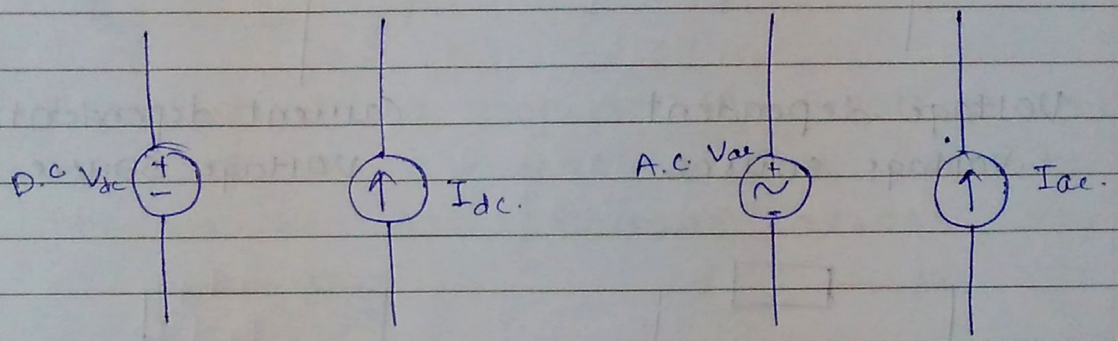
Network concepts.

Energy Sources —

→ Energy sources can be classified into two sources

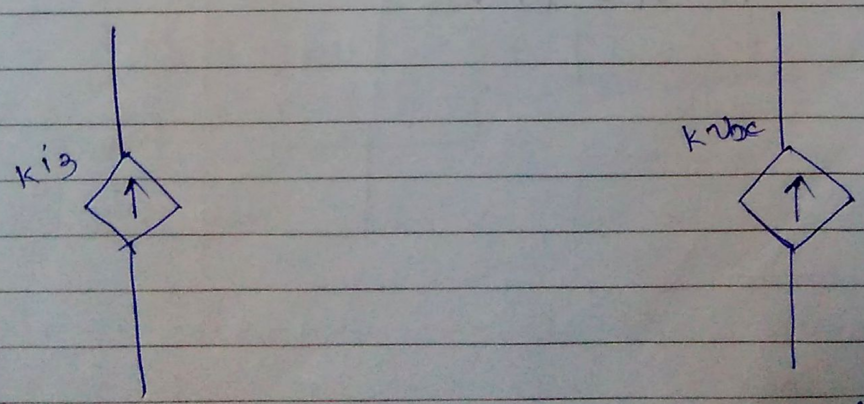
(i) Independent E.S. —



→ The elements in which the voltage is completely independent of current or the current is completely independent of the voltage else where in the circuit.

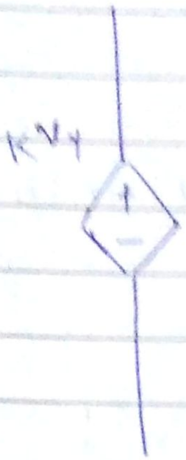
(ii) Dependent E.S. —

→ The element in which the source quantity is determined by a voltage or a current existing at some other location in the system being analysed

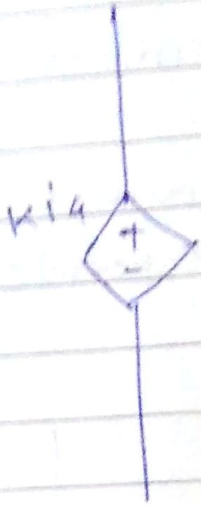


current dependent current source.

voltage dependent current source.

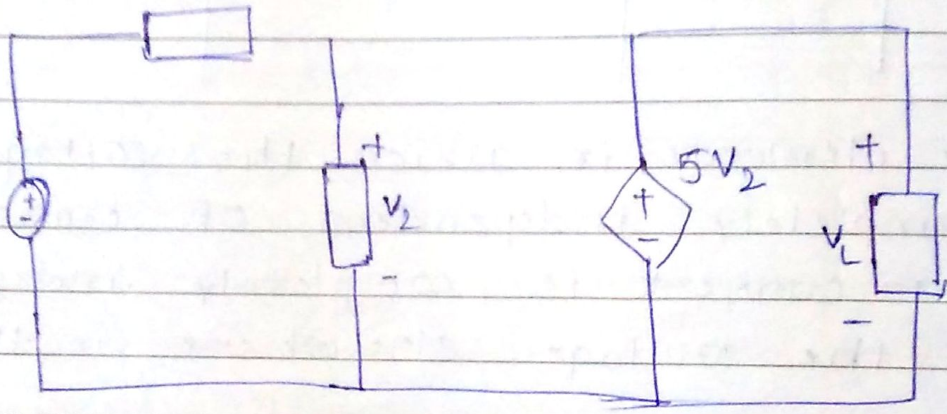


Voltage dependent voltage source



Current dependent voltage source.

Que.



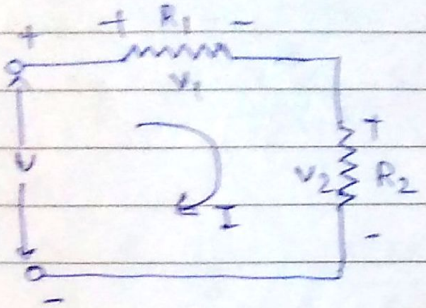
Here, $V_2 = 3V$, $V_L = ?$

Here, $5V_2 = V_L$

$\therefore 5(3) = V_L$

$\therefore V_L = 15\,V.$

⇒ Voltage Division rule —



→ It is used to express the voltage across one of the several series resistors in terms of the voltage across the combination.

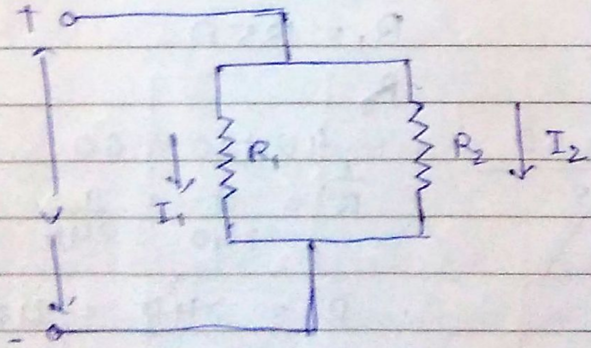
Here $V = V_1 + V_2$ (series)

$\therefore V = IR_1 + IR_2$

$\therefore I = \dfrac{V}{R_1 + R_2}$ —— (1)

So, $V_1 = \dfrac{VR_1}{R_1 + R_2}$, $V_2 = \dfrac{VR_2}{R_1 + R_2}$.

⇒ Current Division rule —



→ It is used to express the current flowing through one of the several resistors connected in parallel interm of the total current

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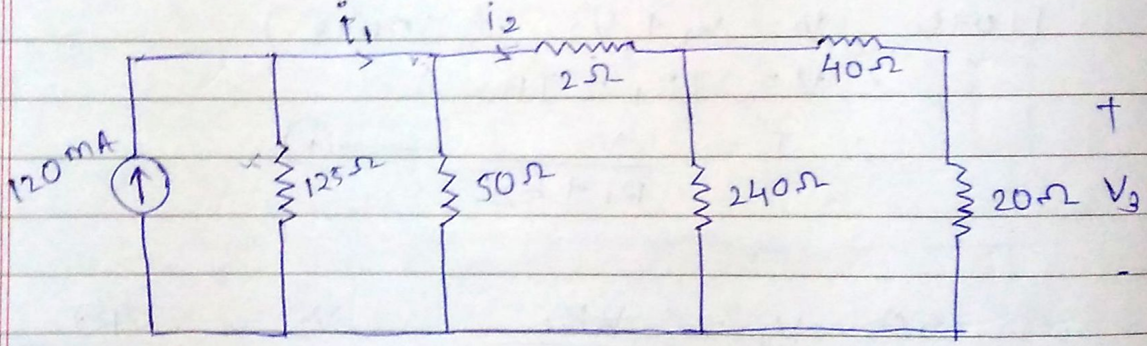
$$I = I_1 + I_2$$
$$= \frac{V}{R_1} + \frac{V}{R_2}$$
$$\therefore I = V\left(\frac{R_1 + R_2}{R_1 R_2}\right)$$
$$\therefore V = \left(\frac{R_1 R_2}{R_1 + R_2}\right) I$$

So, $I_1 = \frac{I}{R_1}\left(\frac{R_1 R_2}{R_1 + R_2}\right)$

$$\therefore I_1 = \frac{I R_2}{R_1 + R_2}, \quad I_2 = \frac{I R_1}{R_1 + R_2}.$$

Que.



Here, $i = i_1 + i_2$.
and $i = 120$ mA.

$$i_1 = \frac{I R_2}{R_1 + R_2}$$
$$= \frac{120 \times 50}{175}$$
$$= \frac{600}{175}$$

$R_1 = 125\,\Omega$.

R_2

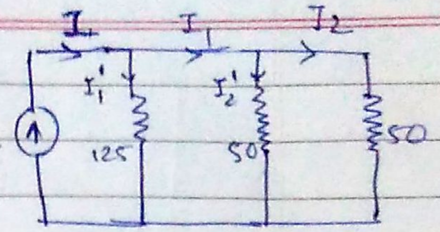
$40 + 20 = 60$

$$\frac{1}{R'} = \frac{4}{240} + \frac{1}{240} = \frac{5}{240}$$

$$\therefore R' = \frac{240}{5} = 48\,\Omega + 2 = 50$$

$$\frac{1}{R''} = \frac{1}{50} + \frac{1}{50} = \frac{2}{50}$$

$\therefore R'' = 25\,\Omega = R_2$



~~$i_1 = \frac{120 \times 125}{150}$~~

~~$\therefore i_2 = \frac{120 \times 125}{150} = 100\ mA.$~~

~~and $i_2 = \frac{120 \times 50}{50 + 50}$~~

$I_1' = \frac{120 \times 25}{150} = 20\ mA.$

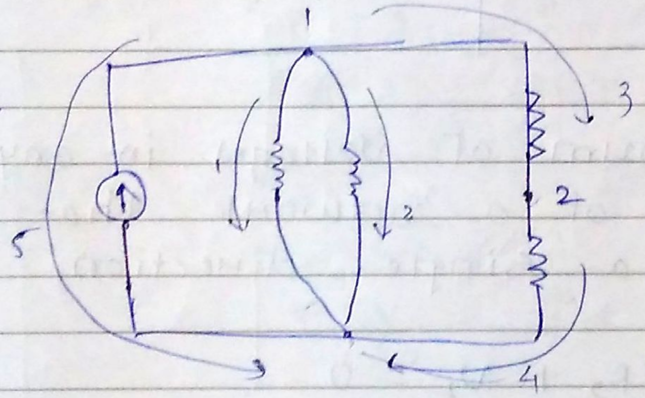
$\therefore I_1 = 120 - 20 = 100\ mA.$

and $I_2' = \frac{100 \times 50}{100} = 50\ mA$

$\therefore I_2 = 100 - 50 = 50\ mA.$

⇒ Branch - A single path in a network composed of one element and the nod at each end of the element.

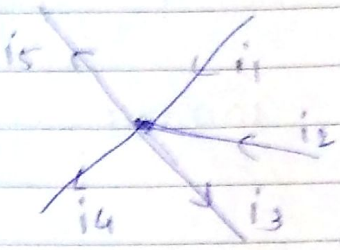
Que.



No. of paths = 5
No. of closed loop = 6

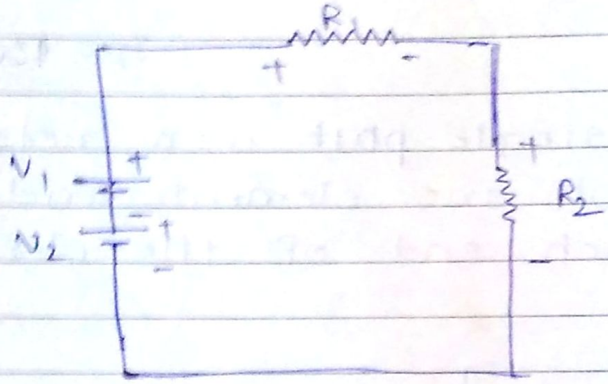
⇒ Kirchhof's current low -

→ The Algebric sum of currents at any nod of a circuit is zero



$$i_1 + i_2 = i_3 + i_4 + i_5$$

⇒ Kirchhoff's voltage law –

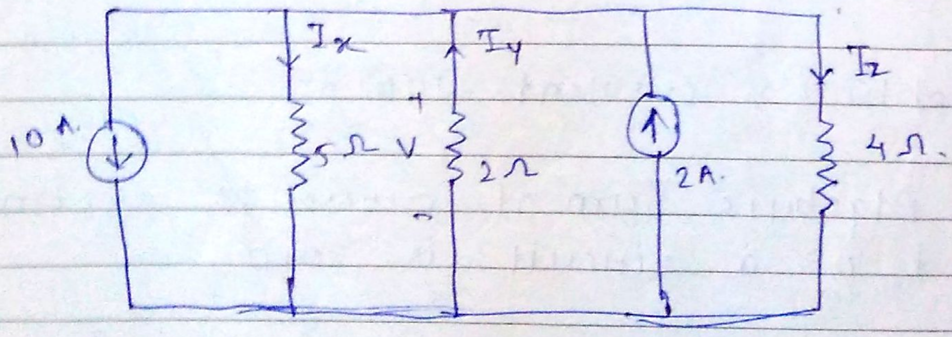


→ The Algebraic Sum of voltages in any closed path of a network that is traversed in a single direction.

$$V_1 - IR_1 - IR_2 + V_2 = 0$$

$$\therefore V_1 + V_2 = I(R_1 + R_2)$$

Que.



$I_x = ?$ $V = ?$

$I_y = ?$

$I_z = ?$

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$I_x + I_z + 10 = I_y + 2$

$\therefore I_x + I_z - I_y = -8 \quad —(1)$

$V = I_x(5)$

$\therefore I_x = \frac{V}{5} \quad —(2)$

$V = I_y(2)$

$\therefore I_y = +V/2 \quad —(3)$

$V = I_z(4)$

$\therefore I_z = \frac{V}{4} \quad —(4)$

from eq. (1).

$\therefore \frac{V}{5} + \frac{V}{4} + \frac{V}{2} = -8$

$\therefore \frac{8V + 10V + 20V}{40} = -8$

$\therefore \frac{38V}{40} = -8$

$\therefore \frac{V}{20} = -8$

$\therefore V = \cancel{160V}\ -8.42\ V$

$\cancel{I_x = \frac{160}{5} = 32A}$

$\cancel{I_y = \frac{160}{2} = 80A}$

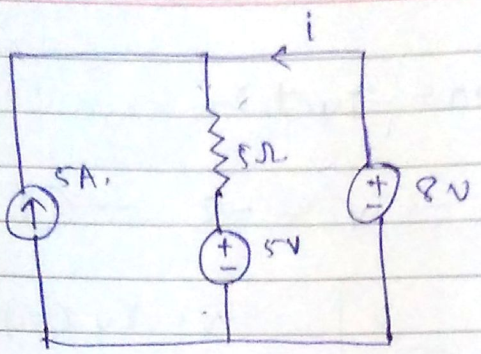
$\cancel{I_z = \frac{160}{4} = 40A}$

$I_x = \frac{-8.42}{5} = -1.68A$

$I_y = \left(\frac{-8.42}{2}\right) = 4.21A$

$I_z = \frac{-8.42}{4} = -2.105A$

Que.



$\cancel{8 - 5 = i(5)}$

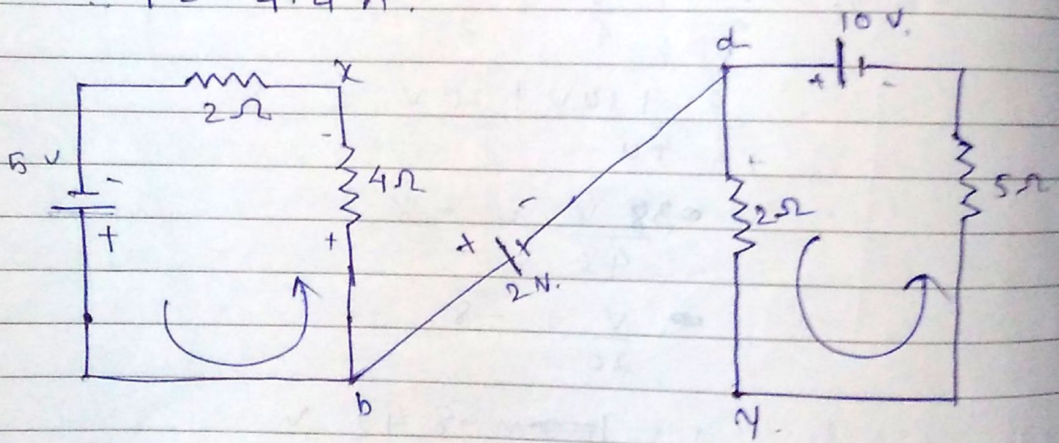
$\cancel{\therefore i(5) = 3}$

$(i+5)5 = 3$

$\therefore i + 5 = 0.6$

$\therefore i = -4.4\ A.$

Que.



find V_{xy} ?

$V_{xy} = V_{xb} + V_{bd} + V_{dy}$ — (1).

