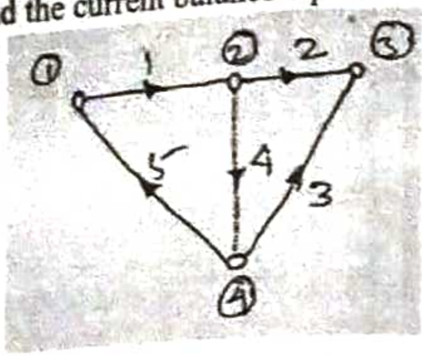
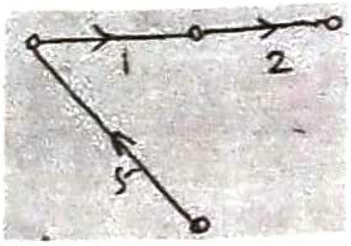
Ex- Determine the cut-set matrix and the current balance equation of the following graph?

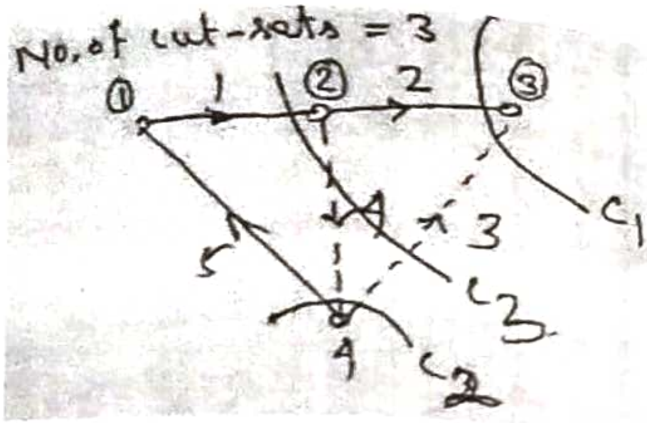


Solution:

Tree



No of twigs=1, 2, 5



<u>Cut-set matrix</u>

branch

cut-set	1	2	3	4	5
C1	0	1	1	0	0
C2	0	0	1	-1	1
C3	1	0	1	-1	0

$i_2 + i_3 = 0$

$i_3 - i_4 + i_5 = 0$ where, i_1, i_2, i_3, i_4, i_5 are respective branch currents.

$i_1 + i_3 - i_4 = 0$

...al & Mesh Analysis Of Electric Circuits

... - It is a equipotential point at which two or more circuit elements are joined.

... - It is that point of a network where three or more circuit elements are joined.

... - It is a part of a network which lies between junction points.

... Analysis

In the nodal analysis it is essential to compute branch current.

In this method, the number of independent node equations needed is one less than the number of junctions in the network.

i.e $\boxed{n = j-1}$

where n → denotes the no. of independent node equations

j → the no. of junction.

... Analysis

In the mesh analysis KVL is applied around each ...ed loop & by solving these loop equations, the branch current is determined.

For this method the no. of independent mesh equations needed is

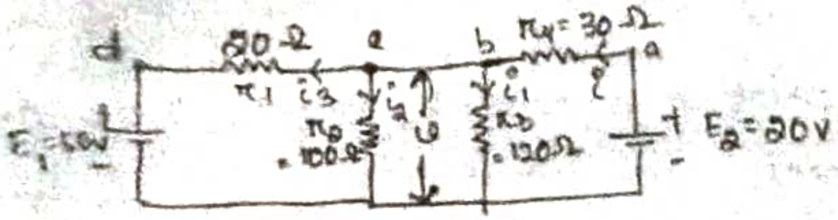
$$\boxed{m = b-(j-1)}$$

where b → the no. of branches.

Note

If $m<n$, the mesh method offers advantages while for $m>n$, the nodal method is preferred.

Ex



Using Nodal method find the current through r_2.

