Superposition Theorem

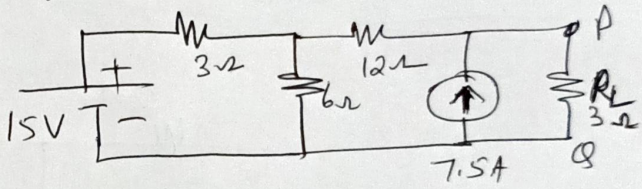
— When Current Source & Voltage Source both are present

— Consider Voltage Source alone and open circuit Current Source. Then find Load Current

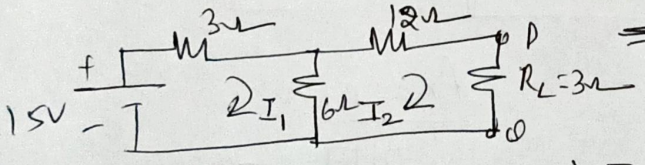
Consider Current Source alone and Short Circuit Voltage Source, find the load Current.

By Superposition theorem Add both the Currents if it is in same direction.

Example :- Find current through 3Ω (RL) Resistor By Super-position Theorem



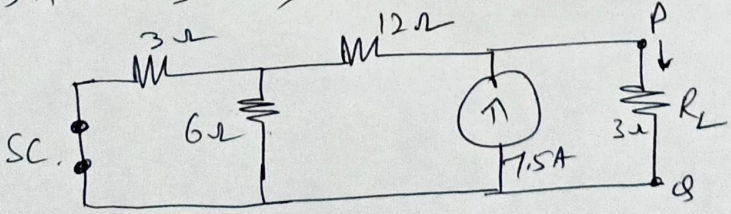
When 15V acting alone, Open circuit 7.5A Source



$$\Rightarrow \begin{bmatrix} 9 & -6 \\ -6 & 21 \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \end{bmatrix} = \begin{bmatrix} +15 \\ 0 \end{bmatrix}$$

$\therefore I_2 = 0.588A$ from P to Q

When 7.5A acting alone, Short Circuit 15V Battery, Draw the circuit



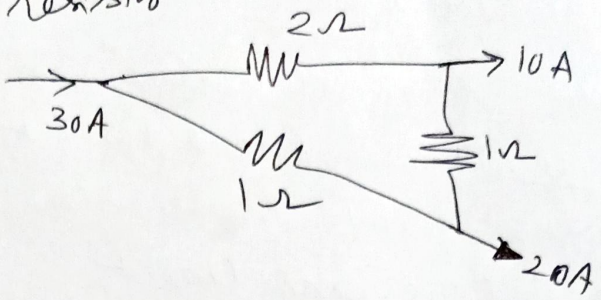
Using Current Division formula $I_{PQ} = \dfrac{7.5 \times \left[\frac{3\times6}{3+6} + 12\right]}{\frac{3\times6}{3+6} + 12 + 3} = 6.17A$

$\therefore$ 6.17A from P to Q

By Superposition Theorem Current thro' R_L $= 0.588 + 6.17 =$ 6.7647 Amps

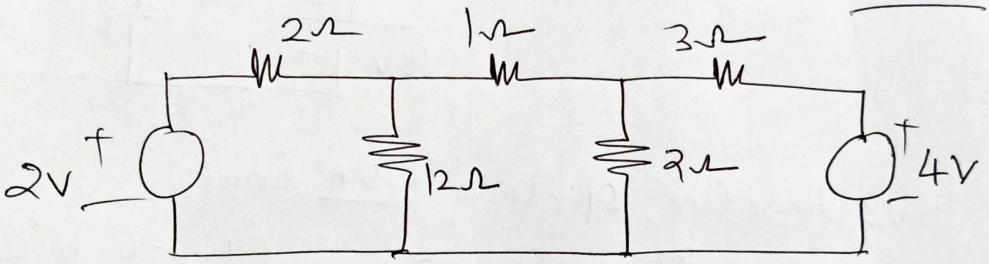
ANSWER

Home Work using Superposition Theorem find Current Thro' 2Ω Resistor.



ANSWER: 10 Amps.

Home Work: Find Current Thro' 3Ω resistor by Superposition Theorem



ANSWER :-

0.1752 − 0.9635

= 0.7883A ANSWER

(4): Thevenin's theorem:-

- This theorem is very helpful in finding current through or voltage across of any complicated network consisting of more number of sources and Resistors.

