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Subject LCA

Assignment sessional

Submitted to Engr. Sohail Imran

Q No 1:- Evaluate the determinants.

Solutions (i) Given

$$\begin{vmatrix} 2 & 1 \\ -4 & 3 \end{vmatrix}$$

Solution:-

$$\begin{vmatrix} 2 & 1 \\ -4 & 3 \end{vmatrix}$$

$= 6 - (-4)$

$= 6 + 4 = 10$

(ii) Given:-

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

Solution:- Expand by Row 1

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

$= 0 - 2(30 - 3) + 11(-6 - 12)$

$= -2(27) + 11(-18)$

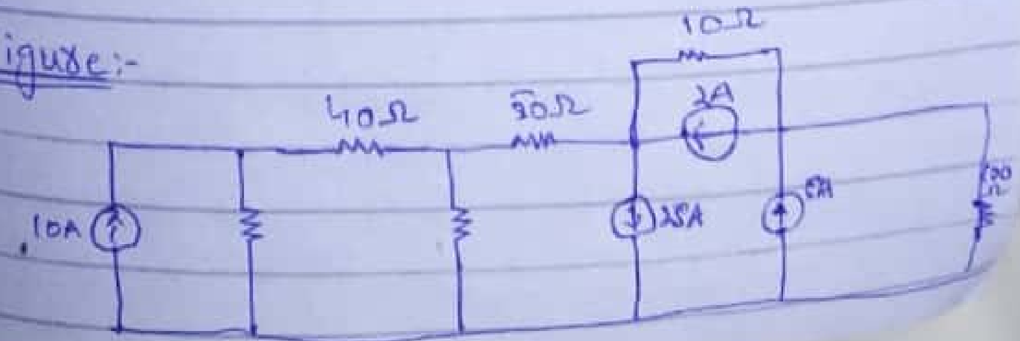
$= -54 - 198$

$= -252.$

Q No 2:-

Ans:-

Figure:-



solution:-

All nodes in the above circuit is verified so we will solve it through nodal analysis.

(1) Applying KCL on node 1:-

$$\frac{V_1}{20} + \frac{V_1 - V_2}{40} = 10$$

$$\frac{2V_1 + V_1 - V_2}{40} = 10$$

$$3V_1 - V_2 = 10 \times 40$$

$$3V_1 - V_2 = 400 \quad — (1)$$

(2) Applying KCL on node 2:-

$$\frac{V_2 - V_1}{40} + \frac{V_2}{100} + \frac{V_2 - V_3}{50} = 0$$

$$\frac{5V_2 - 5V_1 + 2V_2 + 4V_2 - 4V_3}{200} = 0$$

$$-5V_1 + 11V_2 - 4V_3 = 0$$

(iii) Applying KCL on node 3:-

$$\frac{V_3 - V_2}{50} + \frac{V_3 - V_4}{10} = 2 - 2.5$$

$$\frac{V_3 - V_2}{50} + \frac{5V_3 - 5V_4}{5 \times 10} = -0.5$$

$$\frac{V_3 - V_2 + 5V_3 - 5V_4}{50} = -0.5$$

$$-V_2 + 6V_3 - 5V_4 = -25 \quad \text{— (3)}$$

(4) Applying KCL on node 4:-

$$\frac{V_3 - V_2}{10} + \frac{V_3}{200} = 5 - 2$$

$$\boxed{\frac{20V_3 - 20V_2}{10} + \frac{V_3}{200} = 3}$$

$$\frac{20V_3 - 20V_2 + V_3}{200} = 3$$

$$-20V_2 + 21V_3 = 600 \quad \text{— (4)}$$

Solving further by using calculator:-

So we get

$V_1 = 180.46\,V$

$V_2 = 141.3\,V$

$V_3 = 163.2\,V$

$V_4 = 172.5\,V$

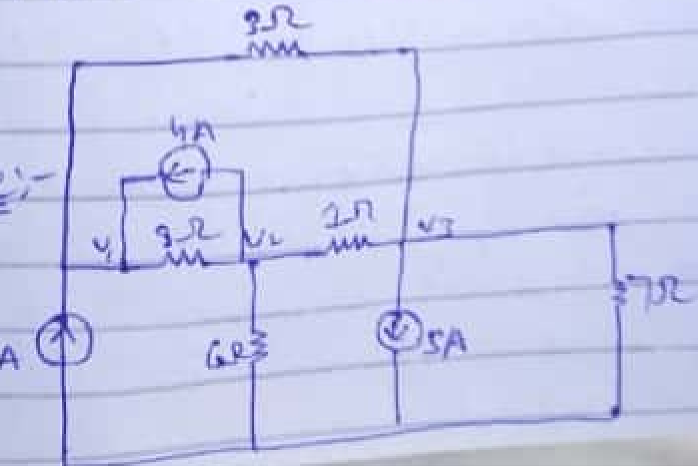
As from the figure we know that $V_2 = V_p$

Result:-

$V_p = 141.3\,V$

Q No 3:-

Ans:- Figure:-



Solution:-

Solving by nodal analysis:

① Applying KCL on node 1:-

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

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

$$2V_1 - V_2 - V_3 = 36 \quad — ①$$

② Applying KCL on node 2:-

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

$$\frac{5V_2 - 5V_1 + V_2 + 15V_2 - 15V_3}{15} = 4$$

$$-5V_1 + 23V_2 - 15V_3 = -60 \quad — ②$$

③ Applying KCL on node 3:-

$$V_3 - V_2 + \frac{V_3 - V_1}{3} + \frac{V_3}{7} = 5$$

$$\frac{21V_3 - 21V_2 + 7V_3 - 7V_1 + V_3}{21} = 5$$

$$-7V_1 - 21V_2 + 31V_3 = -105 \quad — ③$$

Now solving by Cramer's rule:-

(5)

$$\begin{bmatrix} 2 & -1 & -1 \\ -5 & 2 & -15 \\ -7 & -21 & 31 \end{bmatrix} \begin{bmatrix} V_1 \\ V_2 \\ V_3 \end{bmatrix} = \begin{bmatrix} 36 \\ 4 \\ -105 \end{bmatrix}$$

A X B

$$|A| = \begin{vmatrix} 2 & -1 & -1 \\ -5 & 2 & -15 \\ -7 & -21 & 31 \end{vmatrix}$$

$$= 2\begin{vmatrix} 2 & -15 \\ -21 & 31 \end{vmatrix} - (-1)\begin{vmatrix} -5 & -15 \\ -7 & 31 \end{vmatrix} + (-1)\begin{vmatrix} -5 & 2 \\ -7 & -21 \end{vmatrix}$$

$$= 2(62-(315))\ 1(-155-105)-1(105-(-14))$$

$$= 2(62-315)\ 1(-155-105)-1(105+14)$$

$$= 2(-253)+1(-260)-1(119)$$

$$= -506 - 260 - 119$$

$$= -786$$

$$V_1 = \frac{|AB|}{|A|} = \begin{vmatrix} 86 & -1 & -1 \\ 4 & 2 & -15 \\ -105 & -21 & 31 \end{vmatrix}$$

$$= 86\begin{vmatrix} 2 & -15 \\ -21 & 31 \end{vmatrix} - (-1)\begin{vmatrix} 4 & -15 \\ -105 & 31 \end{vmatrix} - 1\begin{vmatrix} 4 & 2 \\ -105 & -21 \end{vmatrix}$$

$$= -9108 - 1451 - 126$$

$$= \frac{-10685}{-786}$$

$$V_1 = 13.59\,V$$

(6)

$$V_2 = \begin{vmatrix} 2 & 36 & -1 \\ -5 & 4 & -15 \\ -7 & -105 & 31 \end{vmatrix}$$

$$= 2\begin{vmatrix} 4 & -15 \\ -105 & 31 \end{vmatrix} - 36\begin{vmatrix} -5 & -15 \\ -7 & 31 \end{vmatrix} + (-1)\begin{vmatrix} -5 \\ -7 \end{vmatrix}$$

