AMERICAN INTERNATIONAL UNIVERSITY–BANGLADESH (AIUB)

FACULTY OF SCIENCE & TECHNOLOGY

DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING

ELECTRICAL CIRCUIT LAB - 1

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Section: W, Group: 2

LAB REPORT ON

Verification of Kirchhoff's Voltage Law (KVL) and Kirchhoff's Current Law (KCL)

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Submitted By

Name	ID	Contribution
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3. KAZI ABDULLAH JARIF	22-46386-1	Experimental Procedure, Result, and Calculation, Discussion, and Conclusion
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TABLE OF CONTENTS

1. Introduction:

Kirchhoff's circuit laws are two approximate equalities that deal with the current and potential difference (commonly known as voltage) in electrical circuits. They were first described in 1845 by Gustav Kirchhoff. This generalized the work of Georg Ohm and preceded the work of Maxwell. Widely used in electrical engineering, they are also called Kirchhoff's rules or simply Kirchhoff's laws.

2. Theory and Methodology:

Kirchhoff's Voltage Law (KVL):

Kirchhoff's Voltage Law (KVL) in a DC circuit states that "the algebraic sum of the Voltage drop around any closed path is equal to the algebraic sum of the Voltage rises". In other words, "the algebraic sum of the voltage rises and drops around any closed path is equal to zero". A plus (+) sign is assigned for the potential rises (- to +) and minus sign (-) is assigned to a potential drop (+ to -). In symbolic form, Kirchhoff's Voltage Law (KVL) can be expressed as

$\sum cV=0$, Where C is used for the closed-loop and V is used for the potential rises and drops.

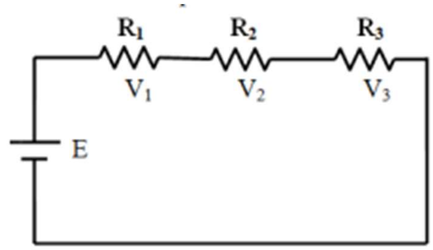

Figure-1: Loop circuit

Analysis of KVL circuit

For doing a complete analysis of KVL, with the given values of circuit parameters follow the following steps:

Step 1: Calculate the value of supply current, I:

$$I = E / (R1+R2+R3)$$

Step 2: Calculate V1, V2, and V3:

$$V1= I\times R1 \quad V2= I\times R2 \quad V3= I\times R3$$

Step 3. Use KVL to verify:

$$\sum_c V=0 \text{ or } E-V1-V2-V3=0$$

Kirchhoff's Current Law (KCL):

Kirchhoff's Current Law (KCL) in a DC circuit states that" the algebraic sum of the currents entering and leaving an area, system or junction is zero". In other words, "the sum of the currents entering an area, system or junction must be equal to the sum of the currents leaving the area, system or junction". In equation form,

$$\sum I \text{ Entering} = \sum I \text{ leaving}$$

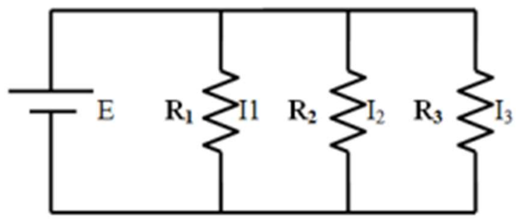

Figure-2: Node circuit

Analysis of KCL circuit

For doing a complete analysis of KVL, with the given values of circuit parameters follow the following steps:

Step 1. Calculate the value of equivalent resistance of circuit:

$$R_{eq} = \left(\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}\right)^{-1}$$

Step 2. Calculate supply current, I:

$I = E/R_{eq}$

Step 3. Calculate current through different branches:

$I_1 = E / R_1$

$I_2 = E / R_2$

$I_3 = E / R_3$

Step 4. Use KCL to verify:

$$\sum I \text{ Entering} = \sum I \text{ leaving or } \quad I = I_1 + I_2 + I_3$$

3. Apparatus

- Resistors
- Connecting wire
- Trainer Board
- AVO meter or Multimeter
- DC source

4. Precautions:

- Connecting the circuit should be done carefully.
- Before connecting the supply with the circuit, the whole connection diagram should be checked by the instructor.

