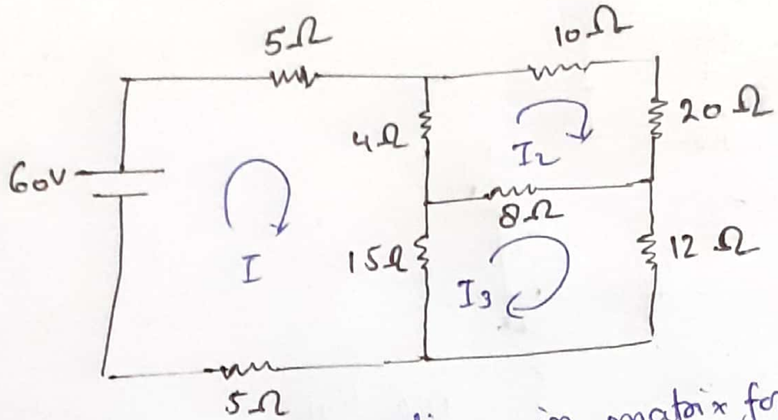
Electrical Assignment - II

Mayank Goyal
2K19/A13/26
Civil Engineering (IInd sem)

① Find the current delivered by the battery



writing mesh equations in matrix form

$$\begin{bmatrix} (5+4+15+5) & -4 & -15 \\ -4 & (10+20+4+8) & -8 \\ -15 & -8 & (15+8+12) \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \\ I_3 \end{bmatrix} = \begin{bmatrix} 60 \\ 0 \\ 0 \end{bmatrix}$$

$$\begin{bmatrix} 29 & -4 & -15 \\ -4 & 42 & -8 \\ -15 & -8 & 35 \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \\ I_3 \end{bmatrix} = \begin{bmatrix} 60 \\ 0 \\ 0 \end{bmatrix}$$

$$I_1 \Rightarrow \frac{\begin{bmatrix} 60 & -4 & -15 \\ 0 & 42 & -8 \\ 0 & -8 & 35 \end{bmatrix}}{\begin{bmatrix} 29 & -4 & -15 \\ -4 & 42 & -8 \\ -15 & -8 & 35 \end{bmatrix}} = \frac{60(42\times35-64)}{29(42\times35-64)-4(4\times35+15\times8)-15(4\times8+15\times42)}$$

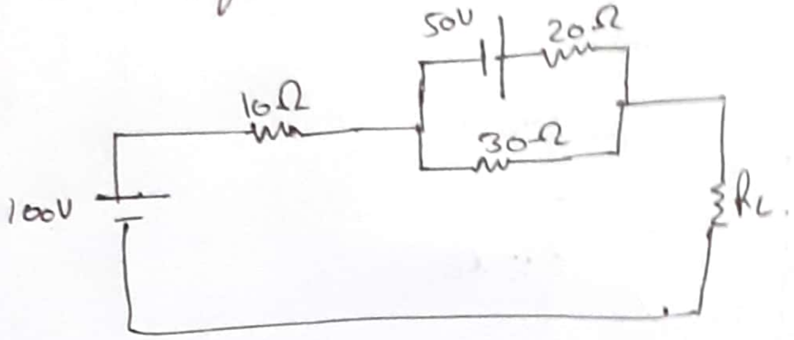
$$\Rightarrow \frac{84360}{40774-1040-9930} = \frac{84360}{29804}$$

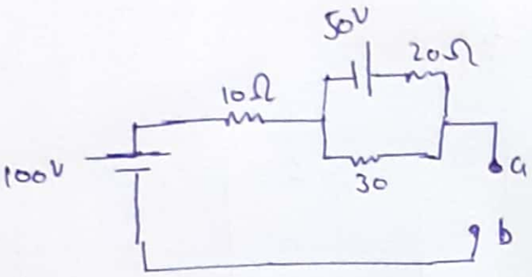
$I_1 = 2.8A$

Current delivered by battery $= I_1$

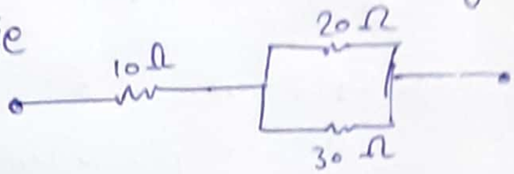
$\Rightarrow 2.8A$ // Ans

② Assuming R_L is the load Resistor, find Thevinin equivalent circuit.



