12 Dec

P

4.1 For the circuit of Fig. 4.3, determine the nodal voltages v_1 and v_2.

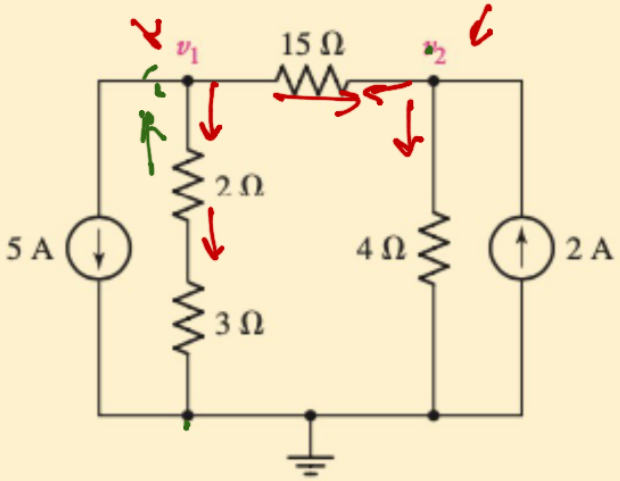


FIGURE 4.3

$4v_1 - 19v_2 + 120 = 0$

$v_1 - v_2$ → i = current flowing from higher to lower node

KCL @ v_1 $\quad -5 - \frac{v_1 - 0}{2+3} - \frac{v_1 - v_2}{15\,\Omega} = 0$

$-5 - \frac{v_1}{5} - \frac{v_1}{15} + \frac{v_2}{15} = -75 - 3v_1 - v_1 + v_2 = 0$

$= -4v_1 + v_2 - 75 = 0$ ——— (1)

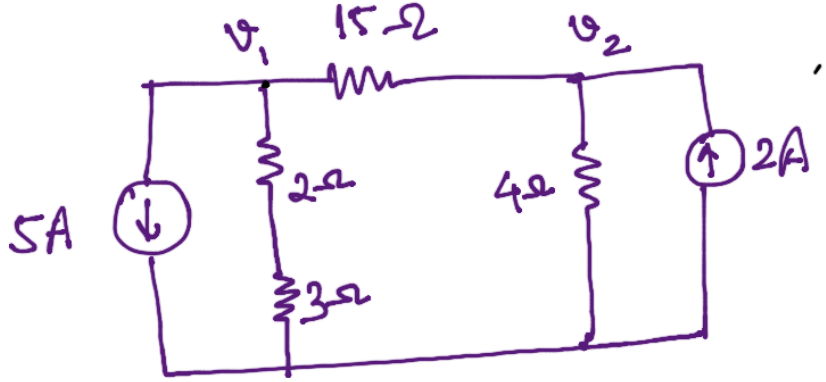
KCL @ v_2 $\quad + \frac{v_1 - v_2}{15} - \frac{v_2}{4} + 2 = 0$

$4v_1 - 4v_2 - 15v_2 + 120 = 0$

$4v_1 - 19v_2 + 120 = 0$ ——— (2)

Ex 4.1

(Solved for reference)



$v_1, v_2 = ?$

Node v_1 KCL: $-5 - \frac{v_1}{5} - \frac{v_1 - v_2}{15} = 0$

$\Rightarrow \quad +75 + 3v_1 + v_1 - v_2 = 0$

$\Rightarrow \quad 4v_1 - v_2 + 75 = 0 \quad \cdots\cdots\cdots (1)$

Node v_2 KCL $\quad -\frac{v_2 - v_1}{15} + 2 - \frac{v_2}{4} = 0$

$\Rightarrow \quad -4v_2 + 4v_1 + 120 - 15v_2 = 0$

$\Rightarrow \quad 4v_1 - 19v_2 + 120 = 0 \quad \longrightarrow (2)$

$(1) - (2) \Rightarrow \quad 18v_2 = 45 \quad \Rightarrow \quad \boxed{v_2 = 5/2 \text{ V}}$

