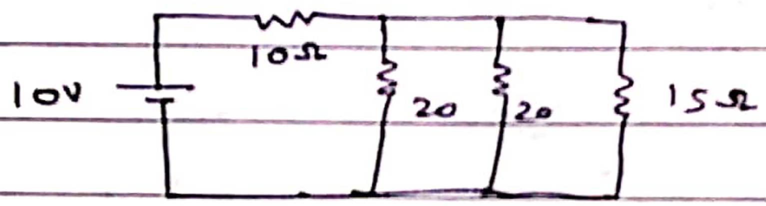
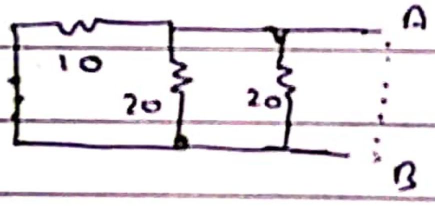
Bhaskar Subedi
BCT A 22

Thevenin's & Norton cont

1. Determine the current I_L through the 15 Ω resistor in the network given in fig 1 by a) thevenin's theorem
b) Norton's theorem



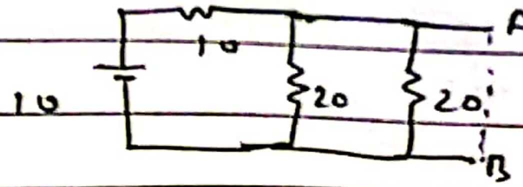
for R_{TH} or R_N

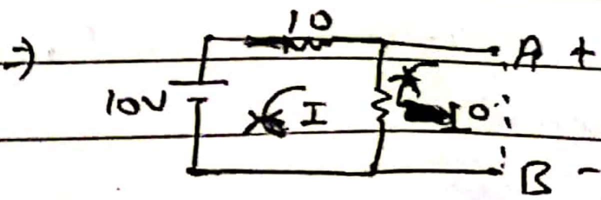


$R_{Th} = R_N = (10 \parallel 20) \parallel 20$
$= 5\Omega$

a) By thevenin's theorem

calculation of V_{Th}





Using KVL

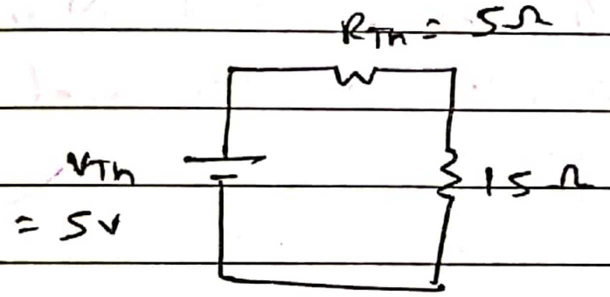
$$10\,V = 10I + 10I$$

$$\therefore I = 0.5$$

$$-V_{Th} = 10(0 - I)$$

$$V_{Th} = 10I = 10 \times 0.5 = 5\,V$$

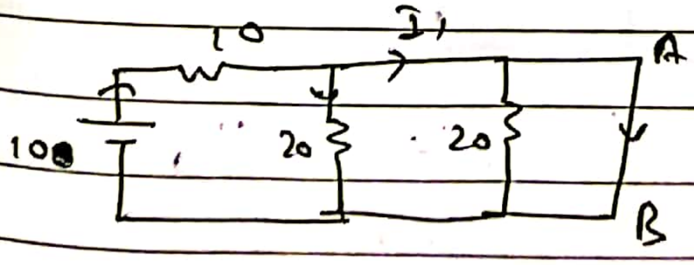
Then of thevenin circuit is



Then $I_L = \frac{V_{Th}}{5+15} = \frac{5}{20} = 0.25\,A$

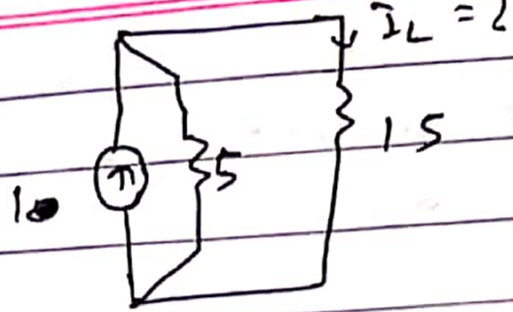
b) **By norton's theorem**

calculation of I_N



$$I = \frac{100}{5} = 20\,A$$

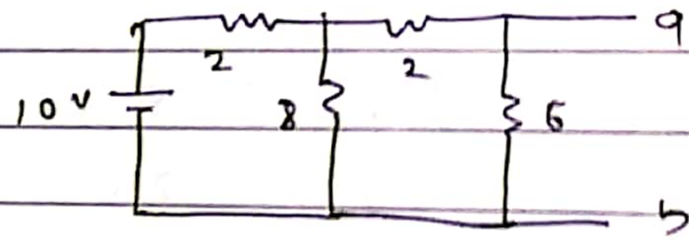
$$I_1 = \frac{20}{20+20} \times 20 = 10\,A$$



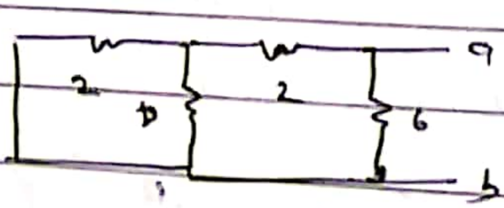
$$I_L = \frac{5 \times 10}{15+5}$$

$$= \cancel{0.5A} \quad 0.25A$$

2. Obtain the Thevenin and Norton equivalent circuit at terminal ab for network of fig 2.



~~$R_{Th} = R_N =$~~

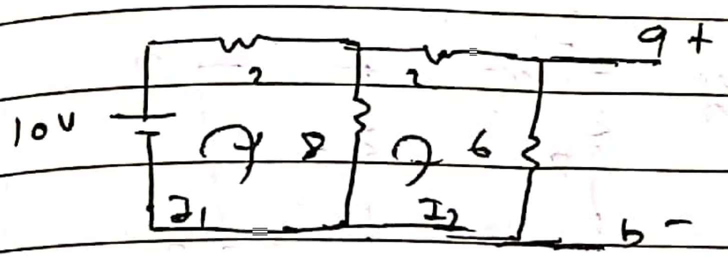


$$R_{Th} / R_N = ((2 \| 8) + 2) \| 6$$

$$= 3.6 \| 6$$

$$= 2.25\ \Omega$$

By thevenin's theorem



Mesh I

$$2I_1 + 8(I_1 - I_2) = 10$$

$$10I_1 - 8I_2 = 10 \quad \text{--- (I)}$$

Mesh II

$$2I_2 + 6I_2 + 8(I_2 - I_1) = 0$$

$$16I_2 - 8I_1 = 0$$

$$-8I_1 + 16I_2 = 0 \quad \text{--- (II)}$$

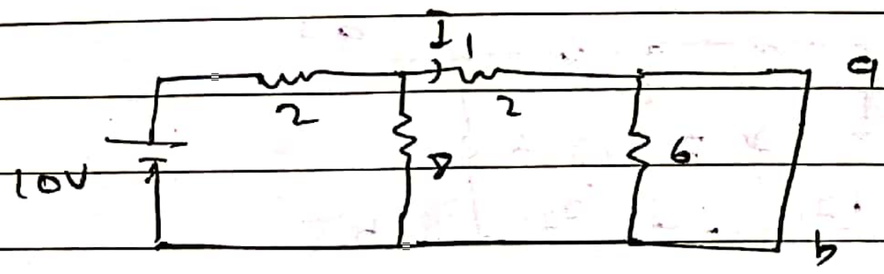
$$I_1 = 1.667 = 5/3, \quad I_2 = 0.8333 = 5/6$$

Then

$$V_{Th} = I_2 \times 6 = \frac{5}{6} \times 6 = 5\text{ V}$$

$$\therefore V_{Th} = 5\text{V}$$

By norton equivalent.