Soln

As node b + c are electrically same, the KCL equation across node b is

$$i = i_1 + i_2 + i_3$$

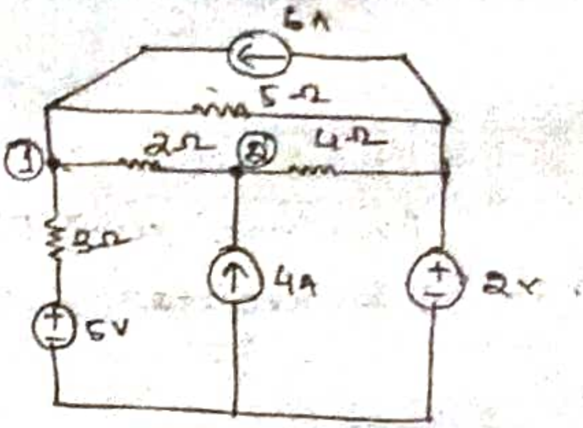
$$\Rightarrow \frac{20-v}{30} = \frac{v}{120} + \frac{v}{100} + \frac{v-50}{20}$$

$$\Rightarrow \frac{20}{30} + \frac{50}{20} = v\left[\frac{1}{30} + \frac{1}{120} + \frac{1}{100} + \frac{1}{20}\right]$$

$$\Rightarrow \boxed{v = 31.18\ V}$$

$$i_2 = \frac{v}{100} = \frac{31.18}{100}$$

$$\Rightarrow \boxed{i_2 = .3118\ A = 311.8\ mA}$$



Using Nodal method find the current through the resistors in the circuit.

For node '1'

$$\frac{V_1-5}{3}+\frac{V_1-V_2}{2}+\frac{V_1-2}{5}=6$$

$$\Rightarrow V_1\left(\frac{1}{3}+\frac{1}{2}+\frac{1}{5}\right)-\frac{V_2}{2}=6+\frac{2}{5}+\frac{5}{3}$$

$$\Rightarrow \frac{31}{30}V_1-\frac{V_2}{2}-\frac{121}{15}=0 \qquad \text{———— (i)}$$

For node '2'

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

$$V_2\left(\frac{1}{2}+\frac{1}{4}\right)-\frac{V_1}{2}=4+\frac{1}{2}$$

$$\frac{3}{4}V_2-\frac{V_1}{2}-\frac{9}{2}=0 \qquad \text{———— (ii)}$$

...ing eqn (i) & (ii) $V_1 = 15.76\,V$ & $V_2 = 16.31\,V$

...ent through resistor $3\Omega = \frac{V_1-5}{3} = \frac{15.76-5}{3} \simeq 3.6\,A$

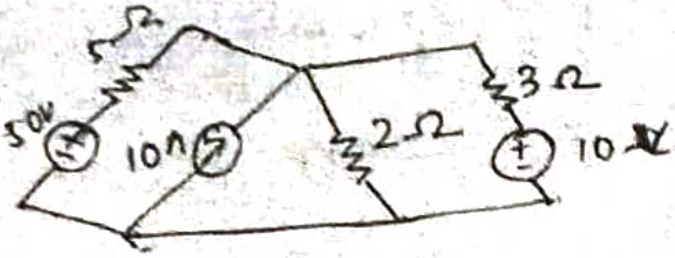
...t through resistor $2\Omega = \frac{V_1-V_2}{2} = \frac{15.76-16.51}{2}$

$= -0.375\,A$

... through $5\Omega = \frac{V_1-2}{5} = \frac{15.76-2}{5} = 2.76A$

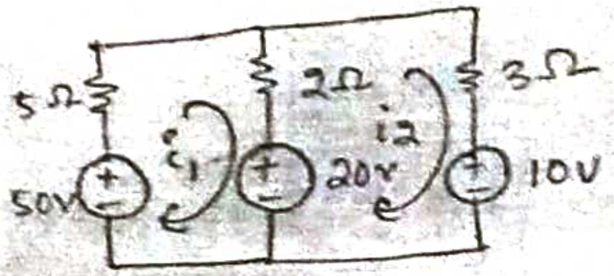
... through $4\Omega = \frac{V_2-2}{4} = \frac{16.51-2}{4} = 3.63\,A$

Ex-6



Using mesh analysis, find the current flow through 50V source e in the network.

