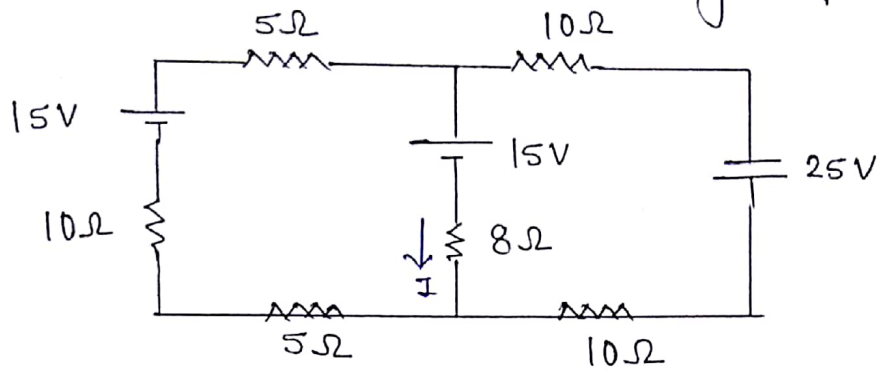
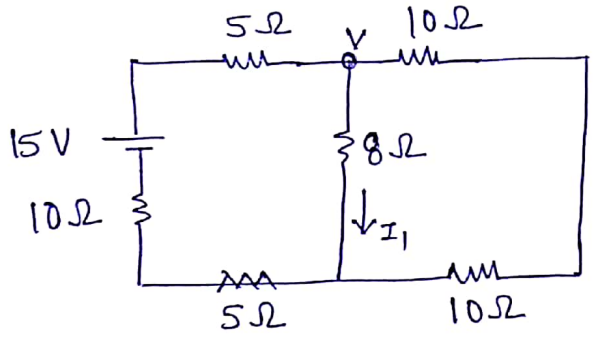
Que: Find current in each branch using superposition Theorem



Solution:

STEP 1:-

Consider 15V volt source & short circuit 15V & 25V volt. source. (



Apply KVL at node 1

$$\frac{V-15}{(5+10+5)} + \frac{V}{8} + \frac{V}{(10+10)} = 0$$

$$\frac{V-15}{20} + \frac{V}{8} + \frac{V}{20} = 0$$

$$\frac{2(V-15)+5V+2V}{40} = 0$$

$$9V = 300$$

$$V = 33.33V$$

$$I_1 = \frac{V}{8} = \frac{33.33}{8} = 4.167A$$

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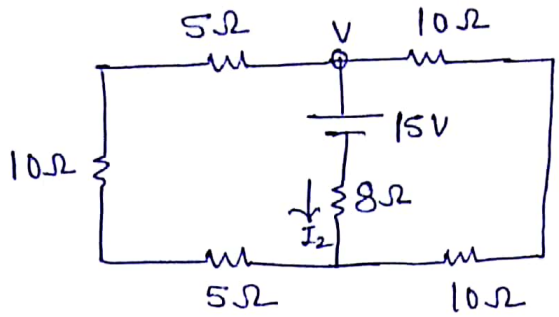
STEP-2

Consider 15V source & short circuit another 15V & 25V volt. source.



$$\frac{V}{(5+10+5)} + \frac{V-15}{8} + \frac{V}{(10+10)} = 0$$

$$\frac{2V + 5(V-15) + 2V}{40} = 0$$

$$\frac{9V - 75}{40} = 0$$

$$9V - 75 = 0 \times 40$$

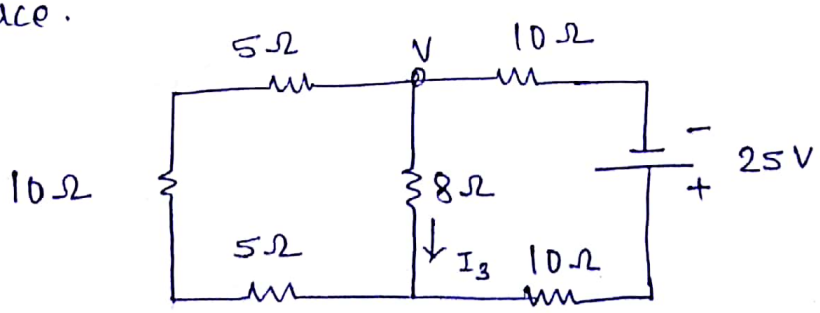
$$9V = 75$$

$$V = \frac{75}{9} = 8.333V$$

Current $I_2 = \frac{V-15}{8} = \frac{8.33-15}{8} = -0.833A$

STEP 3 :-

Consider 25V volt. source & short circuit both 15V volt. Source.



Apply kvl at node 1

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$$\frac{V}{20} + \frac{V}{8} + \frac{V+25}{20} = 0$$

$$\frac{2V + 5V + 2(V+25)}{40} = 0$$

$$9V + 50 = 0 \times 40$$

$$V = \frac{-50}{9} = -5.556V$$

$$I_3 = \frac{V+25}{20} = \frac{-5.556 + 25}{20}$$

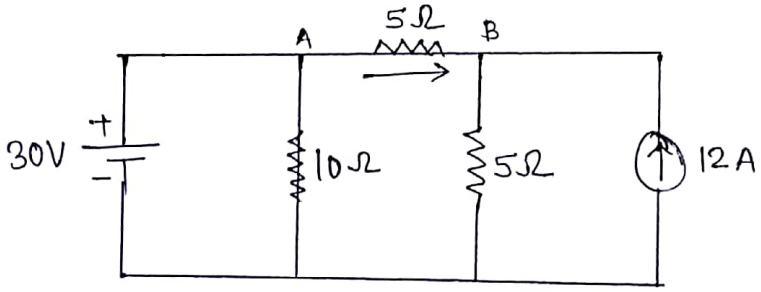
$$= 0.9722A$$

STEP-4 $I = I_1 + I_2 + I_3$

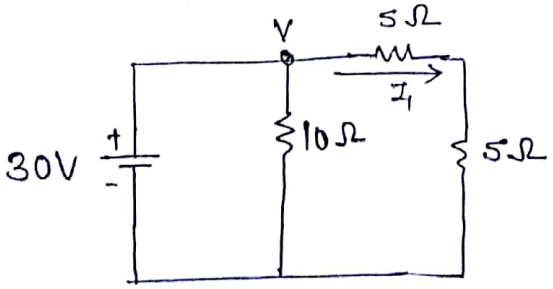
$= 4.167 - 0.833 + 0.9722A$

$= 4.3062A$

Que:- Using superposition theorem find current I_{AB}



Sdution: Step 1 consider 30V. volt. source & open circuit 12A current sour



since V = 30V (node voltage)

