFs applied is equal to the algebraic sum of the voltage drops in the elements. It is also known as Mesh law.

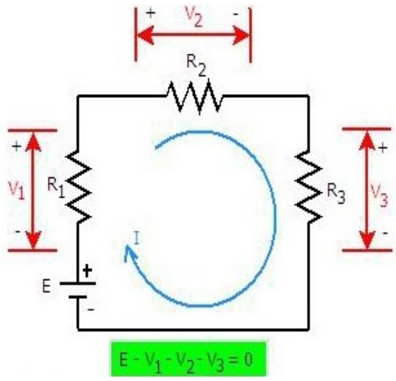
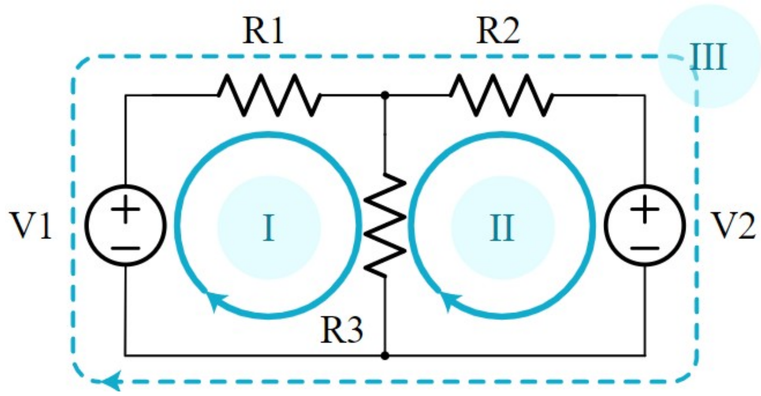


Fig. 2: Kirchoff's voltage law

Component Values used:
Voltage source E= 5V
R1= 1KΩ , R2= 1KΩ R3= 1KΩ

Circuit diagram



Components used in the circuit

V_1 = 10 V
V_2 = 10 V
R_1 = 1 Ω
R_2 = 1 Ω
R_3 = 1 Ω

Procedure:

A. KCL

1) Connect the circuit as shown in the diagram
2) Measure currents in every branch and note it in observation table as practical value.
3) Calculate theoretical current values using mesh equations

B. KVL

1) Connect the circuit as shown in the diagram
2) Using a voltmeter, measure the source voltage E and the voltage drop across the resistances R_1, R_2 and R_3.
3) Find the current I= E / R1+R2+R3
4) Calculate theoretical values as V1=IR1, V2=IR2, V3=IR3

Observation Tables:

1) Verification of KCL-

Current (A)	Theoretical Value	Practical value
I_1	3.33 mA	3.33 mA
I_2	3.33 mA	3.33 mA
I_3	6.67 mA	6.67 mA

Calculate $(I_1 + I_2)$ and compare it with I_3. These two values should be equal.

2) Verification of KVL-

Voltage (V)	Theoretical Value	Practical value
V_{R1}	1.67 V	1.67 V
V_{R2}	1.67 V	1.67 V
V_{R3}	1.67 V	1.67 V

V_{R1} , V_{R2} and V_{R3} are the voltage drops across resistances R_1 R_2 and R_3. Calculate $(V_{R1} + V_{R2} + VR3)$ and compare it with E. These two values should be equal.

