NETWORK THEOREMS

CONTENTS:

- Norton's Theorem
- Thevenin's Theorem
- Solving Electrical circuits

Er. Ripple Sahni

Assistant Professor

Chandigarh Engineering College

Landran, Mohali

WHY NETWORK THEOREMS??

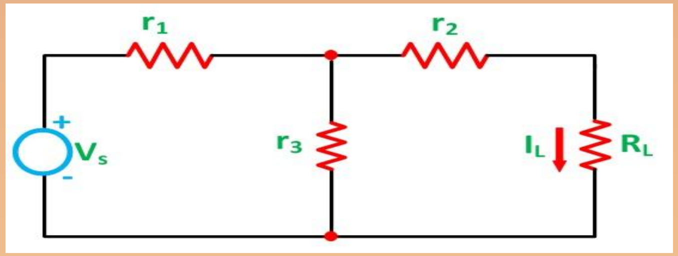
- Network theorems are used to reduce complicated networks to simpler less-complicated networks
- Electric circuit theorems are always beneficial to help find voltage and currents in multi-loop circuits. These theorems use fundamental rules or formulas and basic equations of mathematics to analyze basic components of electrical or electronics parameters such as voltages, currents, resistance, and so on.
- These fundamental theorems include the basic theorems like Superposition theorem, Norton’s theorem and Thevenin’s theorems.

NORTON'S THEOREM

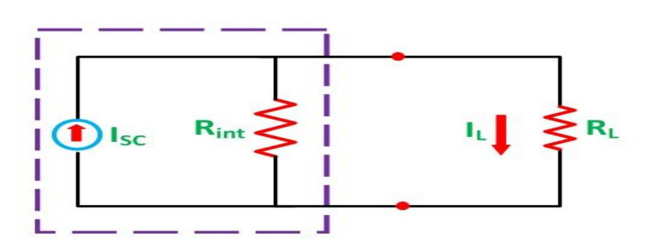
- A linear active network consisting of the independent or dependent voltage source and current sources and the various circuit elements can be substituted by an equivalent circuit consisting of a current source in parallel with a resistance.
- The Norton's theorems reduce the networks equivalent to the circuit having one current 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.

EXPLANATION OF NORTON'S THEOREM

- In order to find the current through the load resistance R_L as shown in the circuit diagram below



Step 1:- Norton's equivalent circuit is drawn by keeping the equivalent resistance R_{eq} in parallel with the short circuit current I_{SC}.



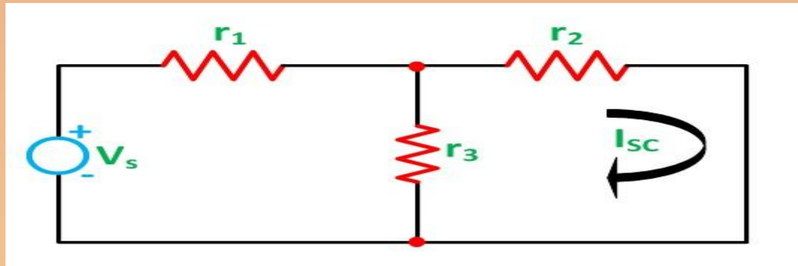
$$I_L = I_{SC}\frac{Req}{Req+RL}$$

where, I_L is the load current, I_{sc} is the short circuit current

R_{eq} is the equivalent resistance of the circuit, R_L is the load resistance of the circuit

EXPLANATION OF NORTON'S THEOREM

Step 2 – In order to find I_{SC}, short the load terminals and find the short circuit current I_{SC} flowing through the shorted load terminals using conventional network analysis methods.