Statement:-

Any Linear network consisting of emf's and resistors can be replaced by an equivalent voltage source V_{Th} in series with an resistor R_{Th}, when seen from two points A & B as shown in the figure (b)

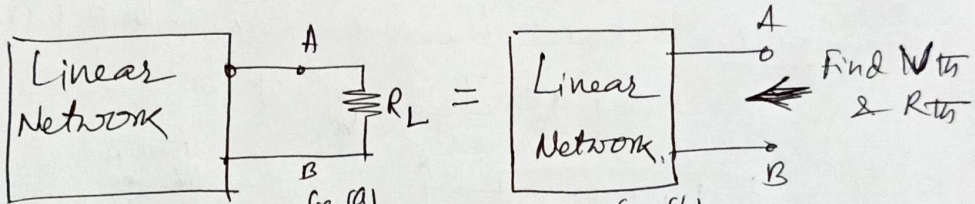


fig (a) fig (b)

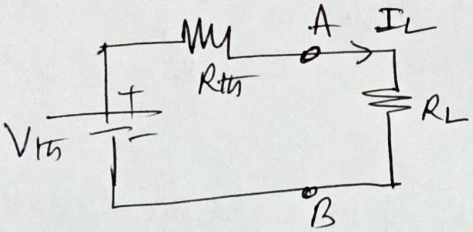


fig (c)

- As shown in fig (c), the entire Circuit is replaced by V_{Th} and R_{Th} as shown. Connect R_L between A & B. Then find Load Current. $\therefore I_L = \text{Load Current} = \frac{V_{Th}}{R_{Th}+R_L}$

Where V_{Th} is called open Circuit voltage or Thevenin's voltage and it is calculated from Circuit b.

R_{Th} is called Open Circuit Resistance or Thevenin's Resistor and it is calculated from Circuit b

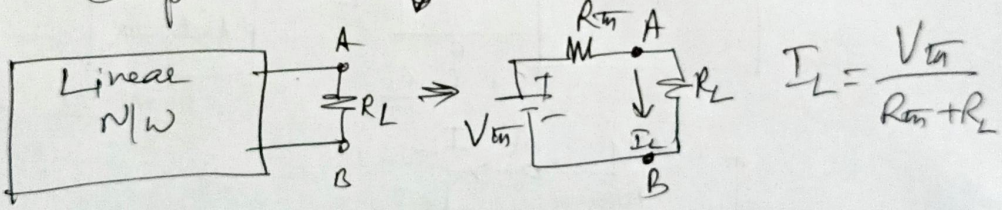
Steps involved in Solution of Network using Thevenin's Theorem

— **Step 1:-** Remove the Load Resistance and mark as A & B

— **Step 2:-** To find R_{th}, replace all Voltage Sources by their internal resistance and Current Source by open Circuit
Find Resistance ACross A & B, This gives R_{th}.

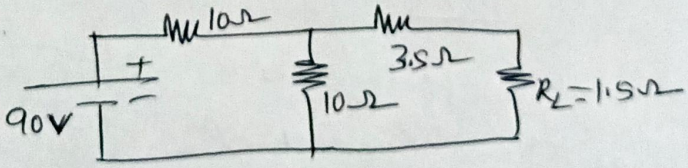
— **Step 3:-** Find the open Circuit Voltage V_{AB} for the Step 1 Circuit, and is called V_{th}.