Sol^n



$$50 - 5i_1 - 2(i_1 - i_2) - 20 = 0$$

$$\Rightarrow 30 - 5i_1 - 2i_1 + 2i_2 = 0$$

$$\Rightarrow 7i_1 - 2i_2 = 30 \quad \text{—(1)}$$

$$20 - 2(i_2 - i_1) - 3i_2 - 10 = 0$$

$$\Rightarrow 10 - 2i_2 + 2i_1 - 3i_2 = 0$$

$$\Rightarrow 2i_1 - 5i_2 = -10 \quad \text{—(2)}$$

$$5(7i_1 - 2i_2 = 30)$$

$$2(2i_1 - 5i_2 = -10)$$

$$34 i_1 = 170$$

$$\Rightarrow \boxed{i_1 = 5.48A}$$

Network Theorem

1) Thevenin's Theorem

Any two terminal bilateral linear d.c circuit can be replaced by an equivalent circuit consisting of a voltage source & a series resistor.

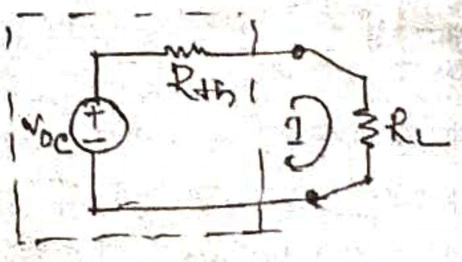
Steps

(i) Remove the load resistor (R_L) & find the open circuit voltage (V_{oc}) across the open circuited load terminal.

(ii) Deactivate the constant sources (for voltage source, remove it by internal resistance & for current source delete the source by open circuit) & find the internal resistance looking through the open circuited load terminal. Let this resistance be R_{Th}.

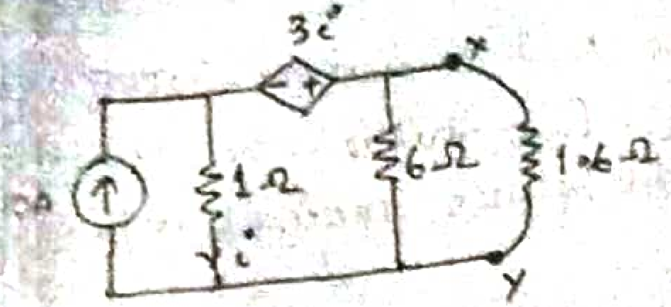
(iii) Obtain Thevenin's equivalent circuit by placing R_{Th} in series with V_{oc}.

(iv) Reconnect R_L across the load terminals.

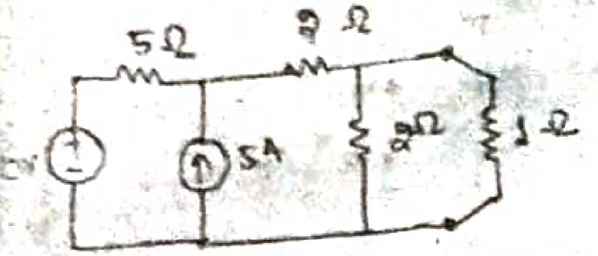


$$\boxed{\text{The load current } (I) = \frac{V_{oc}}{R_{Th}+R_L}}$$

[illegible]



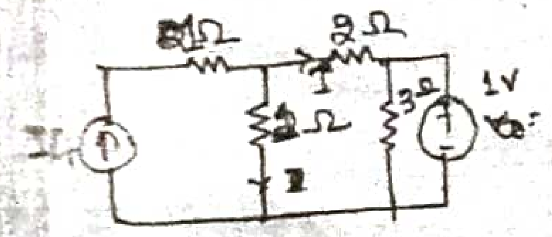
Find current through 1.6 Ω resistor in the circuit.