Conclusion

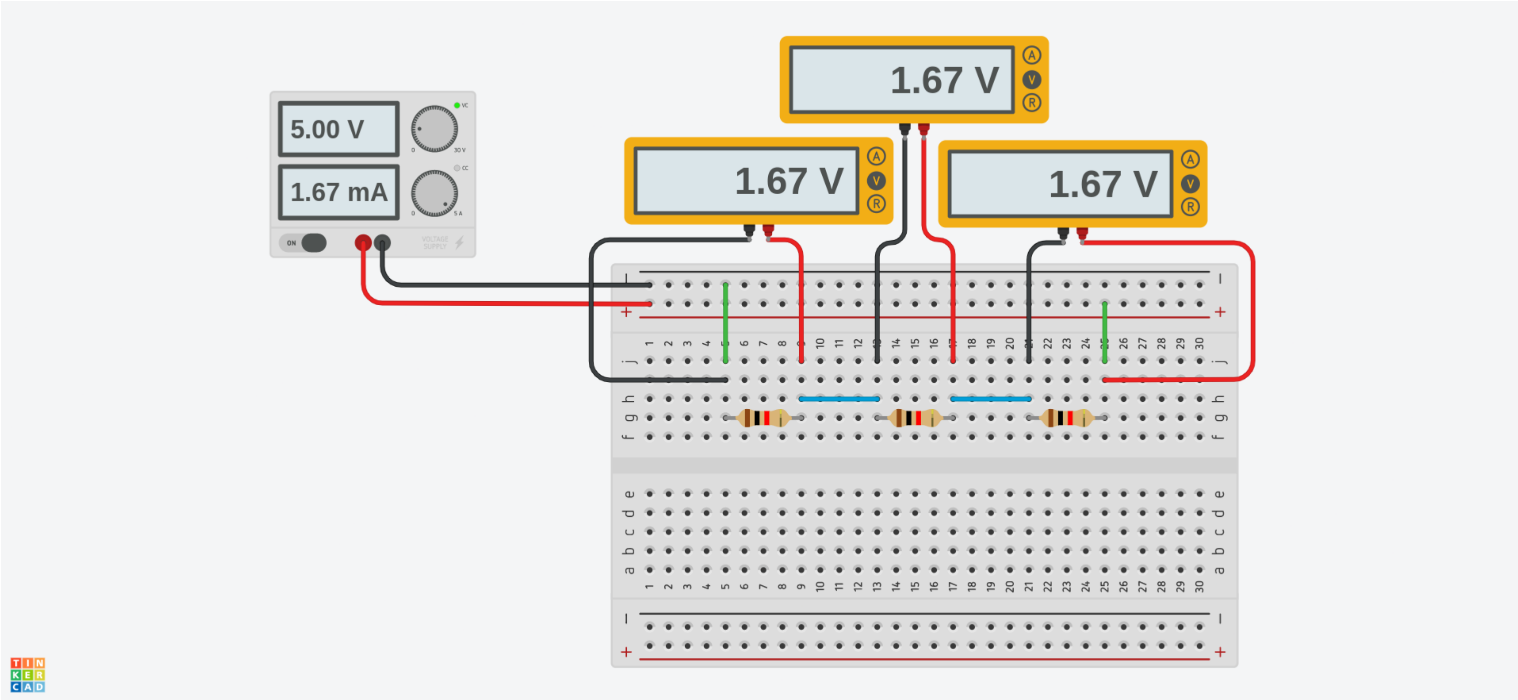
Kirchhoff's Voltage Rule and Kirchhoff's Current Rule were understood, studied and experimentally verified in detail. The values were calculated theoritically and then practically, and their results were compared. The percentage error was also calculated.