— **Step 4:-** Draw Thevenin's Equivalent Circuit, Then Compute I_L



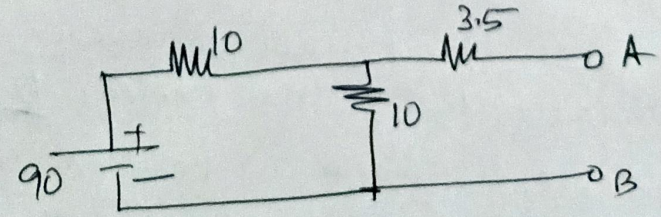
Example 1:-

Find the Current through R_L of 1.5Ω, for the Circuit shown in the figure

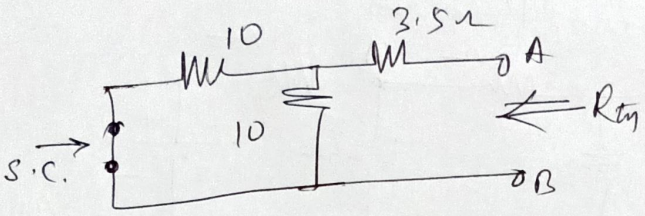


Answer: 4.1 A

Solution:- **I-step** - Remove R_L and Mark A and B

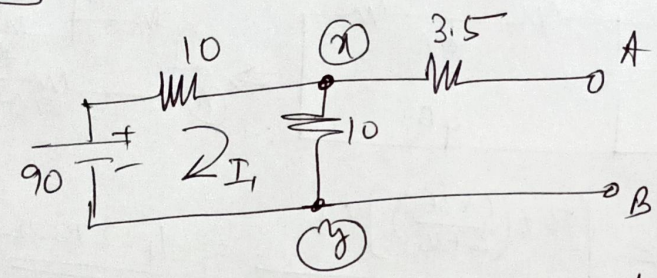


II-Step — To find R_{Th}, Replace All Voltage Source by Short Circuit



$$\therefore R_{Th} = \frac{(10\times10)}{(10+10)} + 3.5 = \underline{8.5\Omega} = R_{Th}.$$

III-Step — To find V_{Th}, find open Circuit voltage of Step-1 Circuit



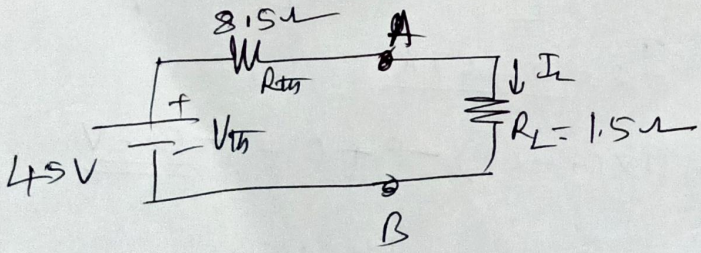
- Here the voltage across AB is equal to voltage across loop

$\therefore V_{AB} = V_{xy}$

- Let I_1 be the mesh current $\therefore I_1 = \frac{90}{10+10} = \underline{4.5A}$

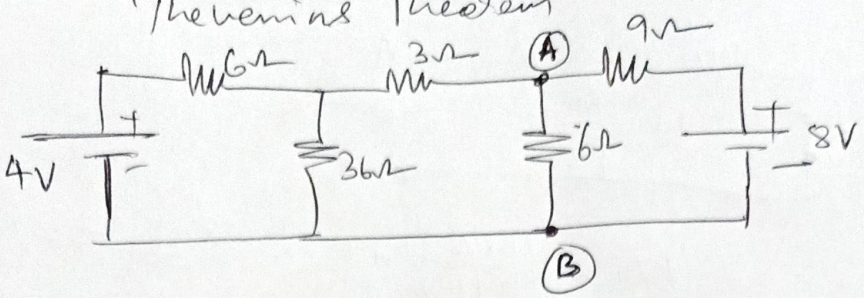
- $\therefore V_{xy} = 10 \times 4.5 = 45V = V_{Th}$

IV step Write Thevenin's Equivalent Circuit then find I_L



$$I_L = \frac{V_{Th}}{R_{Th}+R_L} = \frac{45}{8.5+1.5} = \underline{4.5A}$$ **ANSWER**

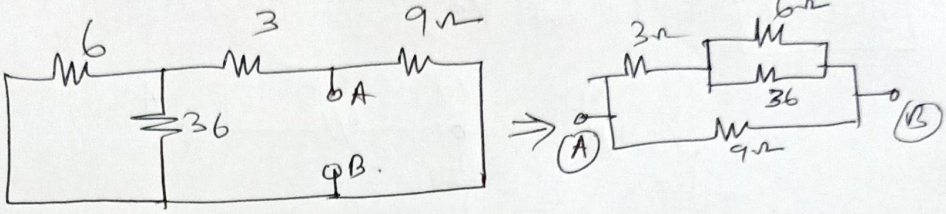
Problem 2 Find current through 6Ω resistor using Thevenin's Theorem



Ans: 0.545A

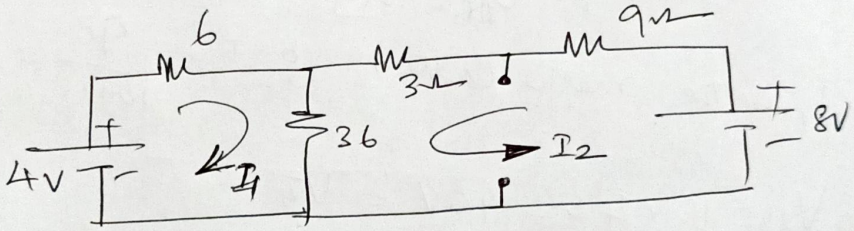
Solution

TO find R_{th}



$$R_{AB} = R_{th} = \frac{\left[3+\left(\frac{6\times36}{6+36}\right)\right]\times9}{3+\left(\frac{6\times36}{6+36}\right)+9} = 4.275\Omega$$

