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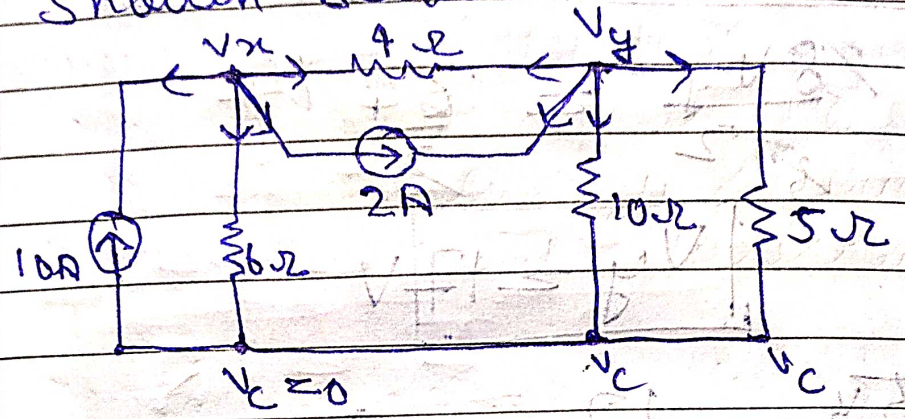
11/Dec/20

Tutorial Sheet-1

① Find the node voltages (V_x) and (V_y) using nodal analysis for the circuit shown below



$$-10 + \frac{V_x}{6} + 2 + \frac{V_x - V_y}{4} = 0$$

$$\frac{V_x}{6} + \frac{V_x}{4} - \frac{V_y}{4} = 8$$

$$\frac{5V_x}{12} - \frac{V_y}{4} = 8 \quad \text{---(1)}$$

$$\frac{V_y - V_c}{10} + \frac{V_y - V_c}{5} - 2 + \frac{V_y - V_x}{4} = 0$$

$$\frac{3V_y}{10} + \frac{V_y}{4} - \frac{V_x}{4} = 2$$

$$\frac{11V_y}{20} - \frac{V_x}{4} = 2 \quad \text{---(1)}$$

$$\frac{11V_y}{5} - V_x = 8$$

Multiplying $\frac{5}{12}$ in Eq (1)

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$\frac{11V_y}{12} - \frac{5}{12}V_x = \frac{10}{3}$

$\frac{5}{12}V_x - \frac{V_y}{4} = 8$

$\frac{28V_y}{3 \times 12} = \frac{34}{3}$

$V_y = 17V$

$\frac{5}{12}V_x - \frac{17}{4} = 8$

$\frac{5}{12}V_x = 8 + \frac{17}{4}$

$V_x = \frac{12}{5}\left[\frac{49}{4}\right]$

$V_x = \frac{147}{5} = 29.4$

$V_x = 29.4V$

$\therefore V_y = 17V$ & $V_x = 29.4V$

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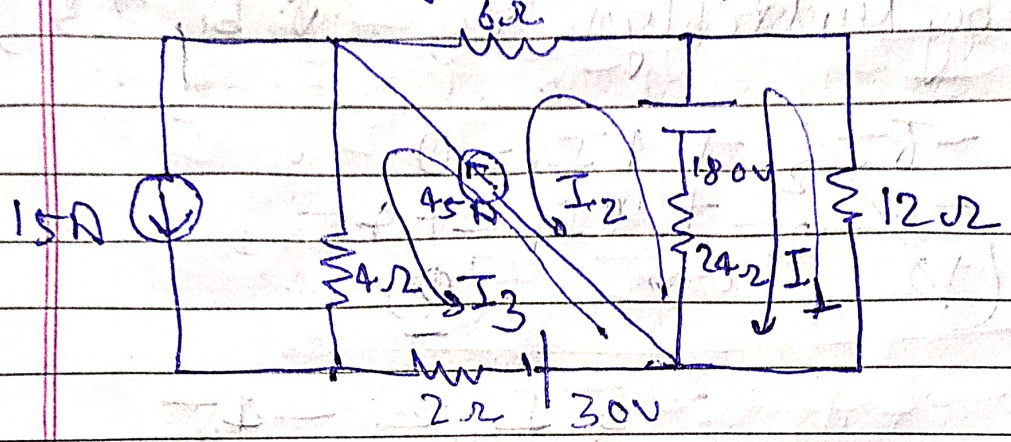
(2) Find the Current through 12Ω using Mesh analysis for the Network.



Total 3 Mesh

Mesh-1

$+12I_1 - 180 + 24(I_1 - I_2) = 0$

$12I_1 + 24I_1 - 24I_2 = 180$

$36I_1 - 24I_2 = 180$

$3I_1 - 2I_2 = 15$ — (i)

Mesh-2

$-24(I_2 - I_1) + 180 - 6I_2 - 4(I_3 - 15) - 2I_3 + 30 = 0$

$-24I_2 + 24I_1 + 180 - 6I_2 - 4I_3 + 60 - 2I_3 + 30 = 0$

$-30I_2 + 24I_1 - 6I_3 + 270 = 0$ — (ii)

$I_3 - I_2 = 45$ — (iii)

$\boxed{I_3 = I_2 + 45}$

Putting the value of I_3 in Eq (ii)

$-30I_2 + 24I_1 + 270 - 6(I_2 + 45) = 0$

$-30I_2 + 24I_1 + 270 - 6I_2 - 270 = 0$

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$-30I_2 + 24I_1 = 0$ — (iv)

