Norton’s Thm:

- Norton's theorem is used for simplifying a network in terms of currents instead of voltages. According to this theorem, any complicated network can be replaced by equivalent circuit consisting of

  (a) an ideal current source (I_N) of infinite internal resistance and

  (b) a resistance (R_N) in parallel with it as shown in Fig. 1.24.

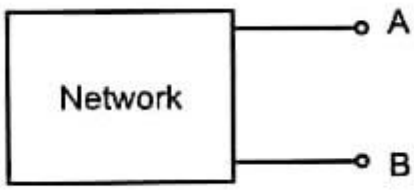


Fig. 1.23

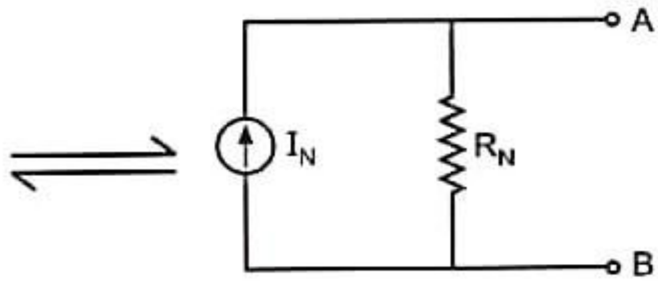
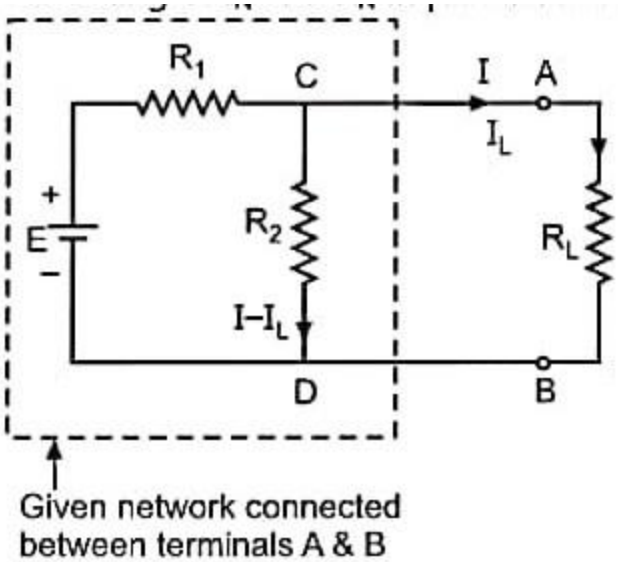
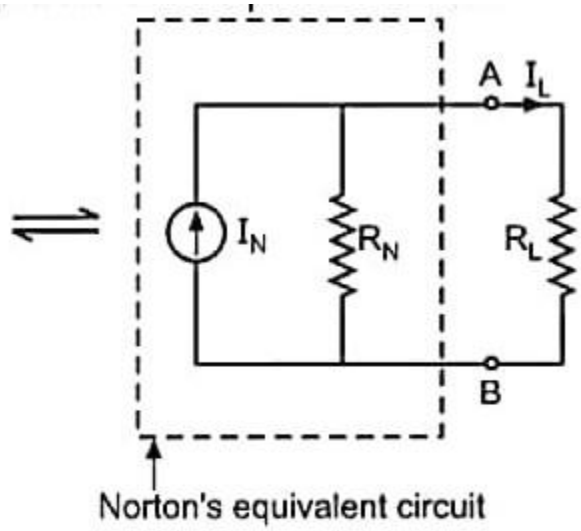


Fig. 1.24 : Norton's equivalent circuit

Statement : *Any two-terminal linear network, containing sources of e.m.f. and resistances, can be replaced by an equivalent circuit consisting of constant current source (I_N) in parallel with a single resistance (R_N).* The constant current is equal to the current which would pass in a short circuit placed between the terminals and R_N is the resistance between the terminals when all the sources in the network have been replaced by their internal resistances.





How to Nortonize a given circuit ?

To understand how to Nortonize a given circuit, consider the following circuit shown in Fig. 1.29.

