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Semester 2nd

Subject LCA

Dept BE/Electrical

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Assignment No # 3

Chapter # 4

(9) Evaluate the following det determine

(a) $\begin{bmatrix} 2 & 1 \\ -4 & 3 \end{bmatrix}$ (b) $\begin{bmatrix} 0 & 2 & 11 \\ 6 & 4 & 1 \\ 3 & -1 & 5 \end{bmatrix}$

Solution: The first determinant is simply evaluated as

$$\begin{bmatrix} 2 & 1 \\ -4 & 3 \end{bmatrix} = (2 \times 3) - (1 \times (-4))$$

$$= 6 - (-4)$$

$$= 6 + 4$$

$$= 10$$

$$\boxed{\det |A| = 10}$$

(b) Evaluate the determine from the first column.

$$\begin{bmatrix} 0 & 2 & 11 \\ 6 & 4 & 1 \\ 3 & -1 & 5 \end{bmatrix} = 0 \begin{bmatrix} 4 & 1 \\ -1 & 5 \end{bmatrix} - 6 \begin{bmatrix} 2 & 11 \\ -1 & 5 \end{bmatrix} + 3 \begin{bmatrix} 2 & 1 \\ 4 & 1 \end{bmatrix}$$

$$= 0(4 \times 5 - 1 \times (-1)) - 6(2 \times 5 - 11 \times (-1)) + 3(2 \times 1 - 11 \times 4)$$

$$= 0(22) - 6(21) + 3(-42)$$

$$= 0 - 126 \; ...$$

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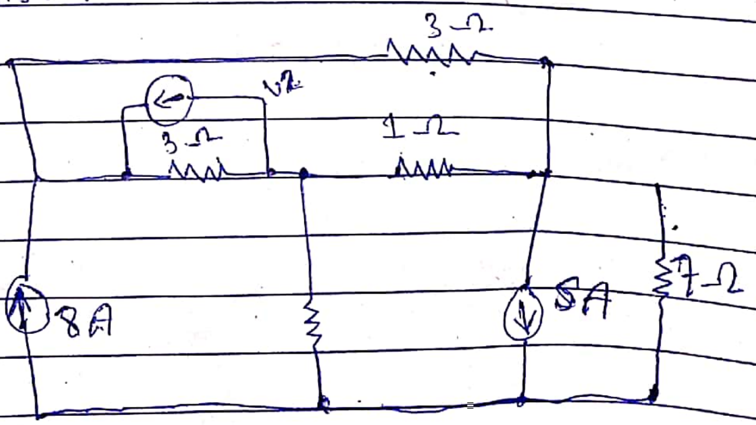
Apply KCL to node V2 given

$$5-2 = \frac{V3-V2}{10} + \frac{V3}{200} \quad -④$$

Solving the four equation (1) (2) (3) & (4) Thus

$$\boxed{Vp = 171.639\,V}$$

(13) Using the bottom node as reference determine the voltage across the 5 Ω resistor in the circuit of fig 4.39 and calculate the power dissipated by the 7 Ω resistor.



Solution

5 Start with the lebaling the ~~circuit~~ Nodes of the circuit.

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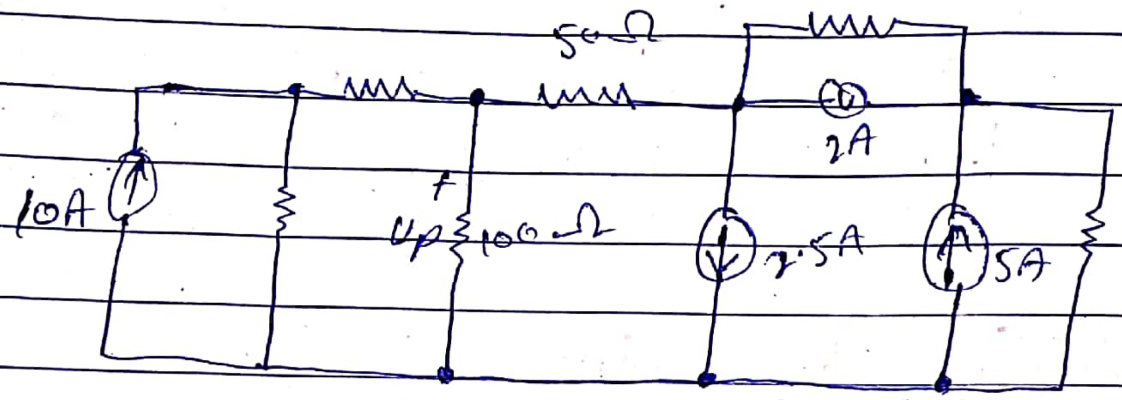
$\boxed{\det |B| = -252}$

(12) use Nodal analysis to find v_p in the circuit



Soluation:-

→ We redraw the given circuit and specify the nodal voltage as shown below

Apply KCL to node v_1 given

$$10 = \frac{v_1}{20} + \frac{v_1 - v_p}{40} \quad \text{—— (1)}$$

Apply KCL to node v_p gives

$$0 = \frac{v_p - v_1}{40} + \frac{v_p}{100} + \frac{v_p - v_2}{50}$$

Apply KCL to node v_2 gives

$$2 - 2.5 = \frac{v_2 - v_p}{} + \frac{v_2 - v_3}{10}$$

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Soluation: Start with labeling the Nodes of the circuit

Let the voltage accross the 8A current source to be v1 while v2 denote the voltage accross the 5Ω resistor. finally, let the voltage accross the 5A current source is labeled v3

For the Node v1

$$-8-4 \frac{v_1 - v_2}{3} + \frac{v_1 - v_3}{3} = 0$$

$$\left(\frac{1}{3} + \frac{1}{3}\right) v_1 - \left(\frac{1}{3}\right) v_2 - \left(\frac{1}{3}\right) \times 3 = 12$$

$$9v_1 - v_2 - v_3 = 36 \quad (1)$$

For the Node v2

$$4 + \frac{v_2 - v_1}{3} + \frac{v_2}{5} + \frac{v_2 - v_3}{1} = 0$$

$$-\left(\frac{1}{3}\right) v_1 + \left(\frac{1}{3} + \frac{1}{3}\right) v_2 - v_3 = -4$$

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For node v_3

$$5 + \frac{v_3 - v_2}{1} + \frac{v_3 - v_1}{3} + \frac{v_3}{7} = 0$$

$$-\left(\frac{1}{3}\right) v_1 - v_2 + \left[1 + \frac{1}{3} + \frac{1}{7}\right] v_3 = -5$$

$$-7v_1 - 21v_2 + 31v_3 = 105 \quad — (3)$$

Solve the three equation:

(1) (2) and (3)

$v_1 = 26.733V$
$v_2 = 2.833V$
$v_3 = 8.633V$

Thus $v_{5\Omega} = v_2$

$$\boxed{v_{5\Omega} = 2.833V}$$

Since the voltage accross the 7Ω resistor is v_3, therefore

$$P_{7\Omega} = \frac{v_3^2}{7}$$

$$= \frac{8.633^2}{7}$$

$$= \frac{74.528689}{7}$$

$$\boxed{P_{7\Omega} = 10.646W}$$

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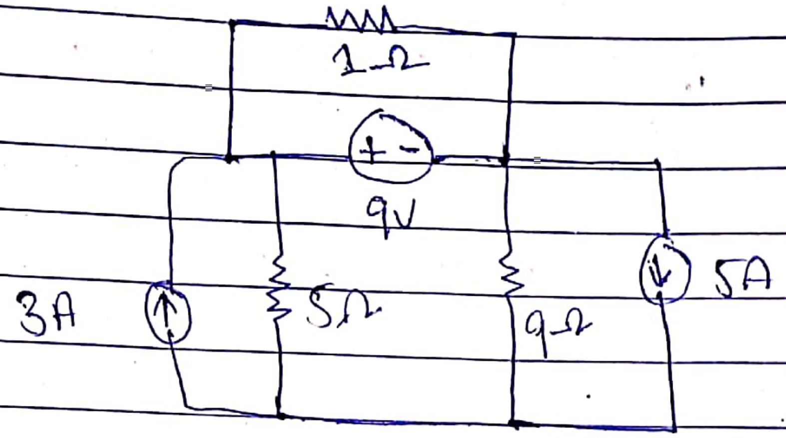
(19) Determine a numerical voltage for the voltage labeled.



Solution :- Consider v_1 and v_2 as a Super node

Apply kcl on Supernode.

$\cancel{45}v_1 - \cancel{45}v_2 + 9v_1 + \cancel{45}v_2 - \cancel{45}v_1 + 9v_2$

$9v_1 + 9v_2 = 135$ — (1)

So $v_1 - v_3 = 9$ — (1)

Combine equation (1) and (2)

$9v_1 + \cancel{9v_2} = 135$

$9v_1 - \cancel{9v_2} = 81$

$18v_1 = 216$

$v_1 = \frac{216}{18}$

$\boxed{v_1 = 12V}$

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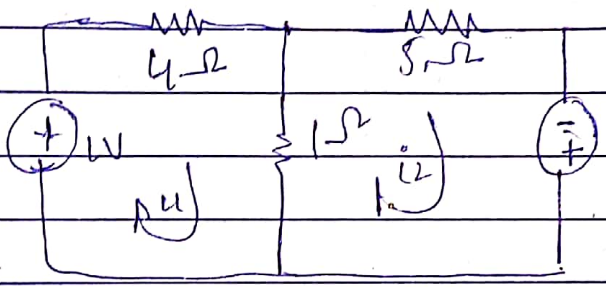
putting in eq (8)

$v_2 = v_1 - 9$

$v_2 = 12 - 9$

$\boxed{v_2 = 3}$

(99) Determine the current flowing out of the postive Terminal of each voltage source in the circuit.



Solution by Mesh Analysis

Apply KVL on i_1.

$4i_1 + (i_1 - i_2) = 1$

$5i_1 - i_2 = 1$ —(1)

Apply KVL on i_2

$1(i_2 - i_2) = 1$

~~5i1~~ → $5i_1 - i_2 = 1$ —(1)

Apply kvl on i_2.

$1(i_2 - i_1) + 5i_2 = 2$

$-i_1 + 6i_2 = 2$ — (ii)

Multiplying 5 with equation (2) so adding with eq (1)

$5i_1 - i_2 = 1$

$-5i_1 + 30i_2 = 10$

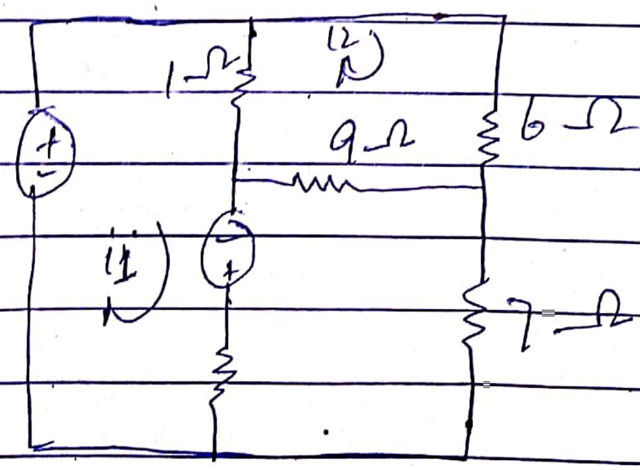
$29i_2 = 11$

$i_2 = 11/29$

Reasult = $i_1 = 0.275A$

$i_2 = 0.379A$

Q 32/5



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Solution:-

write the first mesh equation.

$$-8+1(i_1-i_2)-3+5(i_1-i_3)=0$$

$$6i_1-i_2=5 \quad \text{—} (1)$$

write the 2nd mesh equation:-

$$1(i_2-i_1)+6i_1+9(i_2-i_3)=0$$

$$-i_1+16i_2-9i_3=0$$

write the third mesh equation:-

$$5(i_3-i_1)+3+9(i_3-i_2)+7i_3=0$$

$$-5i_1-9i_2+21i_3=-3 \quad \text{—} (3)$$

Solve the three equation (1) (2) and (3) then

$i_1 = 987.205\, mA$

$i_2 = 150.147\, mA$

$i_3 = 157.017\, mA$

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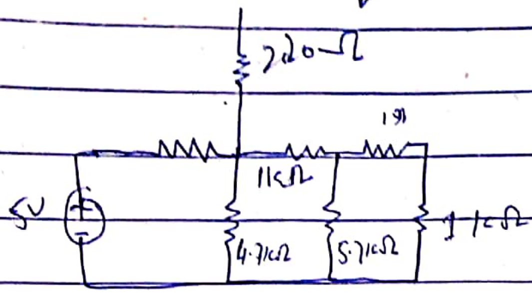
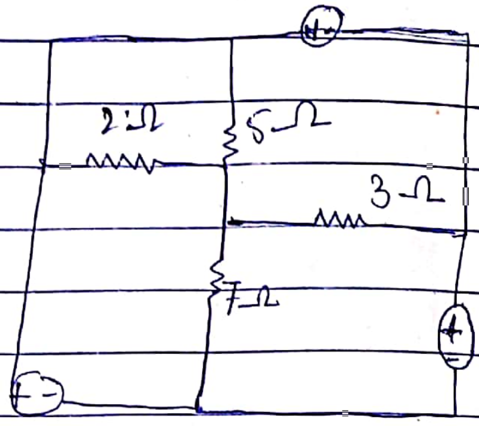
QNo 35) Chose the manzero value of the three voltage Source of figure so that no current any resistor in the circuit.





Sol: (3) Lets name the Source v_1, v_2 and v_3 from the bottom.

And the current i_1, i_2, i_3

For the current in resistance to be equal to zero, weneed.

$$i_1 - i_2 = 0$$
$$i_3 - i_4 = 0$$
$$i_1 - i_3 = 0$$
$$i_2 - i_4 = 0$$

(2) Now we apply KVL on each of the four loop.

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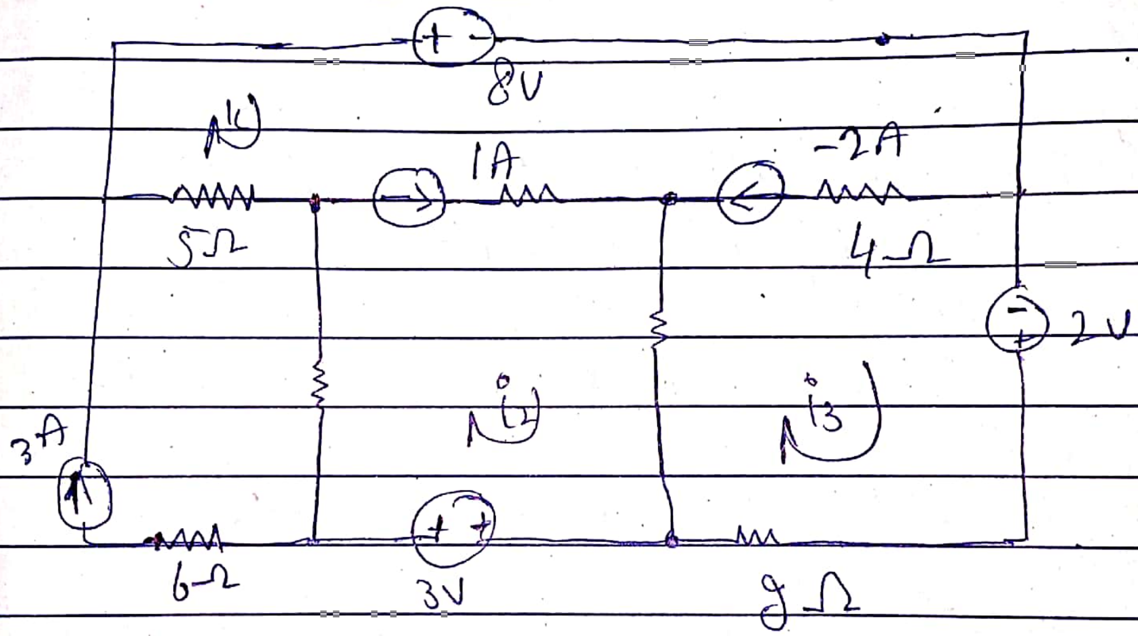
$$9(i_1 - i_3) + 5(i_1 \quad i_2) = 0$$
$$3(i_2 - i_4) + 5(i_2 \quad i_1) = -v_2$$
$$7(i_3 - i_4) + 2(i_3 \quad i_3) = v_1$$
$$3(i_4 - i_2) + 7(i_4 \quad i_3) = v_3$$

(3) $v_1 - v_2 - v_3 = 0$

(4.6)



Solution: lets call the unlabiled mesh current i_4 we can immediately see that

$$i_4 = 3A$$

Mesh analysis of $i_1 - i_2 - i_3$ supernode given us.

