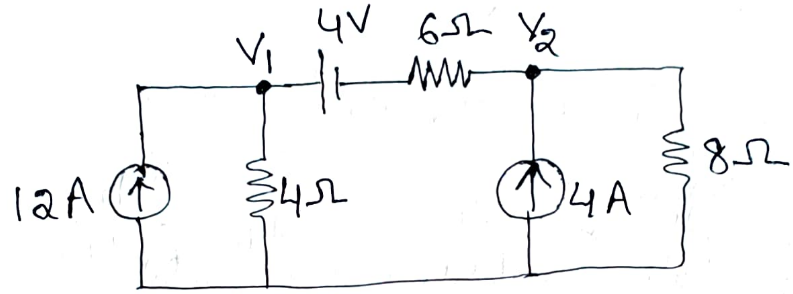
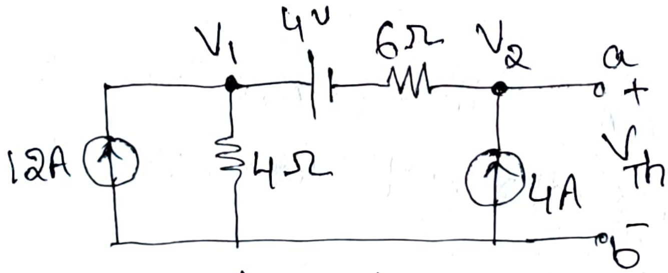
Section-C

7. Using thevenin's theorem, find the current flowing through the 8Ω resistor of the network shown.



Sol:- (i) To find V_{Th}: Remove $R_L = 8\Omega$



$V_{Th} = V_2$

By nodal analysis,

At node-1: $\frac{V_1}{4} + \frac{V_1 - 4 - V_2}{6} = 12$

$$3V_1 + 2V_1 - 8 - 2V_2 = 144$$

$$5V_1 - 2V_2 = 152 \longrightarrow (1)$$

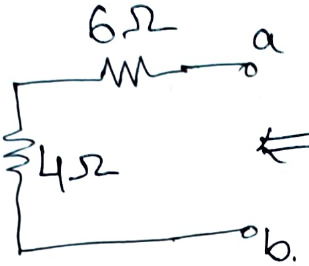
At node-2: $\frac{V_2 + 4 - V_1}{6} = 4$

$$-V_1 + V_2 = 20 \longrightarrow (2)$$

Solving eq-(1) & (2), we get

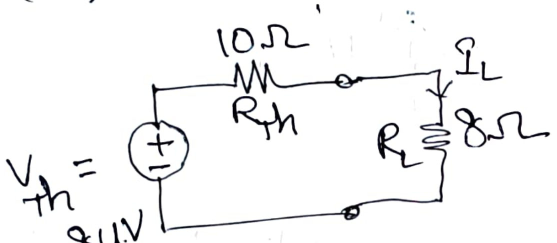
$$\boxed{V_1 = 64V \qquad V_{Th} = V_2 = 84V}$$

ii) To find R_{th}:



$\Leftarrow R_{th} = 6+4 = 10\Omega.$

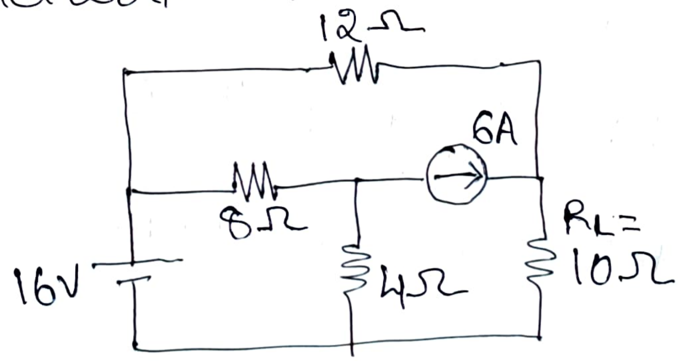
(iii) To find current in 8Ω resistor:



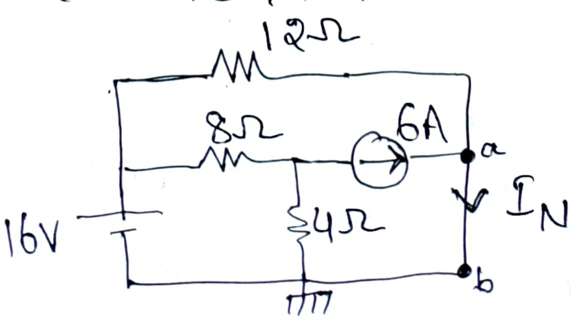
$$I_L = \frac{V_{th}}{R_{th}+R_L} = \frac{84}{18}$$

$$\boxed{I_L = 4.67\,A}$$

(8) Using Norton's theorem, find the current flowing through 10Ω resistor in the network shown.