$-3I_2 + 2I_1 = 0$ — (v)

by multiplying eq (v) by 2 & (i) by 3

$-6I_2 + 4I_1 = 0$

$-6I_2 + 9I_1 = +45$

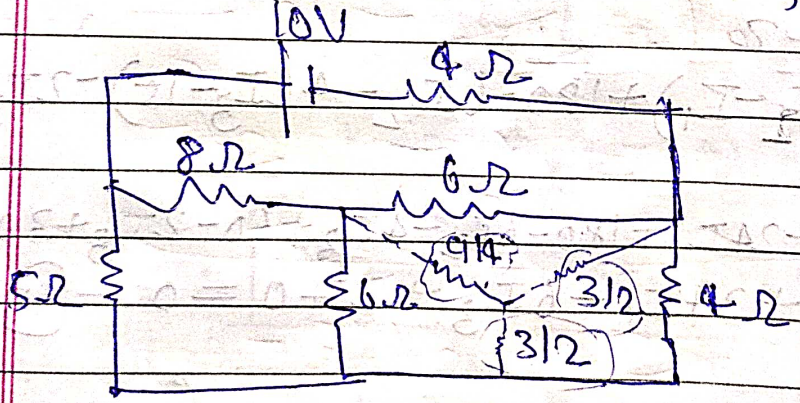
(+) (-) (-)

$-5I_1 = -45$

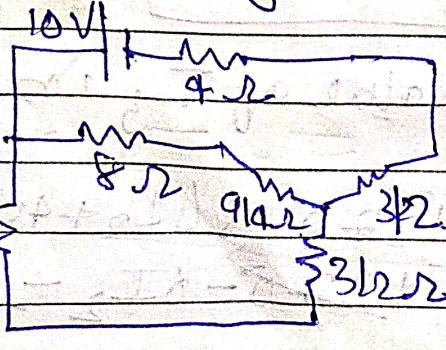
$I_1 = 9A$

∴ Current through $R_{12\Omega}$ is 9A

(3) Find the supply current using Star-delta formation,



by using Delta to Star



$5 + \frac{3}{2} = \frac{13}{2}$ (6.5)

$8 + \frac{9}{4}2.25$ (10.25)

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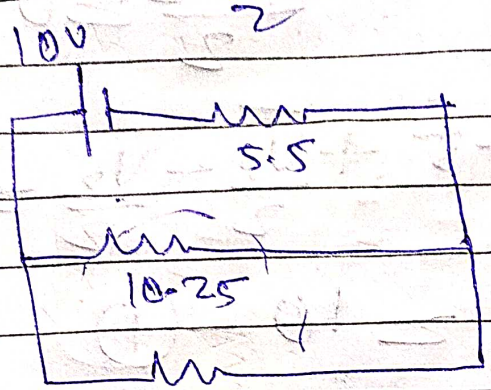
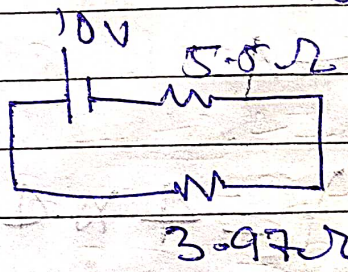
$9 + \frac{3}{2} = 5.5\ \Omega$



$\therefore 6.5\ \Omega$

$R = \frac{10.25 \times 6.5}{10.25 + 6.5} = \frac{66.625}{16.75} = 3.97\ \Omega$



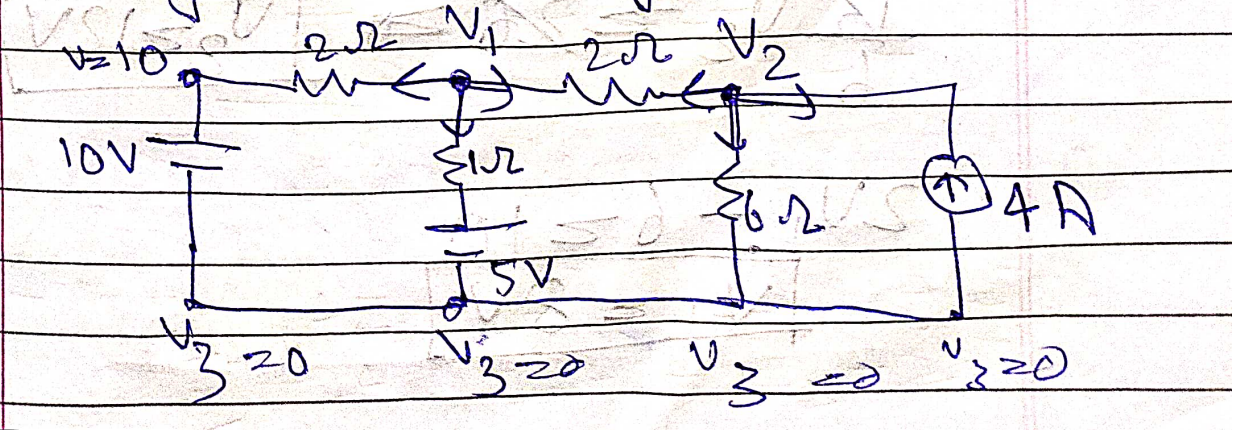
$R_{Net} = (5.5 + 3.97)\ \Omega$

$\boxed{R_{net} = 9.47\ \Omega}$

$I = \frac{V}{R_{net}} = \frac{10}{9.47} = 1.05\ A$

$\boxed{I = 1.05A}$

(4) Find the Node Voltages & branch current using Nodal analysis.