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$8+5(i_1-3)+3(i_2-3)$

$-3+2i_3-2=0$

By Apply KVL on the lower b/w Super-Node and the uper righ node we get.

$i_2 - i_1 = 0$

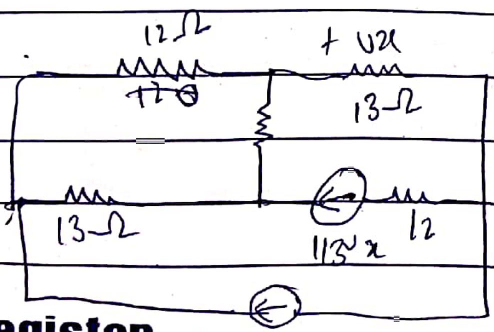
$2 + i_1 - i_3 = 0$

After solving these three equation we get

$i_1 = 1.4A$
$i_2 = 2.4A$
$i_3 = 3.4A$

Q No 47:- Figure

Through carefully application of the Super mesh tecnige obtain values ofor all three mesh current as labeled.



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we are going in the problem that $\boxed{I_1 = 5A}$

The equation for the Second mesh can be write as,

$I_3 = I_1 = \frac{0x}{3}$

$3I_3 - 5(3) = 0x \quad 13I_3$

$3I_3 - 15 = 13I_3$

$-15 = 10I_3$

$\boxed{I_3 = -1.5A}$

The equation of the 3rd mesh

$-13I_1 + 36I_2 - 11I_3 = 0$

$-13(5) + 36I_2 - 11(-1.5) = 0$

$-65 + 36I_2 - 11(-1.5) = 0$

$36I_2 = 48.5$

$I_2 = 1.3A$

Result $I_1 = 5A$

$I_2 = 1.3A$

$I_3 = 1.5A.$

two meshes 1 and 2, we obtain the following matrix equation.

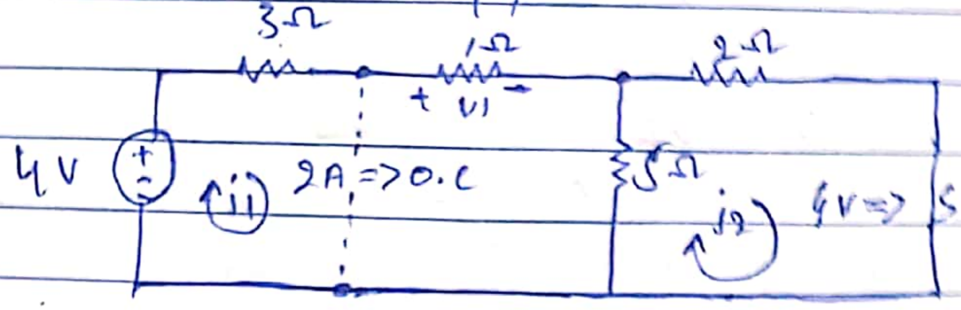
$$\begin{bmatrix} 3+1+5 & -5 \\ -5 & 5+2 \end{bmatrix}\begin{bmatrix} i_1 \\ i_2 \end{bmatrix} = \begin{bmatrix} 4 \\ 0 \end{bmatrix}$$

we find

$$i_1 = \frac{14}{19} A$$

For 1Ω resistor, ohm's law gives

$$v_1 = 1 \cdot i_1 = \frac{14}{19} v \approx \boxed{736.84 \, mV}$$



To obtain v_2 we set the two 4V source to zero as shown below. Apply nodal analysis to the two node v_a and v_b we obtain the following matrix equation

$$\begin{bmatrix} \frac{1}{3}+1 & -1 \\ -1 & 1+\frac{1}{3}+\frac{1}{2} \end{bmatrix}\begin{bmatrix} v_a \\ v_b \end{bmatrix} = \begin{bmatrix} 2 \\ 0 \end{bmatrix}$$

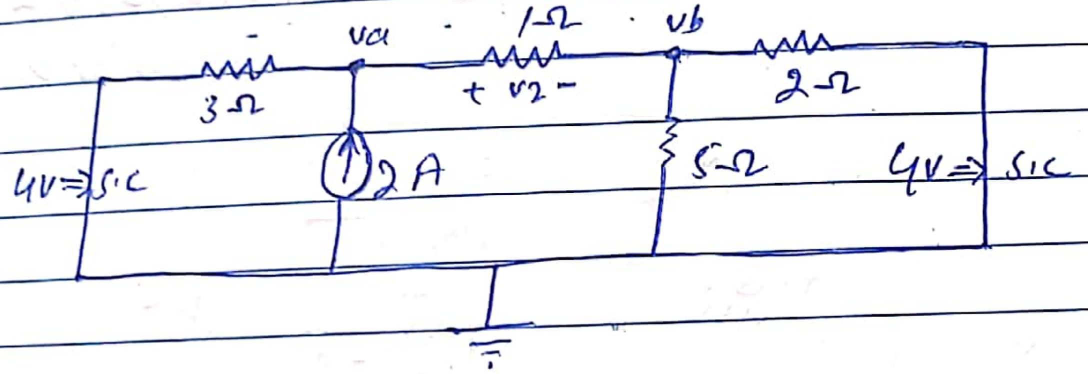
matrix equation we find:

$$v_a = \frac{51}{19}\ V \quad \text{and} \quad v_b = \frac{21}{19}\ V$$

By inspection, it is clear that

$$v_2 = v_a - v_b = \frac{51}{19} - \frac{30}{19} = \frac{21}{19}$$

$$\boxed{v_2 = 1.105\,V}$$



To obtain v_3 we set the 2A and the left 4V source to zero as shown below. Apply mesh analysis to the two meshes 1 and 2 we obtain the following matrix equation.

$$\begin{bmatrix} 3+1+5 & -5 \\ -5 & 5+2 \end{bmatrix} \begin{bmatrix} i_1 \\ i_2 \end{bmatrix} = \begin{bmatrix} 0 \\ -4 \end{bmatrix}$$

The matrix equation we find:

$$i_1 = \frac{-10}{19}\ A$$

For the 1 Ω resistor, ohm's law gives

$$V_3 = 1 \cdot i_1 = -\frac{10}{19} V$$

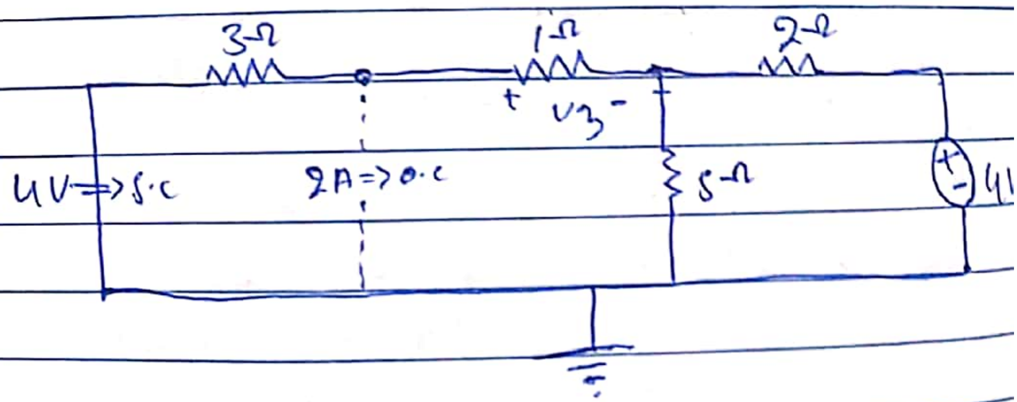
$$\boxed{V_3 = -526.32 \, mV}$$

There fore

$$V_x = V_1 + V_2 + V_3$$

$$V_x = 736.84 \, mV + 1.105 \, V - 526.32 \, mV$$

$$\boxed{V_x = 1.316 \, V}$$



It is required to evaluate the value of the current source that results in reducing the Vx values by 10%. Let the new values of Vx is V. The current source values affects only its contribution which is V2. Let the new values

v_2 is v_2'. Thus

$$v_x' = 0.9 \cdot v_x = 0.9 \cdot 1.316\ V$$

$$\boxed{v_x' = 1.1844\ V}$$

and

$$v_2' = v_x' - (v_1 + v_3) = 1.1844V - (736.84mV - 526.32mV) = 973.88mV$$

Apply nodal analysis to the two nodes v_a and v_b in the circuit shown below gives.

$$I_{cs} = \left(1 + \frac{1}{3}\right) v_a - v_b \quad \text{—— (1)}$$

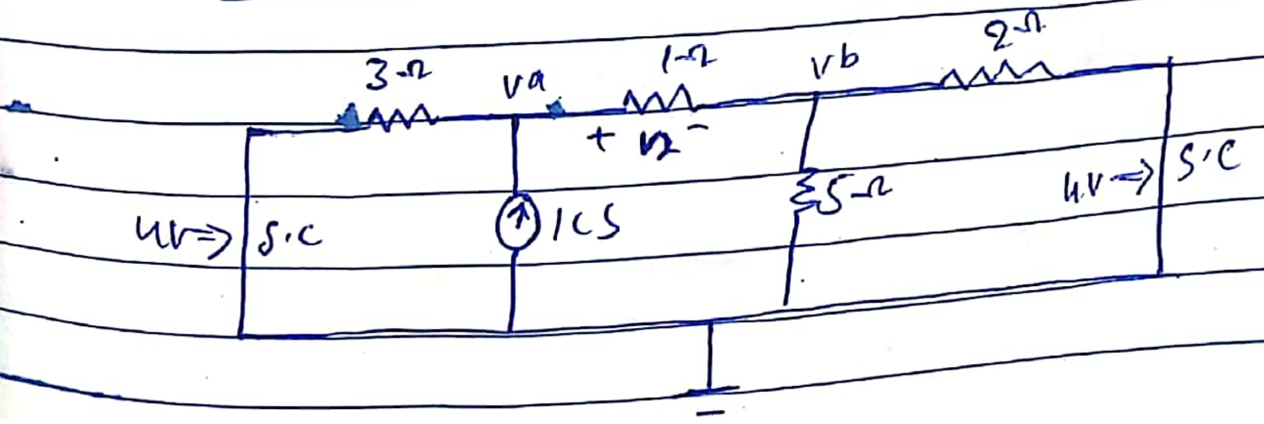
$$0 = -v_a + \left(1 + \frac{1}{5} + \frac{1}{2}\right) v_b \quad \text{—— (2)}$$

we have

$$v_a - v_b = v_2' = 973.88\ mV \quad \text{—— (3)}$$

Solving the three equation (1), (2) and (3) we

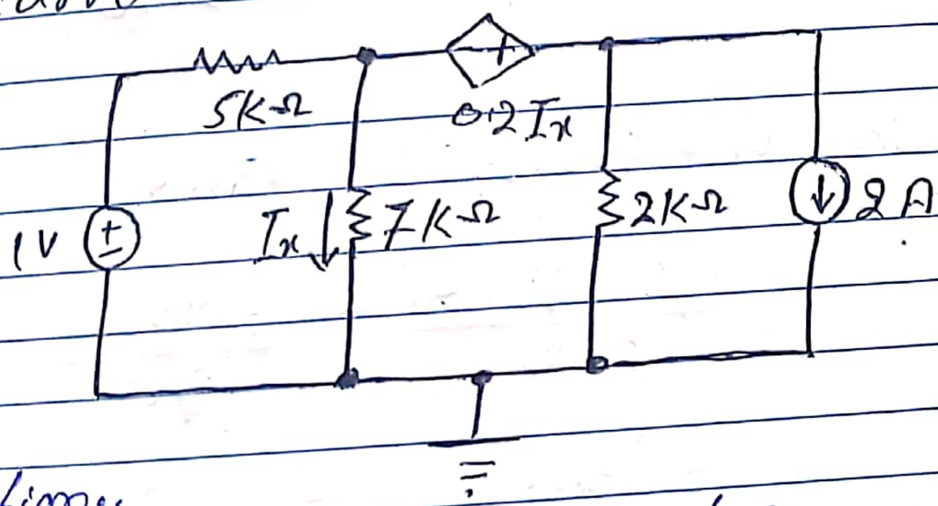
$$\boxed{I_{cs} = 1.7623\ A}$$



we verify our result in part (a) using pspice as shown below we obtain.

$$v_x = 6.053 - 4.737 = \boxed{1.316V}$$

(II) Empoly superposition principles to obtain a values for the current I_x as labeled.



Solution:

Since There are two independet source, let

where I_{x1} and I_{x2} are the contribution due to the 1V voltage source and 2A current source, respectivly.

To obtain i_{x1}, we set the 2A current source to zero (replacing it with an open circuit) as shown below.

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Apply KCL to the supernode X gives

$$\frac{V1-1}{5000}+\frac{V1}{7000}+\frac{V2}{2000}=0$$

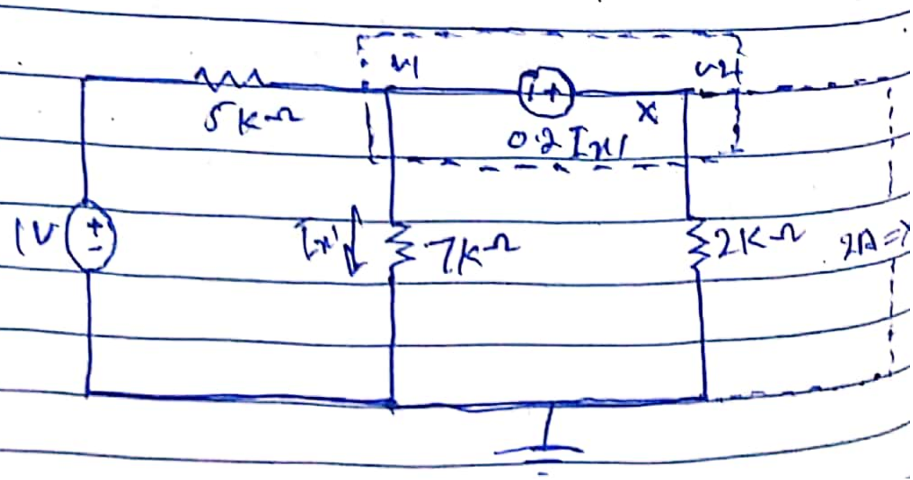
But $V_2 = V_1 + 0.2 I_{x1}$; here

$$\frac{V1-1}{5000}+\frac{V1}{7000}+\frac{V1+0.2I_{x1}}{2000}=0$$

But $V_1 = 7000 I_{x1}$; hence,

$$\frac{7000I_{x1}-1}{5000}+\frac{7000I_{x1}}{7000}+\frac{7000I_{x1}+0.2I_{x1}}{2000}=0$$

Then $\boxed{I_{x1} = 33.9\,\mu A}$



To ... I_{x2} we set the 1V voltage source to zero (replacing it with a short circuit) as shown below.

