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Semester: 2nd

Deptt. : Electrical.

Subject: Linear Circuit analysis

Assignment:

Ques :- Solve the following questions from text book.

(i) Chapter 4 :- 2, 12, 13, 19, 29, 32, 35, 46, 47
(ii) Chapter 5 :- 10, 11, 13, 25, 29

Chapter 4 :-

Q2) Evaluate the following determinant.

(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.

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

$$= 6 - (-4)$$

$$= 6 + 4$$

$$\boxed{\det(A) = 10}$$

b) evaluate determinant from the first Column

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

$= 0(4\times5 - 1\times(-1)) - 6(2\times5 - 11\times(-1)) + 3(2\times1 - 11\times4)$

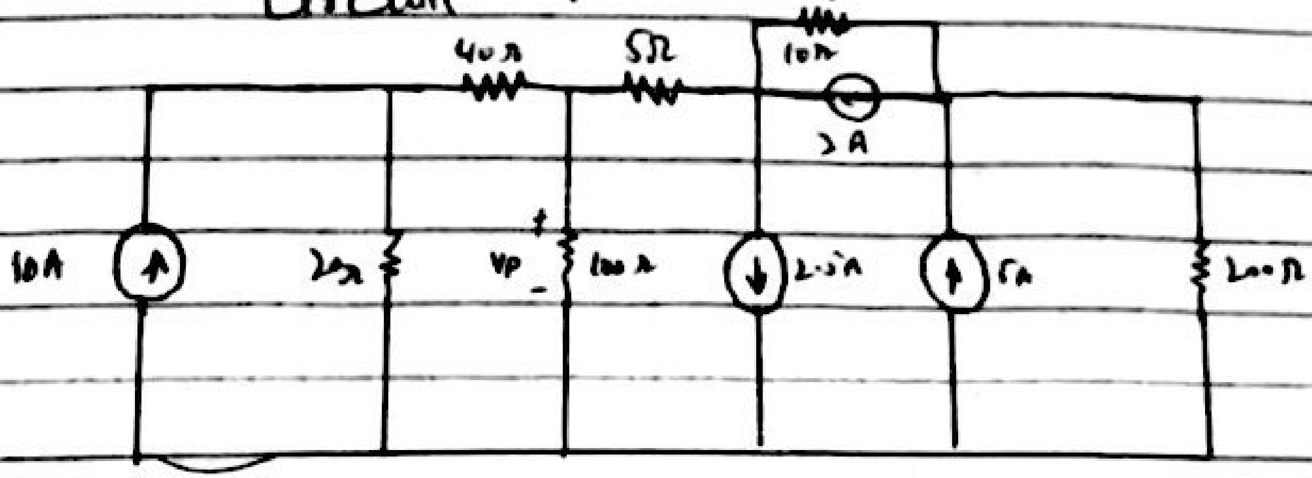
$= 0(21) - 6(21) + 3(-42)$

$= 0 - 126 - 126$

$= 0 - 252$

$\boxed{\det(B) = -252}$

Q12 Use nodal analysis to find v_P in the circuit



Sol

Apply KCL to node V_1 give

$$10 = \frac{V_1}{20} + \frac{V_1 - V_P}{40} \quad -①$$

Apply KCL to node V_P give

$$0 = \frac{V_P - V_1}{40} + \frac{V_P}{100} + \frac{V_P - V_2}{50} \quad -②$$

Apply KCL to node V_2 give

$$2 - 2.5 = \frac{V_2 - V_P}{50} + \frac{V_2 - V_3}{10} \quad - ③$$

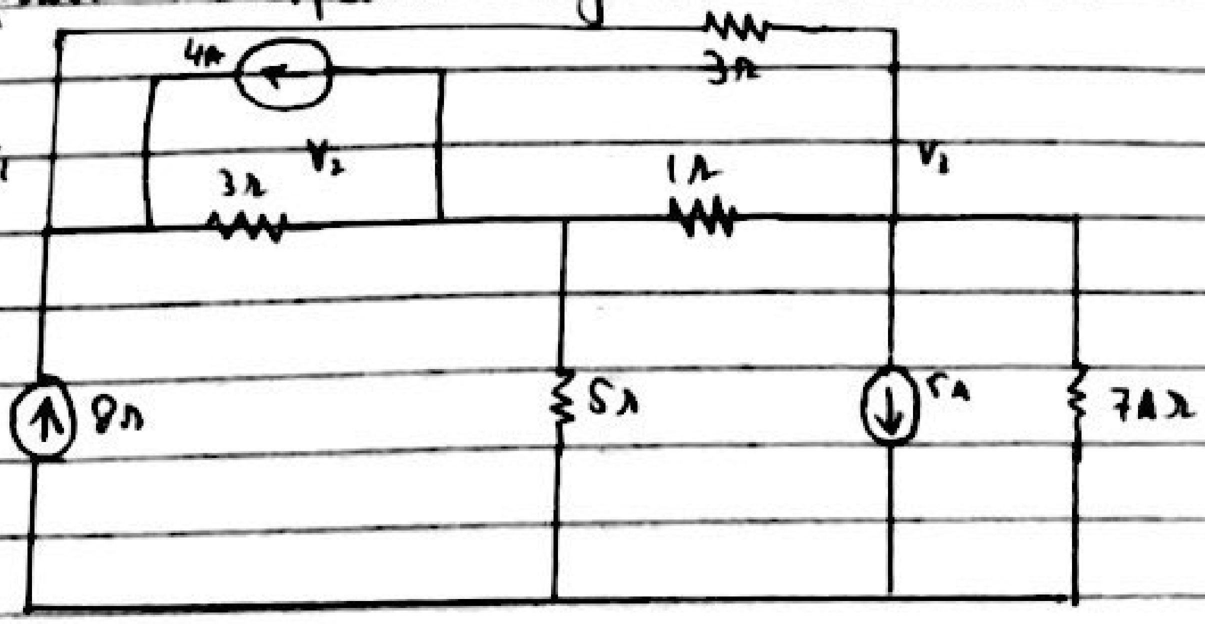
Apply KCL to node V_3

$$5-2 = \frac{V_3 - V_2}{10} + \frac{V_3}{20} \quad -(3)$$

Solve the four equation
(1), (2), (3), and (4) then

$$V_P = 171.639\ V,$$

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



Sol

The voltage accross the 8A current source to be V_1, while V_2 denote the voltage across the 5Ω resistor, finally the voltage across the 5A current is labeled as -

From the node V_1

$$-8-4+\frac{V_1-V_2}{3}+\frac{V_1-V_3}{3}=0$$

$$\left(\frac{1}{3}+\frac{1}{3}\right)V_1-\left(\frac{1}{3}\right)V_2-\left(\frac{1}{3}\right)V_2=12$$

$$2V_1-V_2-V_3=36 \quad -①$$

From node V_2

$$4+\frac{V_2-V_1}{3}+\frac{V_2}{5}+\frac{V_2-V_3}{1}=0$$

$$-\left(\frac{1}{3}\right)V_1+\left(\frac{1}{2}+\frac{1}{3}\right)V_2-V_3=-4$$

$$-5V_1+23V_2-15V_3=-60 \quad -②$$

From node V_3

$$5+\frac{V_3-V_2}{1}+\frac{V_3-V_1}{9}+\frac{V_3}{7}=0$$

$$-\left(\frac{1}{3}\right)V_1-V_2+\left(1+\frac{1}{3}+\frac{1}{7}\right)V_3=-5$$

$$-7V_1-21V_2+31V_3=-105 \quad -③$$

Solve the three eq ①, ② and ③

$$V_1=26.733V$$
$$V_2=8.833V$$
$$V_3=8.633V$$

Thus $V_{5\Omega}=V_2$

$$\boxed{V_{5\Omega}=8.833\,V}$$

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Since the voltage across the 7Ω resistor is V_3. Therefore

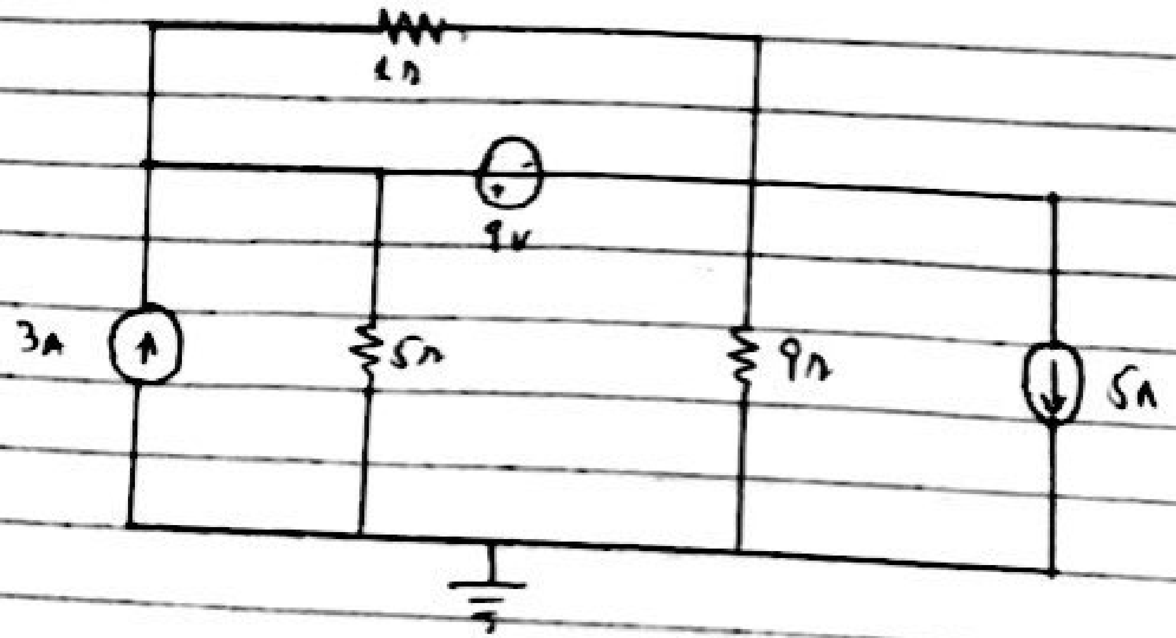
$$P_{7\Omega} = \frac{V_3^2}{7}$$

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

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

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

Q19) determine the numerical value for the voltage labeled V_1



Solution:

Consider V_1 and V_2 as a super node

Apply KCL on super node.

$$\frac{V_1 - V_2}{1} + \frac{V_1}{5} + \frac{V_2 - V_1}{1} + \frac{V_2}{9} = 3 - 5$$

$$\frac{45V_1 - 45V_2 + 9V_1 + 45V_2 - 45V_1 + 9V_2}{45} = 3 - 5$$

$$9V_1 + 9V_2 = 135 \quad - (1)$$

So

$$V_1 - V_2 = 9 \quad - (2)$$

Combining eq (1) and (2)

$$9V_1 + 9V_2 = 135$$
$$9V_1 - 9V_2 = 81$$
$$18V_1 = 216$$

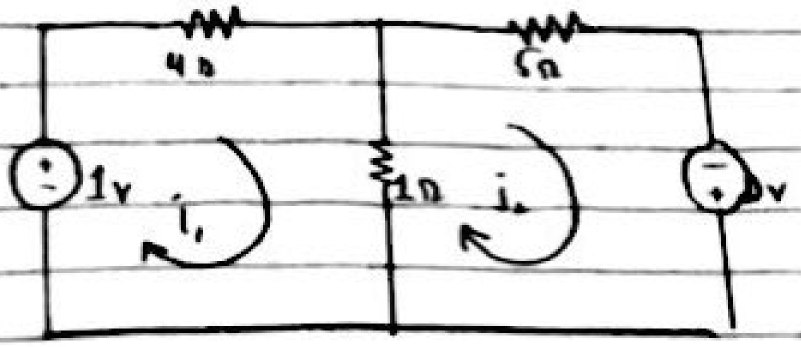
$$V_1 = \frac{216}{18}$$

$$\boxed{V_1 = 12V}$$

Put in eq - (2)

$$V_2 = V_1 - 9$$
$$V_2 = 12 - 9$$
$$\boxed{V_2 = 3}$$

Q27) Determine the current flowing out of the positive terminal of each voltage source in the circuit.



Solution:

Applying KCL on i_1

$$4i_1 + 1(i_1 - i_2) = 1$$
$$5i_1 - i_2 = 1 \quad \text{— (i)}$$

Applying KVL on i_2

$$1(i_2 - i_1) + 5i_2 = 2$$
$$-i_1 + 6i_2 = 2 \quad \text{— (ii)}$$

Multiply 5 with eq (2)
& adding with eq (1)

$$5i_1 - i_2 = 1$$
$$-5i_1 + 30i_2 = 10$$
$$29i_2 = 1$$
$$i_2 = 11/29$$

$\boxed{i_2 = 0.379}$

Puting in eq ①

$5i_1 = 1 + 0.379$

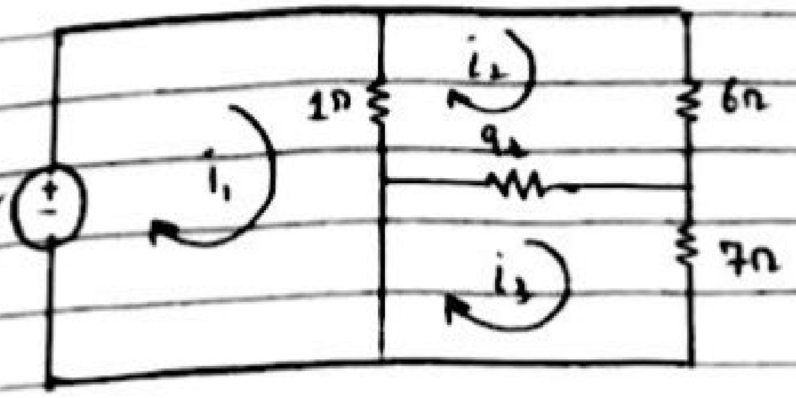
$i_1 = 0.275$ A

Result

$i_1 = 0.275$ A

$i_2 = 0.379$ A

Q32



Sol.

write the equati.

$-2 + 1(i_1 - i_2) - 3 + 5(i_1 - i_3) = 0$

$6i_1 - i_2 - 5i_3 = 5$ — ①

write the 2nd eq.

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

$-i_1 + 16i_2 - 9i_3 = 0$ — ②

write 3rd eq.

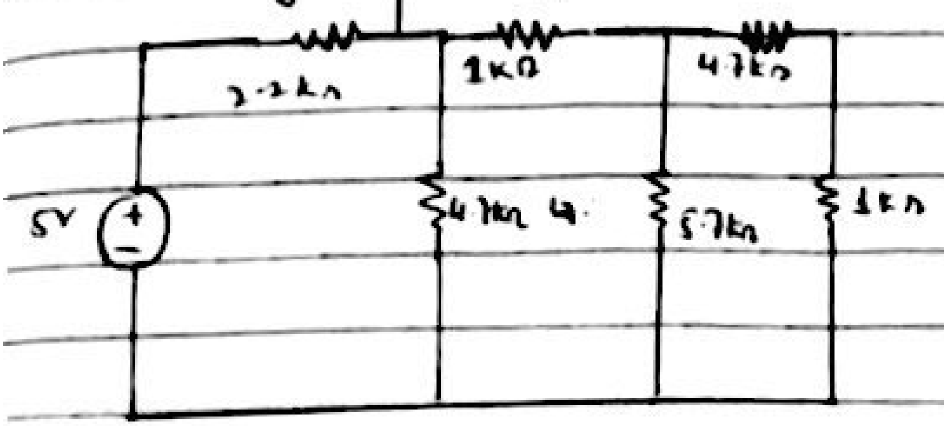
$5(i_3 - i_1) + 3 + 9(i_3 - i_2) + 7i_3 = 0$

$-5i_1 - 9i_2 + 21i_3 = -3$ — ③

Solve the three eq ①, ② and ③

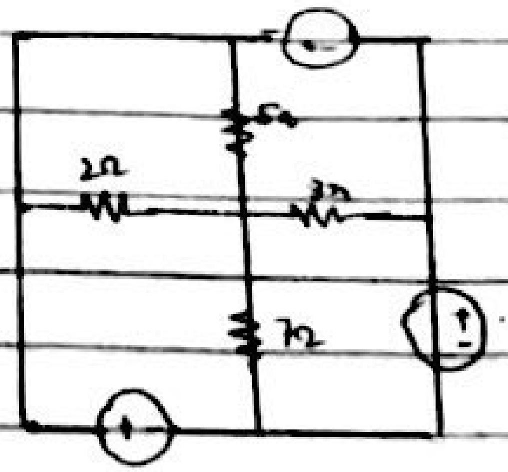
$i_1 = 989.205$ mA
$i_2 = 150.147$ mA
$i_3 = 157.017$ mA.

Q28) Chose nonzero value of the three voltage. Source of figure so that current flows through any resister in the circuit.



Solut-

let name the sources V_1, V_2 And V_3 from top to bottom.



And the current i_1, i_2, i_3 and i_4

form the currents in resistor to be equal to zero.

