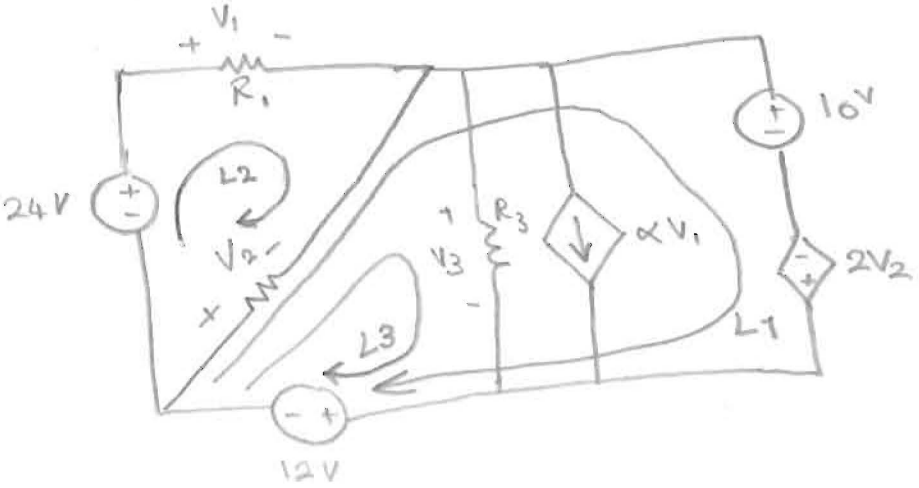
example 1 :

find $V_1 - V_3$



KVL

L_1 : $V_2 + 10V - 2V_2 + 12V = 0 \Rightarrow V_2 = 22V$

L_2 : $-24V + V_1 - V_2 = 0$

$-24V + V_1 - 22V = 0 \Rightarrow V_1 = 46V$

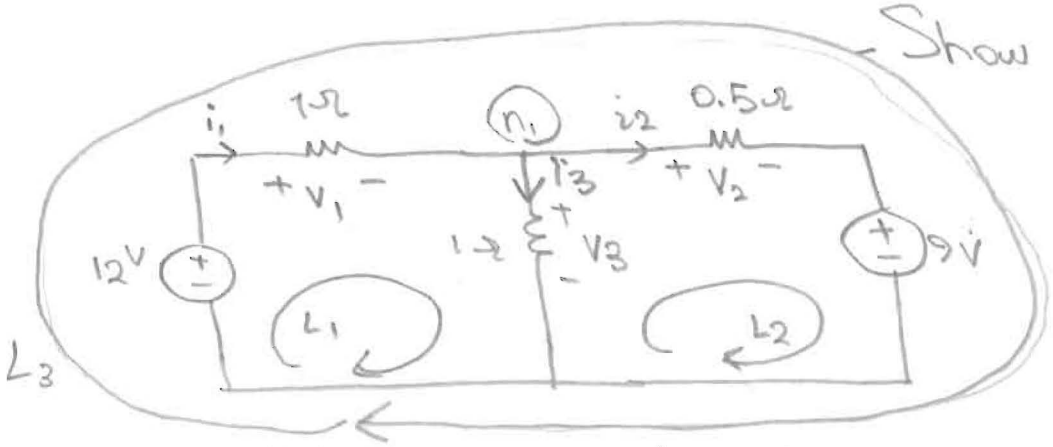
L_3 : $V_2 + V_3 + 12V = 0$

$22V + V_3 + 12V = 0 \Rightarrow V_3 = -34V$

Example 2 :

- Find $i_1 - i_3$ and $V_1 - V_3$

- Show that $\sum P = 0$



KVL :

L_1 : $-12V + V_1 + V_3 = 0$ (1)

L_2 : $-V_3 + V_2 + 9V = 0$ (2)

L_3 : $-12V + V_1 + V_2 + 9V = 0$ $\Rightarrow$ This is the sum of (1) & (2) $\rightsquigarrow$ not an independent equation.

KCL (n1) : $i_3 + i_2 - i_1 = 0$

$$\frac{V_3}{R_3} + \frac{V_2}{R_2} - \frac{V_1}{R_1} = 0 \Rightarrow \frac{V_3}{1\Omega} + \frac{V_2}{0.5\Omega} - \frac{V_1}{1\Omega} = 0$$

$$V_3 + 2V_2 - V_1 = 0 \quad (3)$$

$$\begin{cases} V_1 + V_3 = 12V & (1) \\ V_2 - V_3 = -9V & (2) \\ V_3 + 2V_2 - V_1 = 0 & (3) \end{cases} \Rightarrow \begin{cases} V_1 = 4.5V \\ V_2 = -1.5V \\ V_3 = 7.5V \end{cases}$$