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$$\frac{V_1-10}{2}+\frac{V_1-0}{4}+\frac{V_1-V_2}{2}=0$$

$$\frac{V_1-5}{2}+\frac{V_1-5}{4}+\frac{V_1}{2}-\frac{V_2}{2}=0$$

$$2V_1-\frac{V_2}{2}=10 \quad \text{---(1)}$$

$$-4+\frac{V_2-V_1}{2}+\frac{V_2}{6}=0$$

$$\frac{V_2}{6}+\frac{V_2}{2}-\frac{V_1}{2}=4$$

$$4\left(\frac{4V_2}{6}-\frac{V_1}{2}\right)=4\times 4$$

$$\frac{8}{3}V_2-2V_1=16$$

$$-\frac{V_2}{2}+2V_1=10$$

$$\left(\frac{16}{6}-\frac{3}{6}\right)V_2=26$$

$$\frac{13}{6}V_2=26 \Rightarrow \boxed{V_2=12V}$$

$$2V_1-6=10$$

$$\boxed{V_1=8V}$$

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$I_{2\Omega} = \frac{V_2 - V_1}{2} = \frac{12-4}{2} = 2$

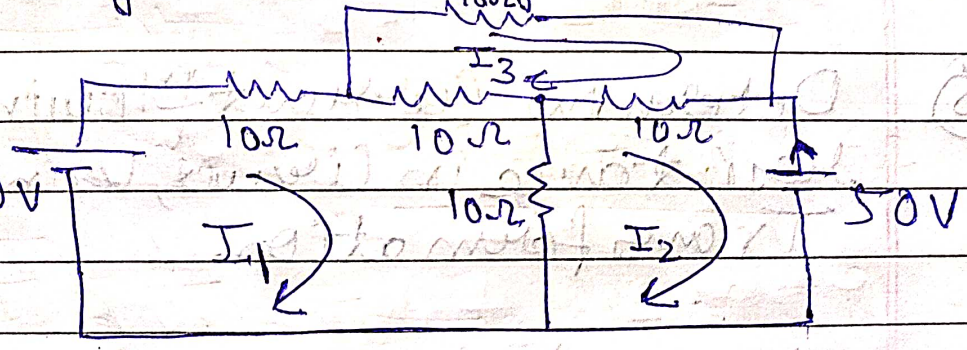
$\boxed{I_{2\Omega} = 2A}$

$I_{1\Omega} = \frac{V_1 - 5}{1} = 3A$

$I_{6\Omega} = \frac{12}{6} = 2A$

$\boxed{I_{2\Omega} = \frac{10-8}{2} = 1A}$

(5) Find the mesh current using mesh analysis in the given circuit



Loop - I

$100 - 10I_1 - 10(I_1 - I_3) - 10(I_1 - I_2) = 0$

$100 - 30I_1 + 10I_2 + 10I_3 = 0$

$10 - 3I_1 + I_2 + I_3 = 0$ — (1)

Loop - II

$-10(I_2 - I_3) - 50 - 10(I_2 - I_B) = 0$

$20I_2 + 10I_3 + 10I_1 = 50$

$I_1 + 2I_2 + I_3 - 50 = 0$ — (II)

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Loop-(3)

$$-10I_3 - 10(I_3 - I_2) - 10(I_3 - I_1) = 0$$
$$-10I_3 - 10I_3 + 10I_2 - 10I_3 + 10I_1 = 0$$
$$-30I_3 + 10I_1 + 10I_2 = 0$$
$$-3I_3 + I_2 + I_1 = 0 \quad \text{(III)}$$

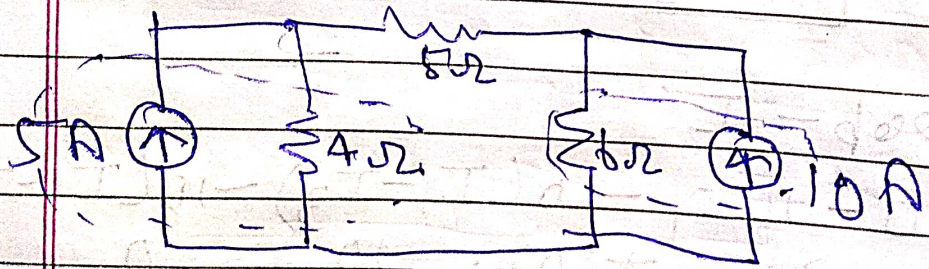
by Solving eq-(I), (II) & (III)

$I_1 = -3.75\ A$

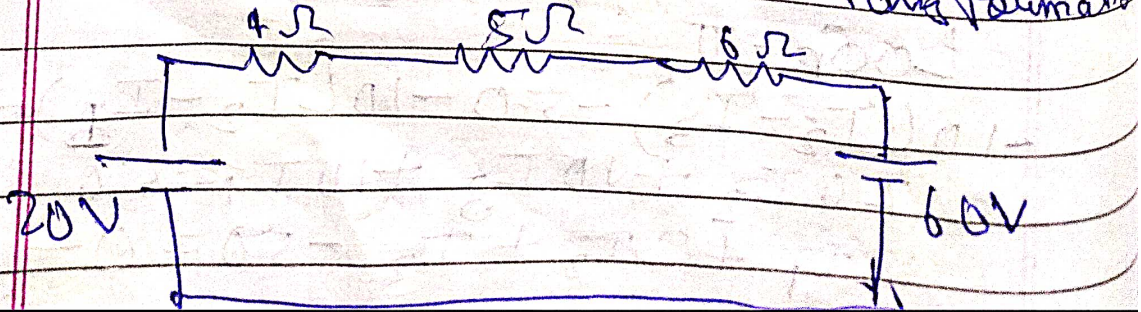
$I_2 = 0\ A$

$I_3 = 1.25\ A$

(6) Determine current flowing 5Ω resistance in circuit, using Source Transformation.



