Experiment No. 5

Kirchhoff's Laws

1. Introduction

1.1   Objective:

To verify Kirchhoff's current and voltage laws experimentally.

1.2 Components

1. DC circuit training system

2. Set of wires.

3. DC Power supply

4. Digital A.V.O. meter

1.3 Theory

Kirchhoff 's laws relate to the conservation of energy, which states that energy cannot be created or destroyed, only changed into different forms. This can be expanded to laws of conservation of voltage and current. In any circuit, the voltage across each series component (carrying the same current) can be added to find the total voltage. Similarly, the total current entering a junction in a circuit must equal the sum of current leaving the junction.

1.3.1 Kirchhoff's Current Law "KCL"

"current law" is based upon the fact that at any connecting point in a network the sum of the currents flowing toward the point is equal to the sum of the currents flowing away from the point. The law is illustrated in the examples in Fig.(1), where the arrows show the directions in which it is given that the currents are flowing. (The number alongside each arrow is the amount of current associated with that arrow.)
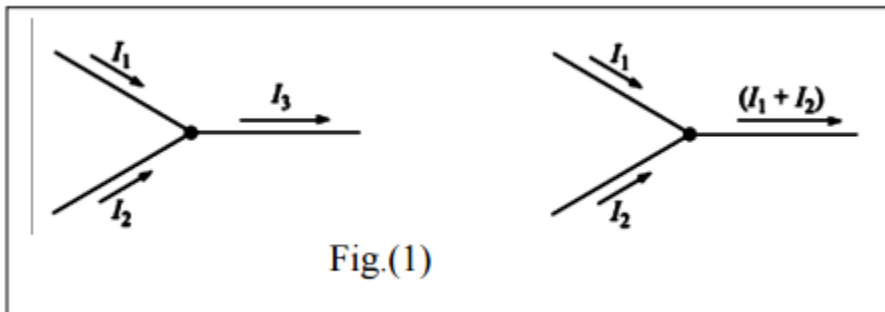
Fig.(1)

The sum of the currents flowing TO a node point equals the sum of the currents flowing FROM that point.

However, by Kirchhoff's current law, $I_3 = I_1 + I_2$, and thus, as shown in Fig. (1), we need to use only two current designations. In other words, if we know any two of the three currents, we can then find the third current. In the same way, if there are, say, four branch currents entering and leaving a node point, and if we know any three of the currents, we can then find the fourth current, and so on.

$$I_1+I_2=I_3$$

$$I_1+I_2-I_3=0$$

The Kirchhoff's current law can be state in the form:

> **The algebraic sum of the currents at a node (junction point) is equal to zero**

1.3.2. Kirchhoff's Voltage Law "KVL"

It states as follows;

The algebraic sum of the products of currents and resistance in each of the conductors in any closed path (or mesh) in a network plus the algebraic sum of the e.m.fs. in that path is zero.

2

In other words, $\sum IR + \sum e.m.f. = 0$ round a mesh

Let us now write the equation for Fig. (2) in accordance with Kirchhoff's voltage law. To do this, we start at any point, such as A, and move completely around the circuit (we will assume in the CW sense here), listing the ''voltage drops'' and the ''voltage rises'' as we go. (In doing this, remember that we have defined that going from ''minus to plus'' constitutes a RISE in voltage and going from ''plus to minus'' constitutes a DROP in voltage.) Thus, if we agree to list all ''voltage drops'' on the left-hand sides of our equations and all the ''voltage rises'' on the right-hand sides, the Kirchhoff voltage equation for Fig. (2) is:
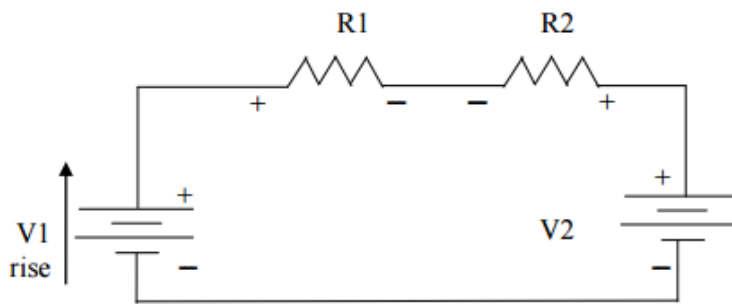
$$R_1 I + R_2 I + V_2 = V_1$$