Post-Lab Questions

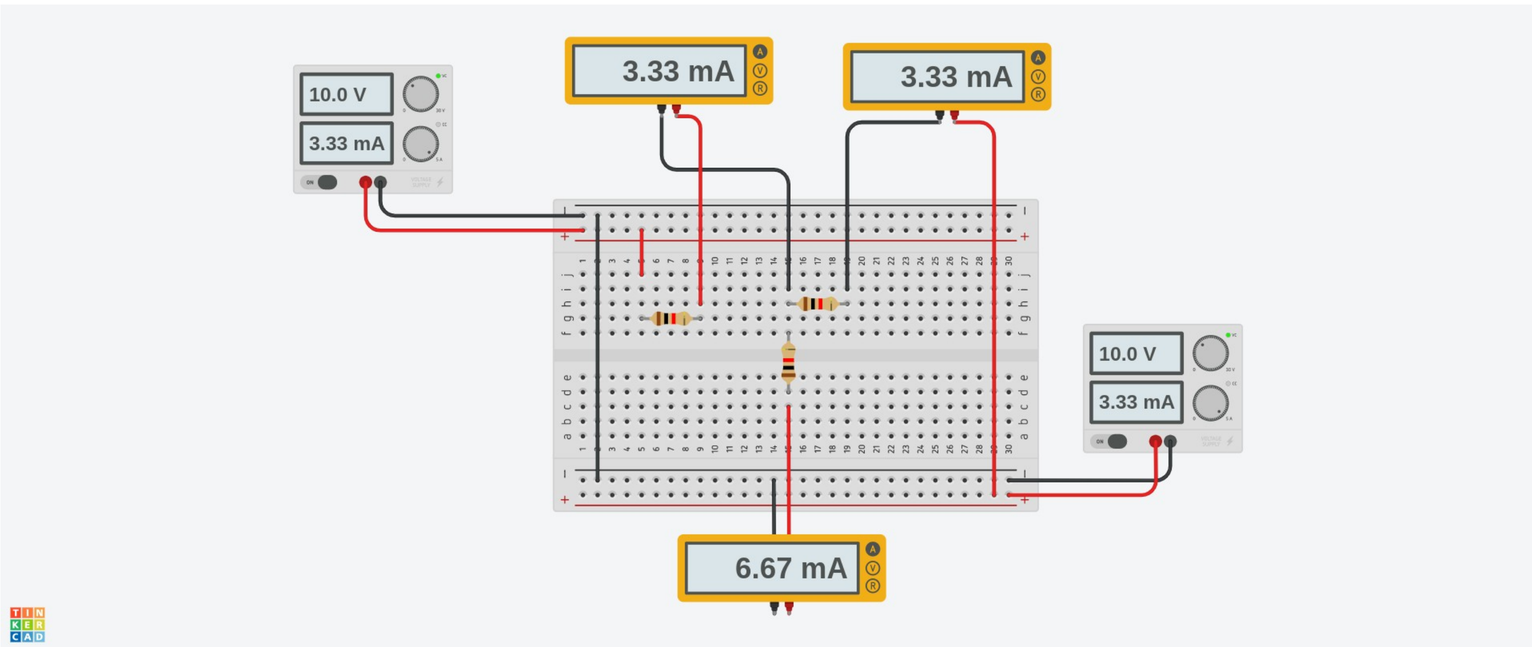
1. Theoretically calculate the voltages and currents for each element in the circuit and compare them to the measured values.
2. Calculate the percentage error in the two measurements and provide a brief explanation for the error.

Note: Students are instructed to do all necessary calculations and answer the questions on separate sheets and attach them.

Tinkercad Circuits for Verification of KVL



Tinkercad Circuits for Verification of KCL



Components used in Verification of KVL

Name	Quantity	Component
P1	1	5 , 5 Power Supply
R1, R2, R3	3	1 kΩ Resistor
Meter1, Meter2, Meter3	3	Voltage Multimeter

Components used in Verification of KCL

Name	Quantity	Component
P1, P2	2	10 , 5 Power Supply
R1, R4, R3	3	1 kΩ Resistor
Meter7, Meter8, Meter9	3	Amperage Multimeter

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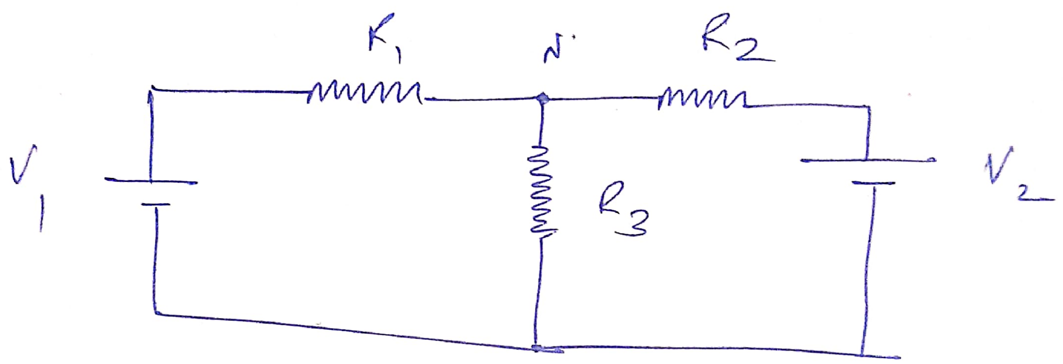
13/02/2022