by using Source Transformation



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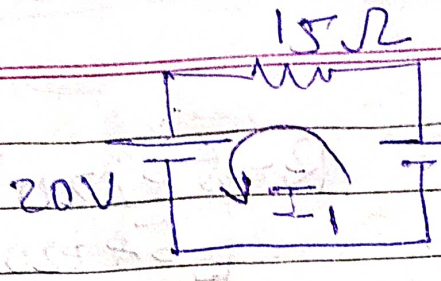


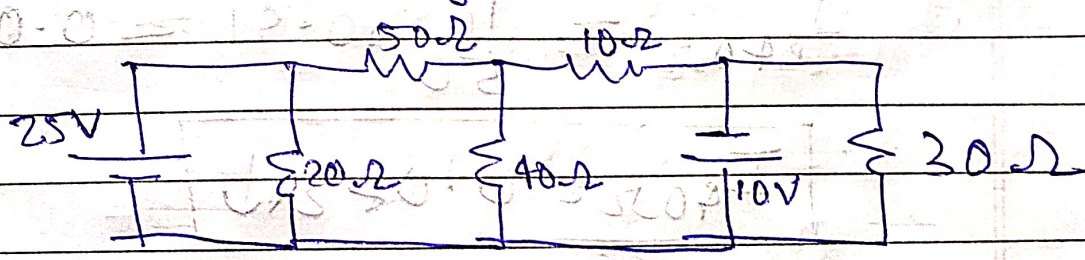
$60 - 15I_1 - 20 = 0$

$40 = 15I_1$

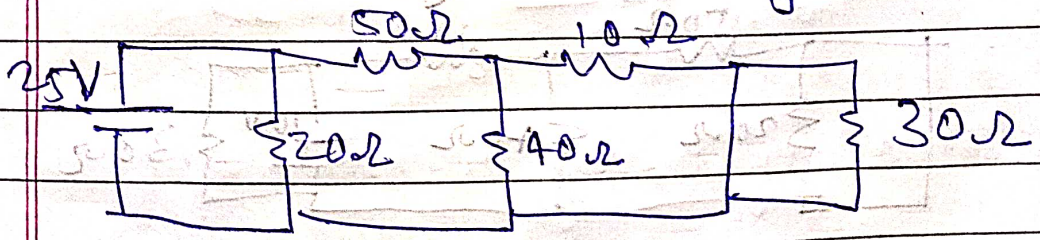
$I_1 = \frac{8}{3} = 2.66A$

∴ Current through 5Ω is 2.66A

(7) Find the Current through 4ohm resistor using Superposition Theorum



Taking (25V) battery



Since, there is short circuit-path

$I_{30\Omega} = 0$

∴ R_{10} & R_{40} are in ||

$R = 8\Omega$

↳ and in series with R_{50}

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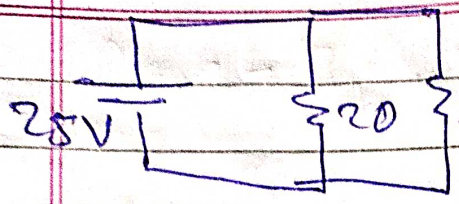


$R = \frac{58 \times 20}{58+20}\ \Omega$

$R = 14.87\ \Omega$

$V = IR$

$I_T = 1.681\ A$

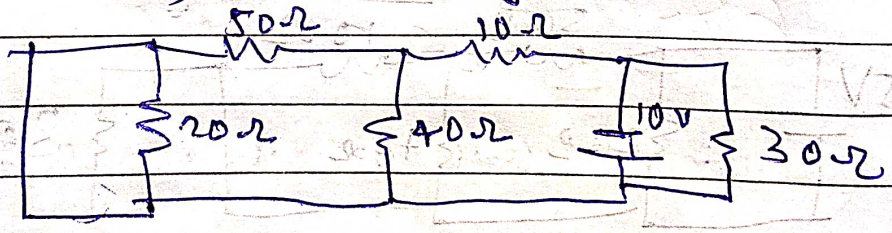
Now, by using current divider

$I_{(R_{Net}=78\Omega)} = \frac{20}{78} \times 1.681 = 0.41\ A$

$I_{R40\Omega} = \frac{10}{50} \times 0.41 = 0.082\ A$

$I_{40\Omega} = 0.082\ A$

Case-II, taking 10V battery



by R_{50} & R_{40} in Parallel

$R = \frac{50 \times 40}{90} = 22.22\ \Omega$

$R_{(50||20)}$ & R_{10} in Series

$R = 22.22 + 10 = 32.22\ \Omega$

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by taking $R_{[(50||20)+10]\Omega}$ & R_{30} in Parallel

