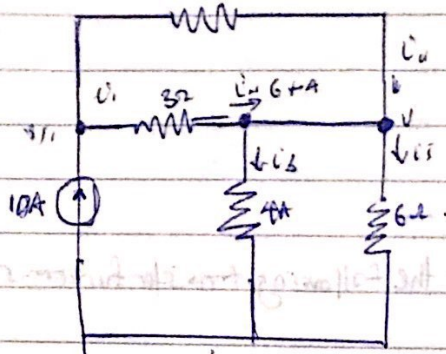


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19/ENG 04/064

Circuit Theory Assignment



At node 1, KCL:

$$i_0 = i_1 + i_2 = \frac{V_1 - 0}{2} + \frac{V_1 - V_3}{3}$$

$$60 = 20V_1 - 20V_2 + 3(V_1 - V_3)$$

$$60 = 2V_1 - 2V_2 + 3V_1 - 3V_3$$

$$60 = 5V_1 - 2V_2 - 3V_3 \dots (1)$$

At Node 2 KCL

$$i_2 = i_3 + 6A$$

$$64 = i_2 - i_3$$

$$64 = \frac{V_1 - V_2}{3} - \frac{(V_2 - 0)}{4}$$

$$768 = 4(V_1 - V_2) - 3V_2$$

$$768 = 4V_1 - 7V_2 \dots (2)$$

At Node 3: KCL

$$64 + i_2 = i_3$$

$$64 = i_3 - i_1$$

$$64 = \frac{V_3 - 0}{6} - \frac{(V_1 - V_2)}{2}$$

$$384 = V_3 - 3(V_1 - V_2)$$

$$384 = -3V_1 + 4V_3 \dots (3)$$

Using Cr

Using Cramer's rule

$$5V_1 - 2V_2 - 3V_3 = 60$$

$$4V_1 - 7V_2 = 768$$

$$-3V_1 + 0 + 4V_3 = 384$$

$$\begin{bmatrix} 5 & -2 & -3 \\ 4 & -7 & 0 \\ -3 & 0 & 4 \end{bmatrix} \begin{bmatrix} V_1 \\ V_2 \\ V_3 \end{bmatrix} = \begin{bmatrix} 60 \\ 768 \\ 384 \end{bmatrix}$$

$$V_1 = \frac{\Delta_1}{\Delta}, \quad V_2 = \frac{\Delta_2}{\Delta}, \quad V_3 = \frac{\Delta_3}{\Delta}$$

$$\Delta = \begin{vmatrix} 5 & -2 & -3 \\ 4 & -7 & 0 \\ 3 & 0 & 4 \end{vmatrix} = -45$$

$$\Delta_1 = \begin{vmatrix} 60 & -2 & -3 \\ 768 & -7 & 0 \\ 384 & 0 & 4 \end{vmatrix} = -3600$$

$$\Delta_2 = \begin{vmatrix} 5 & 60 & -3 \\ 4 & 768 & 0 \\ 3 & 384 & 4 \end{vmatrix} = 2800$$

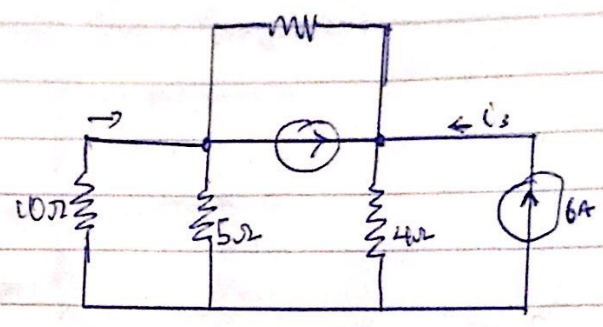
$$\Delta_3 = \begin{vmatrix} 5 & -2 & 60 \\ 4 & -7 & 768 \\ -3 & 0 & 384 \end{vmatrix} = -7020$$

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

$$V_2 = \frac{\Delta_2}{\Delta} = \frac{2800}{-45} = -64V$$

$$V_3 = \frac{\Delta_3}{\Delta} = \frac{-7020}{-45} = 156V$$

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At node 1 KCL

$$i_1 = i_2 + i_3 + i_4$$

$$\frac{0 - V_1}{10\Omega} = \frac{V_1 - V_2}{5\Omega} + 12 + \frac{V_1 - 0}{5}$$