TO find V_{th}



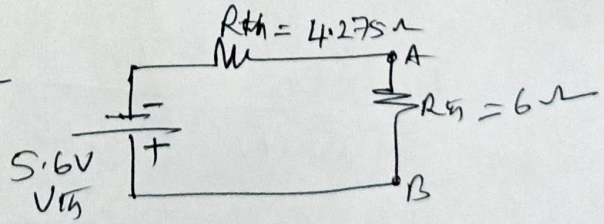
By Matrix Method

$$\begin{bmatrix} 42 & +36 \\ +36 & 48 \end{bmatrix}\begin{bmatrix} I_1 \\ I_2 \end{bmatrix} = \begin{bmatrix} +4 \\ +8 \end{bmatrix}$$

$$I_2 = 0.2667A$$

$$\therefore V_{th} = (9\times0.2667) - 8 + 0 = -5.6V$$

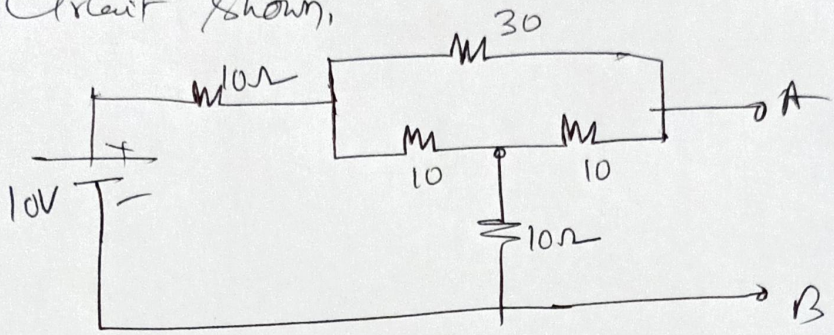
Thevenin's Equivalent



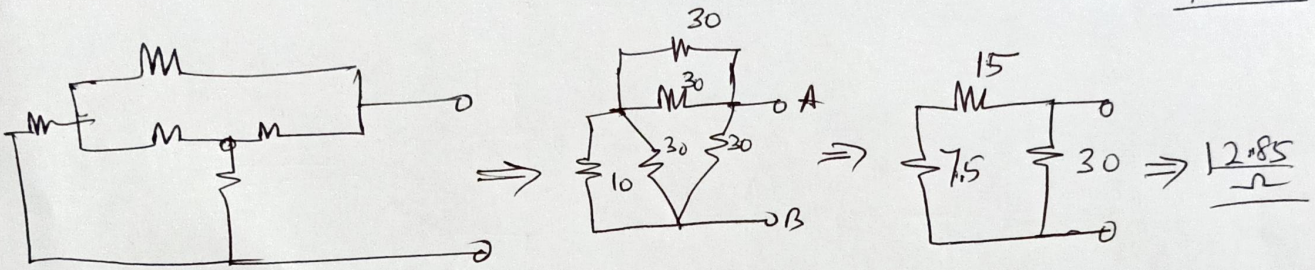
$$I_L = \frac{5.6}{4.275+6} = 0.545A$$

Problem 3.

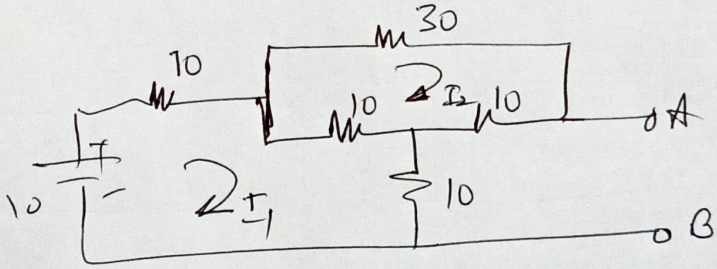
Find Thevenin Equivalent Circuit across AB of the Circuit shown.



Ans: 4.28V, 12.8Ω



To find V_{th}



By Matrix Method $\begin{bmatrix} 30 & -10 \\ -10 & 50 \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \end{bmatrix} = \begin{bmatrix} 10 \\ 0 \end{bmatrix}$

$I_1 = 0.35A, \quad I_2 = 0.071A$

$V_{th} = (-10 \times 0.071) - (10 \times 0.35) = -4.28V$