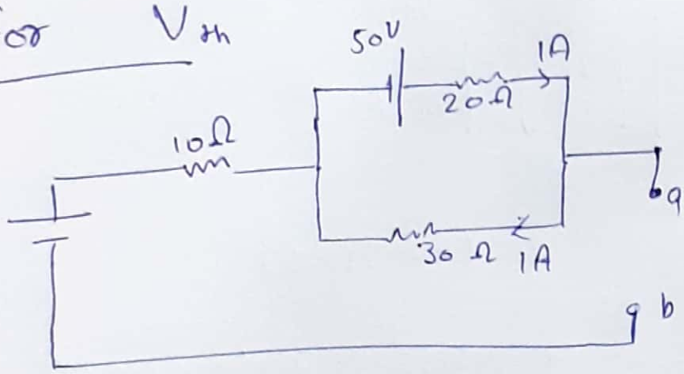


For R_{th}
short circuit in Battery
ie



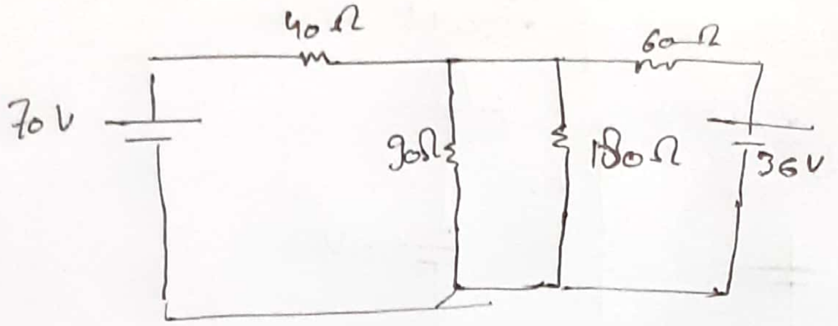
$$R_{eq} = 10 + \frac{20 \times 30}{20 + 30} = 22\Omega \text{ Ans}$$

For V_{th}

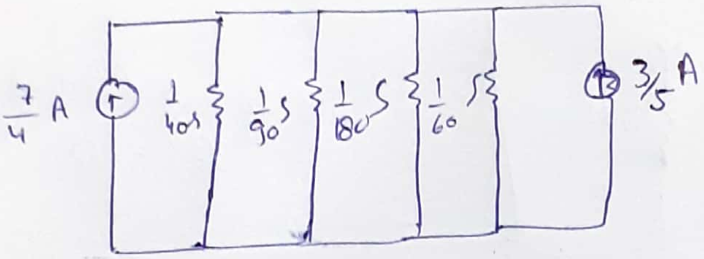


$$V_{ab} = V_{th} = -20 + 50 + 100$$
$$= 130\text{V Ans}$$

(3) In the network, find the current through ~~the~~ 90 Ω resistor



Using Nodal analysis



$I = \frac{3}{5} + \frac{7}{4}$

$I \Rightarrow \frac{47}{20}$ A

Current thru $\Rightarrow$ 90 Ω $= \frac{R_t}{90} \times I$

$$R_t \Rightarrow \frac{1}{\frac{1}{40} + \frac{1}{90} + \frac{1}{180} + \frac{1}{60}} = \frac{5}{120} + \frac{3}{180 60}$$