Apply KCL to the supernode given

$$\frac{V1}{5000} + \frac{V1}{7000} + \frac{V2}{2000} = -2$$

But $V1 = 7000\, I_{x2}$; hence

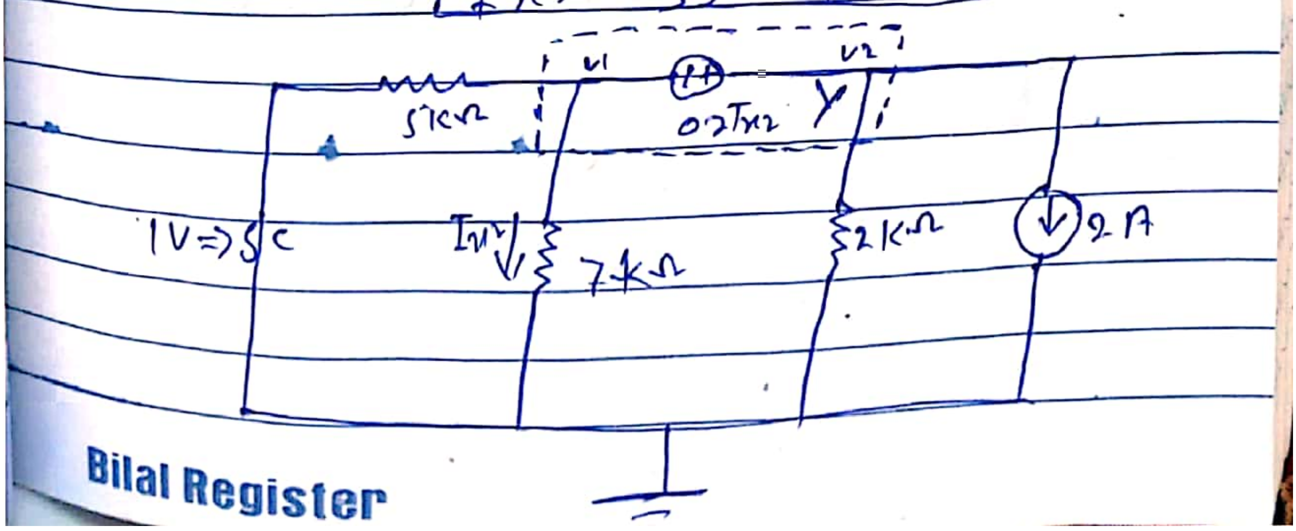
$$\frac{7000 I_{x2}}{5000} + \frac{7000 I_{x2}}{7000} + \frac{7000 I_{x2} + 0.2 I_{x2}}{2000} = -2$$

Thus $\boxed{I_{x2} = -338.98\ mA}$

Therefore; $I_x = I_{x1} + I_{x2}$

$= 33.9\ \mu A + (-338.98 mA)$

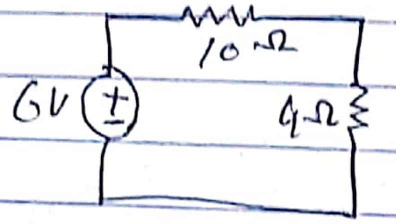
$\boxed{I_x = -338.95\ mA}$



Result:

$I_x = -338.95\,mA$

13:: perform an appropriate source tranformation on each of the circuit depicted in. 5.58, taking care to retain the 4-Ω resistor in each final circuit.



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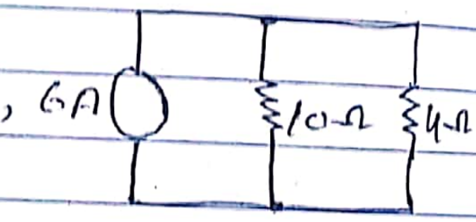
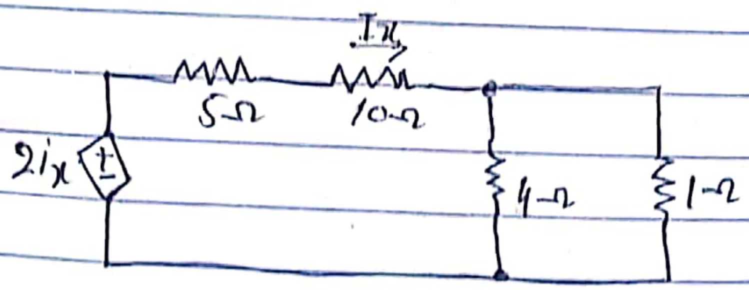




Solution:

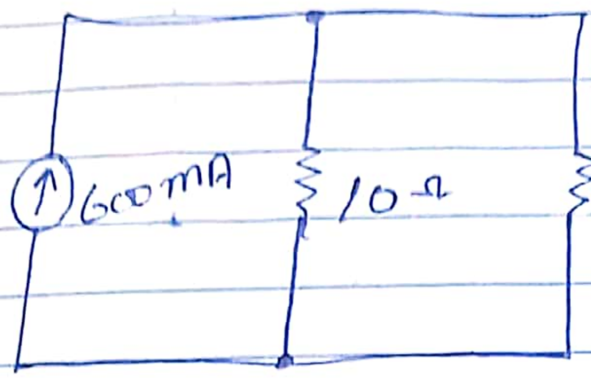
To get the values of the new source we use:

$I \; V/R$

$I = 6/10$

$\boxed{I = 0.6A}$

And we can draw the circuit as:

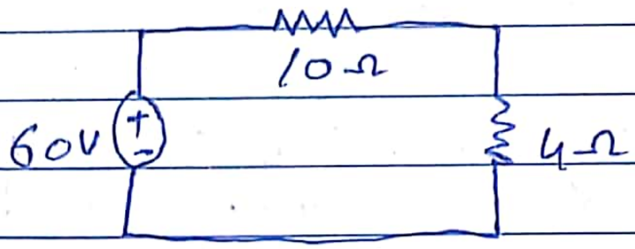


The new voltage source will have the value of:

$$V = 10 \cdot 6$$

$$\boxed{V = 60\,V}$$

And we draw it as

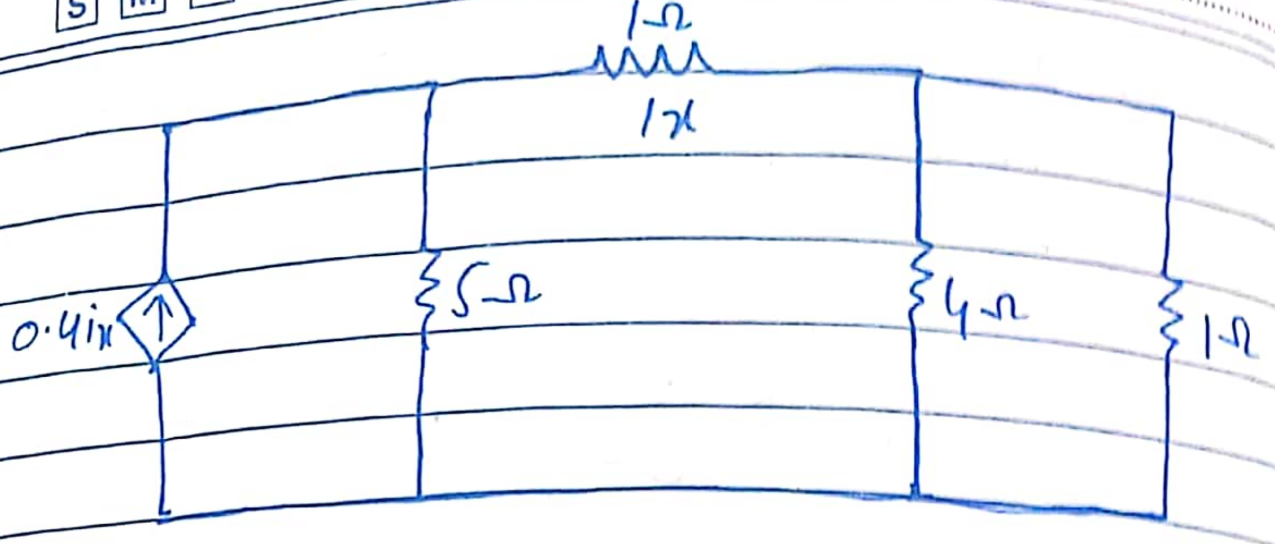


To get the value of the new current source we use

$$I = \frac{2i_x}{5}$$

$$I = 0.4 i_x$$

And we draw it as:



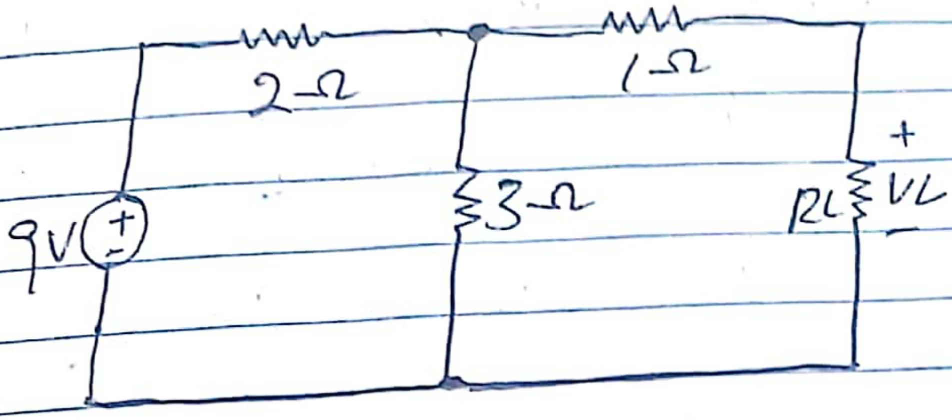
Result :-

(a) We replace the 10 Ω resistor and the voltage source with a 600 mA current source in parallel with a 10 Ω resistor.

(b) We replace the 10 Ω resistor and the current source with a 60V voltage source in series with a 10 Ω resistor.

(c) We replace the 5 Ω resistor and the dependent voltage source with a dependet current source labeled 0.4ix in parallel with a 5Ω resistor.

25:: determine the Thevenin equivalent of the network connected to RL. (b). Determine VL for RL = 1Ω, 3.5Ω, 6.257Ω and 9.8Ω



Solution::

To get V_{Th} we disconnect RL and find the voltage between the two disconnected point. As we can see this voltage is the one on the 3Ω resistor.

$$V_{Th} = 9v \cdot \frac{3}{5}$$

$$\boxed{V_{Th} = 5.4v}$$

we can calculate R_{Th} as:

$$R_{Th} = 1 + 3 \| 2$$

$$\boxed{R_{Th} = 2.2\,\Omega}$$

Then we calculate VL as:

$$V_L = V_{Th} \cdot \frac{R_L}{R_L + R_{Th}}$$

For each value of RL we get:

$R_L = 1\Omega \Rightarrow \boxed{V_L = 1.688V}$

$R_L = 3.5\Omega \Rightarrow \boxed{V_L = 3.316V}$

$R_L = 6.257\Omega \Rightarrow \boxed{V_L = 3.995V}$

$R_L = 9.8\Omega \Rightarrow \boxed{V_L = 4.41V}$

Result:

$V_{Th} = 5.4V$, $R_{Th} = 2.2\Omega$

$V_L = 1.688V, 3.316V, 3.995V, 4.41V$

27: (a) obtain the norton equivalent of the network connected to RL.

(b) obtain the Thévenin equivalent of the same network.

(c) use either to calculate iL for RL = 0 Ω, 1Ω, 4.923 Ω

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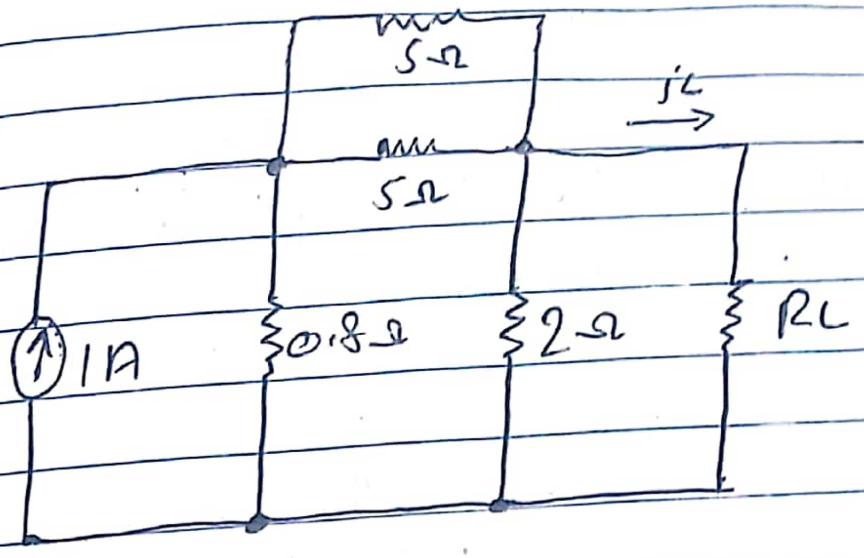
and 8.107 Ω.



Solution:

(a) we calculate RN as:

$$R_N = (0.8 + 5 \parallel 5) \parallel 2$$

$$R_N = 3.3 \parallel 2$$

$$\boxed{R_N = 1.245\,\Omega}$$

For i_N we have:

$$i_N = \frac{0.8}{0.8 + 2.5}$$

$$\boxed{i_N = 0.242A}$$

(b) Now we can V_{Th} as:

$$V_{Th} = i_N . R_N$$

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$\boxed{V_{Th} = 0.302V}$

And

(c) using Thevenin equivalent we get:

$$i_L = \frac{V_{Th}}{R_{Th} + R_L}$$

For each value of RL giving us:

(1) $R_L = 0\Omega \Rightarrow \boxed{i_L = 0.243A}$

(2) $R_L = 1\Omega \Rightarrow \boxed{i_L = 0.135A}$

(3) $R_L = 4.923\Omega \Rightarrow \boxed{i_L = 0.049A}$

(4) $R_L = 8.107\Omega \Rightarrow \boxed{i_L = 0.032A}$

Result:

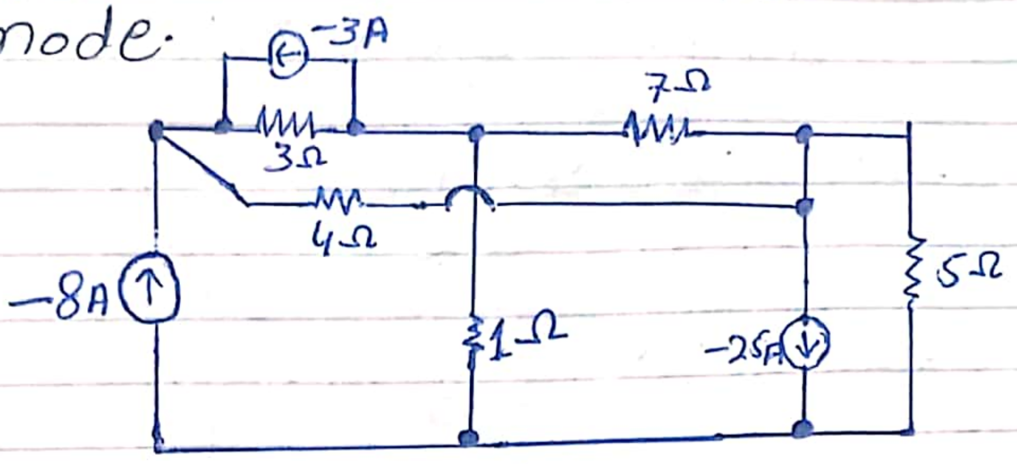
(a) $i_N = 0.242A$, $R_N = 1.245\Omega$

(b) $V_{Th} = 0.302V$, $R_{Th} = 1.245\Omega$

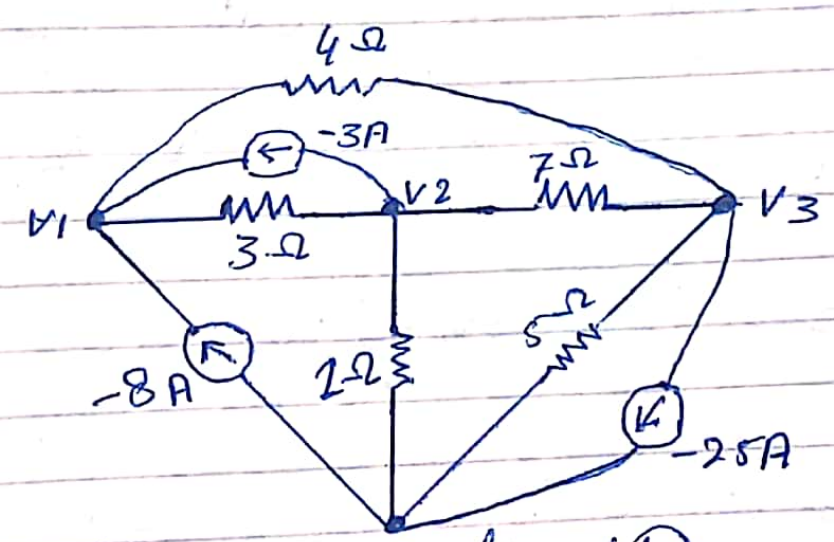
(c) $i_L = 0.243A, 0.135A, 0.049A, 0.032A$.

