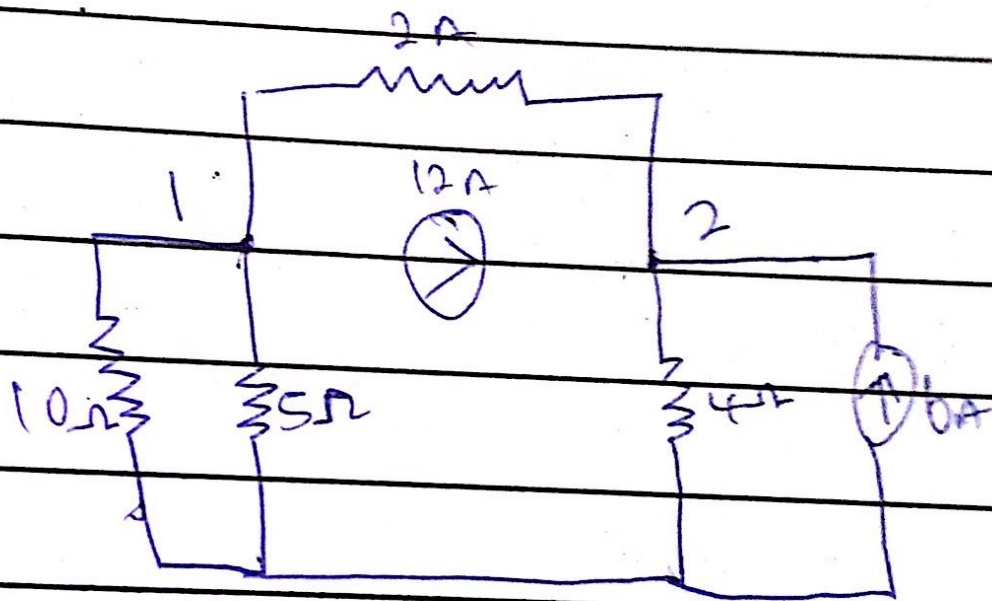


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Solution.



At node 1 with KCL

$$\bar{I}_1 = \bar{I}_2 + \bar{I}_3 + \bar{I}_r$$

$$\frac{V_0 - V_1}{10} = \frac{V_1 - V_2}{2} + \frac{V_1 - V_0}{5} + 12A$$

multiply through by 10

$$V_0 - V_1 = 5(V_1 - V_2) + 2(V_1 - V_0) + 120$$

$$V_0 - V_1 = 5V_1 - 5V_2 + 2V_1 - V_0 + 120$$

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$$U_0 - U_1 = 7U_1 - 5U_2 + U_0 + 120$$

$$-U_1 = 7U_1 - 5U_2 + U_0 - U_0 + 120$$

$$-U_1 = 7U_1 - 5U_2 + 120$$

$$-8U_1 + 5U_2 = 120 \quad \text{--- (1)}$$

At node 3.

$$\bar{I}_4 = -\bar{I}_2 - \bar{I}_5 + \bar{I}_6$$

$$\bar{I}_6 = \bar{I}_4 + \bar{I}_2 + \bar{I}_5$$

$$\frac{U_2 - U_0}{4} = 12 + \frac{U_1 + U_2}{2} + 6U_1$$

Multiply by 4

$$U_2 - U_0 = 48 + 2(U_1 + U_2) + 24$$

$$U_2 = 48 + 2U_1 - 2U_2 + 24$$

$$U_1 = 72 + 2U_1 - 2U_2$$

$$3U_2 - 2U_1 = 72 \quad \text{--- (2)}$$

Applying elimination method

$$5U_2 - 8U_1 = 120 \quad \text{--- (1)}$$

$$3U_2 - 2U_1 = 72 \quad \text{--- (2)}$$



NkV

$$10V_2 - 16V_1 = 240$$

$$+ 24V_2 - 16V_1 = 576$$

$$34V_2 = 816$$

$$V_2 = 24V$$

Putting the value of V_2 in eqn (2)