KVL for LOOP-1

$5 - 4i_1 - 2i_1 = 0$

$\therefore 5 - 6i_1 = 0$

$\therefore 5 = 6i_1$ — (1).

$\therefore i_1 = 5/6\ A.$

$\therefore V_{bx} = 4i_1 = 4(5/6) = 3.33V$

KVL for LOOP-2

$10 - 7i_2 = 0$

$\therefore \frac{10}{7} = i_2$

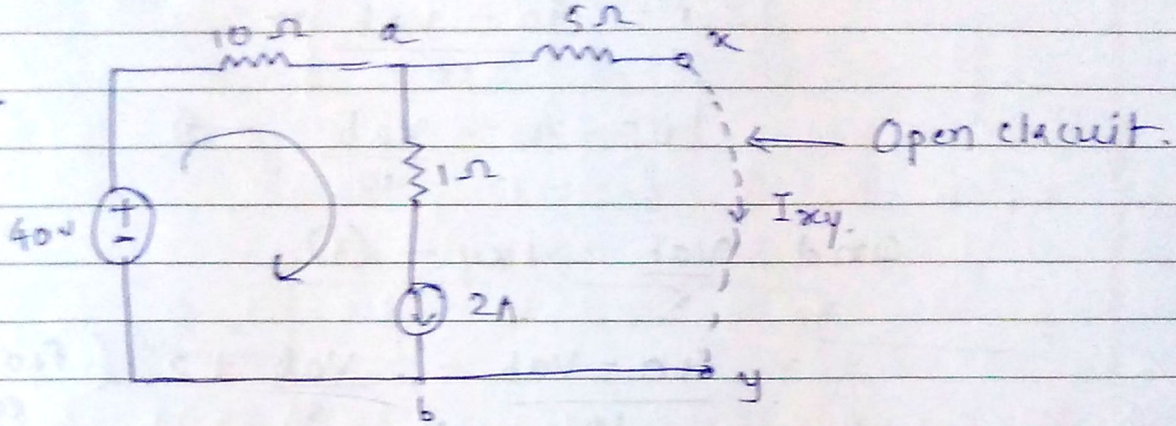
$\therefore i_2 = 1.428\ A.$

$\therefore V_{dy} = (1.428)(2)$

so, $V_{xy} = -3.33 + 2 + 2.857$

$\therefore V_{xy} = 1.527$ V.

Que.



→ find I_{xy} and V_{xy} —

~~$40 - 10(2) - 1(2) = 0.$~~

~~$40 - 10(2) = V_a$~~

~~$\therefore V_a = 20$ V~~

~~$V_b = -40$ V~~

~~so, $V_{ab} = V_a - V_b$~~

~~$= 60$ V~~

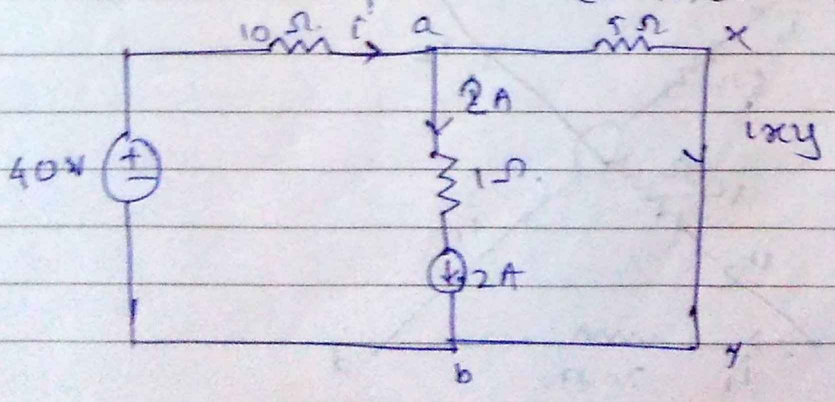
$40 - V_{ab} = 10\,i$

$\therefore 40 - V_{ab} = 20$

$\therefore V_{ab} = 20$ V.

$I_{xy} = 0.$ (open circuit)

(ii) Now x & y are connected —



57 V.

$\therefore\ i = i_{xy} + 2$ — (1)

and $40 = 10i + V_{ab}$

$\therefore\ i = \dfrac{40 - V_{ab}}{10}$

$\therefore\ i = 4 - \dfrac{V_{ab}}{10}$ — (2)

and $\dfrac{V_{ab}}{5} = i_{xy}$ — (3)

$\therefore\ \dfrac{40 - V_{ab}}{10} = \dfrac{V_{ab}}{5} + 2$ (from eq. (1))

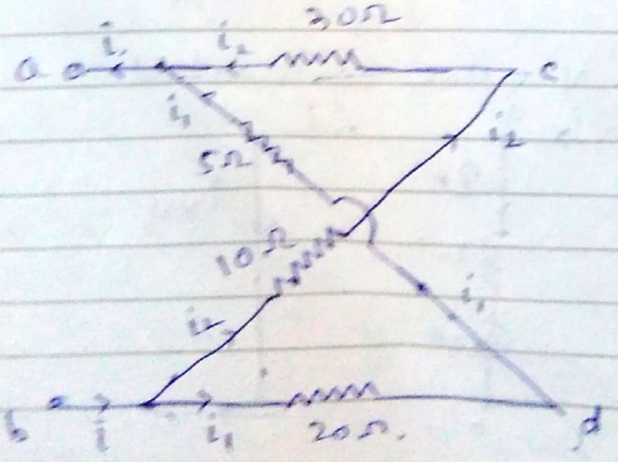
$\therefore\ 4 - \dfrac{V_{ab}}{10} = \dfrac{2V_{ab}}{10} + 2$

$\therefore\ 2 = \dfrac{3V_{ab}}{10}$

$\therefore\ V_{ab} = 6.66\ V.$

$I_{xy} = \dfrac{6.66}{5} = 1.33\ A.$

Que find Vab. so, that the voltage across 10Ω resister is 45 V also find the drop across 5Ω resistor



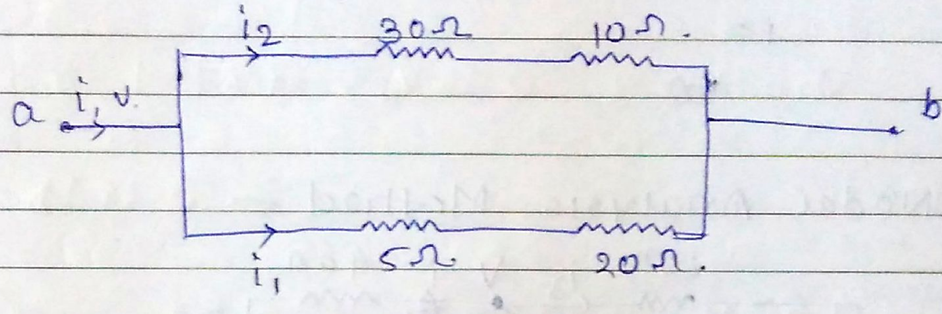
$$i_2 = \frac{45}{10} = 4.5\,A.$$

and $\quad V_2 = 30(4.5) = 135\,V$

and $\quad V = V_1 + V_2$

$\quad = 45 + 135$

$\therefore V_1 = 180\,V$



$$R_T = \frac{(40)(25)}{40+25} = \frac{1000}{65} = 15.38\,\Omega$$

so, $\quad i = \frac{V}{R_T} = \cancel{15.38} \quad \frac{180}{15.38}\,A$

$\therefore i = 11.7\,A.$

so, $\quad i_1 = 7.2\,A.$

so, $\quad V_5 = i_1(5)$

$\therefore V_5 = 36\,V.$

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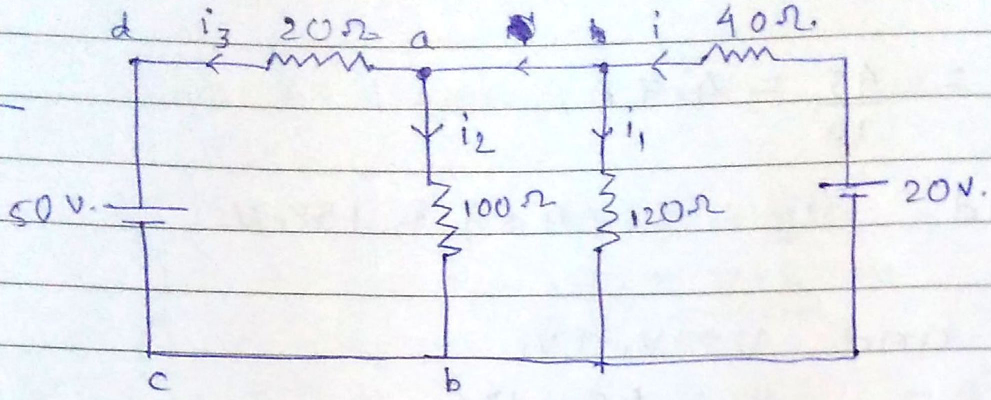
Que

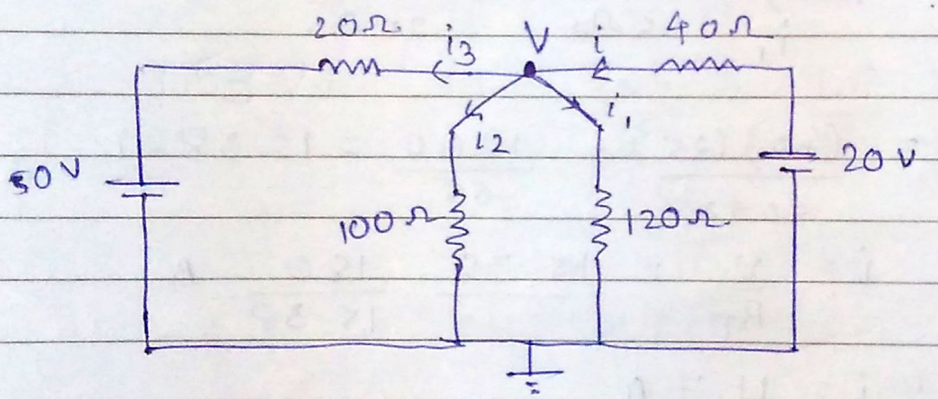


→ ~~At b node~~, ~~for~~ loop ~~abcd~~,

~~i=~~

~~50~~

⇒ Nodal Analysis Method —



$$\frac{20-V}{40} = \frac{V}{120} + \frac{V}{100} + \frac{V-50}{20}$$

$$\therefore 0.5 - \frac{V}{40} = \frac{V}{120} + \frac{V}{100} + \frac{V}{20} - 2.5$$

$$\therefore 3 = \frac{V}{120} + \frac{V}{100} + \frac{V}{20} + \frac{V}{40}$$

$$\therefore \underline{V = 32V}$$

$i_T = i_1 + i_2 + i_3$.

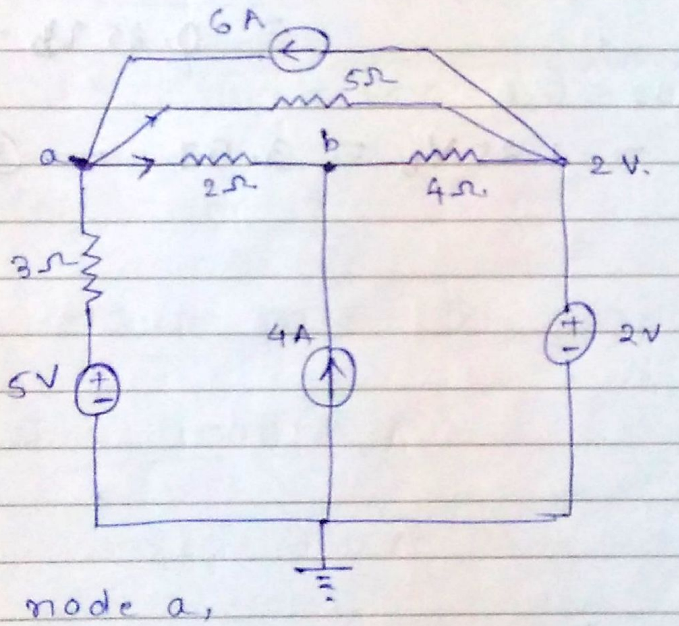
so. $i_1 = \frac{V}{120} = \frac{32}{120} = 0.266$ A.

$i_2 = \frac{V}{100} = \frac{32}{100} = 0.32$ A.

$i_3 = \frac{V-50}{20} = -0.9$ A

$\therefore i = -0.314$ A.

Que



at perticular node we have to assume them at higher potential

→ for node a,

$$\frac{V_a-5}{3} + \frac{V_a-V_b}{2} + \frac{V_a-2}{5} - 6 = 0. \longrightarrow (1).$$

→ for node b,

$$\frac{V_b-V_a}{2} + \frac{V_b-2}{4} - 4 = 0 \longrightarrow (2)$$

→ solving eq. (1) and eq. (2),

$$\therefore \frac{V_a-5}{3} + \frac{V_a-V_b}{2} + \frac{V_a-2}{5} - 6$$

$$= \frac{V_b-V_a}{2} + \frac{V_b-2}{4} - 4 = 0$$

$$\therefore 2\left(\frac{V_a-V_b}{2}\right) + \frac{V_a-5}{3} + \frac{V_a-2}{5} = \frac{V_b-2}{4} + 2$$

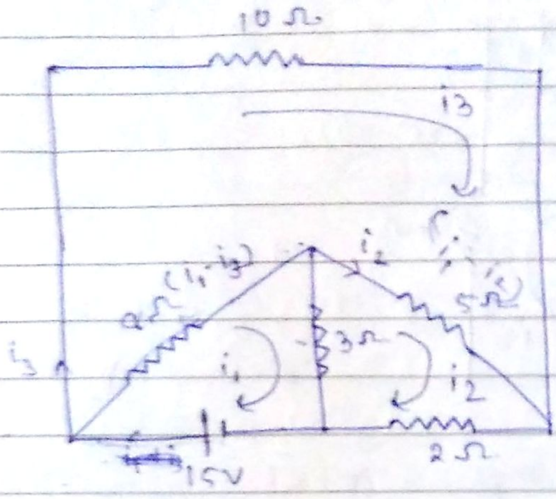
$$\therefore V_a - V_b + 0.33V_a - 1.67 + 0.2V_a - 0.4$$

$$= 0.25V_b - 0.5 + 2$$

$$\therefore 1.53V_a - 1.25V_b = 3.57 \quad \text{—— (3)}$$

⇒ Mess analysis method –

Que



i_1, i_2 and i_3 are not branch currents. They are loop currents.

for loop-1

$$15 - 8(i_1 - i_3) - 3(i_1 - i_2) = 0. \quad \text{--- (1)}$$

for loop-2

$$-3i_1 + 10i_2 - 5i_3 = 0 \quad \text{--- (2)}.$$

for loop-3

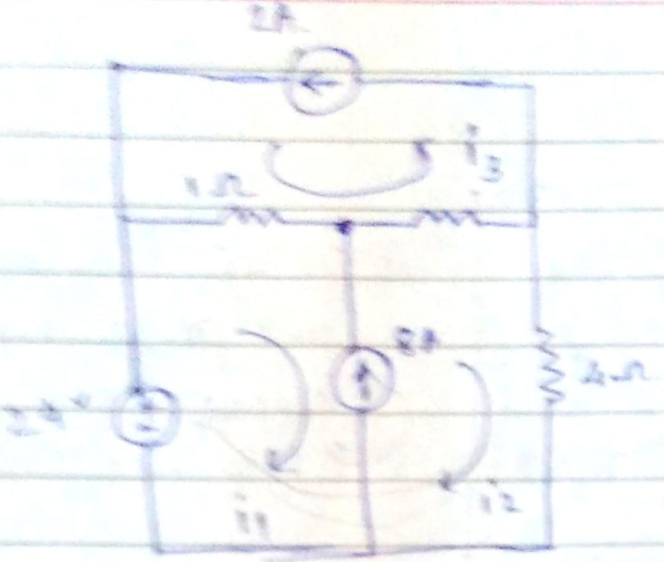
$$-8i_1 - 5i_2 + 23i_3 = 0. \quad \text{--- (3)}.$$

$\therefore i_1 = 2.63$ A

$\therefore i_2 = 1.4$ A

$\therefore i_3 = 1.22$ A.

Que.



$P_{4\Omega} = ?$

→ Here. $i_3 = 2A$

$i_2 - i_1 = 8A$

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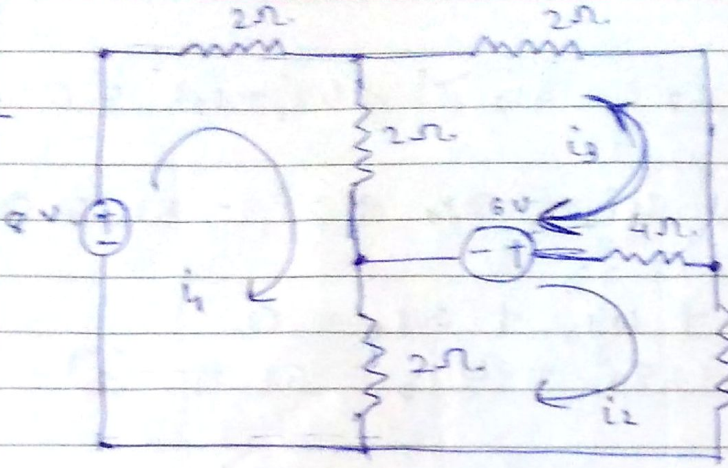
Que.