Example 4.2

Determine the nodal voltages for the circuit of 4.4a, as reference to the bottom node.



(a)



Reference node (b)

Solution:

We have three nodes in the circuit V_1, V_2 and V_3.

Applying KCl on node 1

$$-8-3 = \frac{V_1 - V_2}{3} + \frac{V_2 - V_3}{4}$$

Taking L.C.M

$$-11 = \frac{4V_1 - 4V_2 + 3V_1 - 3V_3}{12}$$

$$-11 = \frac{7V_1}{12} - \frac{4V_2}{12} - \frac{4V_3}{12}$$

$$-11 = 0.5833V_1 - 0.333V_2 - 0.25V_3$$

Applying KCl At node 2

$$3 = \frac{V_2 - V_1}{3} + \frac{V_1}{1} + \frac{V_2 - V_3}{7}$$

$$3 = \frac{7V_2 - 7V_1 + 21V_2 + 3V_2 - 3V_3}{21}$$

$$3 = \frac{-7V_1}{21} + \frac{31V_2}{21} - \frac{3V_3}{21}$$

$$3 = -0.333V_1 + 1.4762V_2 - 0.1429V_3$$

Applying KCl At node 3

$$25 = \frac{V_3}{5} + \frac{V_3 - \cancel{8}_2}{7} + \frac{V_3 - V_1}{4}$$

Taking LCM

$$25 = \frac{28V_3 + 20V_3 - 20V_2 + 35V_3 - 35V_1}{140}$$

$$25 = \frac{-35V_1}{140} - \frac{20V_2}{140} + \frac{83V_3}{140}$$

$$25 = -0.25V_1 - 0.1429V_2 + 0.5929V_3$$

↳ Simplifying Futher by Grammer Rule

$$\underset{A}{\begin{bmatrix} 0.5833 & -0.3333 & -0.2500 \\ -0.3333 & 1.4762 & -0.1429 \\ -0.2500 & -0.1429 & 0.5929 \end{bmatrix}} \underset{B}{\begin{bmatrix} V_1 \\ V_2 \\ V_3 \end{bmatrix}} \underset{C}{\begin{bmatrix} -11 \\ 3 \\ 25 \end{bmatrix}}$$

Let det of $A = \Delta x$

$$\Delta x = \begin{vmatrix} 0.5833 & -0.3333 & -0.2500 \\ 0.3333 & 1.4762 & -0.1429 \\ -0.2500 & -0.1429 & 0.5929 \end{vmatrix}$$

$$\Delta x = 0.5833 \begin{vmatrix} 1.4762 & -0.1429 \\ -0.1429 & 0.5929 \end{vmatrix}$$

$$-(-0.3333) \begin{vmatrix} -0.333 & -0.1429 \\ 0.2500 & 0.5929 \end{vmatrix} - 0.2500 \begin{vmatrix} -0.333 & 1.4762 \\ 0.2500 & -0.1429 \end{vmatrix}$$

$$\Delta x = 0.583(0.875 - 0.020) + 0.333(-0.1976 - 0.0357] - 0.2500(0.0476 - 0.3690)$$

$$\Delta x = 0.49868 - 0.0777 + 0.079$$
$$\Delta x = 0.316$$

Now

$$V_1 = \frac{1}{\Delta x}\begin{bmatrix} -11 & -0.33 & -0.250 \\ 3 & 1.476 & -0.142 \\ 25 & -0.142 & 0.592 \end{bmatrix}$$

$$= -11\begin{bmatrix} 1.476 & -0.142 \\ 0.142 & 0.592 \end{bmatrix} - 3\begin{bmatrix} 0.33 & -0.250 \\ -0.142 & 0.592 \end{bmatrix}$$

$$+25 = \begin{bmatrix} 0.33 & -0.250 \\ 1.476 & -0.142 \end{bmatrix}$$

$$= -11(0.875 - 0.020) - 3(-0.197 - 0.035)$$
$$+25(0.047 + 0.36)$$

$$= -10.145 + 0.69 + 10.41$$
$$= 1.714$$

$$V_1 = \frac{1.714}{0.3167} = 5.412v$$

$$V_2 = \frac{1}{\Delta x}\begin{bmatrix} 0.583 & -11 & -0.250 \\ -0.333 & 3 & -0.142 \\ -0.250 & 25 & 0.592 \end{bmatrix}$$

$$= 0.583\begin{bmatrix} 3 & -0.142 \\ 25 & 0.592 \end{bmatrix} + 11\begin{bmatrix} -0.333 & -0.142 \\ -0.250 & 0.592 \end{bmatrix}$$

$$-0.250\begin{bmatrix} 0.333 & 3 \\ 0.250 & 25 \end{bmatrix}$$

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$= 0.583(1.778 + 3.572) + 11(0.197 - 0.035$
$- 0.25(-8.332 + 0.75$

$= 3.86 - 2.56 + 2.83$

$= 2.450$

So

$$V_2 = \frac{2.45}{0.3167} = 7.73\ V$$

Now

$$V_3 = \frac{1}{\Delta x}\begin{bmatrix} 0.5833 & -0.333 & -11 \\ -0.33 & 1.476 & 3 \\ -0.250 & -0.142 & 25 \end{bmatrix}$$

$$0.583\begin{bmatrix} 0.333 & -11 \\ \cancel{-0.250}\ 1.476 & 3 \end{bmatrix} - (-0.333)\begin{bmatrix} 0.33 & 3 \\ -0.25 & 25 \end{bmatrix}$$

$$-11\begin{bmatrix} 0.333 & 1.4762 \\ 0.250 & -0.142 \end{bmatrix}$$

$= 0.583(15.238) + 0.333(-9.0825)$
$-11(0.107)$

$= 14.67$

$$\text{So}\quad V_3 = \frac{14.67}{0.316} = 46.32\ V$$

So

$V_1 = 5.412\ V$
$V_2 = 7.73\ V$
$V_3 = 46.32\ V$

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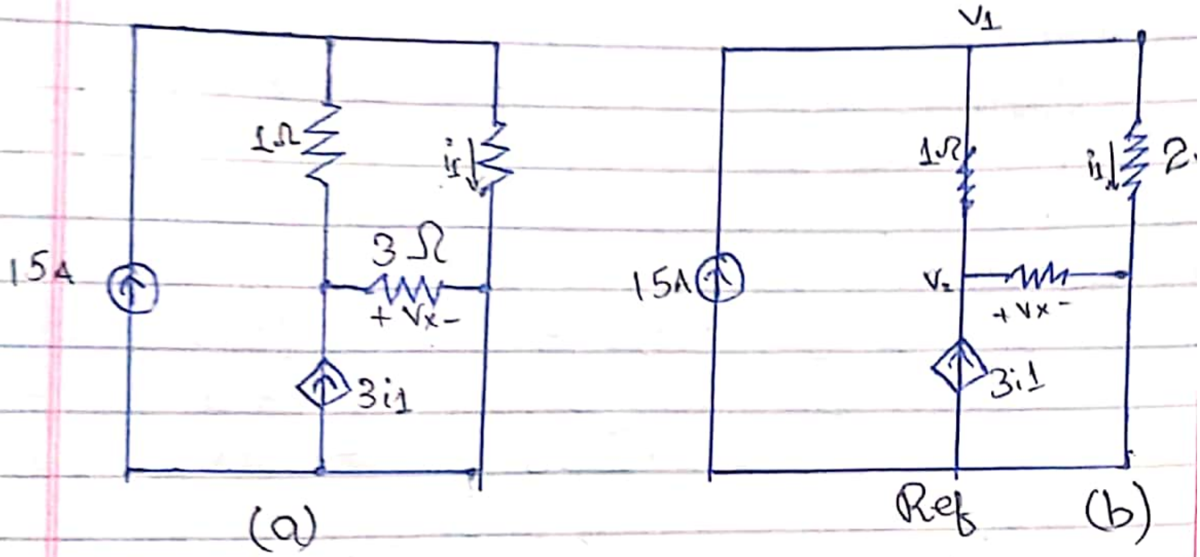
Example 4.3

Determine the power Supplied by the dependent source of figure.



Example 4.3

Solution:

↳ Applying KCl on V_2

$$15 = V_1 - V_2 = \frac{V_1}{2}$$

$$15 = \frac{2V_1 - 2V_2 + V_1}{2}$$

$$30 = 3V_1 - 2V_2 \quad \text{— (i)}$$

↳ Applying KCl on V_2

$$3i_1 = V_2 - V_1 + \frac{V_2}{3}$$

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$3i = 3V_2 \quad 3V_1 + V_2$ -- (2)

i_1 is flowing Across

$\frac{V_1}{3\Omega}$ or $\frac{V_1}{2}$

So $i_1 = \frac{V_1}{2}$

Put eq (2)

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

$9V_1 = 6V_2 - 6V_1 + V_2$

$8V_2 + 15V = 0$

$-15V_1 + 8V_2 = 0$ -- (3)

×ing (5) with eq (i) by

Subtraction from eq (3)

$$\begin{array}{r} \cancel{15}V_1 - 7V_2 = 0 \\ -15V_1 + 10V_2 = 30 \\ \hline 3V_2 = -30 \\ V_2 = -10 \end{array}$$

×ing 5 with eq (i)

$5 \times \quad 3V_1 - 2V_2 = 30$

$= 15V_1 - 10V_2 = 150$

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Combining eq (i) and eq(3)

$$15v_1 - 10v_2 = 150$$
$$\underline{-15v_1 + 8v_2 = 0}$$
$$-2v_2 = 150$$

$$v_2 = -75$$

Putting in eq 3

$$-15v_1 + 8(-75) = 0$$
$$v_1 = -40$$

Now:

$$i_1 = \frac{v_1}{2} = \frac{-40}{2} = -20A$$

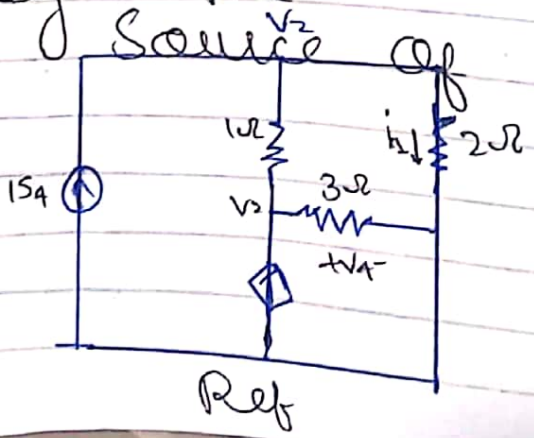
for Power, $P = iv$

$$P = (3i_1)(v) = +3(-20)(-75)$$

$$P = 4.5 \text{ KW}.$$

Example 4.4

Determine the power Supplied by the dependent Source of figure



Applying KCl on V_1

$$15 = V_1 - V_2 + \frac{V_1}{2}$$

$$30 = 2V_1 - 2V_2 + V_1$$
$$30 = 3V_1 - 2V_2 \quad \text{---- (i)}$$

Apply KCl on V_2

$$3V_x = V_2 - V_1 + \frac{V_2}{3}$$

$$V_x = \frac{V_2}{3}$$

$$\frac{\cancel{3}V_2}{\cancel{3}} = \frac{3V_2 - 3V_1 + V_2}{\cancel{3}}$$

$$-3V_1 + V_2 = 0 \quad \text{--- (2)}$$

Combine eq (i) and (2)

$$\cancel{3V_1} - 2V_2 = 30$$
$$\cancel{-3V_1} + V_2 = 0$$
$$V_2 = 30$$

Example 4.5 :

Determine the value of unknown node voltage V_1 in the circuit of figure.

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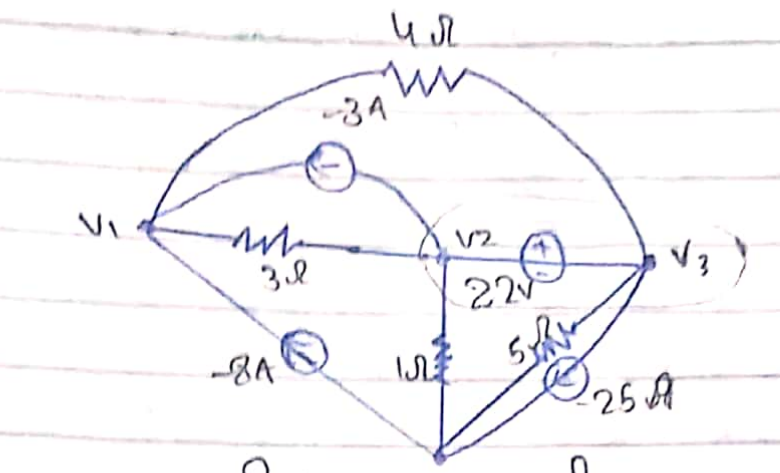


Refrence node

Solution :

Applying KCl on V1

$$-8-3 = \frac{V_1-V_2}{3} + \frac{V_1-V_2}{4}$$

$$-11 = \frac{4V_1-4V_2+3V_1-3V_2}{12}$$

$$(-11)(12) = 7V_1-4V_2-3V_3$$

$$-(132) = 7V_1-4V_2-3V_3 \quad \text{--- (i)}$$

Applying KCl on node i-e

V_2 & V_3.

$$3+25 = \frac{V_2-V_1}{3} + \frac{V_3-V_1}{4} + \frac{V_3}{5} + V$$

$$28 = \frac{20V_2-20V_1+15V_3+12V_3+60V}{60}$$

$(28)(60) = -35V_1 + 80V_2 + 27V_3$

$1680 = -35V_1 + 80V_2 + 27V_3$ —— (2)

Multiply 5 eq (1)

$35V_1 - 20V_2 - 15V_3 = -660$ —— (3)

Combining eq (2) and (3)

$$\begin{array}{r} -\cancel{35}V_1 + 80V_2 + 27V_3 = 1680 \\ \cancel{35}V_1 - 20V_2 - 15V_3 = -660 \\ \hline 60V_2 + 12V_3 = 1020 \end{array}$$

We know from super node

$V_2 + 22 = V_3$ —— (5)

putting V_3 in eq (4)

