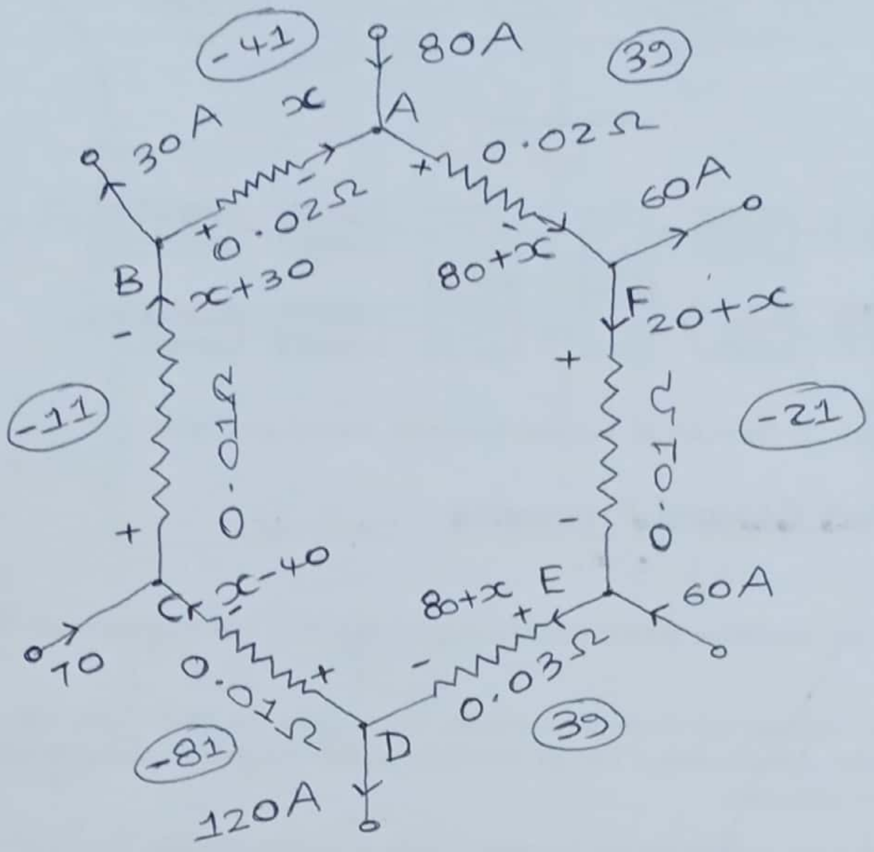
1) Find the current in all the branches in the network shown :-



Solution :- Let us assume that current to be in conventional clockwise direction

$$-0.02x - 0.02(80+x) - 0.01(20+x) - 0.03(80+x)$$
$$- 0.01(x-40) - 0.01(x+30) = 0$$

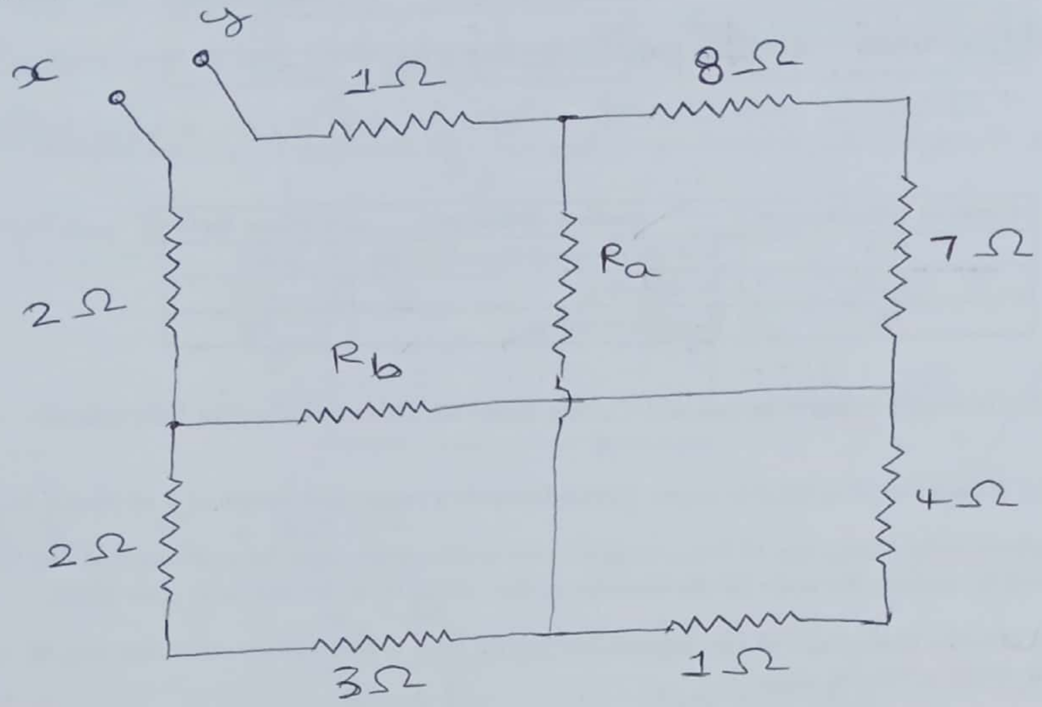
$$-0.02x - 0.02x - 1.6 - 0.01x - 0.2 - 0.03x - 2.4$$
$$- 0.01x + 0.4 - 0.01x - 0.3 = 0$$

$$-0.1x = 4.1$$

$$\boxed{x = -41\ A}$$

Current flow is in opposite direction

2) Find the equivalent resistance between x & y

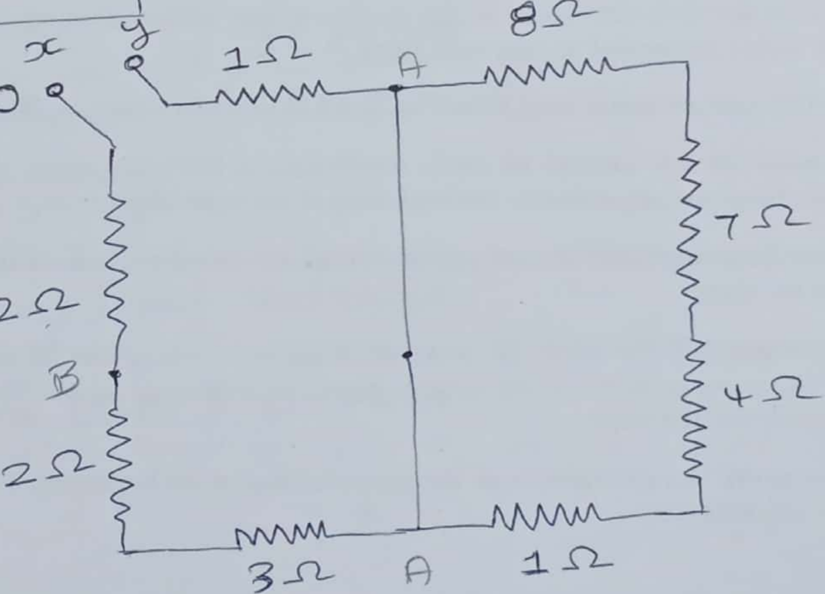


i) $R_a = \infty ; R_b = \infty$

→ both are open circuit

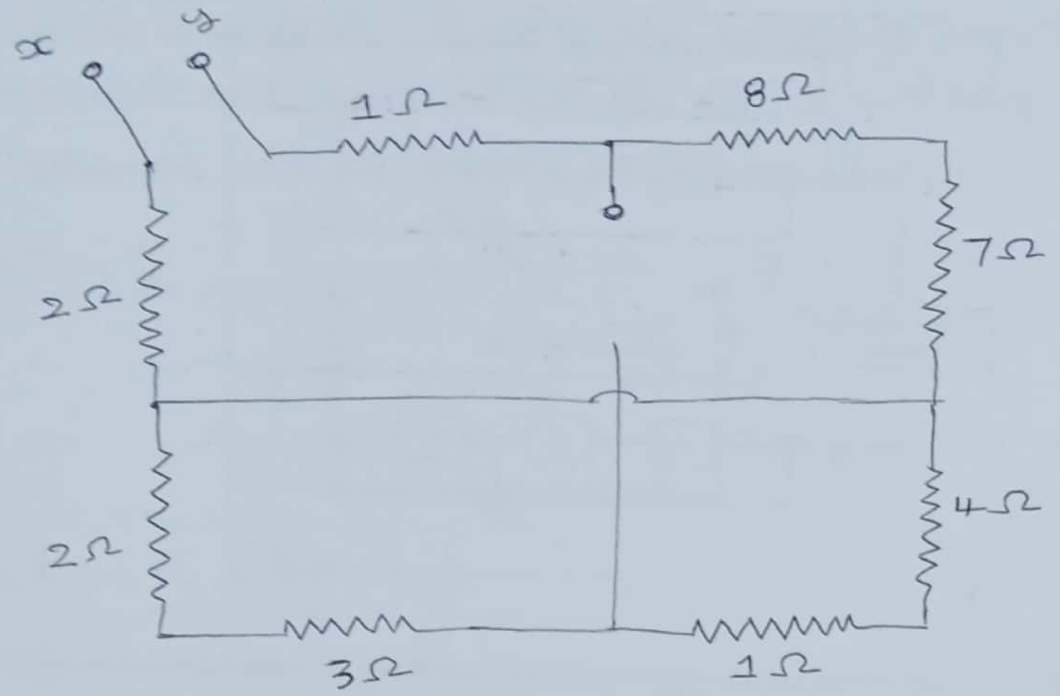
$$\boxed{R_{xy} = 28\,\Omega}$$

ii) $R_a = 0 ; R_b = \infty$



$$\boxed{R_{xy} = 8\,\Omega}$$

iii) $R_a = \infty ; R_b = 0$

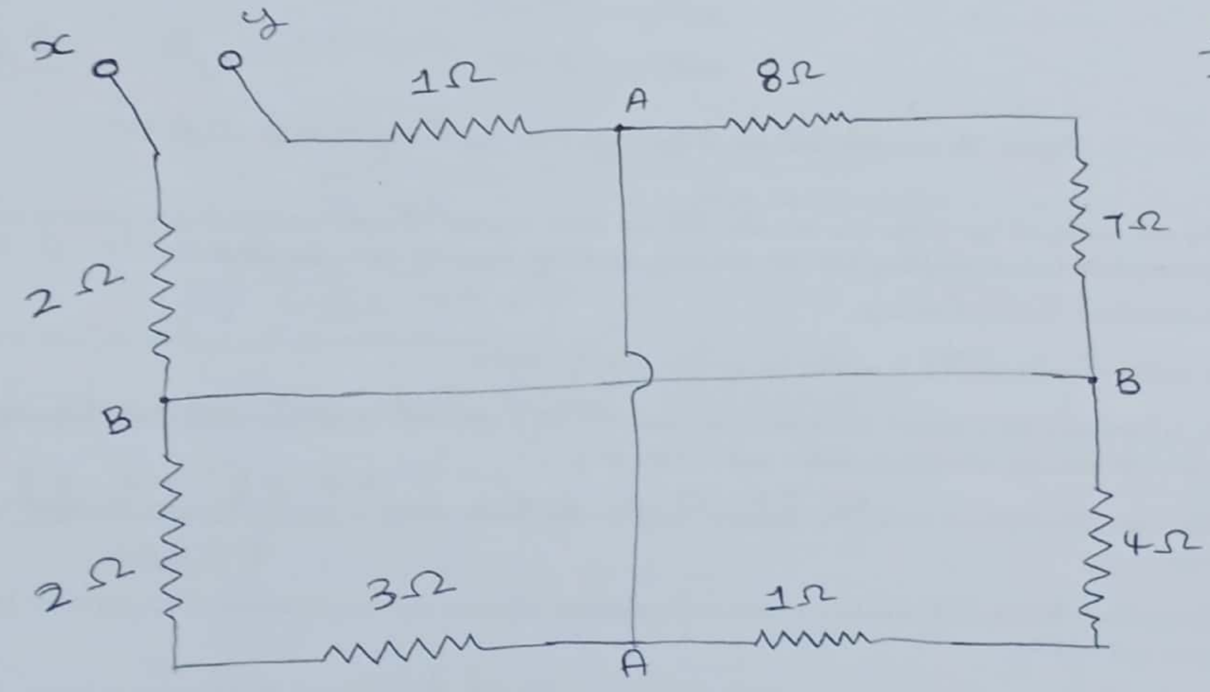


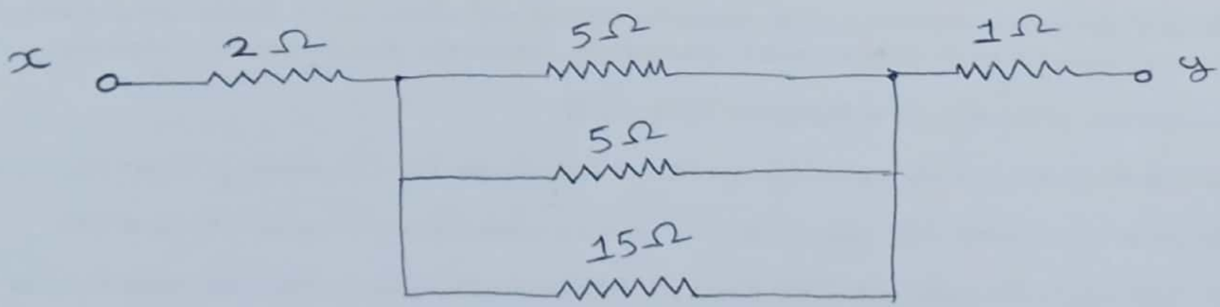
$\boxed{R_{xy} = 18\Omega}$

iv) $R_a = 0 ; R_b = 0$

$\frac{5 \times 5}{10} = \frac{25}{10} = \frac{5}{2}$

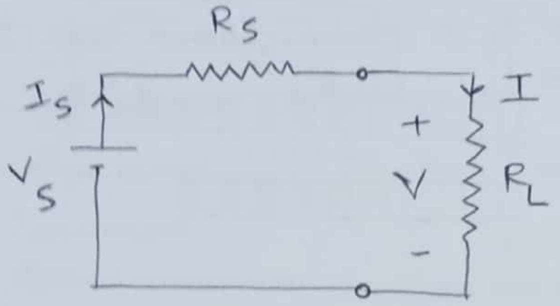
$\frac{\frac{5}{2} \times 15}{\frac{5}{2} + \frac{15}{1}}$





3) A battery of EMF 12V and internal resistance of 0.05 Ω supplies power to a load resistance R_L. Determine the % change in load voltage as load resistance varies from 10 Ω to 100 Ω.

Solution :-



Case 1 $\quad R_L = 10\,\Omega$

$$V = \frac{V_S \cdot R_L}{R_S + R_L} = \frac{12 \times 10}{10 + 0.05}$$

$$\boxed{V = 11.94V}$$

case 2 $\quad R_L = 100\,\Omega$

$$V = \frac{V_S \cdot R_L}{R_S + R_L} = \frac{12 \times 100}{100 + 0.05}$$

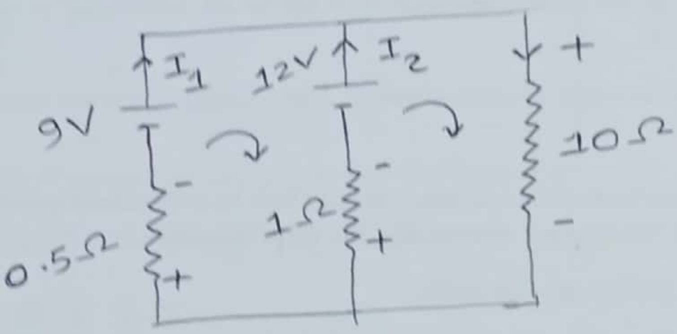
$$\boxed{V = 11.99\,V}$$

- % change in the load voltage

$$\frac{11.99 - 11.94}{11.94} \times 100 = 0.42\,\%$$

4) Two batteries A and B are connected in parallel and a load of $10\,\Omega$ is connected across them. Battery A has an EMF of 9V and internal resistance of $0.5\,\Omega$ and B has an EMF of 12V and internal resistance of $1\,\Omega$. Determine i) the magnitude & direction of current flowing through load resistance ii) current supplied by each battery and iii) Potential difference across the load resistance

Solution



loop 1

$$9 - 12 + I_2 - 0.5 I_1 = 0$$

$$I_2 - 0.5 I_1 = 3V$$

loop 2

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

$$12 - 10 I_1 - 10 I_2 - I_2 = 0$$

$$11 I_2 + 10 I_1 = 12$$

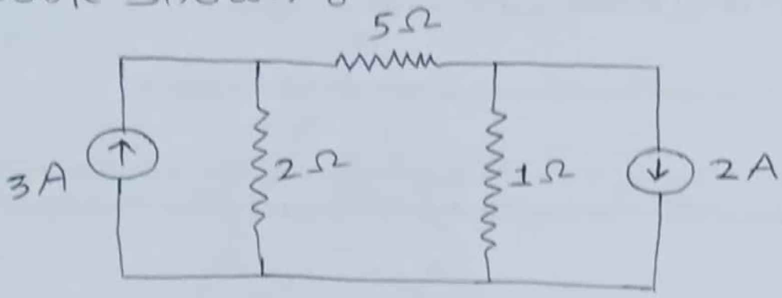
Solving for I_1 & I_2

$$\left.\begin{aligned} I_1 &= -1.35A \\ I_2 &= 2.322 A \end{aligned}\right\} \text{current supplied by each battery}$$