$i_1 - i_2 = 0$

$i_3 - i_4 = 0$

$i_1 - i_3 = 0$

$i_2 - i_4 = 0$

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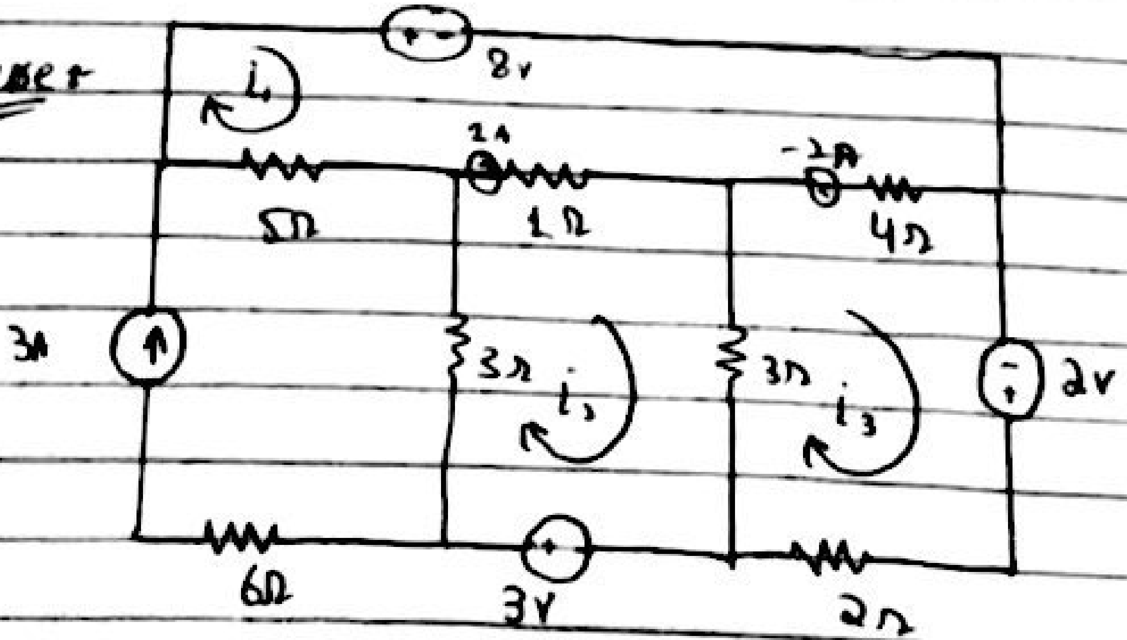
(2) Now we will apply KVL on each of the four loops

$$2 \cdot (i_1 - i_3) + 5 (i_1 \quad i_2) = 0$$
$$3 \cdot (i_2 - i_4) + 5 (i_2 \quad i_1) = -V_2$$
$$7 \cdot (i_3 - i_4) + 2 \cdot (i_3 \quad i_1) = V_1$$
$$3 \cdot (i_4 - i_2) + 7 \cdot (i_4 \quad i_3) = V_3$$

(3) $V_1 = V_2 = V_3 = 0$

(4) figure:



Sol:

$i_4 = 3A$

Mesh analysis $i_1 - i_2 - i_3$ superior given us.

$$8 + 5(i_1 - 3) + 3(i_2 - 3)$$
$$-3 + 2i_3 - 2 = 0$$

By Apply KVL on the lower left super mode and the upper right node we get

$$i_1 - i_2 - 1 = 0$$

$$2 + i_1 - i_3 = 0$$

After solving these three eq we get.

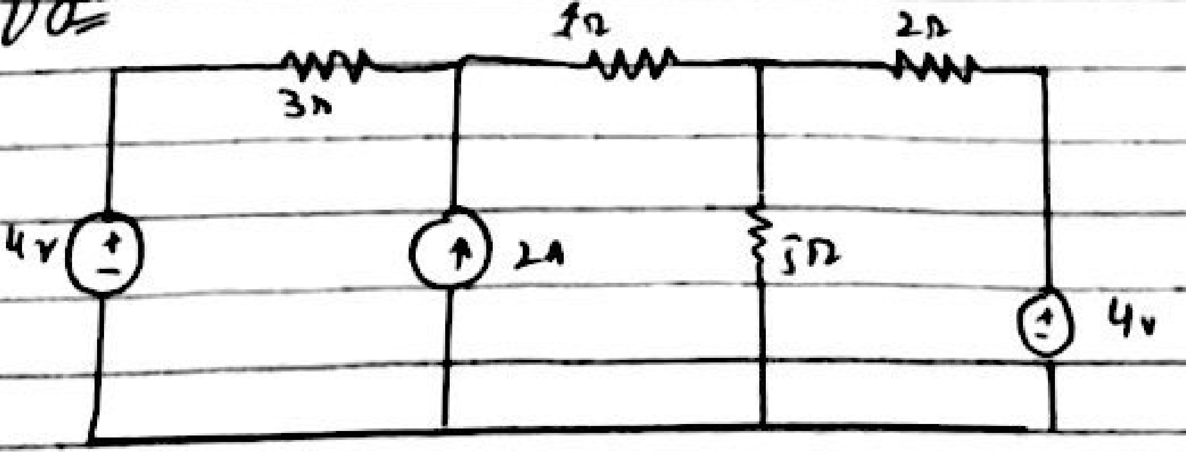
$$i_1 = 1.4 \text{ A}$$

$$i_2 = 2.4 \text{ A}$$

$$i_3 = 3.4 \text{ A}$$

Question No (5)

(10) figure:-



Solution

there are three sources.

$$V_x = V_1 + V_2 + V_3$$

where V_1, V_2 and V_3 are the contribution due to the left 4v voltage source. 2A current source and the right 4 voltage source respectively.

To obtain v_1 we set the 2Ω and the right 4V source to zero as shown below. Apply mesh analysis to the two meshes 1 and 2 we obtain the following matrix equation

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

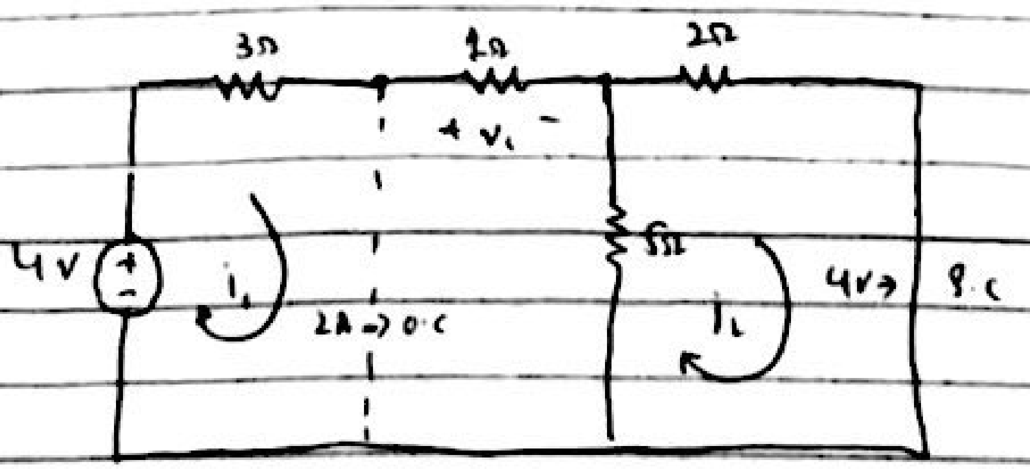
we find.

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

for 1 Ω resistor, ohm's law given

$$v_1 = 1 \cdot i_1 = \frac{14}{19} \text{ V}$$

$$\boxed{= 736.84 \text{ mV}}$$



To obtained 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.

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

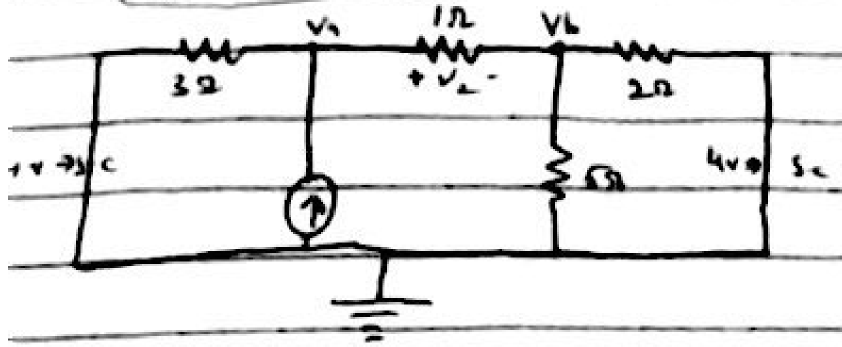
Matrix eq we find

$$V_a = \frac{51}{18}\ v \quad \text{and} \quad V_b = \frac{21}{19}\ v$$

By inspection, it is clear that.

$$V_2 = V_a - V_b = \frac{51}{19} - \frac{30}{19} = \frac{21}{19}$$

$$\boxed{V_2 = 1\cdot 105\ v}$$



To obtain V_3 we set the 2A and left 4V source to zero as shown below
Apply mesh analysis to the two mesh 1 and 2 we obtain the folowing 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 metrix eq we find

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

the 1 Ω resistor, ohm's law gives

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

$$\boxed{V_3 = -526\cdot 32\ mv}$$

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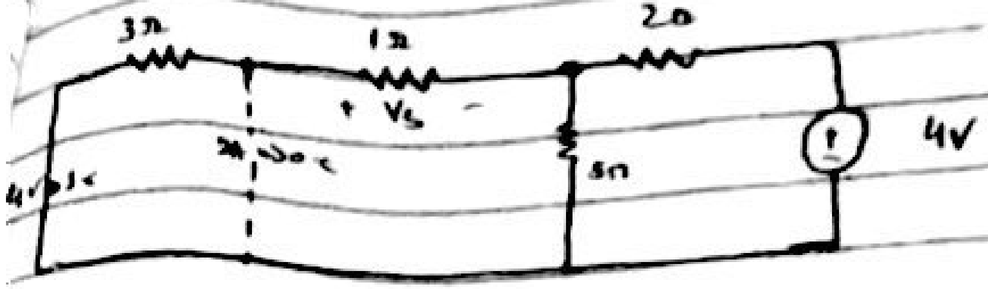
Therefore