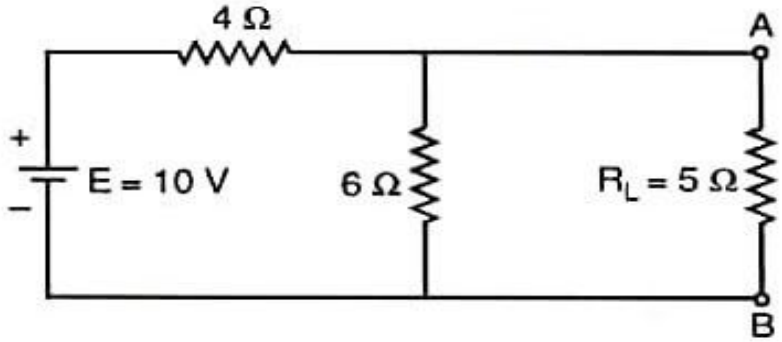


Fig. 1.29

The procedural steps for finding Norton's equivalent circuit are as under.

Step I : Disconnect the load resistor $R_L = 5\ \Omega$ from the terminals A and B.

Step II : To find Norton's current, put a short across the terminals A and B. It results in shorting out 6 Ω resistor as shown in Fig. 1.30. Now the entire battery current flows through the short circuit.

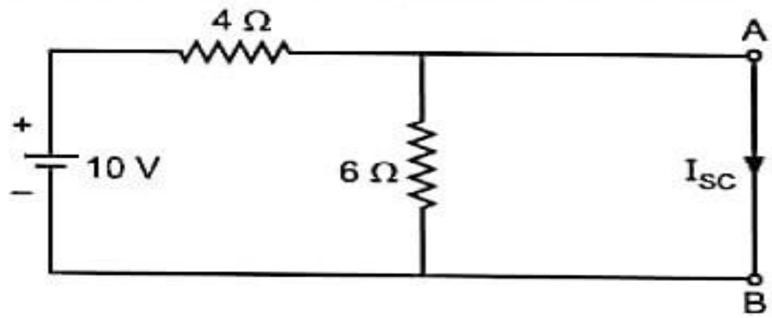


Fig. 1.30

$$I_{SC} = \frac{10 \text{ volts}}{4\ \Omega} = 2.5 \text{ A}$$

This current is also called Norton's current (I_N).

$$\therefore \qquad I_N = 2.5 \text{ A}$$

Step III : Remove the short from terminals A and B, so that they are again open. To find R_{eq}, remove the battery and replace it by its internal resistance (in this case it is zero). The equivalent resistance (R_{eq}) is also known as Norton's resistance R_N of the circuit viewed back from open terminals A and B as shown in Fig. 1.31.

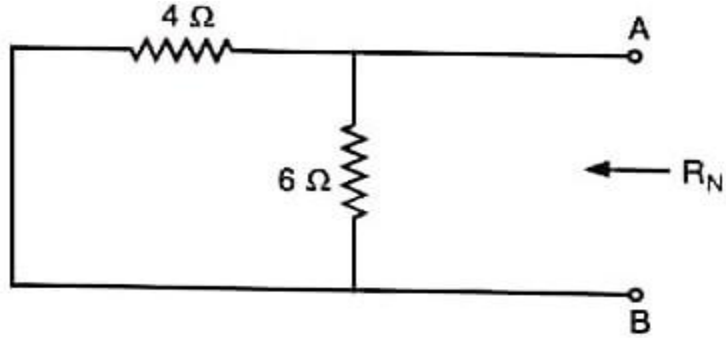


Fig. 1.31

$$R_N \text{ or } R_{eq} = \frac{4 \times 6}{4 + 6} \qquad (\because 4\,\Omega \parallel 6\,\Omega)$$

$\therefore$

$$R_{eq} = 2.4\,\Omega$$

Or

$$R_N = 2.4\,\Omega$$

The Norton's equivalent of the given circuit consists of a 2.5 A constant current source in parallel with a 2.4 Ω resistance. (Refer Fig. 1.32)

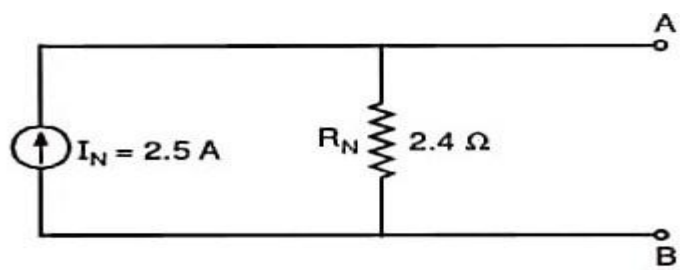


Fig. 1.32 : Norton's equivalent circuit

Step IV : Load current I_L passing through R_L = 5 Ω can be obtained by using the proportional current formula.