$$I_1 = \frac{V}{(5+5)} = \frac{30}{10} = 3A$$

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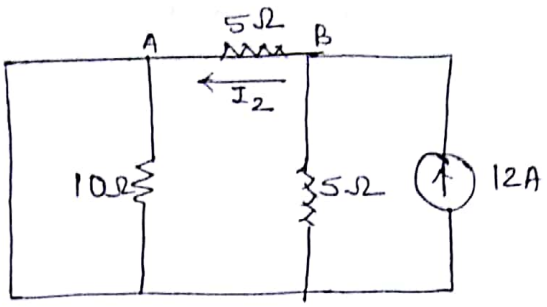
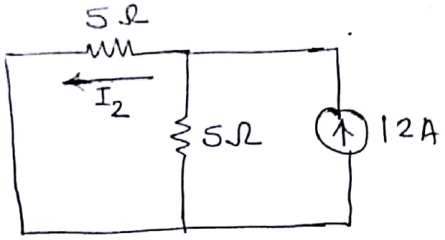
STEP 2 :- consider 12A current source & S/C 30V source.





Apply current division rule.

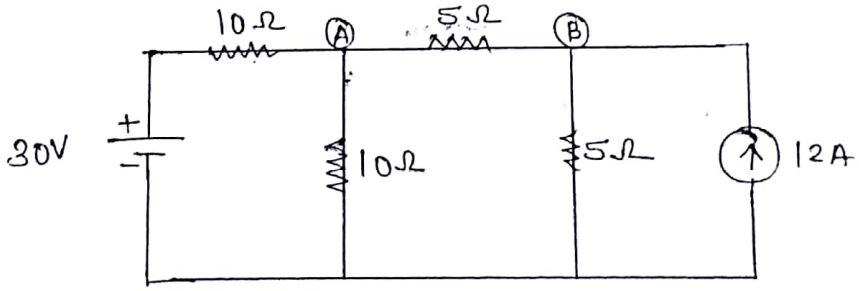
$$I_2 = \frac{12A \times 5}{5+5} = 6A$$

STEP 3 :- $I = I_1 - I_2$

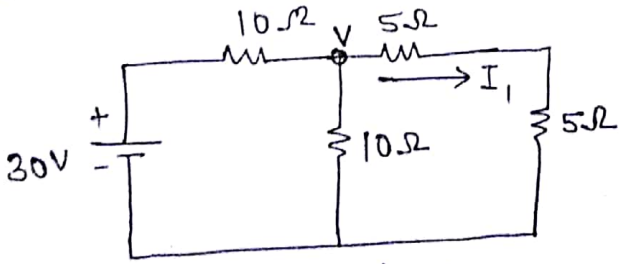
$= 3 - 6 = -3A$ (A to B)

$I = 3A$ (B to A)

Que: Find current I_{AB} using superposition Theorem :-



Solution: STEP 1. consider 30V voltage source & open circuit 12A current source.



Apply KVL at node 1

$$\frac{V-30}{10} + \frac{V}{10} + \frac{V}{10} = 0$$

$3V - 30 = 0 \quad V = 10V$

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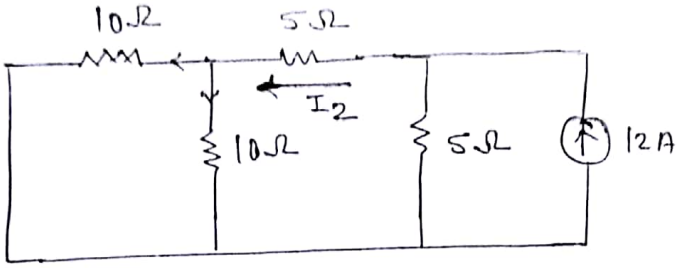
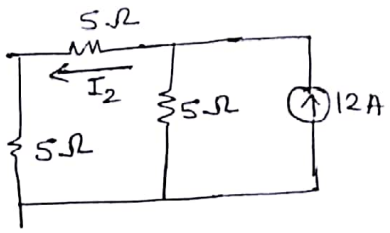
$$I_1 = \frac{V}{10} = \frac{10}{10} = 1A$$

STEP 2:- Consider 12A current source & S/C 80V source.



$10||10 = \frac{10\times10}{10+10} = 5\Omega$



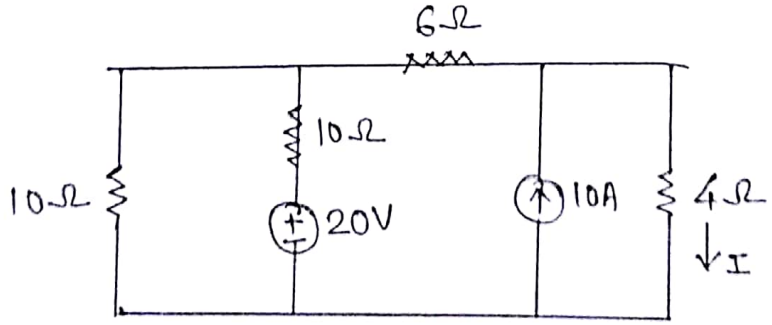
$$I_2 = \frac{12A \times 5}{5+5+5} = \frac{60}{15} = 4A$$

STEP 3:- $I = I_1 - I_2$

$= 1A - 4A = -3A$ (A to B)

$I = 3A$ (B to A)

Que: Using superposition Theorem find current in 4Ω resistor



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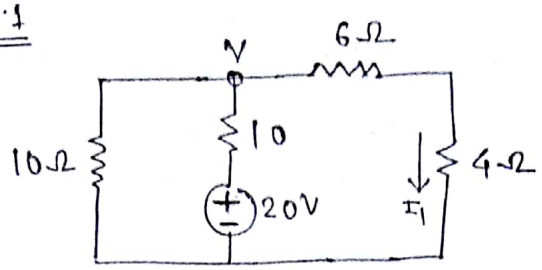
Solution:-

STEP 1



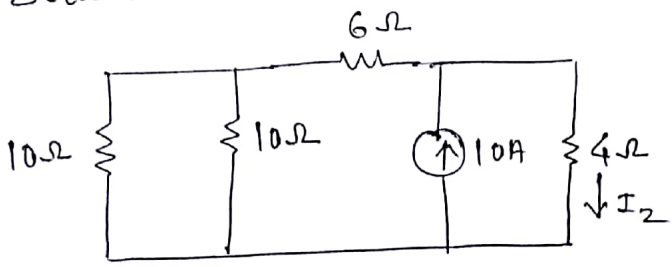
$$\frac{V}{10} + \frac{V-20}{10} + \frac{V}{10} = 0$$

$$3V - 20 = 0$$

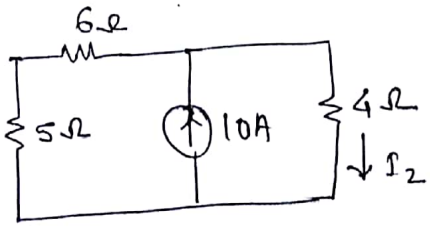
$$V = \frac{20}{3} = 6.667\,V$$

$$I_1 = \frac{V}{6+4} = \frac{6.667}{10} = 0.66667\,A$$

STEP 2:- Consider 10A current source and short circuit 20V source.



