AMERICAN INTERNATIONAL UNIVERSITY-BANGLADESH (AIUB)
ELECTRICAL CIRCUITS 1 (DC) LAB
LAB REPORT

Course Instructor : Fairuza Faiz

Experiment No : 02

Name of the Experiment : Familiarizing with the basic DC circuit terms & concepts: Introduction to laboratory equipment's.

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Title of the Experiment: Verification of Kirchhoff's Voltage Law (KVL) and Kirchhoff's Current Law (KCL)

Abstract: There are two sections in this experiment. In the first circuit Kirchhoff s Voltage Law (KVL) will be verified and in the second Kirchhoff's Current Law (KCL) will be verified

Introduction:

The main objective of this experiment was to verify Kirchhoff's Voltage Law (KVL) and Kirchhoff's Current Law (KCL) law. In doing so, followings were performed:

a) To design an electrical circuit with relevant parameters and sources.

b) To set up the circuit with appropriate connections, sources, and instruments.

c) To compare the measured value with the theoretical estimated value.

d) To find the reason for error in result, and to draw conclusion on how to overcome.

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

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

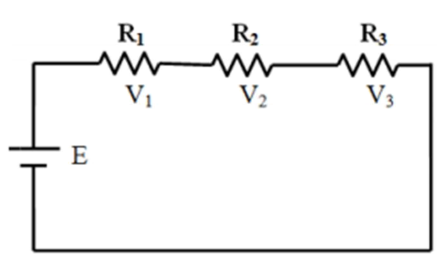

Figure-1

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:

$$I = E / (R_1+R_2+R_3)$$

Step 2: Calculate V_1, V_2, and V_3:

$$V_1= I\times R_1 \qquad V_2= I\times R_2 \qquad V_3= I\times R_3$$

Step 3: Use KVL to verify:

$$\sum_c V=0 \text{ or } \quad E-V_1-V_2-V_3=0$$

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 word, "the sum of the currents entering an area, system or junction must be equal the sum of the currents leaving the area, system or junction". In equation form,

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

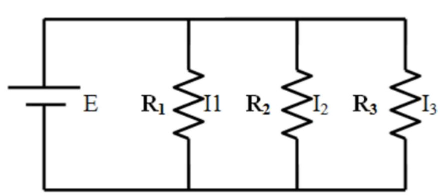

Figure-2

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:

$$I_1 = E / R_1 \qquad I_2 = E/R_2 \qquad I_3 = E/R_3$$

Step 4: Use KCL to verify:

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

Apparatus:

1. Resistors
2. Connecting wire
3. Trainer Board
4. AVO meter or Multimeter
5. DC source

Precautions:

1. The circuit was connected so carefully.
2. Before connecting supply with the circuit, the whole connection diagram was checked.

Experimental Procedure:

1. The circuit was connected as shown in the figure 1.
2. The voltage was measured across each elements of the circuit.
3. The following table was filled with necessary calculations.
4. The circuit was connected as shown in the figure 2.
5. The current across each branches of the circuit was measured.
6. The following table was filled with necessary calculations.

Simulation and Measurement:

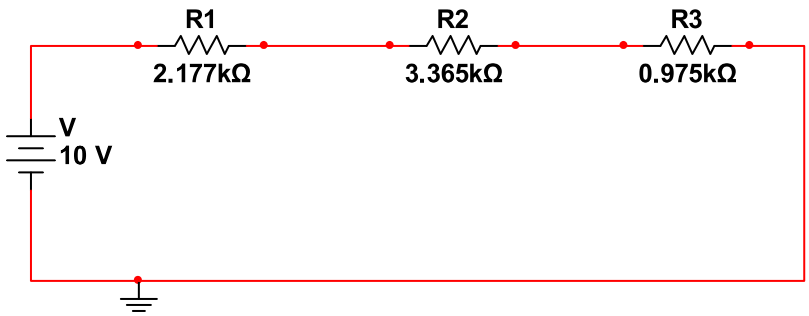

Figure1: Circuit of verification of KVL

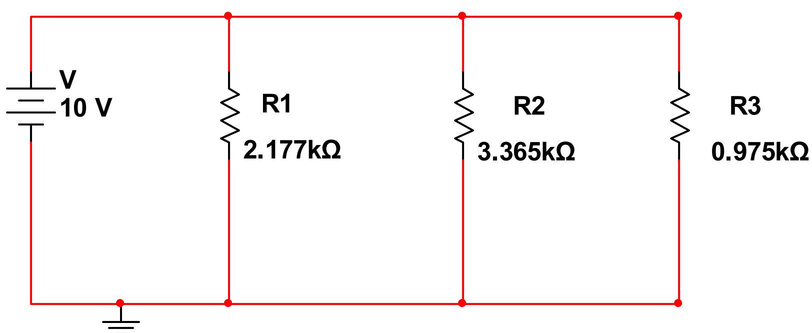

Figure: Circuit of verification of KCL

Table-1

No. of obs.	R_1 KΩ	R_2 KΩ	R_3 KΩ	V		V_1		V_2		V_3		$V=V_1+V_2+V_3$		%Error = %(mv-cv)/cv
				C V	M V	C V	M V	C V	M V	C V	M V	C V	M V	
01	2.177	3.365	0.975	10	10.04	3.34	3.339	5.163	5.18	1.496	1.5	10	10.04	0.40%

Table-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
				C A	M A	C A	M A	C A	M A	C A	M A	C A	M A	
01	2.177	3.365	0.975	0.0178	0.01782	0.0046	0.00459	0.00298	0.00297	0.01029	0.0103	0.0178	0.0178	0.30%

Calculations:

For KVL:

$R_1 = 2.177\ K\Omega = 2.177 \times 10^3\ \Omega$

$R_2 = 3.365\ K\Omega = 3.365 \times 10^3\ \Omega$

$R_3 = 0.975\ K\Omega = 0.975 \times 10^3\ \Omega$

$V = 10\ V$

$R = R_1+R_2+R_3 = (2.177+3.365+0.975)\ K\Omega = 6.517\ K\Omega = 6517\ \Omega$

$$I = \frac{V}{R} = \frac{10}{6517}\ A = 1.53445 \times 10^{-3}\ A$$

Now,

$V_1 = I \times R_1 = 1.53445 \times 10^{-3} \times 2.177 \times 10^3 = 3.34$ V

$V_2 = I \times R_2 = 1.53445 \times 10^{-3} \times 3.365 \times 10^3 = 5.163$ V

$V_3 = I \times R_3 = 1.53445 \times 10^{-3} \times 0.975 \times 10^3 = 1.496$ V

So,

$V_1 + V_2 + V_3 = 3.34 + 5.163 + 1.496 = 10$ V

<u>For KCL:</u>

$R_1 = 2.177$ KΩ $= 2.177 \times 10^3$ Ω

$R_2 = 3.365$ KΩ $= 3.365 \times 10^3$ Ω

$R_3 = 0.975$ KΩ $= 0.975 \times 10^3$ Ω

V = 10 V

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

$$= \left(\frac{1}{2.117} + \frac{1}{3.365} + \frac{1}{0.975}\right)^{-1}$$

$$= 561.1\ \Omega$$

We know,

$$V = IR$$

$$\therefore I = \frac{V}{R} = \frac{10}{561.1} = 0.01782\ \text{A}$$

$$I_1 = \frac{V}{R1} = \frac{10}{2.177 \times 10^3} = 4.5935 \times 10^{-3}\ \text{A}$$

$$I_2 = \frac{V}{R2} = \frac{10}{3.365 \times 10^3} = 2.9718 \times 10^{-3}\ \text{A}$$

$$I_3 = \frac{V}{R3} = \frac{10}{0.975 \times 10^3} = 10.2564 \times 10^{-3}\ \text{A}$$

Result:

In KVL:

Theoretical value:

$V = 10\ V$,

and $V_1+V_2+V_3 = 3.34 + 5.163 + 1.496 = 10\ V$.

Meter value:

$V = 10.04\ V$,

$V_1+V_2+V_3 = 3.339 + 5.18 + 1.5 = 10.019\ V$

In KCL:

Theoretical value:

$I_1=4.5935 \times 10^{-3}\ A$, $I_2=2.9718 \times 10^{-3}\ A$, $I_3= 10.2564 \times 10^{-3}\ A$.

$\therefore\ I_1 + I_2\ I_3 =4.5935 \times 10^{-3} + 2.9718 \times 10^{-3} + 10.2564 \times 10^{-3} = 0.0178\ A = I$

Meter value:

$I_1=4.6 \times 10^{-3}\ A$, $I_2=2.984 \times 10^{-3}\ A$, $I_3=10.29 \times 10^{-3}\ A$

$\therefore I_1 + I_2 + I_3 =4.6 \times 10^{-3} + 2.984 \times 10^{-3} + 10.29 \times 10^{-3} = 0.0178\ A = I$

Discussion:

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

Conclusion: In this experiment KVL and KCL was observed and verified.

Reference: [1] Robert L. Boylestad, “Introductory Circuit Analysis”, 10th Edition.