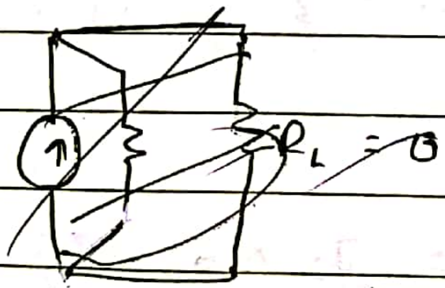
$$\cancel{I} = \frac{10}{2.25} = \cancel{4.44\ A}$$

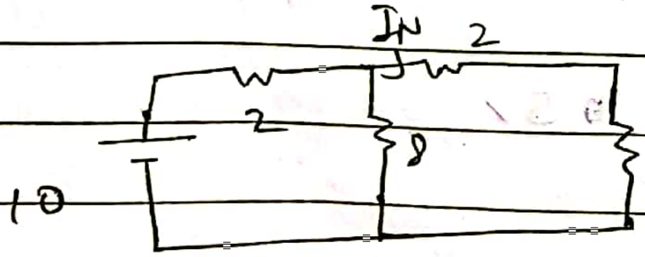
$$\cancel{I_1} = \cancel{\frac{8}{2+8} \times 4.44}$$

$$= \cancel{\frac{32}{9}} = \cancel{3.556\ A}$$

$$= I_{SC}$$

~~Then~~





$6 \| 0 = 0$

$$R_{eq} = (8\|2) + 2 = 3.6\ \Omega$$

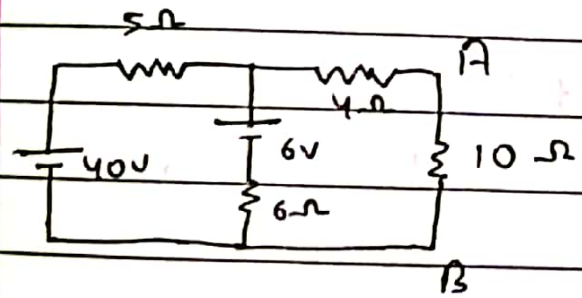
$$I = \frac{10}{3.6} = 2.778\ A = \frac{25}{9}\ A$$

Then

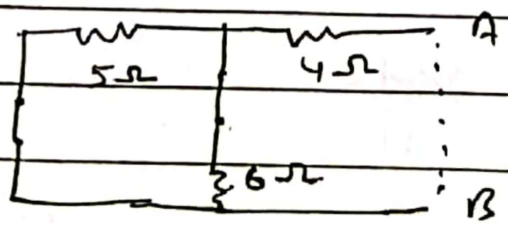
$$I_N = \frac{8}{2+8} \times \frac{25}{9}$$

$$= 2.22\ A$$

3. Find pd across AB in the circuit shown in fig3 a) Using Thevenin's theorem b) using Norton's Theorem



for, R_{Th} or R_N

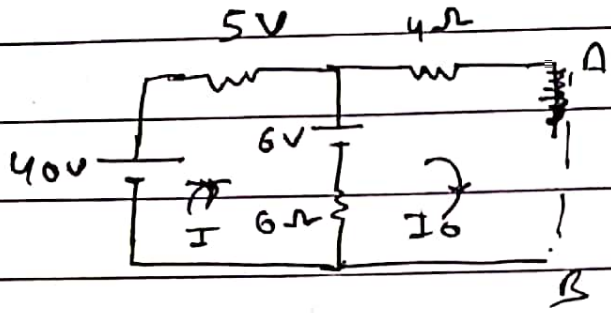


$$R_{Th} / R_N = (6 \| 5) + 4$$

$$= \frac{74}{11} = 6.727\ \Omega$$

By thevenin's theorem

Calculation of V_{Th}



Apply KVL

$$40 - 6 = 5I + 6I$$

$$34 = 11I$$

$$I = \frac{34}{11} = 3.09$$

$$\cancel{V_{BA} + 6 = 6I + 4I}$$

$$\cancel{= 6 \times \frac{34}{11} + 4 \times \frac{34}{11} - 6}$$

$$V_{BA} + 6 = 6(0 - I)$$

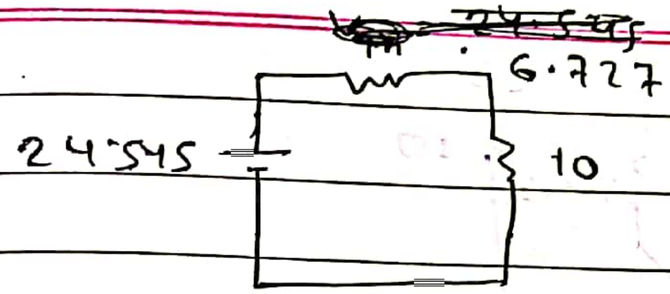
$$V_{BA} = -6 \times \frac{34}{11} - 6$$

$$V_{BA} = -\frac{270}{11}$$

$$V_{AB} = \frac{270}{11} = 24.545\ V = V_{Th}$$

The thevenin's circuit is

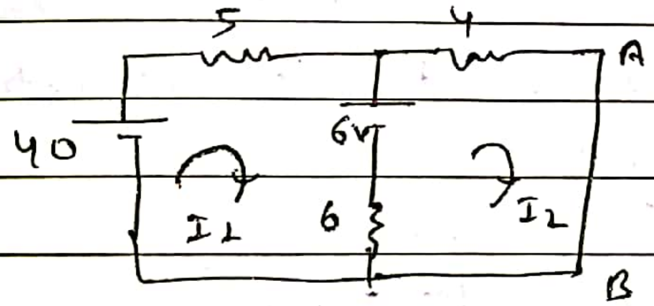
Then



Then

$$I_L = \frac{24.545}{6.727+10}$$
$$= 1.46A$$

By Noton's theorem



Mesh I $\quad 40 - 6 = 5I_1 + 6I_1 - 6I_2$

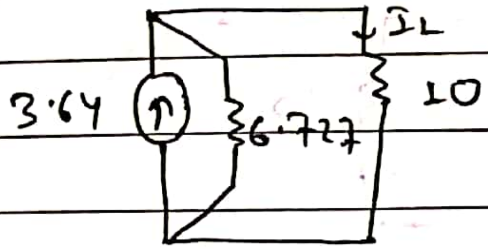
$$34 = 11I_1 - 6I_2 \quad —(1)$$

$$6 = 4I_2 + 6I_2 - 6I_1$$
$$6 = -6I_1 + 10I_2 \quad —(11)$$

Solving (1) & (11)

$I_1 = 5.08\,A \qquad I_2 = 3.64\,A$

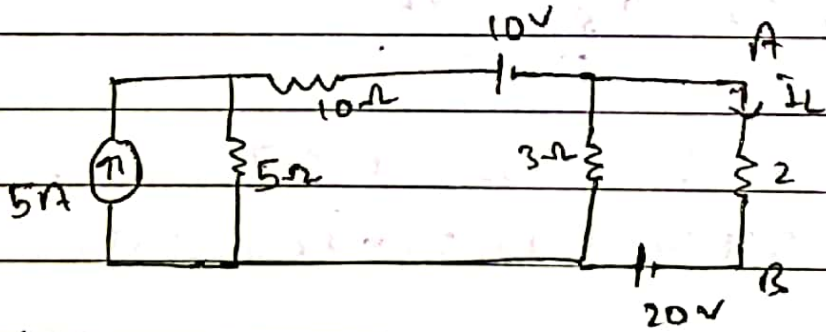
So $I_N = 3.64\,A$.



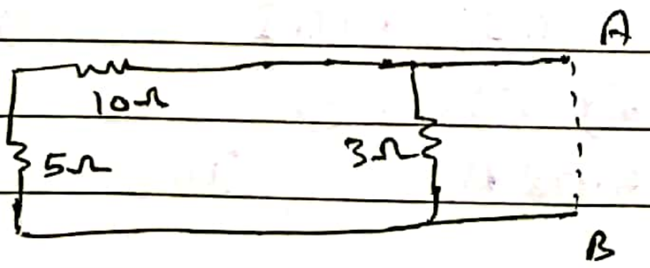
Then $I_L = \dfrac{6.727}{10 + 6.727} \times 3.64$

$= 1.46$ A

(4) Use Thevenin's and Norton Equivalent ~~theo~~ theorem to determine the current I_L, through the 2Ω resistor of the network shown in fig 4



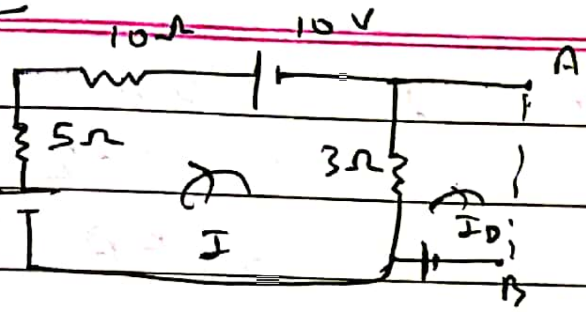
for R_{Th} or R_N



$R_{Th} / R_N = (10+5) \parallel 3$

$= 2.5\,\Omega$

Thevenin's.