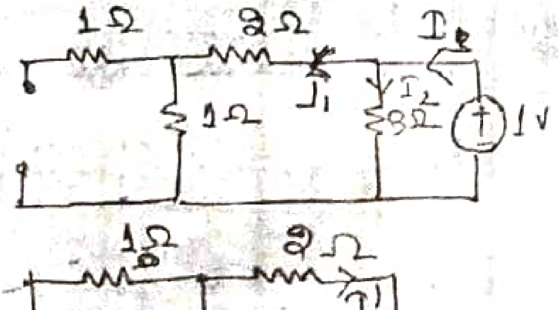
Find power loss in 1 Ω resistor using Norton's theorem.

Superposition Theorem

If a number of voltage or current sources are acting simultaneously in a linear network, the resultant current in any branch is the algebraic sum of the current that would be produced in it, when each source acts alone replacing all other independent source by their internal resistance.

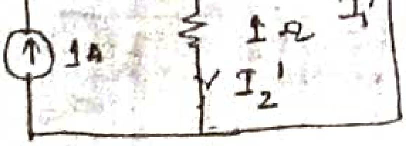


Find I in the circuit



$$I_2 = \frac{1}{3 \,\|\, 3} = \frac{1}{1.5} = \frac{2}{3}\,A$$

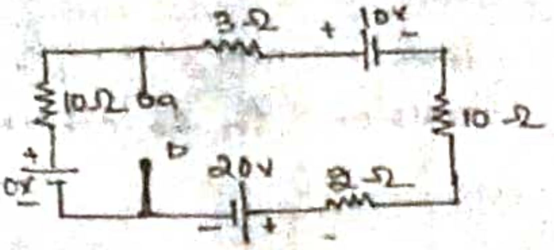
$$I_1 = \frac{1}{3}\,A$$



$$I_1' = \frac{1}{3} \times 1 = \frac{1}{3}$$

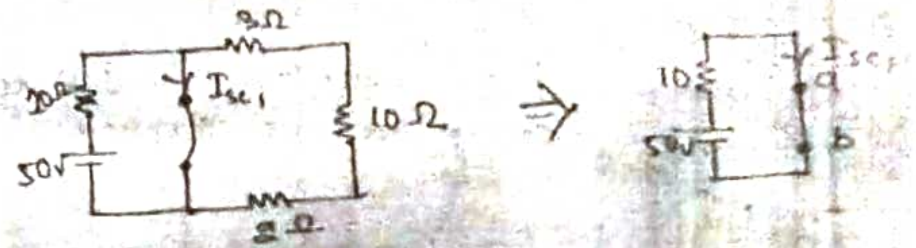
$$I = I_1 - I_1' = \frac{1}{3} - \frac{1}{3} = 0$$

Ex-2

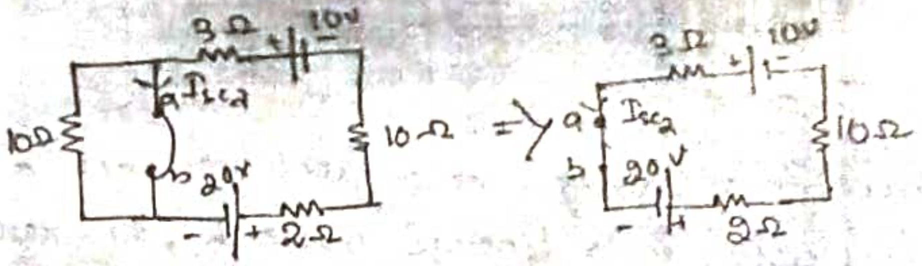


Find the current through a link, that is to be connected between terminals a-b.