$V_x = V_1 + V_2 + V_3$

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

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



It is require to evaluate the values of the current sources that results in reducing the V_x values by 10%. Let the new values of V_x is V'_x the current sources values affectes only its contribution which is V_2, let the new value of V_2 is ~~V'~~ V'_2 thus:

$V'_x = 0.9V_x = 0.9 \cdot 1.316\,V$

$\boxed{V'_x = 1.1844\,V}$

and

$V'_2 = V'_x - (V_1 + V_2) = 1.1844\,V - (736.84\,mV - 526.$

$= 973.88\,mV$

Apply nodal analysis to the two nodes V_a and V_b in the circuit show below gives.

$$I_{cs} = \left(1+\frac{1}{5}\right)V_a - V_b \quad \text{—} \; (1)$$

$$0 = -V_a + \left(1+\frac{1}{5}+\frac{1}{2}\right)V_b \quad \text{—} \; (2)$$

we have

$$V_a - V_b = V_x = 973.88\,mV \quad \text{—} \; (3)$$

Solving the three eq. (1), (2) and (3) we

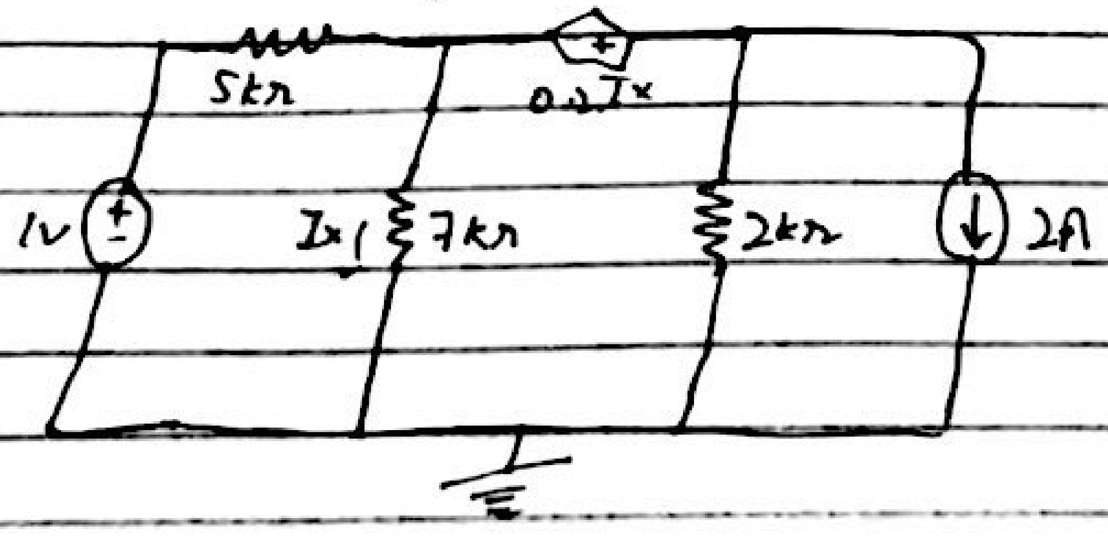
$$\boxed{I_{cs} = 1.7623\,A}$$

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

$$V_x = 6.053 - 4.737$$

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

(11) Qu. Empoly Superposition Principles to obtain a value from the current I_x labeled



Solution

Since there are two independent source let.

Where I_{x1} and I_{x2} are the contributio due to the 1v voltage source and 2A current source, respectively

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

Apply KCL to the superior x gi.

$$\frac{V_1 - 1}{5000} + \frac{V_1}{7000} + \frac{V_2}{2000} = 0$$

But $V_2 = V_1 + 0.2 I_{x1}$ he.

$$\frac{V_1 - 1}{5000} + \frac{V_1}{7000} + \frac{V_1 + 0.2 I_{x1}}{2000} = 0$$

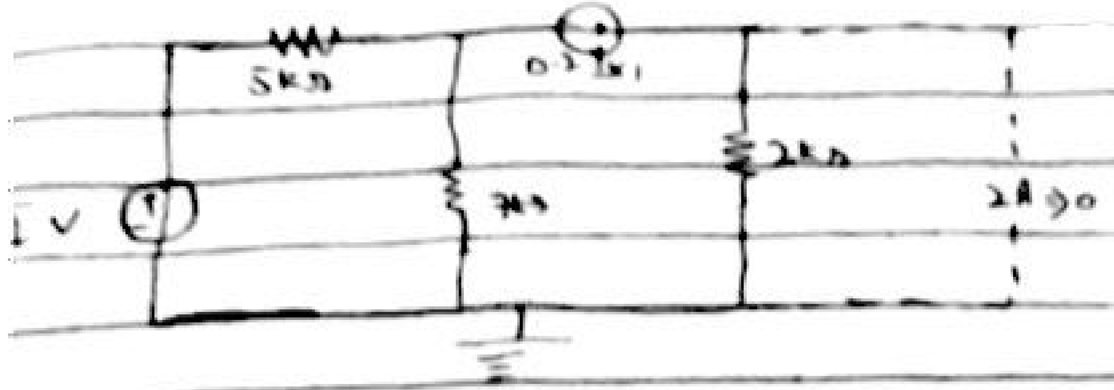
But $V_1 = 7000 I_{x1}$, hence.

$$\frac{7000 I_{x1} - 1}{5000} + \frac{7000 I_{x1}}{7000}$$

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

Then

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



To obtain I_{x_2} we set the 1v voltage source to zero (replacing it with a short circuit) as shown below.

Apply KCL to the Supernode Y give

$$\frac{V_1}{5000} + \frac{V_1}{7000} + \frac{V_2}{2000} = -2$$

But

$V_1 = 7000\, I_{x_2}$; hen.

$$\frac{7000\, I_{x_2}}{5000} + \frac{7000\, I_{x_2}}{7000} + \frac{7000\, I_{x_2} + 0.2\, I_{x_2}}{2000} = -2$$

Thus

$$\boxed{I_{x_2} = -338.38 \text{ mA}}$$

There fore.. $I_x = I_{x_1} + I_{x_2}$

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

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

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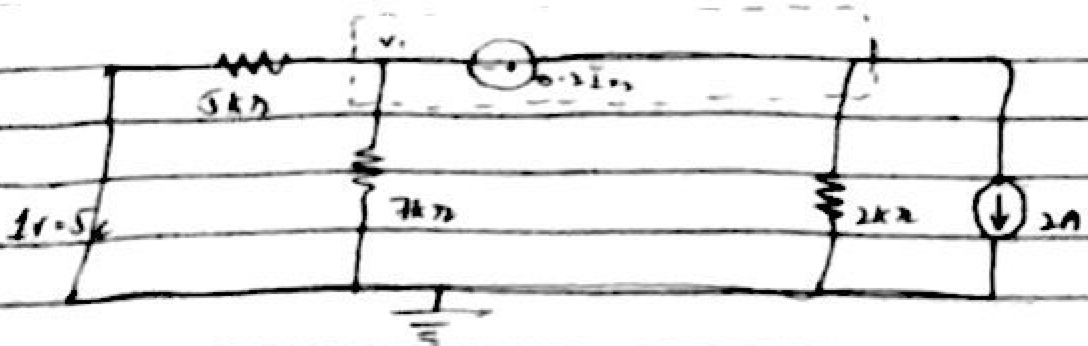
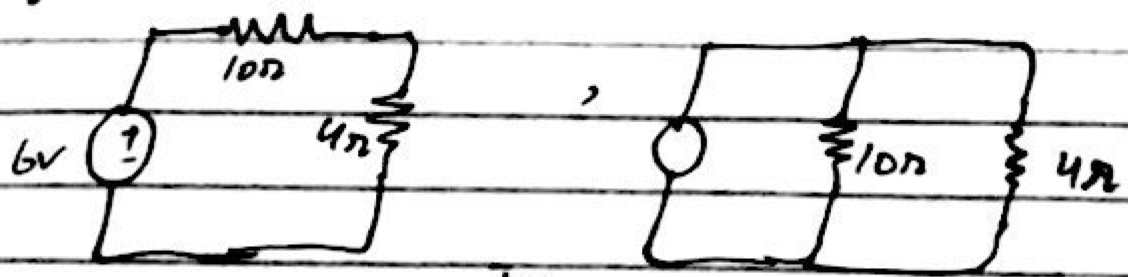
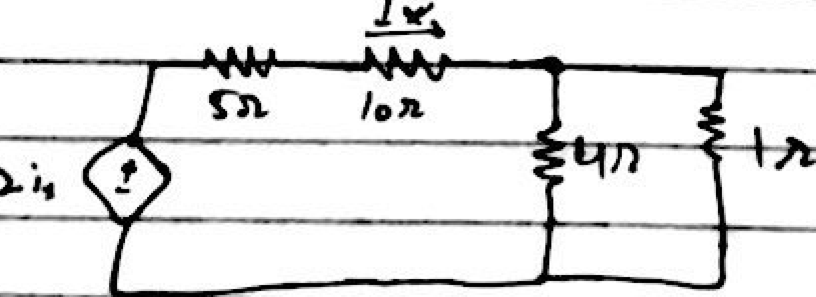


Result: $\boxed{I_x = -338.95\ mA}$

3. Perform and appropriate Source transformation on each of the circuit depicted in 5.58 taking care to retain the 4Ω resistor in each final circuit.