Mesh I $\quad 25-10 = 5I + 10I + 3I$

$$15 = 18I$$

$$I = \frac{5}{6} = 0.833$$

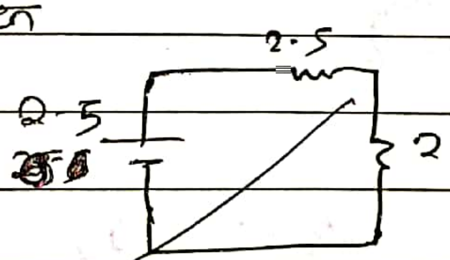
Mesh II

$V_{BA} + 20 = -3I = -3 \times 0.833$

$V_{BA} = -2.5$

$V_{AB} = 2.5 = V_{Th}$

Then

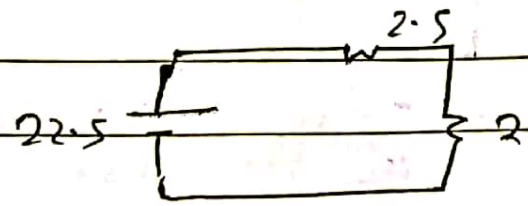


$$I_{Th} = \frac{2.5}{2.5+2} = 0.5556$$

$$V_{BA} + 20 = -3I$$

$$-V_{Th} = -3 \times \frac{5}{6} - 20$$

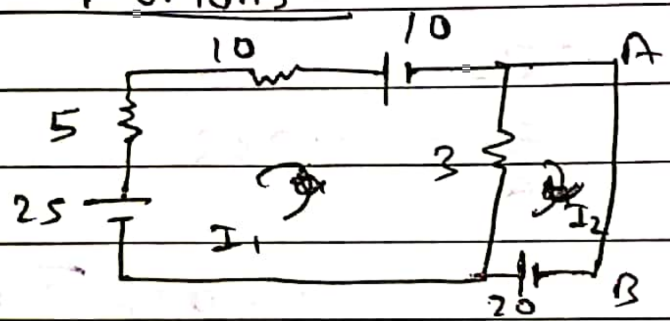
$$V_{Th} = 22.5$$



Then $I_L = \frac{22.5}{2.5+2}$

$= 5A$

By Norton's



Mesh I $-10+25 = 5I_1 + 10I_1 + 3I_1 - 3I_2$

$+15 = 18I_1 - 3I_2$ — (i)

Mesh II

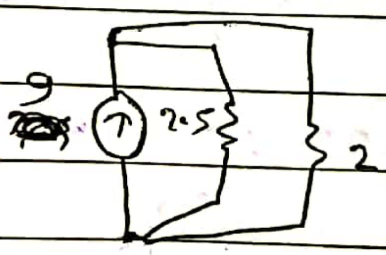
$+20 = 3(I_2 - I_1)$

$+20 = 3I_2 - 3I_1$ — (ii)

Solving (i) and (ii)

$I_1 = 2.33A$ $I_2 = 9\ A$

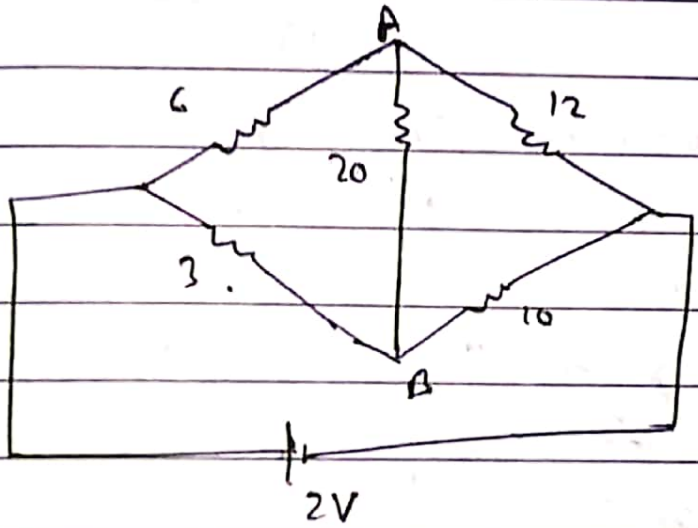
Then



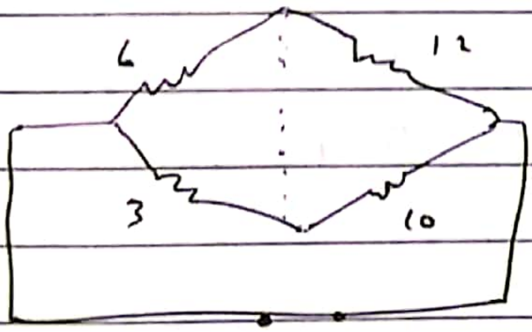
Then $I_L = \frac{2.5}{2.5+2} \times 9 = 5A$

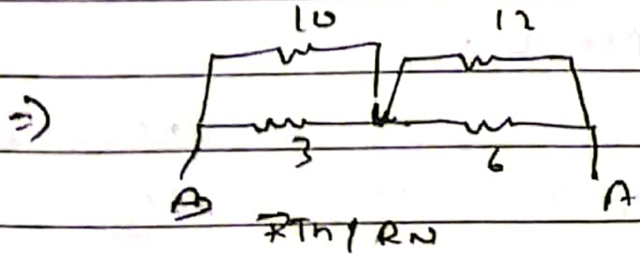
Ans

5. Determine the current in 20Ω resistor of the network shown in fig 5 a) Using Thevenin's theorem b) Using Norton's theorem