$10 \| 10 = 5\Omega$



$$I_2 = \frac{10 \times 11}{4+6+5} = 7.334\,A$$

STEP 3:-

$$I = I_1 + I_2$$

$$= 0.667 + 7.334$$

$$I = 8\,A$$

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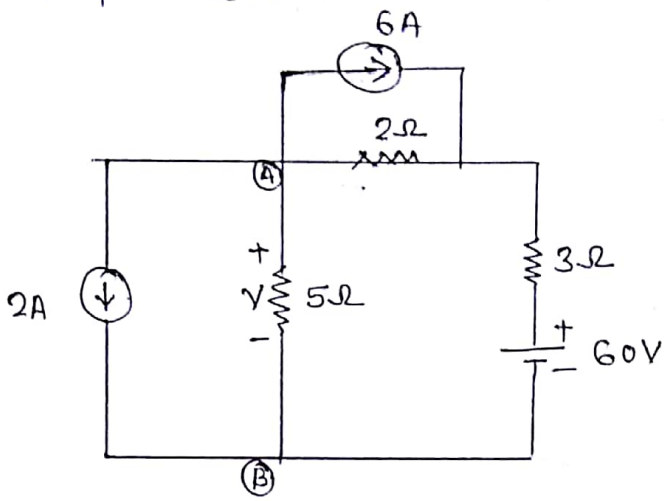
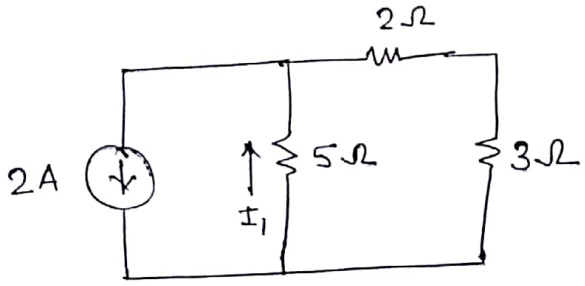
Que: Find volt. drop V across 5Ω resistor using superposition Theo -em.



Solution:-

STEP 1

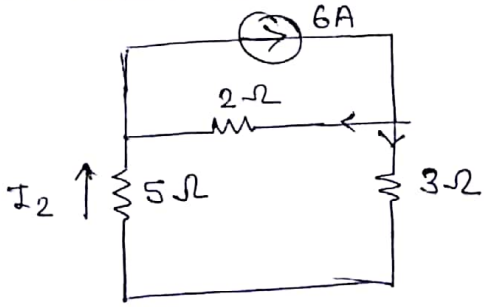
Consider 2A current source & open circuit 6A current source & short circuit 60V source.



∴ करेंट डीविजन नियम से $I_1 = \frac{2 \times 5}{5+5} = 1A$

अत: voltage $V_1 = 5 \times 1 = 5V$

STEP 2 :- Consider 6A current source and open circuit 2A current source & short circuit 60V source.



$I_2 = \frac{6 \times 2}{(2+3+5)} = \frac{12}{10} = 1.2A$

अत: voltage in 5Ω resistor = $V_2 = 5 \times 1.2 = 6V$

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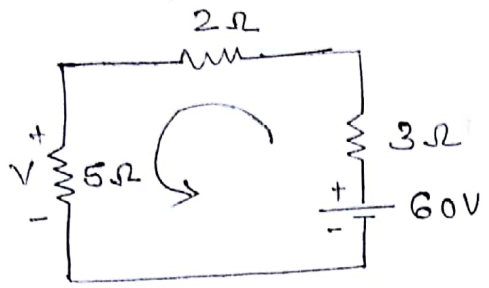
STEP3:- consider 60V voltage source & open circuit both 6A & 2A current source.



$$I_3 = \frac{60}{(3+2+5)} = 6\,A$$

$$V_3 = 5 \times 6 = 30V$$

STEP 4: $V = V_1 + V_2 + V_3$

$= 5V + 6V - 30V$

$= -19V$

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THEVENIN'S THEOREM

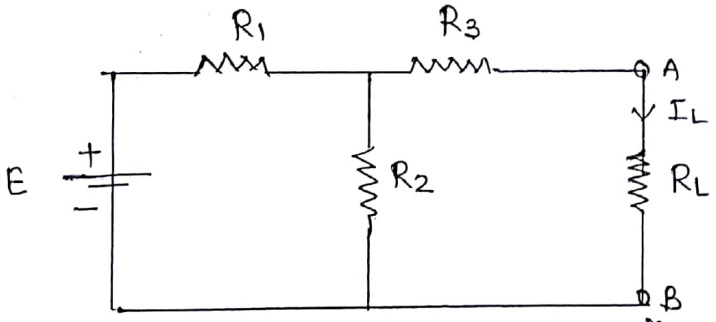
इस Theorem के अनुसार किसी linear, bilateral Network के दो टर्मीनल के बीच लोड Resistance में current flow हो रहा है तो उसे equivalent circuit के द्वारा replace कर दिया जाता है जिसमें E_{Th}, R_{Th} के साथ series में जुड़ा होता है।

जहां पर E_{Th} = Open circuit volt. या Thevenin Voltage.

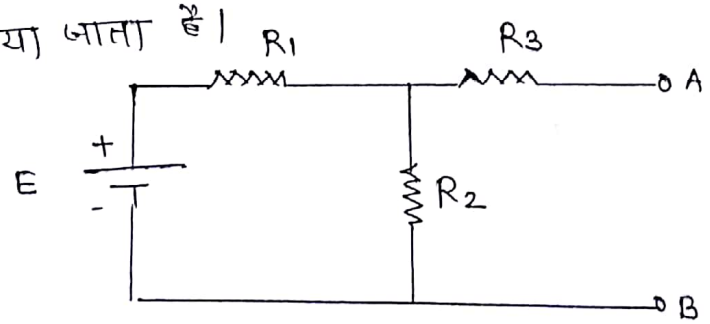
R_{Th} = Thevenin resistance.