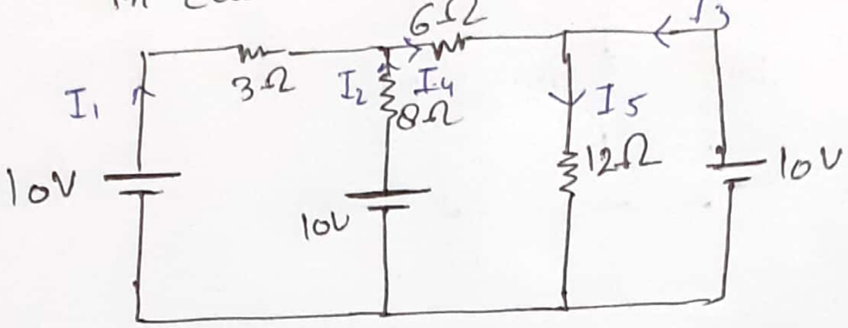
$$\Rightarrow \frac{5+2}{120}$$

$$R_t \Rightarrow \frac{120}{7}\ \Omega$$

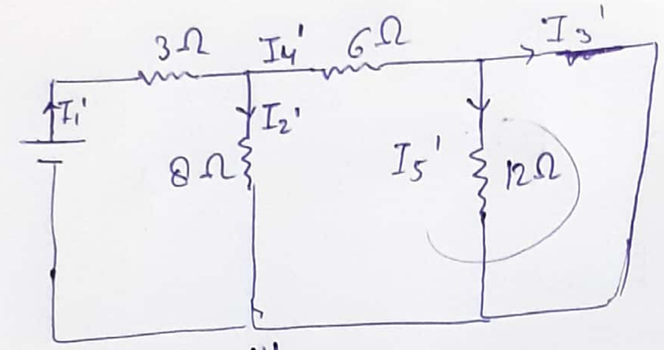
$$I \text{ from } 90\ \Omega \Rightarrow \frac{120}{7 \times 90} \times \frac{47}{20}$$

$\Rightarrow$ 0.447 A Ans

(4) Using Super position theorem, find current which flows in each resistor of circuit.



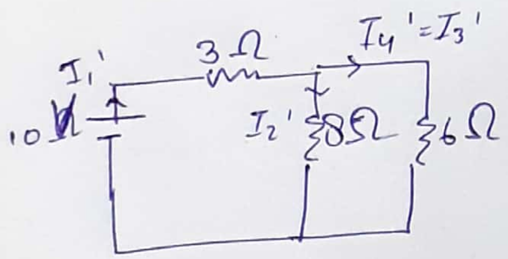
(I)



12 Ω will be ignored due to short circuit

$I_5' = 0$

⇓



$I_1' \Rightarrow \frac{10}{R_{eq}} \Rightarrow \frac{10}{\left[3 + \left(\frac{8\times 6}{8+6}\right)\right]} = \frac{10}{3 + \frac{48}{14}}$

$I_1' \Rightarrow \frac{70}{45}$

$\boxed{I_1' \Rightarrow \frac{14}{9}\,A}$

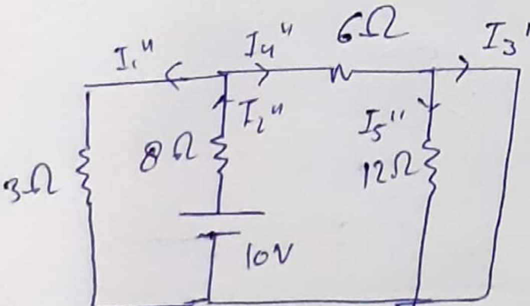
~~Voltage drop across 3Ω~~

$|I_3'| = |I_4'| \Rightarrow \frac{8}{14} \times \frac{14}{9} = \frac{8}{9}A \Rightarrow$

$I_3' = -\frac{8}{9}\,A$

$I_4' = \frac{8}{9}\,A$

(II)



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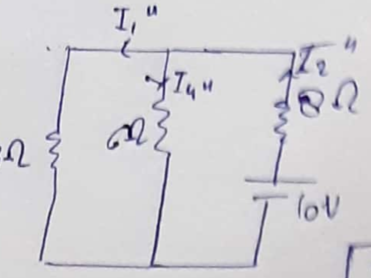