Calculating R_{Th} or R_N



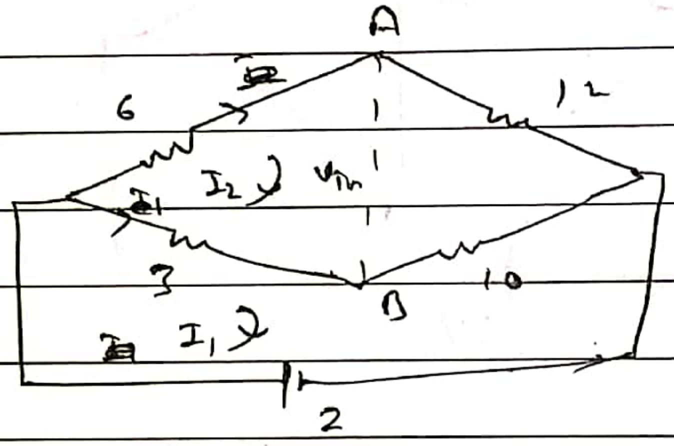


$$R_{Th} = R_N = (3 \parallel 10) + (12 \parallel 6)$$

$$= \frac{3 \times 10}{3+10} + \frac{12 \times 6}{12+6}$$

$$= \frac{82}{13} \Omega$$

By Thevenin's Theorem



~~Applying KVL,~~

$$\cancel{2 = 3I_1 + 10I_1}$$

$$\cancel{I_1 = \frac{2}{13} A}$$

~~Apply, KVL,~~

Mesh I_1

$$2 = 3(I_1 - I_2) + 10(I_1 - I_2)$$

$$2 = 13I_1 - 13I_2 \quad -(1)$$

Mesh II

$$0 = 6(I_2) + 12I_2 + 10(I_2 - I_1) + 3(I_2 - I_1)$$

$$0 = -13I_1 + 31I_2$$

$$\therefore I_1 = \frac{31}{117}$$

$$\therefore I_2 = \frac{1}{9}$$

Then

$$V_{Th} = 3(I_2 - I_1) + 6I_2$$

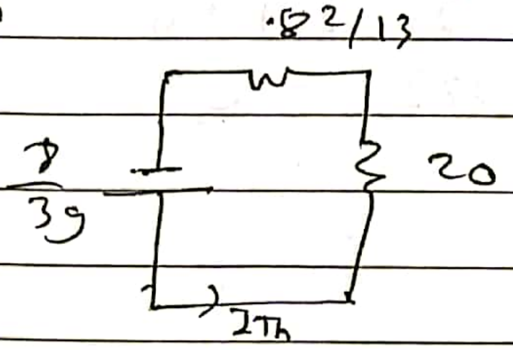
$$= 9I_2 - 3I_1$$

$$= 9 \times \frac{1}{9} - \frac{3 \times 31}{117}$$

$$V_{Th} = \frac{8}{39} = V_{BA}$$

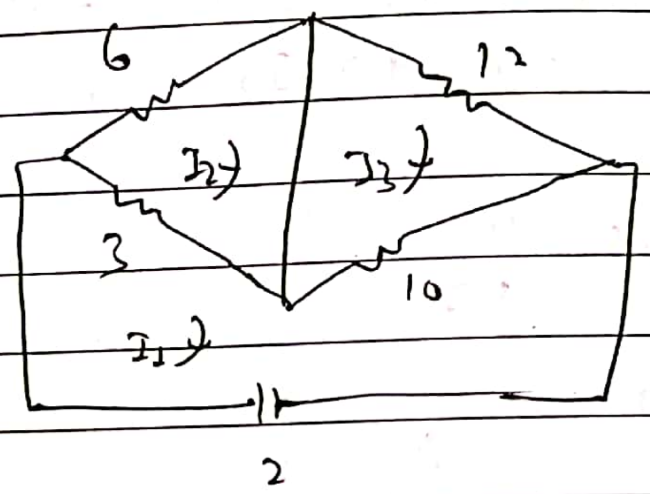
$$\therefore V_{AB} = -\frac{8}{39}$$

Then



$$I_{Th} = \frac{8/39}{82/13 + 20} = 7.79 \times 10^{-3} = 7.8\,mA$$

b) Norton's Theorem



Mesh I

$2 = 3(I_1 - I_2) + 10(I_1 - I_3)$

$2 = 3I_1 - 3I_2 + 10I_1 - 10I_3$

$2 = 13I_1 - 3I_2 - 10I_3$ — (1)

Mesh II

$3(I_2 - I_1) + 6I_2 = 0$

$-3I_1 + 9I_2 = 0$ — (ii)

Mesh III

$12I_3 + 10(I_3 - I_1) = 0$

$-10I_1 + 22I_3 = 0$ — (iii)

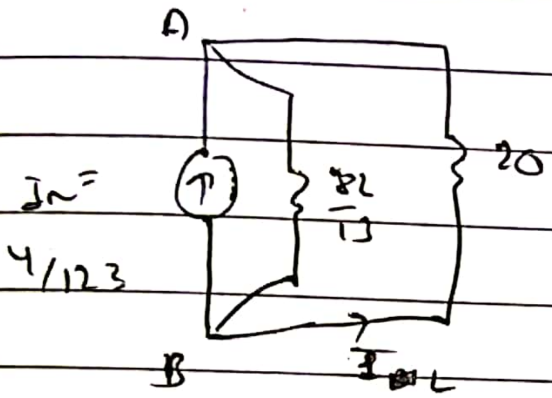
solving

$I_1 = \frac{11}{41}$ $I_2 = \frac{11}{123}$ $I_3 = \frac{5}{41}$

$I_N = I_3 - I_2$

$= \frac{5}{41} - \frac{11}{123}$

$= \frac{4}{123}$ ~~(B to A)~~ (B → A)



$$I_L = \frac{82/13}{20 + 82/13} \times \frac{4}{123}$$

$$= \frac{82}{13} \times \frac{13}{342} \times \frac{4}{123}$$

$$= \frac{8}{39}$$

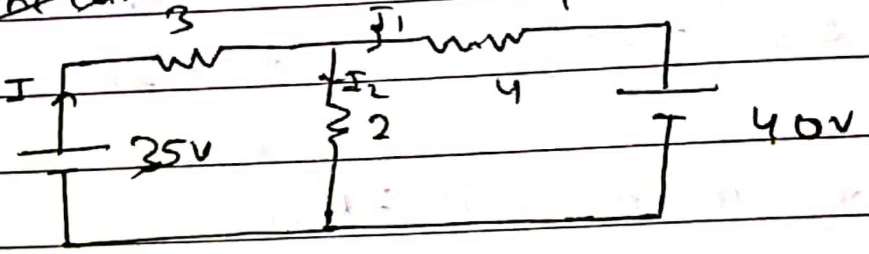
$= 7.8\,mA$ Ans

Name: Bhaskar Subedi
Class: BCT A 22

Tutorial No: 3

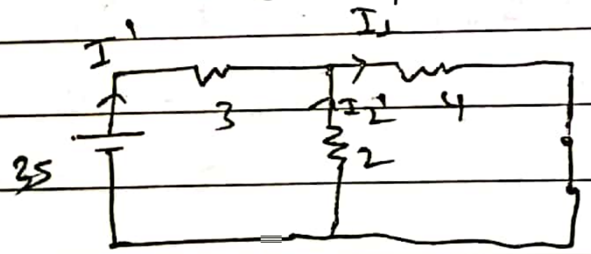
~~6. Determine the current in 10Ω, by~~

10. By using superposition ~~theo~~ theorem. ~~find the current in resistance R~~ find current from diff branch



soln

Considering ~~12V~~ 35V only



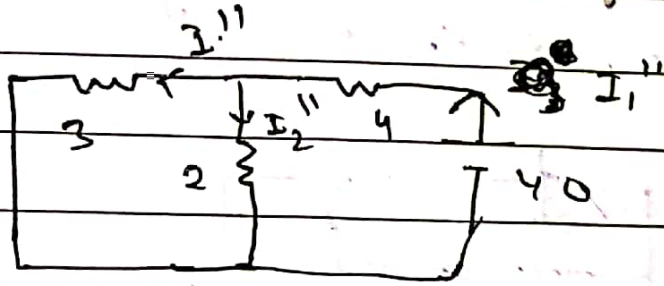
$$R_{eq} = 3 + (4 \parallel 2) = 4.33\ \Omega$$

$$I' = \frac{35}{4.33} = \frac{V}{R_{eq}} = 8.07\ A$$

$$I_1' = \frac{2}{4+2} \times I' = \frac{2}{6} \times 8.07 = 2.69\ A$$

$$I_2' = \frac{4}{4+2} \times I' = \frac{4}{6} \times 8.07 = \cancel{3.84\ A}\ 5.38\ A$$

Again consider 40 V



$R_{eq} = 4 + (3 \parallel 2)$

$= 5.2\ \Omega$.

$I_1'' = \frac{V}{R_{eq}} = \frac{40}{5.2} = 7.69\ A$

$I'' = \frac{2}{3+2} \times 7.69 = 3.076$.