$* \sum P$:

$$\begin{cases} V_1 = 4.5v \\ i_1 = \frac{4.5v}{1\Omega} = 4.5\,A \end{cases} \Rightarrow P_1 = V_1 \times i_1 = 20.25\,w \quad \text{Sink}$$

$$\begin{cases} V_2 = -1.5v \\ i_2 = \frac{V_2}{R_2} = \frac{-1.5v}{0.5v} = -3\,A \end{cases} \Rightarrow P_2 = V_2 \cdot i_2 = 4.5\,w \quad \text{Sink}$$

$$\begin{cases} V_3 = 7.5\,v \\ i_3 = \frac{V_3}{R_3} = \frac{7.5v}{1\Omega} = 7.5A \end{cases} \Rightarrow P_3 = i_3 \cdot V_3 = 56.25\,w \quad \text{Sink}$$

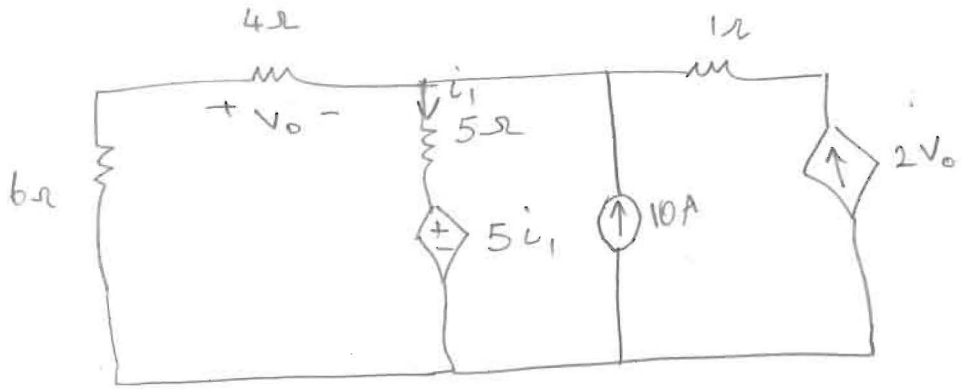
12v Source: $P_5 = V_5 \cdot i_5 = 12v \times (-4.5\,A) = -54\,w$ Source

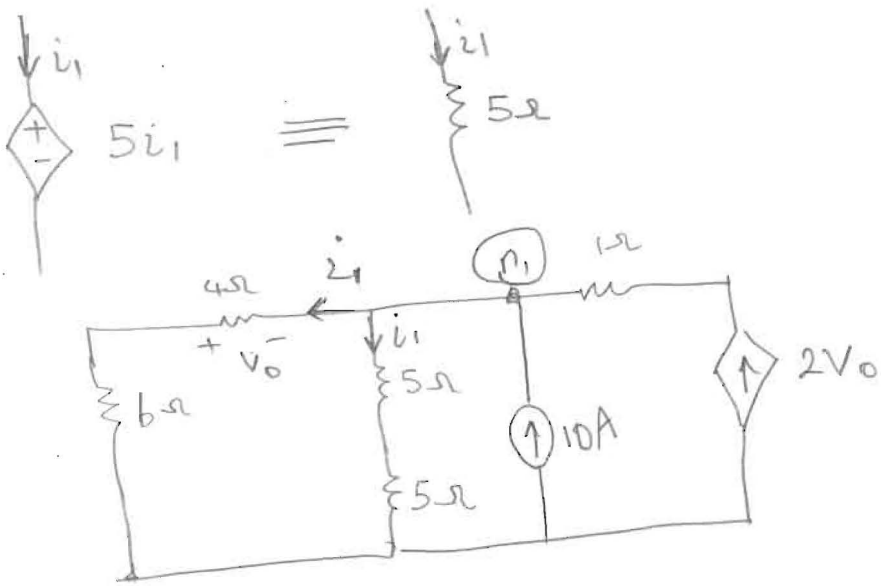
9v Source: $P_6 = V_6 \times i_2 = 9v \times (-3A) = -27\,w$ Source

$$\sum P = 20.25\,w + 4.6\,w + 56.25w - 54 - 27 = 0$$

Example 3 :

— find i_1 ?





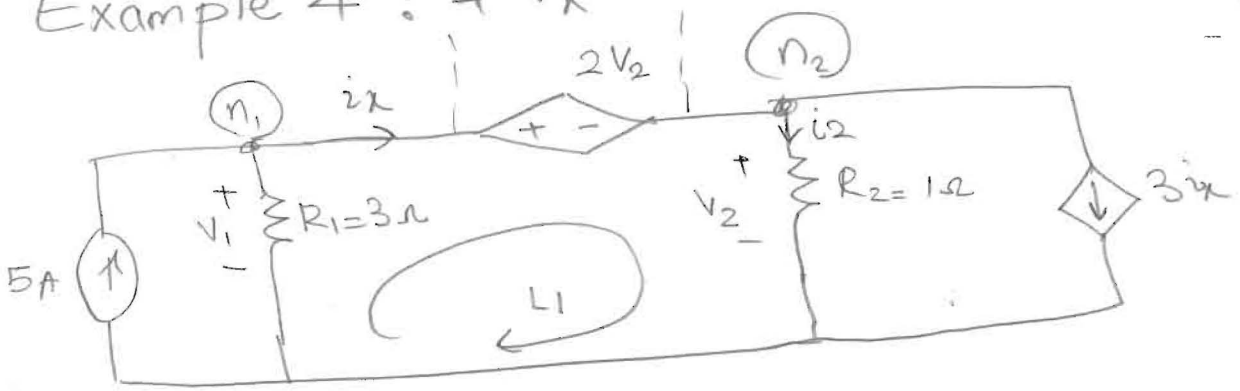
KCL at n_1 :