$I_2'' = \frac{10}{\left(8 + \frac{3\times 6}{3+6}\right)} = 1\,A$

$\boxed{I_2'' = 1A}$

$\boxed{I_5'' = 0}$

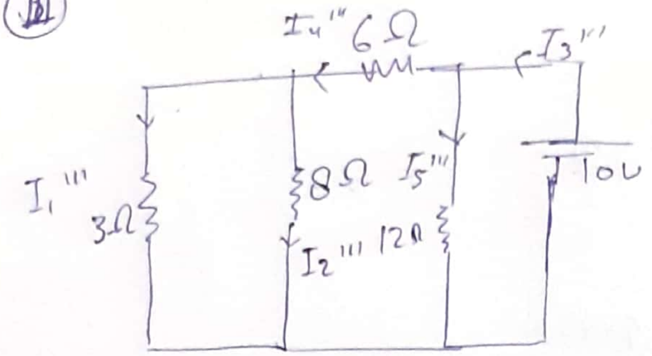
$\boxed{I_4'' = I_3''}$

$\boxed{I_3'' = -\frac{1}{3}\,A}$

$I_4 \Rightarrow \frac{3}{9} \times 1 = \frac{1}{3}\,A$

$I_1 = \frac{2}{-3} \times 1 = -\frac{2}{3}\,A$

(III)



$$I_3''' = \frac{10}{\frac{180}{37}} \Rightarrow$$

$$I_5'' = \frac{\frac{90}{14}}{\frac{180}{37}} \times \frac{37}{18} = \frac{37\times 37}{18\times 2\times 11}$$

$$I_5''' = \frac{275}{1369}\ A$$

$$I_4''' \Rightarrow -\frac{242}{333}\ A$$

$$I_1''' = -8/9\ A$$

$$I_2''' = \frac{1}{5}\ A$$

$$R_{eq} \Rightarrow \frac{\left(6 + \frac{3\times 8}{3+8}\right)\times 12}{\frac{24}{11} + 6 + 12} \Rightarrow$$

$$R_{eq} \Rightarrow \frac{1080}{222} = \frac{180}{37}\ \Omega$$

$$I_1 \Rightarrow I_1' + I_1'' + I_3'''$$

$$\Rightarrow \frac{14}{9} - \frac{2}{3} - \frac{8}{9} = 0\ A$$

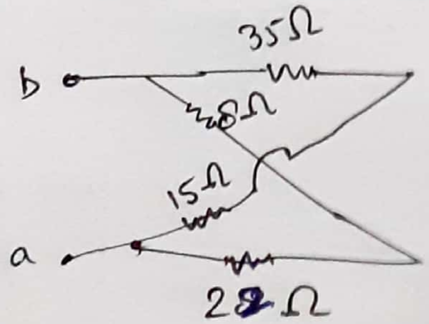
$$I_4 \Rightarrow 0 + 0 + \frac{185}{222} = 0.835\ A$$

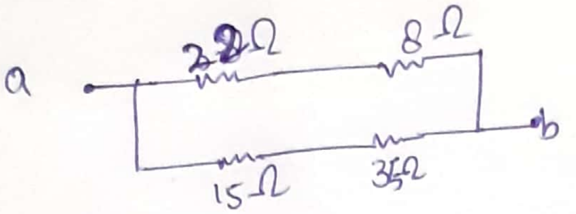
$$I_2 \Rightarrow -\frac{2}{3} + 1 - \frac{1}{5} = 0\ A$$

$$I_5 \Rightarrow -\frac{8}{9} - \frac{3}{5} \Rightarrow 0\ A$$

$$I_3 \Rightarrow \frac{8}{9} + \frac{3}{5} - \frac{242}{190} = 0\ A$$

(5) Find the equivalent resistor b/w the terminals ab, where, all the resistor values are given in Ω