$I_2'' = \frac{3}{3+2} \times 7.69 = 4.614$

According to super position

$I_0 = I' - I''$

$= 8.07 - 3.07 = \cancel{1.92}\ \cancel{2.68}\ 5$

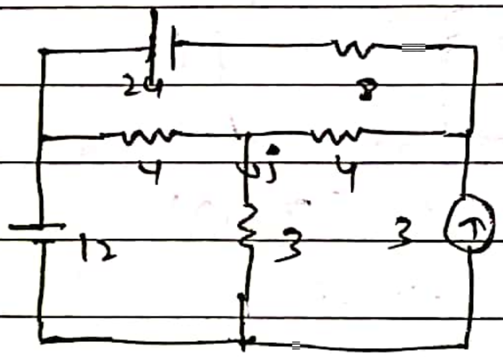
$I_1 = I_1' - I_1'' = \cancel{1.92}\ 7.69\ \cancel{5} - 2.69$

$= \cancel{-5.77\ A}\ 5A$

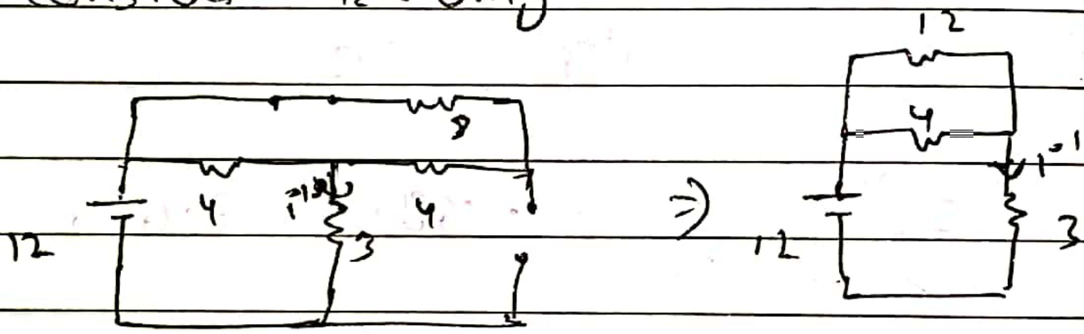
$I_2 = I_2' + I_2'' = \cancel{4.614} + \cancel{3.84}\ 5.38 + 4.614$ (2.69)

$= \cancel{8.454\ A} = 10\ A$

(11) For the circuit in fig 11. Use superposition theorem to find i.

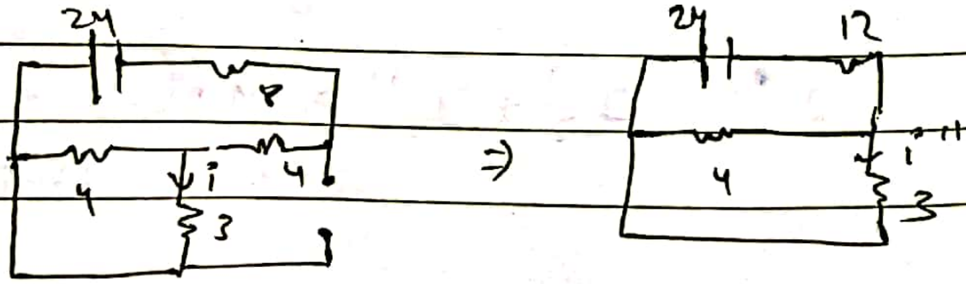


Consider 12 V only



$$R_{eq} = (4 \parallel (8+4)) + 3$$
$$= 6\ \Omega$$
$$i' = \frac{V}{R} = \frac{12}{6}$$
$$= 2\ A$$

Consider : 24 V only



$$R_{eq} = 12 + (4 // 3)$$
$$= 13.71\,\Omega$$

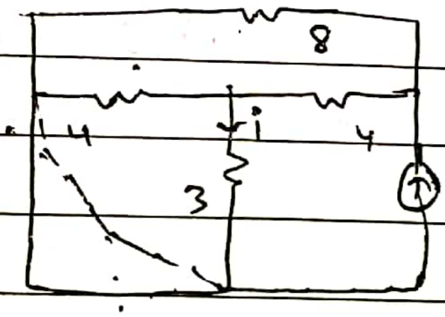
Then,

$$I = \frac{24}{13.71} = 1.75A$$

Then,

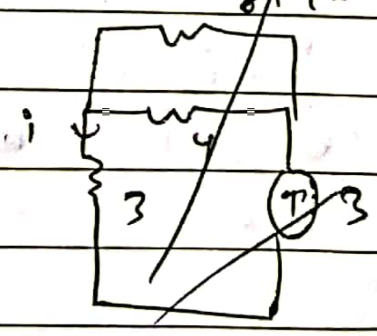
$$i'' = \frac{4}{4+3} \times 1.75 = 1A$$

Consider 3A current source only

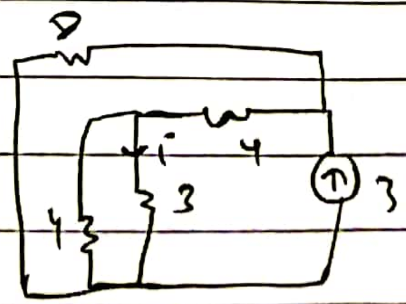


~~8+4 = 12~~

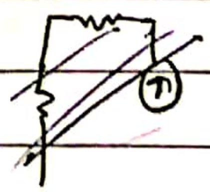
Req ⇒



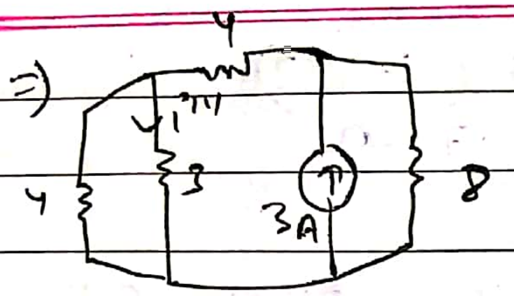
⇒

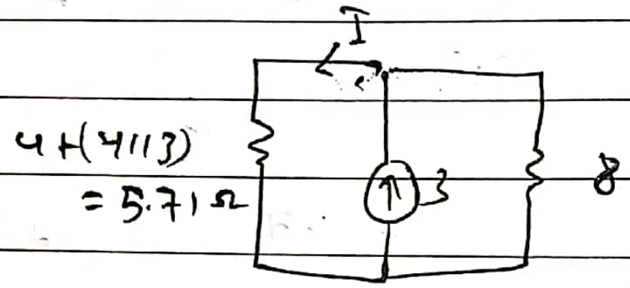


⇒



$\Rightarrow$





$$I = \frac{8}{5.71+8} \times 3 = 1.75$$

Then

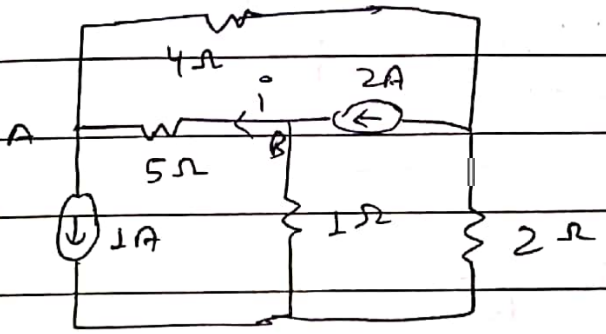
$$i''' = \frac{4}{4+3} \times 1.75 = 1A$$

Then

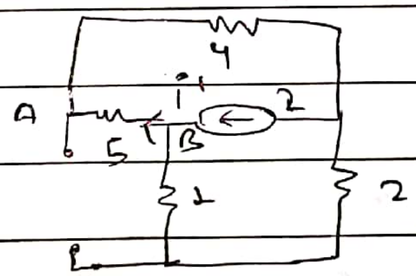
finally,

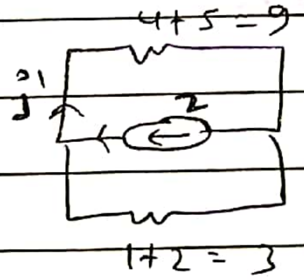
$$i = i' - i'' + i'''$$
$$= 2 - 1 + 1 = \cancel{\;}$$
$$= 2\,A$$

(12) Using superposition theorem, find current through 5Ω.