Current through $10\,\Omega = I_1 + I_2 = 0.972 A$

Potential difference across $10\,\Omega = 0.972 \times 10$
$= 9.72 V$

5) Find the current through $5\,\Omega$ resistor in the network shown :-



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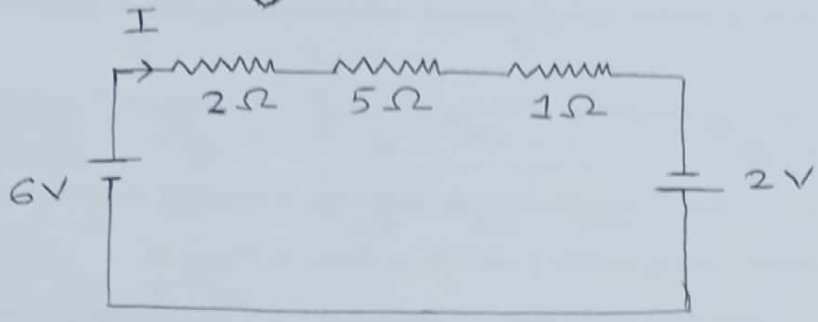
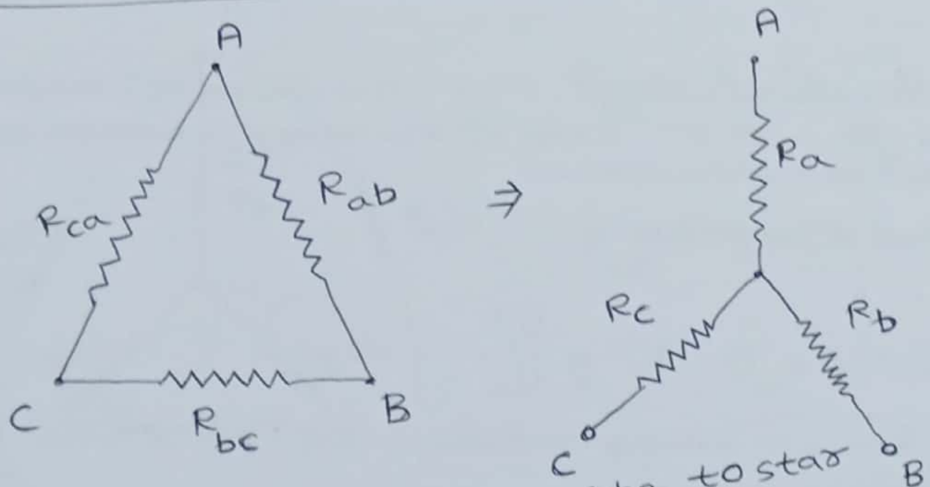


$$6 - 2I - 5I - I + 2 = 0$$

$$8 = 8I$$

$$\boxed{I = 1A}$$

Star-Delta transformation



Delta to star

$$R_a = \frac{R_{ab} * R_{ca}}{R_{ab} + R_{bc} + R_{ca}} \; ; \; R_b = \frac{R_{bc} * R_{ab}}{R_{ab} + R_{bc} + R_{ca}}$$

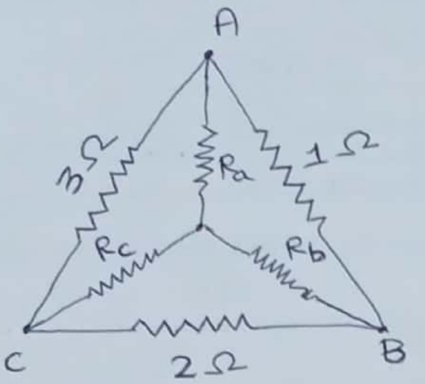
$$R_c = \frac{R_{ca} * R_{bc}}{R_{ab} + R_{bc} + R_{ca}}$$

Star to delta

$$R_{ab} = \frac{R_a \cdot R_b + R_b \cdot R_c + R_c \cdot R_a}{R_c}$$

$$R_{bc} = \frac{R_a \cdot R_b + R_b \cdot R_c + R_c \cdot R_a}{R_a} \; ; \; R_{ca} = \frac{R_a \cdot R_b + R_b \cdot R_c + R_c \cdot R_a}{R_b}$$

1) Transform the given delta to equivalent star ?

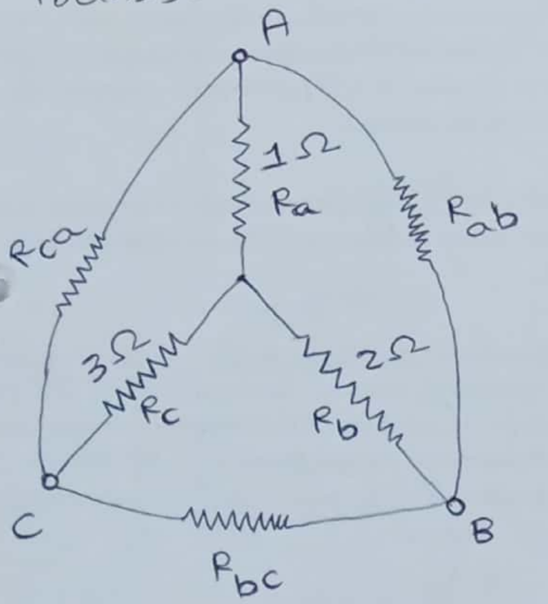


Solution :- $R_b = \dfrac{R_{ab} \cdot R_{bc}}{R_{ab}+R_{bc}+R_{ca}}$; $R_a = \dfrac{R_{ab} * R_{ca}}{R_{ab}+R_{bc}+R_{ca}}$

$$R_c = \frac{R_{ac} * R_{bc}}{R_{ab}+R_{bc}+R_{ca}}$$

$R_b = \dfrac{1 * 2}{6} = 1/3\ \Omega$; $R_a = \dfrac{3}{6} = 1/2\ \Omega$; $R_c = \dfrac{2 * 3}{6} = 1\ \Omega$

2) Transform the given star to equivalent delta ?



$$R_{bc} = \frac{R_a \cdot R_b + R_b \cdot R_c + R_c \cdot R_a}{R_b}$$

$$R_{bc} = \frac{1\times2 + 2\times3 + 3\times1}{1} = 11\ \Omega$$

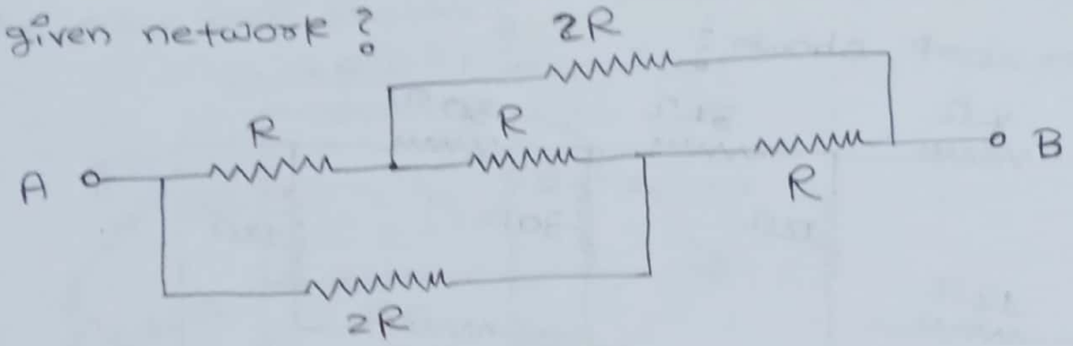
$$R_{ca} = \frac{R_a \times R_b + R_b \times R_c + R_c \times R_a}{R_b}$$

$$\boxed{R_{ca} = 11/2\ \Omega}$$

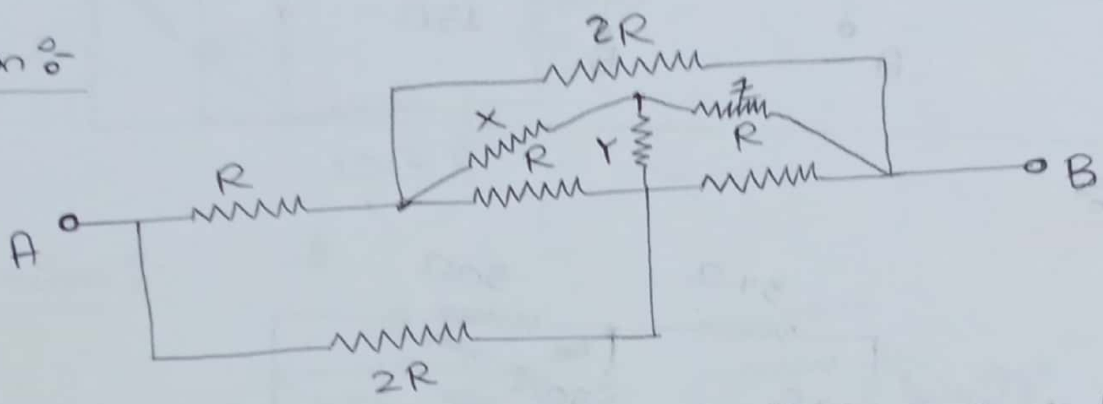
$$R_{ab} = \frac{R_a \cdot R_b + R_b \cdot R_c + R_c \cdot R_a}{R_c}$$

$$\boxed{R_{ab} = 11/3\ \Omega}$$

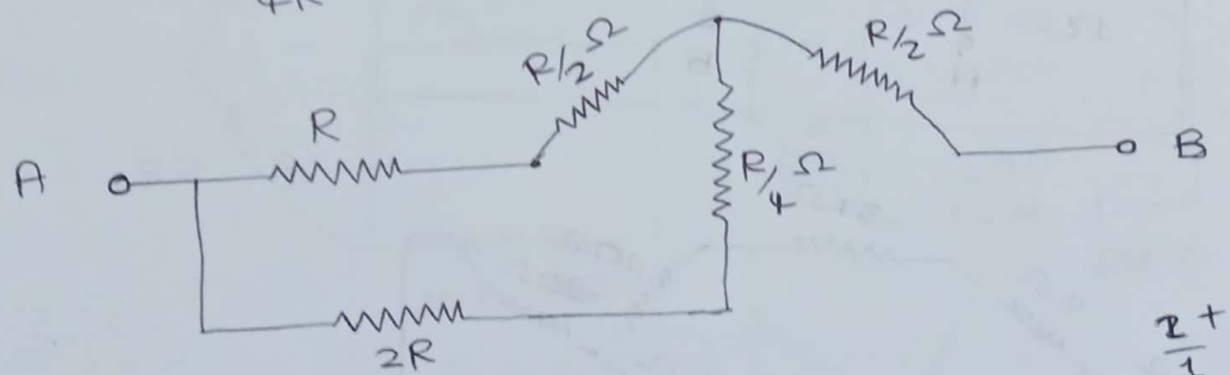
3) Find the equivalent resistance between the terminals A & B in the given network?



Solution:

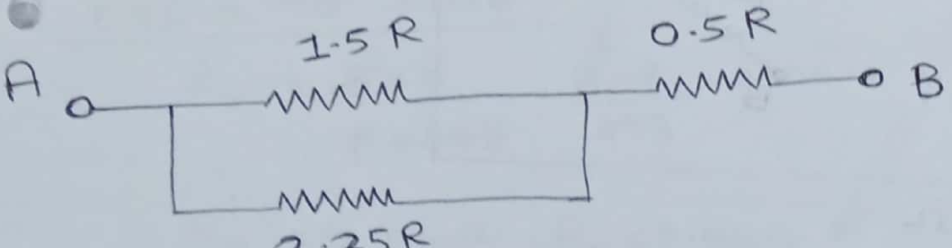


$X = \frac{R \times 2R}{4R} = R/2\ \Omega$; $Y = \frac{R \times R}{4R} = R/4\ \Omega$; $Z = \frac{2R \times R}{4R} = R/2\ \Omega$

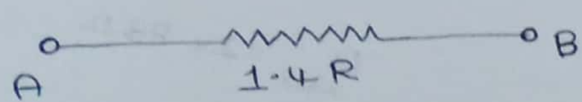


$\frac{2}{1} + \frac{1}{4} = \frac{8+1}{4} = \frac{9}{4}$

$9 \div 4 = 2.25$



$$\frac{1.5R \times 2.25R}{3.75R} = 0.9R$$



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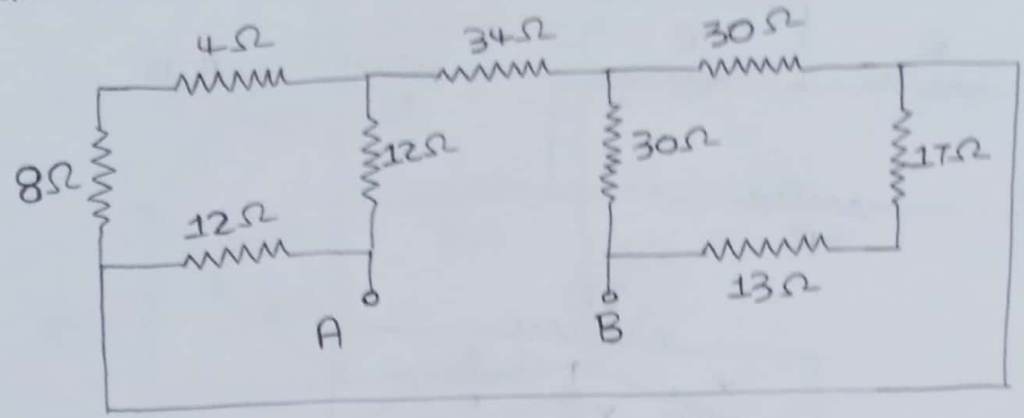
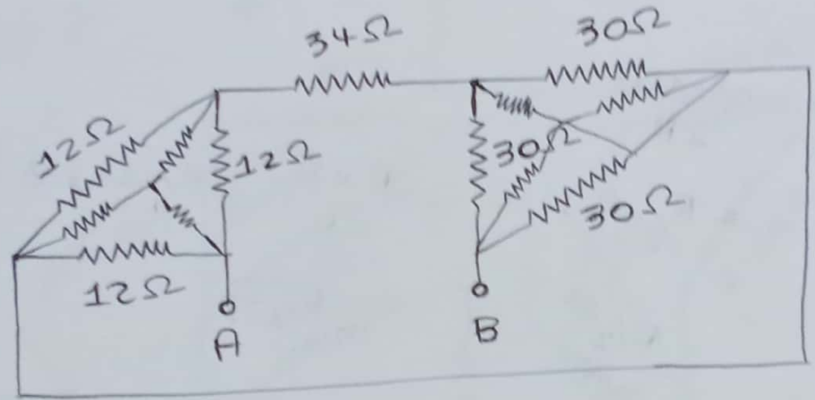
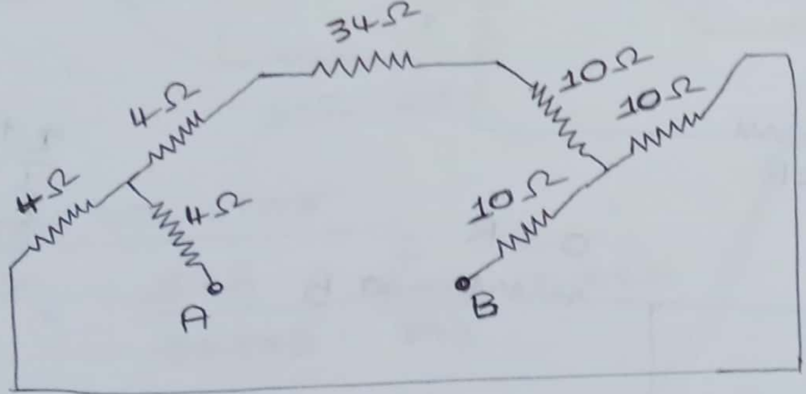
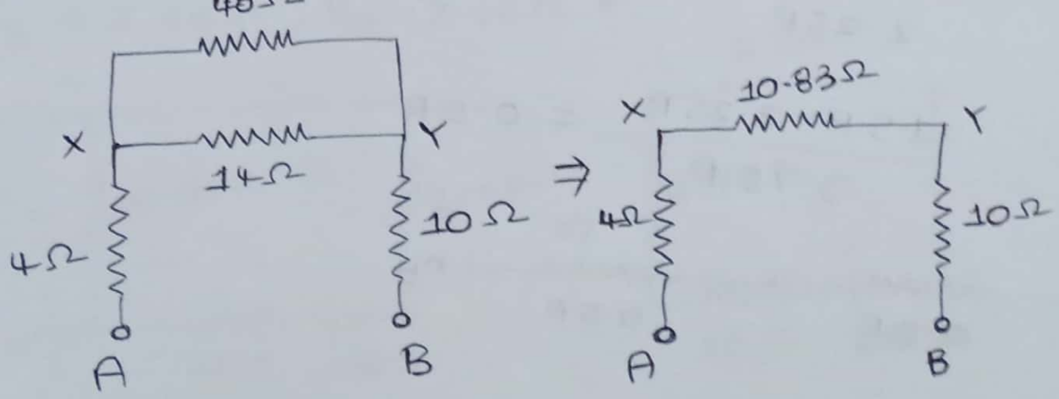
4) Find the equivalent resistance between the terminals A & B in the network shown?