$$-V_1 = 5(V_1 - V_2) + 20 + 2V_1$$

$$120 = -8V_1 + 5V_2 \quad \dots \textcircled{1}$$

At node 2

$$i_3 + i_2 + i_5 = i_6$$

$$12 + \frac{V_1 - V_2}{5} + 6 = \frac{V_2 - 0}{6}$$

$$96 + 4(V_1 - V_2) + 48 = 2V_2$$

$$144 = -4V_1 + 6V_2 \quad \dots \textcircled{2}$$

$$120 = -8V_1 + 5V_2$$

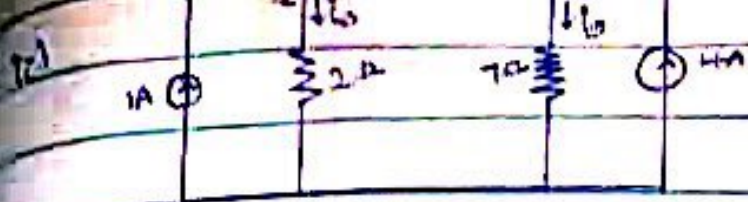
$$144 = -4V_1 + 6V_2$$

Solving sim

$$V_1 = 0, \quad V_2 = 24 \text{ V}$$

$$i_2 = \frac{V_1 - V_2}{5} = \frac{0 - 24}{5} = -4.8 \text{ A}$$

$$i_1 = \frac{0 - V_1}{10} = \frac{0}{10} = 0 \text{ A}$$



At node 1

$$i_1 = i_2 + i_3$$

$$1 = \frac{V_1 - V_2}{2} + \frac{V_1 - 0}{7}$$

$$6 = 7(V_1 - V_2) + 3V_1$$

$$6 = 4V_1 - V_2 \quad \text{--- (1)}$$

At node 2

$$i_4 = i_2 + i_3$$

$$\frac{V_1 - V_2}{2} = 4 + \frac{V_2 - 0}{7}$$

$$7(V_1 - V_2) = 16 + 6V_2$$

$$16 = 7V_1 - 13V_2 \quad \text{--- (2)}$$

Solving (1) & (2) simultaneously.

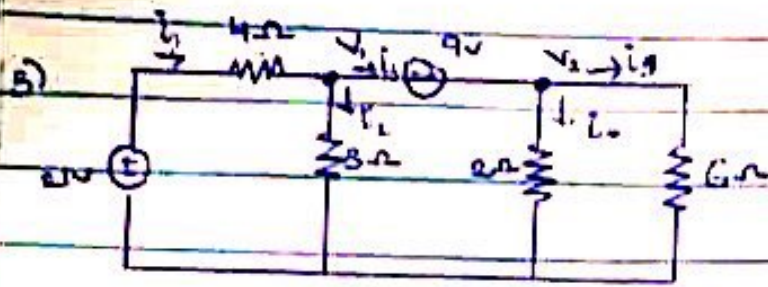
$$V_1 = -2V$$

$$V_2 = -14V$$

$$i_1 = \frac{V_1 - V_2}{2} = \frac{-2 - (-14)}{2} = \underline{\underline{6A}}$$

$$i_3 = \frac{V_1}{7} = \frac{-2}{7} = \underline{\underline{-0.286A}}$$

$$i_2 = \frac{V_2}{5} = \frac{-14}{5} = \underline{\underline{-2.8A}}$$



At Node 1

$$i_1 + i_2 + i_3 + i_4 = 0$$

$$\frac{V_1 - 21}{4} + \frac{V_1}{3} + \frac{V_2}{6} + \frac{V_2}{2} = 0$$

$$7V_1 + 8V_2 - 63 = 0 \quad \text{--- (1)}$$

At loop 1, KVL:

$$V_1 - V_2 = 9 \quad \text{--- (2)}$$

solving (1) & (2) simultaneously

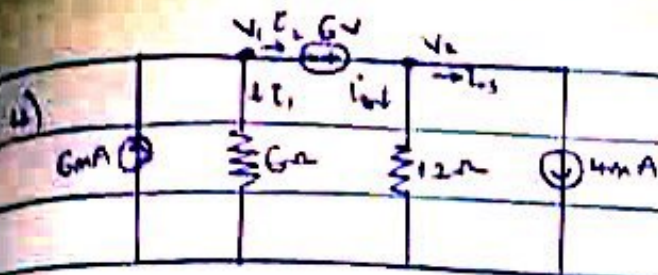
$$V_1 = \underline{\underline{-0.6V}} \quad V_2 = \underline{\underline{8.4V}}$$

$$i_1 = \frac{V_1 - 21}{4} = \frac{-0.6 - 21}{4} = -5.4A$$

$$i_2 = \frac{V_1}{3} = \frac{-0.6}{3} = -0.2A //$$

$$i_5 = \frac{V_2}{6} = \frac{8.4}{6} = 1.4A //$$

$$i_4 = \frac{V_2}{2} = \frac{8.4}{2} = 4.2A //$$



$$V_1 - V_2 = 6V \quad \text{--- (1)}$$

At node 1

$$6mA = i_1 + i_2$$

$$6 \times 10^{-3} = \frac{V_1}{6} + \frac{V_1 - V_2}{12}$$

$$36 \times 10^{-3} = V_1 + 6(V_1 - V_2)$$

$$36 \times 10^{-3} = 7V_1 - 6V_2 \quad \text{--- (2)}$$

At node 2

$$i_2 = i_3 + i_4$$

$$\frac{V_1 - V_2}{12} = \frac{V_2}{12} + 4 \times 10^{-3}$$

$$12(V_1 - V_2) = V_2 + 48 \times 10^{-3} \times 12$$

$$12(V_1 - V_2) = V_2 + 48 \times 10^{-3}$$

$$48 \times 10^{-3} = 12V_1 - 13V_2 \quad \text{--- (3)}$$

Solving  $V_1$  &  $V_2$  simultaneously

$$V_1 = 0.0095V$$

$$V_2 = 0.0051$$

$$= 9.5mV$$

$$= 5.1mV$$

$$i_1 = \frac{V_1}{6} = \frac{9.5 \times 10^{-3}}{6} = 1.583mA$$

$$i_2 = \frac{V_2}{12} = \frac{5.1 \times 10^{-3}}{12} = 0.425mA$$