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F-24

EXPERIMENT : No. 05

- **Aim:** Calculation and verification of Norton's Theorem

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

- **Theory:** The Norton's Theorems reduce the network's equivalent to the circuit having one current ~~same~~ source parallel resistance and load. Norton's theorem is the converse of Thevenin's Theorem. It consists of the equivalent current source instead of an equivalent voltage source as in Thevenin's theorem. The determination of Internal resistance of the source network is identical in both the theorem.

Norton's theorem states that,
"A linear active network consisting of the independent or dependent voltage source & current sources and the various circuit elements can be substituted by an equivalent circuit consisting of a current source in parallel with a resistance. The current source being the short-circuited current across the load terminal i.e. I_{sc} & the resistance being the internal resistance of the source network i.e. R_N."

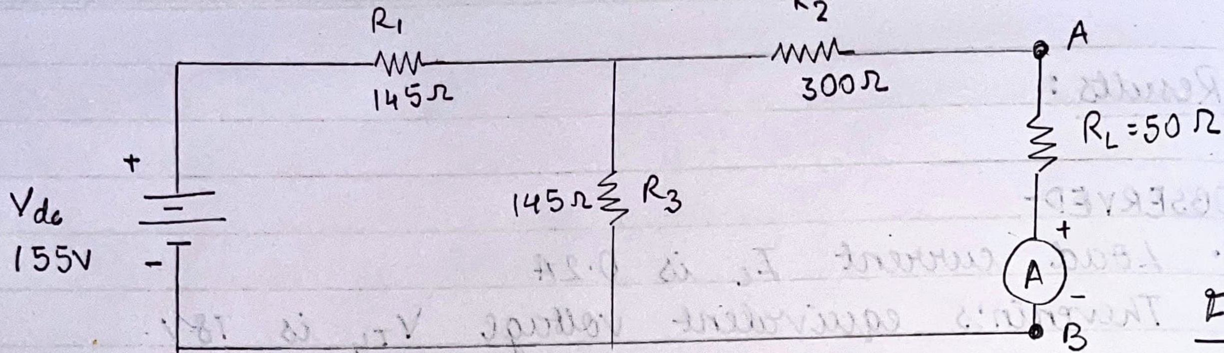

Fig I
Basic Circuit

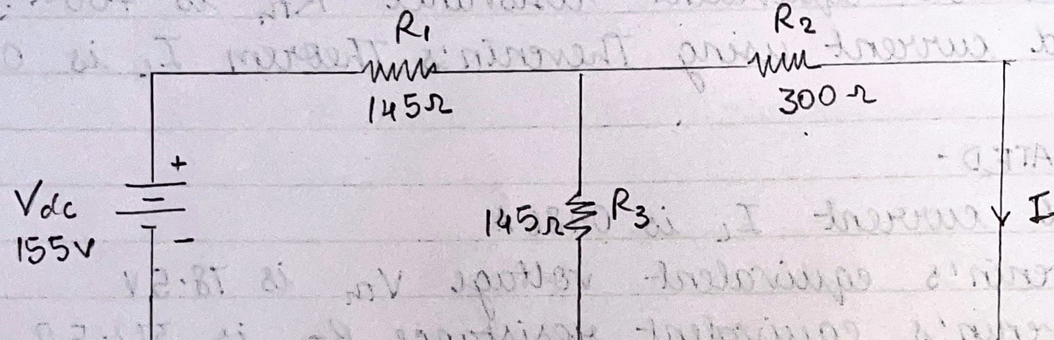

Fig 2
Calc. of Isc

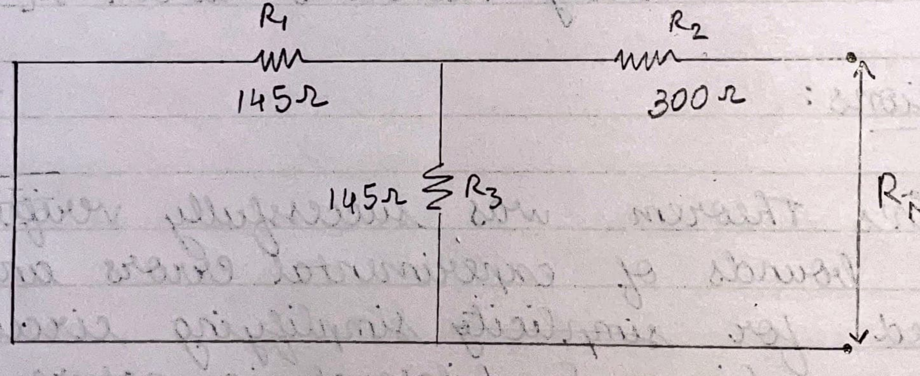

Fig 3
Calc. of RN

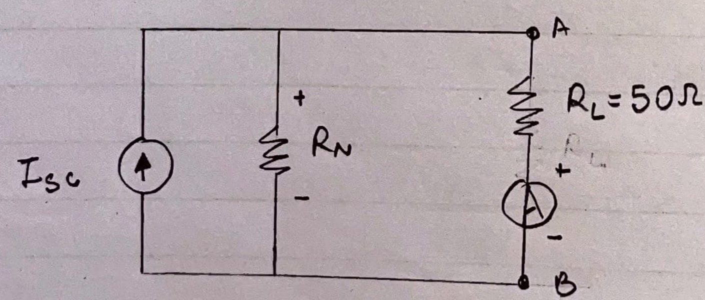

Fig 4
Norton's Equivalent Circuit

Procedure :

1. Connect the circuit as shown in Fig 1.
2. Measure the current through the load resistor (I_L) using ammeter & note it down.
3. Remove the load resistor & calculate the short circuit current (I_{sc}) across the terminals A & B as shown in Fig 2.
