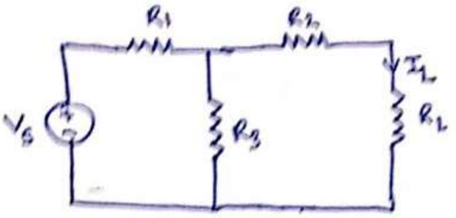
Network Theorems

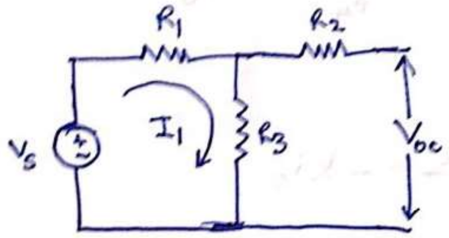
1. Thevenin's Theorem:

• **Statement**

Explanation



Step 1: Remove R_L to find V_{oc} (open circuit voltage)

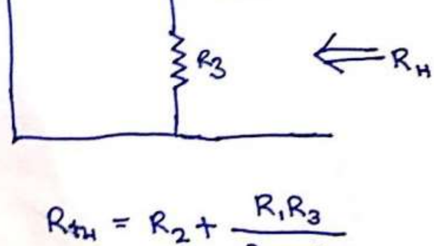


$$V_{oc} = I_1 . R_3$$

$$= \frac{V_s}{R_1 + R_3} \cdot R_3$$

Step 2: To find R_{th}

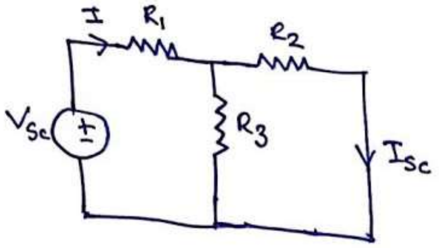
a) if only independent source exist, deactivate each source ~~by~~ internal resistance.



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

b) If both dependent and independent source exist.
Calculate I_{sc}.

$$R_{th} = \frac{V_{oc}}{I_{sc}} \Omega$$



$$I_{sc} = I \frac{R_3}{R_2 + R_3}$$

$$I = \frac{V_s}{R_1 + \frac{R_2 R_3}{R_2 + R_3}}$$

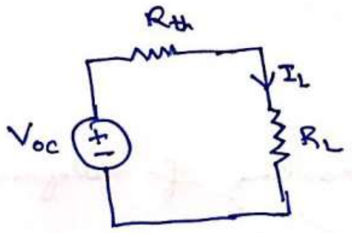
c) <u>if only dependent source exist.</u>

Connect one external voltage source of V_{dc} which flows I_{dc}. Calculate $R_{th} = \frac{V_{dc}}{I_{dc}} \Omega$.

<u>Step 3:</u>

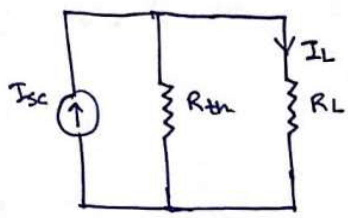
Reconnect R_L to find I_L

<u>Thevenin's Equivalent Circuit</u>



$$I_L = \frac{V_{oc}}{R_{th} + R_L}$$

Norton's Equivalent Circuit



$$I_L = I \frac{R_{th}}{R_{th} + R_L}$$

1.

Thevenin's Theorem:

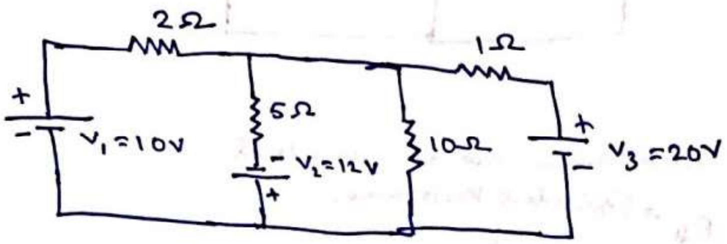
A linear active network consisting of independent and/or dependent voltage ~~sou~~ and current source and linear bilateral network elements can be replaced by an equivalent circuit consisting of a voltage source in series with a resistance, the voltage source being the open circuit voltage across the open circuited node terminals and the resistance being the internal resistance of the source network, looking through the open circuited node terminals.

Norton's Theorem:

A linear active network consisting of independent and/or dependent voltage and current source and linear bilateral network elements can be replaced by an equivalent circuit consisting of current source in parallel with a resistance, the ~~s~~ current source being the short circuited current across the short circuited terminal and the resistance being the internal resistance of the source network, looking through the open circuited node terminals.

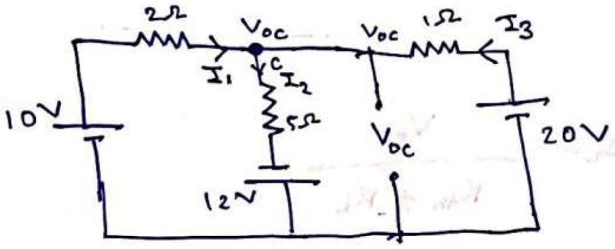
Problems:

1.



Find the current ~~the~~ through 10Ω resistor using Thevenin's Theorem.

Sol: Remove 10Ω



At node c,

$$I_1 + I_3 - I_2 = 0$$

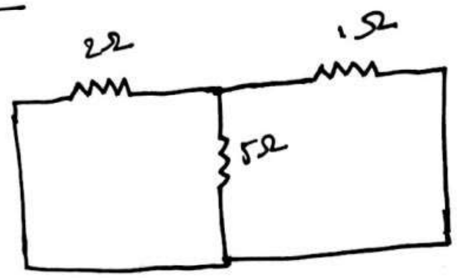
$$\Rightarrow \frac{10 - V_{oc}}{2} + \frac{20 - V_{oc}}{1} - \frac{V_{oc} + 12}{5} = 0$$

$$\Rightarrow 50 - 5V_{oc} + 200 - 10V_{oc} - 2V_{oc} + 24 = 0$$

$$\Rightarrow V_{oc} = 13.29\ V$$

~~To find~~

To find R_{th}



∴ the resistances are in parallel.

R_{th} → Equivalent Resistance

$$\therefore \cancel{R_{eq}}\ R_{th} = \frac{1}{\frac{1}{2} + 1 + \frac{1}{5}}$$

$$= \frac{1}{\frac{5+10+2}{10}} = \frac{10}{17}\ \Omega$$

$$\therefore I_L = \frac{V_{oc}}{R_{th} + R_L}$$

$$= \frac{13.29}{\frac{10}{17} + 10}\ A$$

$$= 1.26\ A$$