Sol^n



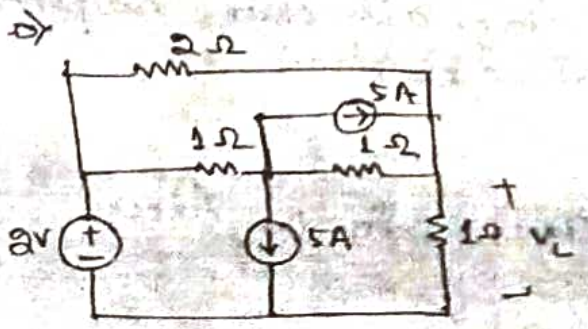
$\boxed{I_{sc_1} = 5A}$



$I_{sc_2} = \frac{30}{15} = 2A$

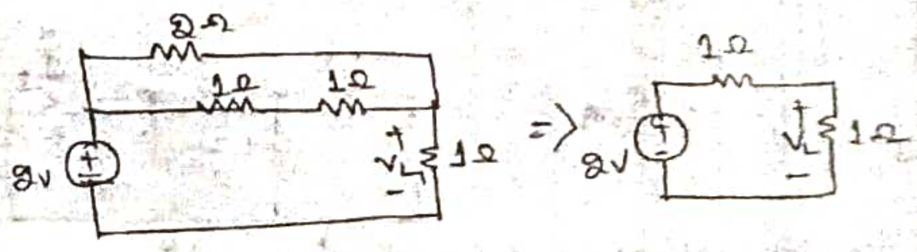
$I_{sc} = I_{sc_1} + I_{sc_2} = 5 + 2 = 7A$

Ex-3

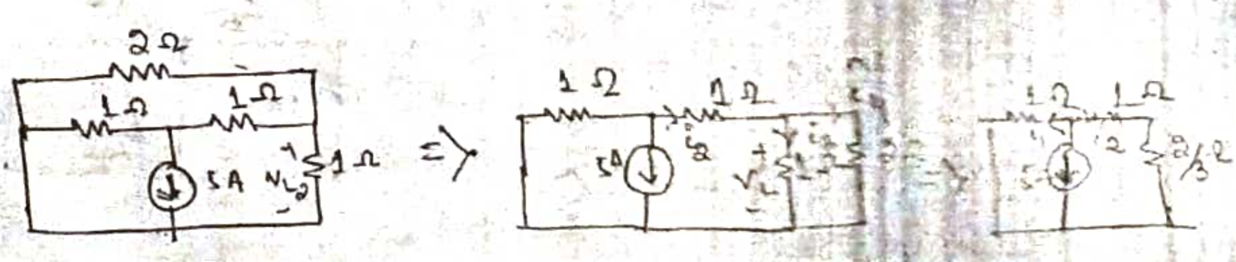


Find V_L.