BEEE Experiment 7

Verification of KCL & KVL

Calculations and Post Lab Questions

Q.1 1. KCL Verification



at node N, $I_1 - I_2 = I_3$ — (1)

Mesh equations using KVL,

$-V_1 + R_1 I_1 + R_3 (I_1 - I_2) = 0$ — (2)

$V_2 + R_3(-(I_1 - I_2)) + R_2 I_2 = 0$ — (3)

$V_1 = 10V$

$V_2 = 10V$

$R_1 = R_2 = R_3 = 1 k\Omega$ — (4)

Putting (4) in (2) and (3),

② $\Rightarrow$

$$-10 + R(I_1) + R(I_1 - I_2) = 0$$

$$R(2I_1 - I_2) = 10$$

③ $\Rightarrow$

$$10 + -(RI_1 - RI_2) + RI_2 = 0$$

$I_1 / 2$

$$10 - RI_1 + 2RI_2 = 0$$

$$R(2I_2 - I_1) = -10$$

④ $\overline{R}(2I_2 + 4I_1) = 20$

$$0 + 3RI_1 = 10$$

$$RI_1 = \frac{10}{3} = 3.33$$

$$I_1 = \frac{3.33}{R} = \frac{3.33}{1000\,\Omega} = 3.33\text{ mA}$$

$$I_1 = I_2 = 3.33\text{ mA}$$

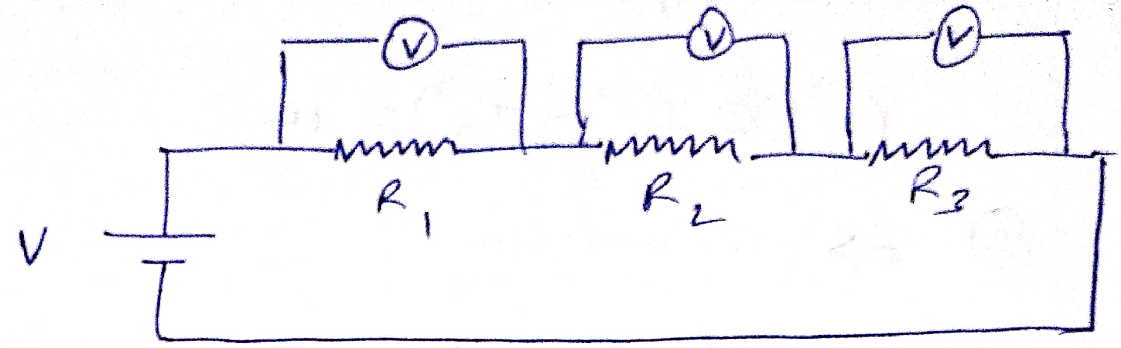
$$I_3 = I_1 + I_2 = 6.66 \text{ or } \approx 6.67\text{ mA}$$

as,

Theoritical value = Practical value.

Percentage error = 0 %.

Verification of KVL



$V = 5V$

$R_1 = R_2 = R_3 = 1 k\Omega$

$V = 5$ so

as $R_t = 3R$

$$I = \frac{V}{R_t} = \frac{5}{3R}$$

$$V_1 = R_1 \cdot I = R \cdot \frac{5}{3R} = 5/3$$

$$= \underline{\underline{1.67\ V}}$$

$$V_2 = R_2 \cdot I = R \cdot \frac{5}{3R} = 5/3$$

$$= \underline{\underline{1.67\ V}}$$

$$V_3 = R_3 \cdot I = R \cdot \frac{5}{3R} = 5/3$$

$$= \underline{\underline{1.67\ V}}$$

Theoritical value of $V_1 = V_2 = V_3 = 1.67V$ is same as pratical value of $V_1 = V_2 = V_3$ $= \underline{1.67V}$

So percentage Error $= \underline{0\%}$