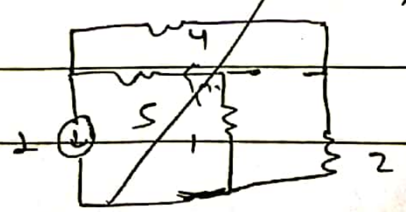
Consider 2A only

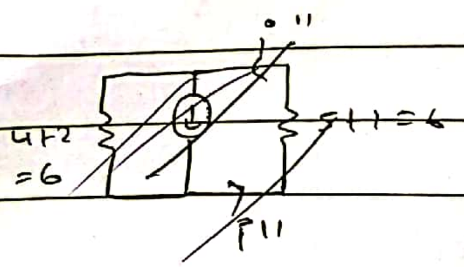


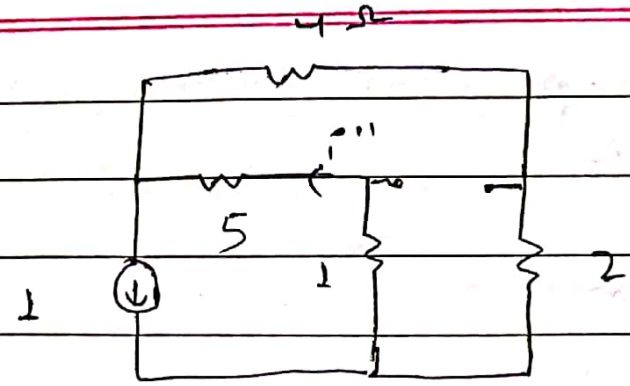
⇒ 

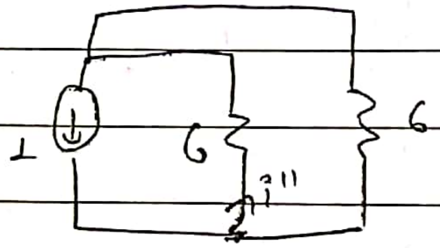
$$i' = \frac{3}{3+9} \times 2 = 0.5\ A$$

Consider 1A only



⇒ 





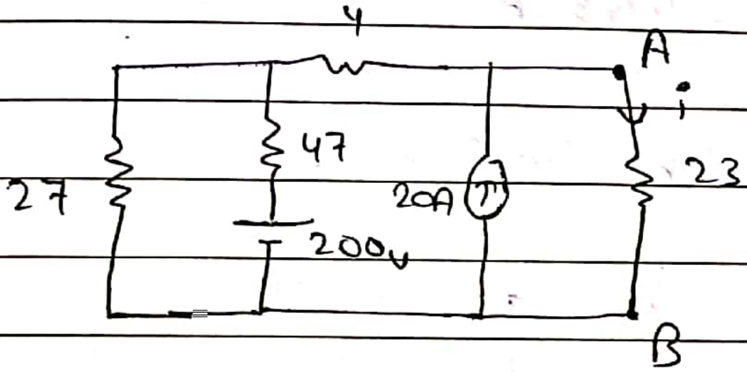
$$i'' = \frac{6}{6+6} \times 1 = 0.5$$

$$i = i' + i''$$

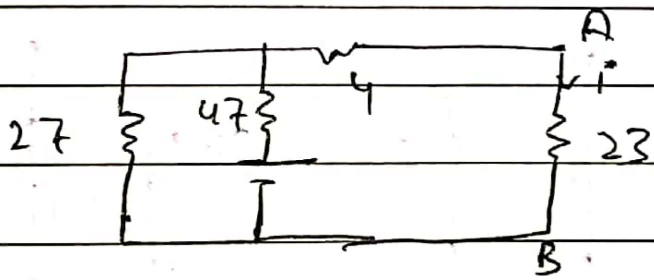
$$\cancel{= 0.5 + 3 = 3.5\,A}$$

$$= 0.5 + 0.5 = 1\,A$$

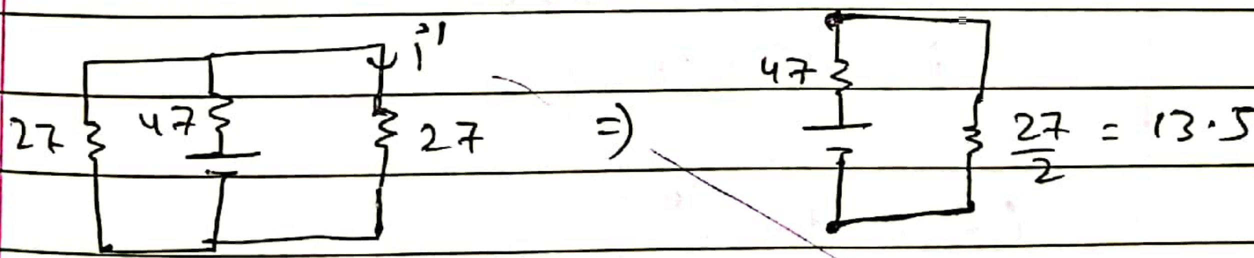
7. Compute the current 23Ω resistor of the fig 7 using superposition theorem

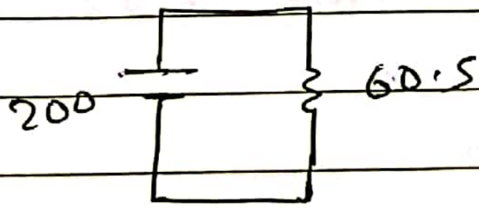


Taking 200V only



~~Req = (4+23)~~



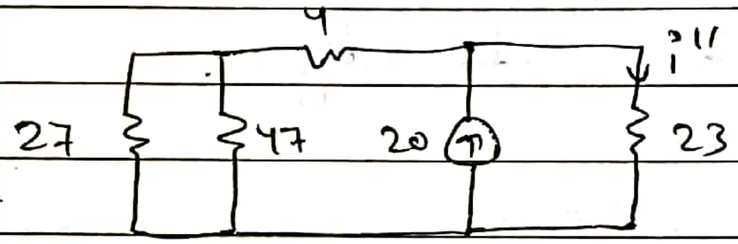


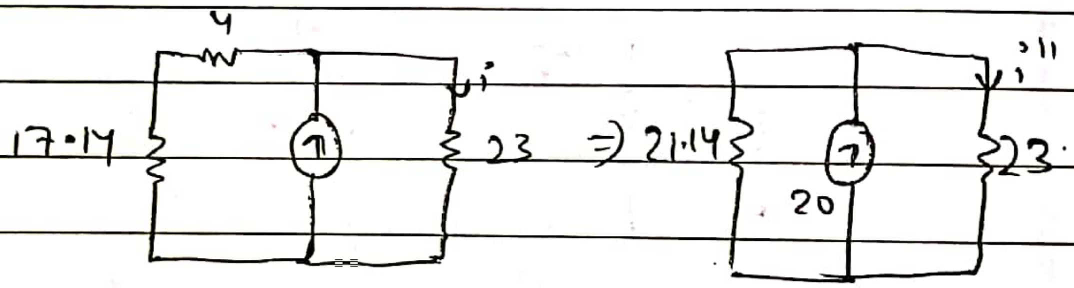
$$I = \frac{200}{60.5} = 3.305$$

$$i' = \frac{27}{27+27} \times 3.309$$

$$= 1.65\ A$$

Consider 20A only





$$i'' = \frac{21.14}{21.14+23} \times 20$$

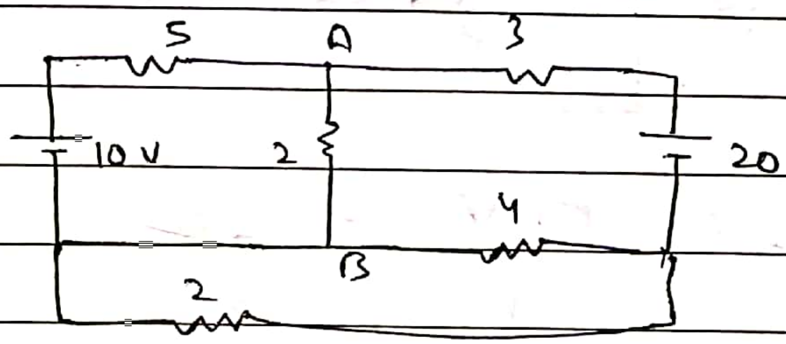
$$i'' = 9.58$$

$$i = i' + i''$$

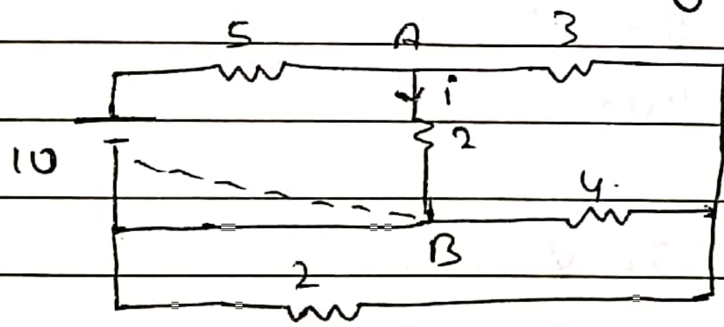
$$= \cancel{9.58} + 1.65 + 9.58$$

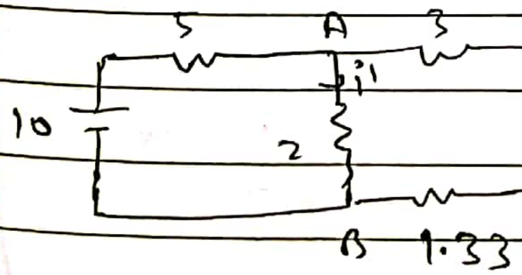
$$= 11.23A.$$

(8) Find the current in 2Ω resistor betwn A and B for network shown in fig 8. using superposition theorem

