Experiment No : 03

Name of the Experiment : Verification of Kirchhoff's Voltage Law.

Objective:

- To verify Kirchhoff's Voltage Law by measuring the summation of voltage around a close loop in a simple electrical circuit.
- Determine an unknown voltage in a complex circuit.
- To gain practical experience by using measuring instruments.

Theory:

Kirchhoff's Voltage Law (KVL) is a fundamental principle in electrical circuit analysis. It states that the algebraic sum of all electrical potential differences (voltages) around any closed loop or mesh in a circuit is equal to zero. This principle arises from the law of conservation of energy, which ensures that the total energy supplied to a circuit is fully utilized within it, without any loss or accumulation in a closed loop. In a closed circuit, a voltage source provides energy, which is then dissipated, stored, or transformed by other circuit components (such as resistors, capacitors, and inductors). The sum of these potential differences, accounting for their polarities, must equal zero because the net change in energy around the loop is zero.

$$\sum_{i=1}^{n} V_i \ = \ 0$$

Where:
- V_i is the i$^{\text{th}}$ voltage across the element in the loop.
- n is the total number of elements in the closed loop.

Apparatus:
- Voltmeter (3 piece; 0-450 V)
- Resistance (2 pieces; 37 Ω, 108Ω)
- AC voltage source (220V, 50Hz)
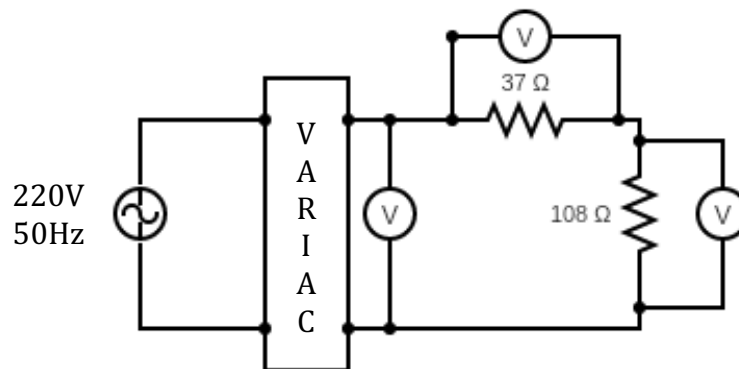- Connecting wires
- VARIAC

Circuit Diagram:

Figure-01: Electric Circuit

Data Table:

SL no.	Voltage (V)	Voltage (V_1)	Voltage (V_2)	Voltage ($V = V_1+V_2$)	Error
1	98.8	25.32	73.4	98.72	0.08%
2	129.5	33.10	96.2	129.3	0.15%
3	149	38.24	111	149.24	0.16%

Result:

The experimental verification of Kirchhoff's Voltage Law (KVL) was successfully conducted, where the sum of the measured voltages across the circuit elements (V1 and V2) was compared to the known applied voltage (V). The results demonstrate a close match between the theoretical and measured voltages, with errors in the range of 0.08% to 0.16%. The highest error observed was 0.08% in the first measurement, and the lowest error was 0.08% in the third. These minor discrepancies can be attributed to instrumental limitations or minor resistive losses within the circuit. Overall, the experiment confirmed that the relationship $V = V_1 + V_2$ holds true, validating the practical application of Kirchhoff's Voltage Law in this setup.

Conclusion:

The close agreement between the measured voltages and the applied source voltage verifies Kirchhoff's Voltage Law within the given experimental setup. The observed errors, though minimal, indicate the presence of minor limitations in measurement precision or circuit conditions, such as resistive losses in wires or connections. Despite these, the low error values confirm high experimental accuracy and validate KVL as a robust principle for analyzing closed-loop circuits, affirming the conservation of energy in electrical systems.