American International University- Bangladesh
Faculty of Engineering (EEE)
EEE 2109 : Introduction to Electrical Circuits Laboratory

<u>Title:</u> Verification of Kirchhoff's Voltage Law (KVL) and Kirchhoff's Current Law (KCL).

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.

Objectives:

The purpose of this experiment is:

- To develop an understanding of Kirchoff's Voltage Law (KVL) and Kirchoff's Current Law (KCL) practically.
- And finally measured values are going to be verified with calculated values.

Theory and Methodology:

Kirchoff's Voltage Law (KVL):

Kirchoff'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, Kirchoff'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.

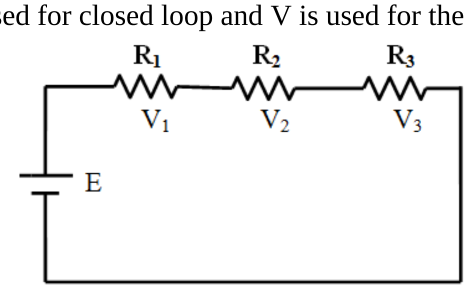

Figure-1: Loop circuit

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:

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

Step 2: Calculate V_1, V_2, and V_3:

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

Step 3. Use KVL to verify:

$\sum_c V=0$ or $E-V_1-V_2-V_3=0$

Kirchoff's Current Law (KCL):

Kirchoff'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,

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

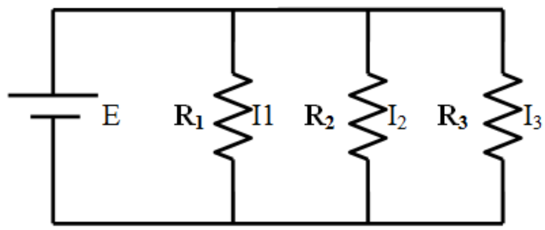

Figure-2: Node circuit

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:

$\sum I$ Entering $= \sum I$ leaving or $I= I_1 + I_2 + I_3$

Pre-Lab Homework:

Read about the KVL and KCL circuit from "Introductory Circuit Analysis'' by Robert L Boylestad. Try to analyze different circuits from text book and compare those with your experimental circuit.

Apparatus:

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

Precautions:

Connecting of circuit should be done carefully. And before connecting supply with the circuit the whole connection diagram should be checked by the instructor.

Experimental Procedure:

1. Connect the circuit as shown in the figure 1.
2. Measure the voltage across each elements of the circuit.
3. Fill the following table with necessary calculations.

Table 1: Measurement data for applying KVL on figure 1

No. of obs.	R_1 KΩ	R_2 KΩ	R_3 KΩ	Source Voltage, E (V)		Voltage Across R_1, V_1 (V)		Voltage Across R_2, V_2 (V)		Voltage Across R_3, V_3 (V)		Total Voltage Drop = V_1+V_2+V_3 (V)		Error = (MV-CV)/CV (%)
				CV	MV	CV	MV	CV	MV	CV	MV	CV	MV	
1														
2														
3														

CV: Calculated Value, MV: Measured Value

4. Connect the circuit as shown in the figure 2.
5. Measure the current across each branches of the circuit.
6. Fill the following table with necessary calculations.

Table 2: Measurement data for applying KCL on figure 2

No. of obs.	R1	R2	R3	I		I_1		I_2		I_3		$I=I_1+I_2+I_3$		% Error = %(mv-cv)/cv
				C	M	C	M	C	M	C	M	C	M	
	KΩ	KΩ	KΩ	A	A	A	A	A	A	A	A	A	A	
1														
2														
3														

Simulation and Measurement:

Compare the simulation results with your experimental data and finally calculate percentage of error (if any).

Result and Calculation:

1. Complete Table~1 and Table~2.
2. Theoretically calculate the voltages and currents for each element in the circuits and compare them to the measured values.
3. Compute the percentage error in the two measurements and provide a brief explanation for the error.

Discussion and Conclusion:

Interpret the data/findings and determine the extent to which the experiment was successful in complying with the goal that was initially set. Discuss any mistake you might have made while conducting the investigation and describe ways the study could have been improved.

Reference:

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