$$R = \frac{32.22 \times 30}{62.22} = 15.535\ \Omega$$

Total Current (I_T) $= \frac{10}{15.535} = 0.64\ A$

Now, by using Current division

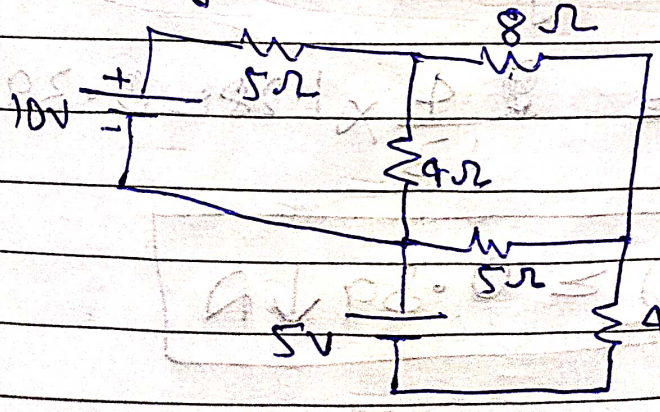
$$I_{30\Omega} = \frac{30}{(32.22)\Omega 62.22} \times 0.64 = 0.31\ A$$

$$I_{40\Omega} = \frac{50}{90} \times 0.31 = 0.162\ A \uparrow$$

$\therefore$ Net Current in $R_{40\Omega} = (0.162 - 0.082)\ A$

$$\boxed{I = 0.086\ A \uparrow}$$

Q.8 Find the Current through 1Ω using Superposition Theorem



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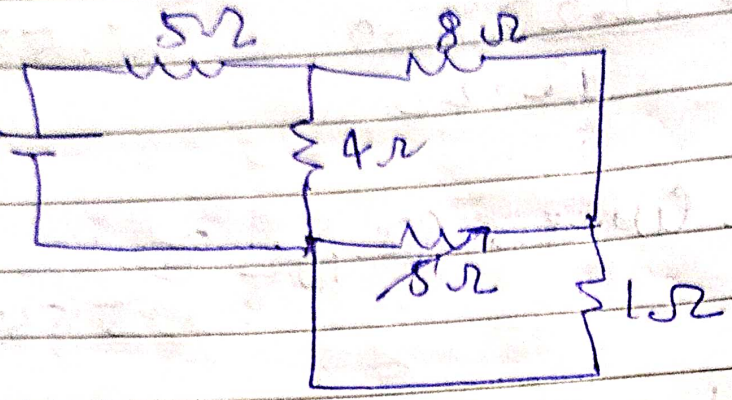
Case-I, taking 10V battery



Here (R=8Ω) will be Short-Circuited

R_1 & R_8 are in Series

$R = 9$

$R_{(1+8).1194} = \frac{9 \times 4}{13} = 2.76\Omega$

& In Series with $R_{5\Omega}$

$R_{Net} = 7.76\Omega$

$I_{Total} = \frac{10}{7.76} = 1.28\,A$

Now, by using Current division

$I_{(8+1)\Omega} = \frac{4}{13} \times 1.28 = 0.39\,A$

$\therefore \boxed{I_{(R=1\Omega)} = 0.39\downarrow A}$

Case-II, taking 5V battery

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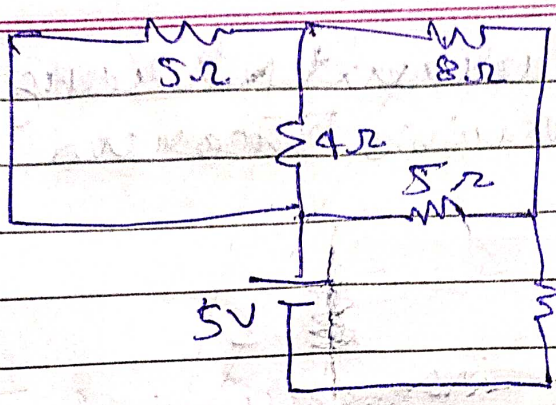

$R_{5\Omega}$ & $R_{4\Omega}$ are in Parallel

$$R = \frac{5 \times 4}{9} = 2.22\ \Omega$$

~~$R_{(5+4)\Omega}$ & $R_{8\Omega}$~~

$R_{(5+4)\Omega}$ & $R_{8\Omega}$ are in Series

$$R = 10.22\ \Omega$$

& In Parallel with $R_{5\Omega}$

$$R = \frac{10.22 \times 5}{15.22} = 3.63\ \Omega$$

Total $R_{Net} = 4.63$

$$I_{Total} = \frac{5}{4.63} = 1.07\ A$$

$$I_{(R=1\Omega)} = 1.07 \downarrow A$$

Total current in $1\Omega = (1.07 + 0.39)\ A$

$$I = 1.48\ A \downarrow$$

Clockwise direction

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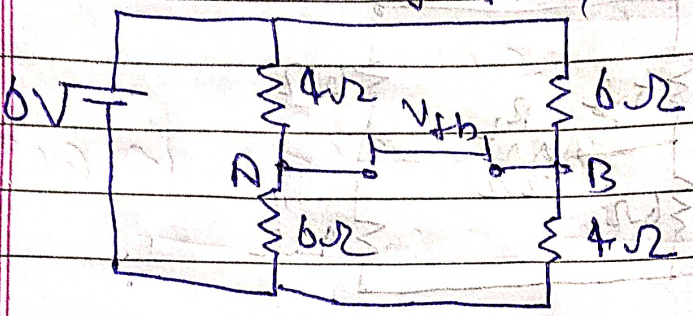
Q.9 Find the current in 2Ω resistance using Thevenin's Theorem