$I_{4\Omega} = ?$

$$-8 + 2(i_1 - i_2) + 2(i_1 \mp i_3) + 2i_1 = 0$$

$$\therefore -8 + 2i_1 - 2i_2 + 2i_1 + 2i_3 + 2i_1 = 0$$

$$\therefore -8 + 6i_1 - 2i_2 + 2i_3 = 0$$

$$\therefore 6i_1 - 2i_2 + 2i_3 = 8 \quad \text{--- (1)}$$

$$6 + 4(-i_2 - i_3) - 2i_2 + 2(i_1 - i_2) = 0$$

$$6 - 4i_2 - 4i_3 - \cancel{2i_2} + 2i_1 - \cancel{2i_2} = 0$$

$$\cancel{\therefore 2i_1 + 4i_3 = -6 \quad \text{--- (2)}}$$

$$6 \cancel{= 4(i_2 - i_3)}$$

$$\therefore -8i_2 - 4i_3 + 2i_1 + 6 = 0$$

$$\therefore 8i_2 + 4i_3 - 2i_1 = 6 \quad \text{--- (2)}$$

$$-8 + 2(i_1 - i_2) + 2(i_1 - i_3) + 2i_1 = 0$$

$$\therefore -8 + 2i_1 - 2i_2 + 2i_1 - 2i_3 + 2i_1 = 0$$

$$\therefore -8 + 6i_1 - 2i_2 - 2i_3 = 0$$

$$\therefore 6i_1 - 2i_2 - 2i_3 = 8 \quad \text{--- (1)}$$

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$\rightarrow \quad 6 + 4(i_3 - i_2) - 2i_2 + 2(i_1 - i_2) = 0$

$\therefore \; 6 + 4i_3 - 4i_2 - 2i_2 + 2i_1 - 2i_2 = 0$

$\therefore \; 6 - 8i_2 + 4i_3 + 2i_1 = 0$

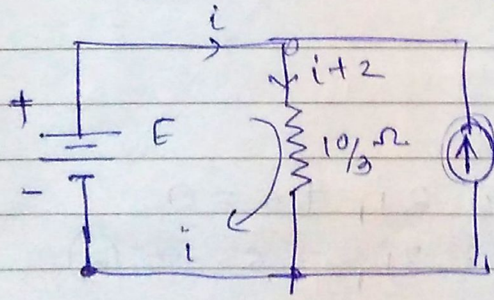
$\therefore \; -2i_1 + 8i_2 - 4i_3 = 6 \quad \text{—— (2)}$

$\rightarrow \quad 6 + 4(i_3 - i_2) + 2i_3 + 2(i_3 - i_1) = 0$

$\therefore \; 6 + 4i_3 - 4i_2 + 2i_3 + 2i_3 - 2i_1 = 0$

$\therefore$

Que. find the value of E if the power supplied by the current source is double that of the supplied by the battery.



$\rightarrow$ Here, power supplied by battery $P = VI$
$= E(i)$.

and power supplied by current $= E(2)$

$\therefore \; 2[Ei] = E(2)$.

$\therefore \; i = 1 \quad \text{—— (1)}$.

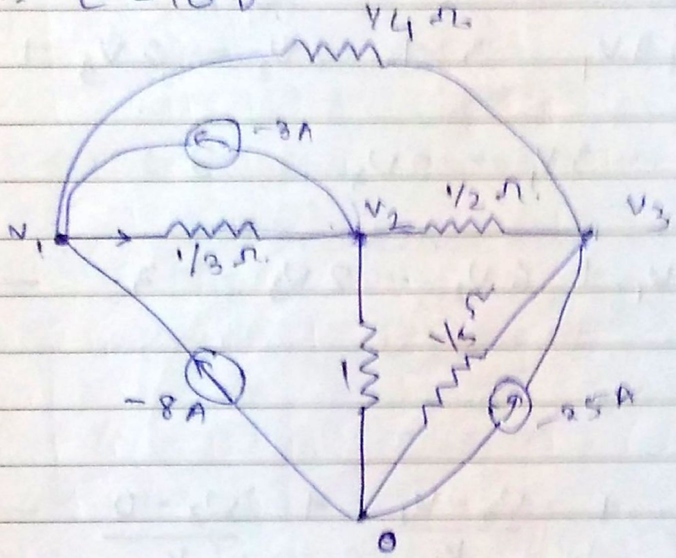
$$E - \frac{10}{3}(i+2) = 0.$$

$$\therefore E = \frac{10}{3}(i+2)$$

$$= \frac{10}{3}(3)$$

$$\therefore E = 10\,V$$

Que.



KCL at node V_1,

$$\frac{V_1 - V_2}{1/3} - (-8) - (-3) + \frac{V_1 - V_3}{1/4} = 0$$

$$\therefore 3(V_1 - V_2) + 11 + 4(V_1 - V_3) = 0$$

$$\therefore 3V_1 - 3V_2 + 4V_1 - 4V_3 + 11 = 0$$

$$\therefore 7V_1 - 3V_2 - 4V_3 = -11 \quad \text{——} \; (1).$$

→ at node v_2,

$$\frac{v_2 - v_1}{1/3} - 3 + \frac{v_2 - v_3}{1/2} + \frac{v_2 - 0}{1} = 0$$

$\therefore 3(v_2 - v_1) - 3 + 2(v_2 - v_3) + v_2 = 0$

$\therefore 3v_2 - 3v_1 - 3 + 2v_2 - 2v_3 + v_2 = 0$

$\therefore 6v_2 - 3v_1 - 2v_3 = 3$

$\therefore -3v_1 + 6v_2 - 2v_3 = 3 \quad \text{—— (2)}$

→ at node v_3,

$$\frac{v_3 - v_2}{1/2} + \frac{v_3 - v_1}{1/4} + \frac{v_3 - 0}{1/5} - (-25) = 0$$

$\therefore 2(v_3 - v_2) + 4(v_3 - v_1) + 5(v_3) = -25$

$\therefore 2v_3 - 2v_2 + 4v_3 - 4v_1 + 5v_3 = -25$

$\therefore 11v_3 - 4v_1 - 2v_2 = -25$

$\therefore 4v_1 + 2v_2 - 11v_3 = 25 \quad \text{—— (3)}$

$v_1 = -6.85\ V$

$v_2 = -4.8\ V$

$v_3 = -5.63\ V$

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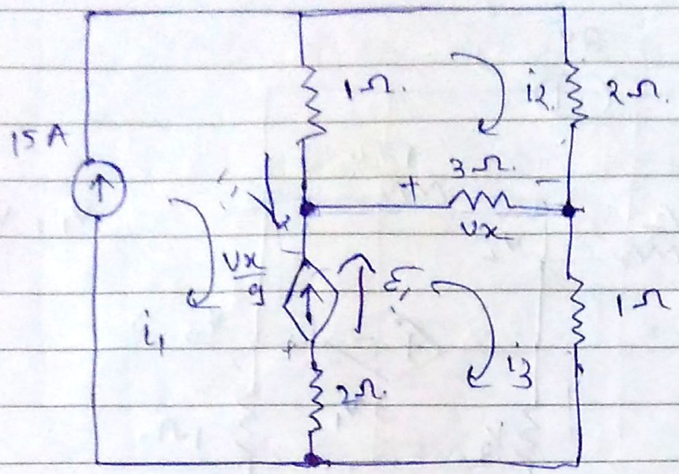
Que.



For ~~supermesh~~, $i_1 = 15$ — (1)

$V_x = 3(i_3 - i_2)$ — (2)

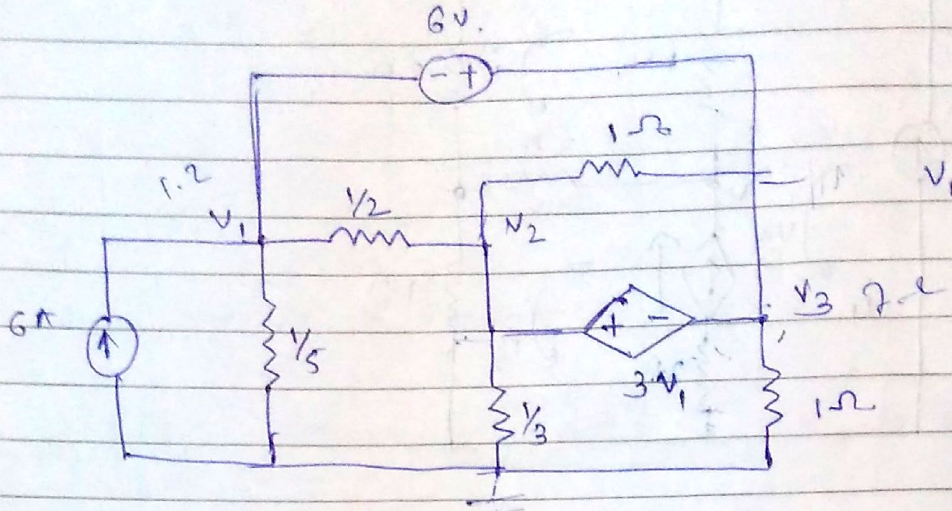
$\frac{V_x}{9} = i_3 - i_1$ — (3)

$i_2 + 2i_3 = 45$ — (4) ($\because$ by putting V_x in eq. (3))

$6i_2 - 3i_3 = 15$ — (5)

$i_2 = 11$ A
$i_3 = 17$ A

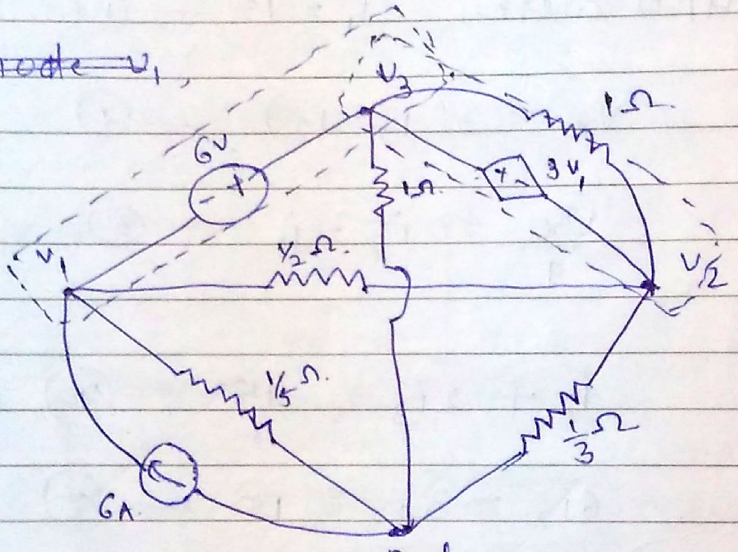
Que



$V_1, V_2, V_3 = ?$

→ ~~At node v_1~~,

Example of SuperNode.



→ At node 1-3,

$$\frac{v_1 - 0}{1/5} - 6 + \frac{v_1 - v_2}{1/2} + \frac{v_3}{1} = 0$$

$$\therefore \; 7v_1 - 2v_2 + v_3 = 6 \quad \text{——} \; (1)$$

→ At node 3-2,

$$\frac{v_2}{1/3} + \frac{v_2 - v_1}{1/2} + \frac{v_3}{1} = 0$$

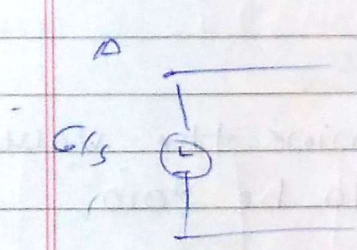
$\therefore -2v_1 + 5v_2 + v_3 = 0$ —— (2)

→ $3v_1 + v_2 - v_3 = 0$ —— (3)

$\therefore v_1 = -0.59 \text{ V}$

$\therefore v_2 = 0.098 \text{ V}$

$\therefore v_3 = -1.672 \text{ V}$



$v_3 = v_1 + 6$

$= \frac{6}{5} + 6$

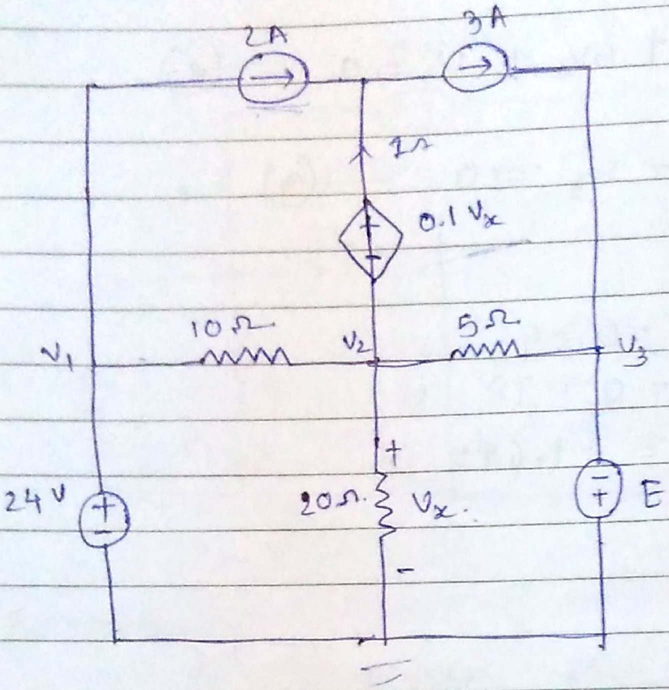
$V_3 = 7.2 \text{ V}$

$S_p = 36$

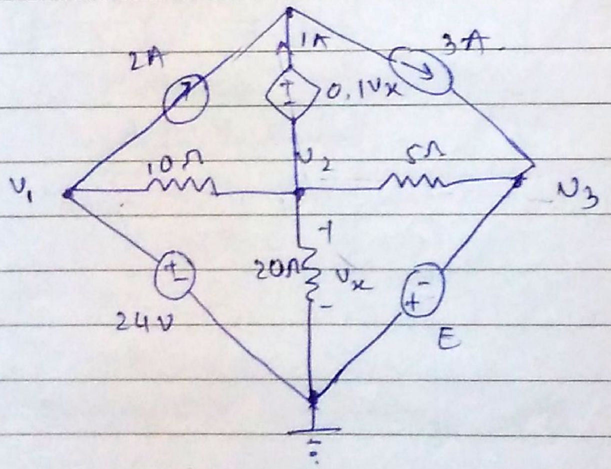
$7.2 + 3.6$

10.8

Que.



→ Using Nodel analysis determine the value of E, which causes V_x to be zero.



→ At node V_2, $(V_2 = V_x)$

$$\cancel{V_1 - 24} \quad \frac{V_x - V_1}{10} + \frac{V_x - V_3}{5} + \frac{V_x - 0}{20} + \cancel{V_x - 0.1V_x}\ 0.1V \ = 0$$

$$\therefore \frac{V_x - 24}{10} + \frac{V_x + E}{5} + \frac{V_x}{20} + 0.1V = 0$$

$\therefore \frac{V_x}{5} - 2.4 + \frac{V_x}{5} + E/5 + \frac{V_x}{20} = 0$

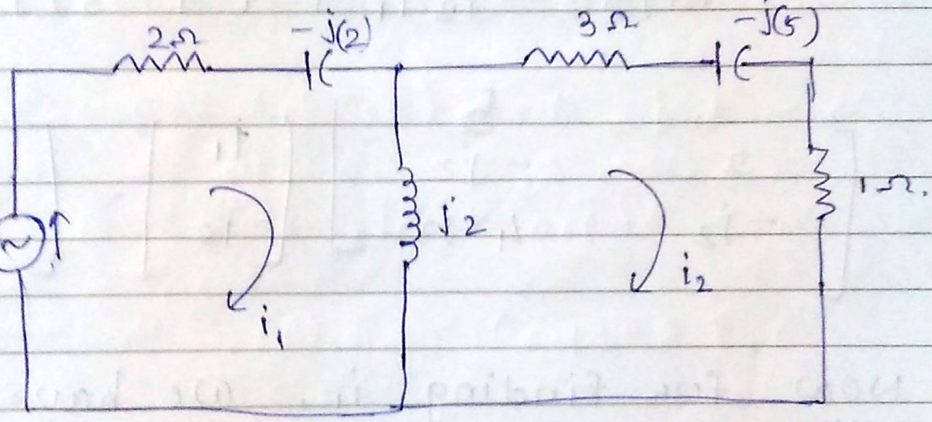
$\therefore \frac{8V_x}{20} + \frac{V_x}{20} + E/5 = 2.4$

$\therefore \frac{9V_x}{20} + E/5 = 2.4$

$\therefore E = 12V.$

$\therefore E = 7V. \quad (\because V_x = 0).$

Que.