$60V_2 + V_2 + 22 = 1020$

$61V_2 = 998$

Dividing both side by 61

$$\frac{\cancel{61}V_2}{\cancel{61}} = \frac{998}{61}$$

$V_2 = 998/61$

$$\boxed{V_2 = 16.4}$$

putting in eq (5)

$$16.4 + 22 = V_3$$

$$\boxed{V_3 = 38.4}$$

putting V_2 and V_3 in eq (1)

$$-132 = 7V_1 - 4(16.4) - 3(38.4)$$

$$-132 = 7V_1 - 65.6 - 115.2$$

$$-132 = 7V_1 - 180.8$$

$$180.8 - 132 = 7V_1$$

~~Divided both side by 7~~

~~180.8~~

$$48.8 = 7V_1$$

Divided both side by 7

$$\frac{48.8}{7} = \frac{\cancel{7}V_1}{\cancel{7}}$$

$$\frac{48.8}{7} = V_1$$

$$\boxed{V_1 = 6.971}$$

Result:

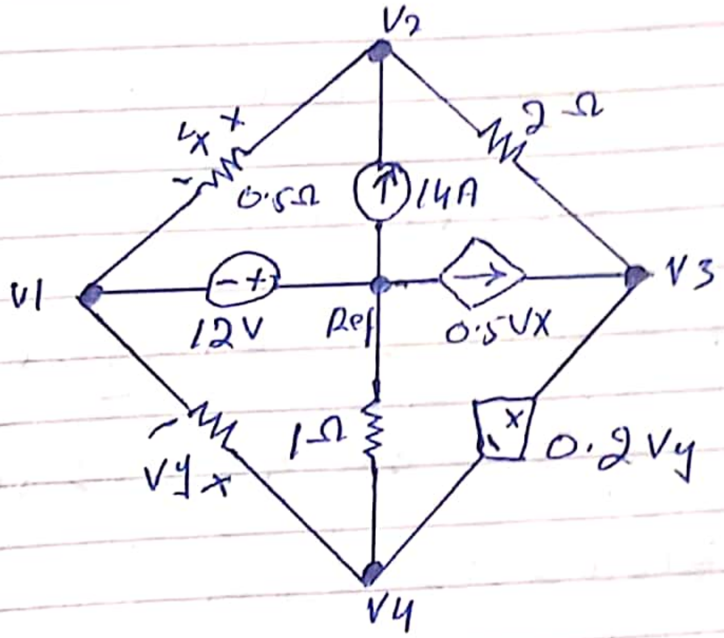
$v1 = 6.971v$, $v2 = 16.4v$

$v3 = 38.4$

~~~

Example 4.6

Determine the node-to reference voltage in the circuit.



Solution:

As $v1 = -12V$

Apply KCL on $v2$

$$\frac{v2 - v1}{0.5} + \frac{v2 - v3}{2} = 14$$
~~~

$$\frac{2V_2 - 2V_1 + 0.5V_2 - 0.5V_3}{1} = 14$$

$$-1V_1 + 2.5V_2 - 0.5V_3 = 14 \quad (1)$$

Apply KCL on supper node
i.e V_3 and V_4

$$0.5V_x = \frac{V_3 - V_2}{2} + \frac{V_4}{1} + \frac{V_4 - V_2}{2.5}$$

$$0.5Vx = \frac{5V_1 - 4.5V_2 + 2.5V_3 + 2V_4}{5}$$

We know that

$$0.5V_x = 0.5(V_2 - V_1)$$

$$0.5V_2 - 0.5V_1 = \frac{5V_1 - 4.5V_2 + 2.5V_3 + 2V_4}{5}$$

$$2.5V_2 - 2.5V_1 = 5V_1 - 4.5V_2 + 2.5V_3 + 2V_4$$

$$7.5V_1 - 7V_2 + 2.5V_3 + 2V_4 = 0 \quad (2)$$

putt the values of equation
V_1 and V_2 in eq (1)
we will get values of V_3

$$-2V_1 + 2.5V_2 - 0.5V_3 = 14$$

$$-(-12) + 2.5(-4) - 0.5V_3 = 14$$

$$12 - 10 - 0.5V_3 = 14$$

$$0.5V_3 = 12$$

$$V_3 = \frac{12}{0.5}$$

$$\boxed{V_3 = 24}$$

putt in eq (2)

$$7.5(-12) - 7(-4) + 2.5(24) + 2V_4 = 0$$

$$2V_4 - 2 = 0$$

$$\cancel{2}V_4 = \cancel{2}$$

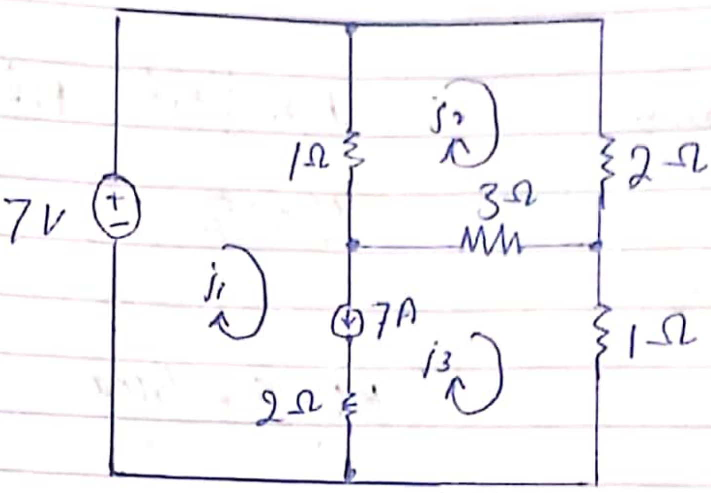
$$V_4 = 1$$

Result:

$V_1 = -12$, $V_2 = -4$, $V_3 = 24$, $V_4 = 1$

Example 4.11

Determine the three mesh current.



(A)

Solution::

We know that there is independent sources between node 2 and node 3 which this a super node.

Apply KVL on super mesh

$1(i_2 - i_1) + 3(i_3 - i_2 + 2i_3 = 7$

$i_2 - i_2 + 3i_3 - 3i_2 + 1i_3 = 7$

$i_1 - 4i_3 + 4i_3 = 7$ ——— (A)

Apply KVL on mesh 2

$(i_2 - i_1) + 2i_2 + 3(i_2 - i_3) = 0$

$$-i_2 + 6i_2 - 3i_2 = 0 \longrightarrow (B)$$

Apply KCL on a node at which independent source is entering.

$$7 + i_3 = i_2$$

$$i_2 - i_3 = 7$$

Apply cramer's rule.

$$\begin{bmatrix} 1 & -4 & 4 \\ -1 & 6 & -3 \\ 1 & 0 & -1 \end{bmatrix} \begin{bmatrix} i_1 \\ i_2 \\ i_3 \end{bmatrix} = \begin{bmatrix} 7 \\ 6 \\ 7 \end{bmatrix}$$

$$|A| = \begin{vmatrix} 1 & -4 & 4 \\ -1 & 6 & -3 \\ 1 & 0 & -1 \end{vmatrix}$$

$$= 1\begin{vmatrix} 6 & -3 \\ 0 & -1 \end{vmatrix} + 4\begin{vmatrix} -1 & -3 \\ 1 & -1 \end{vmatrix} + 4\begin{vmatrix} -1 & 6 \\ 1 & 0 \end{vmatrix}$$

$$= 1(-6) + 4(1+3) + 4(-6)$$

$$= -6 + 16 - 24$$

$$\boxed{|A| = -14}$$

$$|Ax| = \begin{vmatrix} 7 & -4 & 4 \\ 0 & 6 & -3 \\ 7 & 0 & -1 \end{vmatrix}$$

$$= 7\begin{vmatrix} 6 & -3 \\ 0 & -1 \end{vmatrix} + 0 + 7\begin{vmatrix} -4 & 4 \\ 6 & -3 \end{vmatrix}$$

$$= 7(-6) + 7(12 - 24)$$

$$= -42 + 7(-12)$$

$$= -42 - 84$$

$$\boxed{|Ax| = -126}$$

$$Bx = \begin{vmatrix} 1 & 7 & 4 \\ -1 & 0 & -3 \\ 0 & 7 & -1 \end{vmatrix}$$

$$= 1\begin{vmatrix} 0 & -3 \\ 7 & -1 \end{vmatrix} - 1\begin{vmatrix} 7 & 4 \\ 7 & -1 \end{vmatrix} + 0$$

$$= 1(21) - 1(-7 - 28)$$

$$= 21 + 35$$

$$\boxed{|Bx| = 56}$$

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$$Cx = \begin{vmatrix} 1 & -4 & 7 \\ -1 & 6 & 0 \\ 0 & 0 & 7 \end{vmatrix}$$

$$= 1\begin{vmatrix} 6 & 0 \\ 0 & 7 \end{vmatrix} + 1\begin{vmatrix} -4 & 7 \\ 0 & 7 \end{vmatrix} + 0$$

$$= 1(42) + 1(28)$$

$$= 42 + 28$$

$$\boxed{|Cx| = 70}$$

$$|Cx| = \begin{vmatrix} 1 & -4 & 7 \\ -1 & 6 & 0 \\ 1 & 0 & 7 \end{vmatrix}$$

$$= 1\begin{vmatrix} 6 & 0 \\ 0 & 7 \end{vmatrix} + 4\begin{vmatrix} -1 & 0 \\ 1 & 7 \end{vmatrix} + 7\begin{vmatrix} -1 & 6 \\ 1 & 0 \end{vmatrix}$$

$$= 1(42) + 4(-7) + 7(-6)$$

$$= \cancel{42} - 28 - \cancel{42}$$

$$= -28$$

Now

$$i_1 \quad \frac{|Ax|}{|A|} = \frac{-126}{-14} = 9A$$

$$i_2 = \frac{|Bx|}{|A|} = \frac{-56}{-14} = 2.5A$$

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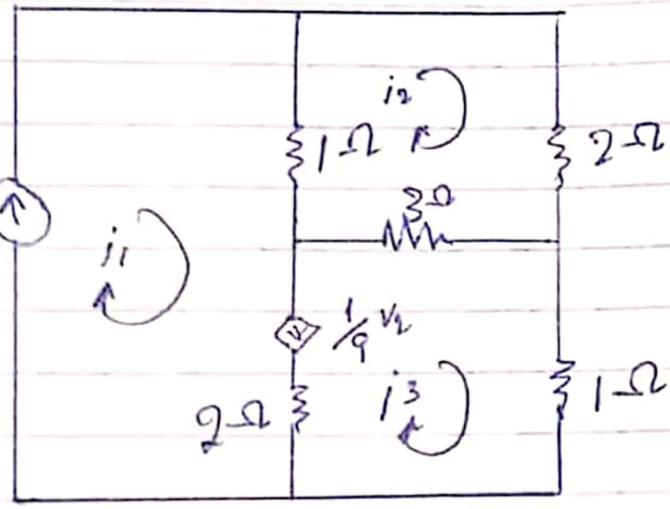
$$i_3 = \frac{|C_x|}{|A|} = \frac{-28}{-14} = 2A$$

Example 4.12

Evaluate the three unknown currents in the circuit.



Solution:

we have one dependent current and one independent source.

Now

we have the V1 = 15A
we have to find two unknown source.

Apply KCL on a node

unsource is entering

$$i_1 + \frac{1}{9} v_x = i_3$$

$$\frac{v_x}{9} = i_3 - i_1$$

$v_x = 3(i_3 - i_2$ from figure
putting in equation.

$$\frac{\cancel{3}(i_3 - i_2)}{\cancel{9}\,3} = i_3 - i_1$$

$$\frac{1}{3} i_3 - \frac{1}{3} i_2 = i_3 - i_1$$

$$-i + i_3 + \frac{1}{3} i_2 - \frac{1}{3} i_3$$

$$-i_1 + \frac{1}{3} i_2 + \frac{2}{3} i_3 = 0$$

$$\boxed{i_1 = 15}$$

$$-15 + \frac{1}{3} i_2 + \frac{2}{3} i_3 = 0$$

$$\frac{1}{3} i_2 + \frac{2}{3} i_3 = 15 \quad \text{—— (A)}$$

$$i_2 + 2i_3 = 45 \quad \text{—— (1)}$$

Apply KVL on mesh 2

$$1(i_1 - i_2) + 2i_2 + 3(i_2 - i_3) = 0$$

$$i_2 - i_1 + 2i_2 + 3i_2 - 3i_3 = 0$$

$$-i_1 + 6i_2 - 3i_3 = 0$$

$$\boxed{i_1 = 15}$$

$$-15 + 6i_2 - 3i_3 = 0$$

$$6i_2 - 3i_3 = 15 \text{ ———— } (2)$$

combining eq (1) and (2)

$$\cancel{6i_2} + 12i_3 = 270$$
$$-\cancel{6i_2} - 3i_3 = -15$$

$$9i_3 = 285$$

$$i_3 = \frac{285}{9}$$

$i_3 = 28.33A$ and

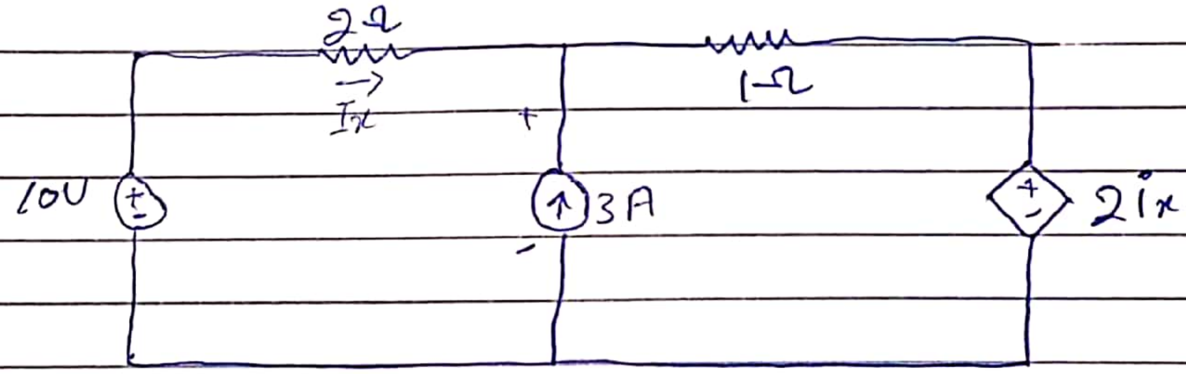
$i_2 = 11A$

Q2 part (ii)

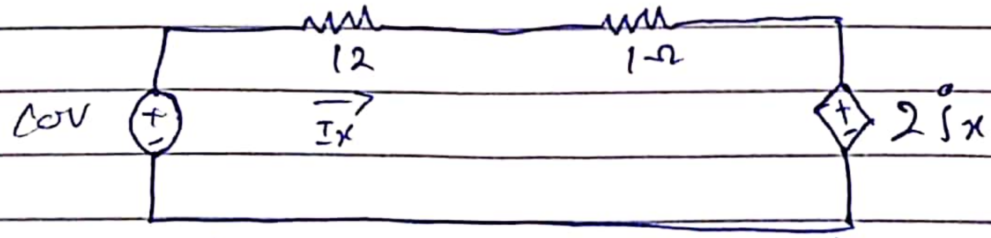
Solve following example

Example 5.3 :-

Use the superposition principle to determine the value of i_x



Solution:- First we will remove current source and will make it in open circuit. Redrawing the circuit

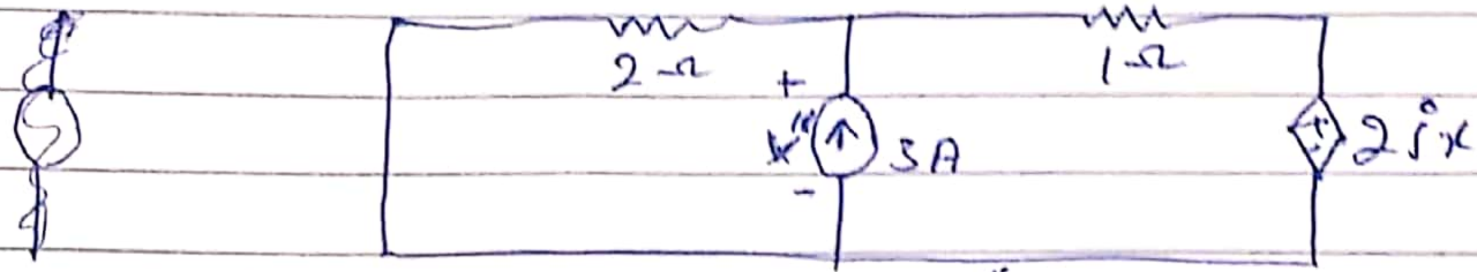


Apply KVL on mesh

$$2i_x' + 1i_x' + 2i_x' = 0$$

$$5i_x' = 10 \implies i_x' = 2A$$

Now we will remove voltage sour
and make it an open current.