solution :-

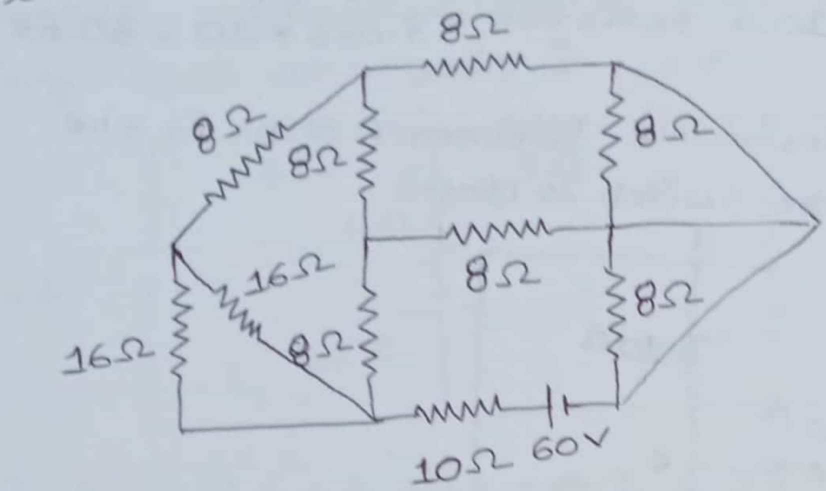




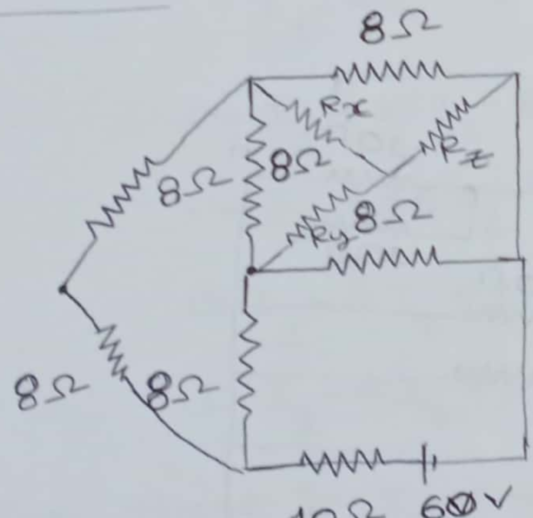


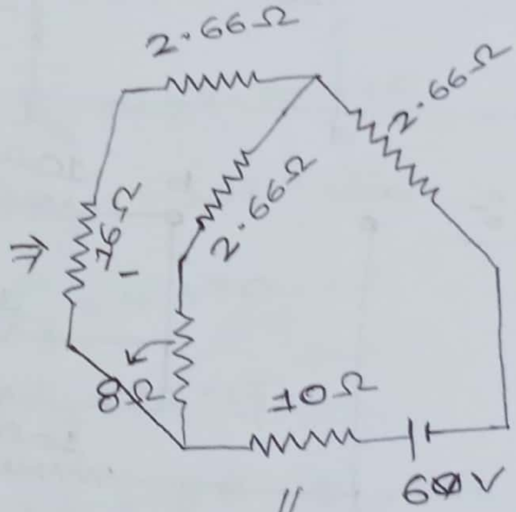
$R_{AB} = 24.83\,\Omega$

5) Find the voltage drop across 10Ω resistor in the network shown ?



Solution :-

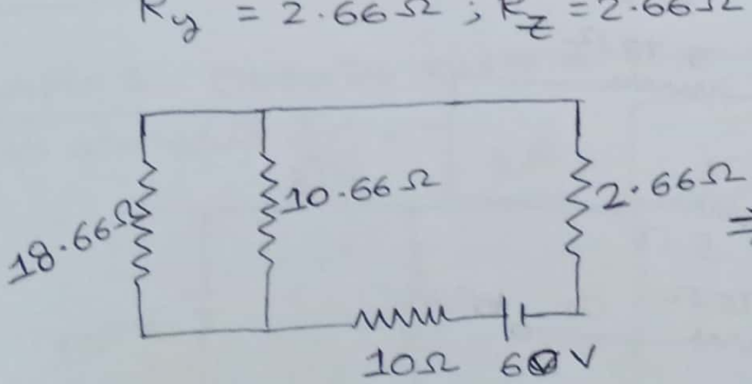


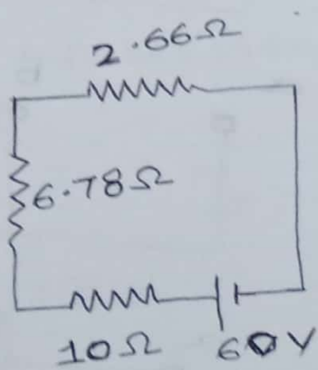


Delta to star

$$R_x = \frac{8\times8}{8+8+8} = \frac{8\times8}{24} = 2.66\,\Omega$$

$$R_y = 2.66\,\Omega \;;\; R_z = 2.66\,\Omega$$





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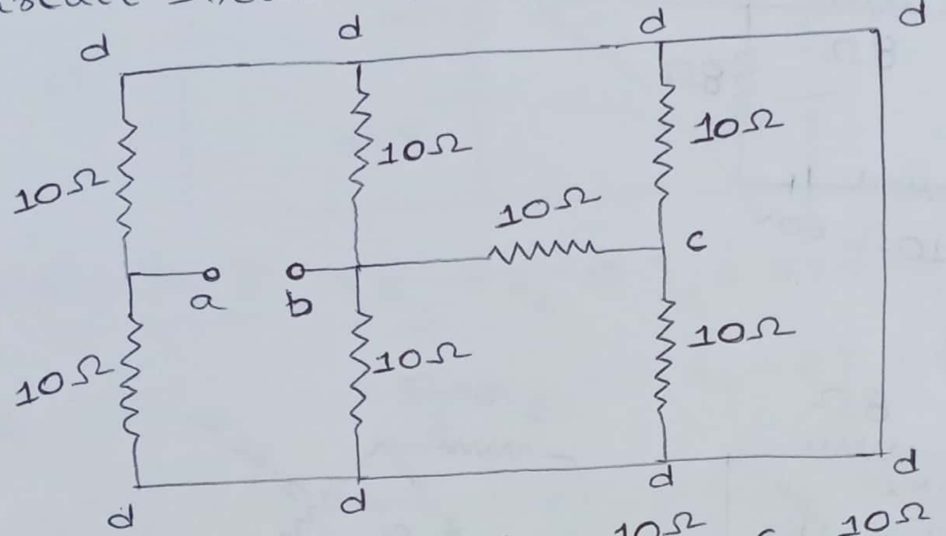
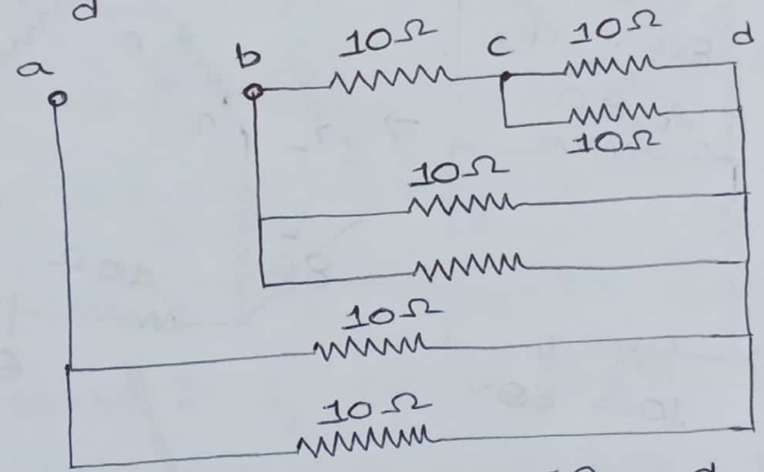
current delivered by 60V source, $I_s = \frac{60}{R_{eq}} = \frac{60}{19.44} = 3.086\,A$

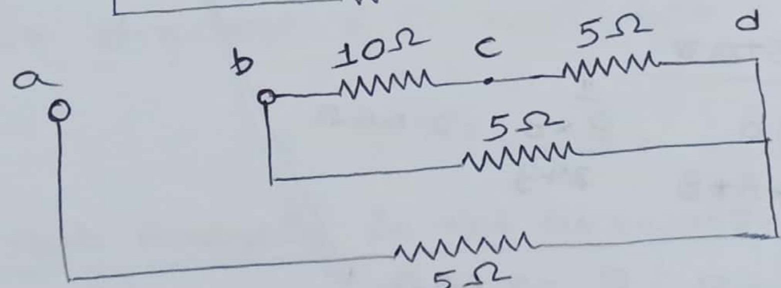
voltage drop across 10Ω resistor = $3.086 * 10 = 30.86\,V$

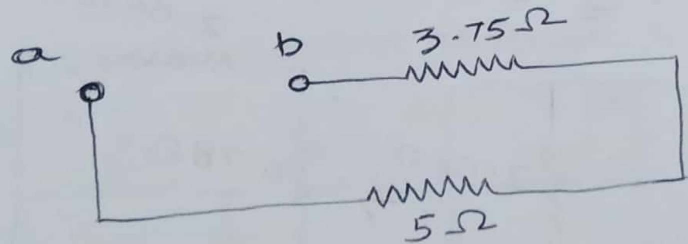
Find the equivalent resistance between A & B in the circuit shown when the switch is closed

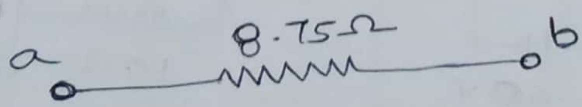


Solution :-



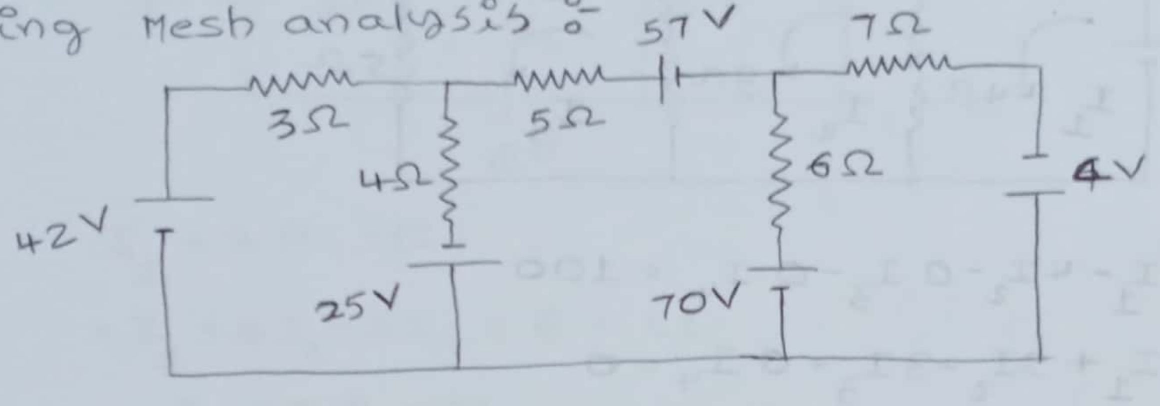






Lecture 7 - Mesh Analysis

Example obtain current through 6 Ω resistor using Mesh analysis :



Solution : $7I_1 - 4I_2 - 0 \cdot I_3 = 25 + 42$

$$7I_1 - 4I_2 - 0 \cdot I_3 = 67 \quad -(1)$$

$$-4I_1 + 15I_2 - 6I_3 = -57 - 70 + 25$$

$$-4I_1 + 15I_2 - 6I_3 = -102 \quad -(2)$$

$$0I_1 - 6I_2 + 13I_3 = 4 + 70$$

$$0 \cdot I_1 - 6I_2 + 13I_3 = 74 \quad -(3)$$

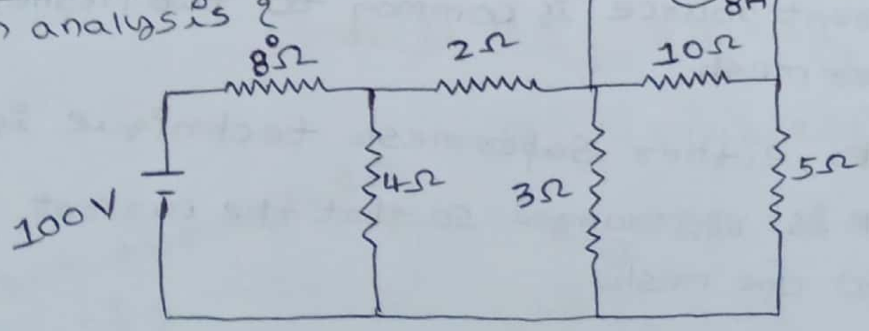
Solving these :- $I_1 = 5A$; $I_2 = -8A$; $I_3 = 2A$

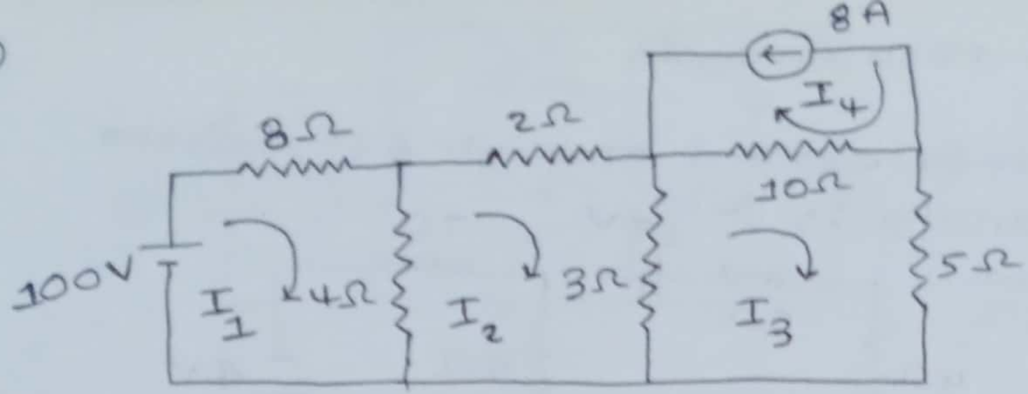
current through 6 Ω resistor $= I_2 \sim I_3$

$$= 10 A$$

Lecture 8 - Mesh Analysis in the Networks with current sources

Example 1 Obtain current through 4 Ω resistor using Mesh analysis ?





$$12I_1 - 4I_2 - 0 \cdot I_3 - 0 \cdot I_4 = 100$$

$$-4I_1 + 9I_2 - 3I_3 - 0 \cdot I_4 = 0$$

$$0 \cdot I_1 - 3I_2 + 18I_3 - 10I_4 = 0$$

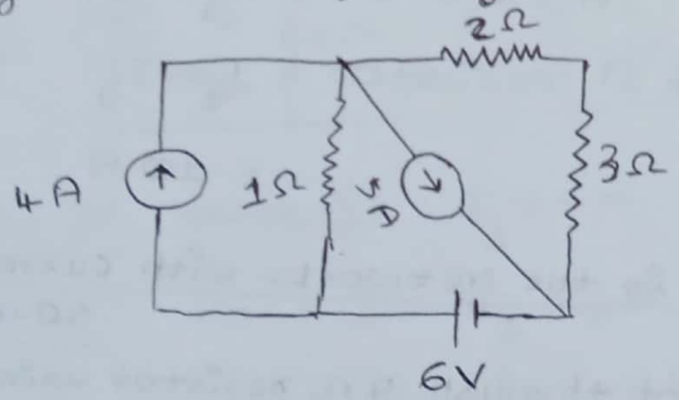
$$I_4 = -8$$

Solving (1) (2) (3) & (4)

$I_1 = 9.26$ A; $I_2 = 2.79$ A ; $I_3 = -3.97$ A

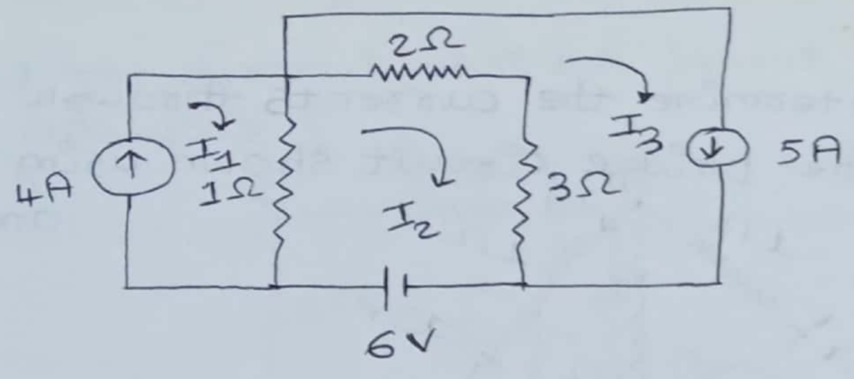
current through 4 Ω resistance $= I_1 - I_2 = 6.47$ A

Example 2 Obtain voltage across 3Ω resistor using Mesh Analysis ?



→ Whenever a current source is common to two meshes, it creates a supermesh.

→ In such networks, either Supermesh technique is applied or network is rearranged so that the current source is confined to one mesh.



$I_1 = 4\,A$ - (1)

$-I_1 + 6I_2 - 5I_3 = 6$ - (2)

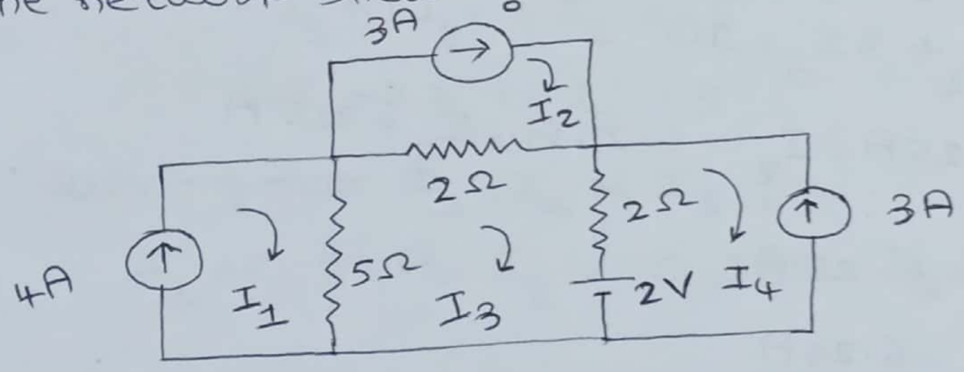
$I_3 = 5\,A$ - (3)

Solving for (1), (2) & (3) $I_2 = 5.83\,A$

- Current through $3\,\Omega = I_2 \sim I_3 = 0.83\,A$

Voltage across $3\,\Omega$ resistor $= 2.49\,V$

Example 3 Determine the current through $5\,\Omega$ resistor in the network shown ?



