Dhaka International University

Department of Computer Science and Engineering

PHY-104: Electricity and Magnetism Lab

Experiment 3

To investigate the characteristics of a series DC circuit and to verify Kirchoff's Voltage Law (KVL)

OBJECTIVES

- To investigate circuits with resistors connected in series.
- To verify Kirchoff's Voltage Law (KVL).
- To verify Voltage Divider Rule (VDR).

THEORY

Series Circuit:

Figure. 1 shows three resistors, R_1, R_2, and R_3, connected in series in a closed circuit powered by a single battery or emf source. In this circuit the current supplied by the battery flows through each resistor, with the current in each resistor being the same. If the current supplied by the battery is I_T, the current in each resistor is I_1, I_2, and I_3, and they are all one and the same, then $I_T = I_1 = I_2 = I_3$.

The voltage drop across the battery V_T will be the total sum of the individual drops across each of the 3 resistors, and

$$V_T = V_1 + V_2 + V_3$$

where V_1 is the potential difference across R_1, V_2 is the potential difference across R_2, and V_3 is the potential difference across R_3. By using Ohm's law

$$V_T = I_T \times R_T$$

$$V_1 = I_1 \times R_1$$

$$V_2 = I_2 \times R_2$$

And

$$V_3 = I_3 \times R_3$$

Finally,

$$I_T R_T = I_1 R_1 + I_2 R_2 + I_3 R_3$$

and since $I_T = I_1 = I_2 = I_3$

$$R_T = R_1 + R_2 + R_3$$

Therefore, when resistors are connected in series, the total resistance is just the sum of the individual resistances. While this has been shown for 3 resistors, the total resistance of any number N (N≥2) of resistors connected in series, end to end, can be found using the same general procedure. Therefore, for resistors connected in series

$$R_T = \sum_{i=1}^{N} R_i$$

Kirchoff's Voltage law (KVL):

We can state Kirchhoff's Voltage Law in three ways which all really say the same thing.

- The algebraic sum of the voltage drops around any closed path of an electric circuit equal zero.
- The algebraic sum of the voltage rises around any closed path of an electric circuit equal zero
- The algebraic sum of the voltage rises equal the algebraic sum of the voltage drops around any closed path of an electric circuit.

Applying Kirchoff's voltage Law around closed loop of Figure 1., we find

$$V_T = V_1 + V_2 + V_3$$

Where, $V_1 = IR_1$, $V_2 = IR_2$, $V_3 = IR_3$

Current I is same throughout the circuit for figure 1. The Current is calculated by using Ohm's Law,

$$I = \frac{V_T}{R_T}$$

The voltage divider rule states that the voltage across an element or across series combination of elements in a series circuit is equal to the resistance of the element divided by total resistance of the series circuit and multiplied by the total impressed voltage. For the elements of Figure 1.

$$V_1 = \frac{R_1 E}{R_T}, \quad V_2 = \frac{R_2 E}{R_T}, \quad V_3 = \frac{R_3 E}{R_T}$$

EQUIPMENTS

- Variable DC power supply
- Digital Multimeter
- Resistances- 3 pieces
- Trainer Board
- Connecting wires

CIRCUIT DIAGRAM

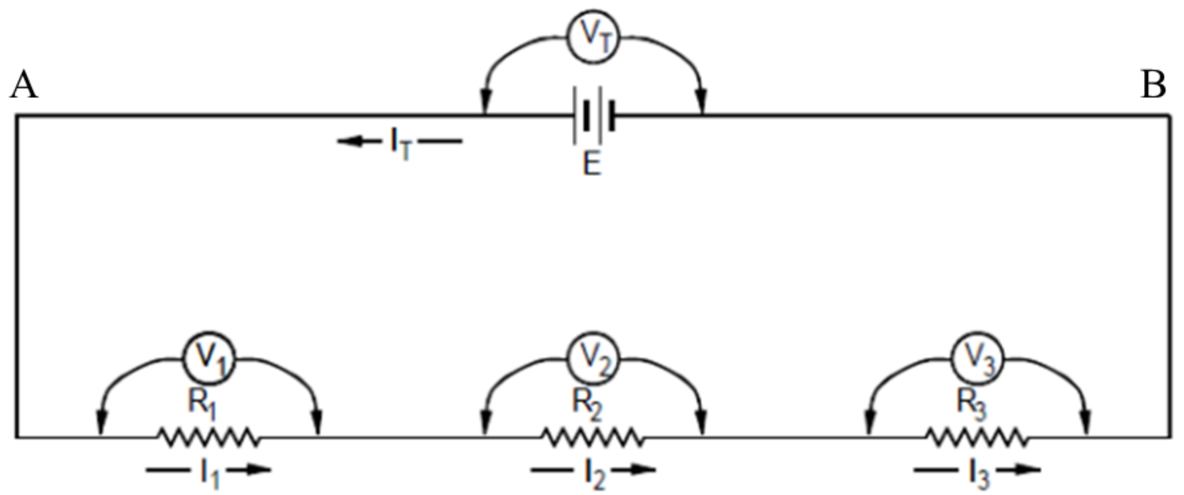

Figure 1: Three resistors R_1, R_2, and R_3 connected in series.

PROCEDURE

1. Measure the resistances by using Ohmmeter and record the values in Table 1.
2. Construct the circuit as shown in Figure 1.
3. Then measure input resistance R_T across points A-B using Ohmmeter and record that value in Table 1.
4. Turn on the DC power supply and set the DC supply to 20V by using Voltmeter.
5. Measure voltage across each resistor with Voltmeter and record in the Table 1.
6. Calculate V_1, V_2, V_3 using Voltage Divider Rule (VDR).

EXPERIMENTAL DATA

Table 1:

Nominal values of Resistance (Ω)	Measured values of Resistance by Ohmmeter (Ω)	Equivalent Resistance, R_T		Measured voltage across each resistor (V)	Calculated Voltage using VDR (V)
		Measured R_T by using Ohmmeter (Ω)	Calculated $R_T = R_1 + R_2 + R_3$ (Ω)		
R_1 =				V_1 =	
R_2 =				V_2 =	
R_3 =				V_3 =	

CALCULATION

CONCLUSION

From the above experiment it we have studied and verified that the observation value is approximately same to the calculation value in series circuit.