→ Using Mesh analysis,

$10 - 2i_1 + i_1 j2 + j_2(i_2 - i_1) = 0$

$\therefore 10 - 2i_1 + \cancel{i_1 j2} + i_2 j2 - \cancel{i_1 j2} = 0$

$\therefore 10 - 2i_1 + i_2 j2 = 0$ —— (1)

$\therefore 2i_1 - i_2 j2 = 10$ —— (1)

→ $-3i_2 + i_2 j5 - i_2 + j_2(i_1 - i_2) = 0$

$\therefore -3i_2 + i_2 j5 - i_2 + i_1 j2 - i_2 j2 = 0$

$\therefore -4i_2 + i_2 j5 + i_1 j2 - i_2 j2 = 0.$ —— (2)

~~from eq.(1),~~

$$\cancel{i_1 = \frac{10 + i_2 j_2}{2}} \quad — ③.$$

→ ~~Putting the value of i_1 in eq.(2),~~

$\therefore$ ~~$-4i_2$~~

$$\therefore 4i_2 + i_2 j_2 - i_2 j5 - i_1 j2 = 0$$

$$\therefore -j2\, i_1 + (4 - j3)\, i_2 = 0 \quad —($$

$$\begin{bmatrix} 2 & -j2 \\ -j2 & 4-j3 \end{bmatrix} \begin{bmatrix} i_1 \\ i_2 \end{bmatrix} = \begin{bmatrix} 10\angle 0^\circ \\ 0 \end{bmatrix}$$

→ Now for finding i_1, we have to replace 1st column with voltage.

so,
$$\frac{\begin{vmatrix} 10\angle 0^\circ & -j2 \\ 0 & 4-j3 \end{vmatrix}}{\begin{vmatrix} 2 & -j2 \\ -j2 & 4-j3 \end{vmatrix}} = i_1$$

$$\therefore i_1 = \frac{(10\angle 0^\circ)(4-j3)}{(8-2j3) - j2^2} = \cancel{\frac{40\angle 0^\circ - (10\angle 0^\circ)}{8-2j3 - j2^2}}$$

$\therefore i_1 = \dfrac{(10+0i)(4-j3)}{(8-2j3) - j2^2} = \dfrac{41.23 \angle -14.03}{(8-2j)+1}$

$= \dfrac{41.23 \angle -14.03}{9-2j}$

$= \dfrac{41.23 \angle -14.03}{9.22 \angle -12.52}$

→ for $i_2 = \dfrac{\begin{vmatrix} 2 & 10\angle 0^\circ \\ -j2 & 0 \end{vmatrix}}{\begin{vmatrix} 2 & -j2 \\ -j2 & 4-j3 \end{vmatrix}}$

$i_1 = 3.7 \angle -10.22\ A, \quad i_2 = 1.5 \angle -63^\circ$.

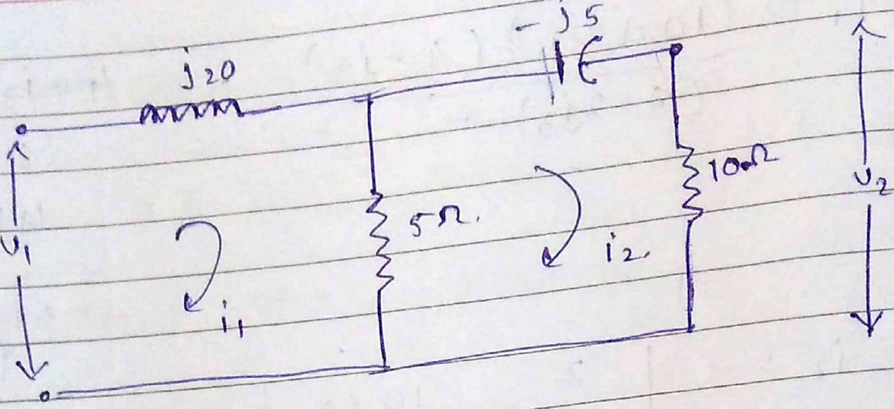
→ Power supplied by the source –

$P = VI_1 \cos\theta$.

$= 10 \times 3.7 \times 0.984$

$\therefore P = 36.41$ watts.

Que.



$$\frac{V_2}{V_1} = ?$$

→ for 1^{st} Mesh –

$$v_1 - I_1 j20 + 5(I_2 - I_1) = 0.$$

$$\therefore v_1 - I_1 j20 + 5I_2 - 5I_1 = 0$$

$$\therefore I_1(5 + j20) - I_2(5) = v_1 \quad \text{—— (1).}$$

→ for 2^{nd} mesh –

$$v_2 + I_2 j5 + 5(I_2 - I_1) + 10 I_2 = 0.$$

$$\therefore 15 I_2 - 5I_1 + I_2 j5 = -v_2 \quad \text{—— (2).}$$

$$\begin{bmatrix} 5 + j20 & -5 \\ -5 & 15 + j5 \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \end{bmatrix} = \begin{bmatrix} v_1 \\ -v_2 \end{bmatrix}$$

$$\therefore I_2 = \frac{\begin{vmatrix} 5+j20 & v_1 \\ -5 & 0 \end{vmatrix}}{\begin{vmatrix} 5+j20 & -5 \\ -5 & 15-j5 \end{vmatrix}}$$

$$\therefore I_2 = \frac{5V_1}{(5+j20)(15-j5) - 25}$$

$$\therefore I_2 = \frac{5V_1}{\cancel{(76.65+10i)} - 25} = \frac{5V_1}{75+300j-25j-100j^2}$$

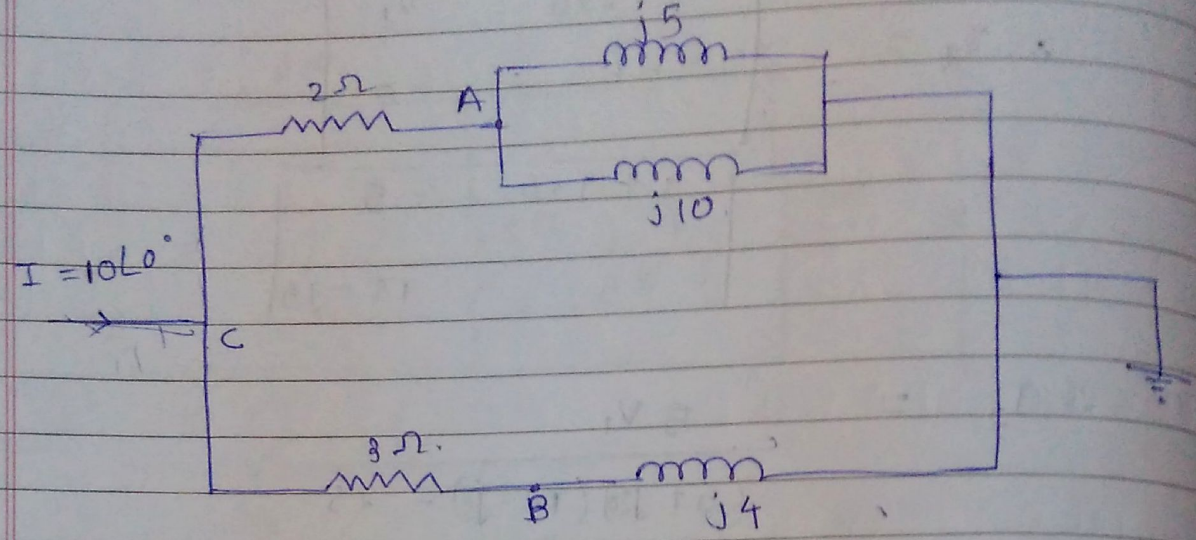
$$\therefore I_2 = \frac{5V_1}{51.97 \angle 11.093} = \frac{5V_1}{150+j275}.$$

$$\therefore I_2 = 0.096 \angle -11.093 \text{ A}.$$

and, $v_2 = 10 I_2$. (from figure).

$$\therefore \frac{v_2}{v_1} =$$

Que.



$V_{AB} = ?$

Here, at node A,

Resister $R_A = \dfrac{j5 \cdot j10}{j5 + j10} = \dfrac{(5\angle 90^\circ)(10\angle 9}{5\angle 90^\circ + 10\angle 9}$

$\therefore R_A = \dfrac{50\angle 180^\circ}{15\angle 90^\circ}$

$\therefore R_A = 3.33\,\Omega \angle 90^\circ$

$\therefore R_A = 0 + 3.33j$

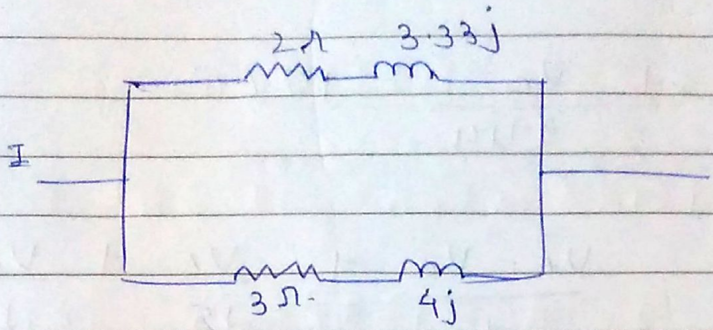
→ Resister $R_1 = 2 + 3.33j\ \Omega$

→ And for B node, Resister $R_1' = 3 + 4j\ \Omega$

$R = \dfrac{(2+3.33j)(3+4j)}{(2+3.33j)+(3+4j)} = \dfrac{19.422\angle 112.}{8.872\angle 55.}$

$= 2.188\angle 56.44$

$\therefore R = 1.21 + 1.824j$



so, $V = IR$

$= (10\angle 0^{\circ})(2.188 \angle 56.44)$

$= 21.88\,V \angle 56.44$

$I_1 = V/R_1$

$= \frac{21.88 \angle 56.44}{2 + 3.33j}$

$\therefore I_1 = 5.632 \angle -2.57\ A$

$I_2 = V/R_2$

$= \frac{21.88 \angle 56.44}{3+4j}$

$\therefore I_2 = 4.376 \angle 3.309\,A$

at point A, $V_A = 5.632 \times 2 = 11.264 \angle -2.57\,V$

at

At node c, $\frac{V_C - V_A}{2} + \frac{V_C}{3+j4} = 10 \angle 0°$

At node A, $\frac{V_A - V_C}{2} + \frac{V_A}{j5} + \frac{V_A}{j10} = 0$

$\rightarrow \therefore 0.5 V_C - 0.5 V_A + (0.12 - 0.16j) V_C = 10 + 0i$

$\therefore 0.5 V_C - 0.5 V_A + 0.12 V_C - (0.16j) V_C = 10 + 0i$

$\therefore 0.62 V_C - 0.5 V_A - (0.16j) V_C = 10 + 0i$

$\therefore (0.62 - 0.16j) V_C - 0.5 V_A = 10$ — (1)

$\rightarrow 0.5 V_A - 0.5 V_C + (0 - 0.2j) V_A + (0 - 0.1j) V_A = 0$

$\therefore (0.5 - 0.3j) V_A - 0.5 V_C = 0$ — (2)

$$\begin{bmatrix} -0.5 & 0.62 - 0.16j \\ 0.5 - 0.3j & -0.5 \end{bmatrix} \begin{bmatrix} V_A \\ V_C \end{bmatrix} = \begin{bmatrix} 10 \\ 0 \end{bmatrix}$$

$\therefore \cancel{0.25 - (0.5 - 0.3j)(0.62 - 0.16)}$

$$\therefore V_A = \frac{\begin{vmatrix} 10 & 0.62 - 0.16j \\ 0 & -0.5 \end{vmatrix}}{\begin{vmatrix} -0.5 & 0.62 - 0.16j \\ 0.5 - 0.3j & -0.5 \end{vmatrix}}$$

$$= \frac{-5}{0.25 - (0.262 - 0.266i)}$$

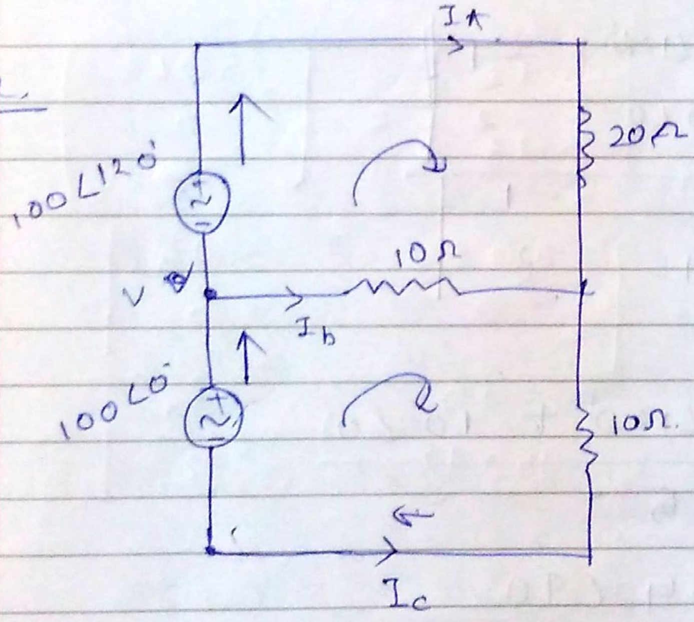
$\therefore V_A = 18.777 \angle 87.41$

$\therefore V_C = 21.8 \angle 56.4 \text{ V}.$

oi

and $V_B = \dfrac{V_C \cdot j4}{(3 + j4)}$

Que.



$I_A, I_B, I_C = ?$

=0.

→ for first loop,

$100\angle120° - 20 I_A + 10(I_B - I_A) = 0$

$\therefore 100\angle120° = 20 I_A - 10 I_B + 10 I_A$

$\therefore 100\angle120° = 30 I_A - 10 I_B$

$\therefore 10\angle120° = 3 I_A - I_B$ ——— ①.

→ for loop - 2,

$$100\angle 0^\circ + 10(I_A - I_B) - 10 I_B = 0.$$

$$\therefore 100 = 20 I_B - 10 I_A$$

$$\therefore 10 = 2 I_B - I_A \quad \text{—— (2)}$$

$$\begin{bmatrix} 3 & -1 \\ -1 & 2 \end{bmatrix} \begin{bmatrix} I_A \\ I_B \end{bmatrix} = \begin{bmatrix} 10\angle 120^\circ \\ 10\angle 0^\circ \end{bmatrix}$$

$$\therefore I_A = \frac{\begin{vmatrix} 10\angle 120^\circ & -1 \\ 10\angle 0^\circ & 2 \end{vmatrix}}{\begin{vmatrix} 3 & -1 \\ -1 & 2 \end{vmatrix}}$$

$$\therefore I_A = \frac{20\angle 120^\circ + 10\angle 0^\circ}{5}$$

$$\therefore I_A = 3.464\angle 90^\circ$$

$$\therefore I_B = \frac{\begin{vmatrix} 3 & 10\angle 120^\circ \\ -1 & 10\angle 0^\circ \end{vmatrix}}{\begin{vmatrix} 3 & -1 \\ -1 & 2 \end{vmatrix}}$$

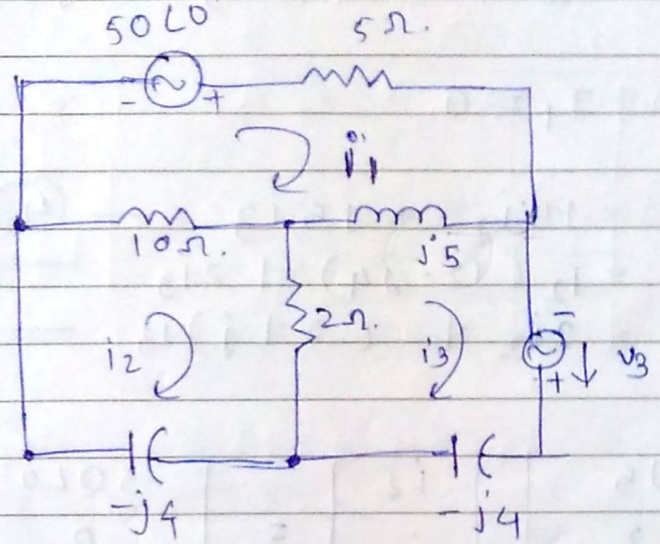
$$= \frac{30\angle 0 + 10\angle 120^\circ}{5} = 5.29\angle 19.10 \text{ .9}^\circ \text{ A.}$$

and $I_C = 5 - I_B = 5.3$

$\rightarrow$ $\cancel{I_A + I_B + I_C = 0}$

$\therefore \cancel{\frac{V + 100\angle 120^\circ}{20} + \frac{V}{10} + \frac{V - 100\angle 0^\circ}{10}}$

Que



when $i_1 = 0$,
$v_3 = ?$

$\rightarrow$ $50\angle 0^\circ - 5i_1 + j5(i_3 - i_1) + 10(i_2 - i_1) = 0$

$\therefore 50\angle 0^\circ - 15i_1 + j5i_3 - j5i_1 + 10i_2 = 0$

$\therefore 50\angle 0^\circ = 15i_1 - 10i_2 + j5i_1 - j5i_3$

$\therefore 50\angle 0^\circ = (15 + j5)i_1 - 10i_2 - j5i_3$ —— (1)

$\rightarrow$ $10(i_1 - i_2) + 2(i_3 - i_2) + j4i_2 = 0$

$\therefore 10i_1 - 12i_2 + 2i_3 + j4i_2 = 0$

$\therefore 10i_1 - i_2(12 - j4) + 2i_3 = 0$ —— (2)

$\therefore \cancel{10i_1}$

·9°. A.