Solution :-

Mesh ① $I_1 = 4\,A$

Mesh ② $I_2 = 3\,A$

Mesh ④ $I_4 = -3\,A$

Mesh ③ $9I_3 - 5I_1 - 2I_2 - 2I_4 = -2$

$9I_3 - 5(4) - 2(3) - 2(-3) = -2$

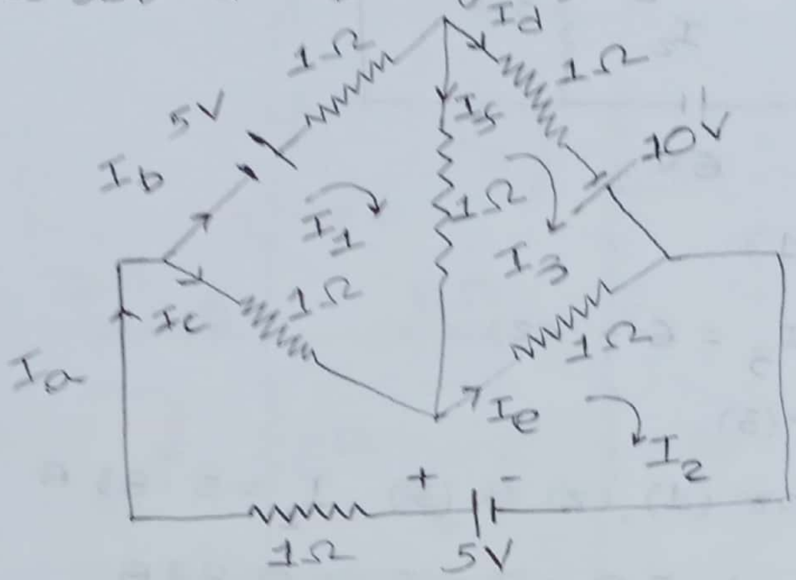
$9I_3 - 20 - 6 + 6 = -2$

$9I_3 = 18$

$\boxed{I_3 = 2A}$

current through $5\,\Omega$
$= I_1 - I_3$
$= 2A$

Example 4 Determine the currents through various branches for the bridge circuit shown using mesh analysis?



$$3I_1 - I_2 - I_3 = 5$$

$$-I_1 + 3I_2 - I_3 = 5$$

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

$I_1 = 6.25A$; $I_2 = 6.25A$; $I_3 = 7.5A$

$I_a = I_2 = 6.25A$

$I_b = I_1 = 6.25A$

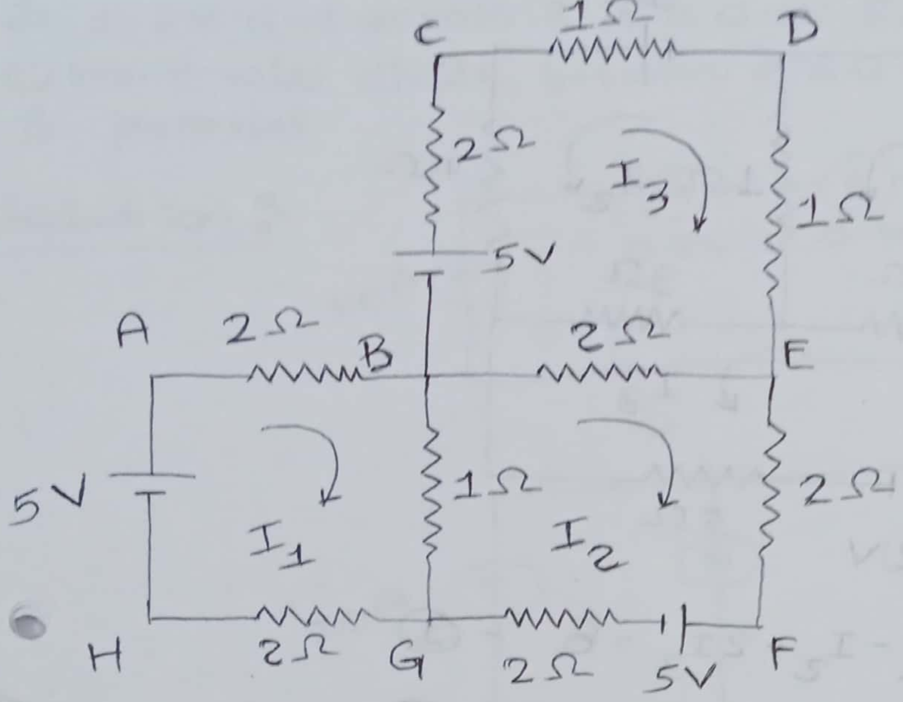
$I_c = I_2 - I_1 = 0A$

$I_d = I_3 = 7.5A$

$I_e = I_2 - I_3 = -1.25A$

$I_f = I_1 - I_3 = -1.25A$

5) Find the current through branch BC using mesh analysis ?



<u>solution :-</u>

$$5I_1 - I_2 - 0 \cdot I_3 = 5$$
$$-I_1 + 7I_2 - 2I_2 = -5$$
$$0I_1 - 2I_2 + 6I_2 = 5$$

Solving for I_1, I_2 & I_3 :-

$I_1 = 0.92\,A$; $I_2 = -0.38\,A$; $I_3 = 0.70\,A$

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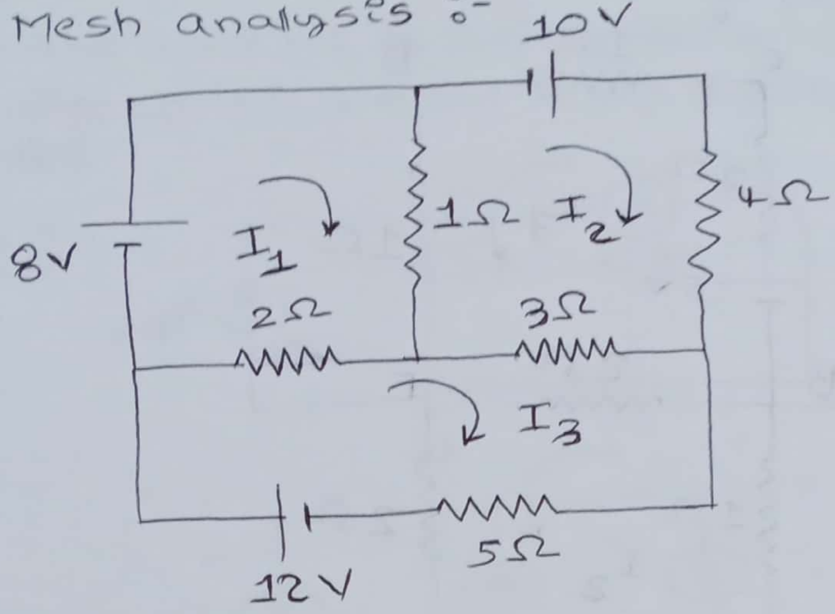
6) Determine the current through 5Ω resistor using Mesh analysis :-



Solution :-

$$3I_1 - I_2 - 2I_3 = 8 \quad - (1)$$

$$-I_1 + 8I_2 - 3I_3 = 10 - (2)$$

$$-2I_1 - 3I_2 + 10I_3 = 12 - (3)$$

$$\frac{12}{1} + \frac{2}{3}(8)$$
$$\frac{36+16}{3}$$

solve for equations (1) (2) & (3)

$$\begin{bmatrix} 3 & -1 & -2 & 8 \\ -1 & 8 & -3 & 10 \\ -2 & -3 & 10 & 12 \end{bmatrix} \longrightarrow \begin{bmatrix} 3 & -1 & -2 & 8 \\ 0 & 23 & -8 & 38 \\ 0 & -11/3 & \frac{26}{3} & 52/3 \end{bmatrix}$$

$$-3 + \frac{2}{3}(-1)$$

$$\frac{-3}{1} - \frac{2}{3}$$

$$\frac{-9-2}{3}$$

$$\begin{bmatrix} 3 & -1 & -2 & 8 \\ 0 & 23 & -8 & 38 \\ 0 & \frac{-11}{3} & \frac{26}{3} & \frac{52}{3} \end{bmatrix} \xrightarrow{R_3 + \frac{11}{69}R_2} \begin{matrix} 3 & -1 & -2 & 8 \\ 0 & 23 & -8 & 38 \\ 0 & 0 & & \end{matrix}$$

$$10 + \frac{2}{3}(-2)$$

$$\frac{10}{1} - \frac{4}{3}$$
$$\frac{30-4}{3}$$

$$\frac{26}{3} - \frac{88}{69}$$
$$\overline{69}$$

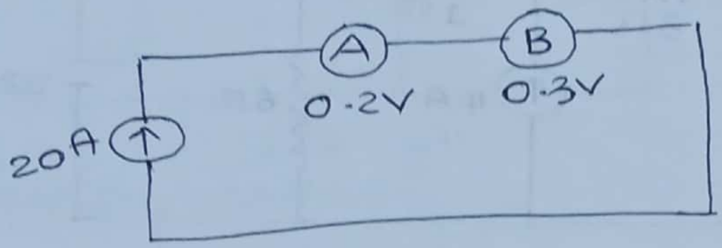
$$\frac{-11}{3} + 23x = 0$$

$$\frac{-11}{3} = -23x$$

$$x = 11/69$$

A current of 20A flows through two Ammeters A & B joined in series. Across A, the potential difference is 0.2V and across B it is 0.3V. Find how the same current will divide between A and B when they are joined in parallel.

Solution :-



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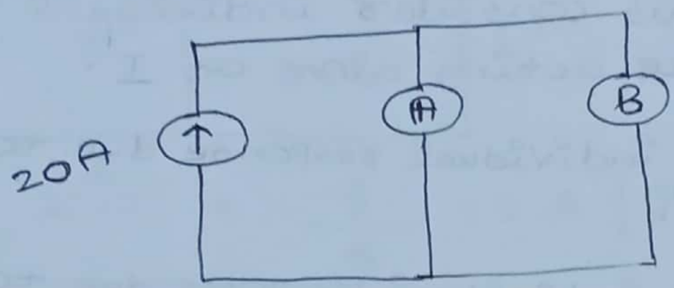
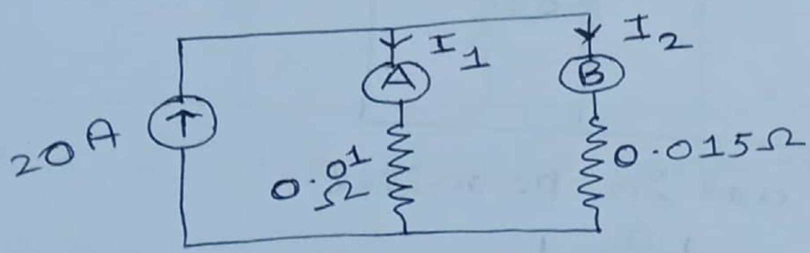


Internal resistances of Ammeter A & B are $\frac{0.2}{20}$ & $\frac{0.3}{20}$ respectively i.e 0.01Ω & 0.015Ω

20 A current will get divided according to resistance in the paths.



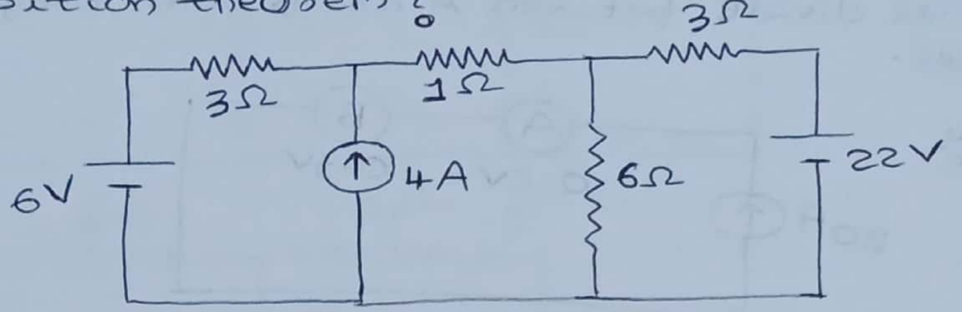
$$I_1 = \frac{20 \times 0.015}{0.01 + 0.015} = 12A$$

$$I_2 = I - I_1 = 8A$$

(19)

Problems on Superposition Theorem :-

1) Obtain current through 1Ω resistor using superposition theorem ?

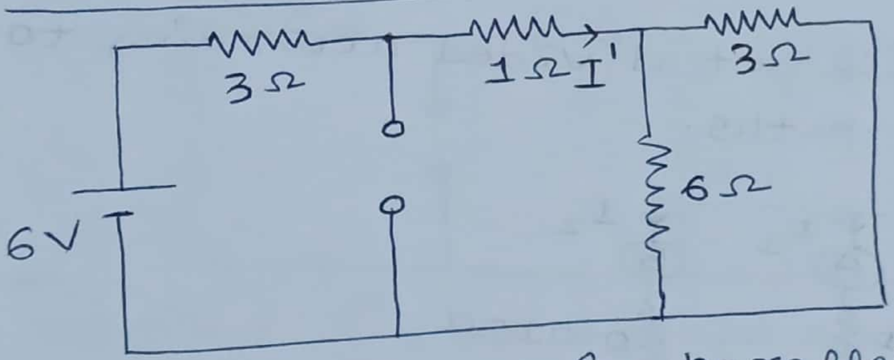


Solution :- Let us consider individual response due to 6V source acting alone as I'.

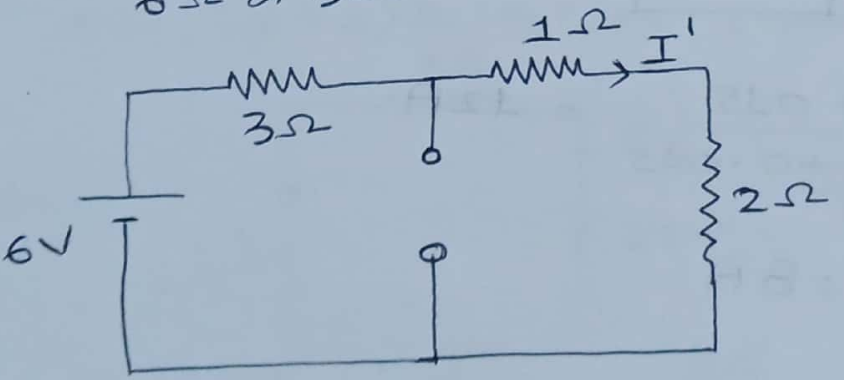
Let us consider individual response due to 4A source acting alone as I''.

Let us consider individual response due to 22V source acting alone as I'''.