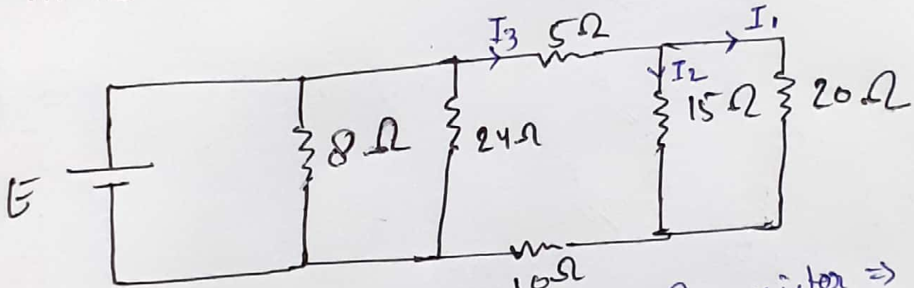


$$\frac{1}{R_{eq}} \Rightarrow \frac{1}{22+8} + \frac{1}{35+15}$$

$$R_{eq} \Rightarrow \frac{30 \times 50}{30+50} \Rightarrow \frac{1500}{80} \Rightarrow 18.75\,\Omega$$

$$R_{eq} = 18.75\,\Omega \text{ Ans.}$$

⑥ Find the value of E which permits a dissipation of 180 W in the 20 Ω resistor.



Power dissipated to 20Ω resistor $\Rightarrow$ $180\,W = \frac{V^2}{R}$

$\sqrt{180 \times 20} = V^2$

$V = 60\,V \Rightarrow$ voltage accross 15 Ω and 20 Ω re

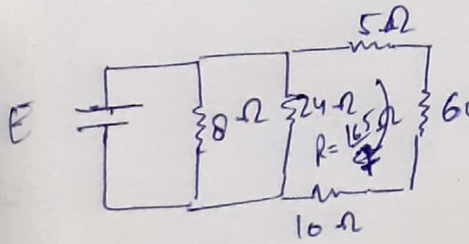
$I_1 \times 20 \Rightarrow 60\,V$

$I_2 \times 15 = 60\,V$

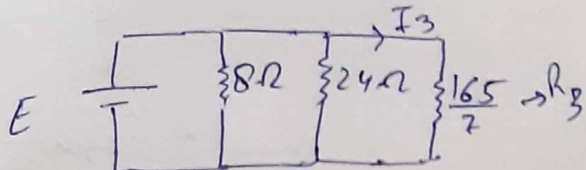
$\Rightarrow I_1 \Rightarrow 3\,A$

$I_2 \Rightarrow 4\,A$

$\boxed{I_3 = I_1 + I_2 = 7A}$



$\Rightarrow$ E

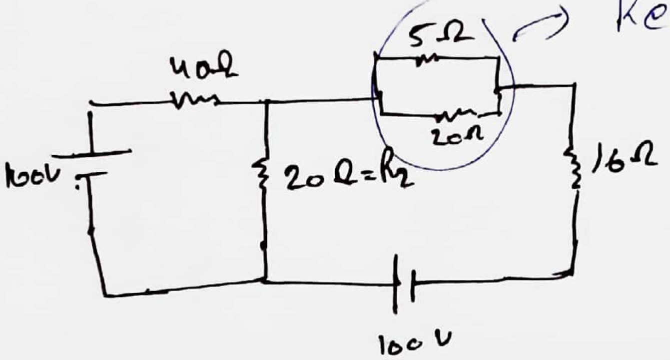


$$R_{eq} \Rightarrow \frac{1}{\frac{1}{8}+\frac{1}{24}+\frac{7}{165}} = \frac{110}{19}\,\Omega$$

$$I_3 \Rightarrow \frac{E}{R_3} \Rightarrow E \Rightarrow \frac{165}{7} \times 7$$

$$\boxed{E = 165\,V}$$ Ans

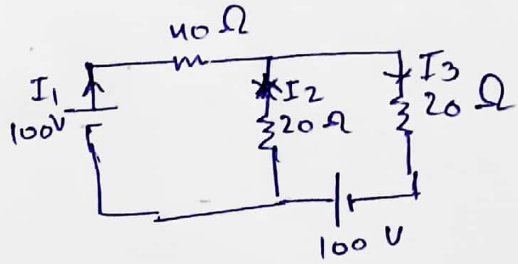
(7) Use superposition theorem, find the current flowin $R_2 = 20\Omega$