$(1) \Rightarrow \quad v_1 = \frac{1}{4}\left(-75 + \frac{5}{2}\right) = \frac{1}{4}\frac{(-145)}{2} = \boxed{-\frac{145}{8} \text{ V}}$

PRACTICE

4.6 Determine i_1 and i_2 in the circuit in Fig. 4.18.

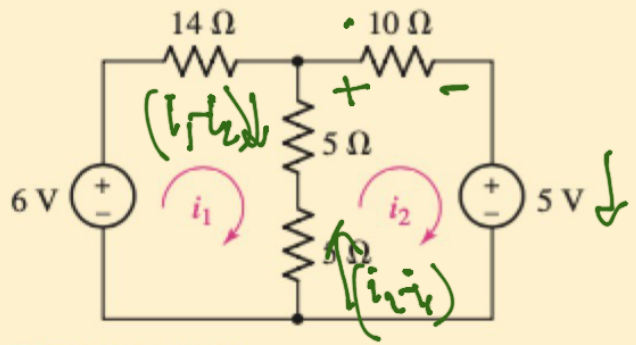
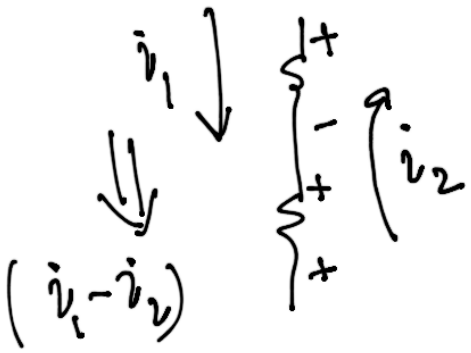


FIGURE 4.18



i_1 & i_2

KVL @ I $\quad +6V - 14\,i_1 - 10\,(i_1 - i_2) = 0$

@ II $\quad -10\,(i_2 - i_1) - 10\,i_2 - 5V = 0$

P 4.6

Ⓘ KVL : $6 - 14 i_1 - 10 (i_1 - i_2) = 0$

$\Rightarrow 6 - 24 i_1 + 10 i_2 = 0 = 3 - 12 i_1 + 5 i_2 = 0$ — ①

Ⓘ KVL $-10 (i_2 - i_1) - 10 i_2 - 5 = 0$

$\Rightarrow 10 i_1 - 20 i_2 - 5 = 2 i_1 - 4 i_2 - 1 = 0$ — ②

① + 6×②

$$\left.\begin{aligned} 3 - 12 i_1 + 5 i_2 &= 0 \\ -6 + 12 i_1 - 24 i_2 &= 0 \end{aligned}\right\}$$

$19 i_2 = -3$

$i_2 = -157.89 \text{ mA}$

$i_1 = \left[4 (-157.89 \times 10^{-3}) + 1\right] / 2 = 184.2 \text{ mA}$

(Solved)

PRACTICE

4.8 Determine i_1 in the circuit of Fig. 4.23 if the controlling quantity A is equal to (*a*) $2i_2$; (*b*) $2v_x$.

Ans: (*a*) 1.35 A; (*b*) 546 mA.

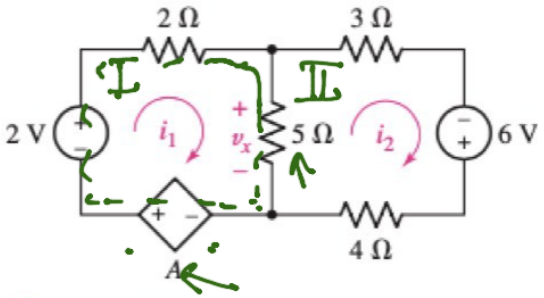


FIGURE 4.23

(a) $A = 2i_2$ (CCVS) (b) $A = 2v_2$ (VCVS)