STEPS FOR CALCULATION OF CURRENT IN THEVENIN THEOREM

STEP(1) REMOVE THE LOAD RESISTANCE (R_L)

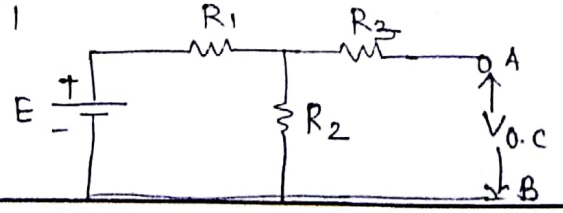


जिस प्रतिरोध में current निकालना होता है सर्वप्रथम उसे open कर दिया जाता है।



STEP(2) DETERMINATION OF OPEN CIRCUIT VOLT. (V_{Th} OR $V_{o.c}$)

लोड resistance को हटाने के पश्चात Terminal AB में open circuit volt. V_{OC} ज्ञात करते हैं।



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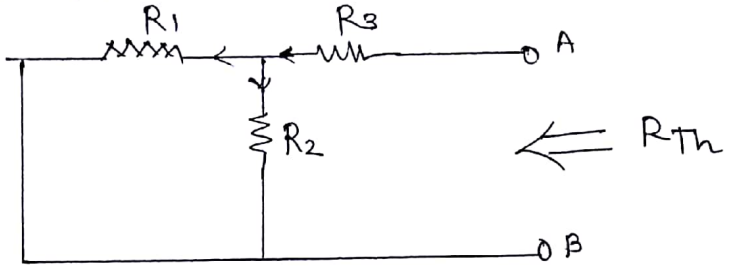
Volt. across resistance $R_2 = I_2 . R_2$

$$V_{Th} = V_{oc} = \left(\frac{E}{R_1 + R_2} \right) . R_2$$

STEP (3) DETERMINATION OF R_{Th}

सभी voltage source को short circuit कर देते हैं और current source को open circuit कर देते हैं। तथा Taminal AB के across, Thevenin resistance R_{Th} ज्ञात करते हैं।

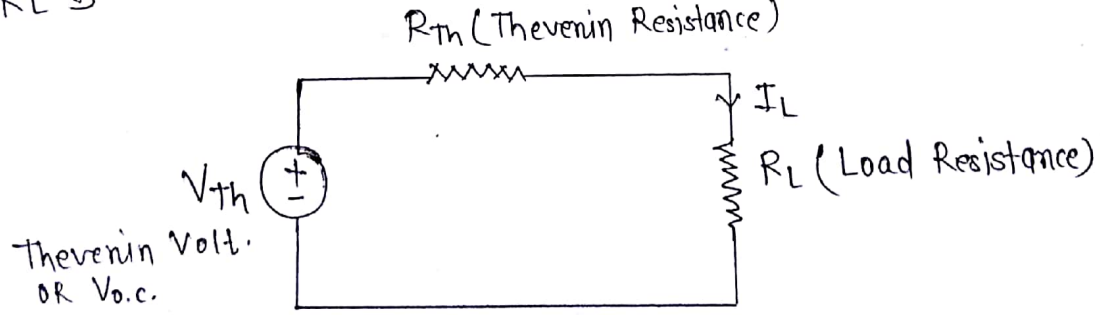


$$R_{Th} = (R_1 || R_2) + R_3$$

$$R_{Th} = \left(\frac{R_1 \times R_2}{R_1 + R_2} \right) + R_3$$

STEP (4) Equivalent circuit

इस परिपथ में Thevenin volt. (open circuit volt. V_{oc}) को R_{Th} तथा R_L के साथ series में जोड़ दिया जाता है। तथा लोड resistance R_L के across current प्राप्त किया जाता है।



$$I_L = \frac{V_{Th}}{(R_{Th} + R_L)}$$

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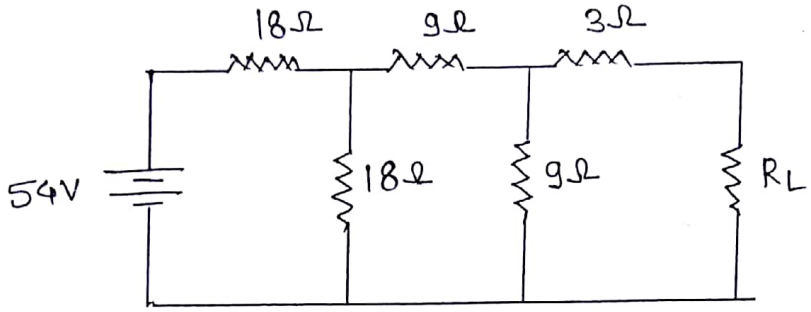
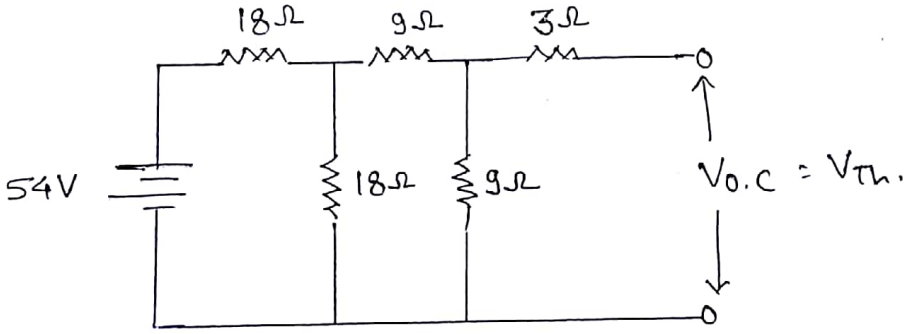
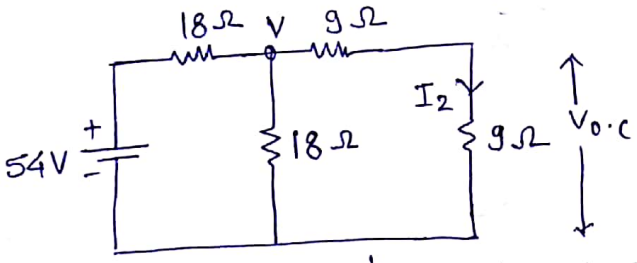
Que: Determine the current flowing through R_L when the value of load resistance is (1) 3Ω (2) 6Ω (3) 9Ω



Solution:

Step 1:- Determination of open circuit voltage V_{Th} or $V_{o.c}$





Apply nodal analysis at node 1

$$\frac{V-54}{18} + \frac{V}{18} + \frac{V}{18} = 0$$

$$3V - 54 = 0$$

$$V = \frac{54}{3} = 18$$

current in 9Ω resistor $I_2 = \frac{V}{R} = \frac{18}{18} = 1A$

So open circuit voltage $V_{o.c} = I_2 R = 1A \times 9\Omega = 9V$

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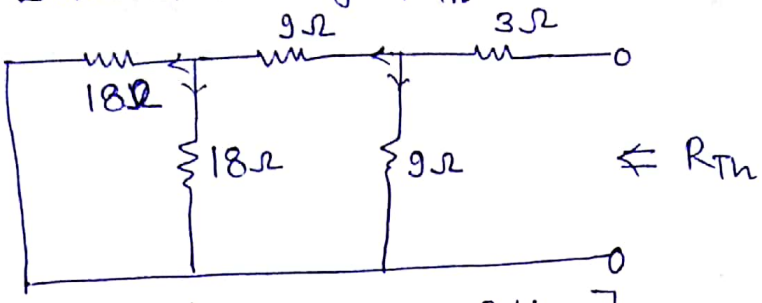
STEP 2 Determination of R_{Th}.



$$R_{Th} = \left[\left\{(18||18)+9\right\}||9\right]+3$$

$$= \left[\left\{\left(\frac{18\times18}{18+18}\right)+9\right\}||9\right]+3$$

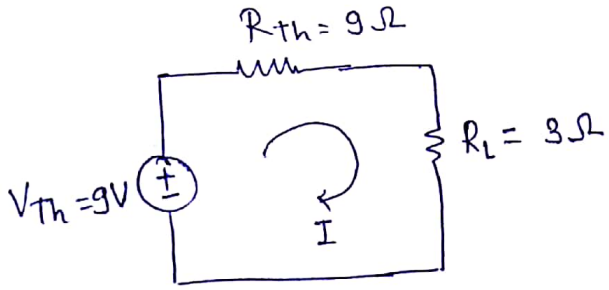
$$= \left[\left\{9+9\right\}||9\right]+3$$

$$= \left[18||9\right]+3$$

$$= \left[\frac{18\times9}{18+9}\right]+3$$

$$= 9\,\Omega$$

STEP-3 Equivalent circuit diagram:-



$$I = \frac{V_{Th}}{R_{Th}+R_L}$$

① जब $R_L = 3\Omega$ तो $I = \frac{9V}{9+3} = \frac{9}{11}A$

② $R_L = 6\Omega$ तो $I = \frac{9V}{9+6} = \frac{9}{15}A$

③ $R_L = 9\Omega$ तो $I = \frac{9V}{9+9} = \frac{1}{2}A$

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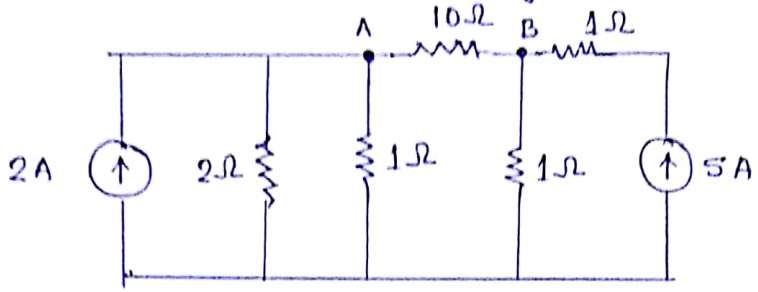
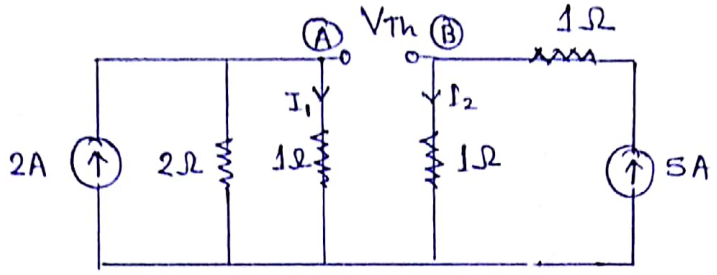
Que. Find current in 10Ω resistor using Thevenin Theorem:-



Solution:- **Step 1** Determination of V_{Th}

Remove the 10Ω resistor and calculate open circuit volt. V_{OC} OR V_{Th}



Apply current division $I_1 = \frac{2 \times 2}{1+2} = \frac{4}{3} A$

$\therefore V_A = I.R = \frac{4}{3} \times 1 = \frac{4}{3} V = 1.33V$

$I_2 = 5A$

$\therefore V_B = I.R = 5 \times 1 = 5V$

$\therefore V_{Th} = V_{AB} = V_A - V_B$

$= 1.33 - 5V$

$= -3.67V$

Step 2 - Calculation of R_{Th}

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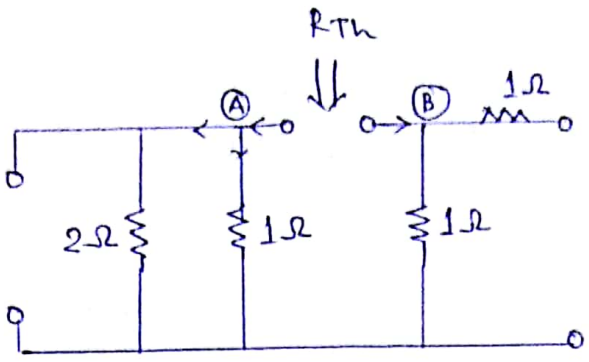
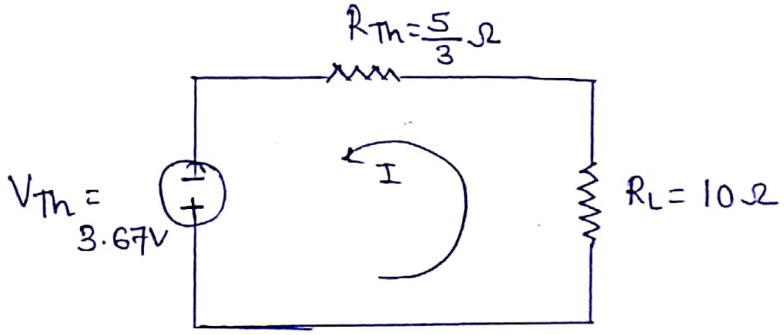


$$\therefore R_{Th} = (1 \| 2) + 1$$

$$= \frac{1 \times 2}{1+2} + 1$$

$$= \frac{5}{3}\,\Omega$$

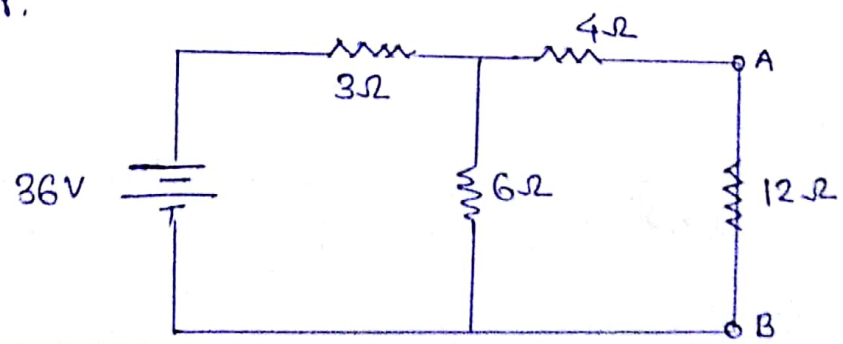
STEP 3 : Equivalent circuit diagram



$$I = \frac{V_{Th}}{R_{Th} + R_L} = \frac{3.67}{(5/3) + 10}$$

$$= 0.315\,A$$

Que: Apply thevenin theorem and find current through 12Ω resistor.