$\rightarrow \quad 2(i_2 - i_3) + j5(i_1 - i_3) + V_3 + j4 i_3 = 0$

$\therefore V_3 = -2i_2 + 2i_3 - j5 i_1 + j5 i_3 - j4 i_3$

$\therefore V_3 = -2i_2 + (2+j) i_3 - j5 i_1 \quad \text{--- (3)}$

$\rightarrow$ Now for $I_1 = 0$

$50\angle 0^\circ = -10 i_2 - j5 i_3 \quad \text{--- (4)}$

$0 = -i_2 (12 - j4) + 2 i_3 \quad \text{--- (5)}$

$V_3 = -2i_2 + (2+j) i_3 \quad \text{--- (6)}$

$$\begin{bmatrix} -10 & -j5 \\ -(12-j4) & 2 \\ \cancel{-2} & \cancel{2+j} \end{bmatrix} \begin{bmatrix} i_2 \\ i_3 \end{bmatrix} = \begin{bmatrix} 50\angle 0^\circ \\ 0 \\ \cancel{V_3} \end{bmatrix}$$

$$\therefore i_2 = \frac{\begin{vmatrix} 50\angle 0^\circ & -j5 \\ 0 & 2 \end{vmatrix}}{\begin{vmatrix} -10 & -j5 \\ j4 - 12 & 2 \end{vmatrix}}$$

$$\therefore i_2 = \frac{100}{-20 + j5(j4 - 12)}$$

$$= \frac{100}{-20 + 20j - j5(12)}$$

$$= \frac{100}{-20 + 20j - 60j}$$

$$\therefore i_2 = \frac{100}{-20 - 40j} = 2.236 \angle 116.56^\circ$$

and $i_3 = \dfrac{\begin{vmatrix} -10 & 50\angle 0 \\ j4-12 & 0 \end{vmatrix}}{-20-40j}$

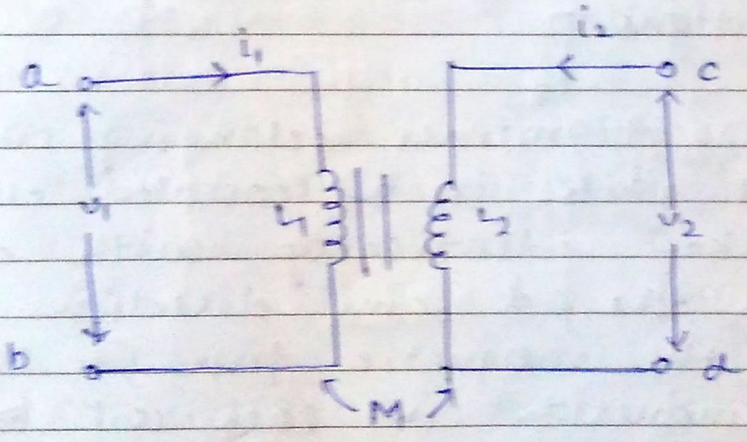
$$= -\frac{50(j4-12)}{-20-40j}$$

$$= \frac{-200j+600}{-20-40j}$$

$=$

→ $V_3 = 16.30V \angle 11.63.$

⇒ Coupled circuits —



→ Two circuits are said to be coupled when energy transfer takes place from one circuit to another circuit by mutual induction.

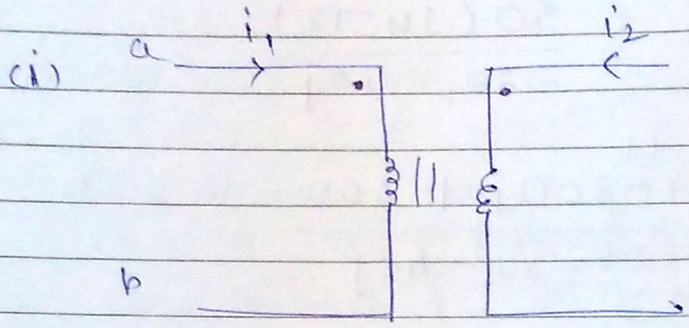
self induced voltage

Mutually induced voltage

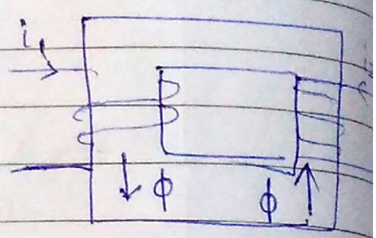
so, $v_1 = L_1 \cdot \frac{di_1}{dt} \pm M \cdot \frac{di_2}{dt}$

$v_2 = L_2 \cdot \frac{di_2}{dt} \pm M \cdot \frac{di_1}{dt}$

(i)



⇒



so, $v_1 = L_1 \cdot \frac{di_1}{dt} + M \cdot \frac{di_2}{dt}$

otherwise (negative).

⇒ Dot conventions -

(i) If the two terminals belonging to different coils in a coupled circuit are marked identically with dots then for the ~~d~~ same direction of current, the magnetic flux of self and mutual induction in each coil ~~have~~ add together.

(ii) → If the current in one winding enters the dot mark and the current in other winding leaves the dot mark, the voltages due to self and mutual induction in any coil have opposite sign

(iii) If two coils are connected in series then,

$$L_{eq} = L_1 + L_2 \pm 2M.$$

⇒ Energy stored in a coupled circuit –

(i) $E = \frac{1}{2} L I^2$ (for one coil).

(ii) $E = \frac{1}{2} L_1 I_1^2 + \frac{1}{2} L_2 I_2^2 \pm M I_1 I_2$

(for coils connected in series)

⇒ Co-efficient of coupling –

It is defined as ~~differa~~ the fraction of total flux ~~fluxc~~ linking in coil denoted by K,

$$K = \frac{\phi_{12}}{\phi_1} = \frac{\phi_{21}}{\phi_2}$$ (ϕ_{12} = flux linking in coil 1 due to coil 2)

$\therefore \phi_{12} = \phi_{21} = K\phi_1 = K\phi_2$

$\therefore L_1 = \frac{N_1 \phi_1}{I_1}, \quad L_2 = \frac{N_2 \phi_2}{I_2}$

$$M_{12} = \frac{N_1 \phi_{12}}{I_2}$$

$$M_{21} = \frac{N_2 \phi_{21}}{I_1}$$

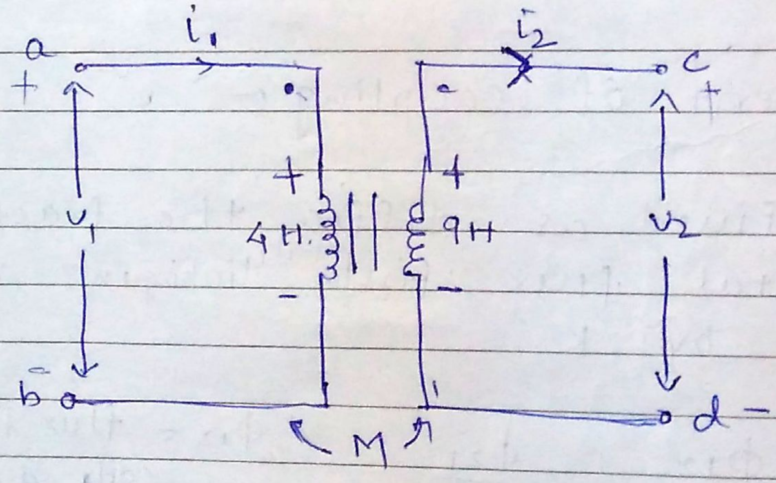
$$\therefore M_{12} \times M_{21} = \frac{N_1 N_2 \cdot \phi_{12} \cdot \phi_{21}}{I_1 I_2}$$

$$= \frac{K^2 N_1 N_2 \phi_1 \phi_2}{I_1 I_2}$$

$$\therefore M^2 = L_1 L_2 K^2$$

$$\therefore K = \frac{M}{\sqrt{L_1 L_2}}$$

Qu.



$i_1(t) = 5\cos(50t$

$i_2(t) = 2\cos(50t$

$K = 0.5$

find v_1, v_2 and total energy stored at $t = 0$.

(Here i_1 is entering in dotted terminal ~~but~~ & v_2 has positive reference at undotted ~~then~~ terminal so, (−). and v_1 is also negative ($\because$ i_2 has positive undotted

$$v_1 = L_1 \frac{dI_1}{dt} \mp M \cdot \frac{dI_2}{dt}$$

but $M = K\sqrt{L_1 L_2}$

$= 0.5\sqrt{4 \times 9}$

$\therefore M = 3\,H$

and, $\frac{di_1}{dt} = -5\sin(50t - 30) \cdot 50$

$\therefore \frac{di_1}{dt} = -250\sin(50t - 30^\circ)$

and $\frac{di_2}{dt} = -2\sin(50t - 30) \cdot 50$

$= -100\sin(50t - 30^\circ)$

so, $v_1 = 5\cos(50t - 30) \cdot \left[-250 \cdot \sin(50t - 30^\circ)\right]$

$+ 3 \cdot \left[-100\sin(50t - 30^\circ)\right]$

$= -1250\sin(50t - 30^\circ)\cos(50t - 30^\circ)$

$- 300\sin(50t - 30^\circ)$

$= -625\left[\sin(100t - 60^\circ) + \sin(0^\circ)\right]$

$- 300\sin(50t - 30^\circ)$

$\therefore v_1 = -625\sin(100t - 60^\circ) - 300\sin(50t - 30^\circ)$

$- 625\ V$

$= -625(-\sin 60) - 300(-\sin 30) - 625$

$= 541.26 + 150 - 625$

and $v_2 = L_2 \cdot \frac{dI_2}{dt} - M \cdot \frac{dI_1}{dt}$

$$\cancel{= 2\cos(50t - 30^\circ) \cdot [-100\sin(50t - 30^\circ)] - 3(-250\sin(50t - 30^\circ))}$$

$$\cancel{= 1.73(50) + 3(-125)}$$

$$= 9 \cdot [-100\sin(50t - 30)] - 3(-250\sin(50t - 30^\circ))$$

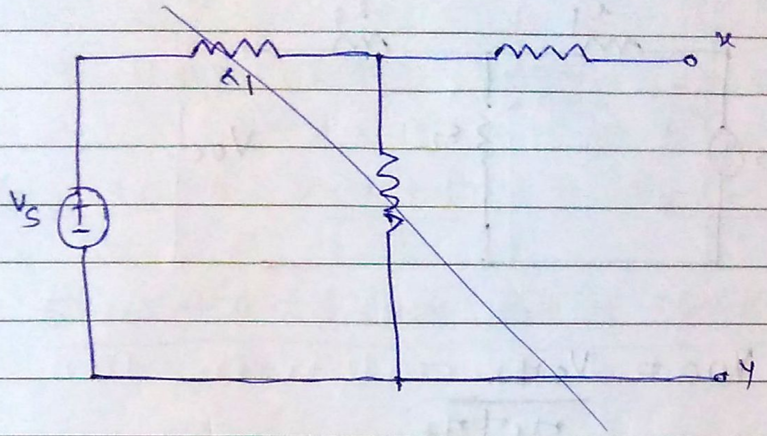
$$= 450 - 375$$

$\therefore v_2 = 75\,V$

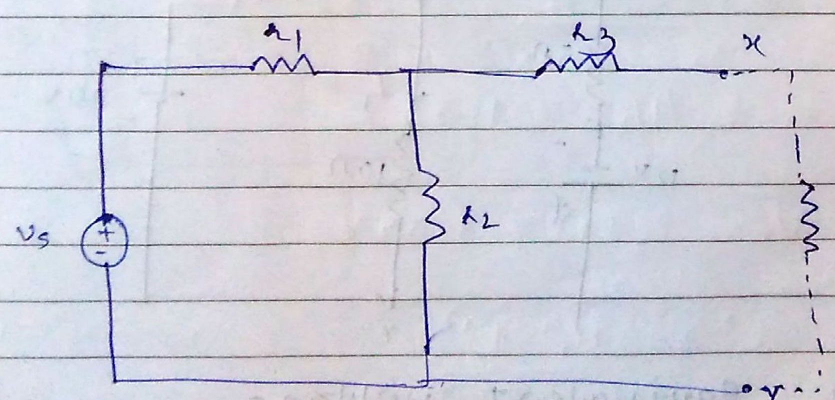
$\rightarrow$ and $v_1 = 4[-250\sin(50t - 30)]$

Network theorems.

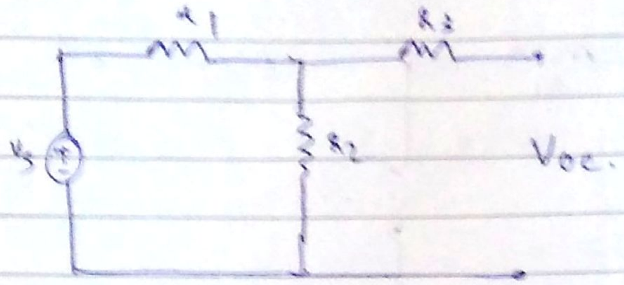
⇒ Thevenin's theorem –



→ Any linear Active Network consisting of independent and /or dependent sources and linear bylateral Network elements can be replaced by an equivalent circuit consisting of a voltage source in series with a resistance. The voltage source be the open circuit voltage across the open circuited load terminals and the resistance be equivalent resistance of the network looking through the open circuited load terminals.

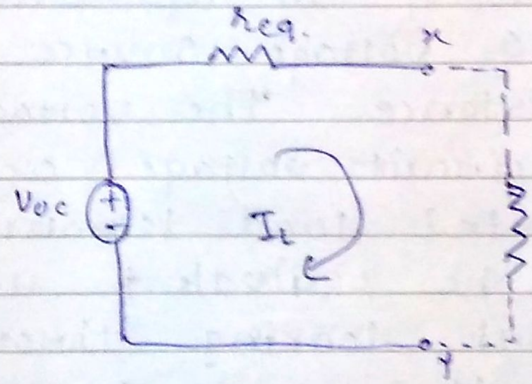


Remove Load,



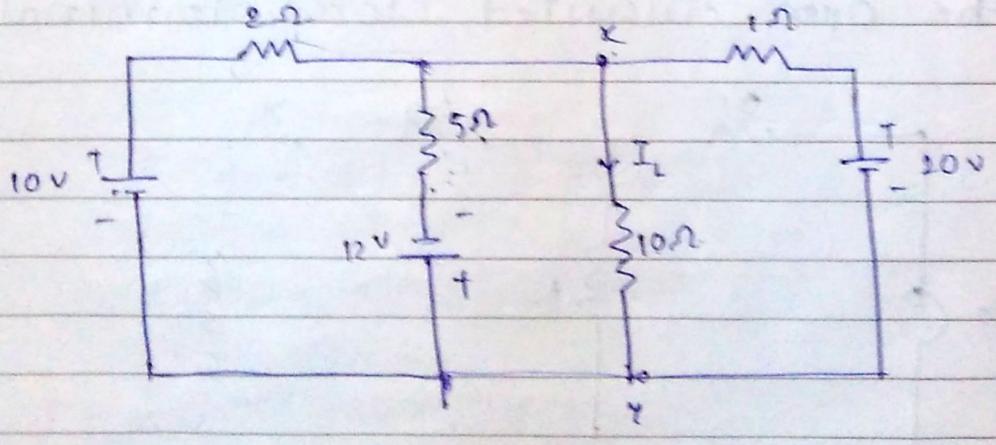
$$V_{oc} = \frac{V_s r_2}{r_1 + r_2}$$

$$r_{eq} = \frac{r_1 r_2}{r_1 + r_2} + r_3 .$$



$$I_L = \frac{V_{oc}}{r_{eq} + r_L}$$

Que.



Here equivalent voltage.
We will remove 10Ω Resistor

so. Open circuit voltage.

$$V_{xy} = \cancel{12 + \frac{10 \times 5}{7} = 19.14\ V.}$$

$$\frac{V_{xy} - 10}{2} + \frac{V_{xy} + 12}{5} + \frac{V_{xy} - 20}{1} = 0$$

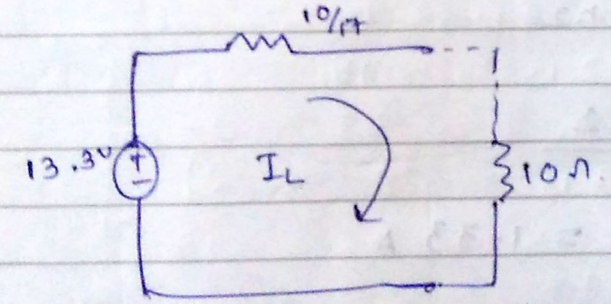
$$\therefore \frac{5V_{xy} - 50 + 2V_{xy} + 24 + 10V_{xy} - 200}{10} = 0$$

$$\therefore 17V_{xy} - 226 = 0$$

$$\therefore V_{xy} = 13.29\ v.$$

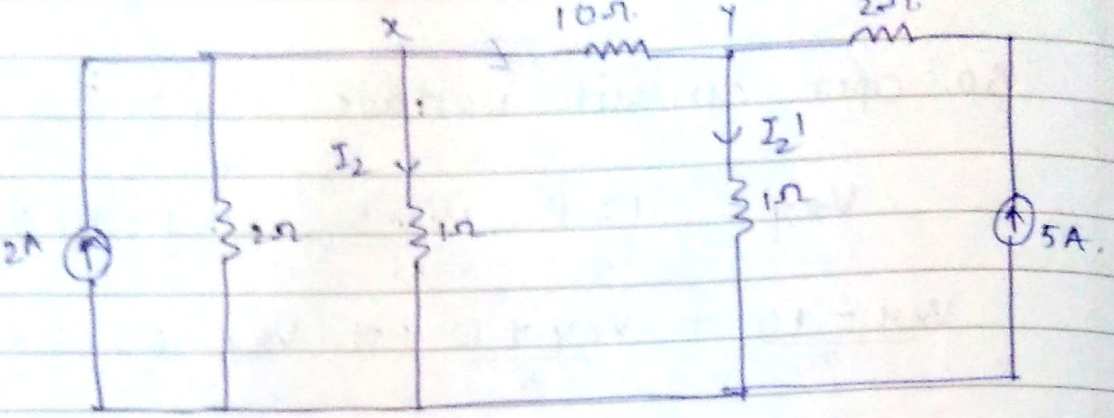
→ $$R_{eq} = \frac{\left(\frac{5 \times 2}{7}\right)(1)}{\frac{5 \times 2}{7} + 1}$$

$$\therefore R_{eq.} = 10/17\ \Omega.$$



$I_L = 1.256\ A.$

Que.