Considering 6V source alone

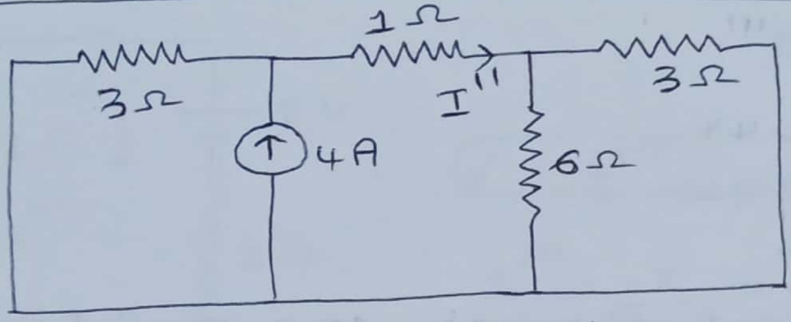


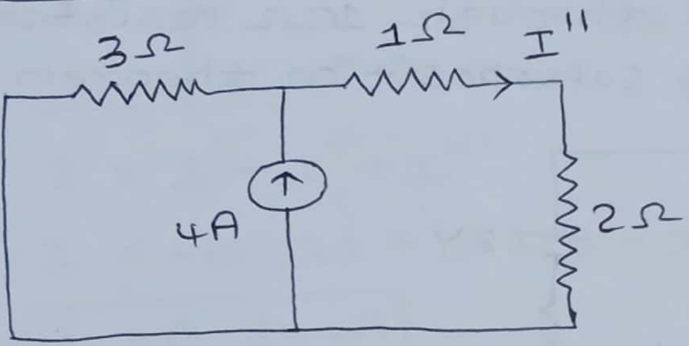
6Ω & 3Ω are in parallel



$$I' = \frac{6V}{6\Omega} = 1A$$

Considering 4A source alone :-

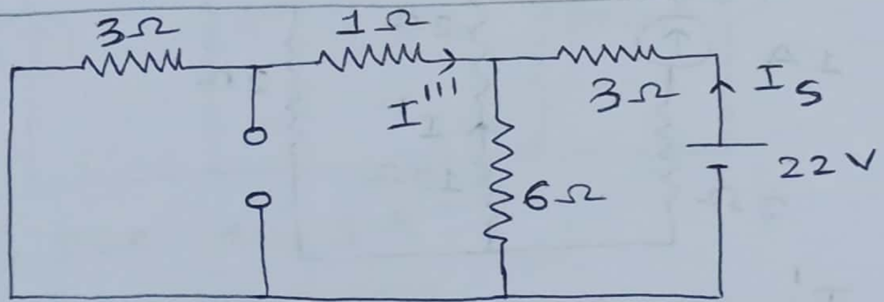




$$I'' = 4 \times \frac{3}{6} = 2A$$ [By current division rule]

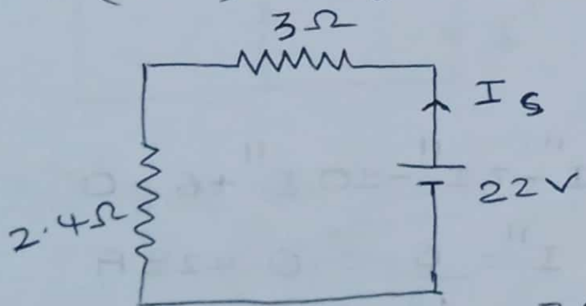
$$\boxed{I'' = 2A}$$

Considering 22V source alone :-

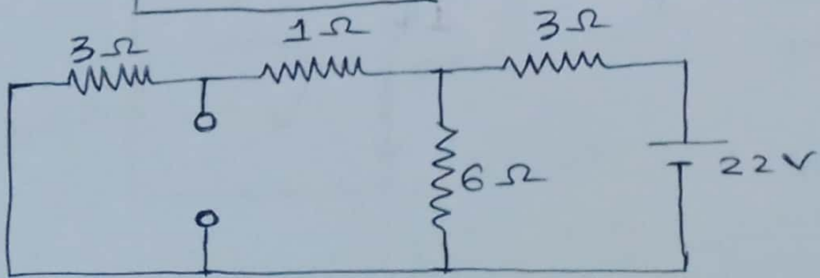


To find I''', we should compute I_s

$6\Omega \,||\, (3+1)\Omega$ gives 2.4Ω



$$I_s = \frac{22}{5.4} = 4.074\,A$$



$$I''' = -I_s * \frac{6}{10}$$

$$\boxed{I''' = -2.44A}$$

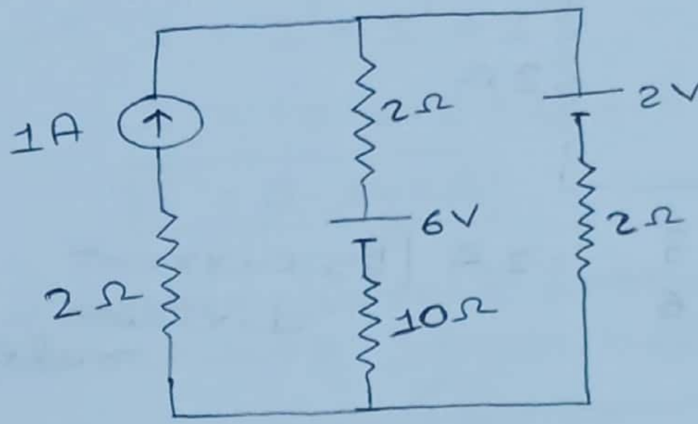
By superposition theorem :-

$$I = I' + I'' + I'''$$

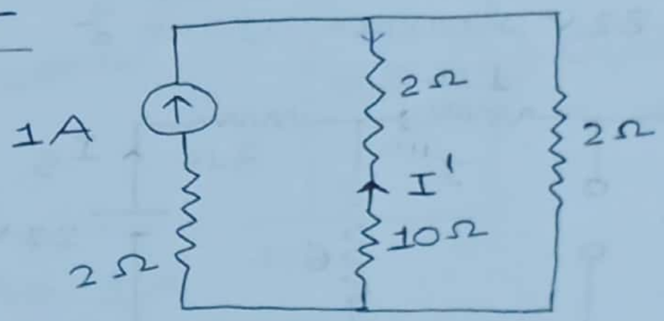
$$I = 1 + 2 - 2.44$$

$$\boxed{I = 0.56\,A}$$

2) Find the current through 10Ω resistor in the network shown using superposition theorem :-

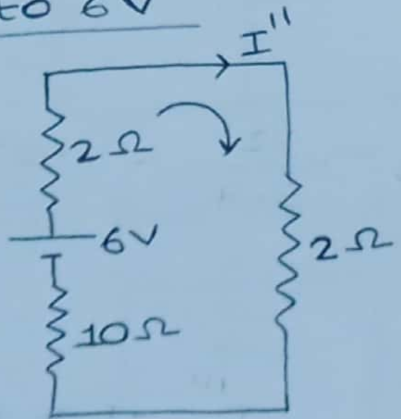


Due to 1A :-



$$I' = \frac{-1(2)}{14} = -0.142\,A$$

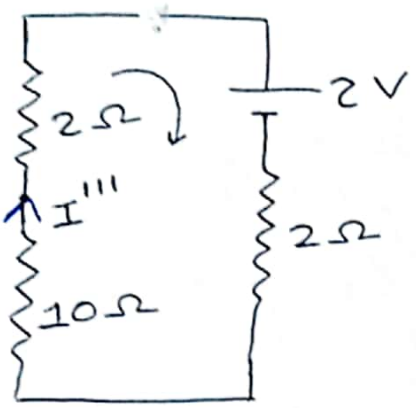
Due to 6V



$$-2I'' - 2I'' - 10I'' + 6 = 0$$

$$I'' = \frac{6}{14} = 0.428\,A$$

Due to 2V



$$\cancel{2 - 2I''' - 10I''' - 2I''' = 0}$$

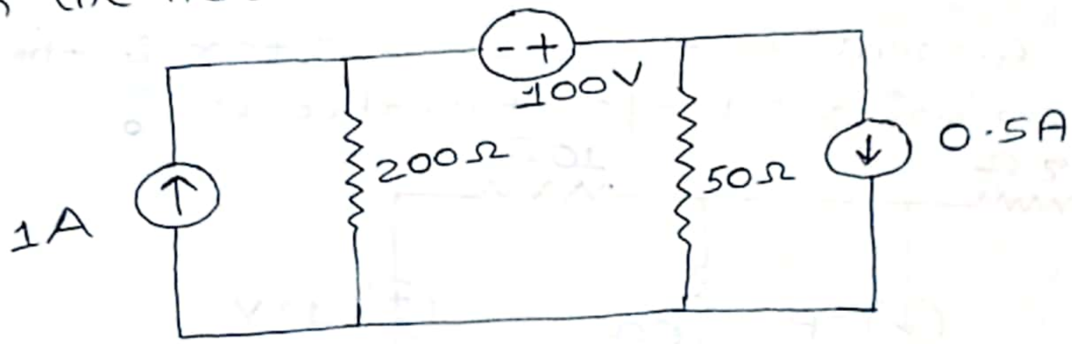
$$I''' = \frac{-2}{14} = -0.142\,A$$

$$\therefore\ I = I' + I'' + I'''$$

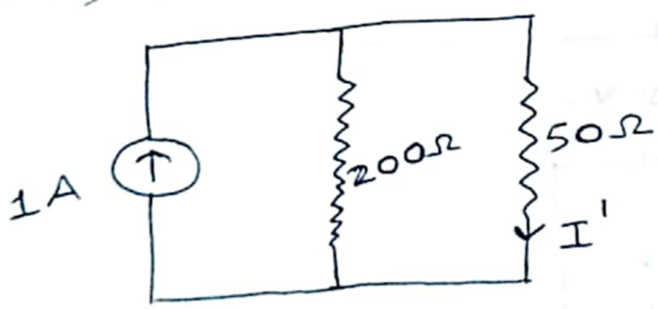
$$I = -0.142 + 0.428 - 0.142$$

$$\boxed{I = 0.144\,A}$$

3) Find the current through 50 Ω resistor in the network shown below ?



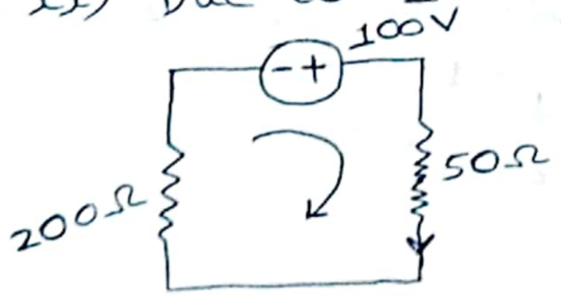
case i) Due to 1 A



$$I' = \frac{1 \times 200}{250}$$

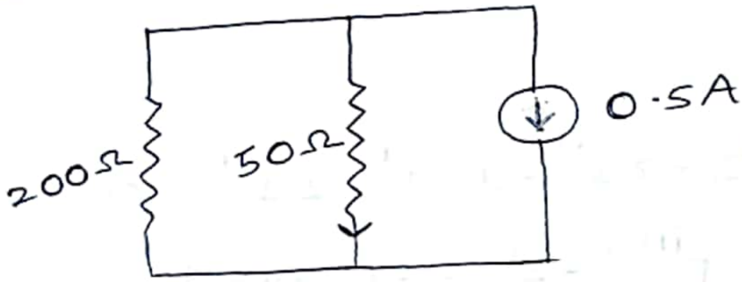
$$\boxed{I' = 0.8\,A}$$

case ii) Due to 100 V



$$I'' = \frac{100}{250} = 0.4\,A$$

case iii) due to 0.5 A



$$I''' = \frac{-0.5 \times 200}{250}$$

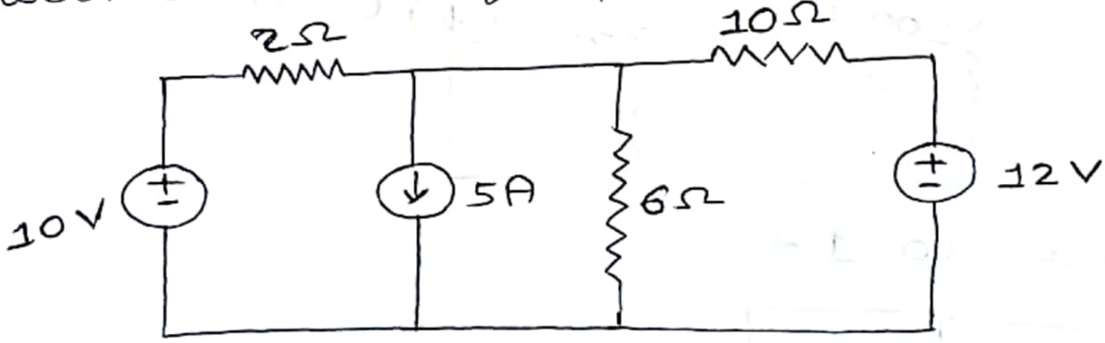
$$\boxed{I''' = -0.4\,A}$$

$$I = I' + I'' + I'''$$

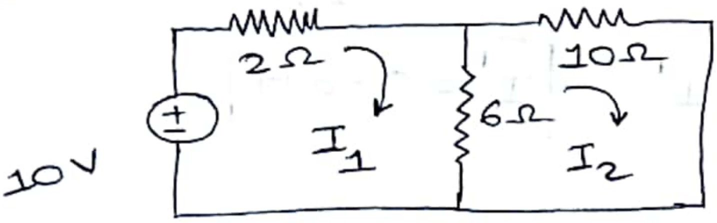
$$I = 0.8 + 0.4 - 0.4$$

$$\boxed{I = 0.8\,A}$$

4) Find the current in the 6 Ω resistor in the network shown using superposition theorem?



solution:- current due to 10V



$$\left.\begin{aligned} 8I_1 - 6I_2 &= 10 \\ -6I_1 + 16I_2 &= 0 \end{aligned}\right\}$$

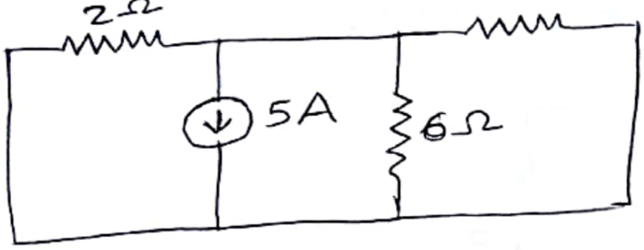
Solving for I_1 & I_2

$I_1 = 1.74\,A$

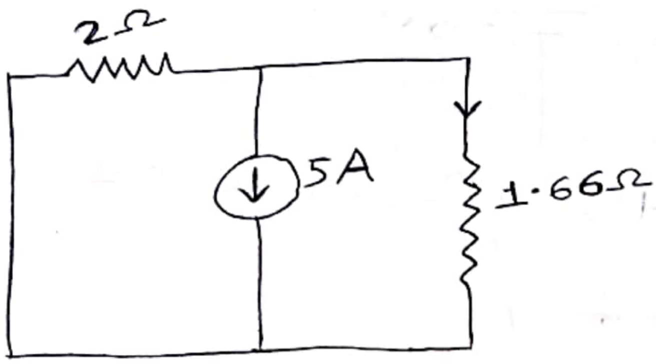
$I_2 = 0.65\,A$

$$I' = I_1 - I_2 = 1.09\,A$$

Current due to 5A

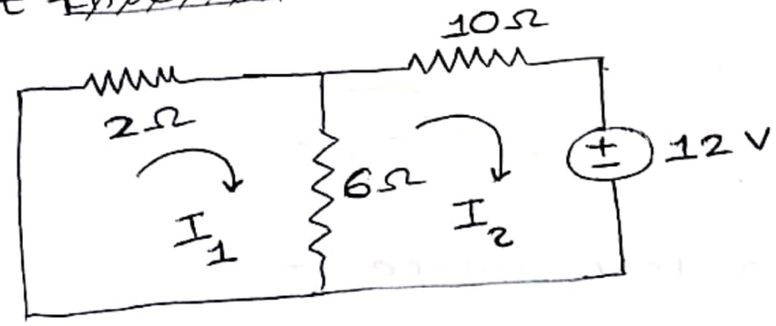


$6\Omega \parallel 10\Omega$



$$I' = \frac{-5 \times 1.66}{6 + 1.66} = -1.08\ A$$

Current ~~[illegible]~~ due to 12V



$$8I_1 - 6I_2 = 0$$

$$-6I_1 + 16I_2 = -12$$

$$I_1 = -0.78\ A \; ; \; I_2 = -1.04\ A$$

$$I''' = I_1 - I_2 = 0.26\ A$$

$$\therefore \; I = 1.09 - 1.08 + 0.26$$

$$\boxed{I = 0.27\ A}$$

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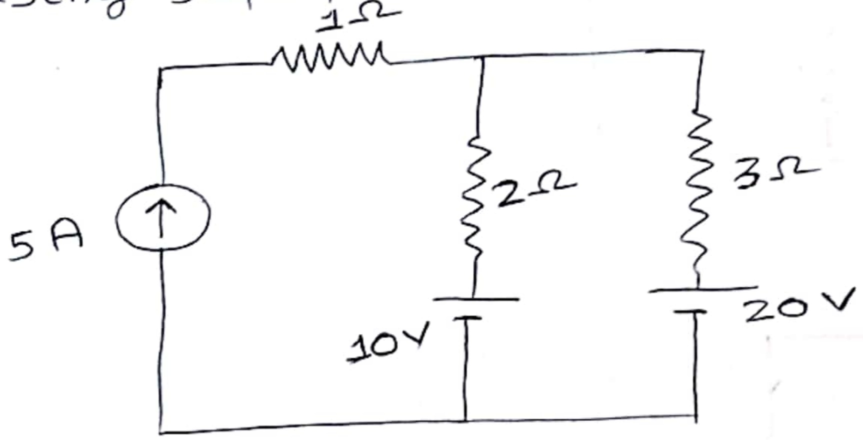
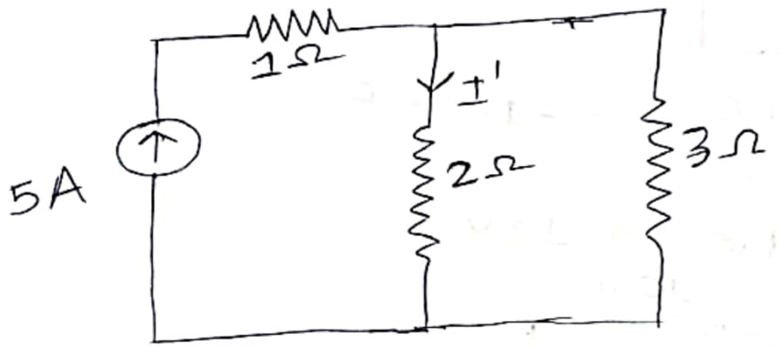
(25)

5) Find the current through 2Ω resistor given using superposition theorem?