Now, the value of current I flowing in the circuit is found out by the equation

$$I = \frac{V_S}{r_1 + \frac{r_2 r_3}{r_2 + r_3}}$$

and the short-circuit current I_{SC} is given by the equation shown below:

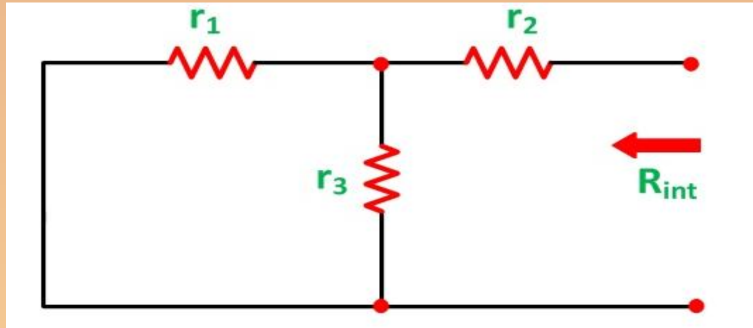
$$I_{sc} = I \frac{r_3}{r_3 + r_2}$$

EXPLANATION OF NORTON'S THEOREM

Step 3 – Find the internal resistance R_{eq} of the source network by deactivating the constant sources as shown in the circuit diagram below and the value of the equivalent resistance is calculated by:

$$Req = r_1 || r_3 + r_2$$

$$Req = \frac{r1r3}{r1+r3} + r_2$$



Step 4 – Reconnect the load resistance R_L of the circuit across the load terminals and find the current through it known as load current I_L.

$$I_L = I_{SC} \frac{Req}{Req+RL}$$

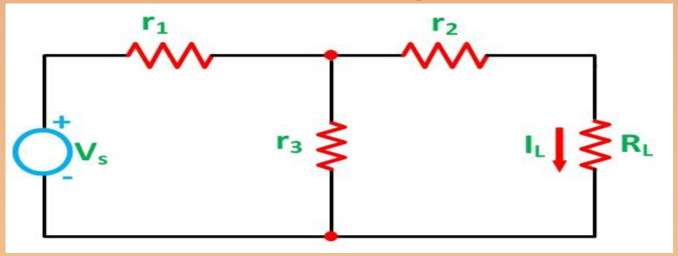
THEVENIN’S THEOREM

- A linear active network consisting of the independent or dependent voltage source and current sources and the various circuit elements can be substituted by an equivalent circuit containing a single source and a single resistor.

- Thevenin’s theorem implies that we can replace arbitrarily complicated networks with simple networks for purposes of analysis

EXPLANATION OF THEVENIN'S THEOREM

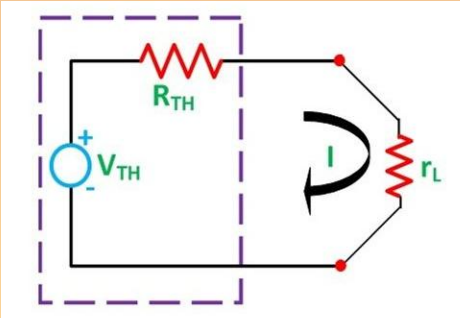
In order to find the current through the load resistance R_L as shown in the circuit diagram below



Step 1:- Thevenin's equivalent circuit is drawn by keeping the equivalent resistance R_{th} in series with Thevenin Voltage V_{th}.

The load current $\mathbf{I_L}$ is given as:

$$I_L = \frac{V_{TH}}{R_{TH} + r_L}$$



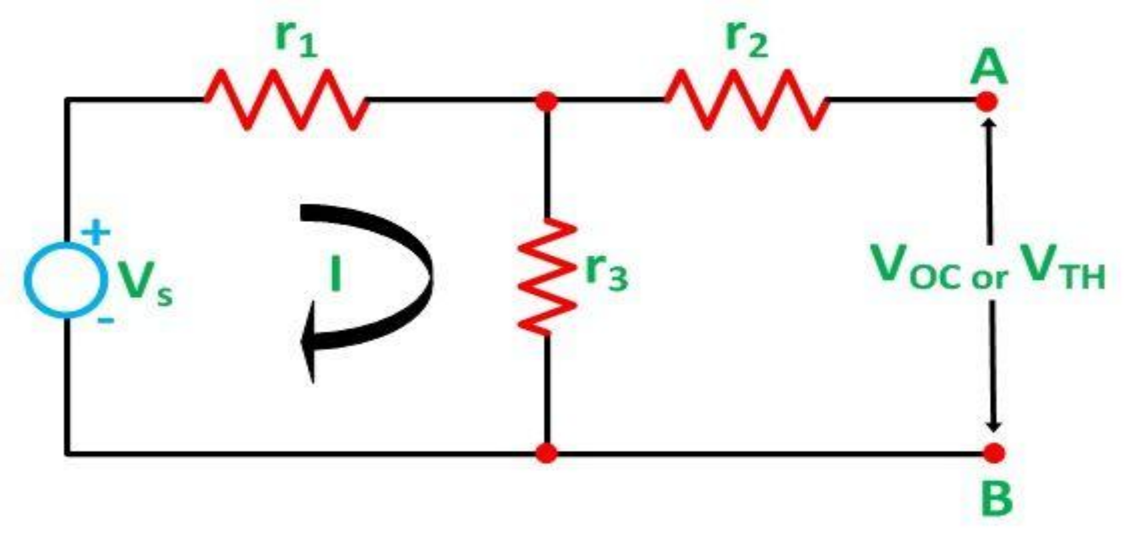
$\mathbf{V_{TH}}$ is the Thevenin's equivalent voltage
$\mathbf{R_{TH}}$ is the Thevenin's equivalent resistance
$\mathbf{r_L}$ is the **load resistance**

EXPLANATION OF THEVENIN'S THEOREM

Step 2:

In order to find V_{TH}, open the load terminals from the circuit as shown in the figure below and V_{oc} or V_{TH} is calculated.

$$V_{OC} = I\, r_3 = \frac{V_S}{r_1 + r_3}\, r_3$$

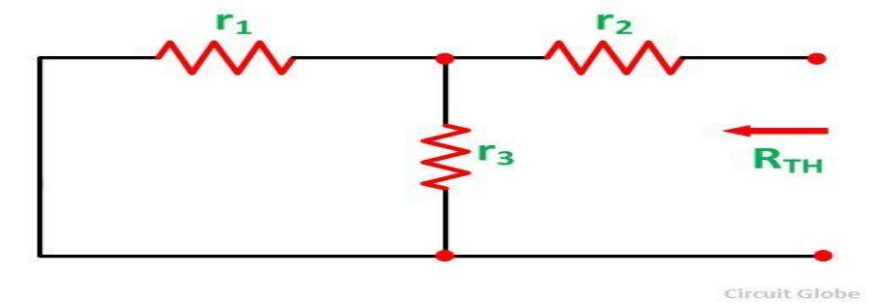


EXPLANATION OF THEVENIN'S THEOREM

Step 3 – Find the equivalent resistance R_{eq} of the source network by deactivating the constant sources as shown in the circuit diagram below and the value of the equivalent resistance is calculated by:

$$Req = r_1 || r_3 + r_2$$

$$Req = \frac{r1r3}{r1+r3} + r_2$$

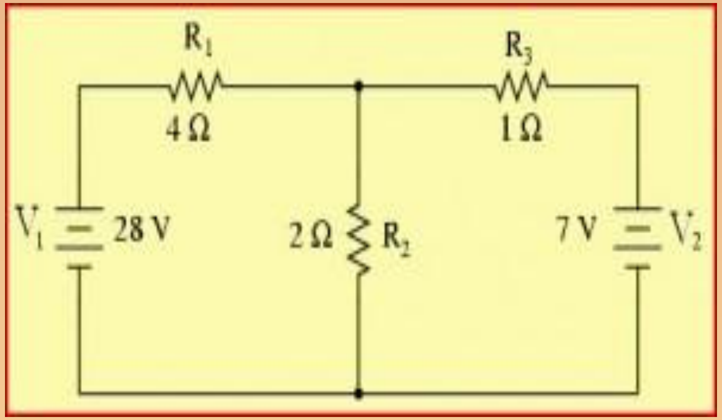


Step 4 – Reconnect the load resistance R_L of the circuit across the load terminals and find the current through it known as load current I_L.