~~Now~~ find powerloss in 10Ω Resistor.

→ Now, we will find open circuit voltage.

$\cancel{R_{eq}} = \frac{2\times1}{3}$

$V_{xy} = V_x - V_y.$

by using current division rule,

$$I_2 = \frac{r_1 I}{r_1 + r_2}$$

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

$$\therefore I_2 = 4/3 = 1.33\ A$$

$$\therefore V_x = I_2(1) = 1.33\ V.$$

→ And $\cancel{I_2' = \frac{r_1' I'}{r_1' + r_2'}}$

$$\cancel{\therefore I_2' = \frac{2\times5}{3} = 10/3}$$

$$\therefore V_y = I_2'(1) = \cancel{3.33\ V}\ 5\ V$$

$\therefore V_{xy} = V_x - V_y$

$\therefore V_{xy} = -3.67\ V$

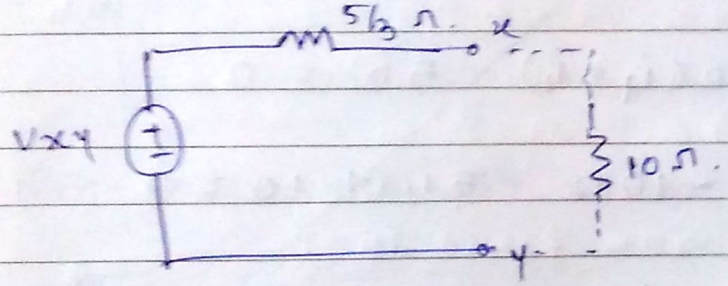
→ Here, we have to remove current source.

so, 2 and 1 Ω will be in parallel and another 1Ω will be in series

$$R_{eq} = \frac{1 \times 2}{3} + 1$$

$$= 2/3 + 1$$

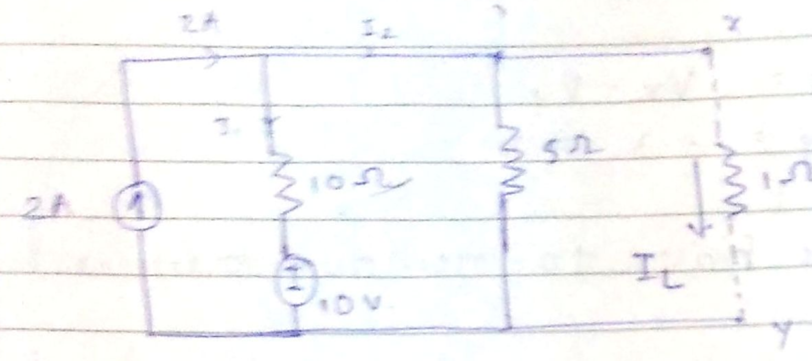
$$\therefore R_{eq} = 5/3\ \Omega.$$



$$I_L = \frac{-3.67}{11.66} = 0.3145\ A.$$

and $P_{10} = 0.99$ Watts.

Que.



→ Here we will find a open circuit voltage,

Here for first loop, KVL

~~10 + 10 I₁ = 2~~ —① $2 + 10(i_2 - i_1) - 10 = 0$

$\therefore -10 i_1 + 10 i_2 - 8 = 0$

$\therefore 10 i_1 - 10 i_2 = -8$

$\therefore 5 i_1 - 5 i_2 = -4$ —①

and for second loop, KVL

$10 + 10(i_1 - i_2) - 5 i_2 = 0$

$\therefore 10 i_1 - 10 i_2 - 5 i_2 + 10 = 0$

$\therefore 10 i_1 - 15 i_2 = -10$

$\therefore 2 i_1 - 3 i_2 = -2$ —②

$i_1 = 2$

$\therefore i_2 = 2A$

$\therefore V_{xy} = 10V$

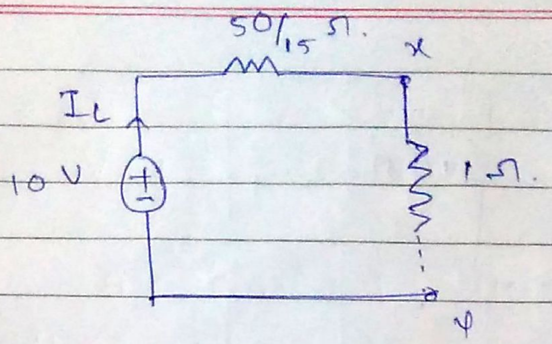
$$\frac{V_{xy} - 10}{10} + \frac{V_{xy}}{5} = 2$$

$\therefore V_{xy} = 10\,V$

and $R_{eq} = 10 \parallel 5$

$\therefore R_{eq} = \frac{50}{15}\,\Omega$

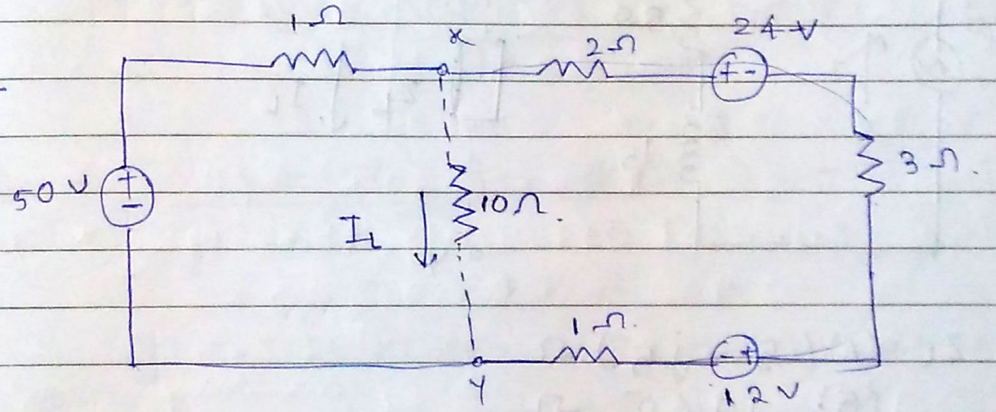
50,



$$10 - I_L\left(\frac{50}{15} + 1\right) = 0$$

$$\therefore I_L = \frac{10}{\frac{50}{15} + 1} = 2.30\ A.$$

<u>Que</u>



Here, Open circuit voltage,

$$\frac{V_{xy} - 50}{1} + \frac{V_{xy} - 24 - 12}{6} = 0$$

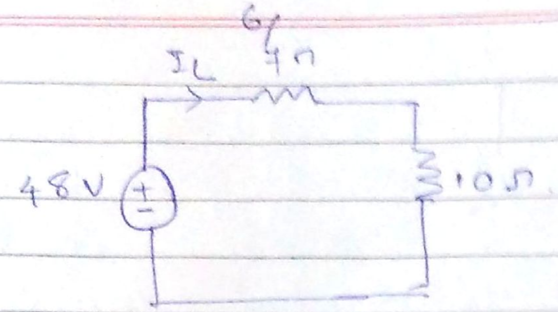
$$\therefore 6(V_{xy} - 50) + V_{xy} - 36 = 0$$

$$\therefore 7V_{xy} - 300 - 36 = 0$$

$$\therefore V_{xy} = 48\ V.$$

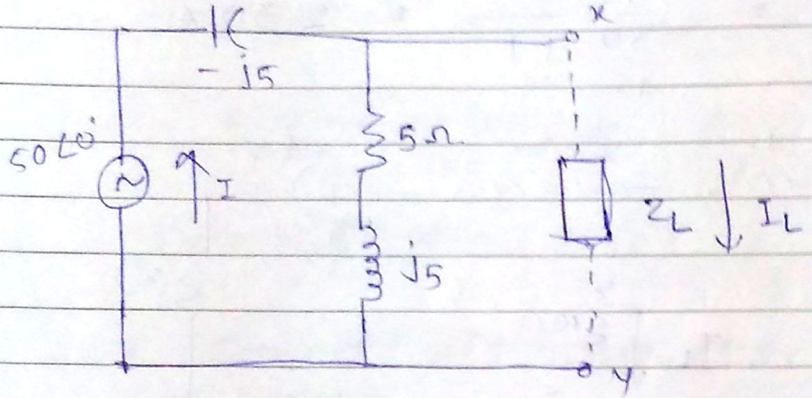
and $Req = \cancel{6}\ 2 + 3 + 1 \parallel 1$

$\therefore Req. = 6/7\ \Omega.$



$$\therefore I_L = \frac{48}{6/4 + 10} = 4.42\ A.$$

Que.



Z_L = (A) $(5 - j5)\ \Omega$

(B) $10\angle 0^\circ\ \Omega$.

Here, KVL for first loop,

$$50\angle 0^\circ - (-j5)I - 5I - j5(I) = 0$$

$$\therefore 50 + \cancel{I(j5)} - 5I - \cancel{j5(I)} = 0$$

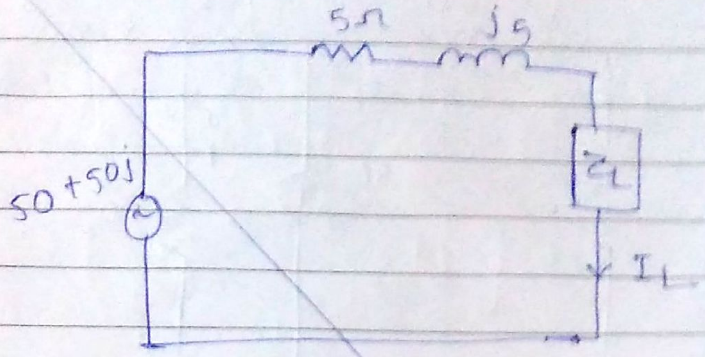
$$\therefore 50 = 5I$$

$$\therefore I = 10\ A.$$

So, $V_{xy} = 5(10) + j5(10)$

$$\therefore V_{xy} = 50 + 50j$$

and,



$$I = \frac{50+50j}{5+j5+5-j5}$$

$$\therefore I_L = \frac{50+50j}{10} = 5+5j = 7.07\angle 45°$$

OR

$$\frac{V_{xy}-50}{-j5} + \frac{V_{xy}-0}{5+j5} = 0 \quad \text{(By node analysis)}$$

$$\therefore (5+j5)(V_{xy}-50) + V_{xy}(-j5) = 0$$

$$\therefore 5V_{xy} - 250 + \cancel{V_{xy}j5} - 50j5$$

$$- \cancel{V_{xy}}(j5) = 0$$

$$\therefore V_{xy} - 50 - 10j5 = 0$$

$$\therefore V_{xy} = 50 + 50j.$$

and, For $Z = 10\angle 0°$

$$I_L = \frac{50+50j}{5+j5+10} = \frac{50+50j}{15+5j}$$

$$\therefore I_L = (2+j4)\,A$$

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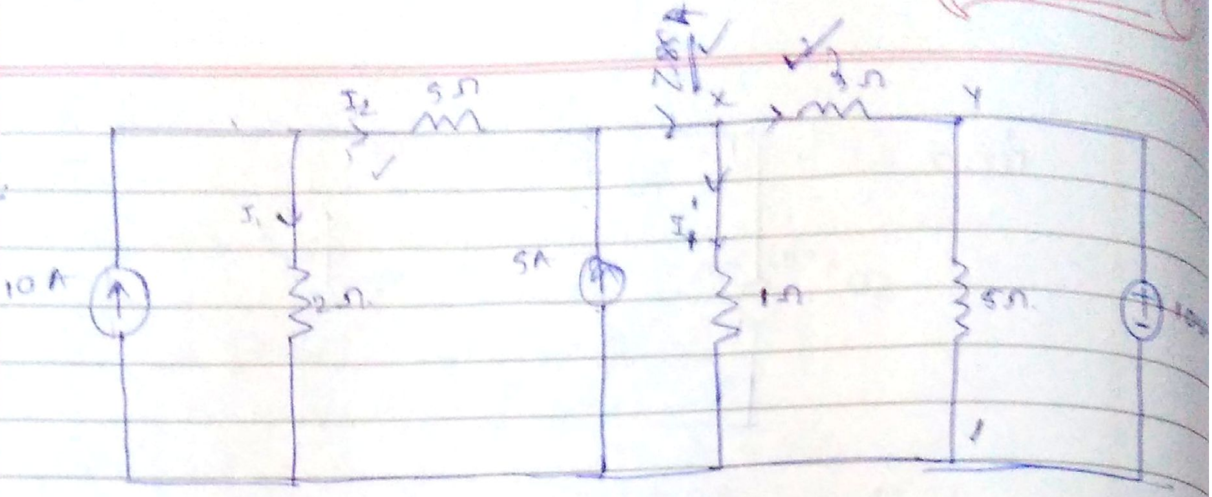
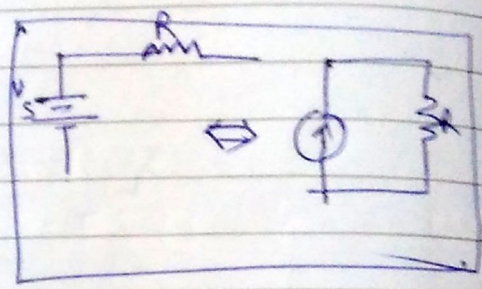


$I_2 = \frac{r_1 I}{r_1 + r_2}$

$= \frac{2 \times 10}{7}$

$\therefore I_2 = 2.85$ A



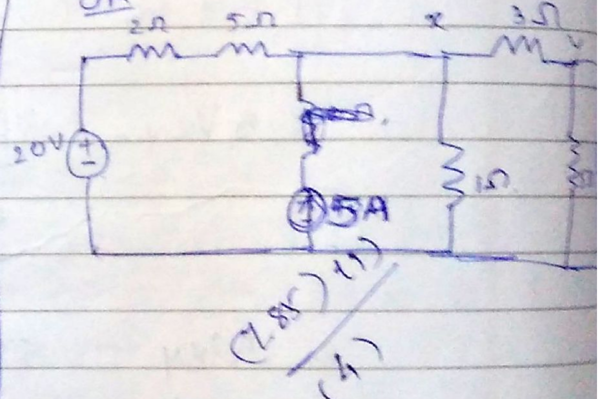
so, current flowing through x node $= 2 + 5 = 7$ A.

$I_1' = \frac{r_2 I}{r_1 + r_2}$

$= \frac{3 \times 7}{4}$

$\therefore I_1' = 5.25$

OR



$\therefore V_x = 5.25$ V

and $V_y = 10$V

-5

here, $\frac{V_x - 20}{7} + \frac{V_x - 10}{2} + V_x = 0$

$\therefore 2V_x - 40 + 7V_x - 70 + 14V_x = 0$

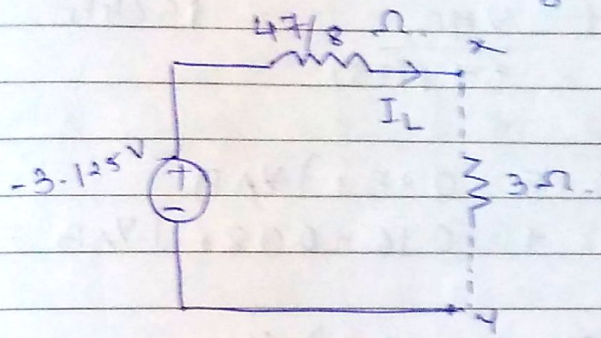
$\therefore 23V_x = 110 \quad \therefore V_x = 6.875$

$\therefore V_{xy} = -3.125\,V$

and $R_{eq} = 7 \| 1 + 5$

$= \frac{7}{8} + 5$

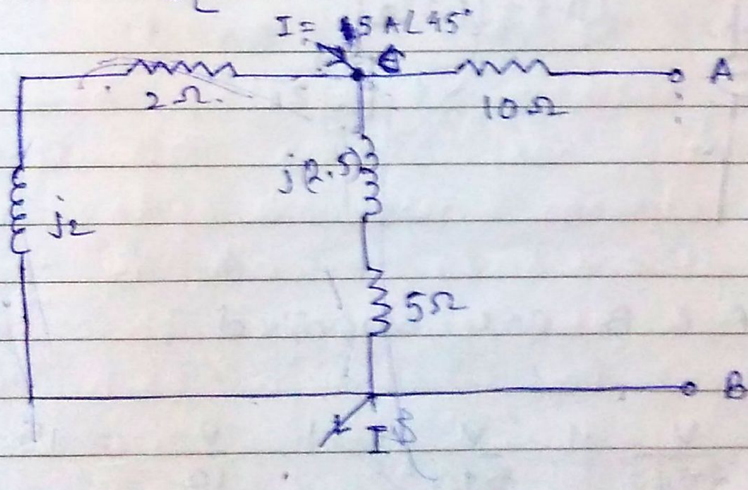
$\therefore R_{eq} = 47/8$



So, $I_L = \frac{-3.125}{47/8 + 3} = \frac{-3.125}{8.875}$

$\therefore I_L = -0.352\,A$

10V. Que



find our current if A & B are shorted.