Sol: The value of the new Source we get

$$I = V/R$$

$$I = 6/10$$

$$\boxed{I = 0.6\ A}$$

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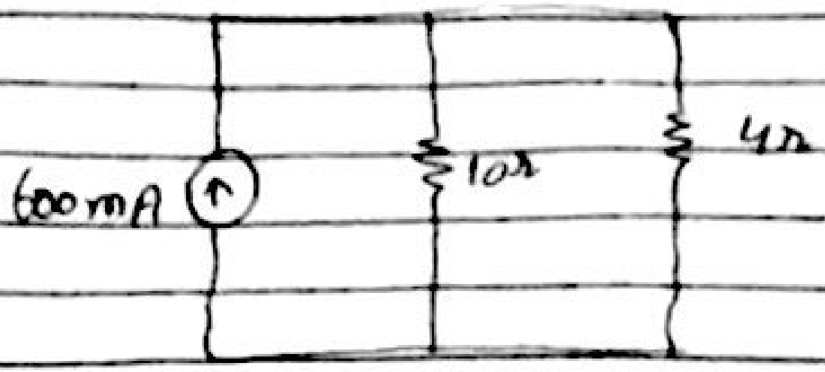
And we can draw the circuit as

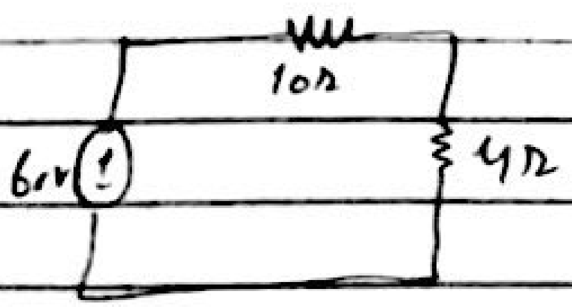


The new voltage source will have the value of

$$V = 10 \cdot 6$$

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

And we draw it as



To get the value of the new current source we are

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

$$I = 0.4i_x$$

And we draw it as

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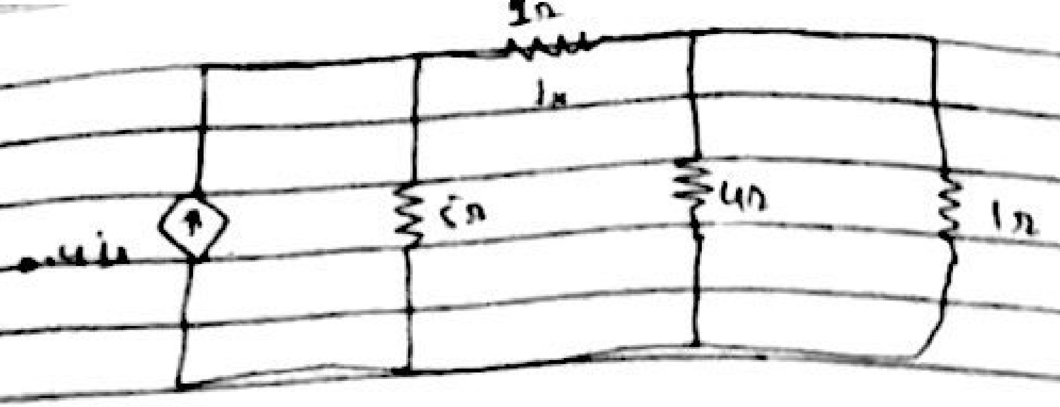


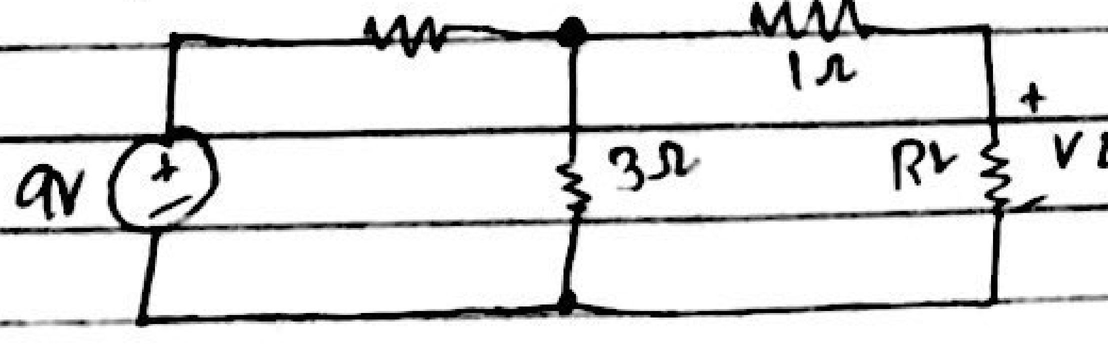
Result

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

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

(c) We replace the 5Ω resistor and dependent vo source with a dependent current source labele $0.4 i_x$ in parallel with a 5Ω resistor.

5:- Determine the thevenin equivalent of th network connected to RL (b) determine VL for RL = 1Ω, 3.5Ω, 6.257Ω and 9



Solution:-

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

$$V_{TH} = 9V \cdot 3/5$$

$$V_{Th} = 5.4V$$

we can calculate R_{Th} as:

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

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

Then we calculate V_L as:

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

for the each value of R_L we get:

$$R_L = 1\Omega \rightarrow V_L = \boxed{1.088V}$$

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

$$R_L = 6.25\Omega \Rightarrow \boxed{V_L = 3.995V}$$

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

Result:-

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

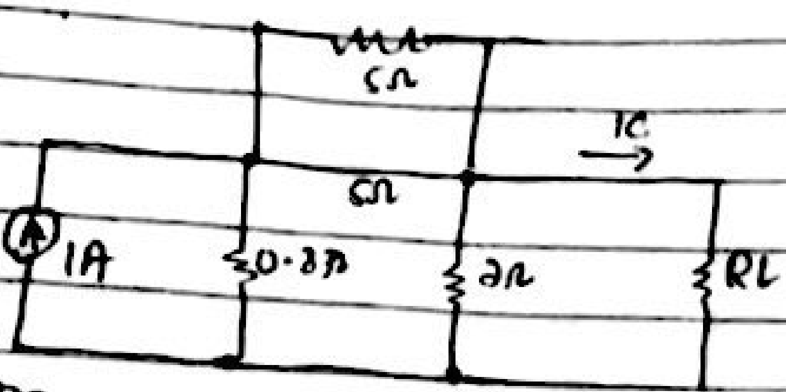
$$V_L = 1.088V, 3.316V, 3.995V, 4.41V$$

27:

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

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

(c) use either to calculate. is for RL = 0Ω, 1Ω, 4.923 Ω and 8.107Ω.



Solution:

(a) we calculate RN as:

$RN = (0.8+5 || 5) || 2$

$RN = 3.3 || 2$

$\boxed{RN = 1.245 \Omega}$

for iN we have:

$iN = 0.8 / 0.8+2.5$

$\boxed{iN = 0.242 A}$

(b) Now we can Vth as

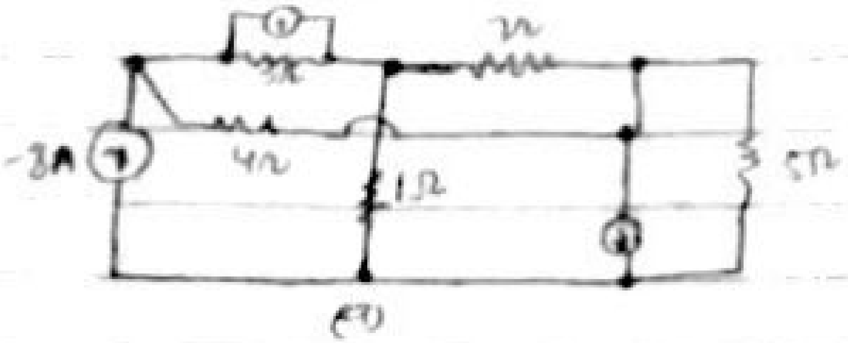
$Vth = iN \cdot RN$

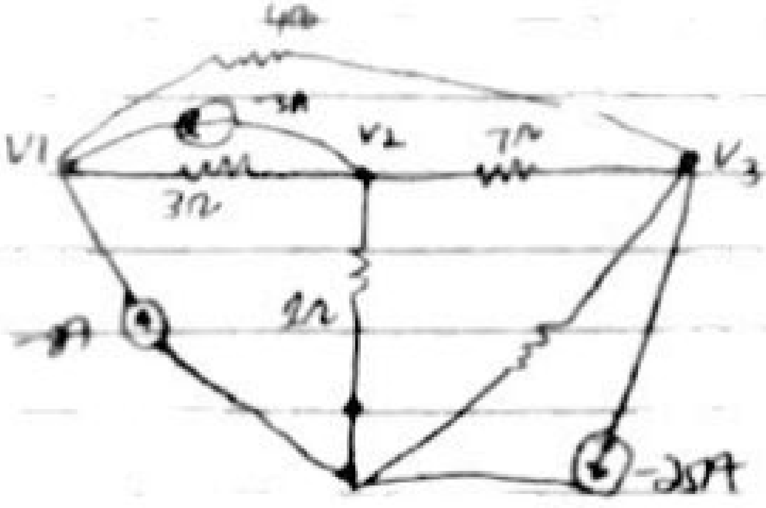
$RN \times IN \Rightarrow 1.245 \Omega \times 0.242 A$