Fig. (2)

Note that V2 appears as a voltage drop, because we go through that battery from plus to minus (+ to -). Alternatively, putting all the battery voltages on the righthand side, the above equation becomes

$$R_1 I + R_2 I = V_1 - V_2$$

$$\text{Hence} \quad I = \frac{V1 - V2}{R1 + R2}.$$

2. Experiment procedure:

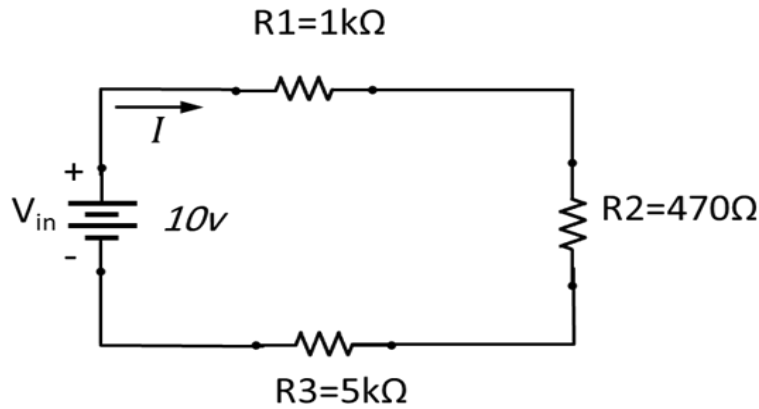1. Using the DC circuit trainer, connect the circuit shown in Fig. (3)

R1=1kΩ

Fig. (3)

2. Using The avometer to measure the values of voltage of each resistor in circuit and record it in the table below.

	1kΩ	470Ω	5kΩ
V (Volt)			

3. 1. Using the DC circuit trainer, connect the circuit shown in Fig. (4)

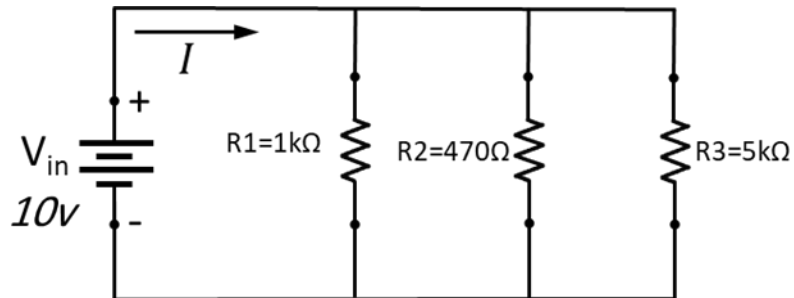

Fig. (4)

4. Using The multimeter to measure the values of current of each resistor in circuit and record it in the table below.

	1kΩ	470Ω	5kΩ
I (mA)			

4

3. Discussion:

1. How do you verify Kirchhoff's law experiment?
2. Discuss the obtained measured results and compare it with the theoretical analysis.
3- Using Kirchhoff's laws, determine the voltages of resistors and the current in each branch for the circuit shown in Fig. (5)
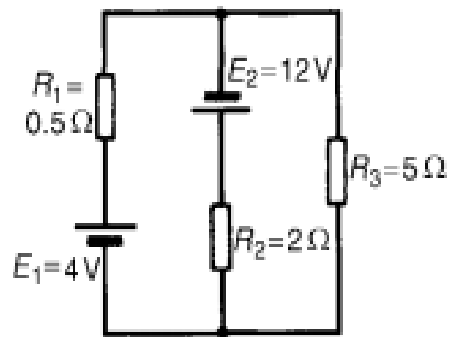

Fig. (5)

Al-Mustaqbal University College   https://www.uomus.edu.iq/