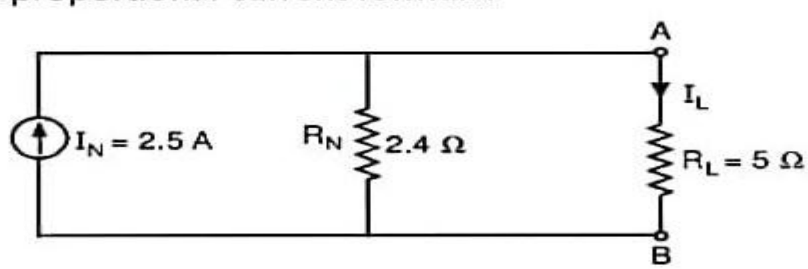


Fig. 1.33

From Fig. 1.33, the current passing through R_L is

$$I_L = I_N \times \frac{R_N}{(R_N + R_L)}$$

$$I_L = 2.5 \times \frac{2.4}{2.4 + 5}$$

$$I_L = 0.81\text{ A}$$

Problems:1

(**Ans.** V_{Th} = 18 V, R_{Th} = 3 Ω)

Using Norton's theorem, calculate the current flowing through 12 Ω resistor as shown in Fig. 1.75.

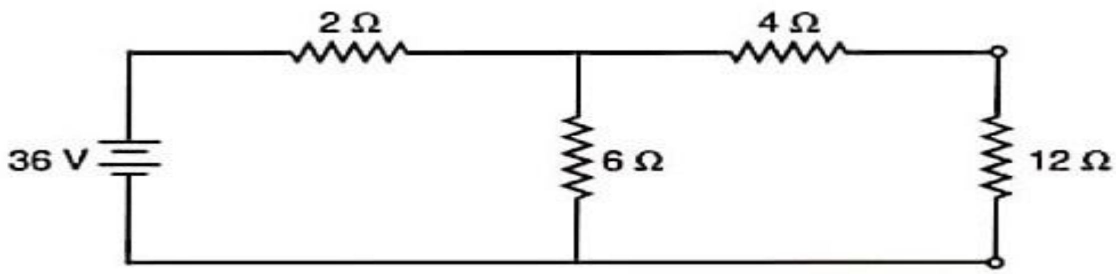


Fig. 1.75

(**Ans.** I_L = 1.54 A)

Problems:2

Nortonize the following circuit and calculate current across 8 Ω resistor.

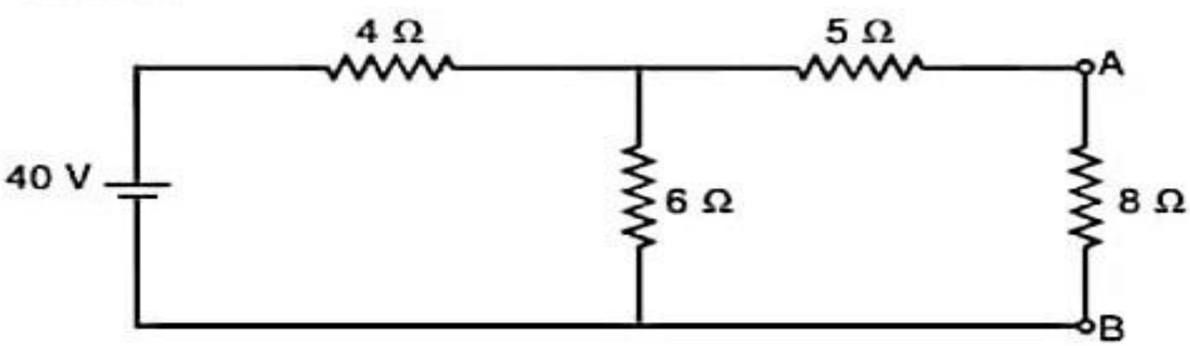


Fig. 1.76

(**Ans.** I_N = 3.24 A, R_N = 7.4 Ω, I_L = 1.55 A)