$= -2902 - 9360 - 553$

$= \frac{-12815}{-786}$

$V_2 = 16.30$

$$V_3 = \begin{vmatrix} 2 & -1 & 36 \\ -5 & 2 & 4 \\ -7 & -21 & -105 \end{vmatrix}$$

$$= 2\begin{vmatrix} 2 & 4 \\ -21 & -105 \end{vmatrix} + 1\begin{vmatrix} -5 & 4 \\ -7 & -105 \end{vmatrix} + 36\begin{vmatrix} -5 & 2 \\ -7 & -21 \end{vmatrix}$$

$= -35280 + 553 + 4284$

$= \frac{-30443}{-786}$

$V_3 = 38.73$

Now we know that

$V_{5\Omega} = V_2$

$\boxed{V_{5\Omega} = 16.30V}$

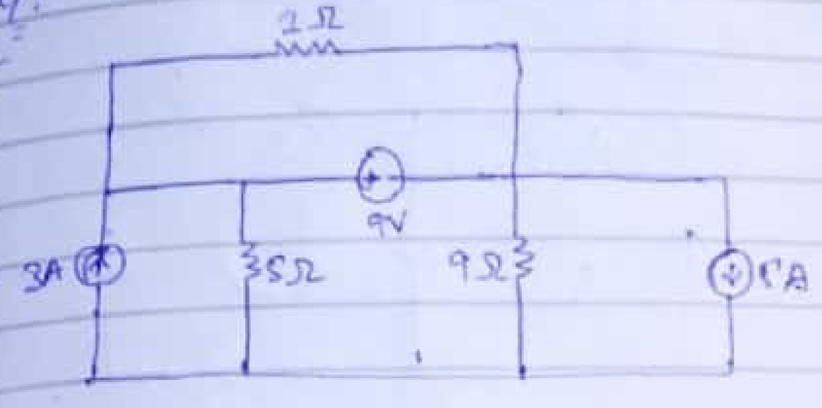
& $P = \frac{V^2}{i} = \frac{V_3^2}{7}$

$P = \frac{(38.73)^2}{7}$

$P = 214.28$ W.

Q No 4:-

Ans:-



Solution:-

considering v_1 & v_2 as a supernode.

Applying KCL on supernode

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

$$\frac{45V_1-45V_2+9V_1+45V_2-45V_1+9V_2}{45}=2$$

$$9V_1+9V_2=90 \quad — (1)$$

& $$V_1-V_2=9 \quad — (2)$$

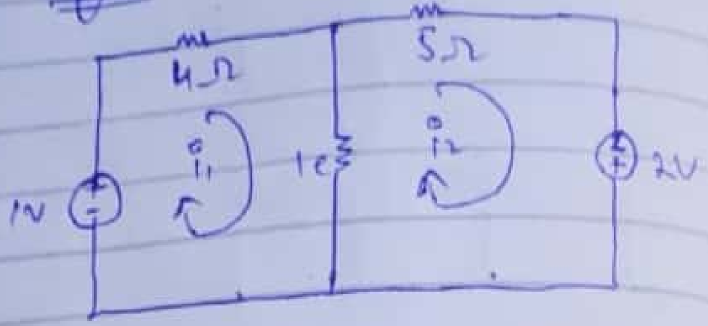
$$9V_1+9V_2=90$$
$$9V_1 \mp 9V_2=81$$
$$18V_1 = 171$$
$$V_1 = 171/18$$
$$V_1 = 9.5V$$

Putting in eq (2)

$$V_2 = V_1 - 9$$
$$V_2 = 9.5 - 9$$
$$\boxed{V_2 = 0.5\ V}$$

Q No 5:-

Ans:- Figure:-



Solutions

Solving by Mesh analysis

Applying KVL on i_1

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

$$5i_1 - i_2 = 1 \leftarrow (i)$$

(ii) Applying KVL on i_2:

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

$$-1i_1 + 6i_2 = 2 \text{ —(ii)}$$

Multiplying 5 with eq (ii) & Add with eq (i)

$$5i_1 - i_2 = 1$$

$$-5i_1 + 30i_2 = 10$$

$$29i_2 = 11$$

$$i_2 = 11/29$$

$$i_2 = 0.379 \text{ A}$$

Putting in eq (i)

$$5i_1 = 1 + 0.379 \text{ A}$$

$$i_1 = 0.275 \text{ A}$$

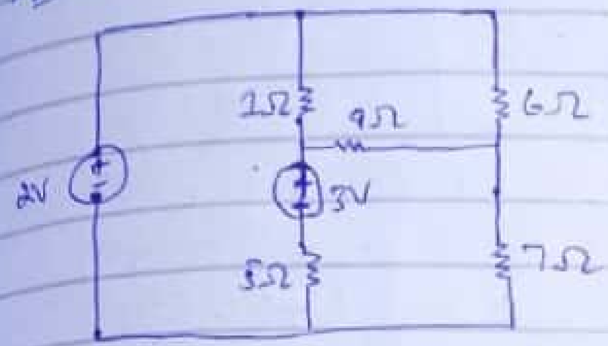
Result:-

$$i_1 = 0.275 \text{ A}$$

$$i_2 = 0.379 \text{ A}$$

Q No 6:-

Ans: Figure:-



Sol:-

Applying KCL on i_1 Mesh:-

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

$$i_1 - i_2 + 5i_1 - 5i_3 = 5$$

$$6i_1 - i_2 - 5i_3 = 5 \quad \text{—} (1)$$

Applying KCL on i_2 Mesh:-

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

$$-i_1 + 16i_2 - 9i_3 = 0 \quad \text{—} (2)$$

Applying KCL on Loop 1:-

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

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

solving by Cramer's rule

$$\begin{bmatrix} 6 & -1 & -5 \\ -1 & 16 & -9 \\ -5 & -9 & 21 \end{bmatrix} \begin{bmatrix} i_1 \\ i_2 \\ i_3 \end{bmatrix} = \begin{bmatrix} 5 \\ 0 \\ -3 \end{bmatrix}$$

$$|A| = \begin{vmatrix} 6 & -1 & -5 \\ -1 & 16 & -9 \\ -5 & -9 & 21 \end{vmatrix}$$

$$= 6\begin{vmatrix} 16 & -9 \\ -9 & 21 \end{vmatrix} + 1\begin{vmatrix} -1 & -9 \\ -5 & 21 \end{vmatrix} - 5\begin{vmatrix} -1 & 16 \\ -5 & -9 \end{vmatrix}$$

$= 6(235) - (-1)(-66) - 5(89)$

$= 1015.$

$$i_1 = \begin{vmatrix} 5 & -1 & -5 \\ 0 & 16 & -9 \\ -3 & -9 & 21 \end{vmatrix}$$

$$= 5\begin{vmatrix} 16 & -9 \\ -9 & 21 \end{vmatrix} + 0 - 3\begin{vmatrix} -1 & -5 \\ 16 & -9 \end{vmatrix}$$