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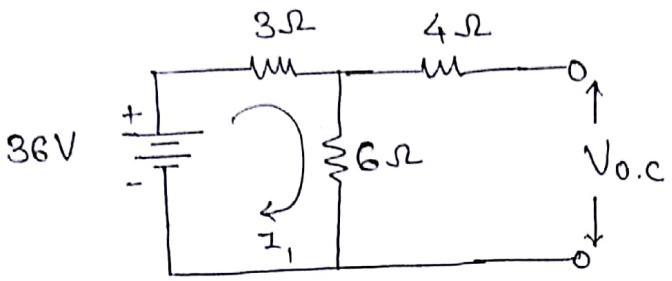
Solution:

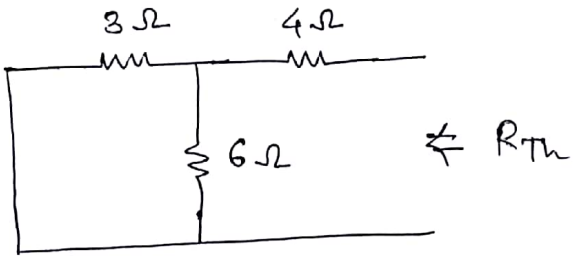
STEP 1 :- Calculation of V_{Th}



$$I_1 = \frac{36V}{9} = 4A$$

$$V_{oc} = V_{Th} = 4 \times 6 = 24V$$

STEP 2 :- Calculation of R_{Th}

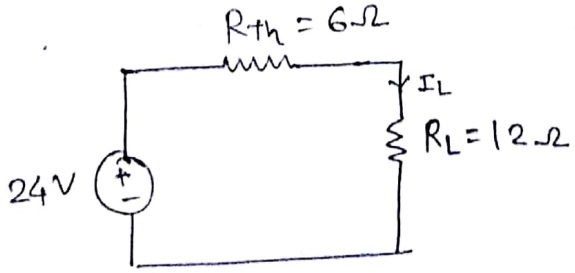


$$R_{Th} = 4 + (3||6)$$

$$= 4 + \frac{3 \times 6}{3+6}$$

$$= 6\Omega$$

STEP 3 :- Equivalent circuit



$$I_L = \frac{V_{Th}}{R_{Th} + R_L}$$

$$= \frac{24V}{6+12}$$

$$= 1.334\ A$$

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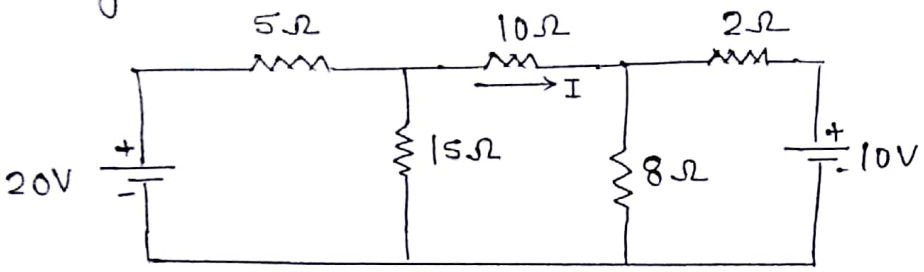
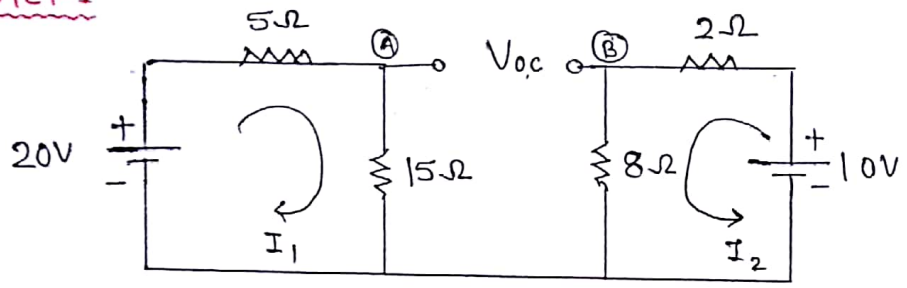
Que: Find current in 10Ω resistor in a network shown below using thevenin Theorem



Solution STEP 1



$$I_1 = \frac{20V}{5+15} = 1A$$

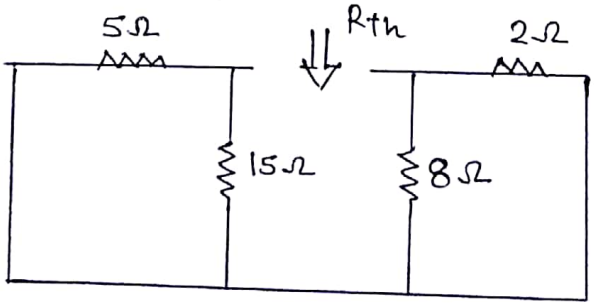
$$I_2 = \frac{10V}{2+8} = 1A$$

$$V_A = I_1 \times 15 = 1 \times 15 = 15V$$

$$V_B = I_2 \times 8 = 1 \times 8 = 8V$$

$$V_{o.c} = V_{Th} = V_{AB} = V_A - V_B$$
$$= 15V - 8V$$
$$= 7V$$

STEP 2:- Calculation of R_{Th}



$$R_{Th} = (5||15) + (8||2)$$
$$= \frac{5 \times 15}{5+15} + \frac{8 \times 2}{8+2}$$
$$= 3.75 + 1.6 = 5.35\Omega$$