Apply KCL on V''

$$\frac{V''}{2} + \frac{V'' - 2ix''}{1} = 3$$

$$\frac{V'' + 2V'' - 2ix''}{2} = 3$$

$$3V'' - 4ix'' = 6$$

We Now from the Figure

$$V'' = -2ix''$$

$$3(-2ix'') - 4ix = 6$$

$$-10ix'' = 6$$

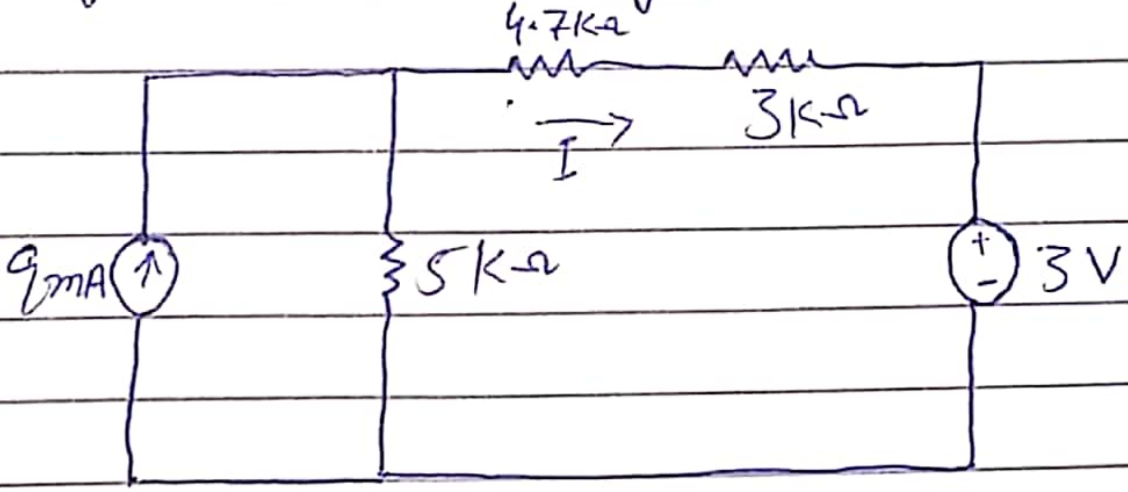
$$ix = -0.6\ A$$

$$ix = ix' + ix''$$

$= 2 + (-0.6)$

$$\boxed{i_x = 1.4A}$$

Example 5.4: compute the current through the 4.7 kΩ resistor after transforming the 9 mA source into an equivalent voltage source.



Solution: we know that

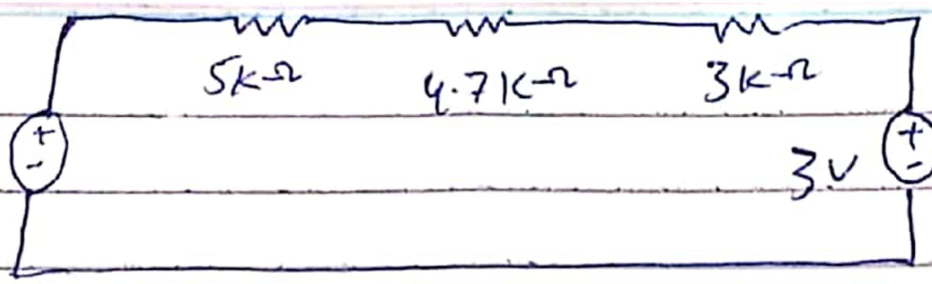
$$V = IR$$

$$V = (9\times10^{-3})(5000)$$

$$= (0.009)(5000)$$

$$V = 45$$

Re drawing the circuit



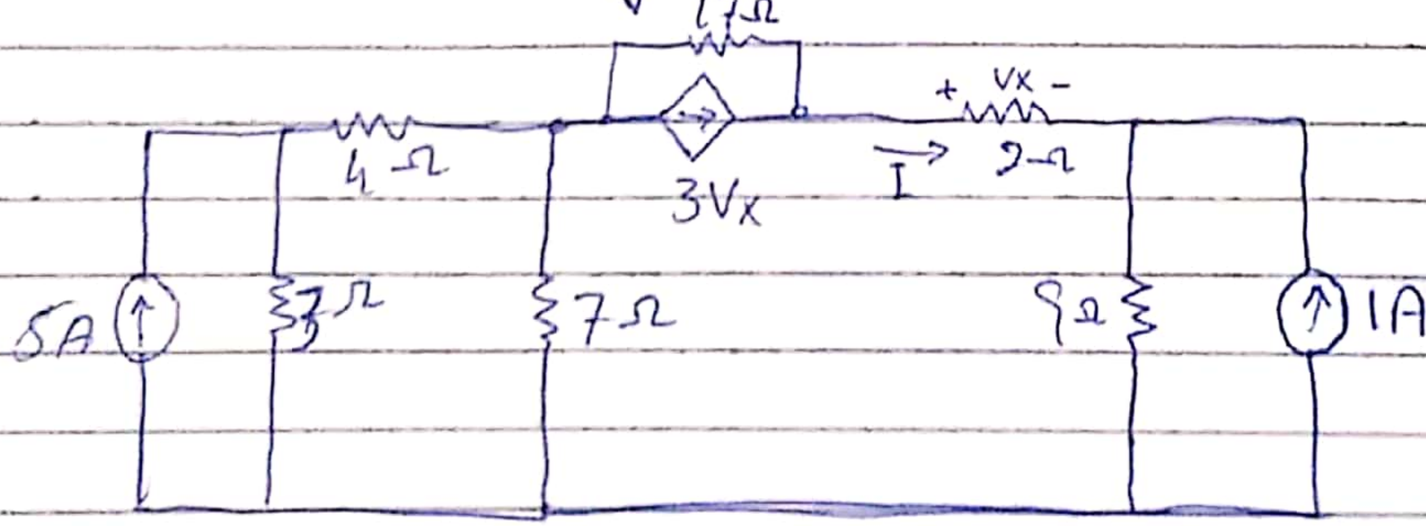
Apply KVL on mesh

$$5000i + 4700i + 3000i = 45 - 3$$

$$12700i = 42$$

$$\boxed{i = 0.0033A}$$

Example 4.5: calculate the current through the 2Ω resistor by making use of source transformation to first simplify the current.

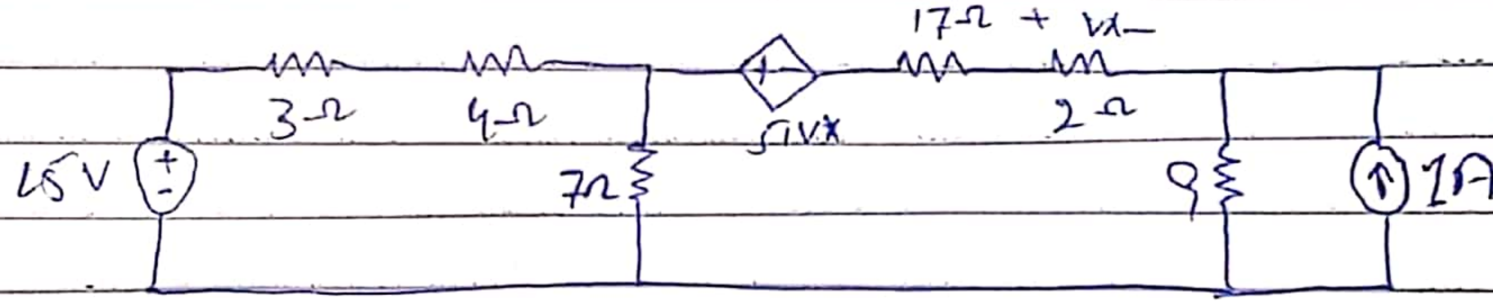


$V = 5(3) = 15\,V$

$V_x = 3(17)$

$V_x = 51$

Re drawing a circuit



$R = 3 + 4$

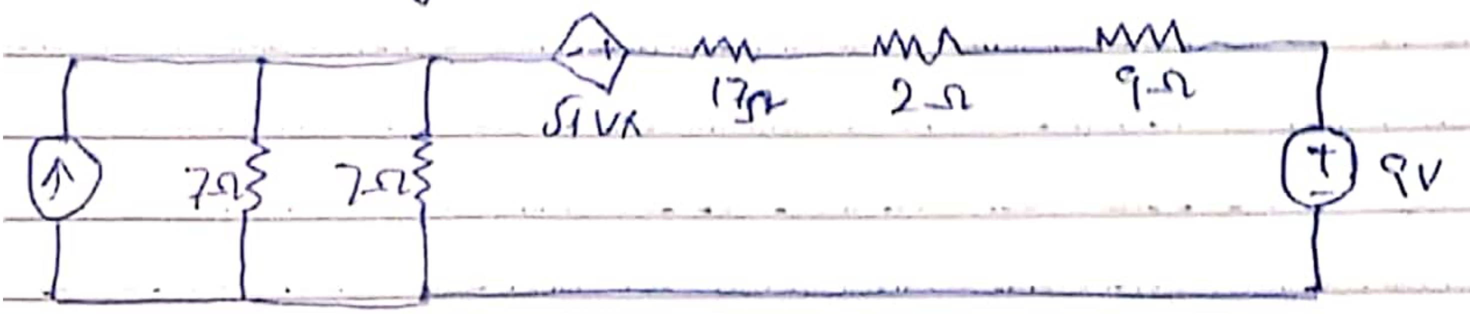
$= 7\,\Omega$

$I = \frac{V}{R} = \frac{15}{2} = 7.5$

$V = IR = 9(1)$

$\boxed{V = 9}$

e drawing a circuit

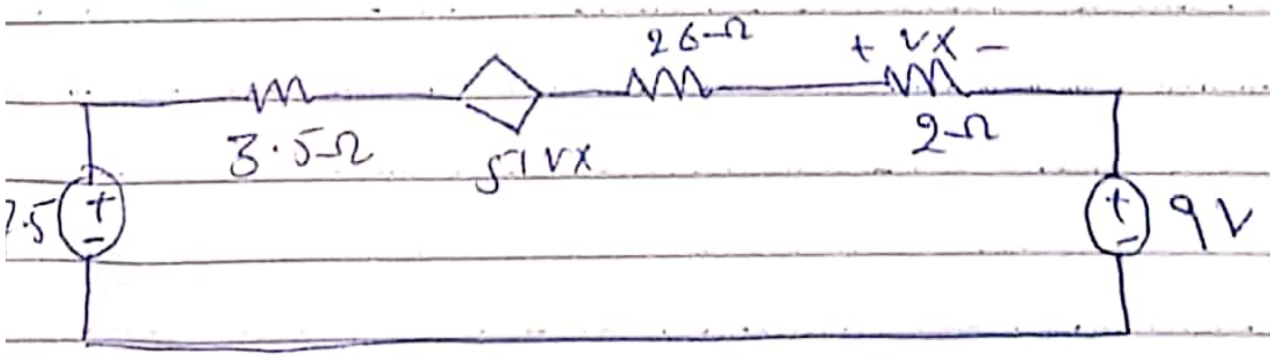


$$V = IR = \left(\frac{15}{7}\right)(7)$$

$$V = 7.5$$

$$R = 17 + 9$$

$$R = 26\Omega$$



Apply KVL on mesh j

$$3.5j - 51V + 28i = 7.5 - 9$$

$$Vx = 21$$

$$3.5j - 51(22)j + 28j = -1.5$$

$$j = \cancel{-1.5 / -1039.5} \Rightarrow \boxed{j = 0.0014A}$$

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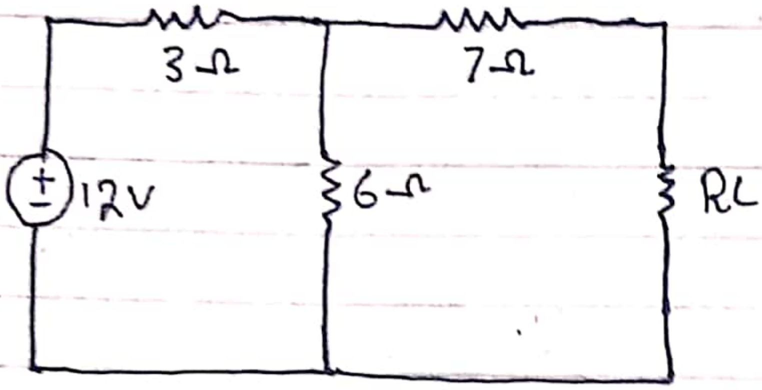
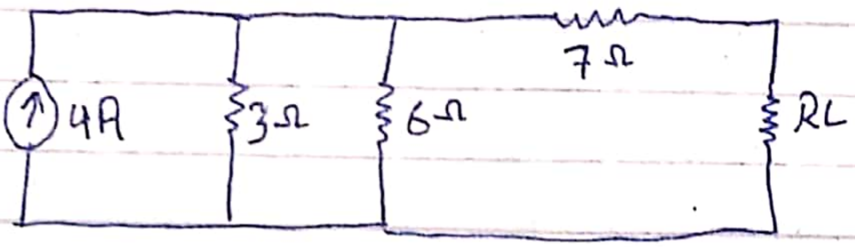
Example 5.6: Consider the circuit shown in Fig. Determine the thévenin equivalent of network A, and compute the power deliververed to the Load resistor RL.