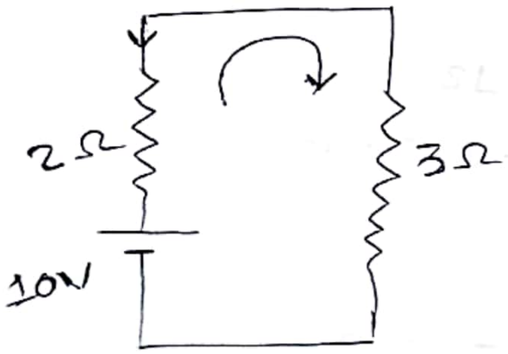


Solution :- current ~~through~~ due to 5A



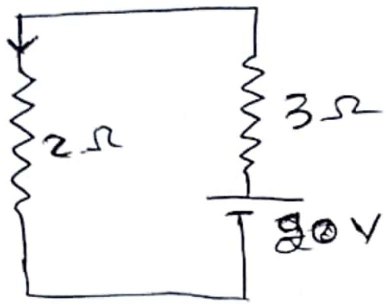
$$I' = \frac{5\times 3}{5} \Rightarrow I' = 3A$$

current due to 10V source :-



$$I'' = \frac{-10}{5} = -2A$$

Current due to 12 V :-



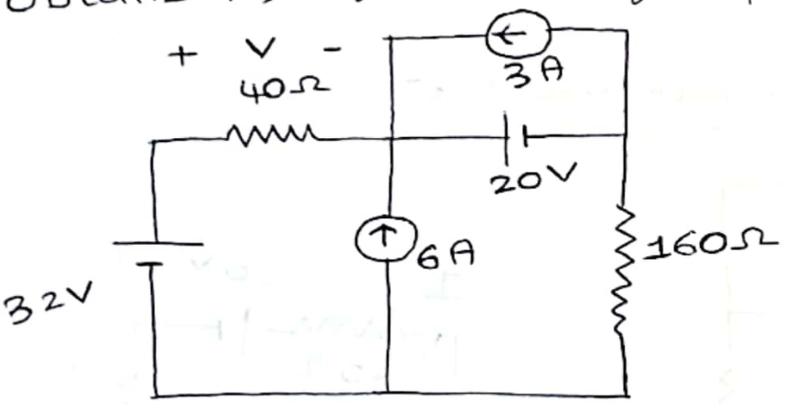
$$I''' = \frac{20}{5} = 4\ A$$

∴ Total current $= I' + I'' + I'''$

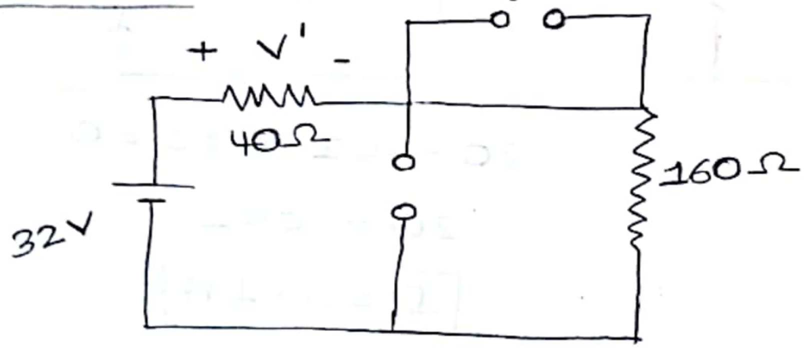
$= 3 - 2 + 4$

$= 5\ A$

6) Obtain voltage 'V' using superposition theorem ?

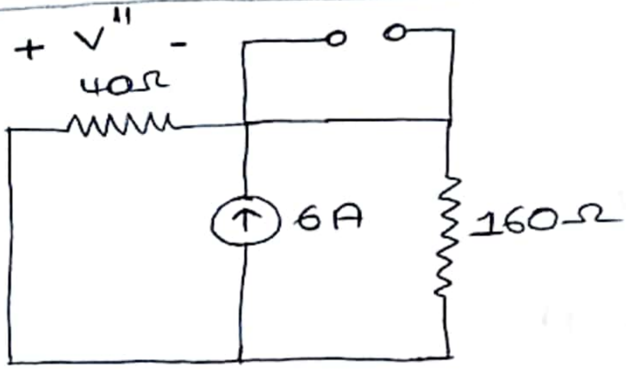


<u>Solution :-</u> Considering 32 V source alone,

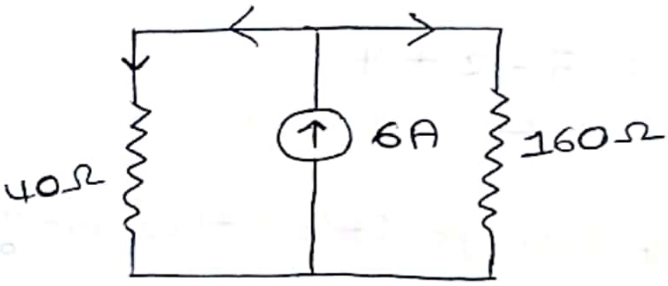


$$V' = 32 \times \frac{40}{200} = 6.4\ V$$ [Voltage division rule]

Considering 6 A source alone :-



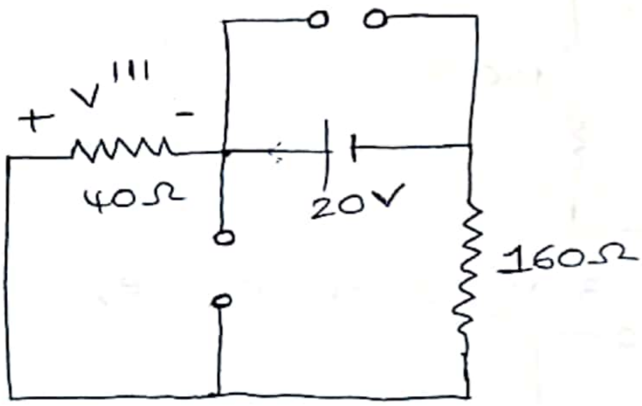
⇓



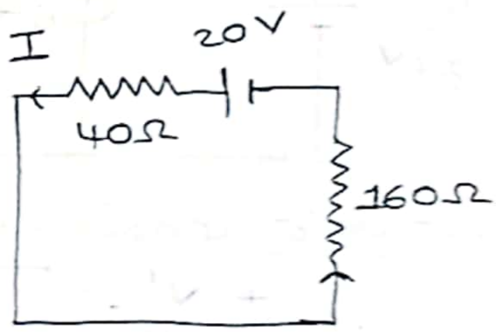
$$I = \frac{6 \times 160}{200} = 4.8\ A$$

$$V'' = -4.8 \times 40 = -192\ V$$

Considering 20V source alone :-



⇒



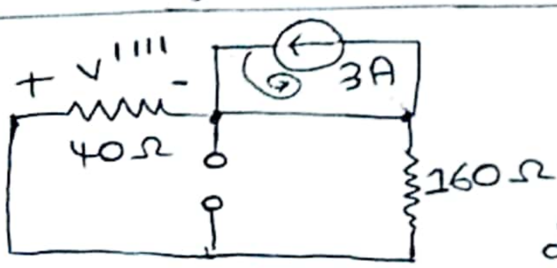
$$20 - 40I - 160I = 0$$

$$20 = 200I$$

$$\boxed{I = 0.1\ A}$$

$$V''' = -0.1 \times 40 = -4\ V$$

Considering 3A source alone :-



Current flows through least resistance path

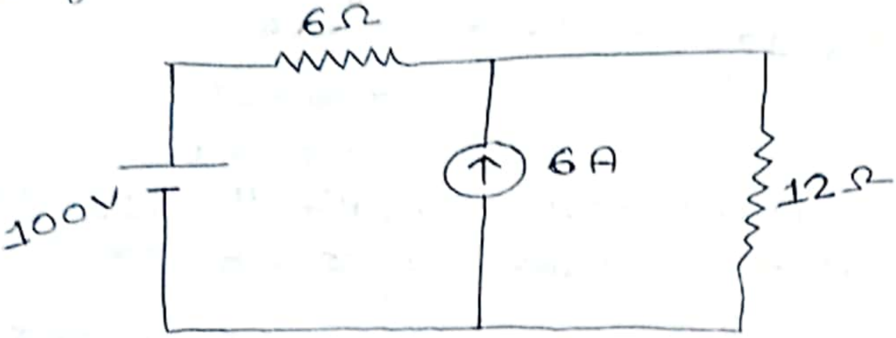
Open circuit :-

$$V'''' = 0$$

$$\therefore\ V = V' + V'' + V''' + V^{IV}$$

$$= 6.4 - 192 - 4 = -189.6\ V$$

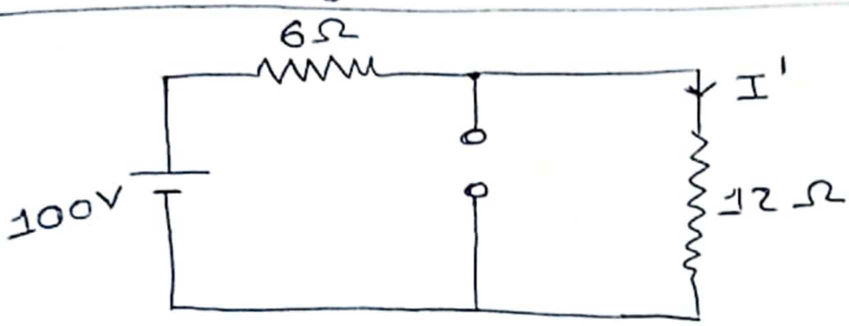
7) Find the power absorbed by 12 Ω resistor using superposition theorem?



Solution:- Let us consider individual current & power responses due to 100 V source acting alone as I' & P'.

Let us consider individual current & power responses due to 6 A source acting alone as I'' & P''.

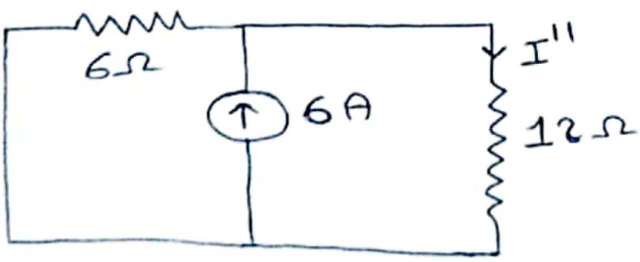
Considering 100 V source alone:-



$$I' = \frac{100}{18} = 5.56\ A \; ; \quad P' = (I')^2 \times 12$$

$$P' = 370.96\ W$$

Considering 6V source alone:-



$$I'' = 6 \times \frac{6\ \Omega}{6+12}$$

$$\boxed{I'' = 2A}$$

$$P'' = (I'')^2 \times 12 = 48\ W$$

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By superposition, current in 12 Ω resistor = I = $I' + I'' = 7.56$ A

Power absorbed by 12 Ω resistor $= I^2 \times 12$

$= 7.56^2 \times 12$

$= 685.84$ W

Adding the individual power responses, $P' + P'' = 418.96$ W which is not equal to the actual power absorbed.

→ Here, individual power responses cannot be superimposed to get total power beceause power is a quadratic term.

→ Thus, to get total power response, apply superposition principle to get total current or total voltage & using that find the power.

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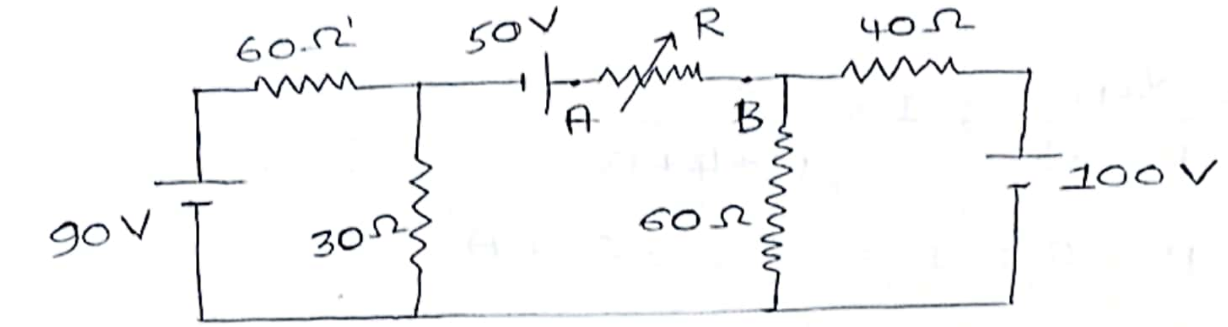
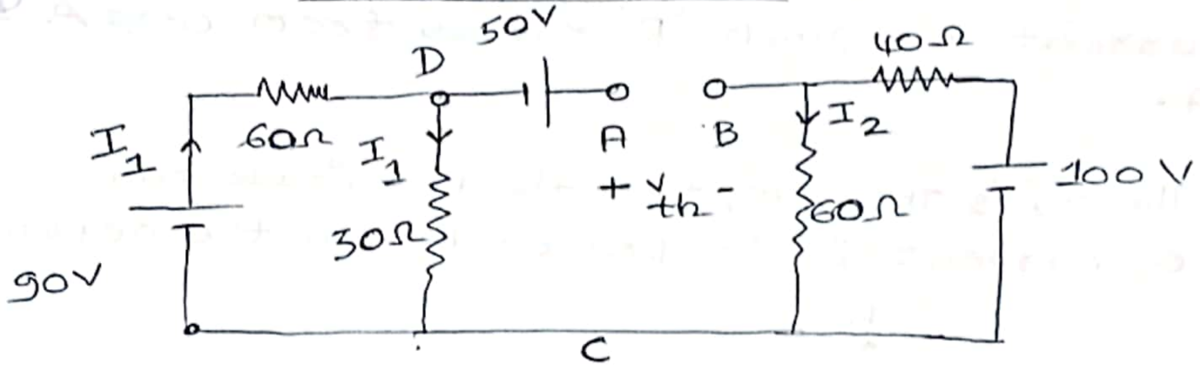
Problems on Thevenin's Theorem :-

1) Using Thevenin's theorem, calculate the range of current flowing through the resistance R, as it varies from 6Ω and 36Ω ?



Solution :- Finding V_{th} :-



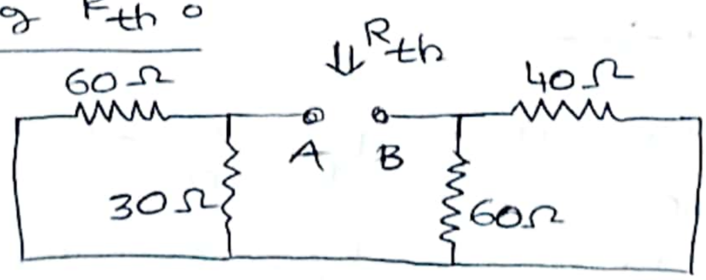
$I_1 = \frac{90}{90} = 1A \quad I_2 = \frac{100V}{100\Omega} = 1A$

By KVL : $50 - V_{th} - 60I_2 + 30I_1 = 0$

$50 - V_{th} - 60 + 30 = 0$

$\boxed{V_{th} = 20V}$

Finding R_{th} :-

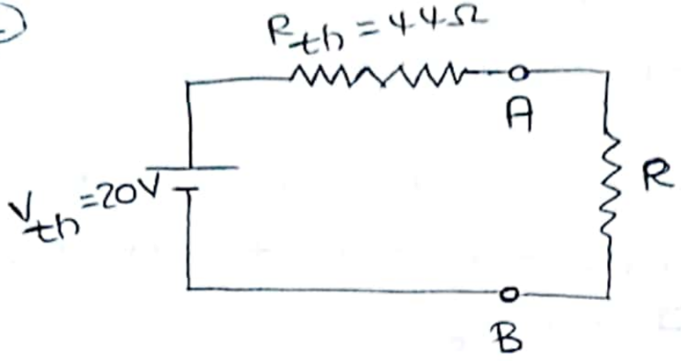


$R_{th} = (60\Omega \| 30\Omega) + (60\Omega \| 40\Omega)$

$= 20\Omega + 24$

$\boxed{R_{th} = 44\Omega}$

(31)



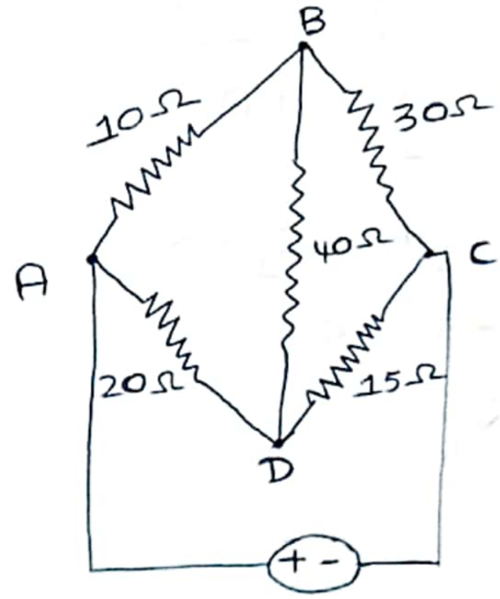
$$I_L = \frac{V_{th}}{R_{th}+R} \; ; \; I = \frac{20}{R + 4.4\Omega}$$

when $R = 6\Omega$; $I = \frac{20}{30} = 0.4\,A$

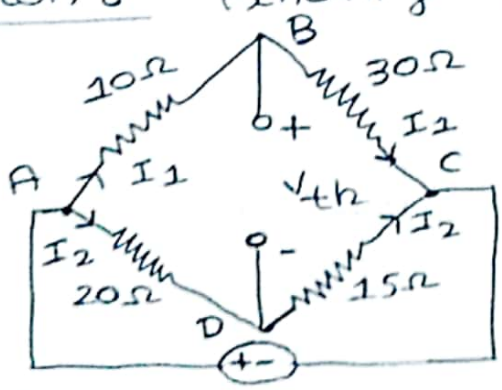
when $R = 36\Omega$; $I = \frac{20}{80} = 0.25\,A$

Hence, current through 'R' ranges from 0.25 A to 0.4A.

2) using Thevenin's Theorem, find the magnitude and direction of current in the branch BD in the network shown?