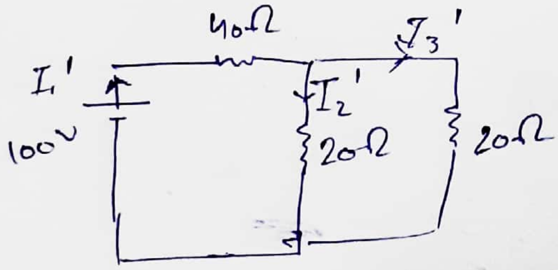
$$Req \Rightarrow \frac{1}{\frac{1}{5}+\frac{1}{20}} \Rightarrow \frac{25}{20\times5} = \frac{1}{4}$$

$Req = 4$

⟹



(I)

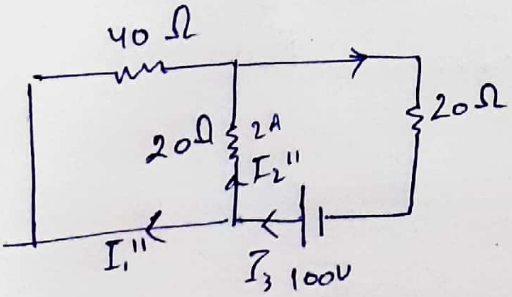


$$I_1' \Rightarrow \frac{100}{40 + \frac{20\times20}{20+20}} \Rightarrow = 2\,A$$

$I_2' = I_3' = 1A$

$\boxed{I_2' \Rightarrow -1A}$

II'



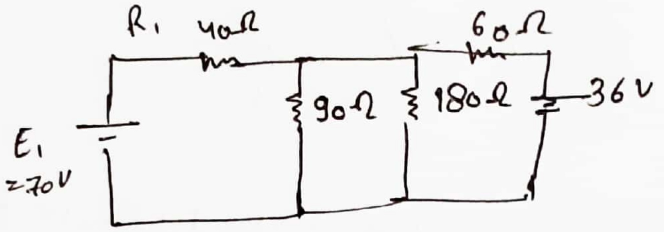
$$I_3' \Rightarrow \frac{100}{20 + \frac{40\times20}{40+20}} \Rightarrow = 3\,A$$

$\boxed{I_2'' = 2A}$

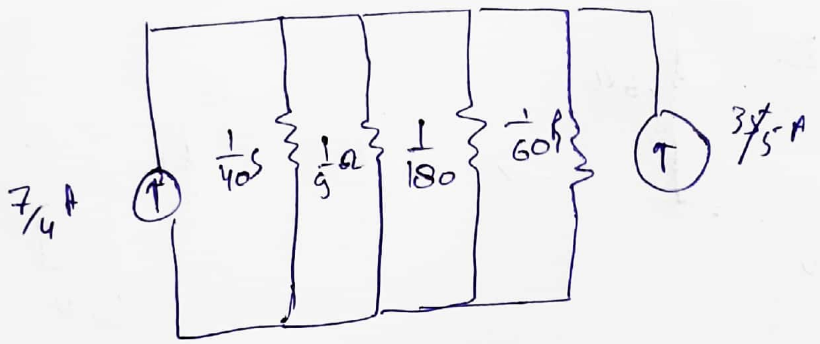
$$I_2 = I_2' + I_2'' = 2 - 1 = 1\,A$$

Current from R_2 = 1A

⑧ Using Nodal analysis find the current through 90Ω



Using Nodal Analysis.