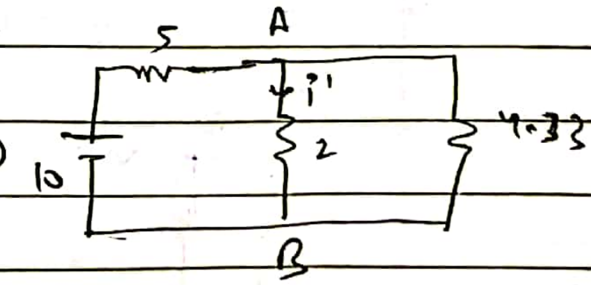


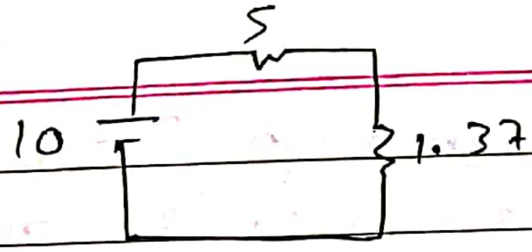
Taking 10 V, only

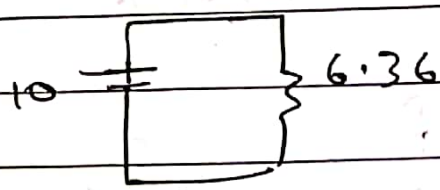




$\Rightarrow$





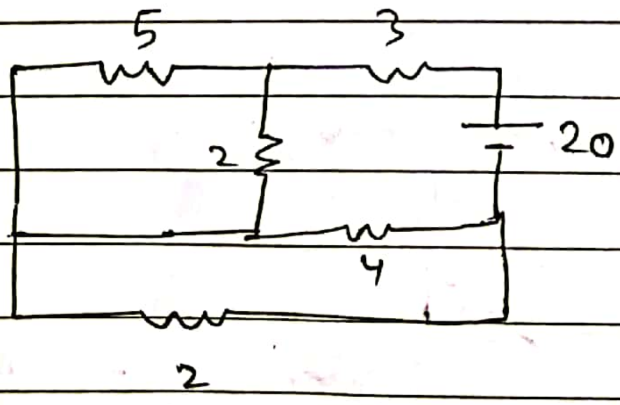


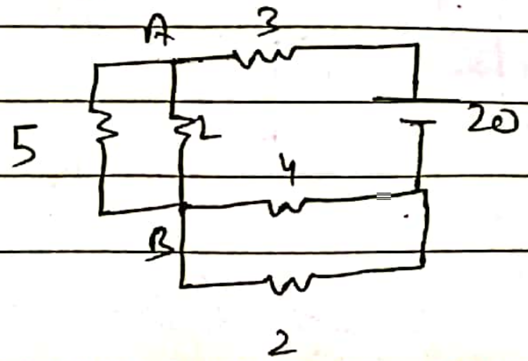
$$I = \frac{V}{R_{eq}} = \frac{10}{6.36} = 1.57\,A$$

$$i' = \frac{4.33}{2+4.33} \times 1.57$$

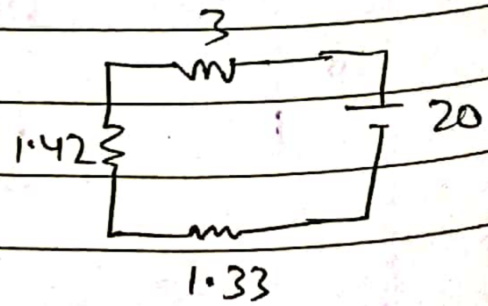
$$i' = 1.07$$

Taking 20 V only





$\Rightarrow$



$R_{eq} = 5.75$

$$I = \frac{20}{5.75} = 3.47\,A$$

Then

$$i'' = \frac{5}{5+2} \times 3.47$$

$$= 2.48$$

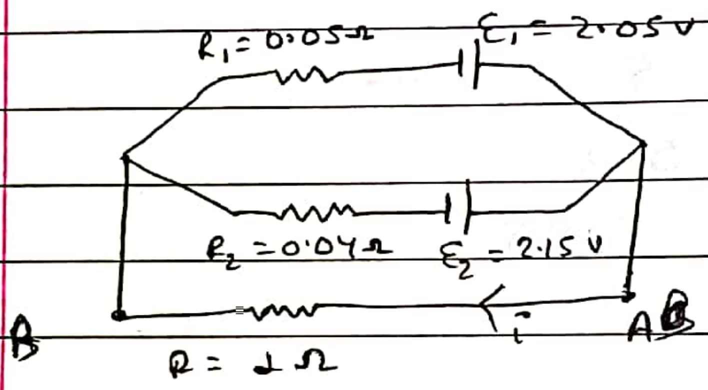
Then

$$i = i' + i''$$

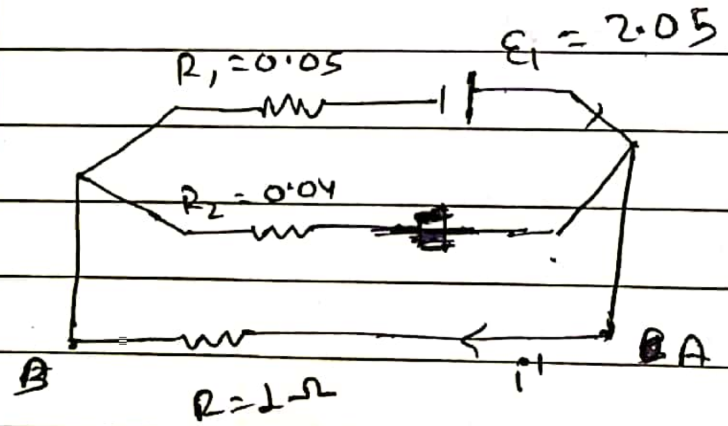
$$= 1.07 + 2.48$$

$$= 3.55\ A.$$

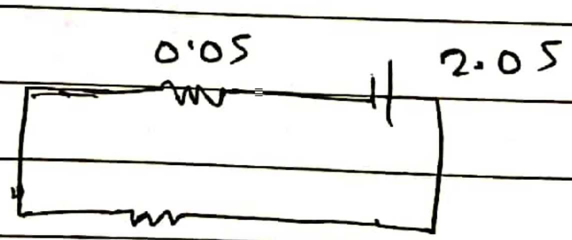
(9) By using superposition theorem. find the current in resistance R shown in fig 9. Internal resistance of cells are negligible



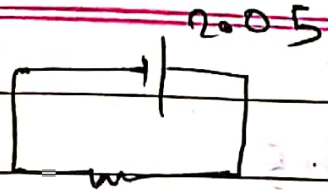
Taking $\varepsilon_1 = 2{\cdot}05$ only