Finding V_{th}

Ans.9



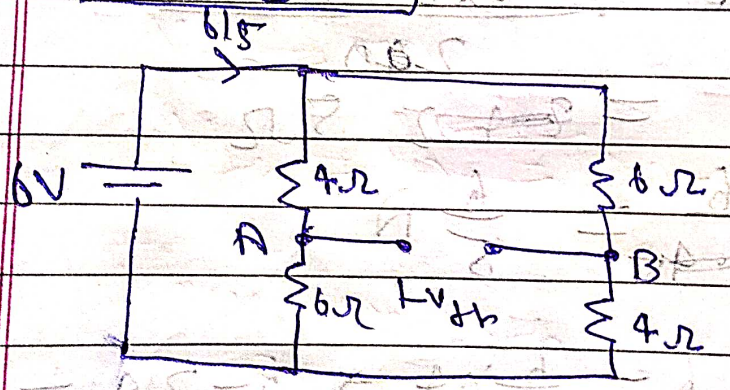
$R_{4\Omega}$ & $R_{6\Omega}$ are in series

$R = 10\Omega$

∴ Then in parallel with $R_{10\Omega}$

$$R_{net} = \frac{10 \times 10}{10+10}\Omega = 5\Omega$$

$$\boxed{I = \frac{6}{5} A}$$



by Current division

$$I_{4\Omega} = \frac{3}{5} A \quad \& \quad I_{6\Omega} = \frac{3}{5} A$$

$$V_A = 6 - \frac{3}{5}(4)$$

$$= \frac{18}{5} V$$

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$$V_B = \frac{6 - 6\times 3}{5}$$

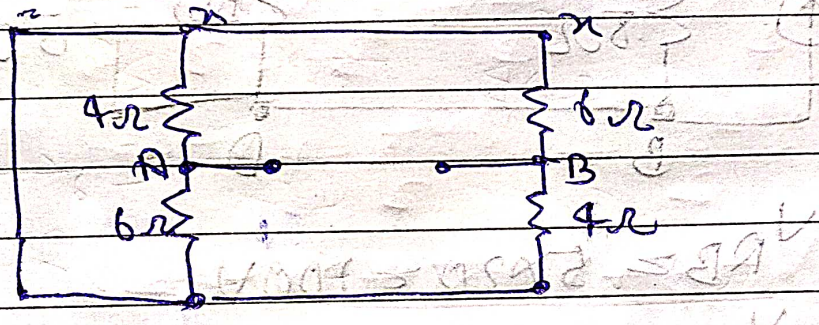
$$= \frac{-12\ V}{5}$$

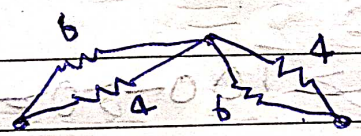
$$V_{th} = V_A - V_B$$

$$= \frac{18}{5} - \frac{12}{5} \Rightarrow \frac{6}{5} V$$

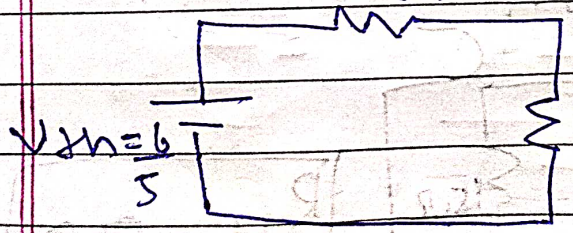
$$\boxed{V_{th} = \frac{6}{5} \text{ Volts}}$$

For find R_{th}





$$\boxed{R_{th} = 4.8\ \Omega}$$



$$I_{2\Omega} = \frac{V_{th}}{R_{th} + R_L}$$

$$= \frac{6}{5 \times 6.8}$$

$$= 0.176A$$

$$\boxed{I_{2\Omega} = 0.176A}$$

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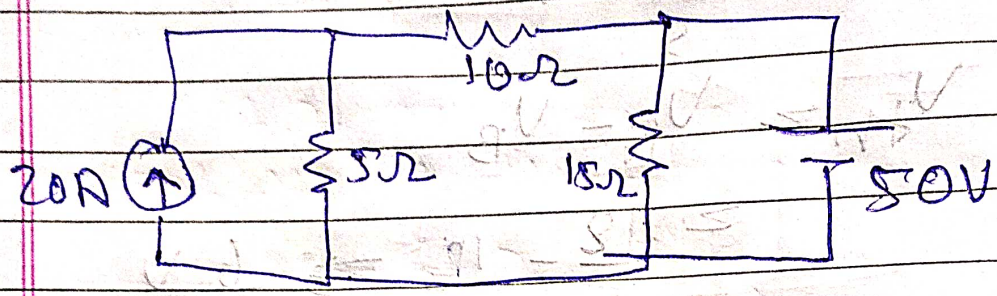
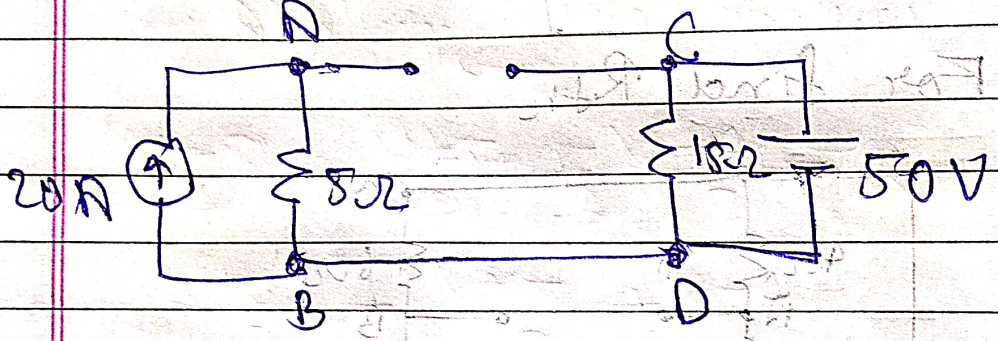
Q-10 Find the current through 10Ω resistance, using Thevenin's theorem