$I = \frac{3}{5} + \frac{7}{4}$

$I = \frac{47}{50}$ A

Current through 90Ω resistor

$$= \frac{R_t}{90} \times I$$

$$\frac{1}{R_t} = \frac{1\times3}{40\times3} + \frac{1\times2}{90\times2} + \frac{1}{180} + \frac{1\times2}{60\times2}$$

$$= \frac{5}{120} + \frac{3\times2}{180\ 60\times2} = \frac{7}{120}$$

$$R_t = \frac{120}{7}$$

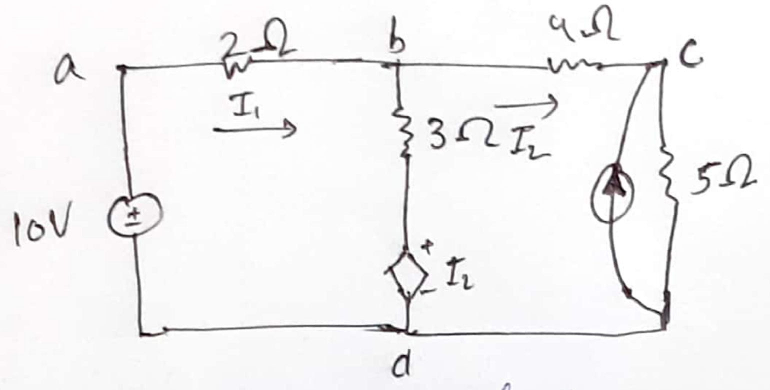
Current from 90 Ω $= \frac{120}{7\times90} \times \frac{7}{20}$

$= 0.447A$

9 Find the

a) value of I_1

b) Thevinin's equivalent b/w c&d removing current source and 5Ω resistance



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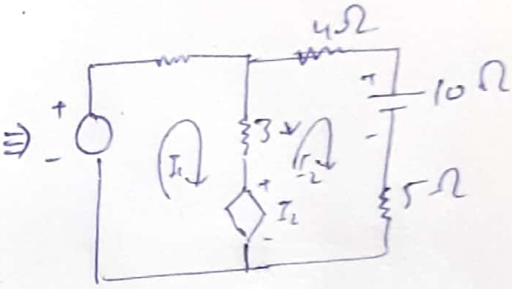

Using mesh analysis

$$\begin{bmatrix} 2+3 & -3 \\ -3 & 3+4+5 \end{bmatrix}\begin{bmatrix} I_1 \\ I_2 \end{bmatrix} = \begin{bmatrix} 10-V \\ V-10 \end{bmatrix}$$

$$\Rightarrow \begin{bmatrix} 5 & -3 \\ -3 & 12 \end{bmatrix}\begin{bmatrix} I_1 \\ I_2 \end{bmatrix} = \begin{bmatrix} 10-V \\ V-10 \end{bmatrix}$$

Constraint of V

$V = \alpha I_2 = I_2 \quad (\alpha = 1)$

$5I_1 - 3I_2 = 10 - I_2 \quad \Rightarrow \quad 5I_1 - 2I_2 = 10 \quad -①$

$-3I_1 + 12I_2 = I_2 - 10 \quad \Rightarrow \quad +3I_1 \cancel{+} 11I_2 = +10 \quad -②$

$① \times 11 - ② \times 2$

$\Rightarrow \quad 55I_1 - 6I_1 = 90$

$49 I_1 = 90$

a) $I_1 = \dfrac{90}{49} = 1.83A$ Ans//

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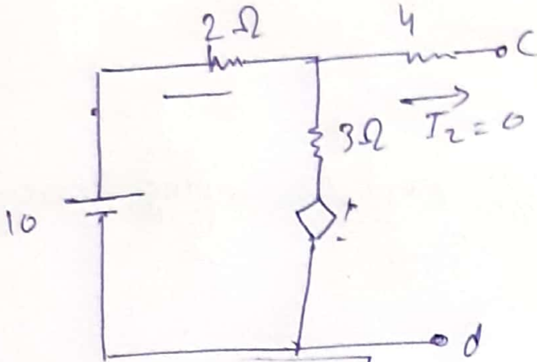
b)