$$I_L = \frac{V_{TH}}{R_{TH} + r_L}$$

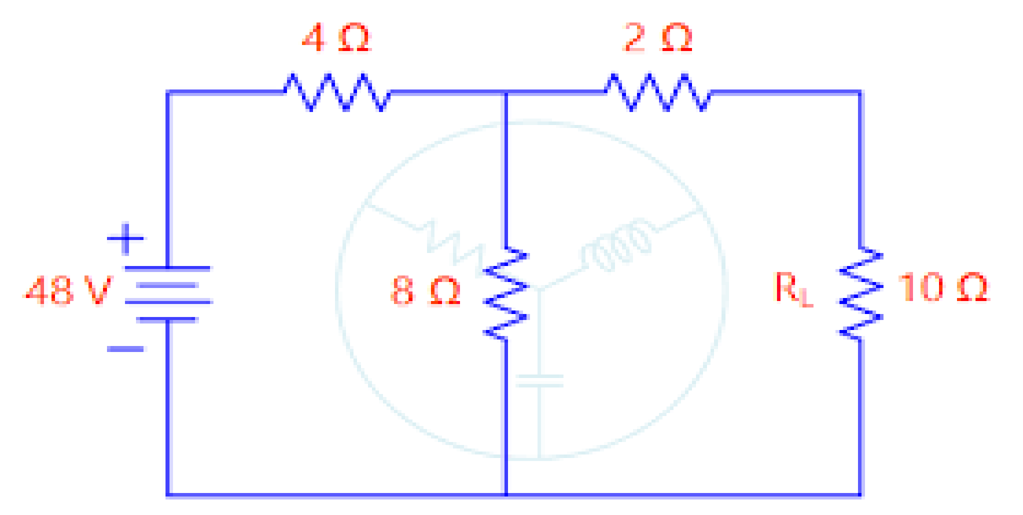
PROBLEMS RELATED TO THEOREMS

- Find the current in 2Ω resistor using Norton's Theorem



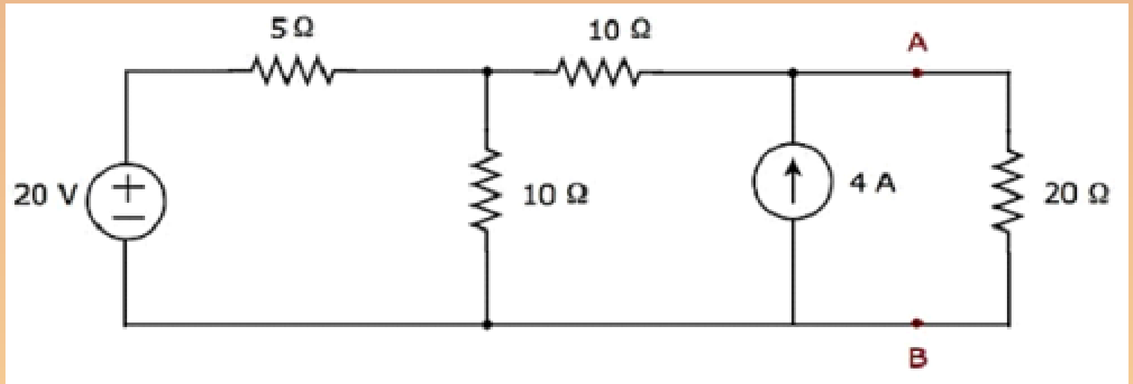
PROBLEMS RELATED TO THEOREMS

- Find the current in 10Ω resistor using Thevenin's Theorem



PROBLEMS RELATED TO THEOREMS

- Find the current in 20Ω resistor using Thevenin's Theorem



THANKS