In order to find, V_{th}

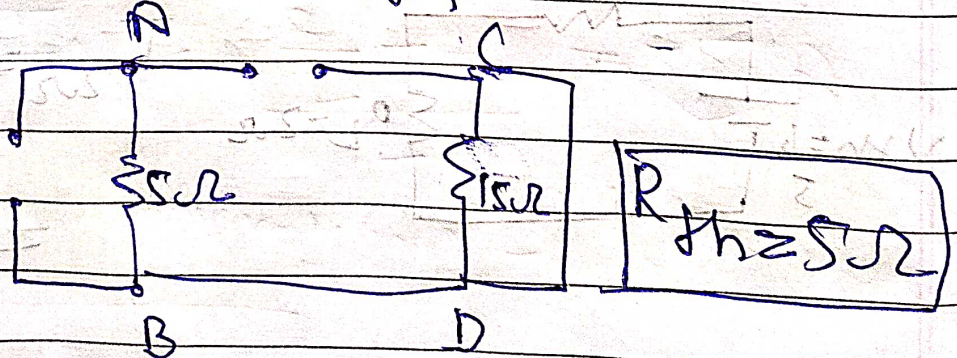


$V_{AB} = 5 \times 20 = 100V$

$V_{CD} = 50$

$V_{th} = V_{AC} = 100 - 50 = 50V$

Now, for R_{th}



Now the thevenin circuit looks like

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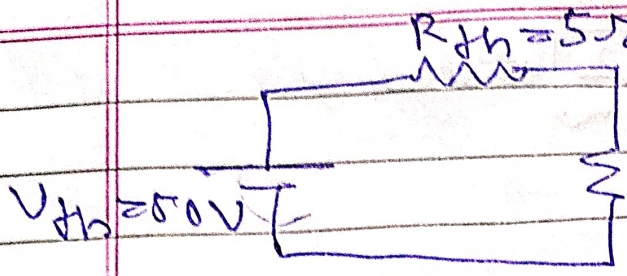
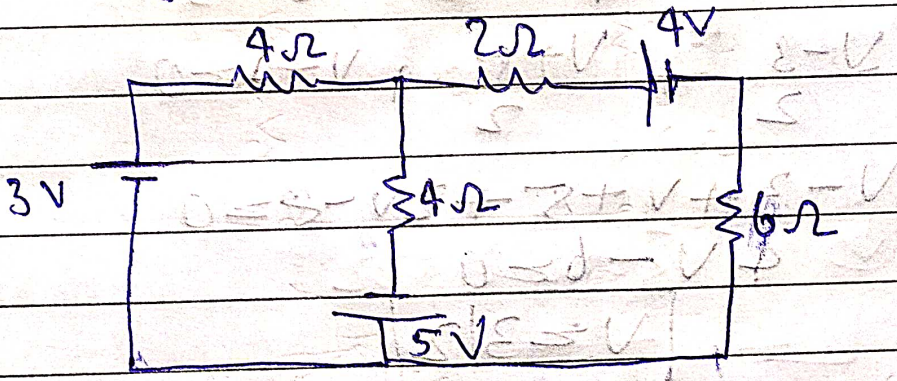


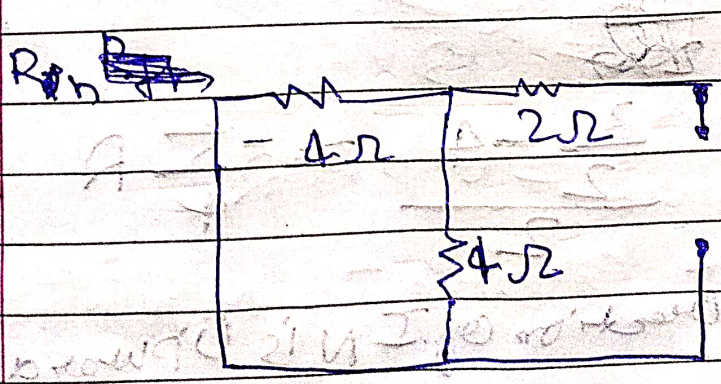
$$I = \frac{V_{th}}{R_{th}+10} = \frac{50}{15} = 3.33$$

$$I_{10\Omega} = 3.33A$$

Q.11 Find the current in 6Ω resistance using Norton's theorem.