$$5(24) - 8V_1 = 120$$

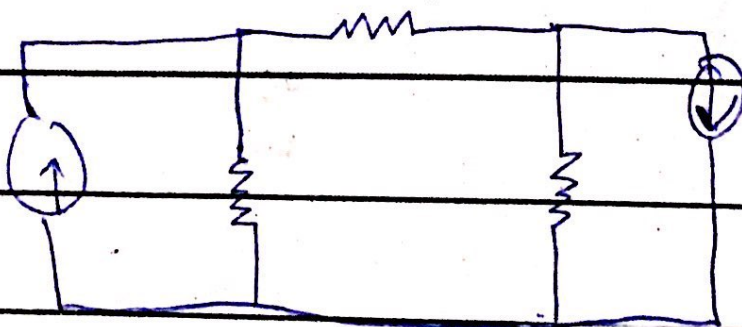
$$-8V_1 = 120 - 120$$

$$-8V_1 = 0$$

$$V_1 = 0$$

$$\bar{I}_1 = 0A, \bar{I}_2 = 0A, \bar{I}_3 = 6A, \bar{I}_4 = 12A$$

Question iii



At node 1

$$\bar{I}_1 = \bar{I}_2 + \bar{I}_3$$

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$$1 = \frac{V_1 - V_2}{6} + \frac{V}{2}$$

$$6 = V_1 - V_2 + 3V$$

$$6 = 4V_1 - V_2 \quad \dots \quad (1)$$

At node 2.

$$\bar{I}_2 = \bar{I}_3 + \bar{I}_5$$

$$\frac{V_1 - V_2}{6} = 4 + \frac{V_2}{7}$$

$$7(V_1 - V_2) = 6(28 + V_2)$$

$$168 = 7V_1 - 13V_2 \quad \dots \quad (2)$$

from eqn (1) $V_2 = 4V_1 - 6$

$$168 = 7V_1 - 13(4V_1 - 6)$$

$$168 = 7V_1 - 52V_1 + 78$$

$$90 = -45V_1$$

$$V_1 = -2V$$

Put the value of V_1 in eqn (1)

$$V_2 = 4(-2V) - 6$$



$$U_2 = -8V - 6V$$

$$U_2 = -14V$$

Current

$$I_2 = \frac{U_1 - U_2}{6} = \frac{-2 + 14}{6} = 2A$$

$$I_3 = \frac{U_1}{2} = \frac{-2}{2} = -1A$$

$$I_4 = \frac{U_2}{7} = \frac{-14}{7} = -2A$$

2 Question 2.

At node 1 using KCL

$$I_{0A} = \frac{V_1}{2} + I_1 + I_2$$

$$I_{0A} = \frac{V_1 - V_3}{2} + \frac{V_1 - V_2}{3}$$

Multiply through by 6

$$6I_{0A} = 3(V_1 - V_3) + 2(V_1 - V_2)$$

$$6I_{0A} = 3V_1 - 3V_3 + 2V_1 - 2V_2$$

$$6I_{0A} = 5V_1 - 2V_2 - 3V_3$$

At node 2 using KCL

$$I_2 = I_3 + I_4$$

$$I_4 = I_2 - I_3$$

$$I_4 = \frac{V_1 - V_2}{3} - \frac{V_2 - 0}{4}$$

$$7I_4 = 4(V_1 - V_2) - 3(V_2)$$

$$7I_4 = 4V_1 - 7V_2 \quad \dots (1)$$

At node 3 KCL

Nkya



$$6u + 1 = 13$$

$$6u = 13 - 1$$

$$6u = \frac{U_3 - U_0}{6} - \frac{U_1 - U_3}{2}$$

$$384 = U_3 - 3(U_1 - U_3)$$

$$384 = -3U_1 + 4U_3 \quad \dots (1)$$

in matrix form

$$\begin{bmatrix} 5 & -2 & -3 \\ 4 & -7 & 0 \\ -3 & 0 & 4 \end{bmatrix} \begin{bmatrix} U_1 \\ U_2 \\ U_3 \end{bmatrix} = \begin{bmatrix} 60 \\ 768 \\ 384 \end{bmatrix}$$

$$D = \begin{bmatrix} 5 & -2 & -3 \\ 4 & -7 & 0 \\ -3 & 0 & 4 \end{bmatrix}$$

$$5(-28) + 2(16 + 0) - 3(0 - 21)$$

$$D = -45$$

$$D_1 = \begin{bmatrix} 60 & -2 & -3 \\ 768 & -7 & 0 \\ 384 & 0 & 4 \end{bmatrix}$$