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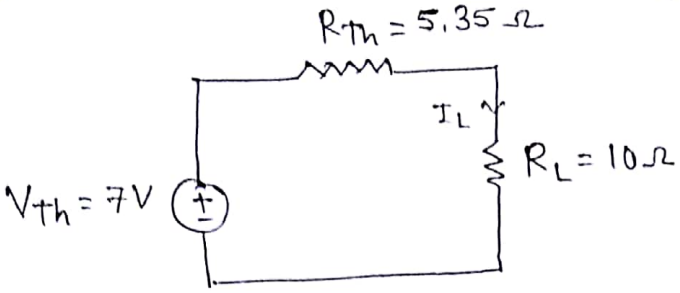
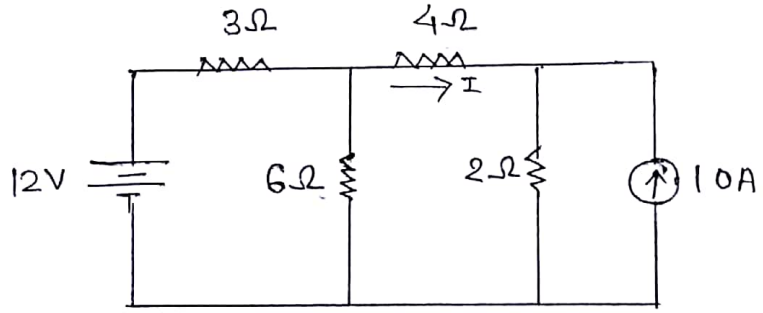
STEP 3:- ~~calc~~ equivalent circuit diagram



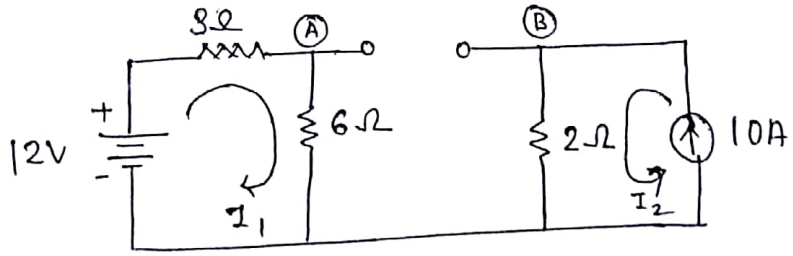
$$I_L = \frac{V_{Th}}{R_{Th} + R_L} = \frac{7}{5.35 + 10}$$

$$I_L = 0.456\,A$$

Que: Using Thevenin Theorem, calculate the current flowing through $4\,\Omega$ resistor



Solution:- STEP 1: Calculation of V_{Th}



$$I_1 = \frac{12V}{6+3} = 1.333\,A \qquad V_A = I_1 \times 6 = 1.33 \times 6 = 8V$$

$$I_2 = 10\,A \qquad V_B = I_2 \times 2 = 10 \times 2 = 20V$$

$$V_{AB} = V_{Th} = V_{oc} = 8 - 20V = -12V$$

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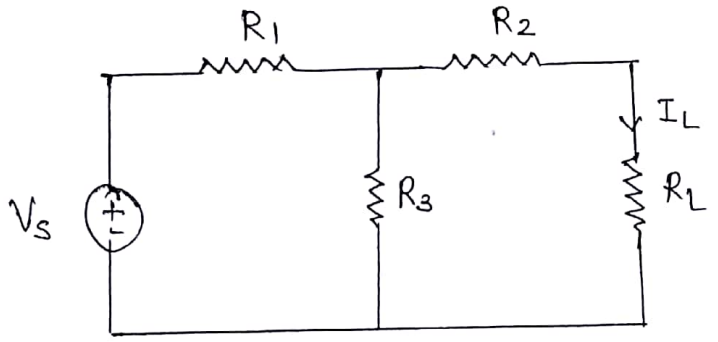
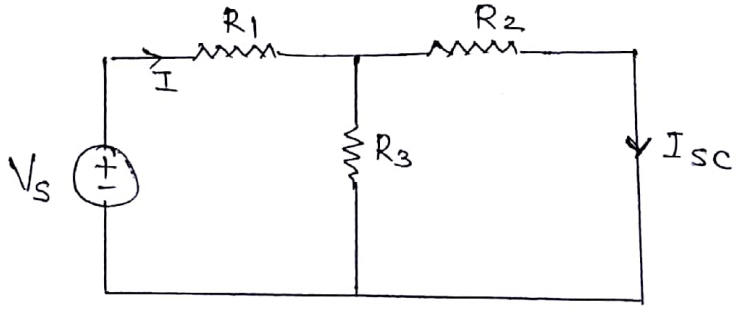
NORTON'S THEOREM

इस Theorem के अनुसार जिस लोड resistor में current निकलना होता है उसे equivalent circuit के द्वारा replace कर दिया जाता है जिसमें output current (I_N), load resistance R_N के साथ parallel लगा होता है।

STEPS FOR SOLUTION THROUGH NORTON'S THEOREM :-



STEP 1 :- SHORT CIRCUIT THE LOAD RESISTANCE R_L



STEP2 :- CALCULATION OF I_{SC} (SHORT CIRCUIT CURRENT)

$$I = \frac{V_S}{R_1 + \left(\frac{R_2 R_3}{R_2 + R_3}\right)}$$

Apply current division rule.

$$I_{SC} = \frac{I \times R_3}{R_2 + R_3}$$

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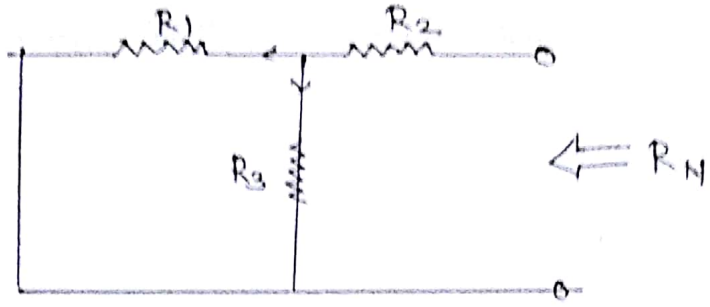
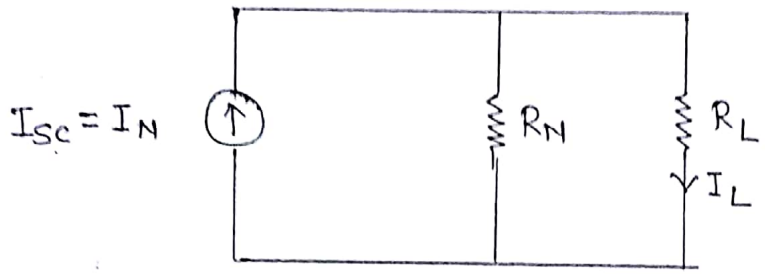
STEP3: CALCULATION OF NORTON RESISTANCE (R_N)