Sol^n



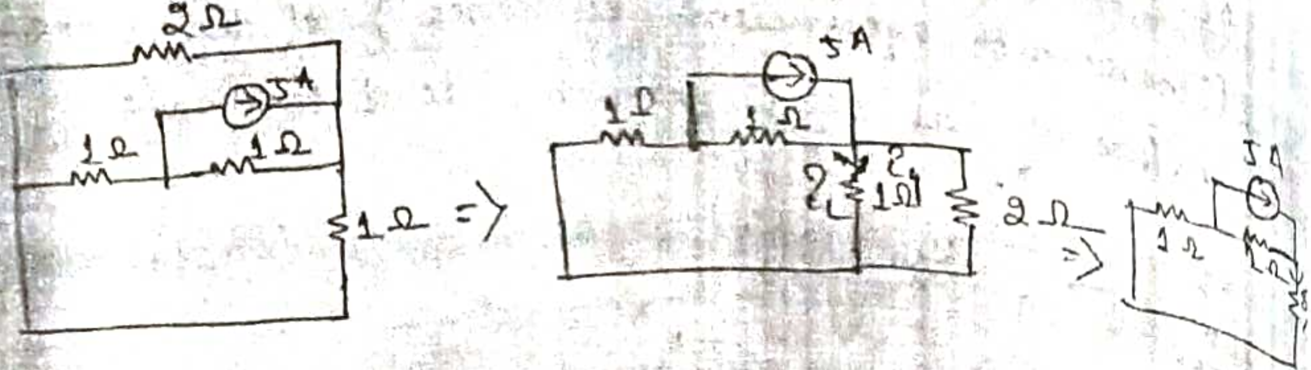
$\boxed{V_L = 1V}$



$i_2 = -5 \times \frac{1}{1+1+\frac{2}{3}} = -5 \times \frac{3}{8} = -\frac{15}{8}$ A

$i_2' = \frac{-\cancel{15}^{5}}{\cancel{8}_{4}} \times \frac{2}{3} = -\frac{5}{4}$ A

$V_{L_2} = 1 \times -\frac{5}{4} = -\frac{5}{4}$ V



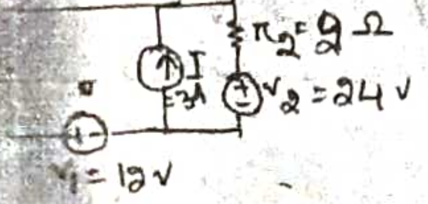
$i_4 = 5 \times \frac{1}{1+\frac{2}{3}} = \frac{15}{5} = 3$ A

$i_L = \frac{2}{3} \times 3 = 2$ A

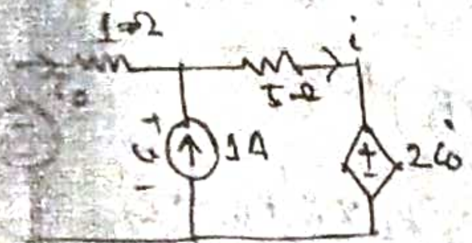
$V_{L_3} = 2 \times 1 = 2$ V

Superposition $V_L = V_{L_1} + V_{L_2} + V_{L_3} = 1 - \frac{5}{4} + 2 = 3 - \frac{5}{4}$

$= \frac{7}{4}$ V



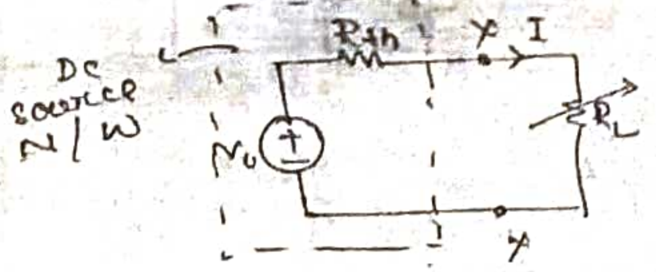
Find current through r_1.



Find i_0 & i.

4. Maximum Power Transfer Theorem

A resistance load, being connected to a dc network, receives maximum power when the load resistance is equal to the internal resistance (Thevenin's equivalent resistance) of the source network as seen from the load terminals.



$$I = \frac{V_0}{R_{th} + R_L}$$

while power delivered to the resistive load is

$$P_L = I^2 R_L = \left(\frac{V_0}{R_{th}+R_L}\right)^2 R_L$$

P_L can be maximised by varying R_L & hence maximum power can be delivered when $(dP_L/dR_L) = 0$

However
$$\frac{dP_L}{dR_L} = \frac{(R_{th}+R_L)^2 \frac{d}{dR_L}(V_0^2 R_L) + V_0^2 R_L \frac{d}{dR_L}(R_{th}+R_L)^2}{(R_{th}+R_L)^4}$$

$$= \frac{(R_{th}+R_L)^2 V_0^2 - V_0^2 R_L \times 2(R_{th}+R_L)}{(R_{th}+R_L)^4}$$

$$= \frac{V_0^2(R_{th}+R_L-2R_L)}{(R_{th}+R_L)^3} = \frac{V_0^2(R_{th}-R_L)}{(R_{th}+R_L)^3}$$