Nky

$$60(-28) + 2(3072) - 3(0 + 2688) \\ = -3600$$

$$V_1 = \frac{\Delta_1}{\Delta_2} = \frac{-3600}{-45} = 80 \text{ V}$$

$$\Delta_2 = \begin{vmatrix} 5 & 60 & -3 \\ 4 & 268 & 0 \\ 3 & 384 & 4 \end{vmatrix}$$

$$5(3072) - 60(10) - 3(1536 + 2304) \\ = 2880$$

$$V_2 = \frac{\Delta_2}{D} = \frac{2880}{-45} = -64 \text{ V}$$

$$\Delta_3 = \begin{vmatrix} 5 & -2 & 60 \\ 4 & -2 & 268 \\ -3 & 0 & 384 \end{vmatrix}$$

$$= 5(-2688) + 2(1536 + 2304) + 60(21) \\ = -7020$$

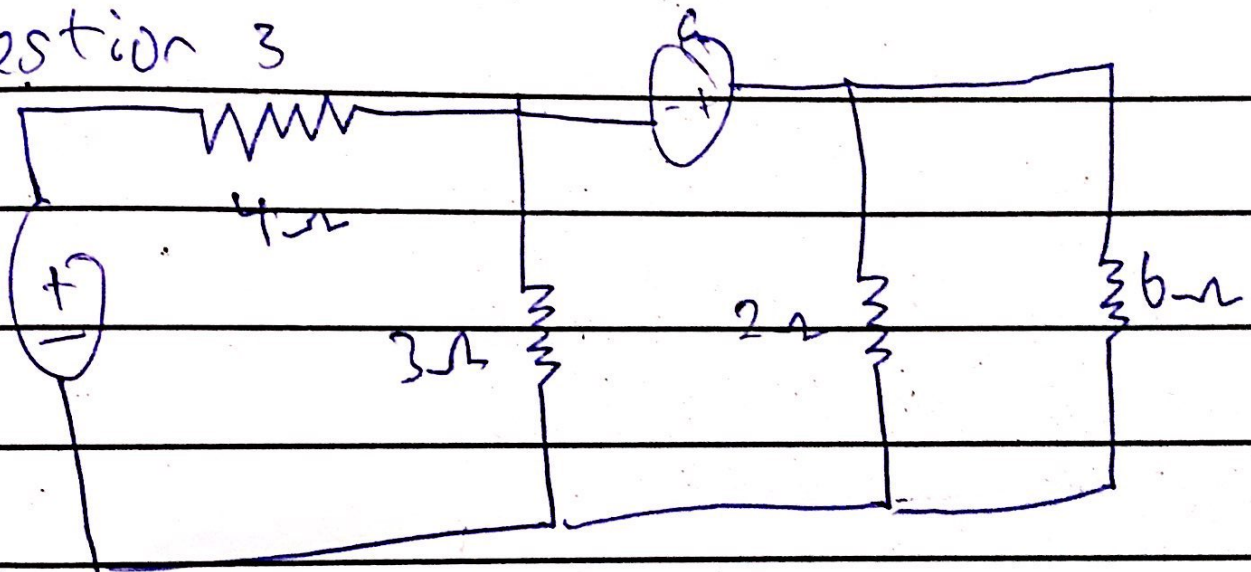
Nikv



$$V_3 A_3 = \frac{-2000}{-45} = 156V.$$

$$V_1 = 80V, \quad V_2 = -64V, \quad V_3 = 156V$$

Question 3



Using KCL at node 1

$$\hat{I}_1 + \hat{I}_2 + \hat{I}_3 + \hat{I}_4 = 0$$

$$\frac{V_1 - 4}{4} + \frac{V_1}{3} + \frac{V_2}{6} + \frac{V_2}{2} = 0$$

$$7V_1 + 8V_2 + 63 = 0 \quad \dots 1$$

Using KVL for loop 1

$$-V_1 - 9 + V_2 = 0$$

$$-V_1 + V_2 = 9$$

NKV



$$7V_1 + 8V_2 = 163$$

$$-V_1 + V_2 = 9$$

$$V_2 = 9 + V_1$$

$$7V_1 + 8(9 + V_1) = 163$$

$$7V_1 + 72 + 8V_1 = 163$$

$$15V_1 + 72 = 163$$

$$15V_1 = 91$$

$$V_1 = 6.067$$