Sol:- (i) To find short circuit current I_N,



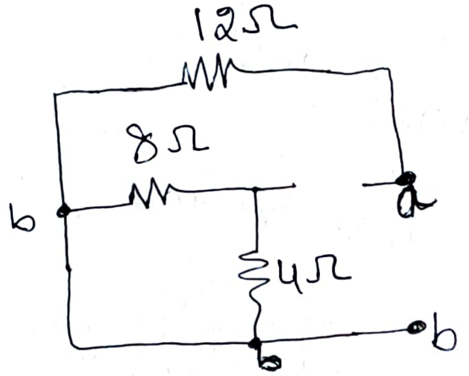
current through 12Ω is

$$I_{12\Omega} = \frac{16}{12} = 1.33A$$

By KCL at node - a,

$$I_N = 6 + I_{12\Omega} = 6 + 1.33 = \underline{\underline{7.33A}}.$$

(ii) To find R_N:

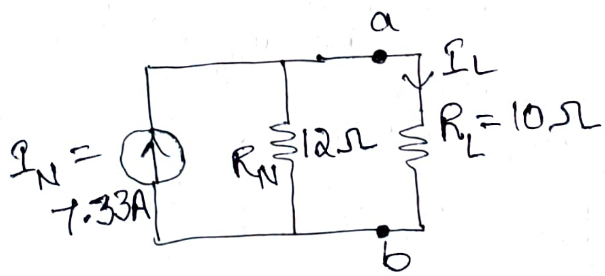


R_N = Resistance between node-a and node-b.

$$\boxed{R_N = 12\Omega}$$

[∵ (8+4) is parallel with short circuit]

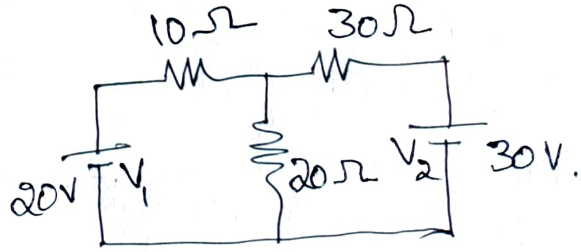
(iii) To find current in 10Ω resistor:



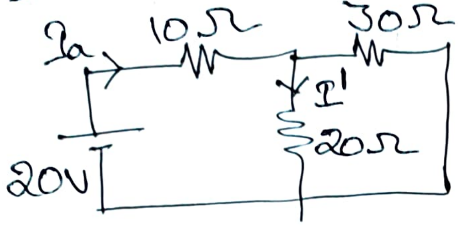
$$I_L = I_N \times \frac{R_N}{R_N + R_L}$$

$$\boxed{I_L = 7.33 \times \frac{12}{22} = 4A}$$

(9) Using superposition theorem, find the current flowing through the 20Ω resistor of the network shown.



sol:- (i) with only 20V source in the network,



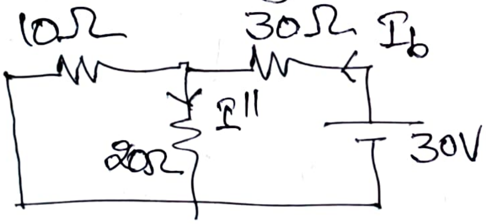
$$I_a = \frac{20}{10 + \frac{20 \times 30}{20+30}} = \frac{20 \times 50}{1100}$$