$$R_N \text{ (Norton Theorem)} = R_2 + (R_1 \| R_3)$$

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

STEP 4: EQUIVALENT CIRCUIT :-



$$I_L = \frac{I_{sc} \times R_N}{R_N + R_L}$$

where I_{sc} = short circuit current

R_N = Norton resistance

R_L = Load resistance

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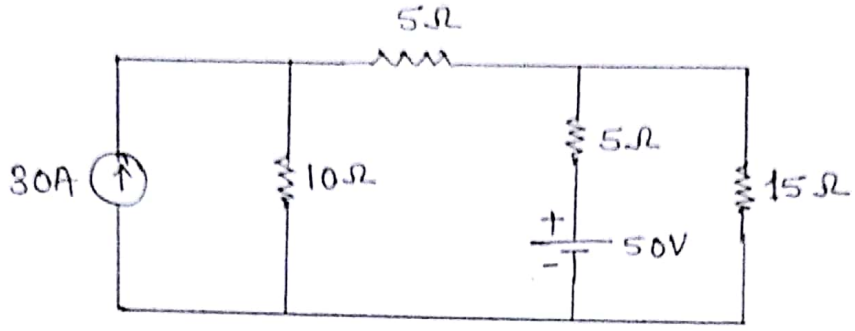
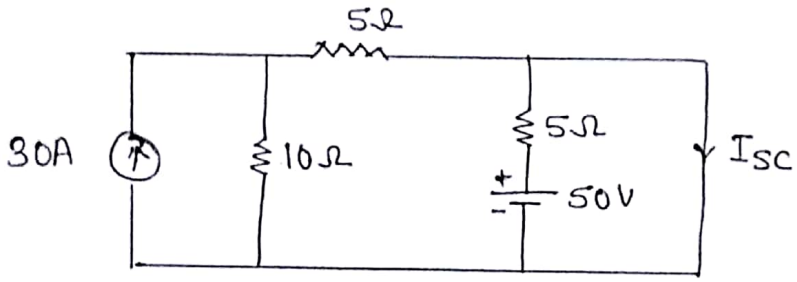
Que: Determine the current flowing through 15Ω resistor using Norton Theorem:



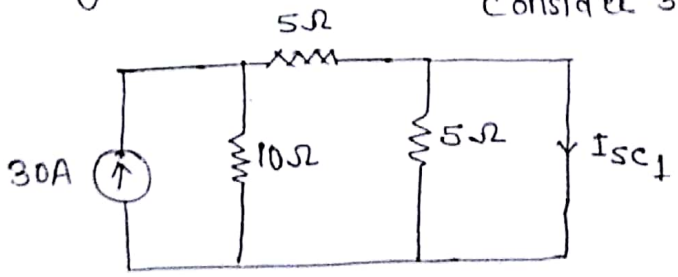
Solution:- STEP 1 :- Short circuit 15Ω resistor.



STEP 2:- Calculation of Isc (short circuit current)

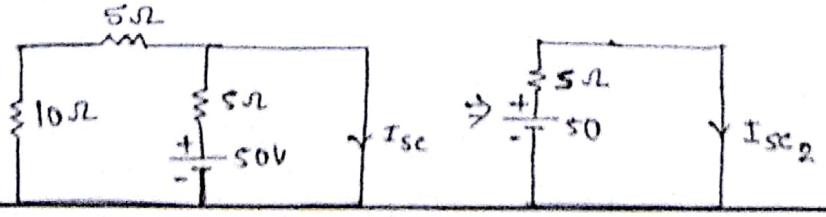
apply superposition theorem

Consider 30A current source & S/C 50V sou -ce.



$$I_{SC1} = \frac{30A \times 10\Omega}{5+10} = \frac{300}{15} = 20A$$

Consider 50V source & O/C 30A current source.



$$I_{SC2} = \frac{50V}{5} = 10A$$

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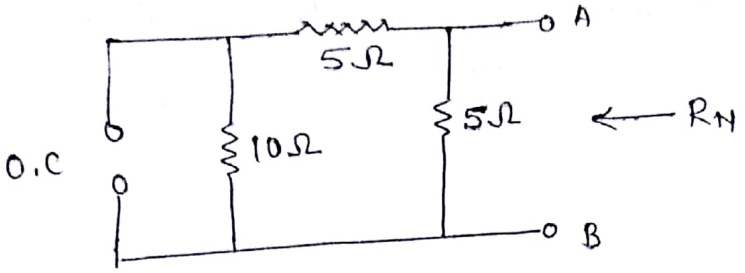
Total current $I_N = I_{SC} = I_{SC1} + I_{SC2}$

$= 20 + 10 = 30\,A$

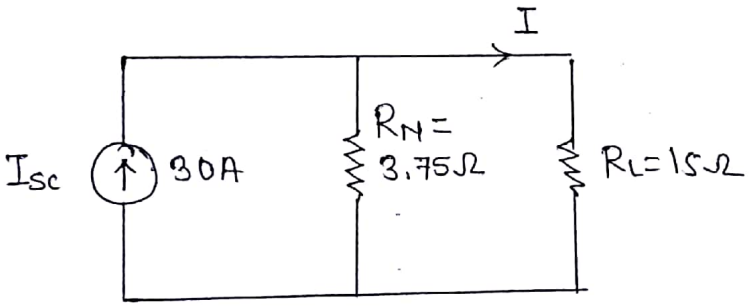
STEP-3 Calculation of R_N



$$R_N = (5+10) \,||\, 5$$

$$= \frac{15 \times 05}{15+5} = 3.75\,\Omega$$

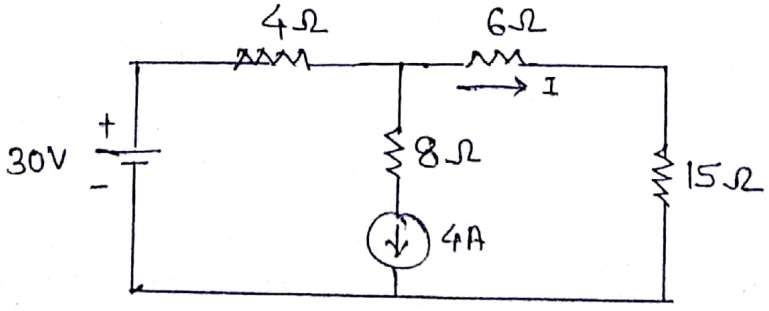
STEP 4:- Equivalent circuit



$$I = \frac{I_{SC} \times R_N}{R_N + R_L} = \frac{30 \times 3.75}{15 + 3.75}$$

$$I = 6A$$

Que:- Using Norton's Theorem find current in 6Ω resistor.



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