$\Rightarrow \boxed{0.301 V}$ ANSWER

Example 4:

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





Reference node (b)

Solution

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

Applying KCL on node 1

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

Taking LCM

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

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

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

Applying KCL At node 2

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

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

$$3 = 7V_1/21 + 3V_2/21 - 3V_3/21$$

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

Applying KCl At node 3

$$25 = V_3/5 \; 2V_2 - V_2/7 + V_3 - V_1/4$$

Taking LCM

$$25 = \frac{28V_2 + 20V_3 - 2V_3 + 35V_3 - 35V_1}{140}$$

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

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

simlifying further by grammer rule

$$\begin{bmatrix} 0.5833 & -0.3333 & -0.2500 \\ -0.3333 & 1.4762 & -0.1429 \\ -0.2500 & -0.1429 & 0.5929 \end{bmatrix} \begin{bmatrix} V_1 \\ V_2 \\ V_3 \end{bmatrix}$$

let det of A = ΔX

$$\Delta X \begin{bmatrix} 0.5833 & 0.3333 & -0.2500 \\ -0.3333 & 1.4762 & -0.1429 \\ 0.2500 & -0.1429 & 0.5929 \end{bmatrix}$$

$$\Delta X = 0.5833 \begin{bmatrix} 1.4762 & -0.1429 \\ 0.1429 & 0.5929 \end{bmatrix}$$

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

$\Delta X = 0.583(0.875 - 0.020]$
$0.333(0.1976\ 0.00357) - 0.2500(0.0476\ 0.3690)$

$\Delta X = 0.498600 - 0.0777 + 0.079$

Now

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

$$= -11 \begin{bmatrix} 1.476 & -0.142 \\ 0.142 & 0.592 \end{bmatrix} - 3 \begin{bmatrix} 0.33 & 0.250 \\ -0.142 & 0.393 \end{bmatrix}$$

$$105\begin{bmatrix} 0.33 & -0.250 \\ 1.476 & -0.142 \end{bmatrix}$$

$$= 11\begin{bmatrix} 1.479 & 0.142 \\ 0.142 & 0.50 \end{bmatrix}$$

$$= 11(0.275 - 0.020) - 3(0.197 - 0.035) + 25(0.047 + 0.36)$$

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

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

$$= 0.583\begin{bmatrix} 3 & 0.142 \\ 25 & 0.592 \end{bmatrix} + 11\begin{bmatrix} 0.333 & -0.142 \\ 0.280 & 0.592 \end{bmatrix}$$

$$= 0.250\begin{bmatrix} 0.333 & 3 \\ 0.280 & 25 \end{bmatrix}$$

$$= 0.53(1.778 + 3.572) + 11(0.197 + 0.035)$$

$$= -0.25(8.332 + 0.74)$$

$$= 2.45$$

So

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

Now

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

$$0.583\begin{bmatrix} 0.333 & 11 \\ 0.350\ 476 & 3 \end{bmatrix} 0.33\begin{bmatrix} 0.33 & 3 \\ 0.25 & 25 \end{bmatrix}$$

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

$= 0.583(15.238) + 0.333(9.0825)$
$-11(0.107)$
$= 14.67$

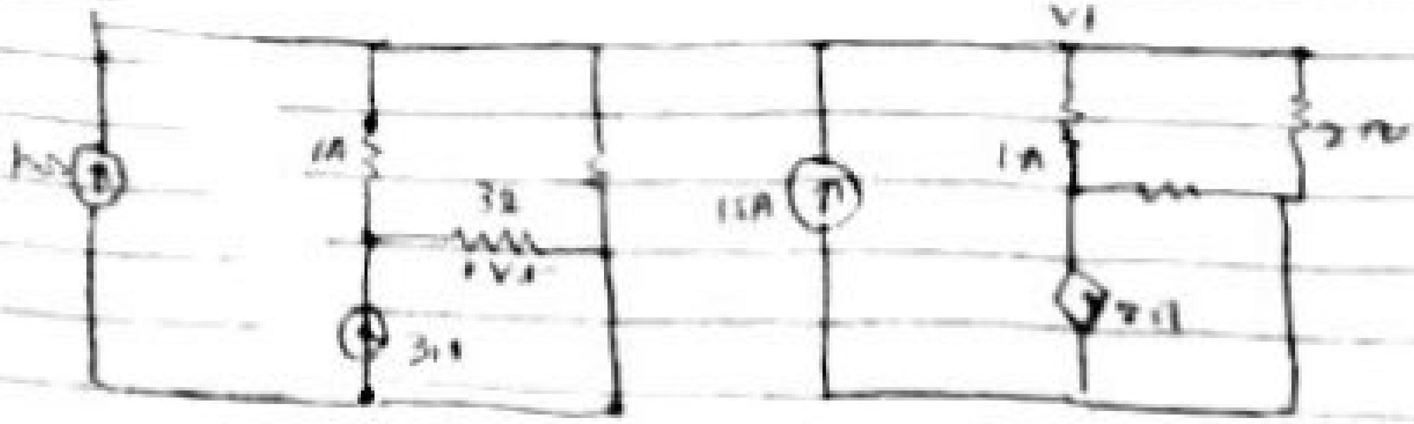
So $V_3 = \frac{14.67}{0.316} = 46.32V$

So

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

Example 4.3.

Determine the power supplied by the dependent source of figure



example 4·3
solution
Applying KCl on v_2

$$15 = \frac{v_1 - v_2}{1} + \frac{v_1}{2}$$

$$15 = \frac{2v_1 - 2v_2 + v_1}{2}$$

$$30 = 3v_1 - 2v_2 \quad \text{— (1)}$$

Applying KCl on v_2

$$3i_1 = \frac{v_2 - v_1}{1} + \frac{v_2}{3}$$

$$3i_1 = 3v_2 - 3v_1 + v_2 \quad \text{— (2)}$$

i_1 is flowing across

$v_1/2\Omega$ or $v_1/2$

so $i_1 = v_1/2$

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)

xing (5) with eq(1) by substraction from eq (3)

$$\begin{aligned} \cancel{15v_1} - 7v_2 &= 0 \\ -15v_1 + 10v_2 &= 30 \\ \hline 3v_2 &= -30 \\ v_2 &= -10 \end{aligned}$$

xing 5 with eq (1)

$5 \times 3v_1 = 2v_2 - 30$

$= 15v_1 - 10v_2 = 150$

combining eq (1) and eq (3)

$$\begin{aligned} 15v_1 - 10 &= 150 \\ -15v_2 + 18v_2 &= 0 \\ \hline -2v_2 &= 150 \end{aligned}$$

$v_2 = 75$

putting in eq 3

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

$v_1 = 40$

Now

$i_1 = -v_1/2 = -40/2 = -20A$

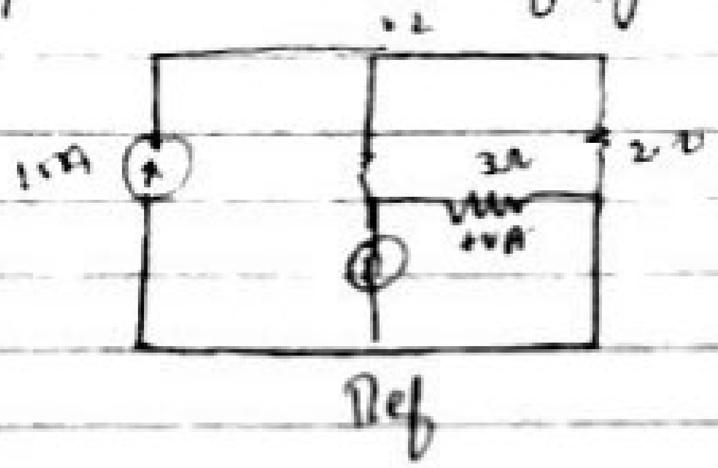
your power, $p = iv$

$p = (3i_1)(v) = 3(-20)(-75)$

$p = 4.5\ kW$

Example 4.4

Determine the power supplied by the dependent source of figure



Applying KCL on the v_2.