$$i_1 + i_1 - 10A - 2V_o = 0 \Rightarrow 2i_1 - 2V_o = 10\,A$$

$$V_o = -i_1 \times 4\Omega = -4i_1$$

$$2i_1 - 2\times(-4i_1) = 10\,A \Rightarrow 2i_1 + 8i_1 = 10\,A \Rightarrow i_1 = 1\,A$$

Example 4 : $+ V_x -$ - find V_x



KCL $\begin{cases} n_1: & i_x + i_1 = 5A \quad (1) \\ n_2: & 3i_x + i_2 = i_x \quad (2) \end{cases}$

KVL @ L1 : $-V_1 + 2V_2 + V_2 = 0$

$V_1 = 3V_2$

$R_1 i_1 = 3 \times R_2 i_2$

$3\Omega \times i_1 = 3 \times 1\Omega \times i_2 \Rightarrow i_1 = i_2$

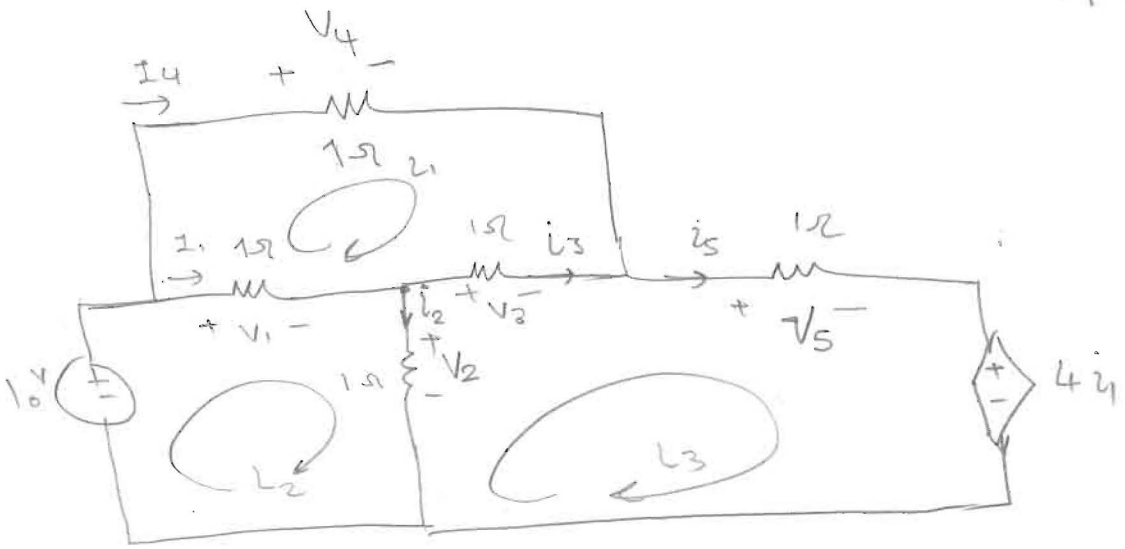
(1) $i_x + i_1 = 5A \rightsquigarrow \begin{cases} i_x + i_2 = 5A \\ (2)\ i_2 - 2i_x = 0 \end{cases} \Rightarrow \begin{cases} i_2 = \frac{10}{3} A \\ i_1 = \frac{10}{3} A \end{cases}$

$R_2 = i_2 . R_2 = \frac{10}{3} A \times 1\Omega = \frac{10}{3} V$

$V_x = 2V_2 = 2 \times \frac{10}{3} V = \frac{20}{3} V$

Example 5 :

Find 5 independent equations for $V_1 - V_5$



$$\begin{cases} i_2 + i_3 - i_1 = 0 & (1) \\ i_5 - i_3 - i_4 = 0 & (2) \end{cases}$$

$$L_1 : \quad V_4 - V_3 - V_1 = 0 \qquad (3)$$

$$L_2 : \quad -10_V + V_1 + V_2 = 0 \qquad (4)$$

$$L_3 : \quad -V_2 + V_3 + V_5 + 4i_1 = 0 \qquad (5)$$

$$i_1 = \frac{V_1}{1\Omega}, \quad i_2 = \frac{V_2}{1\Omega}, \quad i_3 = \frac{V_3}{1\Omega}, \quad i_4 = \frac{V_4}{1\Omega}, \quad i_4 = \frac{V_5}{1\Omega}$$

(1) → $V_2 + V_3 - V_1 = 0$

(2) → $V_5 - V_3 - V_4 = 0$

(3) → $V_4 - V_3 - V_1 = 0$

(4) → $V_1 + V_2 = 10\ V$

(5) → $4V_1 + V_3 + V_5 - V_2 = 0$