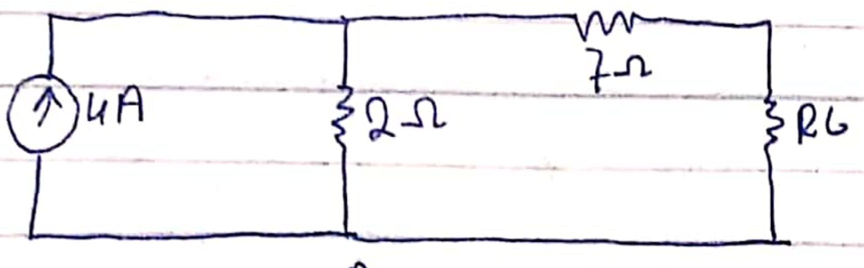


Solution:

$$I = V/R = 12/3 = \cancel{9}\ 4A$$

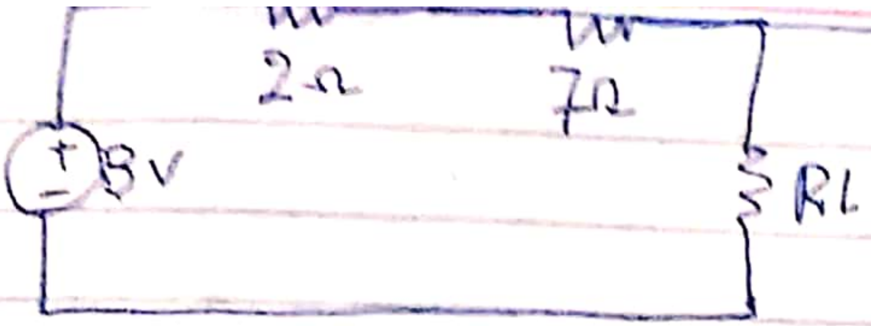


$$R_{eq} = \frac{3\times 6}{3\times 6} = \frac{18}{9} = 2\Omega$$

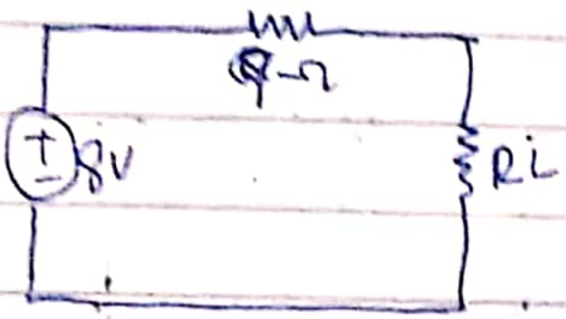


$$v = IR = 4(2)$$

$$V = 8v$$



$R = 2+7 = 9$



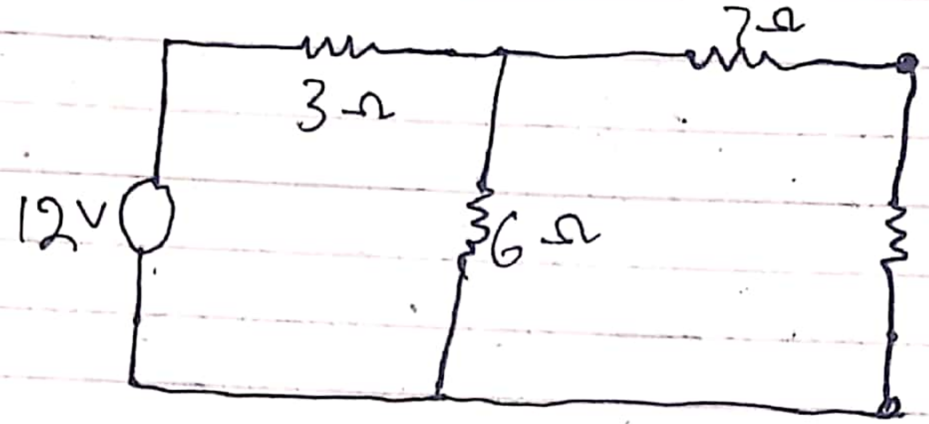
$V_{Th} = 8V$

$R_{Th} = 9\Omega$

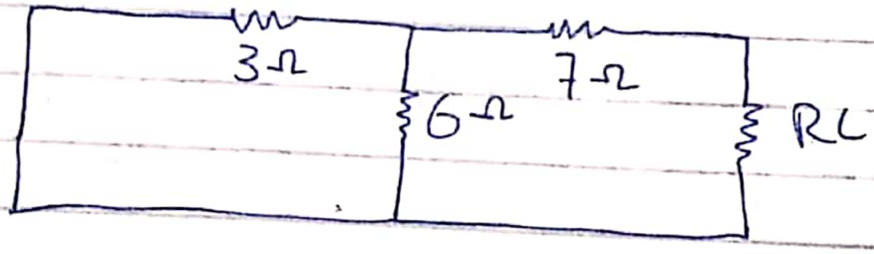
$R.P = \left(\frac{8}{7 + RL}\right)^2 RL$

For any value of RL with have different solution

Example 5.7: Use Thevenin's Theorem determine The Thevenin equivalen for that part of the circuit in to the lift of RL.



For Finding Rth we will remove voltage Source and make it is a Short circuit.



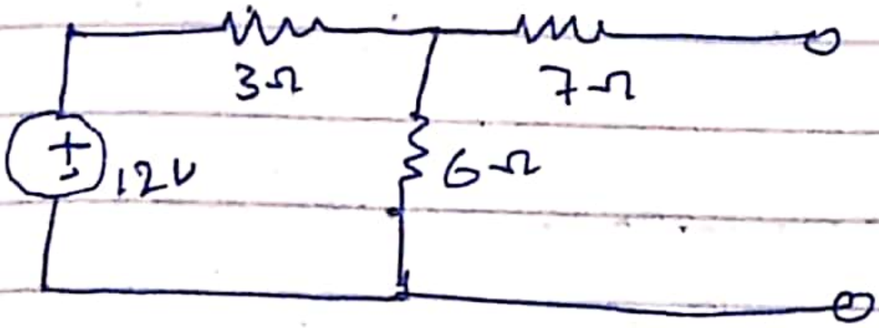
For Rth we will add all the resistor except RL

$$R_{Th} = 3 \| 6 + 7$$

$$= \frac{18}{2} + 7$$

$$R_{Th} = 9$$

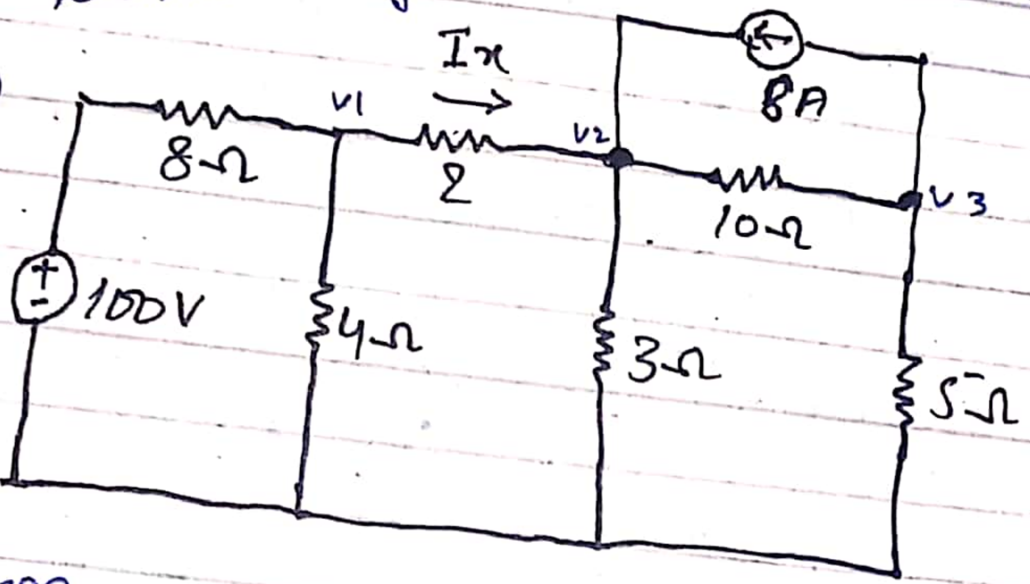
For Voc we will remove RL and make it is an open circuit.



$$V_{oc} = 12\left(\frac{6}{3+6}\right)$$

$$\boxed{V_{oc} = 8V}$$

(part 1)



Solution:

Apply KCL on node 1:

$$\frac{V1-100}{8}+\frac{V1}{4}+\frac{V1-V2}{2}=0$$

$$\frac{V1-100+2V1+4V1-4V2}{8}=0$$

$$7V1-4V2=100 \quad \text{——— (1)}$$

Apply KCL on node 2:

$$\frac{V2-V1}{2}+\frac{V2}{3}+\frac{V2-V3}{18}=8$$

$$\frac{30V2-30V1+20V2+3V2-3V3}{60}=8$$

$-30v_1 + 53v_2 - 3v_3 = 480$ —— (2)

Apply KCL on node 3:

$$\frac{v_3 - v_2}{10} + \frac{v_3}{5} = -8$$

$$\frac{v_3 - v_2 + 2v_3}{10} = -8$$

$-v_2 + 3v_3 = -80$ —— (3)

Taking eq (1)

$7v_1 - 4v_2 = 100$

$v_1 = \frac{4v_2 + 100}{7}$ —— (a)

Taking eq (2)

$-v_2 + 3v_3 = -80$

$v_3 = \frac{v_2 - 80}{3}$ —— (b)

putting eq (a) and (b) in eq (2)

$30(0.57v_2 + 14.28) + 53v_2 - 3(0.33v_2 - 26.67) =$

$-17.1v_2 - 428.4 + 53v_2 - 0.99v_2 + 80.01 = 48$

$$34.91v_1 = 828.39$$

$$v_2 = \frac{828.39}{34.91}$$

$$\boxed{v_2 = 20.31}$$

putting on eq (a)

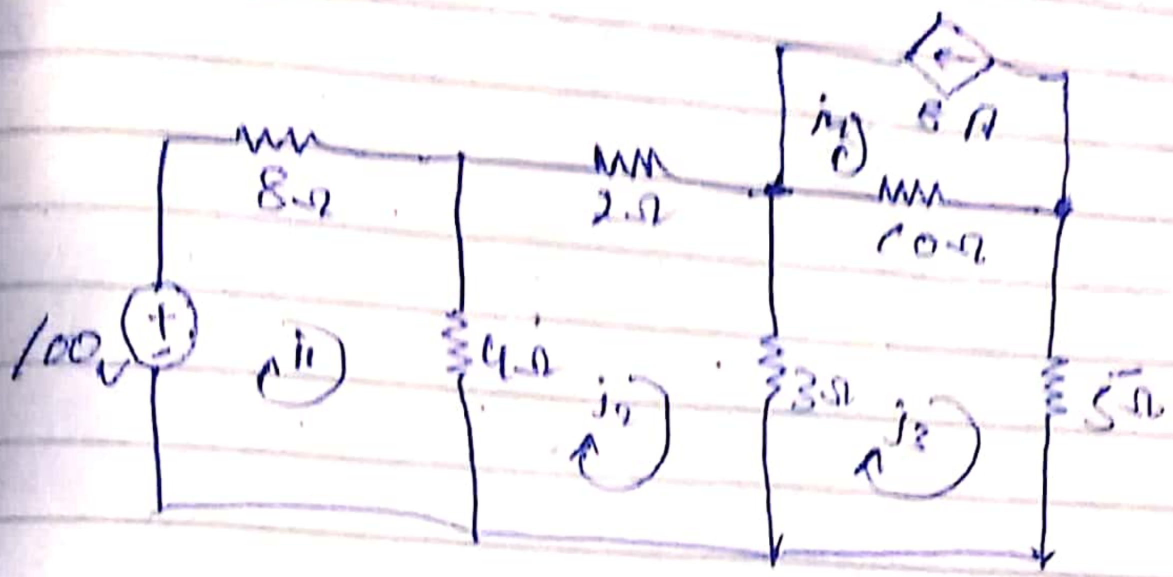
$$v_2 = \frac{4(20.31) + 100}{7}$$

$$v_2 = 25.89$$

$$i_x = \frac{v_1 - v_2}{2} = \frac{25.89 - 20.31}{2}$$

$$\boxed{i_x = 2.79 A}$$

i) Mesh analysis



Apply KVL on loop 1

$$8i_1 + 4(i_2 - i_2) = 100$$

$$8i_1 + 4i_2 - 4i_2 = 100$$

$$12i_2 - 4i_2 = 100 \quad \text{--- (1)}$$

Apply KVL on loop 2.

$$2i_2 + 4(i_2 - i_2) + 3(i_3 - i_2) = 0$$

$$2i_2 + 4i_2 - 4i_2 + 3i_3 - 3i_2 = 0$$

$$-4i_2 + 9i_2 - 3i_3 = 0 \quad \text{--- (2)}$$

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Apply KVL on Loop 3 :-

$3(i_3 - i_2) + 10(i_3 - i_4) + 5i_3 = 0$

$3i_3 - 3i_2 + 10i_3 - 10i_4 + 5i_3 = 0$

As $i_4 = 8$

$-3i_2 + 18i_3 = -80$ —— (3)

Taking eq (1)

$i_1 = \frac{4i_2 - 100}{12}$ —— (a)

Taking eq (3)

$-3i_2 + 18i_3 = -80$

$i_3 = \frac{-3i_2 + 80}{18}$ —— (b)

Putting eq (a) and (b) on eq (2)

$-4(0.33i_2 - 8.33) + 9i_2 - 3(0.16i_2 + 4.44) = 0$

$\Rightarrow -1.32i_2 + 33.32 + 9i_2 - 0.48i_2 - 13.32$

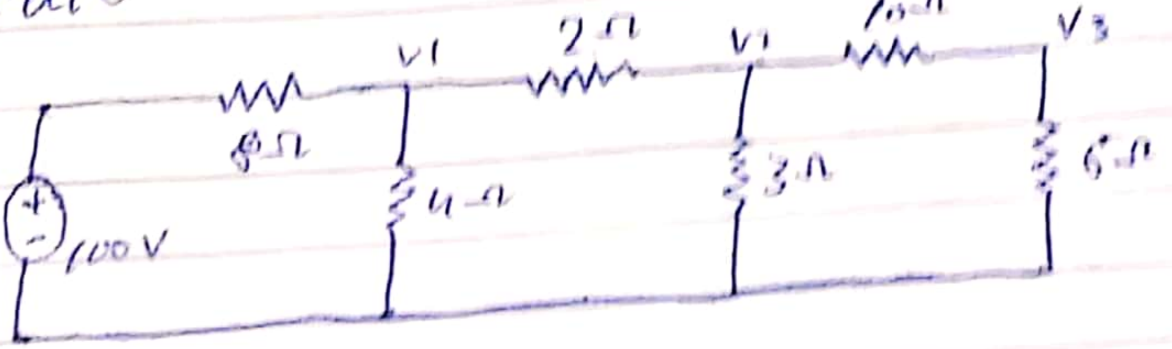
$7.2i_2 = +20$

$i_2 = 20/7.2 \Rightarrow i_2 = i_x$

$i_2 = 2.79A \Rightarrow \boxed{i_x = 2.79A}$

(iii) Superposition Theorem:

First removing the current source and making it an open circuit. Re drawing the circuit



Apply KCL on node 1

$$\frac{-100+v_1}{8} + \frac{v_1 - v_2}{2} + \frac{v_1}{4} = 0$$

$$\frac{v_1 - 100 + 4v_1 - 4v_1 + 2v_3}{8} = 0$$

$$7v_1 - 4v_2 = +100 \quad \text{—— (1)}$$

Apply KCL on node 2:

$$\frac{v_2 - v_1}{2} + \frac{v_2}{3} + \frac{v_2 - v_3}{10} = 0$$

$$-30v_1 + 58v_2 - 3v_3 = 0$$

Apply KCL on node 3

$$\frac{V3-V2}{10}+\frac{V3}{5}=0$$

$$\frac{V3-V2+V3}{10}=0$$

$$-V2+2V3=0 \quad \text{——— (3)}$$

Now Taking eq (1) and (2)

$$7V1-4V2=100$$

$$V1=\frac{4V2+100}{7} \quad \text{——— (a)}$$

Now $-V2+3V3=0$.

$$U3=\frac{1}{3}V2 \quad \text{——— (b)}$$

putting am eq (2)

$$-30(0.57V2+14.28)-4V2+2(0.33V2)=0$$

$$-17.1V2-428.4-4V2+0.60V2=0$$

$$20.44V2=428.4$$

$$V2=-20.95$$

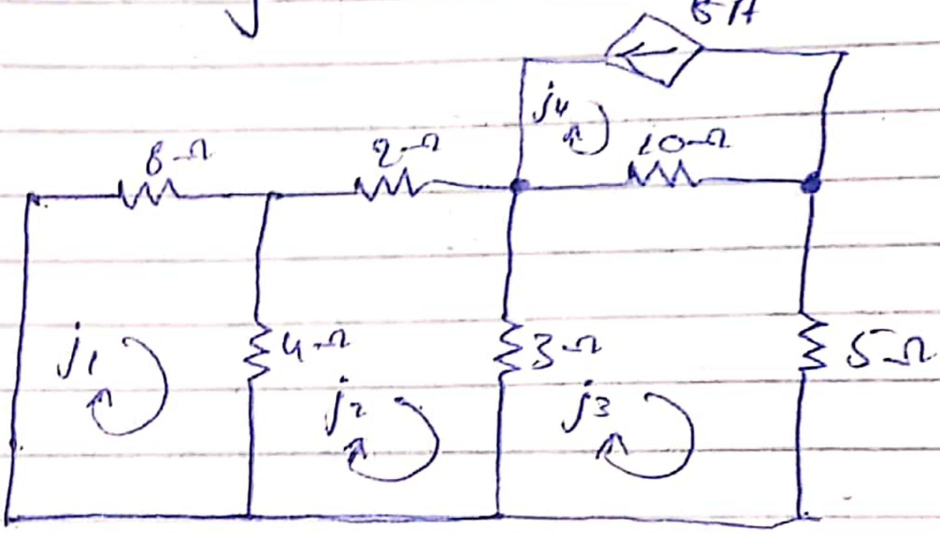
putting on eq (a)

$v_2 = 2.31$

$$i_1 = \frac{2.31 + 20.95}{2}$$

$\boxed{i_1 = 11.63}$

Now Removing voltage source and making it short circuit Re drawing circuit.