$= 5(336 - 81) + 0 - 3(+9 - (-75))$

$= 5(255) + 0 - 3(+9 + 80)$

$= 5(255) + 0 - 3(89)$

$= 1275 - 267$

$i_1 = 1008\ A$

$i_1 = \dfrac{1008}{1015}$

$\boxed{i_1 = 0.993}$

$$i_2 = \begin{vmatrix} 6 & 5 & -5 \\ -1 & 0 & -9 \\ -5 & -3 & 21 \end{vmatrix}$$

$$= 6\begin{vmatrix} 0 & -9 \\ -3 & 21 \end{vmatrix} - 5\begin{vmatrix} -1 & -9 \\ -5 & 21 \end{vmatrix} - 5\begin{vmatrix} -1 & 0 \\ -5 & -3 \end{vmatrix}$$

$= 6(0 - 27) - 5(-21 - 45) - 5(-3 - 0)$

$= 6(-27) - 5(-66) - 5(-3)$

$= -162 + 330 + 15$

$= -162 + 345$

$= 183$

$i_2 = \dfrac{183}{1015} = 0.18\ A$

$$i_3 = \begin{vmatrix} 6 & -1 & 5 \\ -1 & 16 & 0 \\ -5 & -9 & 3 \end{vmatrix}$$

$$= 6\begin{vmatrix} 16 & 0 \\ -9 & 3 \end{vmatrix} + 1\begin{vmatrix} -1 & 0 \\ -5 & 3 \end{vmatrix} + 5\begin{vmatrix} -1 & 16 \\ -5 & -9 \end{vmatrix}$$

$= 6(48-0) + 1(-3+0) + 5(+9+80)$

$= 6(48) + 1(3) + 5(89)$

$= 288 + 3 + 445$

$= 736$

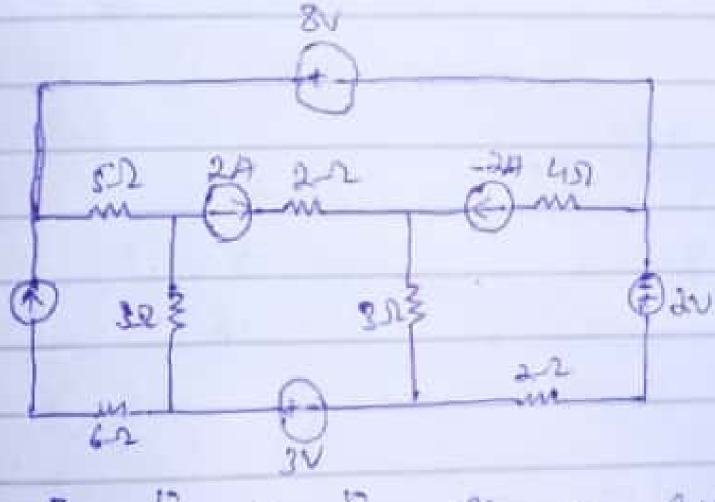
$$i_3 = \frac{736}{1015}$$

$i_3 = 0.72$ A

Q No 7:-

Ans:-

Figure:-



Considering i_1, i_2 & i_3 As a supernode.

Applying KCL supernode.

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

$5i_1 - 15 + 3i_2 - 9 + 2i_3 = -3$

$5i_2 + 3i_2 + 2i_3 = 12$ ← ①

we also know that

$i_2 - i_1 = 1$

where $i_1 = 1 + i_2$ — ⓐ

eq

$i_1 - i_3 = -2$

$i_3 = +2 + i_1$ —— (b)

Putting in eq (1).

$5i_1 + 3(1 + i_1) + 2(-2 + i_1) = 12$

$5i_1 + 3 + 3i_1 - 4 + 2i_1 = 12$

$10i_1 - 1 = 12$

$i_1 = 11/10$

$i_1 = 1.1$ A

Putting in eq A & B

$i_2 = 1 + 1.1$

$i_2 = 2.1$ A.

eq

$i_3 = +2 + 1.1$

$i_3 = 3.1$ A

Result:-

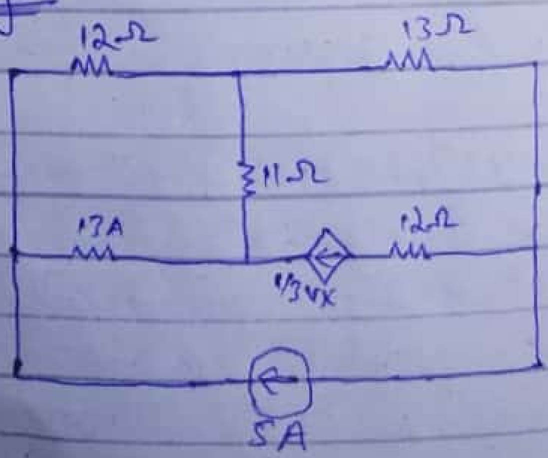
$i_1 = 1.1$ A

$i_2 = 2.1$ A

$i_3 = 3.1$ A

Q8:-

Ans:- Figure:-



from the figure we know that 5A current is flowing through i_2

$i_1 = 5A$

Now there is an independent source b/w i_2 & i_3.

so

$i_1 - i_3 = 1/3 \; v_x$

$i_3 = \frac{13 i_3}{3} + 5$

$i_3 = -1.5A$

Applying Mesh analysis on i_2.

$13(i_2 - i_1) + 11(i_2 - i_3) + 12 i_2 = 0$

$13 i_2 - 13 i_1 + 11 i_2 - 11 i_3 + 12 i_2 = 0$

$36 i_2 - 13(5) - 11(-1.5) = 0$

$36 i_2 = 65 - 16.5$

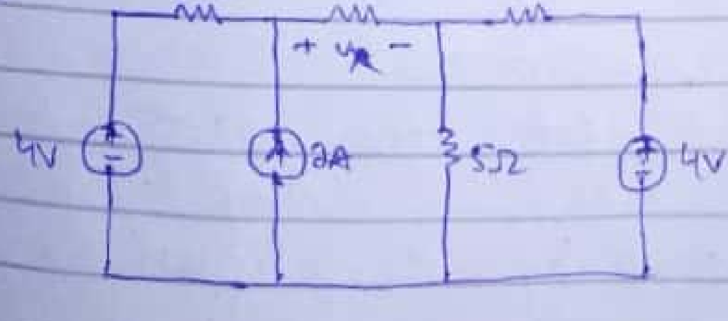
$i_2 = \frac{48.5}{36}$

$i_2 = 1.347 \; A.$

Q No 2:- Chapter # 5

Ans:- (I)

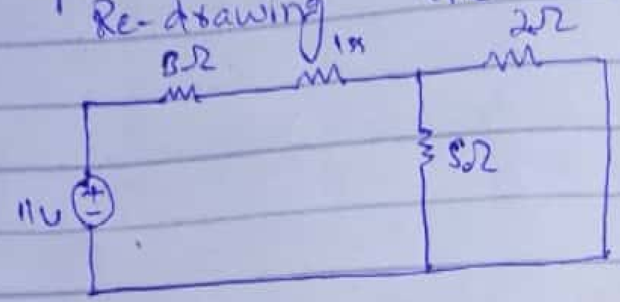
Figure



Solution:-

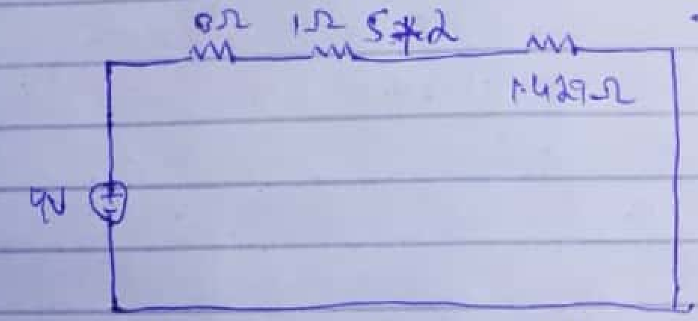
Setting the right-hand voltage as a short circuit & the current source as an open circuit.

