Nhat Ho
105 355 311

Find the current through the battery, two ways:

– with V_4 as the reference node

– with V_2 as the reference node
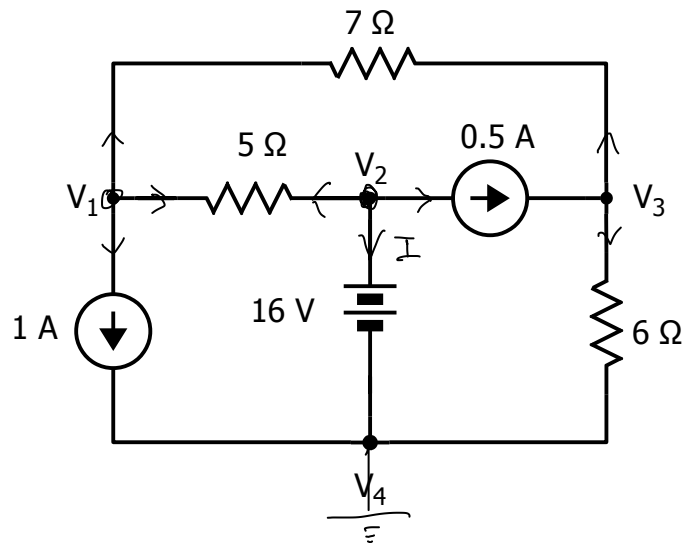
④ V_4 as the reference node :

※ $V_2 = 16V$

$$\frac{V_2 - V_1}{5} + 0.5 + I = 0 \implies \frac{16 - V_1}{5} + 0.5 + I = 0$$

$$\implies 16 - V_1 + 2.5 + 5I = 0 \iff \boxed{V_1 - 5I = 18.5 \quad ①}$$

④ $\frac{V_1 - V_2}{5} + \frac{V_1 - V_3}{7} + 1 = 0 \implies \frac{V_1 - 16}{5} + \frac{V_1 - V_3}{7} + 1 = 0$

$\implies 7(V_1 - 16) + 5(V_1 - V_3) + 35 = 0$

$\iff \boxed{12V_1 - 5V_3 = 77 \quad ②}$

④ $\frac{V_3 - V_1}{7} + \frac{V_3}{6} = 0.5 \iff 6(V_3 - V_1) + 7V_3 = 21$

$\iff \boxed{13V_3 - 6V_1 = 21 \quad ③}$

From ② & ③ $\implies \begin{cases} V_1 = 8.78 \ V \\ V_3 = 5.67 (V) \end{cases}$

From ① $\implies I = \frac{V_1 - 18.5}{5}$

$$\Rightarrow I = \frac{8.78 - 18.5}{5} = -1.944 (A)$$
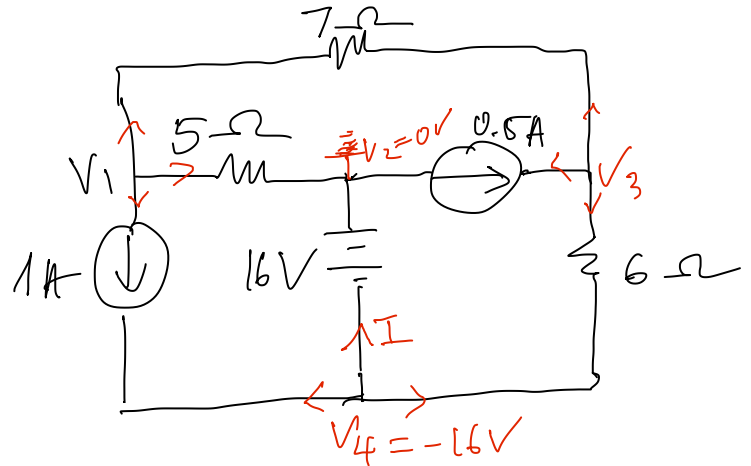
$\Rightarrow$ Current through the battery:

$I = -1.944(A)$ from top to bottom $(V_2 \rightarrow V_4)$

$\partial\partial I = 1.944(A)$ from bottom to the top $(V_4 \rightarrow V_2)$

$\oplus$ V_2 as the reference:

$V_4 = -16 V$

We have:

$$I + \frac{V_4 - V_3}{6} = 1 \iff 6I + V_4 - V_3 = 6$$

$$\iff 6I - 16 - V_3 = 6$$

$$\iff \boxed{6I - V_3 = 22 \quad ①}$$

$$\frac{V_1 - V_3}{7} + \frac{V_1}{5} + 1 = 0 \iff 5V_1 - 5V_3 + 7V_1 + 35 = 0$$

$$\iff 12V_1 - 5V_3 + 35 = 0$$

$$\iff \boxed{12V_1 - 5V_3 = -35 \quad ②}$$

$$\frac{V_3 - V_1}{7} + \frac{V_3 - V_4}{6} = 0.5 \iff 6V_3 - 6V_1 + 7V_3 - 7V_4 = 21$$

$$\iff 13V_3 - 6V_1 - 7V_4 = 21$$

$$\iff 13V_3 - 6V_1 - 7\cdot(-16) = 21$$

$\Longleftrightarrow$ $\boxed{6V_1 - 13V_3 = 91 \ \textcircled{3}}$

From $\textcircled{2} \& \textcircled{3} \Rightarrow \begin{cases} V_1 = -7.22 \ V \\ V_3 = -10.333V \end{cases}$

From $\textcircled{1}$, $6I - V_3 = 22$

$\Rightarrow I = \dfrac{22 + V_3}{6} = \dfrac{22 - 10.333}{6}$

$\Rightarrow I = 1.944 (A)$

$\Rightarrow$ current through the battery :

$I = 1.944 \ (A)$ from bottom to the top $\left(V_4 \rightarrow V_2\right)$

or $I = -1.944 (A)$ from top to bottom $\left(V_2 \rightarrow V_4\right)$