<u>Solution :-</u> Finding V_{th} :-



$$I_1 = \frac{2}{40} = 0.05\,A$$

$$I_2 = \frac{2}{35} = 0.057\,A$$

By KVL :- ABDA

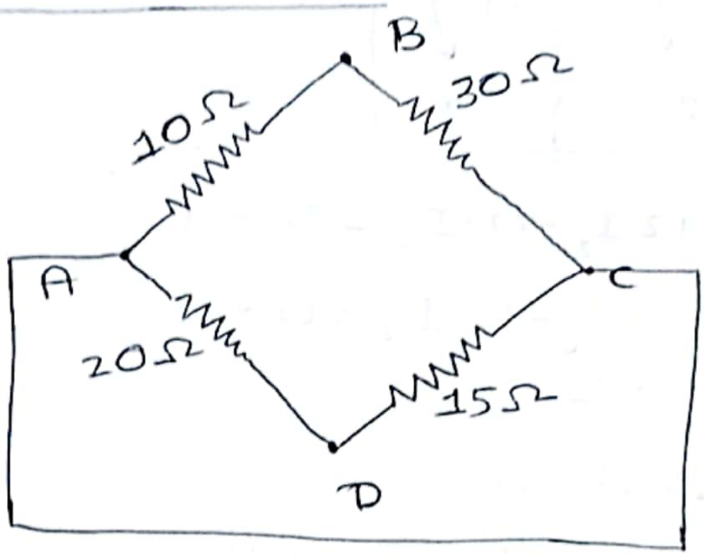
$$-10I_1 - V_{th} + 20I_2 = 0$$

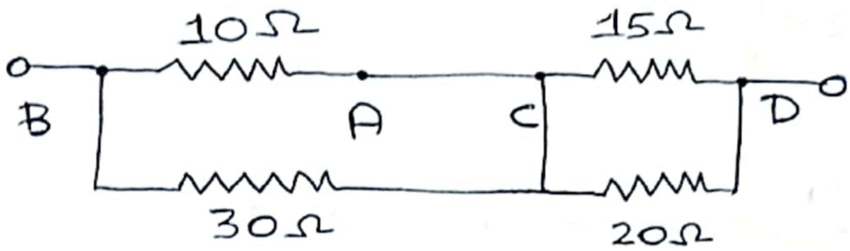
$$V_{th} = -10 I_1 + 20 I_2$$

$$V_{th} = -10(0.05) + 20(0.057)$$

$$\boxed{V_{th} = 0.64\,V}$$

Finding R_{th} :-

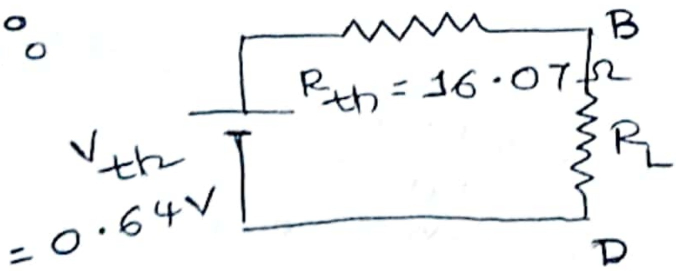




$$\frac{10 \times 30}{40} \qquad \frac{15 \times 20}{35}$$

$$R_{th} = 16.07\,\Omega$$

∴



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

$$= \frac{0.64}{16.07 + 40} = 11.41\,mA$$

Hence, current through the branch BD is 11.41 mA and flows from B to D.

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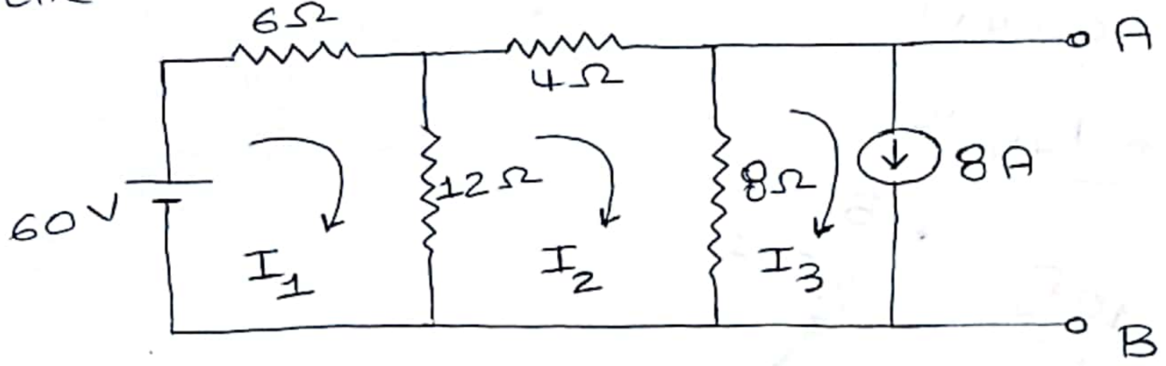
3) Obtain the Thevenin's Equivalent across the terminals A & B for the network given



Solution :-

$$18I_1 - 12I_2 - 0 \cdot I_3 = 0 \quad - (1)$$

$$-12I_1 + 24I_2 - 8 \cdot I_3 = 0 \quad - (2)$$

$$I_3 = 8\,A \quad - (3)$$

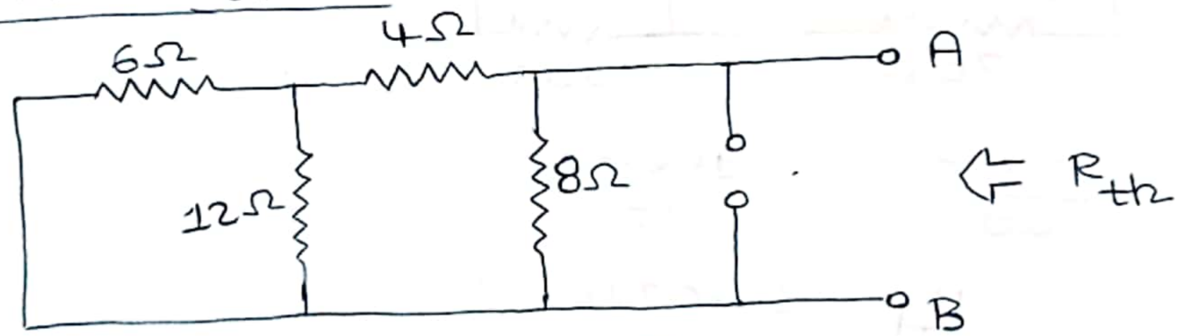
Solving for (1) (2) & (3)

$$I_1 = 7.66\,A \; ; \; I_2 = 6.5\,A \; ; \; I_3 = 8\,A$$

$$V_{th} = (I_2 - I_3)\,8$$

$$\boxed{V_{th} = -12V}$$

To find R_{th} :-

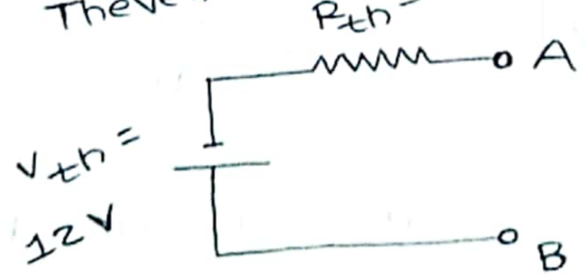


$$R_{th} = \left[(6\Omega \,||\, 12\Omega) + 4\Omega\right] || \, 8\Omega$$

$$R_{th} = [4\Omega + 4\Omega] \,||\, 8\Omega$$

$$\boxed{R_{th} = 4\Omega}$$

Thevenin's Equivalent circuit :-



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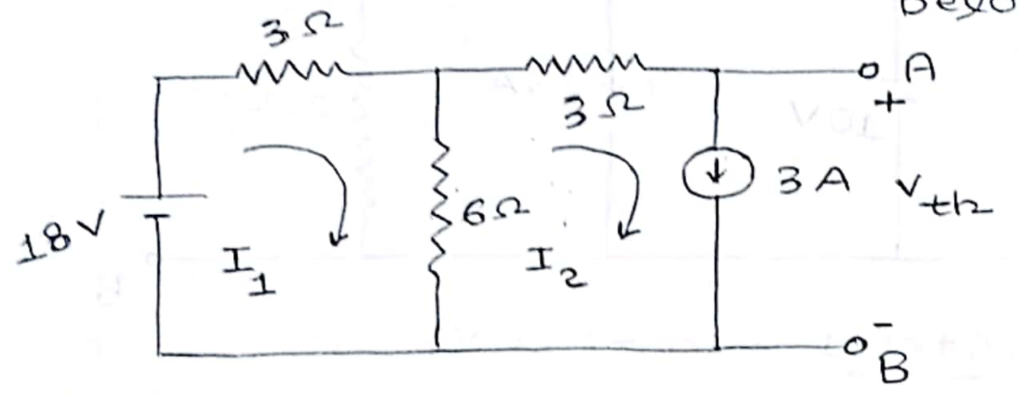
4) Find Thevenin's equivalent voltage & Thevenin's equivalent resistance between the terminals A & B for the network shown below?



Solution :-

$$I_2 = 3A \quad - (1)$$

$$9I_2 - 6I_1 = -V_{th} \quad [\text{Mesh } 2]$$

$$V_{th} = 6I_1 - 9I_2$$

$$9I_1 - 6I_2 = 18 \quad [\text{Mesh } 1]$$

$$9I_1 - 18 = 18$$

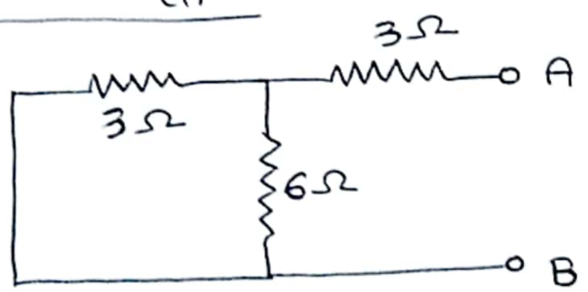
$$I_1 = \frac{36}{9}$$

$$\boxed{I_1 = 4A}$$

$$\therefore V_{th} = 6(4) - 9(3)$$

$$\boxed{V_{th} = -3V}$$

To find R_{th} :-

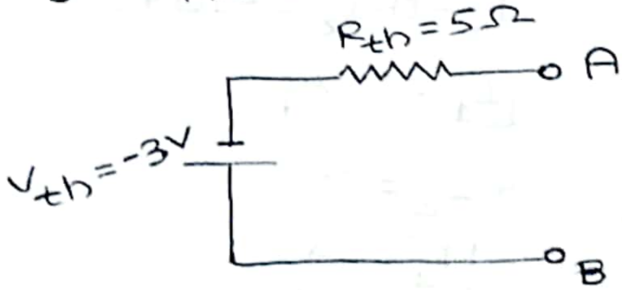


$$R_{th} = [3\Omega \parallel 6\Omega] + 3\Omega$$

$$= 2\Omega + 3\Omega$$

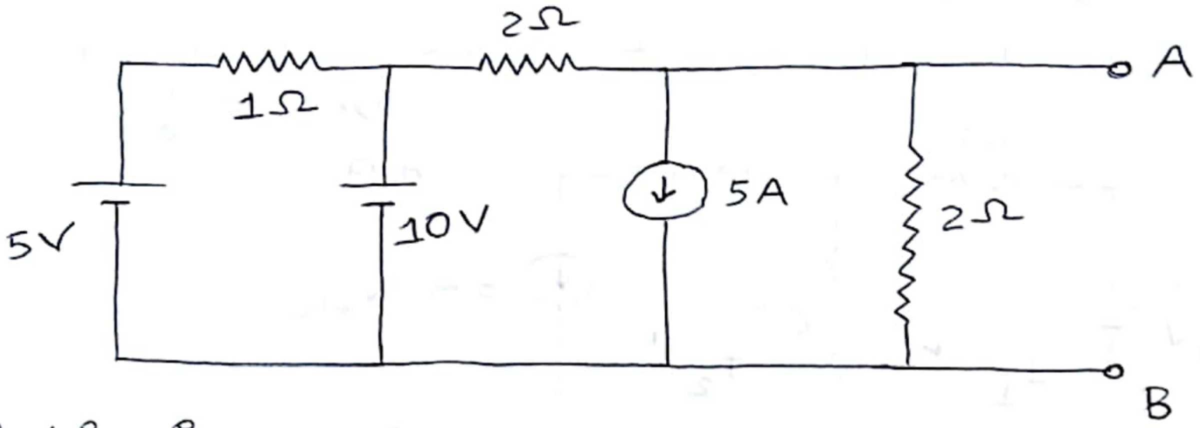
$$\boxed{R_{th} = 5\Omega}$$

Thevenin's Equivalent :-

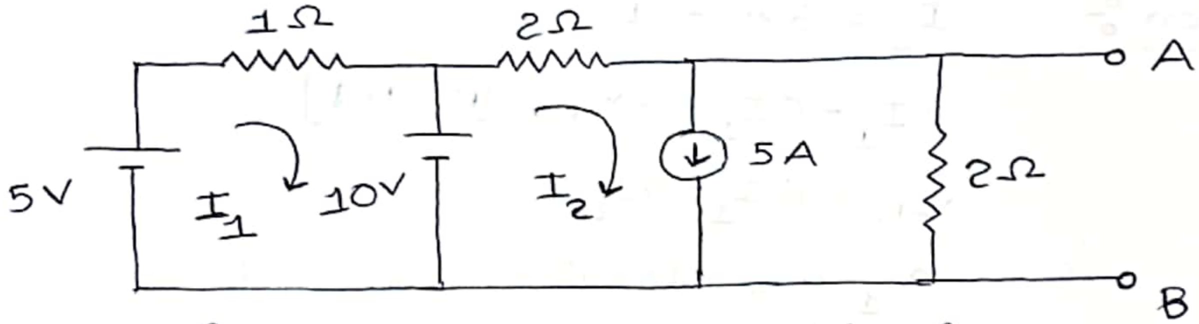


35

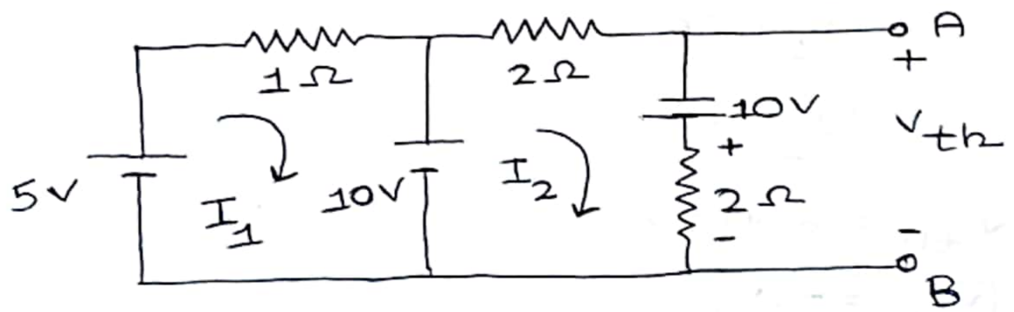
5) Obtain the Thevenin's Equivalent across the terminals A & B in the network shown below?



Solution :- Step 1 - To find V_{th} :-



Applying Source transformation :-



Applying KVL across V_{th} :-

$$2I_2 - 10 - V_{th} = 0$$

$$\boxed{V_{th} = 2I_2 - 10}$$

Mesh analysis :-

$$I_1 - 0 \cdot I_2 = -10 + 5$$

$$\boxed{I_1 = -5A}$$

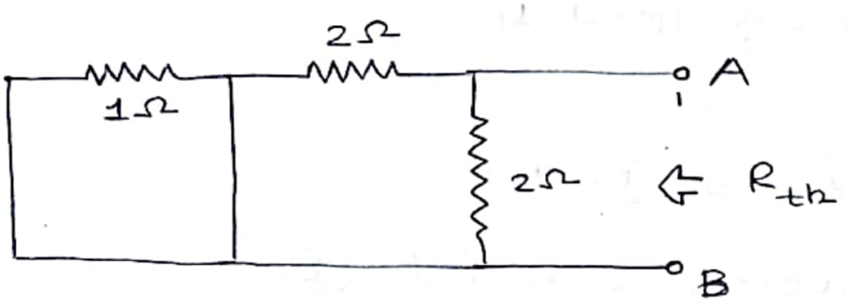
$$4I_2 = 20$$

$$\boxed{I_2 = 5A}$$

$\therefore V_{th} = 2(5) - 10$

$\boxed{V_{th} = 0\,V}$

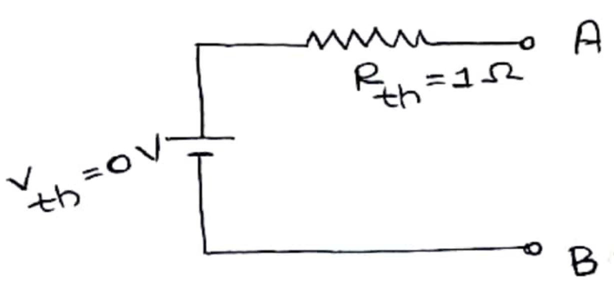
Step 2 To find R_{th} :-



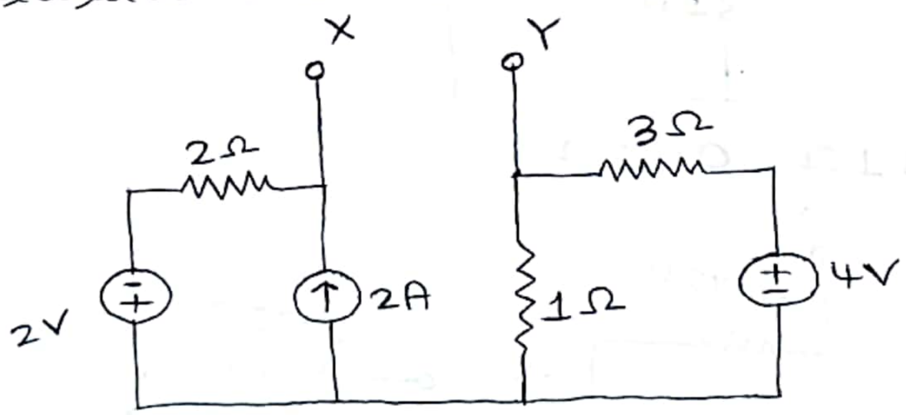
$1\,\Omega$ resistance will go beceause of short circuit

$R_{th} = 2\,\Omega \parallel 2\,\Omega = 1\,\Omega$

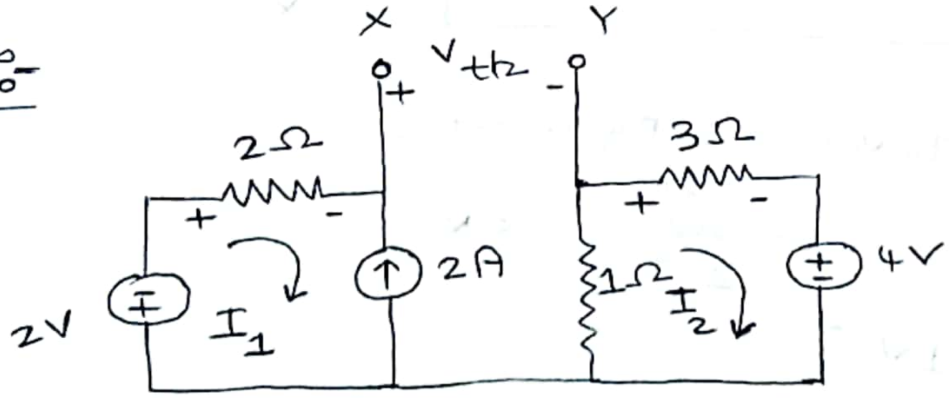
Thevenin's Equivalent Circuit :-



6) Calculate the thevenin's equivalent in the circuit shown?



