اسس كهرباء

قسم هندسة تقنيات التبريد والتكييف

المرحلة الاولى

المحاضرة الخامسة

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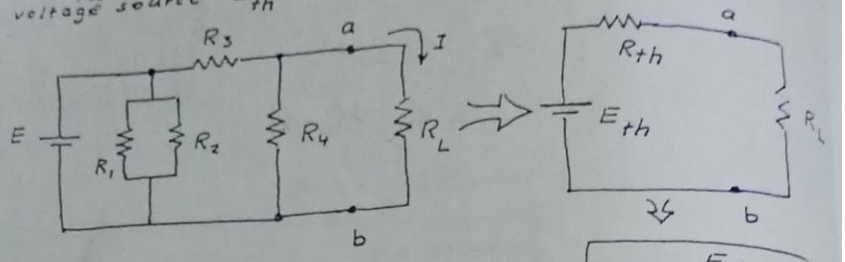
3.2 **Thevenin's Theorem** : Thevenins theorem states that " Any two terminal linear bilateral dc network can be replaced by an equivalent circuit consisting of a voltage source and a series resistor.

Consider the network shown, it can be replaced by the voltage source E_{th} and the series resistor R_{th} :



* To find I through the resistance R_L $\Rightarrow$ $$I = \frac{E_{th}}{R_{th} + R_L}$$

* **Steps to find E_{th} and R_{th} :**

STEP 1 : Remove that portion of the network across which the Thevenins equivalent circuit is to be found.

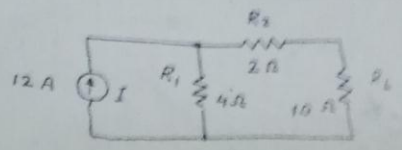
STEP 2 : Mark the terminals of the remaining two-terminal network.

STEP 3 (R_{th}) : Calculate R_{th} by first setting all sources to zero (voltage sources are replaced by short circuits and current sources are replaced by open circuits), and finding the resultant resistance between the two marked terminals.

STEP 4 (E_{th}) : Calculate E_{th} by first returning all sources to their origin positions and finding the open circuit voltage between the marked terminals

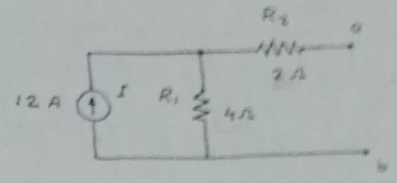
STEP 5 : Draw the Thevenins equivalent circuit with the portion of t circuit previously removed replaced between the terminals of the equivalent circuit.

Example: Using Thevenins theorem, find the current in the $R_L = 10\,\Omega$ of the network shown.



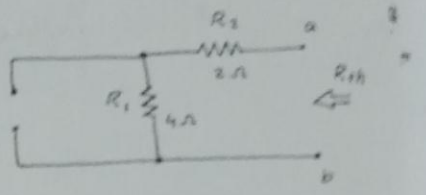
Solution:

steps 1 and 2:



step 3: $R_{th} = ?$

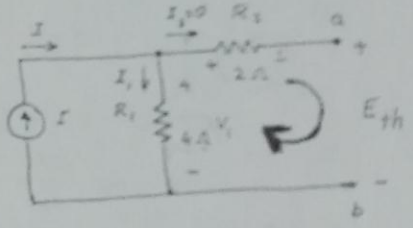
Remove the current source I, then calculate R_{th} between the terminals a and b:



$\therefore R_{th} = R_1 + R_2 = 4 + 2 = 6\,\Omega$

step 4: $E_{th} = ?$

Return the current source to its original position then determine E_{th} across the open circuit terminals a and b.



$I_2 = 0$

$\Rightarrow I_2 R_2 = 0$

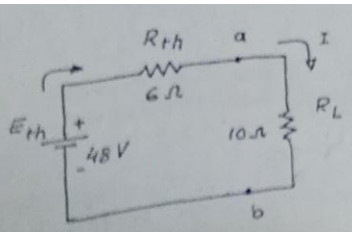
Then

$E_{th} = I_1 R_1 - I_2 R_2$

$= I_1 R_1 = 12(4)$

$= 48\ V$

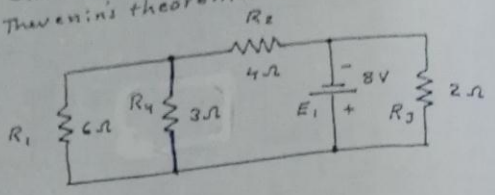
step 5: Draw the Thevenins equivalent circuit representing the network between points a and b with R_L added



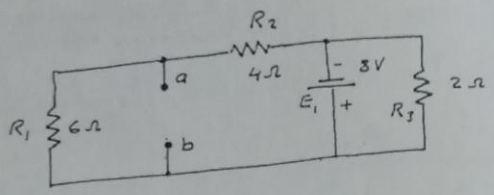
$$\therefore I = \frac{E_{th}}{R_{th} + R_L}$$

$$= \frac{48}{6+10} = 3\ A$$

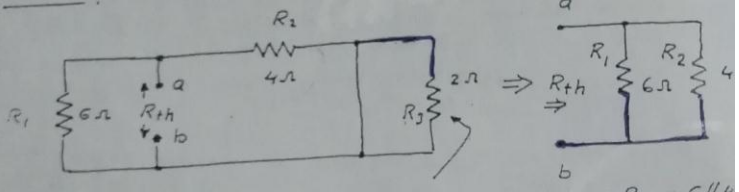
Example: For the circuit shown, find the current in the 3-Ω resistor using Thevenin's theorem.



Solution: steps 1 and 2



step 3: $R_{th} = ?$

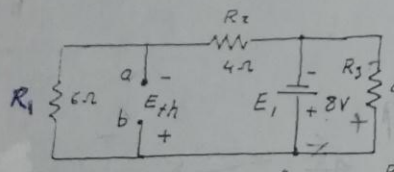


$$\therefore R_{th} = \frac{6(4)}{6+4} = 2.4\ \Omega$$

$R_{th} = 6 \| 4$

$= 2.4$

step 4: $E_{th} = ?$

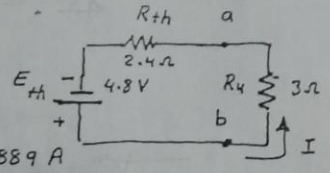


using the voltage di

$$E_{th} = E_1 \frac{R_1}{R_1 + R_2} = 8$$

$$= 4.8\ V$$

step 5



$$\therefore I = \frac{E_{th}}{R_{th} + R_4}$$

$$= \frac{4.8}{2.4+3} = 0.889\ A$$