Ans.11



$R_{4\Omega}$ & $R_{4\Omega}$ in Parallel

$R = 2\Omega$

$R_{2\Omega}$ & $R_{2\Omega}$ are in Series

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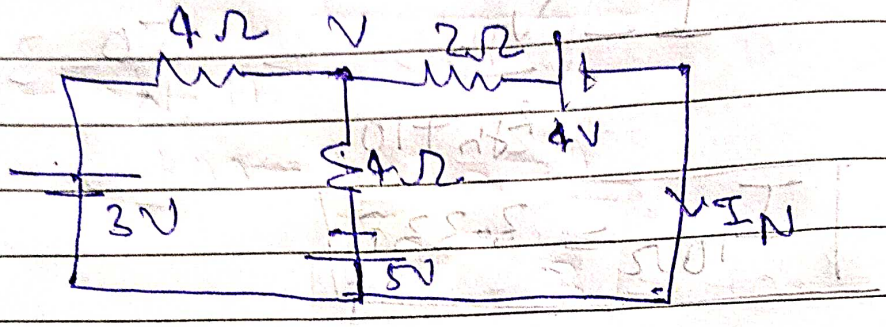
$R_N = 4\Omega$

For I_N



by Applying Nodal analysis

$$\frac{V-3}{4} + \frac{V+5}{4} + \frac{V-4}{2} = 0$$

$$\frac{V-3}{2} + \frac{V+5}{2} + V - 4 = 0$$

$$V - 3 + V + 5 + 2V - 8 = 0$$

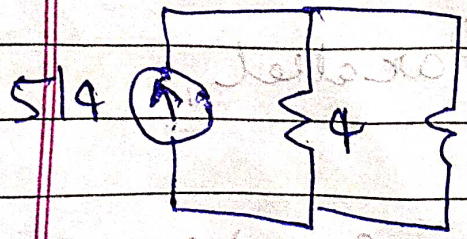
$$4V - 6 = 0$$

$$\boxed{V = 3/2}$$

$I_N =$

$$I_N = \frac{\frac{3}{2} - 4}{2} = -\frac{5}{4} A$$

∴ direction of I_N is Upward



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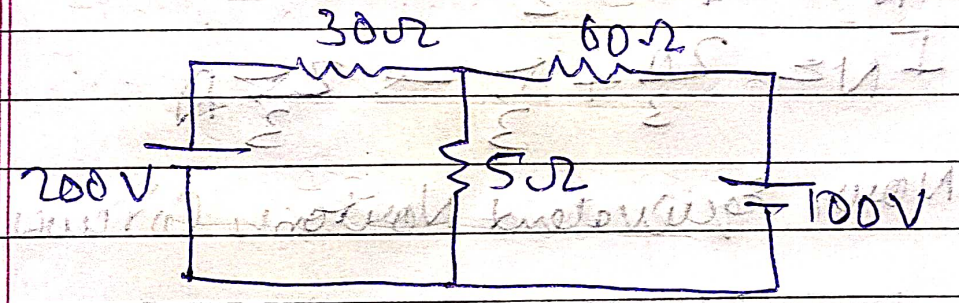
Applying Current division

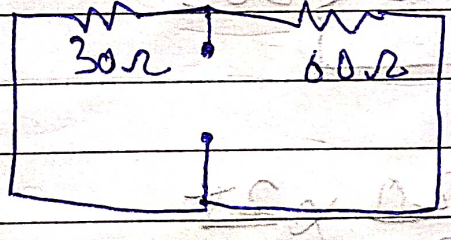
$$I_{6\Omega} = \frac{4}{10} \times \frac{5}{4} = \frac{1}{2} = 0.5\,A$$

Current through 6Ω is 0.5A

Q.12 Find the Current in 5Ω using Norton's theorem



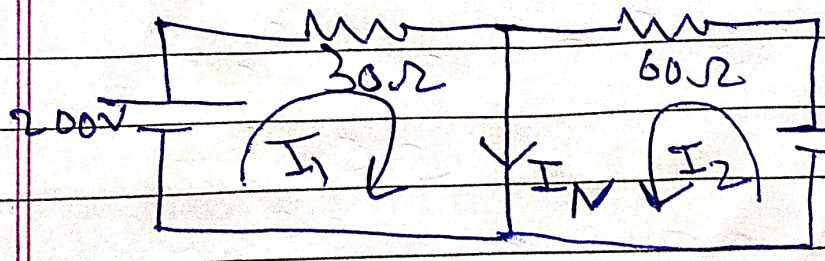
Find R_N



$$R_N = \frac{30 \times 60}{90} = 20\Omega$$

$$\boxed{R_N = 20\Omega}$$

Finding I_N



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20.2.2024

by Applying K.V.L

Loop - I

$200 - 30I_1 = 0$

$$\boxed{I_1 = 20/3}$$

Loop - II

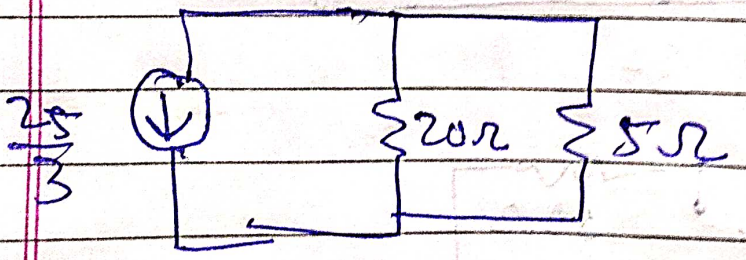
$100 - 60I_2 = 0$

$$\boxed{I_2 = \frac{5}{3}}$$

$I_N = I_1 + I_2$

$I_N = \frac{20}{3} + \frac{5}{3} = \frac{25}{3}$ A

Now, Equivalent Norton's Circuit



$I_{5\Omega} = \frac{20}{25} \times \frac{25}{3}$

$= \frac{20}{3} = 6.665$ A

∴ Current through 5Ω is 6.665A.