Re-drawing the circuit:-



As 5Ω & 2Ω are in parallel so combining both.

$= \frac{5 \times 2}{5 + 2} = \frac{10}{7} = 1.429\,\Omega$



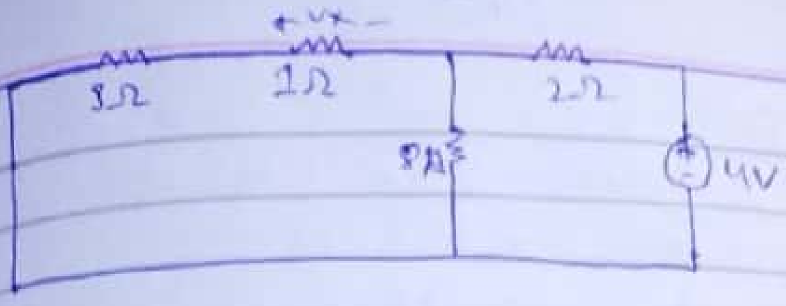
Apply mesh analysis

$3i_1 + 1i_1 + 1.429 = 4$

$i_1 = \frac{4}{5.42}$

$i_1 = V_x = 0.736$

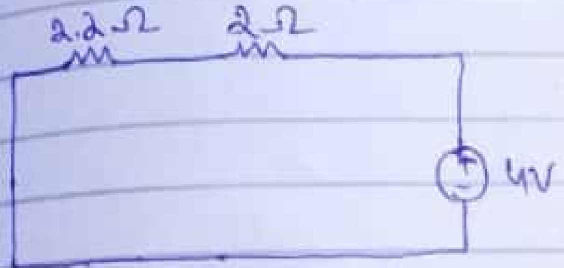
Now ~~let~~, set the left hand side voltage as a short circuit & current source as an open circuit.



As 5Ω is in parallel with 3Ω & 1Ω

$$Req = \frac{5 \times (3+1)}{5 + (3+1)} = \frac{20}{9}$$

$= 2.222\,\Omega$



Now by mesh analysis.

$$i_1 = \frac{4}{4.2} = 0.94\,A$$

$V_{2.2\Omega} = -2.10\,V$

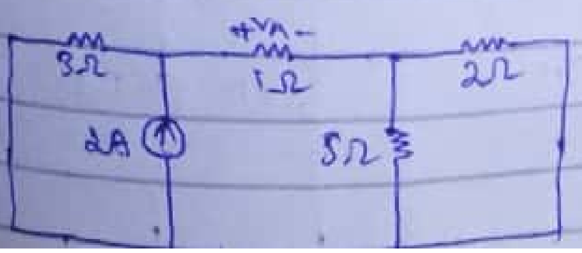
Now for 1Ω

$$V_{x_2} = \frac{-2.10\,(1)}{1+3}$$

$$V_{x_2} = \frac{-2.10}{4}$$

$V_{x_2} = -0.56\,V$

Now setting the two voltages as a short circuit and Re-draw the circuit.

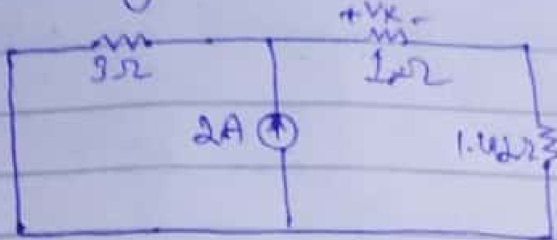


(1b)

$R_{eq} = 5 \| 2$

$= \frac{2 \times 5}{5+2} = \frac{10}{7} = 1.42\,\Omega$

Re-drawing the circuits



Applying current dividing rule.

$I_{2\Omega} = \frac{2(3)}{3+1+1.4}$

$I_{2\Omega} = 1.105$

Now

$V_x = IR$

$V_{x3} = (1.105)(1)$

$V_{x3} = 1.105$

Now

adding all the voltages

$V_x = V_{x1} + V_{x2} + V_{x3}$

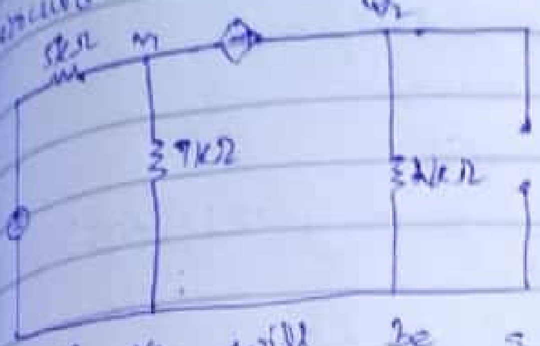
$= 0.73 + (-0.52) + 1.10$

$V_x = 1.31\ V$

Q No 2

Ans:- Figure:-

Removing the current sources so it will be act on open circuit. Redrawing the circuit.



v_1 & v_2 will be a supernode applying KCL on a supernode.

$$\frac{v_1 - 1}{5000} + \frac{v_1}{7000} + \frac{v_2}{2000} = 0$$

&

Now $v_1 - v_2 = 0.2 I_x$

$v_2 = 0.2 I_x + v_1$

$$\frac{v_1 - 1}{5000} + \frac{v_1}{7000} + \frac{0.2 I_x + V}{2000} = 0$$

But $v_1 = 7000 I_{x_1}$

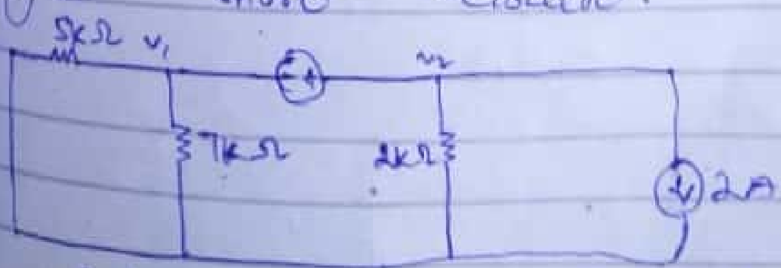
$$\frac{7000 I_{x_1} - 1}{5000} + \frac{7000 I_{x_1}}{7000} + \frac{7000 I_{x_1} 0.2 I_{x_1}}{2000}$$

$1.4 I_{x_2} - 0.2 + 1 I_{x_1} + 3.5 I_{x_2} + 0.1 I_{x_2} = 0$

$6 I_{x_2} = 0.2$

$I_{x_1} = 0.03$ A

Now the voltage source will be get short circuit.