→ Here, first we will find open circuit voltage, so, $\cancel{\dfrac{V_{AB}}{12+2j} + \dfrac{V_{AB}}{15+2.5j} = 0.}$

$\therefore \quad \cancel{V_{AB}\left[\dfrac{1}{12+2j} + \dfrac{1}{15+2j}\right] = 0.}$

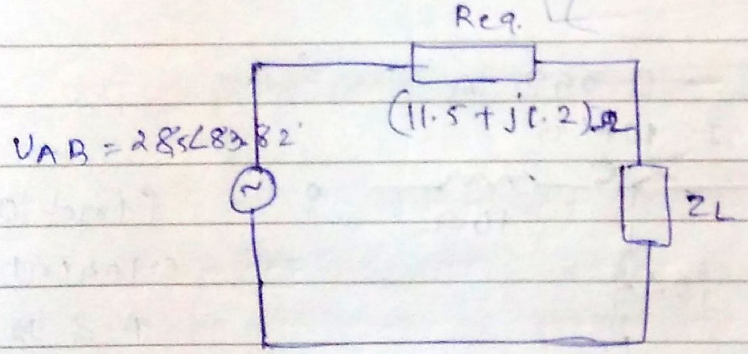
$\therefore$

so, $\dfrac{V_{AB}}{2+2j} + \dfrac{V_{AB}}{5+j(2.5)} = 15\angle 45^\circ$

$\therefore \quad \cancel{V_{AB}}\ (0.25 - 0.25i)V_{AB} + (0.16 - 0.08i)V_{AB} = 15\angle 45^\circ$

$\therefore \quad (0.4\cancel{1} - 0.33i)V_{AB} = 10.68 + 10.6$

$\therefore \quad V_{AB} = 28.50\angle 83.82^\circ$

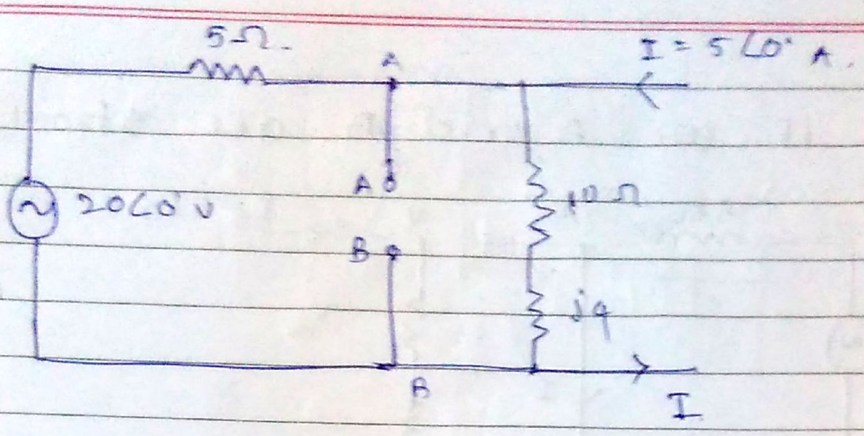


→ Now, A & B are shorted.

so, $\dfrac{V}{2+j2} + \dfrac{V}{5+j2.5} + \dfrac{V}{10} = 15\angle 45^\circ$

$\therefore \quad V = 24.7\angle 77^\circ V.$

Que



→ Here,

$$\frac{V_{AB} - 20}{5} + \frac{V_{AB}}{10 + 4j} = 5\angle 0^\circ$$

$$\therefore V_{AB} - 20(10 + 4j) + 5V_{AB} = 5(5)(10+4j)$$

$$\therefore 10V_{AB} + 4V_{AB}j - 200 - 80j + 5V_{AB}$$

$$= 250 + 100j$$

$$\therefore 15V_{AB} + 4V_{AB}j = 450 + 180j$$

$$\therefore V_{AB}[15 + 4j] = 450 + 180j$$

$$\therefore V_{AB} = 31.22 \angle 6.86^\circ$$

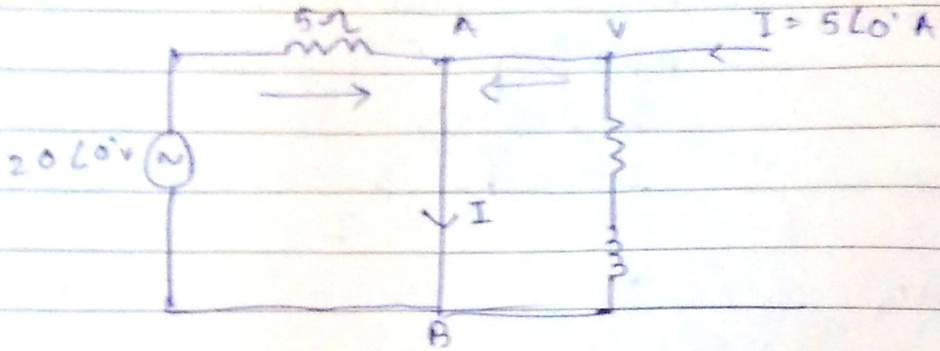
→ $$Z_{eq} = 5 \parallel (10 + 4j)$$

$$= \frac{5(10 + 4j)}{5 + 10 + 4j}$$

$$= \frac{50 + 20j}{15 + 4j}$$

$$\therefore Z_{eq} = 3.46 \angle 6.87^\circ$$

→ Now if ~~the~~ A and B are short-circuited



~~$\frac{V_{AB} - 20}{5} = 5$~~

~~$\therefore V_{AB} - 20$~~

Here, $\frac{20}{5} = 4\text{ A} + 5\text{ A} = 9\angle 0^\circ \text{ A}$

⇒ Super position theorem –

Statement: If a number of voltage and current sources are acting simultaneously in a linear network, the resultant current in any branch is the Algebric sum of the currents that would be produced in it when each source acts alone. Replacing all other voltage sources by short-circuit and current sources by open-circuit.

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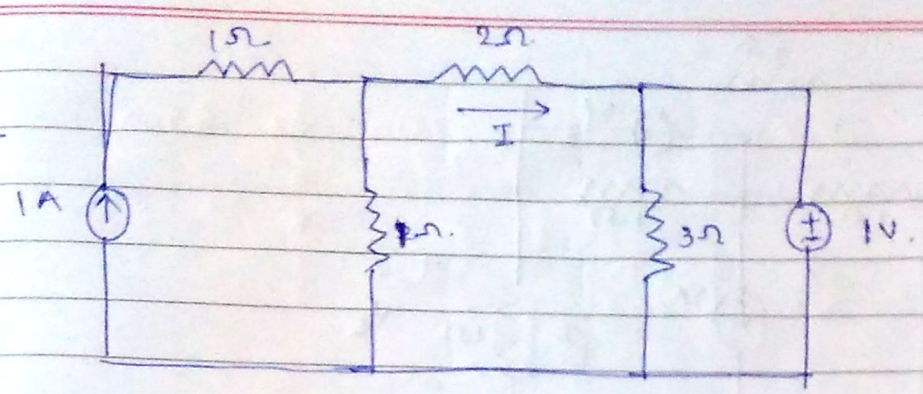
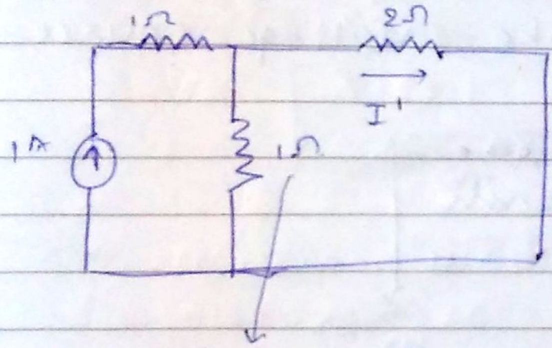


$I_2 = ?$

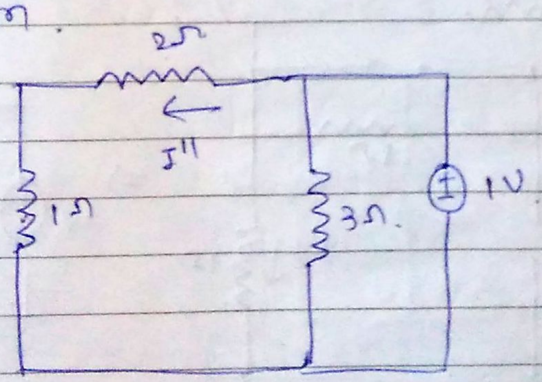
→ Here, we will make voltage source as short circuit



$I' = \frac{I(1)}{1+2} = I/3$

$\therefore I' = 1/3 A.$

→ Now, we will make current source as open.



Here, $I'' = \frac{V}{1+2} = V/3 = 1/3 A.$

So, Resultant current $I = I' - I'' = 1/3 - 1/3 = \underline{0 A}$

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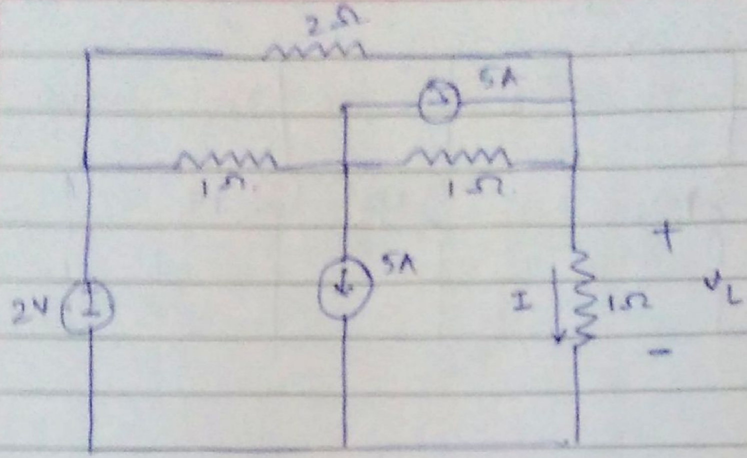
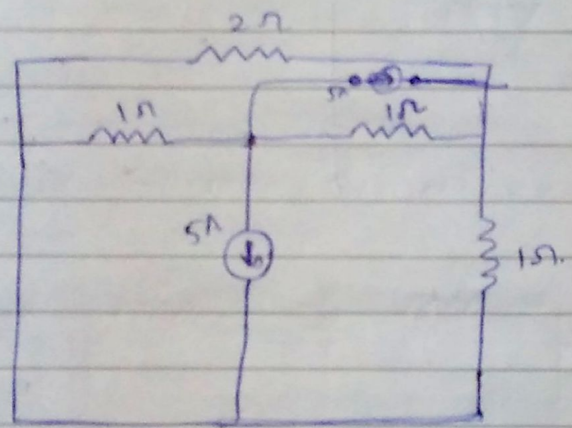
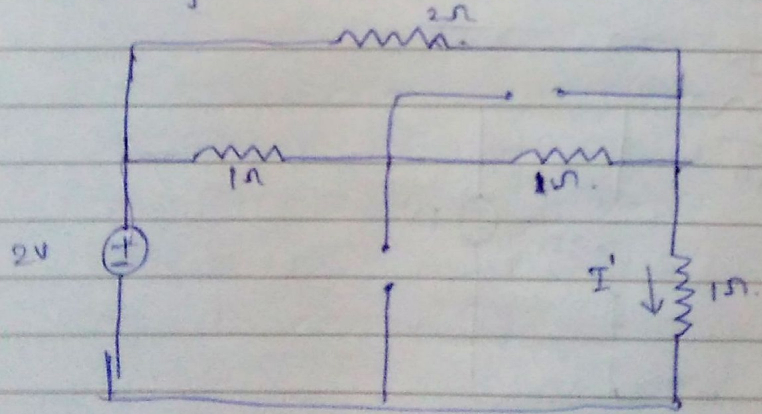


find out V_L using super-position theorem

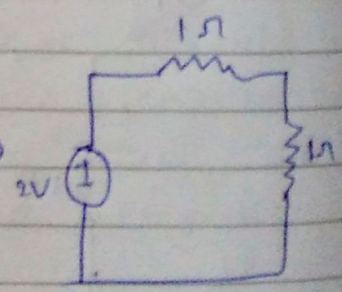
→ Now we will make voltage source as short



→ making current source as open

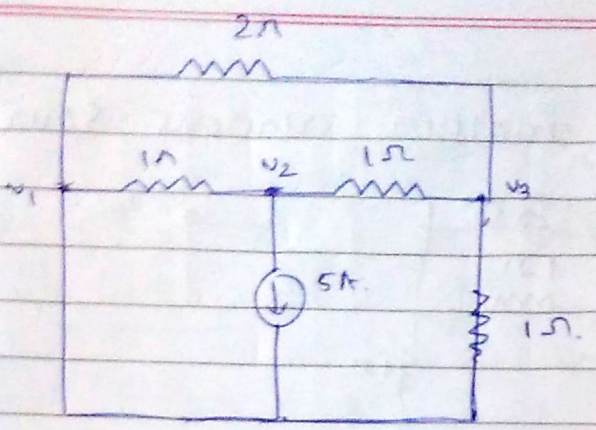


⇒



so, $I' = 2/2 = 1\,A$

$\boxed{\therefore V_L = 1\,V}$



cuited

$$\frac{v_1 - v_3}{2} + \frac{2(v_1 - v_2)}{2} = 0$$

$\therefore v_1 - v_3 + 2v_1 - 2v_2 = 0$

$\therefore 3v_1 - 2v_2 - v_3 = 0$ — (1)

$$\frac{v_2 - v_1}{1} + \frac{v_2 - v_3}{1} + \frac{5}{1} = 0$$

$\therefore 2v_2 - v_1 - v_3 + 5 = 0$

$\therefore v_1 - 2v_2 + v_3 = 5$ — (2)

$$\frac{v_3 - v_1}{2} + \frac{2(v_3 - v_2)}{2} + \frac{2v_3}{2} = 0$$

$\therefore v_3 - v_1 + 2v_3 - 2v_2 + 2v_3 = 0$

$\therefore 5v_3 - v_1 - 2v_2 = 0$

$\therefore v_1 + 2v_2 - 5v_3 = 0$ — (3)

$v_3 = -5$

$\therefore \frac{v_3}{1} = I''$

$\therefore I'' = v_3$

$\therefore I'' = -5A$

Here, $v_1 = 0$,

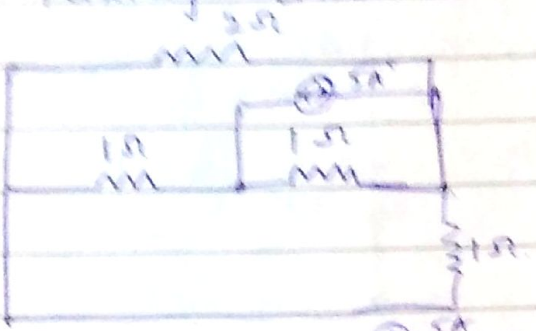
$\therefore -2v_2 + v_3 = 5$ and

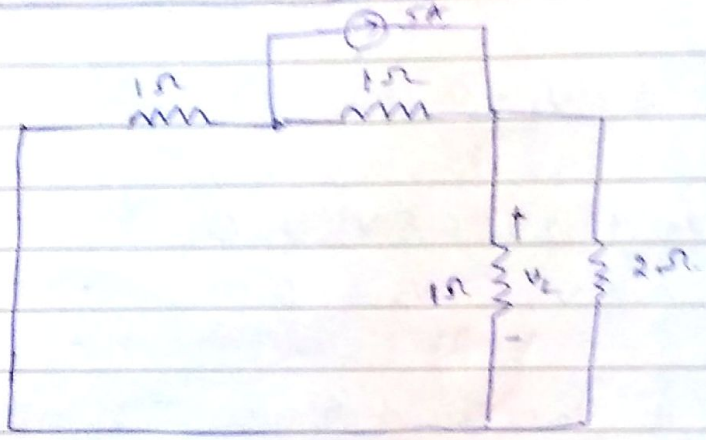
$2v_2 - 5v_3 = 0$

$-4v_3 = 5$

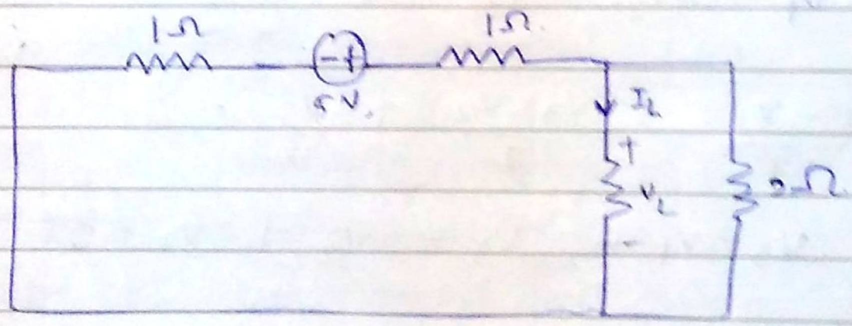
$\boxed{\therefore v_3 = -5/4 \text{ V}}$

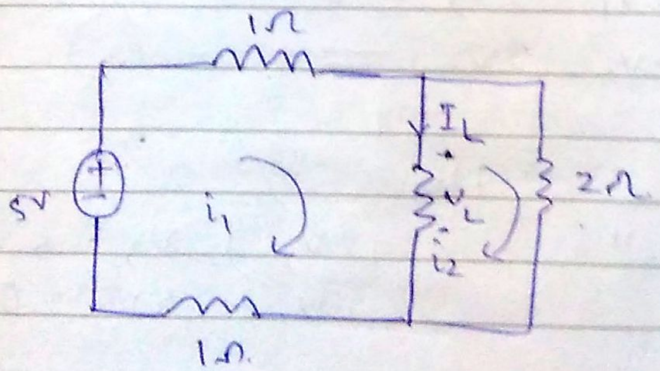
⇒ Now taking another current source.





