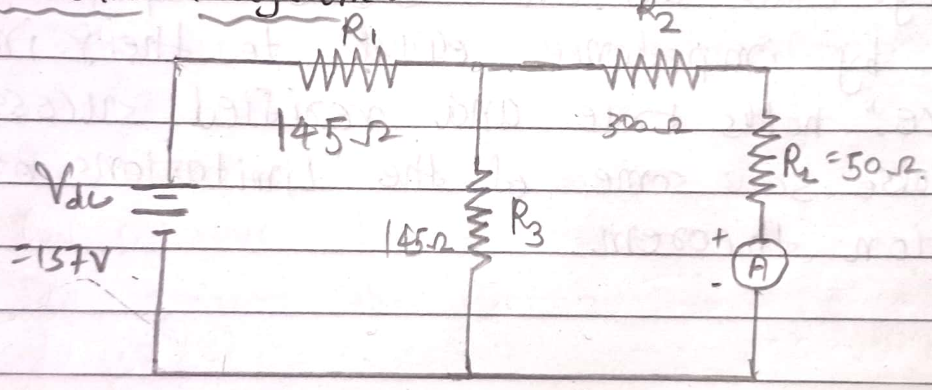
Experiment - 4

Aim :

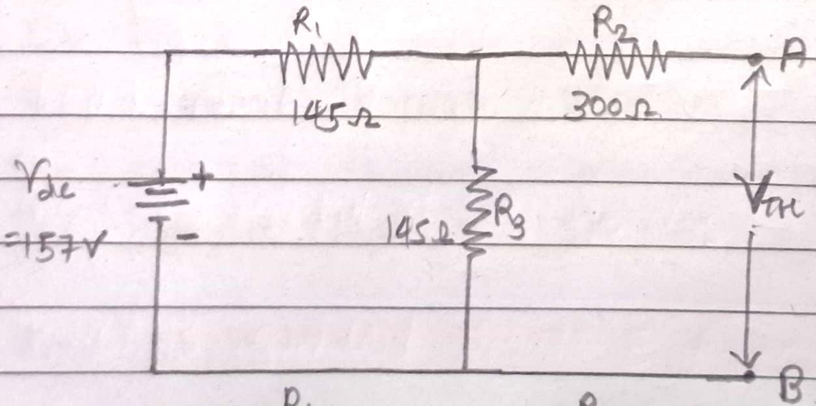
Verification of Thevenin's theorem for electric circuit.

Apparatus : DC power supply, Ammeter (0-1)A, Voltmeter (0-150V), Rheostats, Multimeter.

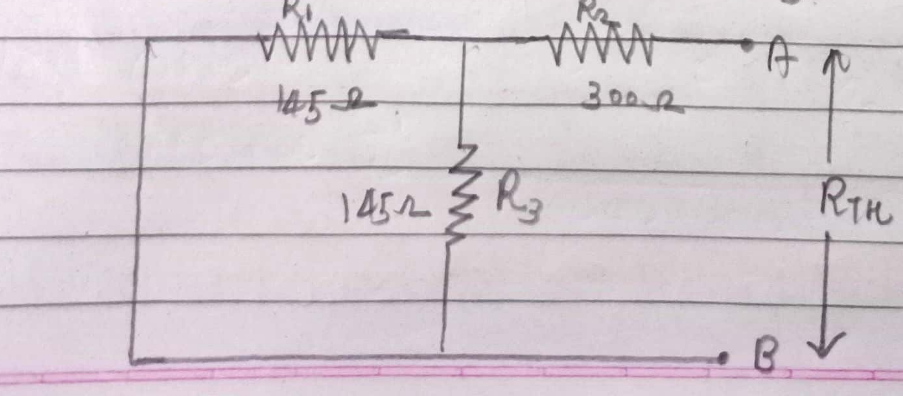
Circuit Diagram :



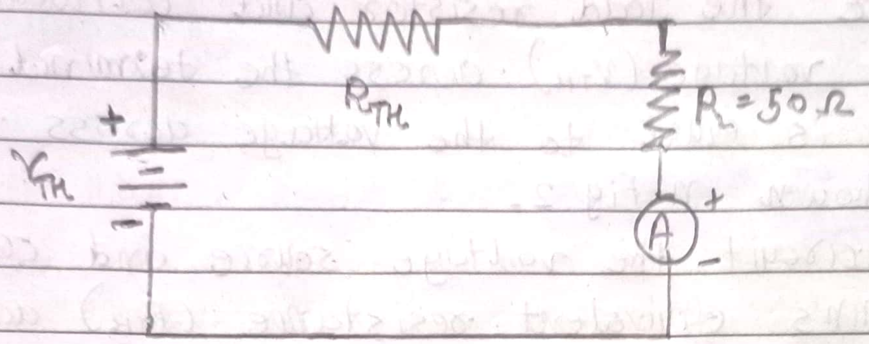
Basic Circuit



Calculation of V_{TH}



Calculation of R_{TH}



Thevenin's Equivalent circuit

Theory:

Thevenin's theorem stats that "Any two terminal, linear bilateral network having number of voltage sources, current sources and resistances can be replaced by a simple equivalent circuit consisting of a single voltage source in series with a resistance, where the value of the voltage source is equal to the open circuit voltage across the two terminals of the network, and the resistance is the equivalent resistance measured between the terminals with all energy sources replaced by their internal resistances."