put the value of V_1

$$V_2 = 9 + (6.067)$$

$$V_2 = 15.067$$

$$V_2 = 15.07 \text{ V}$$

Current through the 2- Ω
resistor

$$\frac{V_2}{4} = \frac{15.07}{4} = 3.77$$

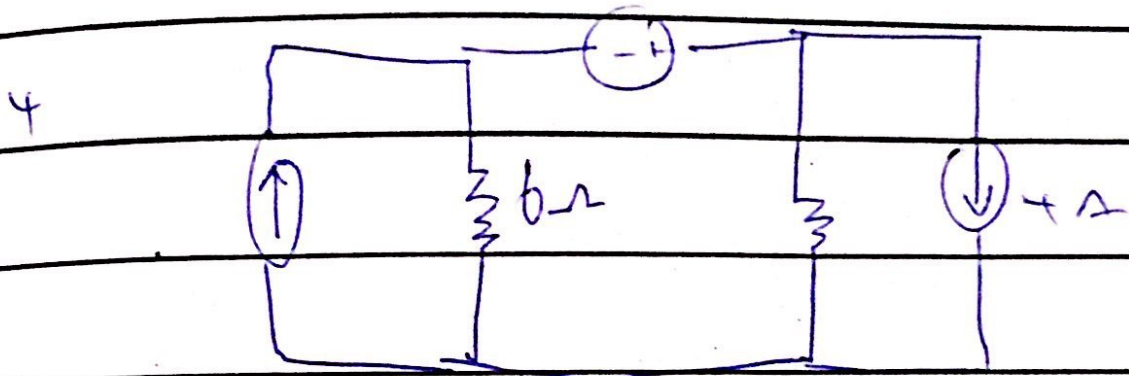
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Nky &
UZO



Current through the 3Ω resistor -

$$I_2 = \frac{V_2}{3} = 0.6 = -0.2 \text{ A}$$



At node 1 using KCL

$$6 \text{ mA} = I_1 + I_2$$

$$6 \text{ mA} = \frac{V_1 - 0}{6} + (V_1 - V_2)$$

$$36 = V_1 + 6(V_1 - V_2)$$

$$36 = V_1 + 6V_1 - 6V_2$$

$$36 = 7V_1 - 6V_2 \quad \dots (1)$$

At node 2

$$1.2 = -I_2 + I_1$$

$$V_1 - V_2 = 1.2 \text{ mA} + \frac{V_2 - 0}{3}$$



$$12(V_1 - V_2) = 48 - V_2$$

$$48 = 12V - 12V_2 - V_2$$

$$48 = 12V - 13V_2 \quad \dots (ii)$$

$$V_1 = 9.5V \text{ and } V_2 = 5.1V$$

Current through 6Ω

$$I = \frac{V_1}{6} = \frac{9.5}{6} = 1.58A, \quad I_2 = \frac{V_1 - V_2}{6}$$

$$= \frac{9.5 - 5.1}{6} = 0.73A$$

Current through the 12Ω resistor

$$I = \frac{V_2}{12} = \frac{5.1}{12} = 0.43A$$

$$V_1 = 9.5V, \quad V_2 = 5.1V$$

$$I_2 = 1.58A, \quad I_4 = 0.43A$$