$i_4 = 8A$

Apply KVL on Loop 1:

$8i_1 + 4(i_1 - i_2) = 0$

$8i_1 + 4i_1 - 4i_2 = 0$

$12i_1 - 4i_2 = 0$

$3i_1 - i_2 = 0$ ——— (1)

Apply KVL on loop 2:

$2i_2 + 3(i_2 - i_3) + 4(i_2 - i_1) = 0$

$2i_2 + 3i_2 - 3i_3 + 4i_2 - 4i_1 = 0$

$-4i_1 + 9i_2 - 3i_3 = 0$ ——— (2)

Apply KVL on loop 3:

$10i_3 + 5i_3 + 3i_3 - 3i_2 + 8(10) = 0$

$-3i_2 + 18i_3 = -80$ ——— (3)

Taking eq (1)

$3i_1 - i_2 = 0$

$i_1 = 0.33 i_2$ ——— (a)

Taking eq (3)

$-3i_2 + 18i_3 = -80$

$i_3 = \frac{3i_2 - 80}{18}$ ——— (b)

$-4(0.33i_2) + 9i_2 - 3(0.16i_2 - 4.44) = 0$

$1.32i_2 + 9i_2 - 0.48i_2 + 13.32 = 0$

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$\dot{I}_2 = 1.354$

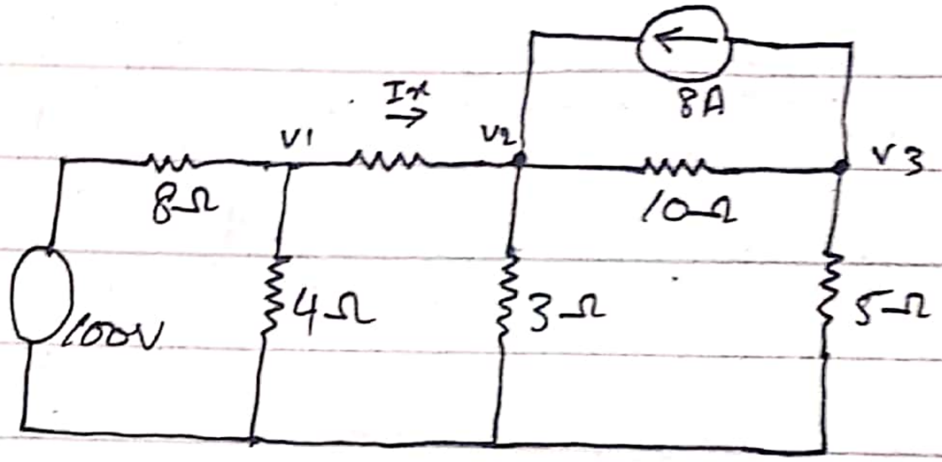
Now $\dot{I}_x = \dot{I}_1 + \dot{I}_2$

$\dot{I}_x = 1.44 + 1.35$

$\dot{I}_x = 2.79\,A$

Result : $\boxed{\dot{I}_x = 2.79\,A}$

Q4:: compare the number of steeps and degree of easiness of all the Three methods with each other



Node analysise

Solution:: Apply KCL on node:

$$\frac{V1-100}{8}+\frac{V1}{4}+\frac{V1-V2}{2}=0$$

$$\frac{V1-100+2V1+4V1-4V2}{8}=0$$

$$7V1-4V2=100 \quad \text{—— (1)}$$

Apply KCL node 2:

$$\frac{V2-V1}{1}+\frac{V2}{3}+\frac{V2-V3}{18}=8$$

$$\frac{30V_2 - 30V_1 + 20V_2 + 3V_2 - 3V_3}{60} = 8$$

$$-30V_1 + 53V_2 - 3V_3 = 480 \quad \text{—— (2)}$$

Apply KCL on node 3:

$$\frac{V_3 - V_2}{10} + \frac{V_3}{5} = -8$$

$$\frac{V_3 - V_2 + 2V_3}{10} = -8$$

$$-V_2 + 3V_3 = -80 \quad \text{—— (3)}$$

Taking eq (1)

$$7V_1 - 4V_2 = 100$$

$$V_1 = \frac{4V_2 + 00}{7} \quad \text{—— (a)}$$

Taking eq (2)

$-v_2 + 3v_3 = -80$

$$v_3 = \frac{v_2 - 80}{3} \quad \text{——— (b)}$$

putting (a) and (b) in eq (2)

$$-30(0.57v_2 + 14.28) + 53v_2 - 3(0.33v_2 - 26.67) = 480$$

$$-17.1v_2 - 428.4 + 53v_2 - 0.99v_2 + 80.01 = 480$$

$$34.91v_2 = 828.39$$

$$v_2 = \frac{828.39}{34.91}$$

$$v_2 = 20.31$$

putting in eq (a)

$$v_2 = \frac{4(20.31) + 100}{7}$$

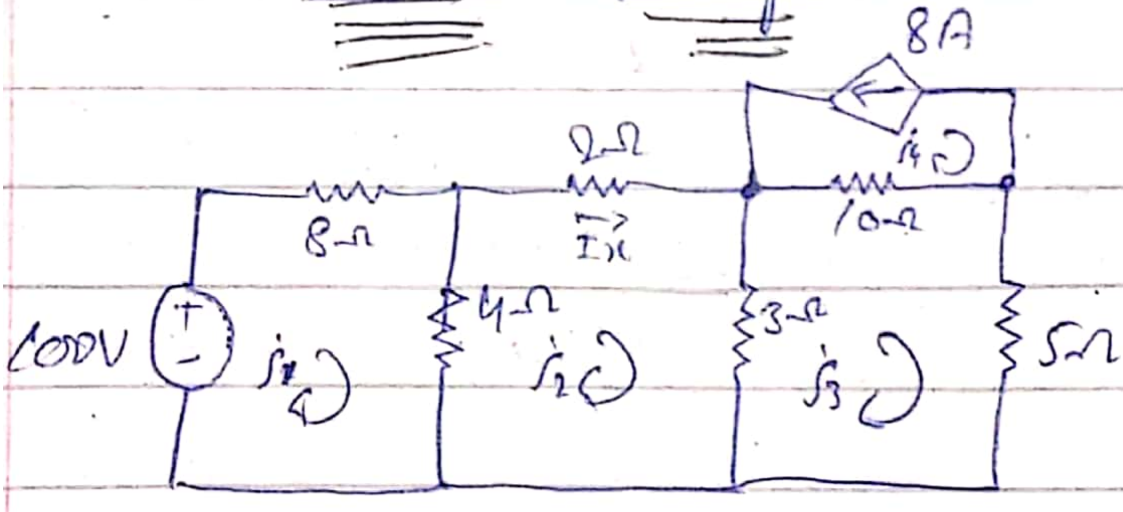
$v_2 = 25.89$

$$i_x = \frac{v_1 - v_2}{2}$$

$$i_x = \frac{25.89 - 20.31}{2}$$

$$\boxed{i_x \quad 2.79A}$$

Mesh analysis



Apply KVL on loop 1:

$8i_1 + 4(i_2 - i_2) = 100$

$8i_1 + 4i_2 - 4i_2 = 100$

$12i_2 - 4i_2 = 100$ —— (1)

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Applying KVL on Loop 2:

$$2i_2 + 4(i_2 - i_2) + 3(i_3 - i_2) = 0$$

$$2i_2 + 4i_2 - 4i_2 + 3i_3 - 3i_2 = 0$$

$$-4i_2 + 9i_2 - 3i_3 = 0 \quad \text{—— (2)}$$

Apply KVL on Loop 3:

$$3(i_3 - i_2) + 10(i_3 - i_4) + 5i_3 = 0$$

$$3i_3 - 3i_2 + 10i_3 - 10i_4 + 5i_3 = 0$$

As $i_4 = 8$

$$-3i_2 + 18i_3 = -80 \quad \text{—— (3)}$$

Taking eq (1)

$$i_1 = \frac{4i_2 - 100}{12} \quad \text{—— (a)}$$

Taking eq (3)

$$-3i_2 + 18i_3 = -80$$

$$i_3 = \frac{-3i_2 + 80}{18} \quad \text{——— (b)}$$

putting (a) and (b) in eq (2)

$$-4(0.33i_2 - 8.33) + 9i_2 - 3(0.16i_2 + 4.44) = 0$$

$$-1.32i_2 + 33.32 + 9i_2 - 0.48i_2 - 13.32 = 0$$

$$7.2i_2 = 20$$

$$i_2 = 20/7.2 \quad \Rightarrow i_2 = 2.79A$$

$$i_2 = i_x$$

$$\boxed{i_x = 2.79\,A}$$

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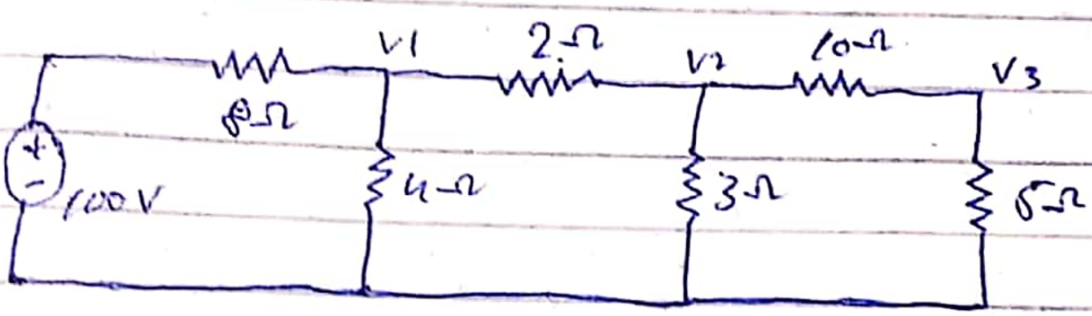
(iii) Superposition Theorem:

First removing the current source and making it an open circuit Re drawing the circuit



Apply KCL on node 1

$$\frac{-100+V1}{8} + \frac{V1-V2}{2} + \frac{V1}{4} = 0$$

$$\frac{V1-100+4V1-4V1+2V3}{8} = 0$$

$7V1 - 4V2 = +100$ —— (1)

Apply KCL on node 2:

$$\frac{V2-V1}{2} + \frac{V2}{3} + \frac{V2-V3}{10} = 0$$

$-30V1 + 53V2 - 3V3 = 0$ ——

Apply KCL on node 3.

$$\frac{V3 - V2}{10} + \frac{V3}{5} = 0$$

$$\frac{V3 - V2 + V3}{10} = 0$$

$$-V2 + 2V3 = 0 \text{ ——— } (3)$$

Now Taking eq (1) and (2)

$$7V1 - 4V2 = 100$$

$$V1 = \frac{4V2 + 100}{7} \text{ ——— } (a)$$

Now

$$-V2 + 3V3 = 0 .$$

$$V3 = \frac{1}{3} V2 \text{ ——— } (b)$$

putting am eq (2)

$$-30(0.57V2 + 14.28) - 4V2 + 2(0.33 V2) = 0$$

$$-17.1V2 - 428.4 - 4V2 + 0.60V2 = 0$$

$$20.44V2 = 428.4$$

$$V2 = -20.95$$

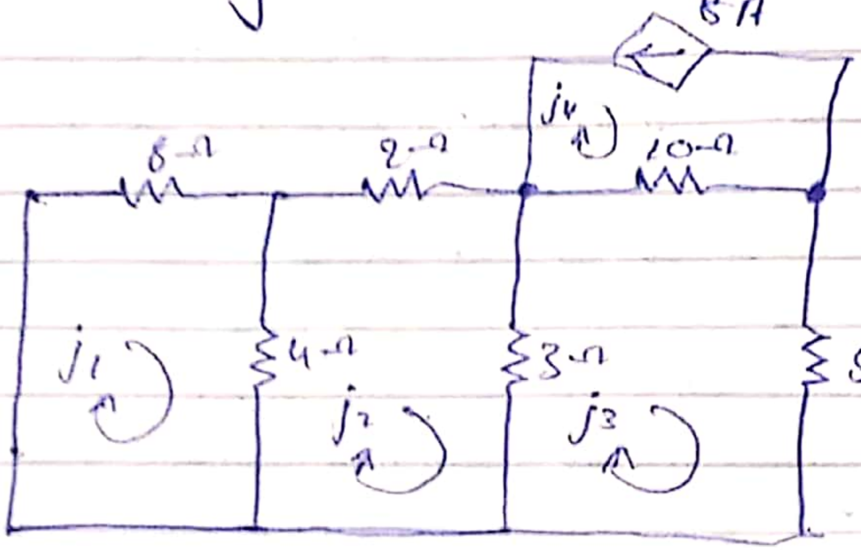
putting in eq (a)

$v_2 = 2.31$

$i_1 = \dfrac{2.31 + 20.95}{2}$

$\boxed{i_1 = 11.63}$

Now Removing voltage source and making it short circuit Re drawing circuit.



$i_4 = 8A$

Apply KVL on Loop 1:

$8i_1 + 4(i_1 - i_2) = 0$

$8i_1 + 4i_1 - 4i_2 = 0$

$12i_1 - 4i_2 = 0$

$3i_1 - i_2 = 0$ ——— (1)

Apply KVL on loop 2:

$$2i_2+3(i_2-i_3)+4(i_2-i_1)=0$$

$$2i_2+3i_2-3i_3+4i_2-4i_1=0$$

$$-4i_1+9i_2-3i_3=0 \quad \text{—— (2)}$$

Apply KVL on loop 3:

$$10i_3+5i_3+3i_3-3i_2+8(10)=0$$

$$-3i_2+18i_3=-80 \quad \text{—— (3)}$$

Taking eq (1)

$$3i_1-i_2=0$$

$$i_1=0.33i_2 \quad \text{—— (a)}$$

Taking eq (3)

$$-3i_2+18i_3=-80$$

$$i_3=\frac{3i_2-80}{18} \quad \text{—— (b)}$$

$$-4(0.33i_2)+9i_2-3(0.16i_2-4.44)=0$$

$$1.32i_2+9i_2-0.48i_2+13.32=0$$

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$\dot{I}_2 = 1.354$

Now $\dot{I}x = \dot{I}_1 + \dot{I}_2$

$\dot{I}x = 1.44 + 1.35$

$\dot{I}x = 2.79\,A$

Result $\boxed{= \dot{I}x = 2.79\,A}$