$\Rightarrow$



$(0{\cdot}04 \| 1) = \frac{1}{26}$

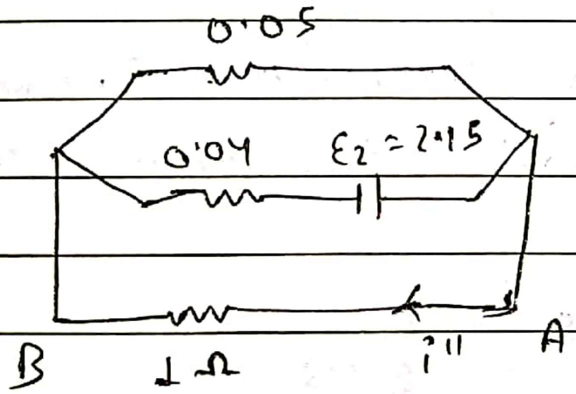


Req = 23/260

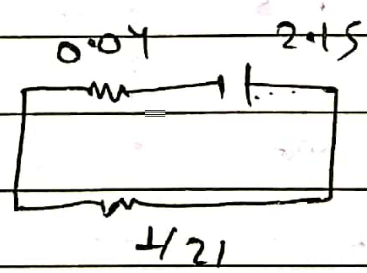
$$I = \frac{2.05}{0.088} = \frac{V}{R_{eq}} = 23.17A$$

$$i' = \frac{0.04}{1+0.04} \times 23.17 = 0.89A$$

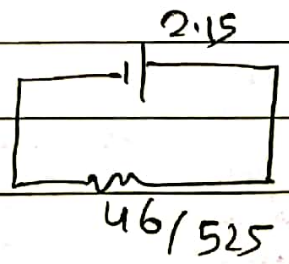
Taking $\mathcal{E}_2 = 2.15$ only



⇒



⇒



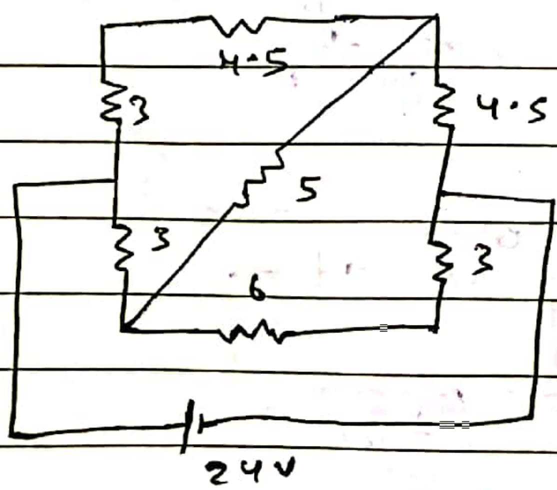
$$I = \frac{2.15}{46/525}$$
$$= 24.53A$$

$$i'' = \frac{0.05}{1+0.05} \times 24.53$$
$$= 1.168\,A$$

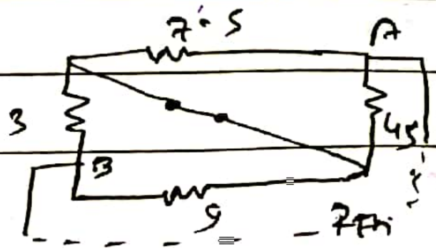
Now

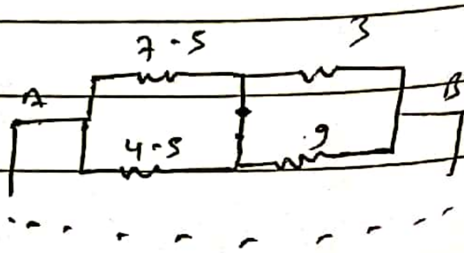
Total current $i = i' + i''$
$$= 0.89 + 1.168$$
$$= 2.06A$$

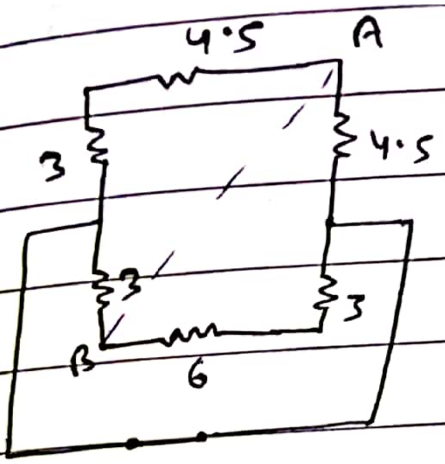
6. Calculate using Thevenin's Theorem the current through the branch 5Ω of fig 6



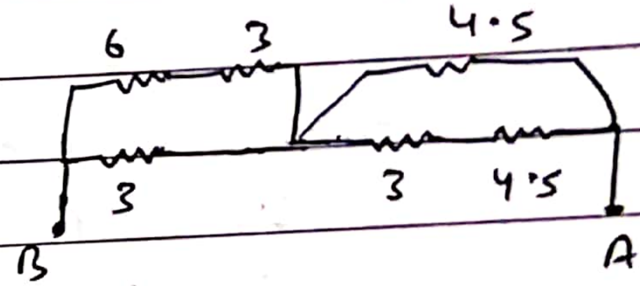
Alternative

=) 

=). 

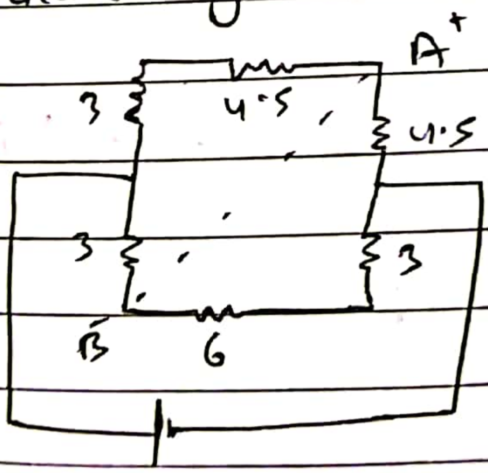


$\Rightarrow$

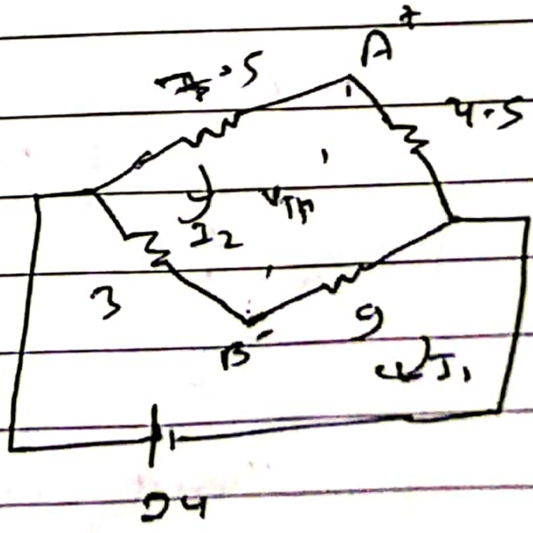


$$R_{TH} = [(6+3) \parallel 3] + [4.5 \parallel (3+4.5)]$$
$$= [9 \parallel 3] + [4.5 \parallel 7.5]$$
$$= 2.25 + 2.8125$$
$$= 5.0625$$

Calculate of V_{TH}



$\Rightarrow$



In Mesh I

$$24 = 3(I_1 - I_2) - 5(I_1 - I_2)$$
$$+I_1 - 4I_2 = +2 \quad \text{—(1)}$$

In Mesh II

$$3(I_2 - I_1) + 7.5I_2 + 4.5I_2 + 9(I_2 - I_1) = 0$$

$$24I_2 - 12I_1 = 0$$

$$I_1 - 2I_2 = 0$$

On calculating,

$$I_1 = 4A$$

$$I_2 = 2A$$

from fig,

current going A to B A

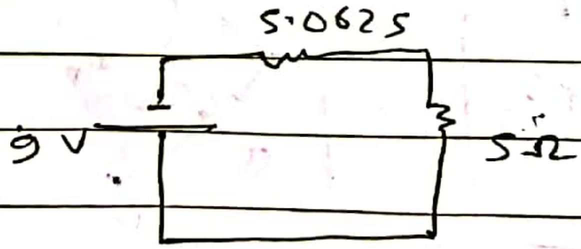
$$V_{Th} = 3(I_2 - I_1) + 7.5\,I_2$$

$$V_{Th} = 3(2-4) + 7.5(2)$$

$$V_{Th} = -6 + 15$$

$$V_{Th} = 9V \quad (B\ to\ A)$$

Now Thevenin's eq. ckt is



$$\text{Current through } 5\Omega = \frac{9}{5.0625+5}$$

$$= 0.894A \text{ Ans}$$