Using Source-transformation.





for loop-1,

$$5 - i_1 - V_L - i_1 = 0$$

$$\therefore 5 - 2i_1 = V_L \quad \text{--- (1)}$$

$V_3 = 5/4$ V.

→ for loop - 2,

$V_L - 2i_2 = 0$

$\therefore V_L = 2i_2$ — (2)

$V_L = 1(i_1 - i_2)$ — (A)

so, $5 - 2i_1 = 2i_2$

$2i_2 = i_1 - i_2$

$\therefore 2i_1 + 2i_2 = 5$. — (3)

$\boxed{3i_2 = i_1}$

$5 - 2i_1 = i_1 - i_2$

and $V_L = (i_2 - i_1)$,

$5 - 3i_1 = -i_2$

$\therefore 5 - 9i_2 = -i_2$

$5 - 2i_1 = i_2 - i_1$

$\therefore 5 = 8i_2$ — (1)

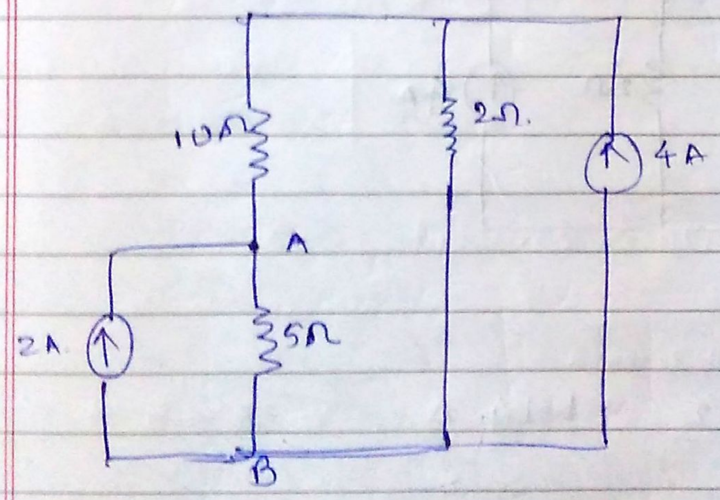
$\therefore i_1 + i_2 = 5$ — (4)

$\therefore \boxed{i_2 = 5/8}$

$\therefore \boxed{\frac{15}{8} = i_1}$

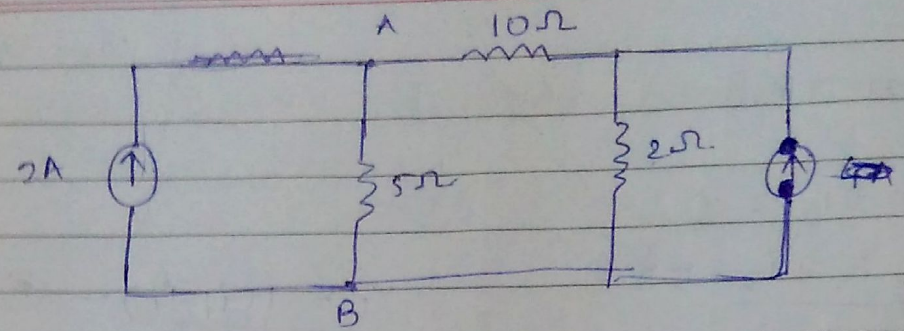
$\frac{15}{8} - \frac{5}{8} = \frac{10}{8} = \boxed{5/4}$

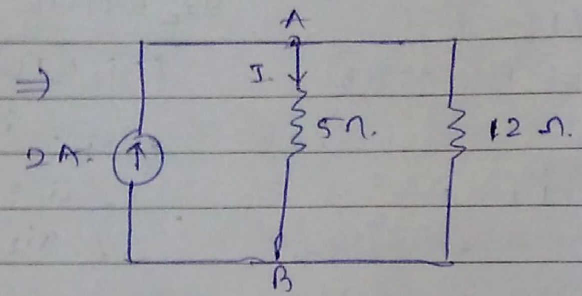
Que.



Find V_{AB} = ?

→ Making 4A current source as open circuit.

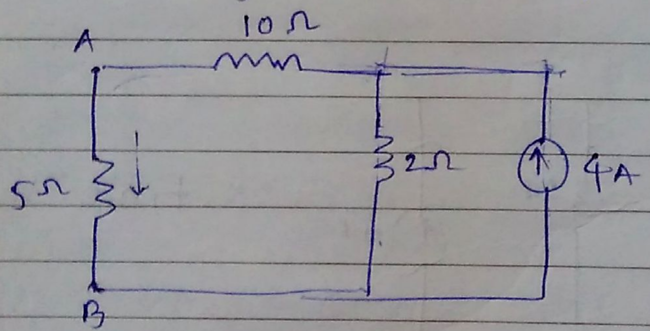




$$I = \frac{2 \times 12}{17} = 1.41 \text{ A.}$$

$$\therefore V_{AB}' = \underline{\underline{7.05 \text{ V.}}}$$

→ Now making 2 A as Open circuit,



so, $I' = \frac{4 \times 2}{17} = \cancel{[illegible]}$ A.

$$\therefore V_{AB}'' = \underline{\underline{2.35 \text{ V}}}$$

so, $V_{AB} = V_{AB}' + V_{AB}''$

$$\boxed{\therefore V_{AB} = 9.4}$$

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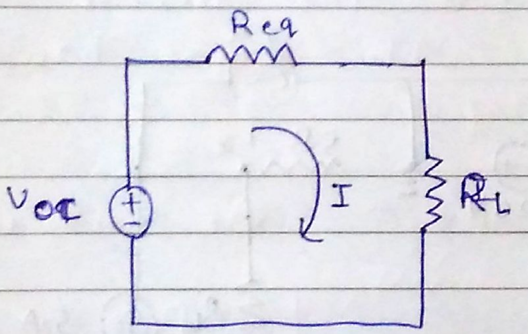
⇒ Maximum Power transfer theorem —

→ It is used to find the value of Load resistance for which there would be max. power transfer from source to load.

→ A resistive load being connected to a DC network, receives max. power when the load resistance is equal to the equivalent resistance of the network as seen from the load terminals.



$$I_L = \frac{V_{oc}}{R_{eq}+R_L}$$

$$\therefore P_L = \cancel{V_{oc}}\ I_L^2 R_L$$

$$\therefore P_L = \left(\frac{V_{oc}}{R_{eq}+R_L}\right)^2 R_L \quad \text{—(1)}$$

→ for Max power,

$$\frac{dP_L}{dR_L} = 0.$$

$$\therefore \left(\frac{V_{oc}}{R_{eq}+R_L}\right)^2 + R_L \cdot \frac{2V_o}{R_{eq}+R_L}$$

$$= (V_{oc})^2 \left[\frac{R_L}{(R_{eq}+R_L)^2}\right] =$$

$$= V_{oc}^2 \left[R_L \cdot \frac{1}{R_{eq}+R_L}\right]$$

$$= V_{oc}^2 \left[R_L \cdot \frac{-1}{(R_{eq}+R_L)^2} + \frac{1}{R_{eq}+R_L}\right]$$

$$= \cancel{\frac{V_{oc}^2}{R_L + R_{eq}} \left[\frac{-R_L}{R_{eq} + R_L} + 1 \right]}$$

$$= \cancel{\frac{V_{oc}^2}{R_L + R_{eq}} \left[\frac{R_{eq}}{R_{eq} + R_L} \right]}$$

$$= V_{oc}^2 \left[\frac{R_{eq} L}{(R_{eq} + R_L)^2} \right] = 0$$

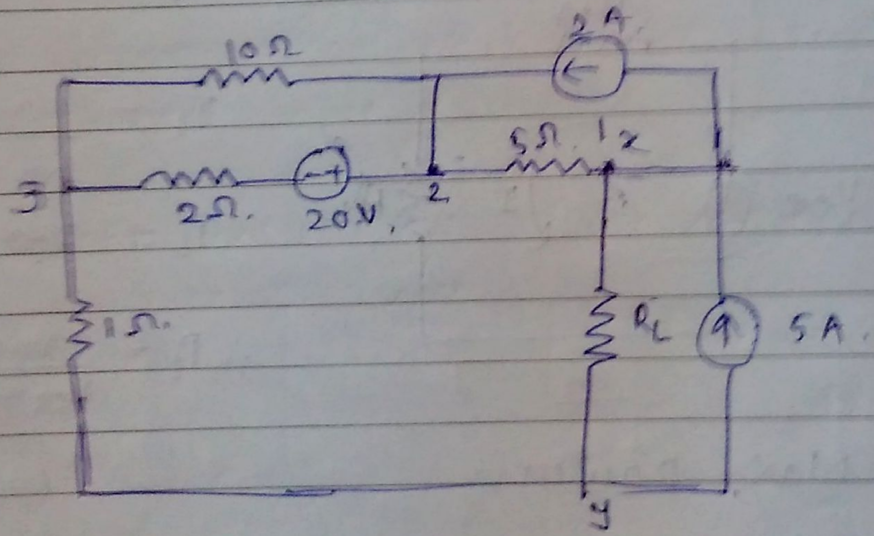
$\therefore (R_{eq} + R_L)^2 (1) - 2(R_{eq} + R_L)(R_L)(1) = 0$

$\therefore R_{eq}^2 + 2R_{eq} + R_L^2 - 2R_{eq}R_L - 2R_L^2 = 0$

$\therefore R_L = R_{eq}$

$$P_{max} = \frac{V_{oc}^2}{4R_L}$$

Que



Here, xy is Open circuit,

→ Using Nodal Analysis,

$$\frac{V_1 - V_2}{5} = 5 - 2$$

$$\therefore \frac{V_1 - V_2}{5} = 3$$

$\therefore V_1 - V_2 = 15$ —— (1)

$$\cancel{\frac{V_2 - V_1}{5} - 5 + \frac{V_2 - V_3}{10}}$$

for node - 3,

$$\frac{V_3 - V_2}{10} + \frac{V_3 + 20}{2} + \frac{V_3}{1} = 0$$

for node - 2,

$$\frac{V_2 - 20 - V_3}{2} + \frac{V_2 - V_1}{5} + \frac{V_2 - V_3}{10} = 2$$

$$\therefore \frac{5(V_2 - 20 - V_3) + 2(V_2 - V_1) + V_2 - V_3}{10} = 2$$

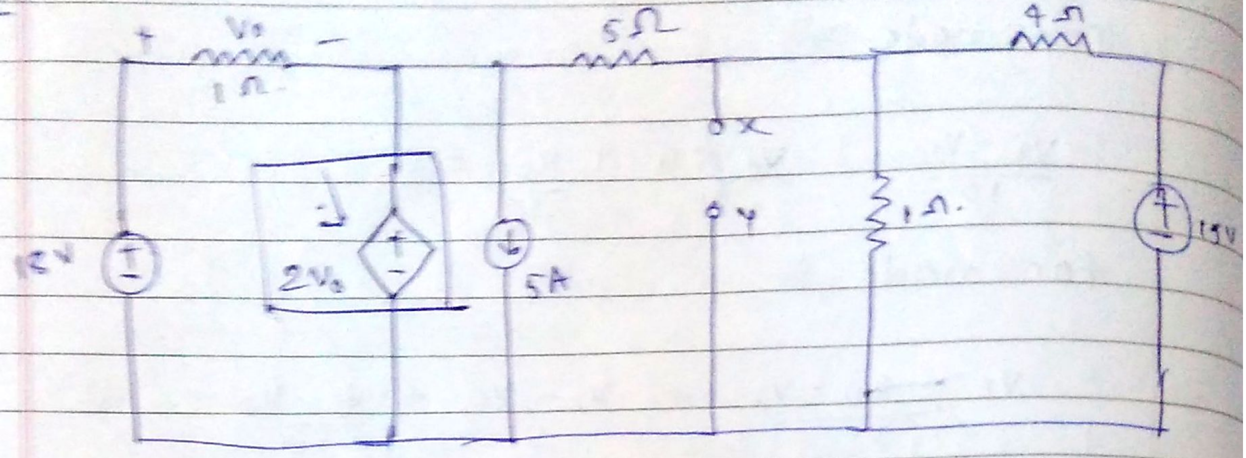
$$\therefore 5V_2 - 100 - 5V_3 + 2V_2 - 2V_1 + V_2 - V_3 = 20$$

$$\therefore -2V_1 + 8V_2 - 6V_3 = 120$$

$$\therefore -V_1 + 4V_2 - 3V_3 = 60$$

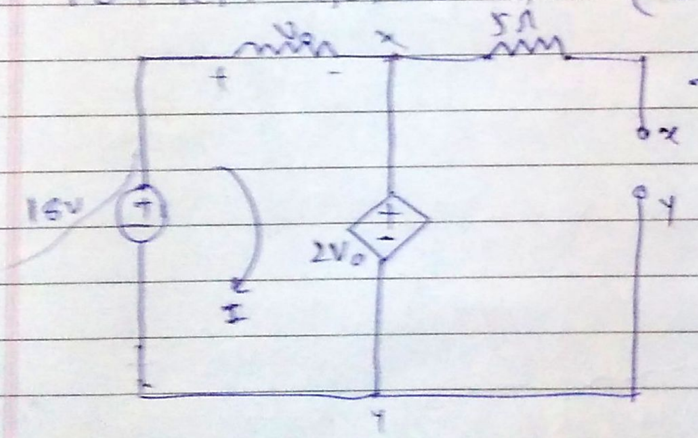
M.Imp

Que



Using Super-position theorem, find the thevinin's equivalent circuit for the portion of the network at the left of terminals x-y. also find the current through 1Ω Resistance at the right hand side of terminal x-y.

→ for left network; (we can't remove dependent source)



→ Due to 18 V source

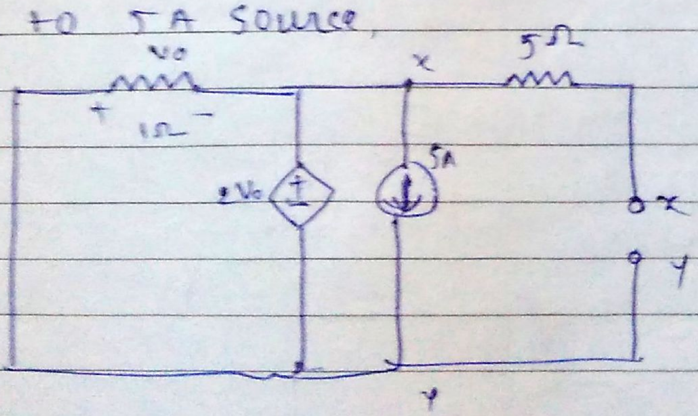
$\therefore 18 = V_0 + 2V_0$

$\therefore 18 = 3V_0$

$\therefore V_0 = 6\ V$

$\therefore V_{oc_1} = 12\ V.$ ($\because V_{oc1} = 2V_0$

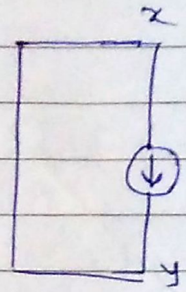
→ Due to 5A source,



~~Using Nodal~~

$\cancel{\frac{V_x}{1} + V_x - 2V_o}$

→ Mesh equation,



$2V_o + V_o = 0$

$\therefore V_o = 0$

so, $V_{oc2} = 0$.

so, $V_{oc} = V_{oc1} + V_{oc2}$

$= 12 + 0$

$\therefore V_{oc} = 12V$

→ ~~Isc Req = 5Ω.~~

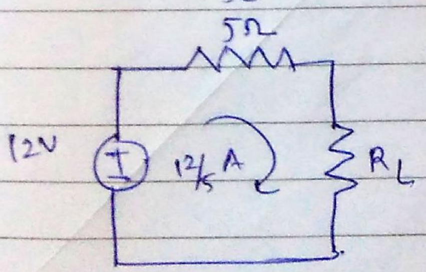
~~∴ Isc =~~

~~Thevin~~

→ Here Dependent source is present. So, we have to find I_{sc} first.

$I_{sc} = \frac{V_{oc}}{5} = 12/5 \ A.$

$R_{eq} = \frac{V_{oc}}{I_{sc}} = \frac{12}{12/5} = 5\Omega$



Thevinin's eq. circuit.