$15 = v_1 - v_2 + v_1/2$

$$30 = \frac{v_1 - v_2 + v_1}{2}$$

$$30 = 2v_1 - 2v_2 + v_1$$

$$30 = 3v_1 - 2v_2 \quad \text{---} \quad (1)$$

Applying kcl on v_2

$$3v_x = \frac{v_2 - v_1 + v_2}{2}$$

$$v_x = \frac{v_2}{3}$$

$$\frac{\cancel{3}v_2}{\cancel{3}} = \frac{3v_2 - 3v_1 + v_2}{3}$$

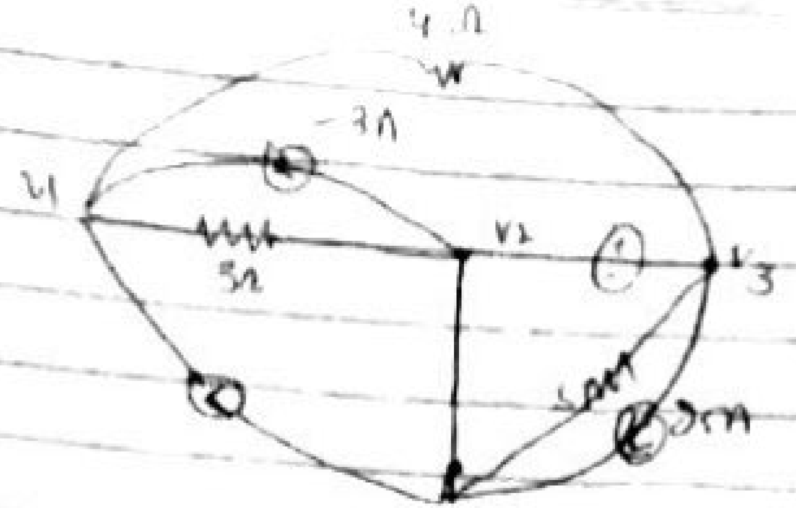
$$-3v_1 + v_2 = 0 \quad \text{---} \quad (2)$$

combine eq (1) and (2)

$$\cancel{3v_1} - 2v_2 = 30$$
$$\cancel{-3v_1} + 3v_2 = 0$$
$$v_2 = 30$$

Example 4.5:

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



Reference node

Solution

Applying KCL on V_1

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

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

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

$$-(132)=7V_1-4V_2-3V_3 \quad -(1)$$

Applying KCL on node i.e

V_2 and V_3

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

$$28=\frac{20V_1+20V_1+15V_3+6V_2}{60}$$

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

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

Multiply eq (1)

$35v_1 - 20v_2 - 15v_3 = -660$ — (3)

combining eq 2 and 3

$$-35v_1 + 80v_2 + 27v_3 = 1680$$
$$35v_1 - 20v_2 - 15v_3 = -660$$
$$60v_2 + 12v_3 = 102 \quad \text{— (4)}$$

we know that from super node

$v_2 + 22 = v_3$ — (1)

putting v_3 in eq 4

$60v_2 + v_2 \; 122 = 1020$

$61v_2 = 998$

Dividing both side by 61

$$\frac{61v_2}{61} = 998/61$$

$$v_2 = 998/61$$

$v_2 = 16.4$

putting in eq (1)

$16.4 + 22 = v_3$

$v_3 = 38.4$

putting v_2 and v_3 in eq (1)

$-132 = 7v_1 - 4(16.4) - 3(38.4)$

$-132 = 7v_1 = 65.6 - 115.2$

$-132 = 7v_1 - 180.8$

$180.8 - 132 = 7v_1$

$48.8 = 7v_1$

Divided both side by 7

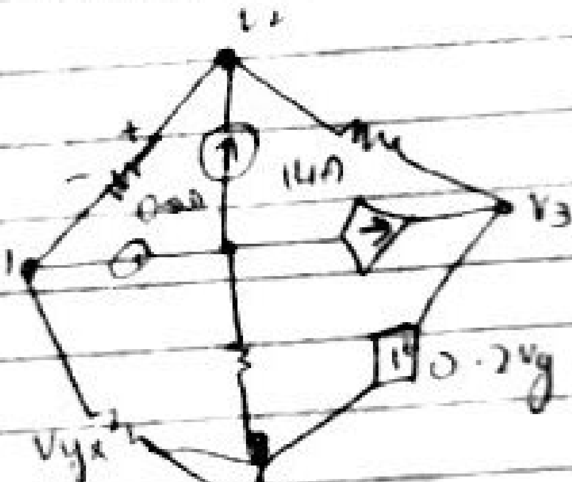
$\frac{48.8}{7} = \frac{\cancel{7}v_1}{\cancel{7}}$

$\frac{48.8}{7} = v_1$

$v_1 = 6.971$

Example 4.6

Determine the node to refrence voltage in the circuit



Solution

As $v_1 = -12V$

Applying KCl on v_1

$\frac{v_2 - v_4}{0.5} + \frac{v_2 - v_3}{2} = 14$

$$\frac{2v_2 - 2v_1 + 0.5v_2}{1} - 0.5v_3 = 14$$

$$-2v_1 + 2.5v_2 - 0.5v_3 = 14 \quad (1)$$

Applying KCL on supper node

i.e. v_3 and v_4

$$0.5v_x = \frac{v_3 - v_2}{2} + \frac{v_4}{1} + \frac{v_4 - v_3}{2.5}$$

$$0.5v_x = \frac{5v_1 - 4.5v_2 + 2.5v_3 + 2v_4}{5}$$

we know that

$$0.5v_x = 0.5(v_2 - v_1)$$

$$0.5v_x = 0.5(v_2 - v_1)$$

$$0.5v_2 - 0.5v_1 = \frac{5v_1 - 4.5v_2 + 2.5v_3 + 2v_4}{5}$$

$$2.5v_2 - 2.5v_1 = 5v_1 - 4.5v_2 + 2.5v_3 + 2v_4$$

$$7.5v_1 - 7v_2 + 2.5v_3 + 2v_4 = 0 \quad (2)$$

put the values of equation v_1 and v_2 in eq (1)

we will get value of v_3

$$-2v_1 + 2.5v_2 - 0.5v_3 = 14$$

$$-2(-6) + 2.5(-4) - 0.5v_3 = 14$$

$$12 - 10 - 0.5v_3 = 14$$

$$0.5v_3 = 12$$

$$v_3 = \frac{12}{0.5}$$

$$v_3 = 24$$

Put in eq (9)

$7.5(-12) - 7(-4)(+2.5) - 1(2v_4 = 0)$

$2v_4 - 2 = 0$

$\cancel{2}v_4 = \cancel{2}$

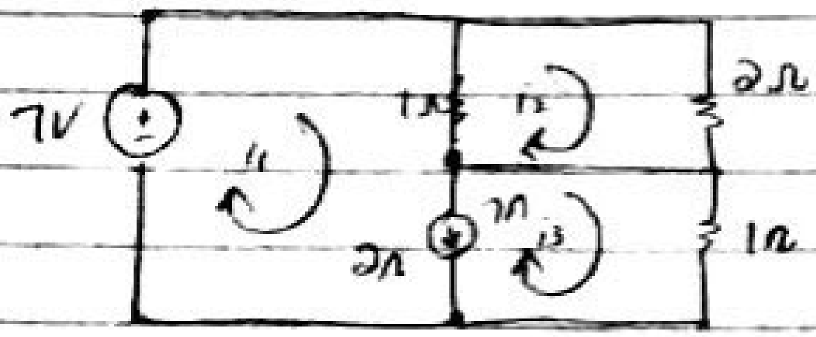
$v_4 = 1$

Result

$v_1 = -12,\ v_2 = -4,\ v_3 = 24,\ v_4 = 1$

Example 4.11

Determine the three mesh current



Solution

we know that there is undependent sources b/w nod 2 and node 3 which this a super node

Apply KVL on super mesh

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

$i_2 - i_1 + 3i_2 - 3i_2 + i_3 = 7$

$i_2 - 4i_3 + 4i_3 = 7$ —— (1)

Applying KVL on mesh 2

$12i_2 - 13(i_2 - 13) = 0$

$-i_2 + 6i_2 + i_3 = 0$ — (3)

Apply kcl on a node on which independent source is entering:

$7 + i_3 = i_2$

$i_2 - i_3 = 7$

Apply cramers rule

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

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

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

$= -6 + 16 - 24$

$|A| = -14$

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

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

$= -42 + 7(-12)$

$= -42 - 84$

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

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

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

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

$= 21 + 35$

$\boxed{|Bx| = 56}$

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

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

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

$= 42 + 28$

$\boxed{|Cx| = 70}$

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

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

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

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

$= -28$

now

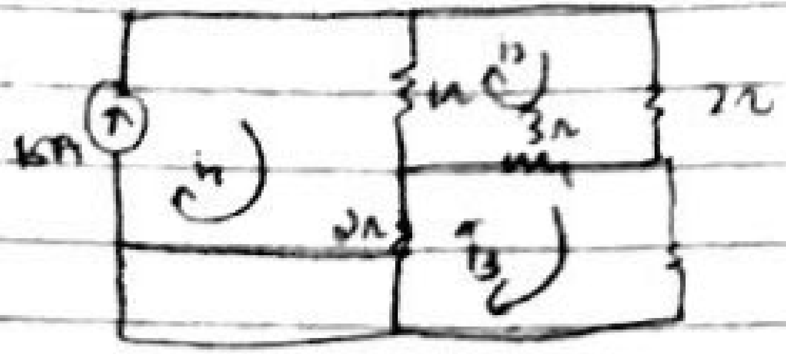
$i_1 = \frac{|Ax|}{|A|} = \frac{-126}{-14} = 9A$

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

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

Example 4-12

Evaluate the three known currents in the circuit.