Procedure:

(1) connect the circuit as shown in Fig.2

(2) measure the current through the load resistor using ammeter and note it down.

(3) Remove the load resistor and calculate the open circuit voltage (V_{TH}) across the terminals. A to B which is equal to the voltage across 50Ω resistor as shown in Fig 2.

(4) Short circuit the voltage source and calculate thevenin's equivalent resistance (R_{TH}) across the terminals A & B as shown in Fig 3.

(5) Connect the circuit as shown in Fig. 4 i.e. thevenin's equivalent circuit and calculate the current through load resistor by using ammeter and note it down.

Observation :

Parameteres	observed values	calculated values
Load current (I_L)	0.2 A	0.186 A
Thevenin's equivalent Voltage V_{TH}	78 V	78.5 V
Thevenin's equivalent Resistance R_{TH}	400 Ω	372.5 Ω
Load current using thevenin's theorem I_L'	0.18 A	0.186 A

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Calculation :

For fig. 1.

$$R_{eq} = R_1 + \frac{R_3 (R_2 + R_L)}{(R_3) + (R_2 + R_L)}$$

$$= 145 + \frac{(145)(300+50)}{145 + (300+50)}$$

$$\boxed{R_{eq} = 247.52\ \Omega}$$

$\therefore$ Total current $= \frac{V_{dc}}{R_{eq}} = \frac{157}{247.52} = 0.634\ A.$

$\therefore$ Load current I_L = Total current $\times \frac{145}{495}$

$$= 0.634 \times \frac{145}{495}$$

$$\boxed{I_L = 0.186\ A.}$$

→ Calculation for V_{TH}

For the calculation of V_{TH} we have to open the circuit across load resistor so the V_{TH} = Potential difference across R_3 (145 Ω)

$$V_{TH} = V_{dc} \frac{R_3}{R_1 + R_3} = 157 \times \frac{145}{290}.$$

$$\boxed{V_{TH} = 78.5V}$$

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→ Calculation for R_{TH}

For this we will short circuit the V_{dc} and will calculate R_{eq} across load resistor

$$R_{TH} = R_2 + \frac{R_1 R_3}{R_1 + R_3}$$

$$= 300 + \frac{145 \times 145}{290}$$

$$\boxed{R_{TH} = 372.52 \, \Omega}$$

Calculation for I_L in Thevenin's equivalent circuit

$$R_{eq} = R_{TH} + R_L = 372.5 + 50$$

$$R_{eq} = 422.50 \, \Omega$$

∴ Current I_L' in thevenin's equivalent circuit

$$I_L = \frac{V_{TH}}{R_{eq}} = \frac{78.5}{422.50} \approx 0.186$$

$$\boxed{I_L = 0.186 A}$$

therefore we clearly see that the thevenin's theorem is valid in this experiment as the current through R_L is constant in Thevenin's as well as normal circuit.

Questions :

1) Calculate the current through load resistor using Thevenin's theorem for circuit shown in Fig. 1 for following values of load resistor

(a) $R_L = 75\,\Omega$ (b) $R_L = 100\,\Omega$.

(a) We have obtained the value of Thevenin resistance (R_{TH}) and Thevenin's voltage (V_{TH}).

∴ Current through load resistor $= \dfrac{V_{TH}}{R_{TH} + R_L}$

$$= \frac{78.5}{372.5 + 75} = 0.175\,A$$

(b) Current through load resistor $= \dfrac{V_{TH}}{R_{TH} + R_L}$

$$= \frac{78.5}{372.5 + 100}$$

∴ $I_L = 0.166\,A$.

Results :

Observed :

(1) Load current I_L is 0.2 A
(2) Thevenin's equivalent voltage V_{TH} is 78 V
(3) Thevenin's equivalent resistance R_{TH} is 400 Ω
(4) Load current using Thevenin's Theorem I_L' is 0.18 A

Calculated :

(1) Load current I_L is 0.186 A.
(2) Thevenin's equivalent voltage V_{TH} is 78.5 V.
(3) Thevenin's equivalent resistance R_{TH} is 372.5 Ω
(4) Load current using thevenin's theorem I_L' is 0.186 A

Conclusion :

Thevenin's Theorem was successfully verified within bounds of experimental errors and can be used for simplifying circuits which are linear and bilateral in nature.