Applying KCL on supernode

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

$\therefore \quad V_2 = V_1 + 0.2 I_{x2}$

$$\frac{V_1}{5000} + \frac{V_1}{7000} + \frac{V_1 + 0.2 I_{x2}}{2000} = -2$$

$\therefore \quad V_1 = 7000 I_{x2}$

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

$1.4 I_{x2} + I_{x2} + 3.5 I_{x2} + 0.2 I_{x2} = -2$

$6 I_{x2} = -2$

$I_{x2} = -2/6$

$I_{x2} = -0.33$ A

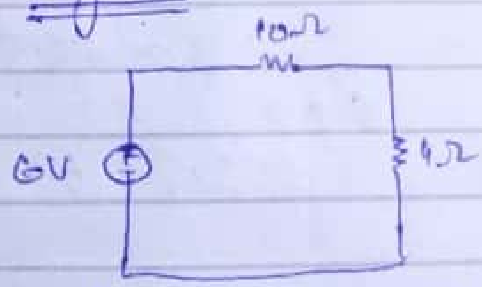
$I = I_{x1} + I_{x2}$

$I = 0.03 - 0.33$

$I = 0.3$ A

Q No 3

Ans: Figure:-



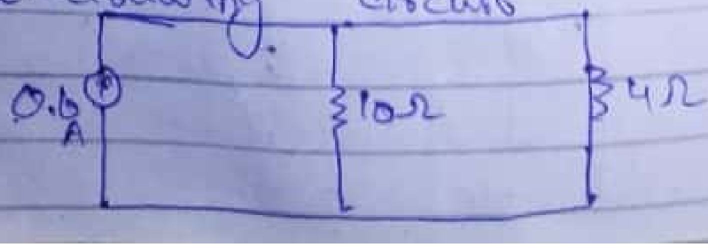
According to ohm's law

$V = IR$

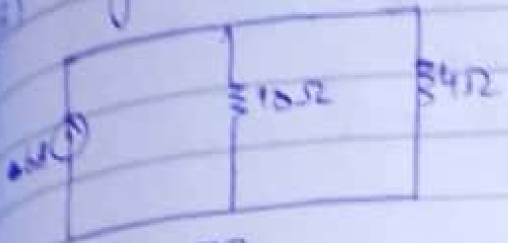
$I = V/R = 6/10$

$I = 0.6$ A

Re-drawing circuit.



(2) Figure 2:-



$v = IR$

$v = (6)(10)$

$V = 60V$

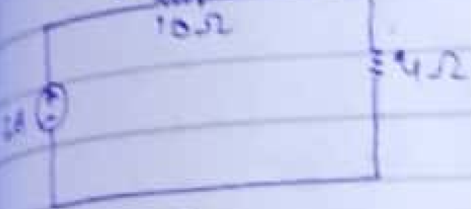
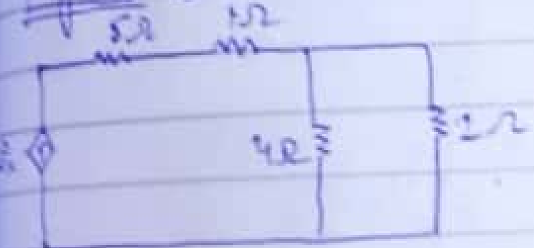