Solution

we have one dependent current and one independent source

Now we have the $i_1 = 15A$

we have to find two unknown source

Apply KCl on a nodes

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

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

Scanned with CamScanner

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

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

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

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

$i_1 = 15$

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

$\frac{1}{3} i_2 + \frac{2}{3} i_3 = 15$ —— A

$i_2 + 2 i_3 = 45$ —— 1

Apply KVL on mesh 2

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

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

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

$\boxed{i_1 = 15}$

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

$6i_2 - 3i_3 = 15$ — ②

combining eq ① and ②

$$\begin{array}{r} 6i_2 + 12i_3 = 270 \\ -\ 6i_2 - 3i_3 = -15 \\ \hline 9i_3 = 285 \end{array}$$

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

$\Rightarrow 28.33A$ and

$\Rightarrow i_2 = 11A$

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

$-V + 3V_3 = -80$ — (3)

Taking eq (1)

$7V_1 - 4V_2 = 100$

$V_1 = \frac{4V_2 + 100}{7}$ — (a)

Taking eq (3)

$V_2 + 3V_3 = -80$

$V_3 = \frac{V_2 - 80}{3}$ — (b)

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

$-30(0.57V_2 + 14.28) + 53V_2 - 3(0.33V_2 - 26.67) = 480$

$-17.1V_2 - 428.4 + 53V_2 - 0.99V_2 + 80.01 = 480$

$34.91V_2 = 828.39$

$V_2 = 20.31$

putting in eq (a)

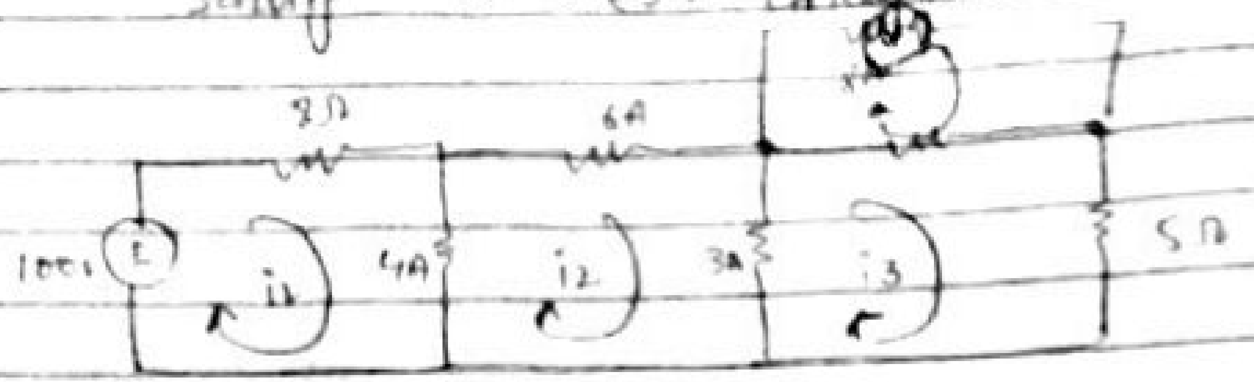
$V_1 = \frac{4(20.31) + (100)}{7} = 25.89$

$i_x = \frac{V_1 - V_2}{2} = 25.89 - 20.31$

$i_x = 2.79A$

Scanned with CamScanner

Solving the mesh analysis



Applying KVL on loop

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

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

$13i_1 - 4i_2 = 100$ — (1)

Applying KVL on loop 2.

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

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

$-4i_1 + 9i - 3i_3 = 0$ — (2)

Applying KVL on loop 3n

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

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

$i_4 = 8$

$-3i_2 + 18i_3 = 80$ — (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 by b in eq (2)

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

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

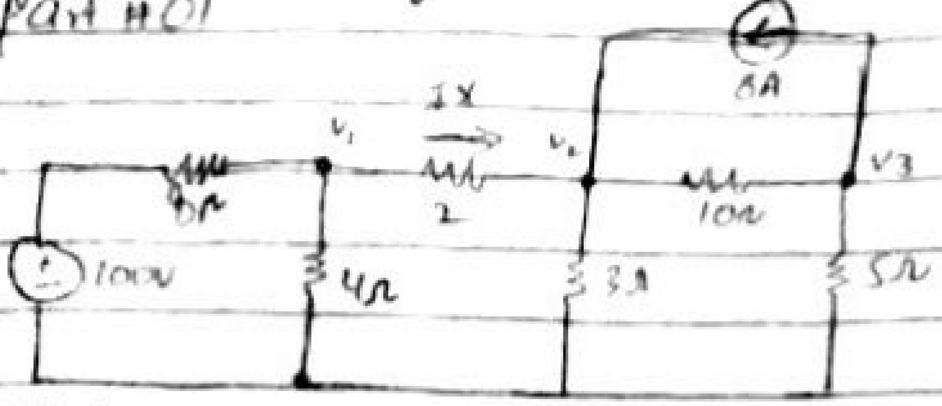
$7.2i_2 = +20 \quad = 20/7.2$

$i_2 = 2.79A$

$i_2 = i_X$

$\boxed{i_X = 2.77A}$

Q3 - Node analysis
Part #01



Solution -

Apply KCL on node 1:-

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

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

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

Apply KCL on node 2 -

$$\frac{v_2 - v_1}{2} + \frac{v_3}{3} + \frac{v_2 - v_3}{12} = 8$$

$$\frac{30v_2 - 30v_1 + 20v_2 + 3v_2 - 3v_3}{60} = 8$$

$$-30v_1 + 58v_2 - 3v_3 = 480 \quad \text{--- (2)}$$

Apply KCL on node 8

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

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

$-V_2 + 3V_3 = -80$ —— (3)

Taking eq (1)

$7V_1 - 4V_2 = 100$

$V_1 = \frac{4V_2 + 100}{7}$ —— (a)

Taking eq (3)

$-V_2 + 3V_3 = -80$

$V_3 = \frac{V_2 - 80}{3}$ —— (b)

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

$-30(0.57V_2 + 14.28) + 53V_2 - 3(0.33V_2 - 26.67) = 420$

$-17.1V_2 - 428.4 + 53V_2 - 0.99V_2 + 80.01 = 420$

$34.91V_2 = 828.39$

$V_2 = \frac{828.39}{34.91}$

$V_2 = 20.31$

putting on eq (a)

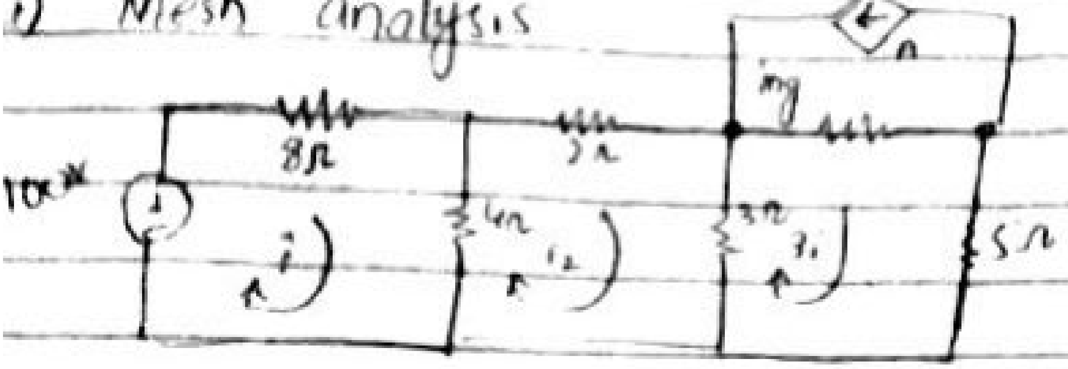
$V_1 = \frac{4(20.31) + 100}{7}$

$V_1 = 25.89$

$i_x = \frac{V_1 - V_2}{2} = \frac{25.89 - 20.31}{2}$

$r = 279A$

i) Mesh analysis



Applying KVL on loop 1

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

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

$12i_1 - 4i_2 = 100$ — (1)

Applying KVL on loop 2

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

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

$-4i_1 + 9i_2 - 3i_3 = 0$ — (2)

Applying KVL on loop 3

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

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

$-3i_2 + 19i_3 = -80$ — (3)

taking eq (1)

$i_1 = \frac{4i_2 - 100}{12}$ — (a)

Taking eq (3) and (b)

$-3i_2 + 19i_3 = -80$

$i_3 = \frac{-3i_2 + 80}{18}$ — (b)

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

$-1.3i_2 + 33.33 + 9i_2 - 0.0482 - 13.33 = 0$

$i_2 = 20/72$

$i_1 = 2.79A$

$i_3 = 1$

$i_x = 2.79A$