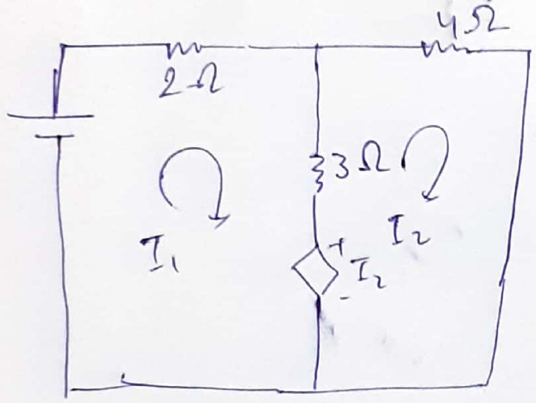


$\boxed{I_2 = 0}$

$V_{oc} = 6V$

$R_{th} = \frac{V_{oc}}{I_{sc}}$

for I_{sc}



$10 - 2I_1 - 3(I_1 - I_2) - I_2 = 0$

$\Rightarrow \quad 5I_1 - 2I_2 = 10 \quad — (1)$

$I_2 + 3(I_1 - I_2) - 4I_2 = 0$

$3I_1 - 6I_2 = 0$

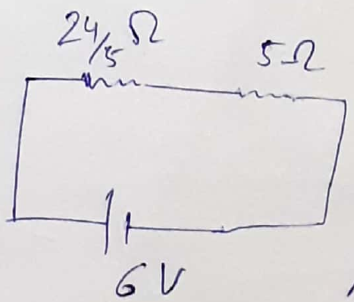
$\boxed{I_1 = 2I_2}$

$10I_2 - 2I_2 = 10$

$I_2 = \frac{5}{4} A$

$R_{th} \Rightarrow \frac{6 \times 4}{5} \Rightarrow \frac{24}{5} \Omega$ Ans //

Hence, thevinin eq circuit



Ans //

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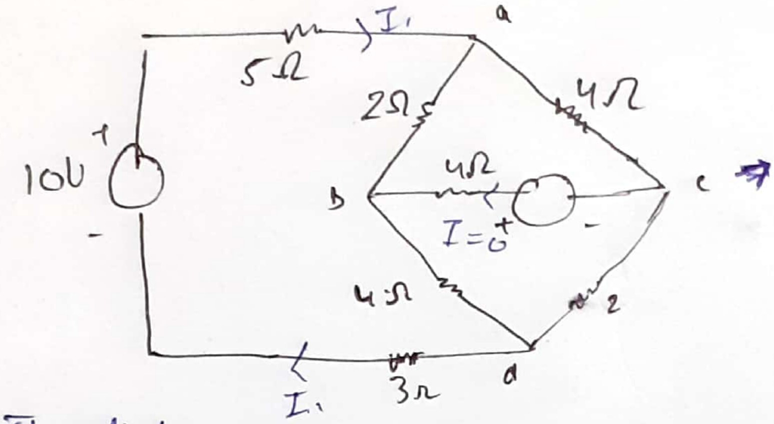
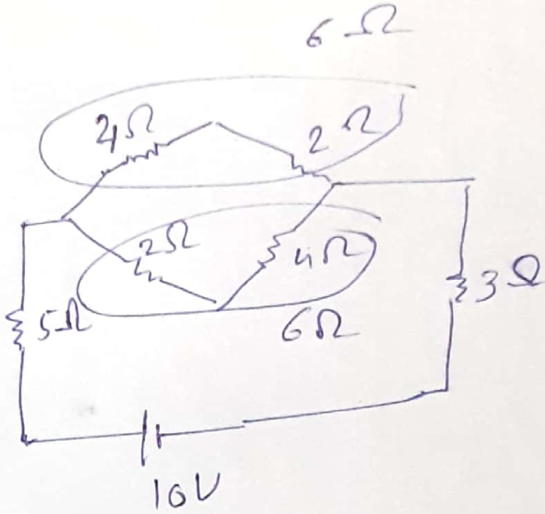
(10) find the current through 3 Ω resistor.





It satisfy condition for balanced wheat stone bridge hence I=0

$$R_{eq} = 5 + \frac{6 \times 6}{6+6} + 3$$

$$R_{eq} \Rightarrow 11\ \Omega$$

$$I_1 \Rightarrow \frac{10}{11} = 0.909$$

~~So~~ I through 3 Ω resistor = 0.91 A Ans