Solution :-



(37) To find V_{th} :-

Applying KVL to the outer loop :-

$$-V_{th} - 3I_2 - 4 - 2 - 2I_1 = 0 \quad -(1)$$

Mesh analysis :-

$$I_1 = -2A \quad -(2) \quad [\text{Mesh } 1]$$

$$4I_2 = -4$$

$$I_2 = -1A \quad -(3) \quad [\text{Mesh } 2]$$

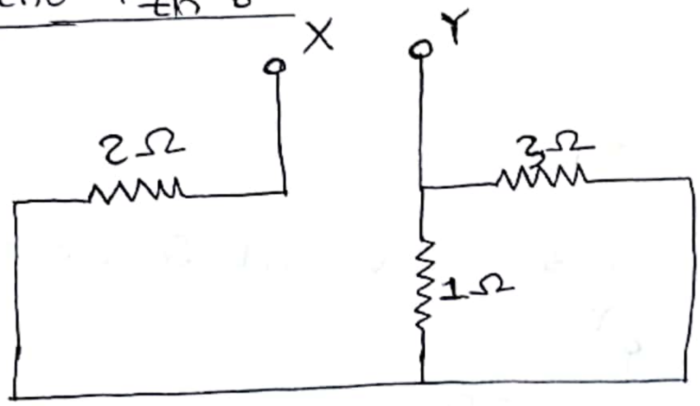
∴ substituting (2) & (3) in (1)

$$V_{th} = -3(-1) - 4 - 2 - 2(-2)$$

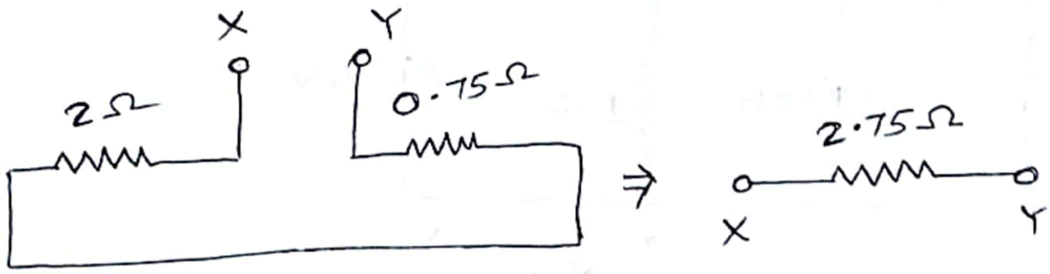
$$V_{th} = 3 - 4 - 2 + 4$$

$$\boxed{V_{th} = 1V}$$

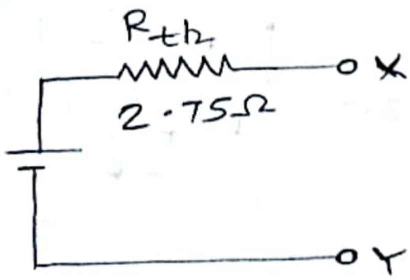
To find R_{th} :-



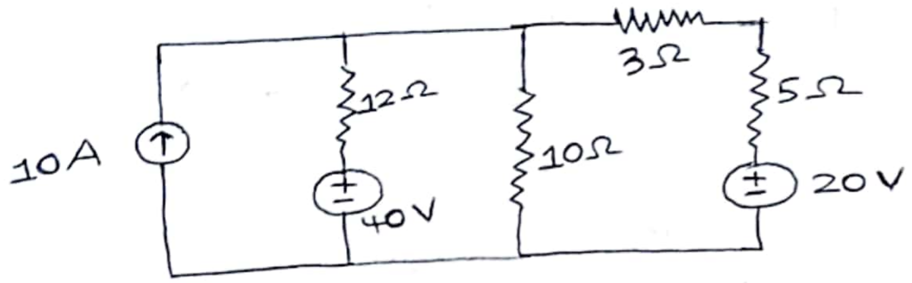
$3\Omega \parallel 1\Omega = 0.75\Omega$



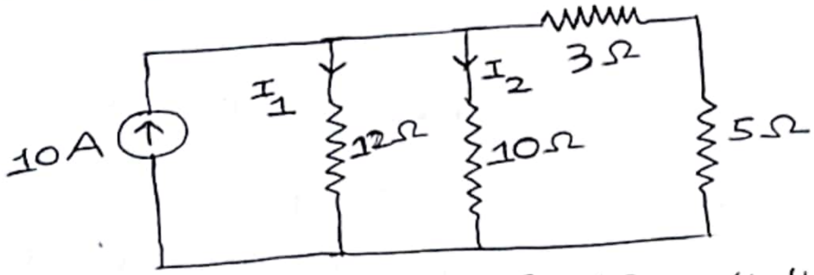
∴ Thevenin's Equilent :-



Determine the current through 5Ω resistor in the given circuit using superposition theorem?



Solution :- i) With only 10A source active



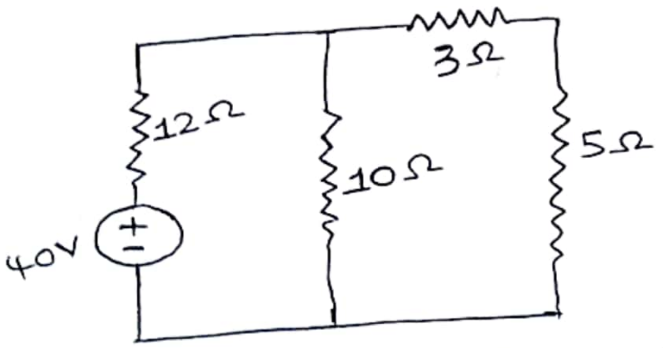
$$(3+5) \parallel 10 = \frac{8 \times 10}{18} = 4.44\Omega$$

$$I_2 = \frac{10 \times 12}{12 + 4.44} = 7.29\,A$$

$$I_3 = \frac{7.29 \times 10}{10 + 8} = 4.05\,A$$

$$\boxed{I'_{5\Omega} = 4.05\,A \downarrow}$$

ii) using 40V as active source

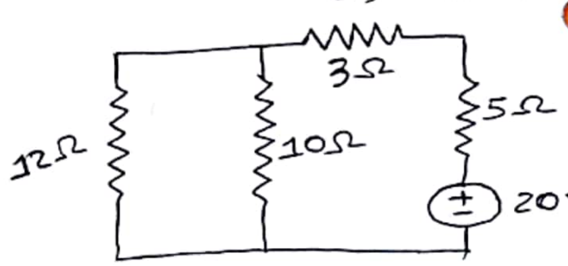


$$R_{eq} = 16.44\Omega$$

$$I = \frac{40}{16.44} = 2.43\,A$$

$$I''_{5\Omega} = \frac{2.43 \times 10}{10 + 8} = 1.35A \downarrow$$

iii) using 20V source as active



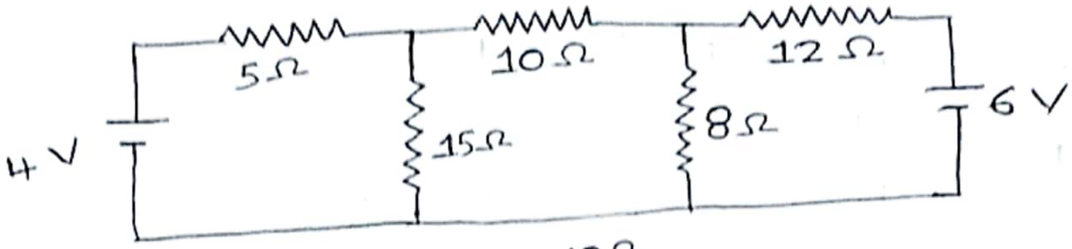
$$R_{eq} = 13.45\Omega$$

$$I'''_{5\Omega} = \frac{20}{13.45} = 1.486\,A \uparrow$$

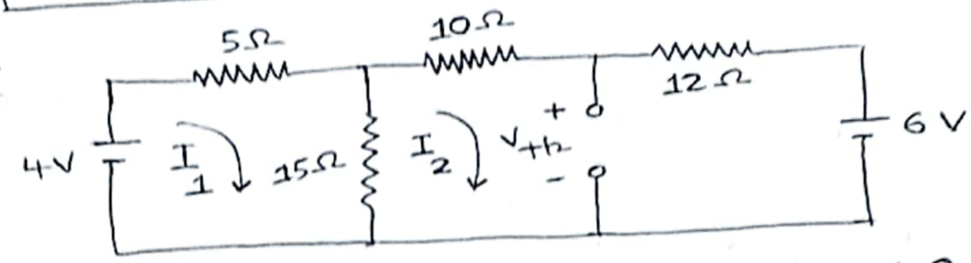
$$I_{5\Omega} = 4.05 + 1.35 - 1.486$$

$$\boxed{I_{5\Omega} = 3.914\,A \downarrow}$$

39) Solve the circuit shown below for the current in 8 Ω resistor using Thevenin's theorem?



Solution :-



KVL for Mesh 1

$$4-5I_1-15(I_1-I_2)=0$$

$$4-5I_1-15I_1+15I_2=0$$

$$-20I_1+15I_2=-4 \quad -(1)$$

KVL for Mesh 2

$$-15(I_2-I_1)-22I_2-6=0$$

$$-15I_2+15I_1-22I_2=6$$

$$15I_1-37I_2=6 \quad -(2)$$

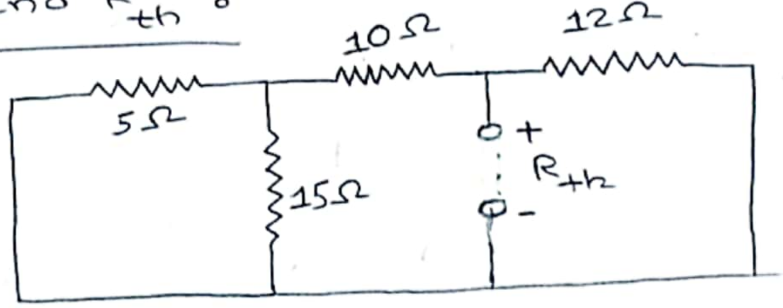
Solving (1) & (2) $I_1=0.112\,A$; $I_2=-0.1165\,A$

$$V_{th}-12I_2-6=0$$

$$V_{th}-12\{-0.1165\}-6=0$$

$$\boxed{V_{th}=4.602\,V}$$

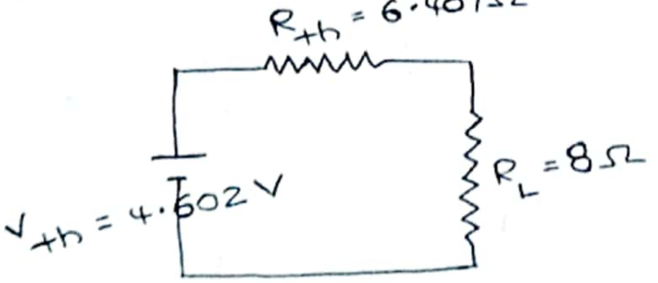
To find R_{th} :-



$$R_{th}=[5\|15+10]\|12$$

$$\boxed{R_{th}=6.407\,\Omega}$$

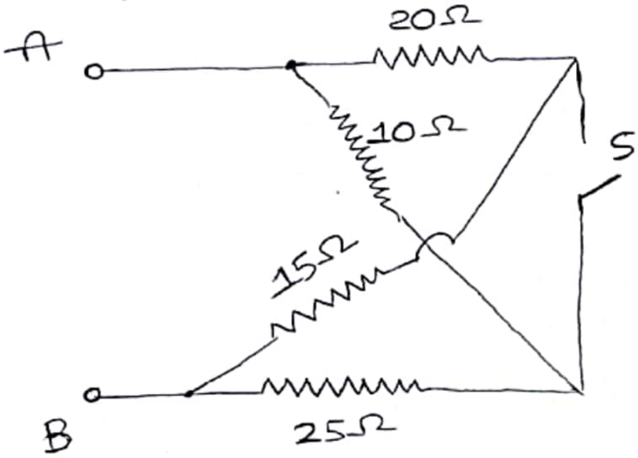
Thevenin's Equivalent :-



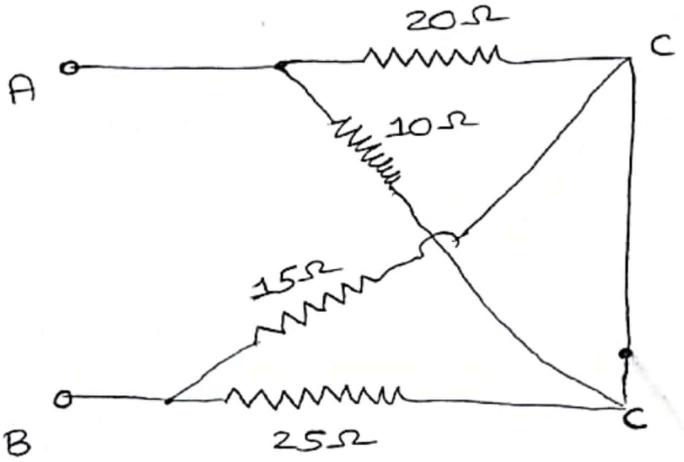
$$I_{8\Omega}=\frac{4.602}{6.407+8}$$

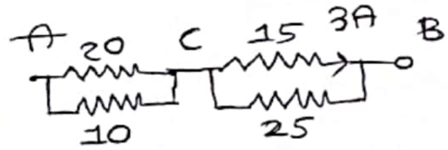
$$\boxed{I_{8\Omega}=0.32A}$$

Find V_{AB}, if current through 15Ω resistor is 3A when switch is i) closed ii) open



Solution:- i) When switch is closed:-





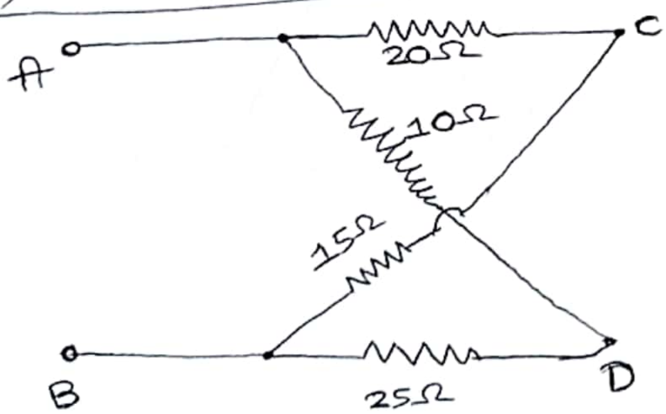
$V_{CB} = 45V$; $\therefore$ current through $25\Omega = \frac{45}{25} = 1.8A$

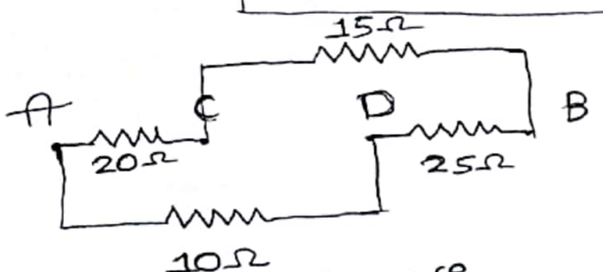
$\therefore$ Total current entering node C is $3+1.8 = 4.8A$.

If $20 \| 10 \Rightarrow R_{AC} = 6.66\Omega$; $\therefore V_{AC} = \text{Total current} \times R_{AC}$

$\Rightarrow V_{AC} = 31.968V$; $V_{CB} = 45V$; $\therefore \boxed{V_{AB} = 76.968V}$

ii) When the switch is open:-





Total resistance across $AB = 35\Omega$

Total current through $15\Omega = 3A$

$\therefore V_{AB} = 35 \times 3 = 105V$