$$I_a = \frac{10}{11} = 0.91A.$$

then

$$I' = I_a \times \frac{30}{30+20} = \underline{\underline{0.55A.}}$$

(ii) with only 30V source in the network,



$$I_b = \frac{30}{30 + \frac{10 \times 20}{10+20}} = 0.82A$$

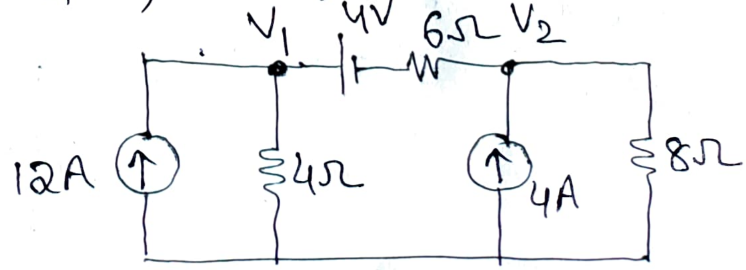
then

$$I'' = I_b \times \frac{10}{10+20} = 0.27A$$

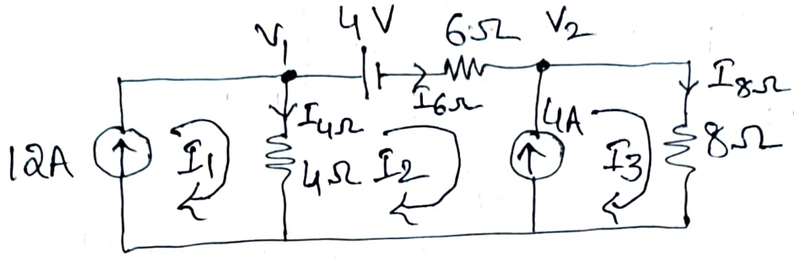
(iii) By superposition theorem, the current flowing through 20Ω resistor is

$$I = I' + I'' = 0.55 + 0.27 = \underline{\underline{0.82A}}$$

(10) Using mesh analysis, determine the currents in 4Ω, 6Ω & 8Ω of the network shown.



Sol:- Let the mesh currents are I_1, I_2 and I_3 as shown



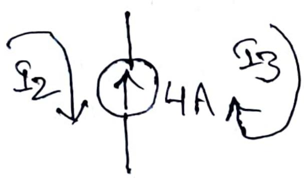
From mesh-1 : $I_1 = 12A.$

from mesh-2 & 3 form a super mesh, then

$$4(I_2 - I_1) + 4 + 6I_2 + 8I_3 = 0$$

$$10I_2 + 8I_3 = 44 \rightarrow (1) \quad [\because I_1 = 12]$$

From 4A current source branch,



$$-I_2 + I_3 = 4 \rightarrow (2)$$

solving eq-(1) & (2), we get

$I_2 = 0.67A$ and $I_3 = 4.67A.$

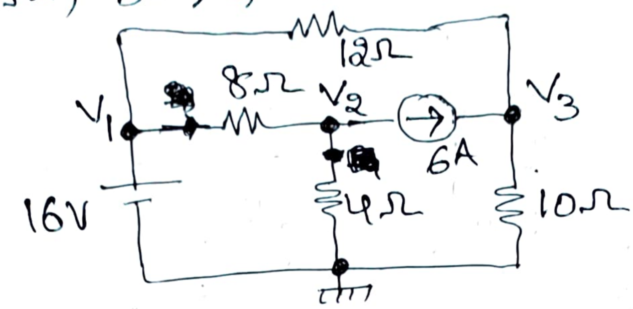
Now,

$$I_{4Ω} = I_1 - I_2 = 12 - 0.67 = \underline{\underline{11.33A}}.$$

$$I_{6Ω} = I_2 = \underline{\underline{0.67A}}$$

$$I_{8Ω} = I_3 = \underline{\underline{4.67A}}.$$

(11) using nodal analysis, determine the currents in 4Ω, 8Ω, $\overset{10\Omega}{\cancel{}}$ & 12Ω in the network shown.



Sol:- Let V_1, V_2 and V_3 are the node voltages at node-1, 2, & 3, respectively, w.r.t ground.

From node-1 : $\boxed{V_1 = 16\text{ V.}}$

From node-2, by KCL :

$$\frac{V_2 - V_1}{8} + \frac{V_2}{4} + 6 = 0.$$

$$-V_1 + 3V_2 = -48 \rightarrow (1) \quad \therefore \boxed{V_2 = -10.67\text{V.}}$$

From node-3, by KCL

$$\frac{V_3 - 16}{12} + \frac{V_3}{10} = 6 \Rightarrow 11V_3 = \cancel{280}\ 440$$

$$\therefore \cancel{V_3 = 25.45\text{V}} \qquad \boxed{V_3 = 40\text{V}}$$

Then,

$$I_{8\Omega} = \frac{V_1 - V_2}{8} = 3.33\text{A}.$$

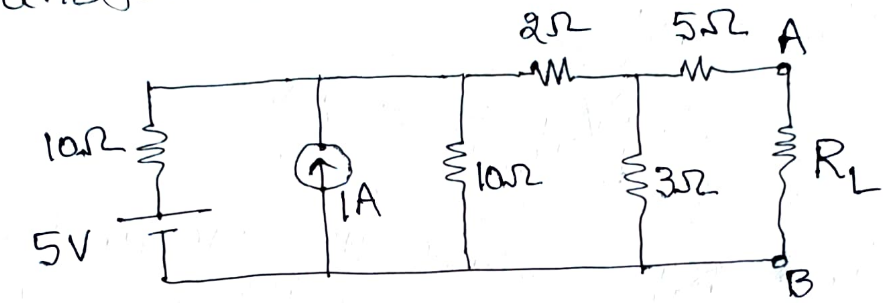
$$I_{4\Omega} = \frac{V_2}{4} = -2.67\text{A}$$