Dependent Voltage Source

KVL @ I

$$A + 2 - 2(i_1) - 5(i_1 - i_2)$$

$$2i_2 + 2 - 2i_1 - 5i_1 + 5i_2 = 0 \quad \text{— (1)}$$

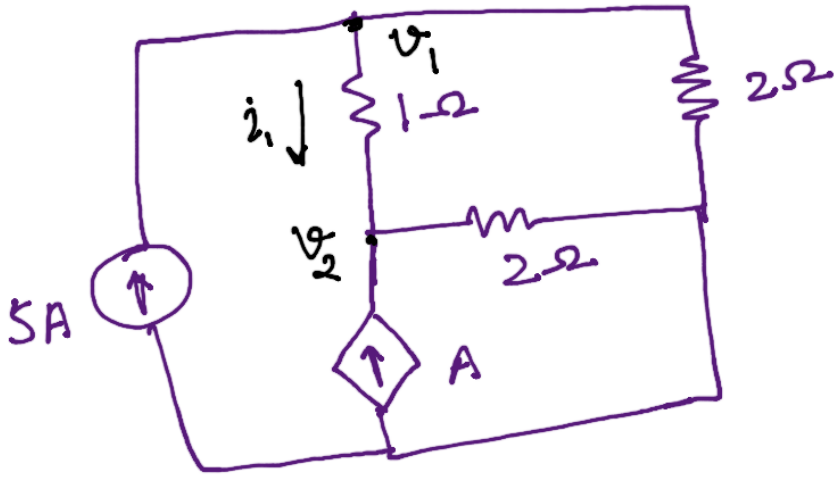
$$2v_x + 2 - 2i_1 - 5i_1 + 5i_2 = 0 \quad \text{— (3)(b)}$$

KVL @ II

$$\rightarrow -5(i_2 - i_1) - 3i_2 + 6 - 4i_2 = 0 \quad \text{— (2)}$$

$$v_x = 5(i_1 - i_2) \quad \text{(case b)}$$

Ex 4.8



$A = 2i_1$

$i_1 = \frac{v_1 - v_2}{1}$

KCL @ v_1 $\quad 5A - \frac{v_1 - v_2}{1} - \frac{v_1}{2} = 0 \Rightarrow -3v_1 + 2v_2 + 10 = 0$ — ①

KCL @ v_2 $\quad A - \frac{v_2}{2} + \frac{v_1 - v_2}{1} = 0 \Rightarrow 6v_1 - 7v_2 = 0$ — ②

$3v_2 = 20$

$v_1 = \frac{7}{6} \times \frac{20}{3} = \frac{70}{9}\ V$

$A = 2v_1$ ② $\Rightarrow$ $2v_1 - v_2 + 2v_1 - 2v_2 = 0 \Rightarrow 4v_1 - 3v_2 = 0$ — ②

$-3v_1 + 2v_2 + 10 = 0$

P 4.8

Fig 4.23

$A = 2i_2$

KVL ① $2 - 2i_1 - 5(i_1 - i_2) + 2i_2 = 0$

$2 - 7i_1 + 7i_2 = 0$ ——— ①

KVL ② $-5(i_2 - i_1) - 3i_2 + 6 - 4i_2 = 0$

$5i_1 - 12i_2 + 6 = 0$ ——— ②

PRACTICE

4.8 Determine i_1 in the circuit of Fig. 4.23 if the controlling quantity A is equal to (*a*) $2i_2$; (*b*) $2v_x$.

Ans: (*a*) 1.35 A; (*b*) 546 mA.

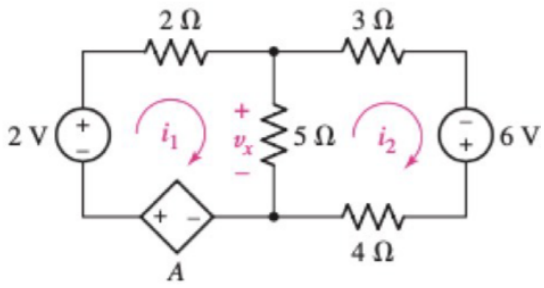


FIGURE 4.23