Figure 3:-

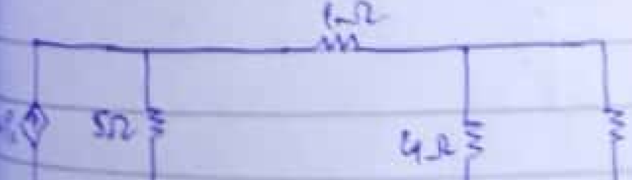


$v = IR$

$I = V/R$

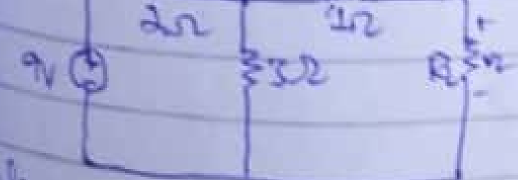
$= 2/5$

$I = 0.4ix$



Q No 4:-

Ans:-



Sol:-

To get R_{Th} we will add all the resistor accept R_L

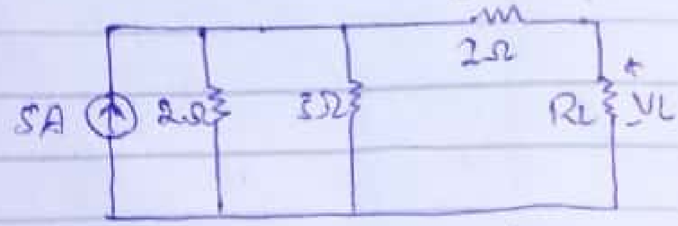
$$R_{Th} = 2 \parallel 3 + 1$$

$$= \frac{6}{5} + 1$$

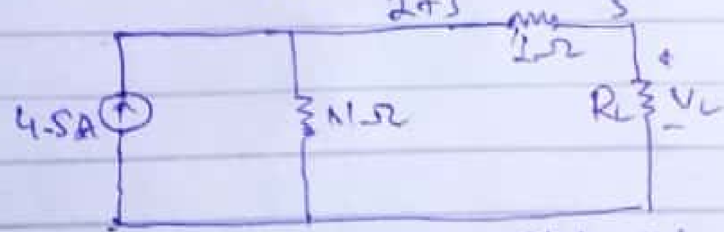
$$R_{Th} = 2.2\,\Omega$$

Now solving by source transformation

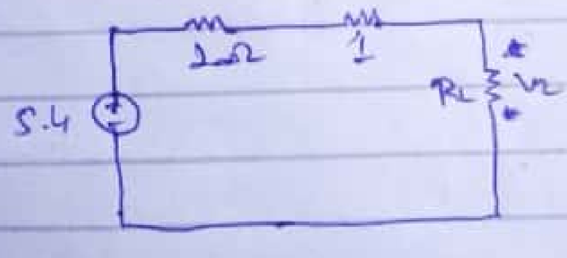
$$I = V/R = \frac{9}{2} = 4.5$$

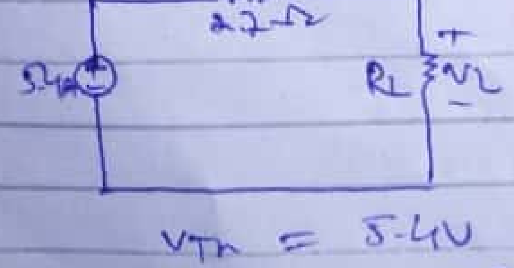


$$R_{eq} = \frac{2\times 3}{2+3} = \frac{6}{5} = 1.2$$



$$V = R = (4.5)(1.5) = 5.4V$$





$$V_{Th} = 5.4V$$

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

Now calculating each value of R_L

$R_L = 1\Omega = \frac{5.4(1)}{1+2.2}$

$V_L = 1.68\,V$

(ii) $R_L = 3.5\Omega$

$= \frac{(5.4)(3.5)}{3.5+2.2}$

$V_L = 3.31\,V$

(iii) $R_L = 6.25\,\Omega$

$= \frac{(5.4)(6.25)}{(6.25)(2.2)}$

$V_L = 3.99\,V$

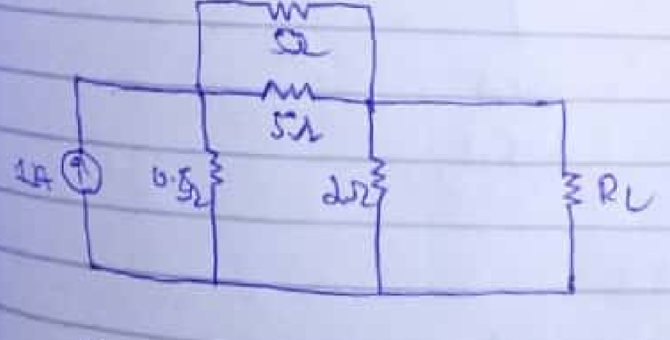
(iv) $R_L = 9.8\Omega$

$= \frac{(5.4)(9.8)}{(2.2)+9.8}$

$V_L = 4.41\,V$

Q No 5:-

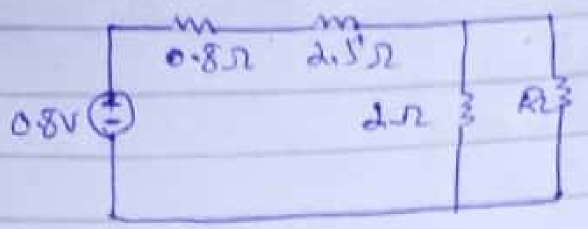
Ans:- Figure:-

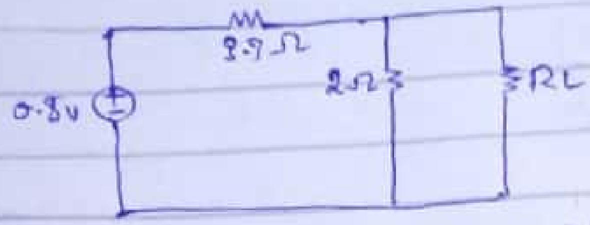


$R_{eq} = \frac{5\times5}{5+5} = \frac{25}{10} = 2.5$

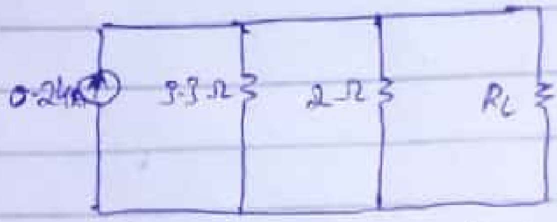
$V = IR$

$= (1)(0.8) = 0.8$



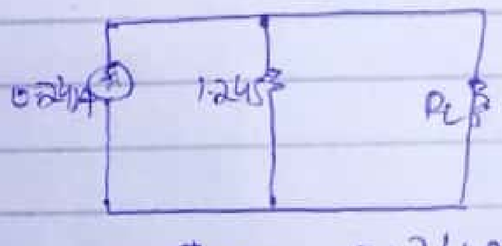


$I = 0.8/3.3 = 0.24$



$R_{eq} = \frac{3.3\times 2}{2+3.3} = \frac{6.6}{5.3}$

$R_{eq} = 1.245$



$I_n = 0.24A$

$R_n = 1.245\Omega$

Now

$V = IR$

$V_{Th} = I_N \cdot R_N$

$= (0.24)(1.245)$

$V_{Th} = 0.302V$

&

$R_N = R_{Th}$

$R_{Th} = 1.245$

Find each value for R_L

i) $R_L = 0\Omega$

$= \frac{0.30\Omega}{1.245+0}$

$i_L = 0.243A$

(2) $R_L = 1\Omega$

$= \frac{0.302}{1.245+1} = 0.13A$

$i_L = 0.135A$

(3) $R_L = 4.92\Omega$

$= \frac{0.302}{1.245+4.923}$

$i_L = 0.049A$

(4) $R_L = 8.107\Omega$

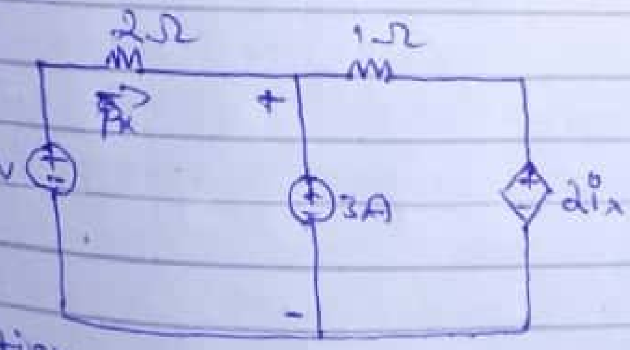
$= \frac{0.302}{1245+8.107}$

$i_L = 0.032A$

QNo2 Part (ii)

Ex 5.3

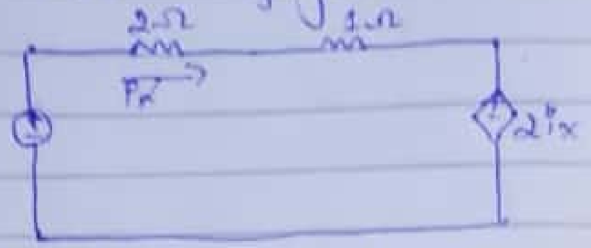
Figure:-



Solution:-

First we will remove current source and will make it an open circuit

So the figure will be



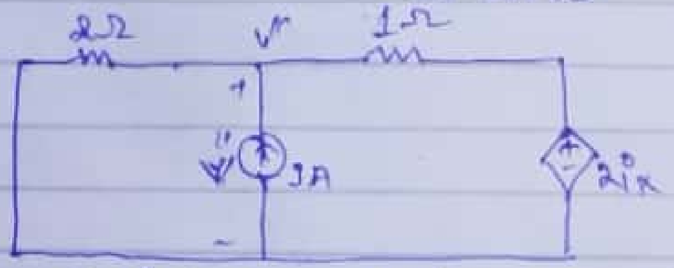
Applying KVL on Mesh

$2i_x' + 1i_x' + 2i_x' = 10$

$5i_x' = 10$

$i_x' = 2A$

Now will remove voltage source for making it an open circuit



Applying KCL on v'

$\frac{v''}{2} + \frac{v' - 2i_x''}{1} = 3$

$\frac{v'' + 2v'' - 2i_x''}{2} = 3$

$3v'' - 4i_x'' = 6$

We know from the figure

$v'' = -2i_x''$

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

$-10i_x'' = 6$

$i_x'' = -6/10$

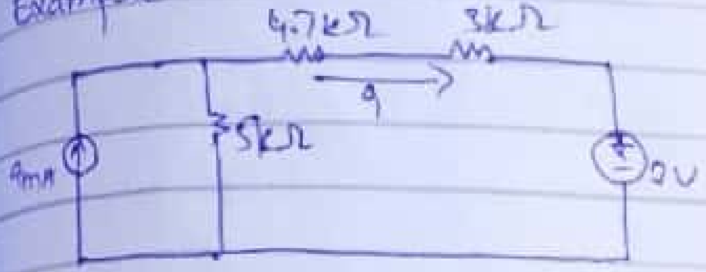
$i_x'' = -0.6\ A$

$i_x = i_x' + i_x''$

$= 2 + (-0.6)$

$i_x = 1.4A$

Example 5.4:



Sol:

We know that

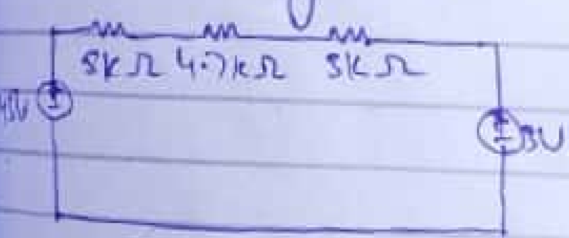
$V = IR$

$V = (9 \times 10^{-3})(5000)$

$= (0.009)(5000)$

$V = 45$

Re drawing the circuit



Applying KVL on Mesh

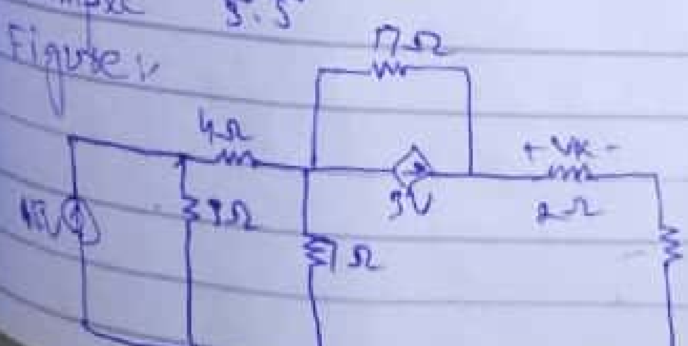
$5000i + 4700i + 3000i = 45 - 3$

$12700i = 42$

$i = 0.003 A$

Example 5.5

Figure:



(26)

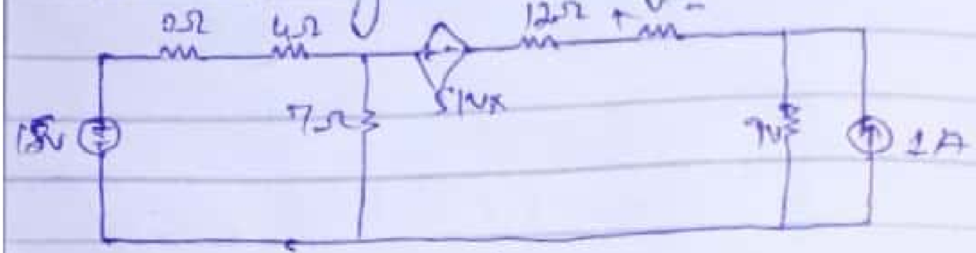
$V = IR$

$V = 5(3) = 15V$

$V_x = 3(17)$

$V_x = 51$

Re drawing a circuit



$R = 3+4$

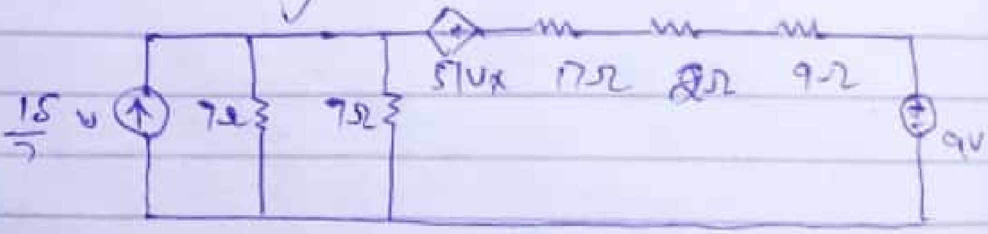
$= 7\Omega$

$I = \frac{V}{R} = \frac{15}{7} = 7.5A$

$V = IR =$ ~~7.5(7)~~ $9(7)$

~~V = 63V~~

Redrawing a circuit

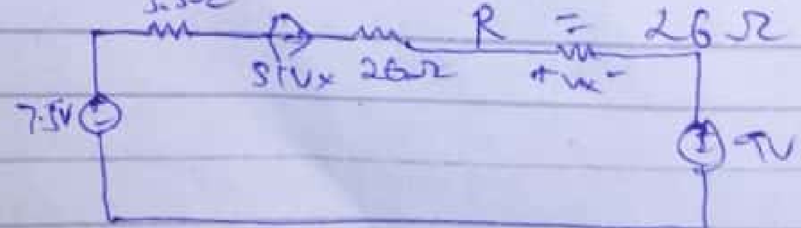


$V = IR = \left(\frac{15}{7}\right)(7)$

$V = 7.5$

$R =$ ~~7.5~~ $17+9$

$R = 26\Omega$



Applying KVL on Mesh

$9.5i - 51V_x + 28i = 7.5 - 9$

$V_x = 21$

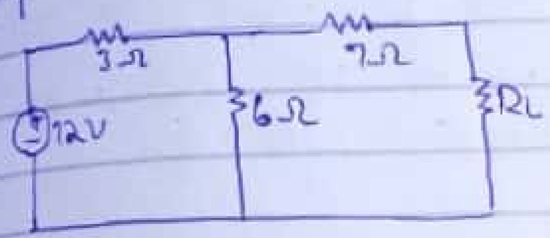
$9.5i - 51(21)i + 28i = 1.8$

$-1039.5i = -1.5$

$i = \frac{-1.5}{-1039.5}$

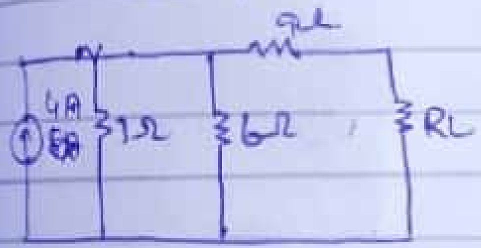
$i = 0.0014A.$

Example 5.6

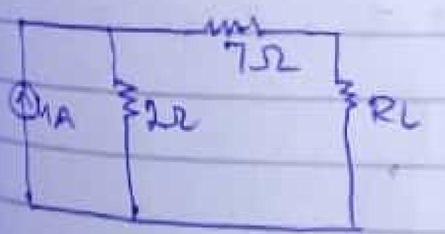


Solution:

$I = V/R = 12/3 = 4A$

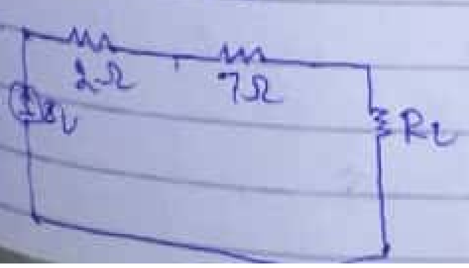


$R_{eq} = \frac{3 \times 6}{3+6} = \frac{18}{9} = 2\Omega$

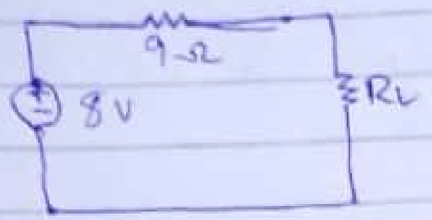


$V = IR = (4)(2)$

$V = 8V$



$R = 2 + 7 = 9$



$V_{TH} = 8V$

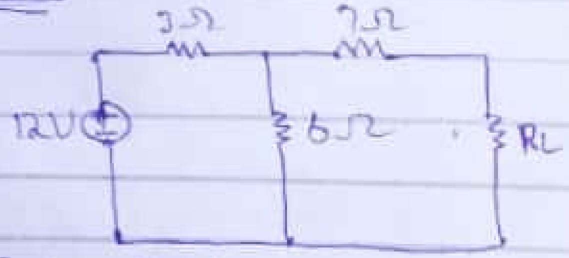
$R_{TH} = 9\Omega$

$$R.P = \left(\frac{8}{9 + R_L}\right)^2 R_L$$

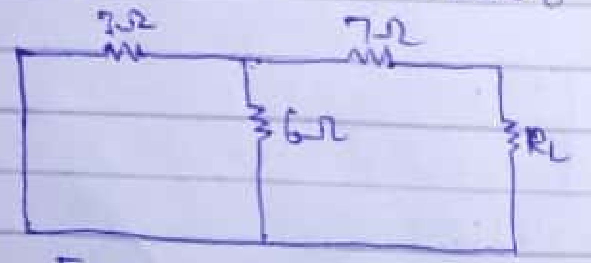
For any value of R_L with ha[ve] different solution.