5. Experimental Procedure and calculation:

1. We connected the circuit as shown in figure 1.
2. Then we measured the voltage across each element of the circuit.
3. After that we fill the following table with the necessary calculations

Table 1: Measurement data for applying KVL in figure 1

No. of obs.	R1 KΩ	R2 KΩ	R3 KΩ	Source Voltage, E (V)		Voltage Across R1, V1 (V)		Voltage Across R2, V2 (V)		Voltage Across R3, V3 (V)		Total Voltage Drop = V1+V2+V3 (V)		Error = (MV-CV)/CV (%)
				CV	MV	CV	MV	CV	MV	CV	MV	CV	MV	
1	6.6	2.1	0.9	5	5	3.43	3.3	1.091	1	0.469	0.4	4.9	4.8	0.02
2	6.6	2.1	0.9	10	10	6.67	6.7	2.187	2.2	0.93	0.9	9.994	9.8	0.019
3	6.6	2.1	0.9	15	14.9	1.563	9.9	10.313	3.2	3.28	1.4	15	14.7	0.02

CV: Calculated Value, MV: Measured Value

4. Then connected the circuit as shown in figure 2.
5. Again measured the current across each branch of the circuit.

6. Then we Fill the following table with the necessary calculations.

Table 2: Measurement data for applying KCL in figure 2

No. of obs.	R1 KΩ	R2 KΩ	R3 KΩ	I		I_1		I_2		I_3		$I=I_1+I_2+I_3$		Error = (MV-CV)/CV (%)
				CA	MA	CA	MA	CA	MA	CA	MA	CA	MA	
1	6.6	2.1	0.9	8.169	8.2	0.76	0.75	2.38	2.4	5.56	5.54	8.7	8.69	0.00115
2	6.6	2.1	0.9	16.384	16.3	1.515	1.56	4.76	4.828	11.11	11.2	17.385	17.588	0.0117
3	6.6	2.1	0.9	24.75	24.3	2.273	2.272	7.142	7.144	16.67	16.617	26.085	26.033	0.002

6. Simulation and Measurement:

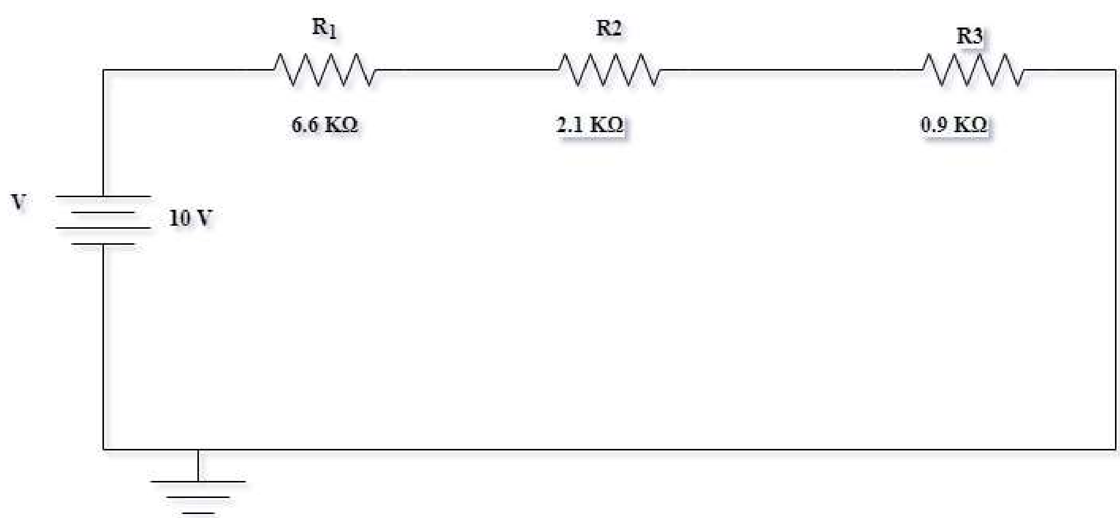

Figure 1: Circuit of verification of KVL

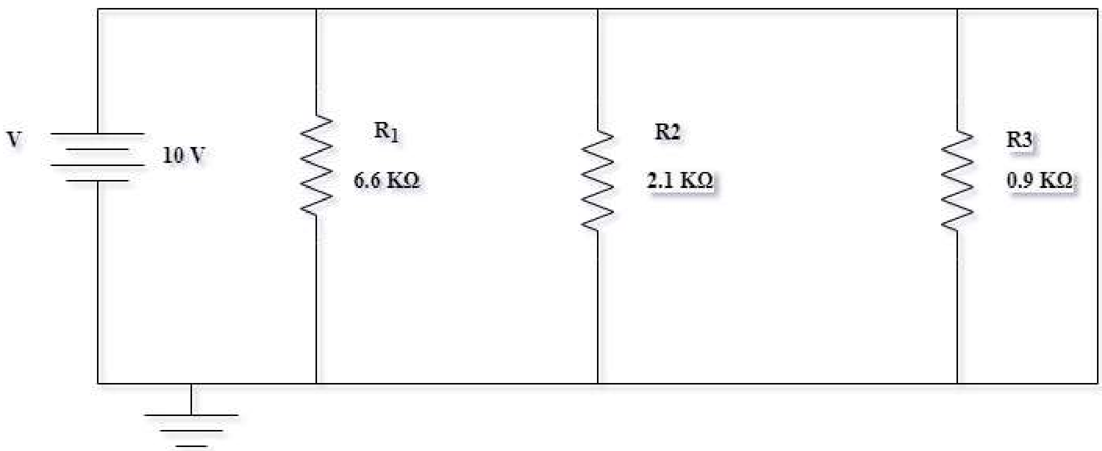

Figure 2: Circuit of verification of KCL

7. Result and Calculation:

For KVL:

R1 = 6.6 KΩ = 6.6×10^3 Ω

R2 = 2.1 KΩ = 2.1×10^3 Ω

R3 = 0.9 KΩ = 0.9×10^3 Ω

R = R1+R2+R3 = (6.6+2.1+0.9) KΩ = 9.6 KΩ

For V = 5 V

I $= \frac{V}{R} = \frac{5}{9.6}$=0.521A

$V_1 = I R_1 = 0.521 \times 6.6 = 3.438\ V$

$V_2 = I R_2 = 0.521 \times 2.1 = 1.091\ V$

$V_3 = I R_3 = 0.521 \times 0.9 = 0.4689\ V$

$V = V_1 + V_2 + V_3 = 3.438\ V + 1.091\ V + 0.4689\ V = 5V$

$V_{CV} = 4.9V$

Error = $(V-V_C)/V_C$ = 0.02 %

For V = 10 V

I $= \frac{V}{R} = \frac{10}{9.6}$=1.041A

$V_1 = I R_1 = 1.041 \times 6.6 = 6.8706\ V$

$V_2 = I R_2 = 1.041 \times 2.1 = 2.1816\ V$

$V_3 = I R_3 = 1.041 \times 0.9 = 0.9369\ V$

V= V_1+ V_2+ V_3=$6.8706V + 2.1816\ V + 0.9369\ V = 10V$

V_{CV} = 9.994V

Error = (V-V_C)/V_C = 0.019%

For V = 15 V

$I = \frac{V}{R} = \frac{15}{9.6}$=1.563A

V_1 = I R_1 = $1.563 \times 6.6 = 9.9\ V$

V_2 = I R_2 = $1.563 \times 2.1 = 3.2823\ V$

V_3 = I R_3 = $1.563 \times 0.9 = 1.4067V$

V = V_1+ V_2+ V_3=$9.9V + 3.2823\ V + 1.4067\ V = 14.7$V

V_{CV} = 15V

Error = (V-V_C)/V_C = 0.02%

<u>For KCL:</u>

R1 = 6.6 KΩ = 6.6×10^3 Ω

R2 = 2.1 KΩ = 2.1×10^3 Ω

R3 = 0.9 KΩ = 0.9×10^3 Ω

R = R1+R2+R3 = (6.6+2.1+0.9) KΩ = 9.6 KΩ

$$R_{eq} = \left(\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}\right)^{-1}$$

$$= \left(\frac{1}{6.6} + \frac{1}{2.1} + \frac{1}{0.9}\right)^{-1}$$

= 0.5751 KΩ

For V = 5 V

$I_1 = \frac{V}{R_1} = \frac{5}{6.6} =$ 0.76A

$I_2 = \frac{V}{R_2} = \frac{5}{2.1} =$ 2.381A

$I_3 = \frac{V}{R_3} = \frac{5}{0.9} =$ 5.56A

I_C = I_1+ I_2+ I_3=$0.76\ A + 2.381\ A + 5.56\ A = 8.701A$

$I = \frac{V}{R} = \frac{5}{0.5751} = 8.69A$

Error = (I-I_C)/I_C = 0.00115%

For V = 10 V

$I_1 = \frac{V}{R_1} = \frac{10}{6.6} = 1.515A$

$I_2 = \frac{V}{R_2} = \frac{10}{2.1} = 4.76A$

$I_3 = \frac{V}{R_3} = \frac{10}{0.9} = 11.11A$

$I_C = I_1 + I_2 + I_3 = 1.515A + 4.76A + 11.11\,A = 17.385A$

$I = \frac{V}{R} = \frac{10}{0.5751} = 17.338A$

Error = $(I-I_C)/I_C = 0.0117\%$

For V = 15 V

$I_1 = \frac{V}{R_1} = \frac{15}{6.6} = 2.273A$

$I_2 = \frac{V}{R_2} = \frac{15}{2.1} = 7.142A$

$I_3 = \frac{V}{R_3} = \frac{15}{0.9} = 16.67A$

$I = I_1 + I_2 + I_3 = 2.273\,A + 7.142\,A + 16.67\,A = 26.085A$

$I = \frac{V}{R} = \frac{15}{0.5751} = 26.033A$

Error = $(I-I_C)/I_C = 0.002\%$

8. Discussion and Conclusion:

- The data/findings were interpreted and determined to the extent to which the experiment was successful in complying.
- The goal was initially set.
- The ways of the study could have been improved, investigated, and described.

In this experiment, KVL and KCL were observed and verified.

9. References

[1] Robert L. Boylestad, "Introductory Circuit Analysis", 10th Edition.