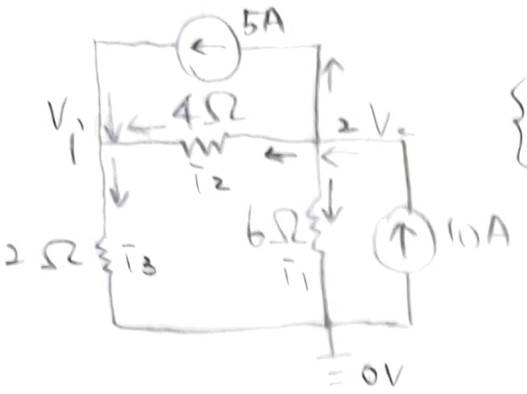
3.1

Solution:



$$\begin{cases} 10A = i_1 + i_2 + 5A \\ i_3 = i_2 + 5A \end{cases}$$

$$\Rightarrow \begin{cases} i_1 + i_2 = 5A \\ i_3 - i_2 = 5A \end{cases} \Rightarrow \begin{matrix} i_1 = 5 - i_2 \\ i_3 = 5 + i_2 \end{matrix}$$

$$i_1 = \frac{V_2 - 0}{6} = \frac{V_2}{6}$$

$$i_2 = \frac{V_2 - V_1}{4}$$

$$i_3 = \frac{V_1 - 0}{2} = \frac{V_1}{2}$$

$$\begin{cases} \frac{1}{6}V_2 = 5 - \frac{V_2 - V_1}{4} \\ \frac{1}{2}V_1 = 5 + \frac{V_2 - V_1}{4} \end{cases} \Rightarrow \begin{cases} 2V_2 = 60 - 3V_2 + 3V_1 \\ 2V_1 = 20 + V_2 - V_1 \end{cases}$$

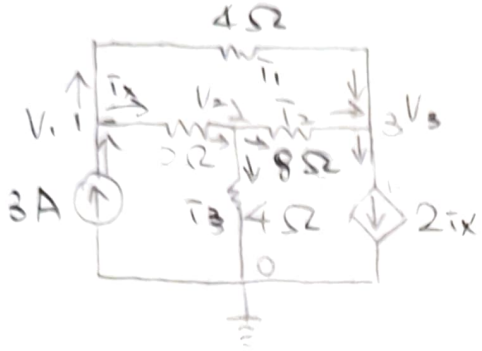
$$\Rightarrow \begin{cases} 3V_1 - 5V_2 = -60 \\ 3V_1 - V_2 = 20 \end{cases} \Rightarrow \begin{matrix} V_2 = 20\,V \\ V_1 = \frac{40}{3}\,V \end{matrix}$$

Answer:

node1 = $\frac{40}{3}$ V, node2 = 20V

3.2

Solution:



$$\begin{cases} 3 = i_x + i_1 \\ i_x = i_2 + i_3 \\ 2i_x = i_2 + i_1 \end{cases}$$

$$i_1 = \frac{V_1 - V_3}{4} = \frac{1}{4}V_1 - \frac{1}{4}V_3$$

$$i_x = \frac{V_1 - V_2}{2} = \frac{1}{2}V_1 - \frac{1}{2}V_2$$

$$i_2 = \frac{V_2 - V_3}{8} = \frac{1}{8}V_2 - \frac{1}{8}V_3$$

$$i_3 = \frac{V_2 - 0}{4} = \frac{1}{4}V_2$$

$$\Rightarrow \quad 3 = \frac{1}{2}V_1 - \frac{1}{2}V_2 + \frac{1}{4}V_1 - \frac{1}{4}V_3$$

$$\begin{cases} \frac{1}{2}V_1 - \frac{1}{2}V_2 = \frac{1}{8}V_2 - \frac{1}{8}V_3 + \frac{1}{4}V_2 \\ V_1 - V_2 = \frac{1}{4}V_1 - \frac{1}{4}V_3 + \frac{1}{8}V_2 - \frac{1}{8}V_3 \end{cases}$$

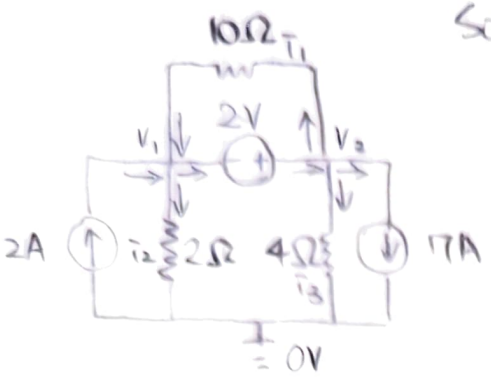
$$\Rightarrow \begin{cases} 3V_1 - 2V_2 - V_3 = 12 \\ 4V_1 - 7V_2 + V_3 = 0 \\ 2V_1 - 3V_2 + V_3 = 0 \end{cases} \Rightarrow \begin{cases} 7V_1 - 9V_2 = 12 \\ -V_1 - 2V_2 = 0 \end{cases}$$