Example 57

Figure:-



For finding R_{TH} we will remove voltage source & make it a short circuit



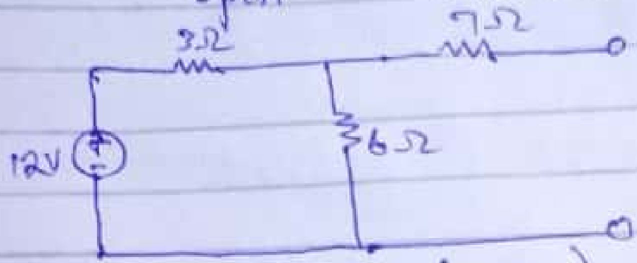
For R_{TH} we will add all the resistor except R_L

$R_{TH} = 3 \parallel 6 + 7$

$= \frac{18}{9} + 7$

$R_{TH} = 9$

For V_{OC} we will remove R_L and make it as an open circuit

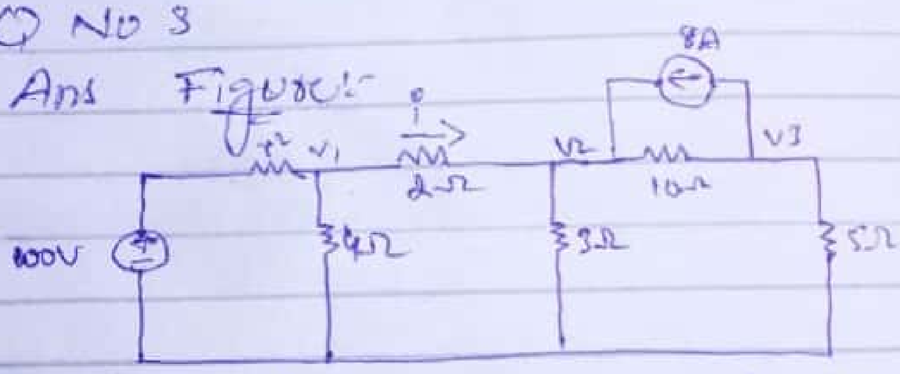


$$V_{OC} = 12\left(\frac{6}{3+6}\right)$$

$V_{OC} = 8V$

Q No 3

Ans Figure:-



Applying KCL on node 1:-

$$\frac{V_C - 100}{8} + \frac{V_1}{4} + \frac{V_1 - V_2}{2} = 0$$

$$\frac{V_1 - 100 + 2V_1 + 4V_1 - 4V_2}{8} = 0$$

$$7V_1 - 4V_2 = 100 \quad \text{—(1)}$$

Applying KCL on node 2:-

$$\frac{V_2 - V_1}{2} + \frac{V_2}{3} + \frac{V_1 - V_3}{10} = 8$$

~~30V2~~ $$\frac{30V_2 - 30V_1 + 20V_2 + 3V_2 - 3V_3}{60} = 8$$

$-30V_2 + 53V_2 - 3V_3 = 480$ — (2)

Applying 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)

$$7V_1 - 4V_2 = 100$$

$$V_1 = \frac{4V_2 + 100}{7} \quad \text{— (a)}$$

Taking eq (2)

$$-V_2 + 3V_3 = -80$$

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

Putting eq (a) & (b) in eq (2)

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

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

$$34.91V_2 = 828.39$$

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

$$V_2 = 20.31$$

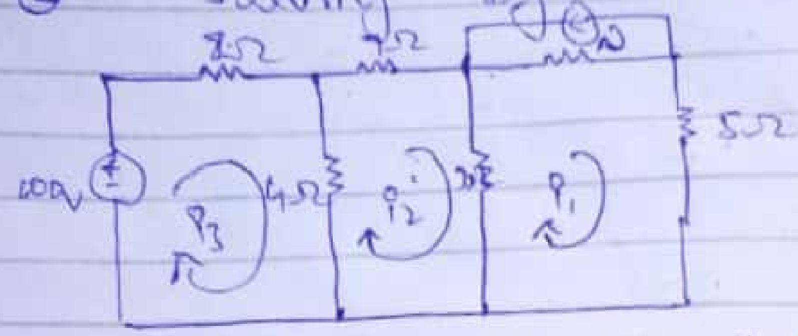
Putting in eq (a)

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

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

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

(3) solving by 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:

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

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

$-4i_2 + 9i_1 - 3i_3 = 0$ — (2)

Applying KVL on Loop 3:

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

As $i_4 = 8$

$-3i_2 + 18i_3 = -80$ — (3)

Taking eq (1)

$i_1 = \frac{11i_2 - 100}{12}$ — (a)

Taking eq (3)

$3i_2 + 18i_3 = -80$

$i_3 = \frac{-3i_2 + 80}{18}$ — (b)

Putting eq a & b in eq (2)

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

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

$7.2i_2 = +20 = 20/7.2$

$i_2 = 2.79\,A$

$i_2 = i_x$

$i_x = 2.79\,A$

Applying KCL on node (3)

$$\frac{V_3 - V_2}{10} + \frac{V_3}{5} = 0$$

$$\frac{V_3 - V_2 + V_3}{10} = 0 \quad —(3)$$

Now Taking eq (1) & (2)

$7V_1 - 4V_2 = 100$

$$V_1 = \frac{4V_2 + 100}{7} \quad —(a)$$

Now

$-V_2 + 3V_3 = 0$

$V_3 = 1/3\,V_2 \quad —(b)$

Putting in eq (2)

$-30(0.57V_2 + 14.28) - 4V_2 + 2(0.33V_2) = 0$

$-17.1V_2 - 428.4 - 4V_2 + 0.66V_2 = 0$

$20.44V_2 = -428.4$

$V_2 = -20.95$

Putting in eq (a)

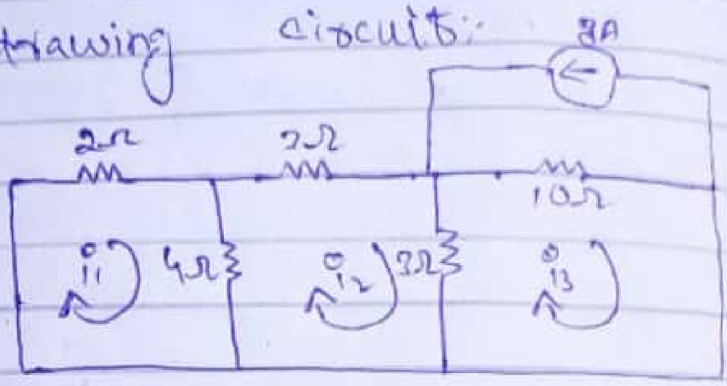
$V_2 = 2.31$

$$i_1 = \frac{2.31 + 20.95}{2} \Rightarrow i_1 = 11.63$$

~~Applying KCL on node (1):~~

Now Removing voltage source and making it short circuit

Redrawing circuit:



$i_4 = 8A$

Applying KVL on loop 1

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

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

$12i_1 - 4i_2 = 0$

$3i_1 - i_2 = 0$ — (1)

Applying KVL on loop (1)

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

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

$-4i_1 + 3i_2 - 3i_3 = 0$ — (2)

Applying KVL on loop (1)

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

$-3i_2 + 18i_3 = -80$

Taking eq (1)

$3i_1 - i_2 = 0$

$i_1 = 0.33 i_2$ — (a)

$-3i_2 + 18i_3 = -80$

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

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

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

$i_2 = 1.354$

NOW

$i = i_1 + i_2$

$i = 1.44 + 1.35$

$i = 2.79\,A$

Result

$\boxed{i = 2.79\ A}$