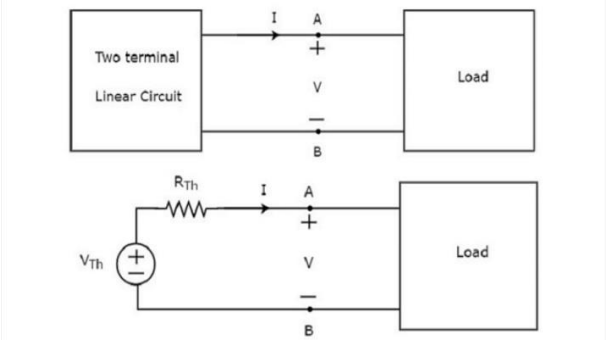
Thevenin's Theorem

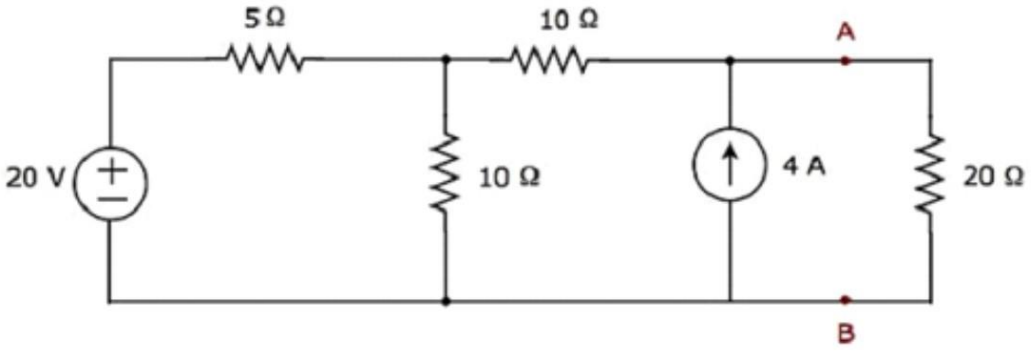
Thevenin's theorem states that any Two terminal linear network or circuit can be represented with an equivalent network or circuit, which consists of a Voltage source in Series with a Resistor. It is known as Thevenin's equivalent circuit.

For this presentation we shall restrict ourselves to using only independent sources



Application:

Let us say that we need to find the voltage across and current through a given load resistance (across AB) in the following network which is composed of several current and voltage sources interconnected with each other.



Steps Involved:

Step 1 – Consider the circuit diagram by opening the terminals.

Step 2 – Find Thevenin's voltage $\mathbf{V_{Th}}$.

Step 3 – Find Thevenin's resistance $\mathbf{R_{Th}}$ across the open terminals.

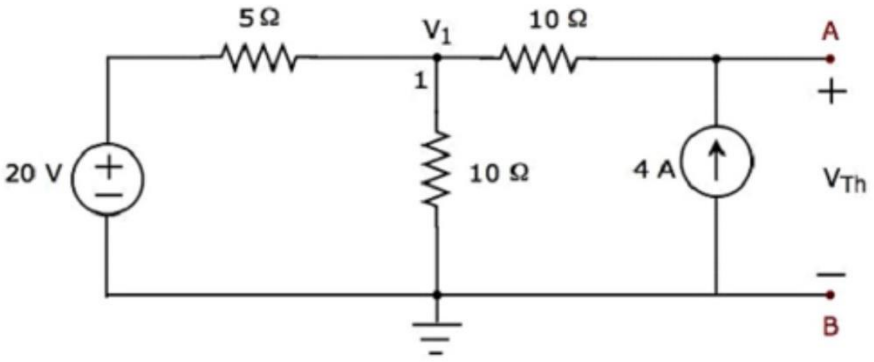
Step 4 – Draw the **Thevenin's equivalent circuit.**

Example:

Q. Find the current flowing through 20 Ω resistor by first finding a **Thevenin's equivalent circuit** to the left of terminals A and B.

Step 1 – Opening the terminals

Remove the 20 Ω resistor from the network by **opening the terminals A & B**.



Step 2 – Calculation of **Thevenin's voltage V_{Th}**.

Nodal analysis:

Nodal equation at node 1:

$$\frac{V_1 - 20}{5} + \frac{V_1}{10} - 4 = 0 \qquad \Rightarrow 3V_1 - 80 = 0$$

$$\Rightarrow \frac{2V_1 - 40 + V_1 - 40}{10} = 0 \qquad \Rightarrow V_1 = \frac{80}{3}V$$

The voltage across series branch 10 Ω resistor is

$$V_{10\Omega} = (-4)\,(10) = -40V$$

The **KVL equation** around second mesh is: $V_1 - V_{10\Omega} - V_{Th} = 0$

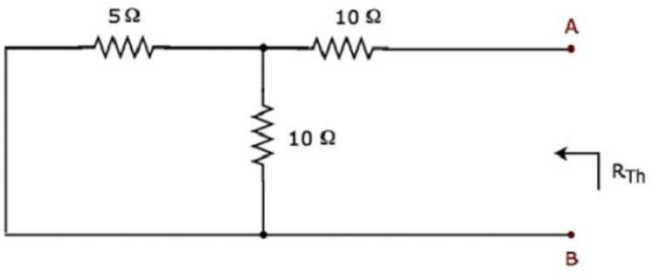
Substituting V_1 and $V_{10\Omega}$ in above equation:

$$\frac{80}{3} - (-40) - V_{Th} = 0$$

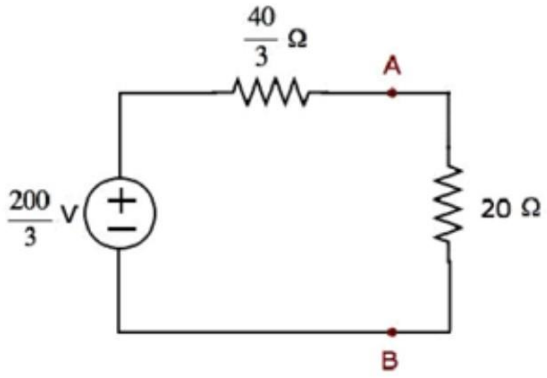
$$V_{Th} = \frac{80 + 120}{3} = \frac{200}{3}V$$

Step 3 – Calculation of **Thevenin's resistance R_{Th}**.

$$R_{Th} = (\frac{5 \times 10}{5 + 10}) + 10 = \frac{10}{3} + 10 = \frac{40}{3}\Omega$$



Step 4 − The Thevenin’s equivalent circuit is placed to the left of terminals A & B.



$$l = \frac{V_{Th}}{R_{Th} + R}$$

$$l = \frac{\frac{200}{3}}{\frac{40}{3} + 20} = \frac{200}{100} = 2A$$