$$I_{10\Omega} = \frac{V_3}{10} = \cancel{2.545\text{A}} = 4\text{A}$$

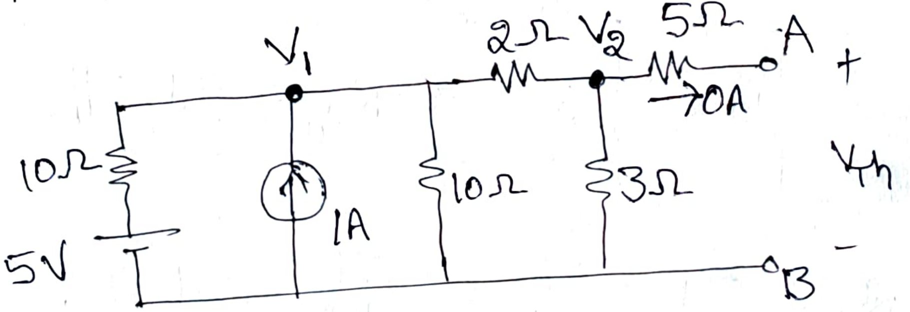
$$I_{12\Omega} = \frac{V_3 - V_1}{12} = \frac{24}{12} = \cancel{0.788\text{A}}.$$

$$I_{12\Omega} = 2\text{A}.$$

(12) In the circuit shown, (a) obtain the condition for maximum power transfer to the load R_L. (b) Hence determine the maximum power transferred.



Sol:- (i) To find thevenin's voltage across the terminals A-B:



By nodal analysis; at node-1,

$$\frac{V_1-5}{10}+\frac{V_1}{10}+\frac{V_1-V_2}{2}=1$$

$$7V_1-5V_2=15 \rightarrow (1)$$

at node-2:

$$\frac{V_2-V_1}{2}+\frac{V_2}{3}=0 \Rightarrow -3V_1+5V_2=0 \rightarrow (2)$$

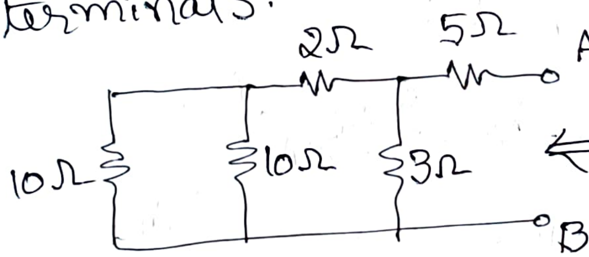
solving eq-(1) & (2), we get

$V_1 = 3.75V$ and $V_2 = 2.25V$.

As no current flow through 5Ω when load terminals are open, the thevenin's voltage V_{Th} across A-B terminals is equal to V_2 only.

$$\therefore \boxed{V_{Th} = 2.25V}$$

(ii) To find R_{Th}, short the 5V and open the 1A sources and calculate R_{Th} between load terminals.

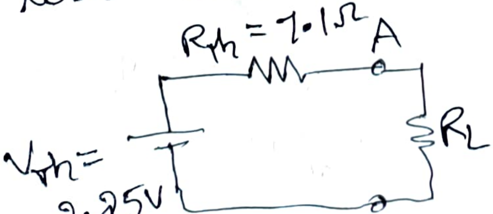


$\Leftarrow R_{Th} = 5 + [3 \,||\, (2 + (10||10))]$

$$R_{Th} = 5 + \frac{3\times7}{3+7} = \frac{71}{10} = 7.1\Omega.$$

$$\boxed{R_{Th} = 7.1\Omega}$$

(iii) the thevenin's equivalent circuit across load terminals is



According to maximum power transfer theorem, for max. power transfer is possible when $R_L = R_{Th}$.

$$\therefore \boxed{R_L = 7.1\Omega}$$

(iv) The value of max. power transferred to the load $P_{L,max}$ is,

$$P_{L,max} = \frac{V_{Th}^2}{4R_{Th}} = \frac{(2.25)^2}{4\times 7.1}$$

$$\boxed{P_{L,max} = 0.18\,W.}$$