Experiment -2: Verification of Ohm's Law, KVL, and KCL

AIM: Verification of Ohm's law, Kirchhoff's voltage law, and Kirchhoff's current law.

APPARATUS REQUIRED: Resistances, Bread-board, Power Supply, Multimeter, connecting wires

THEORY: Ohm's law, Kirchoff's Voltage Law, and Kirchoff's Current Law are essential in the analysis of linear circuitry. Kirchoff's laws deal with the voltage and current in the circuit. Ohm's law relates voltage, current, and resistance to one another. These three laws apply to resistive circuits where the only elements are voltage and current sources and resistors. Using the three laws any resistance of, the current through or voltage across a resistor can be computed if any two of the three quantities are known.

1. **Ohm's Law:** Ohm's law is used to relate voltage to current and resistance. It states that voltage is directly proportional to current and resistance. In mathematical form, Ohm's law states,

$$R = \frac{V}{I} \tag{1}$$

where V is the voltage across an element of the circuit in volts, I is the current passing through the element in amps and R is the resistance of the element in ohms. Given any two of these quantities, Ohm's law can be used to solve for the third.

2. **Kirchhoff's Voltage Law:** Kirchhoff's Voltage Law (KVL) states that the sum of all voltages in a closed loop must be zero.

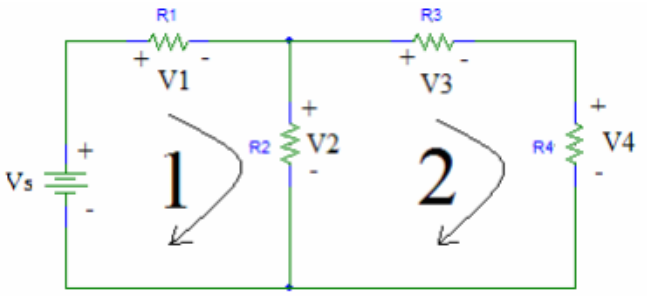

Fig. 2.1: An Example of KVL

A closed loop is a path in a circuit that doesn't contain any other closed loops. *Loop-1* and *Loop-2* in Figure 2.1 are examples of closed loops. The perimeter of the circuit is

also a closed loop, which includes loops 1 and 2, it would be repetitive to include a KVL equation for it. Using clockwise direction, following the path described by *loop-1*, KVL for loop-1 can be written as:

$$V_1 + V_2 = V_s \tag{2}$$

This equation holds true only if the passive sign convention is satisfied. In the case of KVL, the passive sign convention states that when a positive node is encountered while following a loop the voltage across the element is positive. If a negative node is encountered the corresponding element voltage is negative. To simplify the KVL equations, the polarities should be assigned to satisfy the passive sign convention whenever possible.

3. **Kirchoff's Current Law:** Kirchoff's Current Law (KCL) deals with the currents flowing into and out of a given node. KCL states that the sum of all currents at a node must equal zero. KCL is illustrated using Figure 2.2.

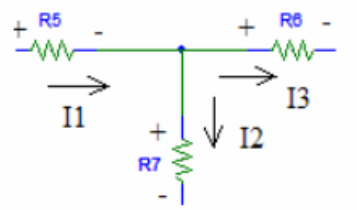

Fig. 2.2: An Example of KCL

The equation obtained by KCL for the node shown in Fig. 2 is

$$I_1 - I_2 - I_3 = 0 \tag{3}$$

In the case of KCL, the passive sign convention deals with the direction of currents concerning the node. Currents entering the node must have opposite signs as those exiting the node. The passive sign convention concerning KVL can also be applied to KCL. On many schematics, the polarities of resistors are already assigned, so the directions of the currents should be assigned such that the current is entering the positive terminal. Following sign convention later simplifies the calculations.

4. **Circuit Analysis:**

The circuit analyzed in this laboratory is shown in Fig. 2.3. The currents, voltages, and

polarities were labeled as shown on the given schematic.

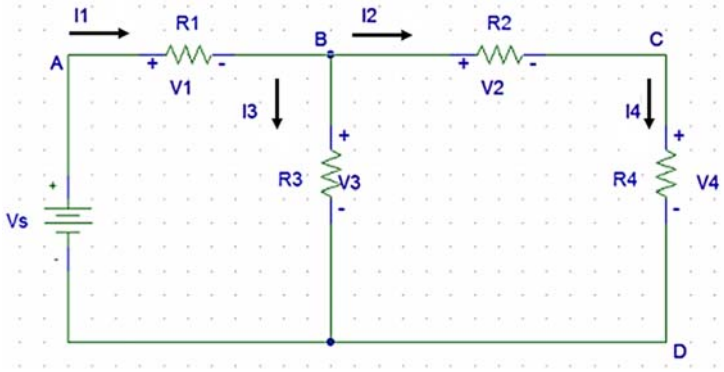

Fig. 2.3: Circuit to be analyzed

The current directions and voltage polarities have all been assigned such that the passive sign convention has been satisfied wherever possible.

5. Observations:

KVL and KCL circuits are analyzed, and the values of different parameters are mentioned in the observation table.

Observation Table 1

S.No.	Resistances		Voltage		Current	
1	Calculated	Observed	Calculated	Observed	Calculated	Observed
2						
3						
4						
5						

Results and Conclusions: Ohm's law, KVL, and KCL are three of the most basic techniques for the analysis of linear circuits. The purpose of this lab was to prove these three laws valid. A circuit was provided with four unknown voltages and three unknown currents. Then the circuit was built on a breadboard. The voltage and current values were measured and placed into KVL and KCL equations to determine whether they turned out as predicted. These measured values were then used in the Ohm's law equation to find resistance. The calculated and measured values were then compared to the expected results from the theories. All three laws are successfully verified.