4. Short circuit the voltage source & calculate Norton's equivalent resistance (R_N) across the terminals A & B as shown in Fig 3.
5. Connect the circuit as shown in Fig 4. i.e. Norton's equivalent circuit & calculate the current through load resistor by using ammeter & note it down.

Questions :

1. Calculate the current through load resistor using Norton's theorem for circuit shown in Fig 1 for following values of load resistance.
(a) $R_{L_1} = 75\,\Omega$ (b) $R_{L_2} = 100\,\Omega$.

A.1 (a) $I'_{L_1} = \dfrac{R_N}{R_{L_1} + R_N} \times I_{sc} = \dfrac{372.5}{75 + 372.5} \times 0.208$

$\boxed{I'_L = 0.193\,A}$

(b) $I'_{L_2} = \dfrac{R_N}{R_{L_2} + R_N} \times I_{sc} = 0.1639\,A$

Observation :

Parameters	Observed Values	Calculated Values
Load Current, I_L	0.19 A	0.183 A
Short circuit current, I_{SC}	0.23 A	0.208 A
Norton's eq. resistance R_N	400 Ω	372.5 Ω
Load current using Norton's Theorem, I_L'	0.20 A	0.183 A

Calculations :

1) Finding R_N –

- $R_N = \frac{145}{2} + 300 = \underline{372.5\ \Omega}$

2) Finding I_{SC} –

$$R_{eq} = \frac{300 \times 145}{300 + 145} + 145 = \underline{242.75\ \Omega}$$

- $I_{SC} = \frac{145}{300+145} \times \frac{V_{dc}}{R_{eq}} = \frac{145}{445} \times \frac{155}{242.75} = \underline{0.208\ A}$

3) Finding I_L' –

$$I_L' = \frac{R_N}{R_L + R_N} \times I_{SC} = \frac{372.5}{50 + 372.5} \times 0.208 = \underline{0.183\ A}$$

Result :

1. Load resistor current = I_L = 0.183 A
2. Norton's equivalent resistance R_N = 372.5 Ω
3. Short circuit current I_{SC} = 0.208 A
4. Load current using Norton's theorem I_L' = 0.183 A.

Conclusion :

As the current through, load resistor in both calculation is same. Norton's theorem is verified.