$$V_2 = \frac{12}{5}, \quad V_1 = \frac{24}{5}, \quad V_3 = -\frac{12}{5}$$

Answer:

node 1 = $\frac{24}{5}$ V, node 2 = $\frac{12}{5}$ V, $V_3 = -\frac{12}{5}$ V

3.3



Solution:

$$2 + i_1 - i_2 = 7 - i_1 - i_3$$

$$\Rightarrow 2i_1 - i_2 + i_3 = 5$$

$$\frac{V_2 - V_1}{10} - \frac{V_1 - 0}{2} + \frac{V_2 - 0}{4} = 5$$

$$\frac{1}{5}V_2 - \frac{1}{5}V_1 - \frac{1}{2}V_1 + \frac{1}{4}V_2 = 5$$

$$4V_2 - 4V_1 - 10V_1 + 5V_2 = 100$$

$$\begin{cases} 14V_1 - 9V_2 = 100 \\ V_1 - V_2 = -2 \end{cases}$$

$$5V_2 = 128$$

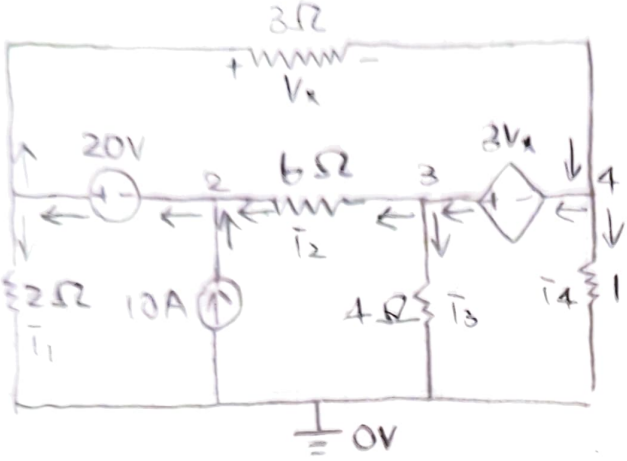
$$V_2 = \frac{128}{5} \qquad V_1 = \frac{118}{5}$$

Answer:

$$V_1 = \frac{118}{5}\,V \;,\; V_2 = \frac{128}{5}\,V$$

3.4

Solution:



$$i_2 + 10 = i_1 + \frac{V_x}{3}$$

$$\begin{cases} \frac{V_x}{3} - i_4 = i_2 + i_3 \end{cases}$$

$$\Rightarrow \begin{cases} \frac{V_3 - V_2}{6} + 10 = \frac{V_1}{2} + \frac{V_1 - V_4}{3} \\ \frac{V_1 - V_4}{3} - V_4 = \frac{V_3 - V_2}{6} + \frac{V_2}{4} \end{cases}$$

$$\Rightarrow \begin{cases} 2V_3 - 2V_2 + 60 = 3V_1 + 2V_1 - 2V_4 \\ 4V_1 - 4V_4 - 12V_4 = 2V_3 - 2V_2 + 3V_3 \end{cases}$$

$$\Rightarrow \begin{cases} 5V_1 + 2V_2 - 2V_3 - 2V_4 = 60 \\ 4V_1 + 2V_2 - 5V_3 - 16V_4 = 0 \end{cases}$$

$$\Rightarrow \begin{cases} 5V_2 + 100 + 2V_2 - 2V_4 - 6V_x - 2V_4 = 60 \\ 4V_2 + 80 + 2V_2 - 5V_4 + 5V_x - 16V_4 = 0 \\ V_2 + 20 - V_4 - V_x = 0 \end{cases}$$

$$\Rightarrow \begin{cases} 7V_2 - 4V_4 - 6V_x = -40 \\ 6V_2 - 21V_4 - 15V_x = -80 \\ V_2 - V_4 - V_x = -20 \end{cases}$$

$$\Rightarrow \begin{cases} V_2 + 2V_4 = 80 \\ -9V_2 - 6V_4 = 220 \end{cases}$$

$$-6V_2 = 460$$

$$V_2 = -\frac{230}{3} \qquad V_1 = -\frac{170}{3}$$

$$V_4 = \frac{235}{3} \qquad V_3 = -\frac{980}{3}$$

Answer: node 1: $-\frac{170}{3}$ V, node 2: $-\frac{230}{3}$ V, node 3: $-\frac{980}{3}$ V, node 4: $\frac{235}{3}$ V