Homework 3 Solution

EECS 70A

Chapter 3, Solution 2.

At node 1,

$$\frac{-v_1}{10} - \frac{v_1}{5} = 6 + \frac{v_1 - v_2}{2} \longrightarrow 60 = -8v_1 + 5v_2 \qquad (1)$$

At node 2,

$$\frac{v_2}{4} = 3 + 6 + \frac{v_1 - v_2}{2} \longrightarrow 36 = -2v_1 + 3v_2 \qquad (2)$$

Solving (1) and (2),

v_1 = **<u>0 V</u>**, v_2 = **<u>12 V</u>**

Chapter 3, Solution 3.

Applying KCL to the upper node,

$$10 = \frac{v_0}{10} + \frac{v_o}{20} + \frac{v_o}{30} + 2 + \frac{v_0}{60} \longrightarrow v_0 = \mathbf{40\ V}$$

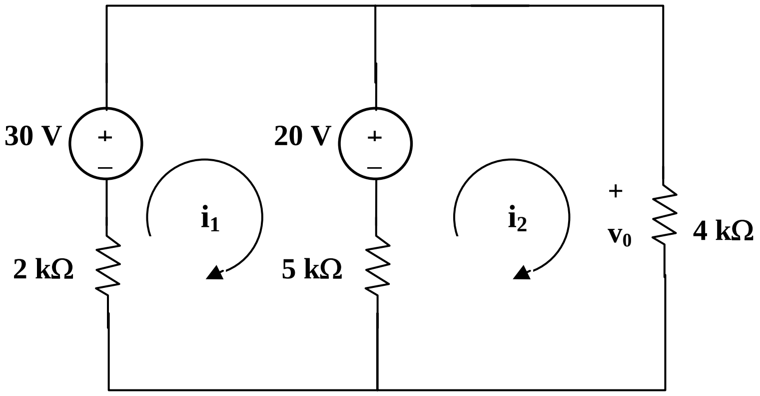
$$i_1 = \frac{v_0}{10} = \mathbf{4\ A},\ i_2 = \frac{v_0}{20} = \mathbf{2\ A},\ i_3 = \frac{v_0}{30} = \mathbf{1.3333\ A},\ i_4 = \frac{v_0}{60} = \mathbf{666.7\ mA}$$

Chapter 3, Solution 6.

$i_1 + i_2 + i_3 = 0$ $$\frac{v_2 - 12}{4} + \frac{v_0}{6} + \frac{v_0 - 10}{2} = 0$$

or v_0 = **<u>8.727 V</u>**

Chapter 3, Solution 35.



Assume that i_1 and i_2 are in mA. We apply mesh analysis. For mesh 1,

$$-30 + 20 + 7i_1 – 5i_2 = 0 \quad \text{or} \quad 7i_1 – 5i_2 = 10 \qquad (1)$$

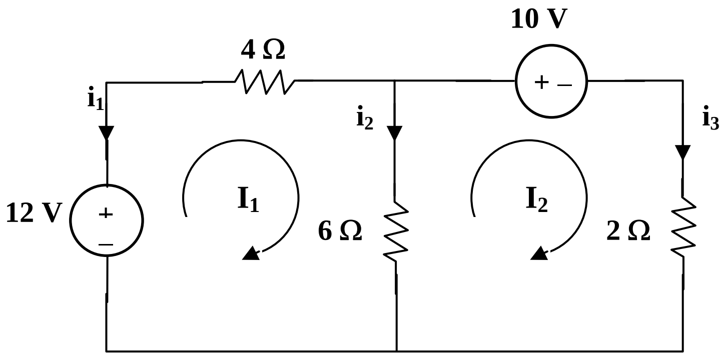
For mesh 2,

$$-20 + 9i_2 – 5i_1 = 0 \quad \text{or} \quad -5i_1 + 9i_2 = 20 \qquad (2)$$

Solving (1) and (2), we obtain, $i_2 = 5$.

$v_0 = 4i_2 =$ **<u>20 volts</u>**.

Chapter 3, Solution 36.



Applying mesh analysis gives,

$$12 = 10I_1 – 6I_2$$

$$-10 = -6I_1 + 8I_2$$

or
$$\begin{bmatrix} 6 \\ -5 \end{bmatrix} = \begin{bmatrix} 5 & -3 \\ -3 & 4 \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \end{bmatrix}$$

$$\Delta = \begin{vmatrix} 5 & -3 \\ -3 & 4 \end{vmatrix} = 11, \quad \Delta_1 = \begin{vmatrix} 6 & -3 \\ -5 & 4 \end{vmatrix} = 9, \quad \Delta_2 = \begin{vmatrix} 5 & 6 \\ -3 & -5 \end{vmatrix} = -7$$

$$I_1 = \frac{\Delta_1}{\Delta} = \frac{9}{11}, \quad I_2 = \frac{\Delta_2}{\Delta} = \frac{-7}{11}$$

$i_1 = -I_1 = -9/11 = -0.8181$ A, $\quad i_2 = I_1 - I_2 = 10/11 = 1.4545$ A.

$v_o = 6i_2 = 6x1.4545 =$ **8.727 V**.

Chapter 3, Solution 69.

Assume that all conductances are in mS, all currents are in mA, and all voltages are in volts.

$G_{11} = (1/2) + (1/4) + (1/1) = 1.75, \quad G_{22} = (1/4) + (1/4) + (1/2) = 1,$
$G_{33} = (1/1) + (1/4) = 1.25, \quad G_{12} = -1/4 = -0.25, \quad G_{13} = -1/1 = -1,$
$G_{21} = -0.25, \quad G_{23} = -1/4 = -0.25, \quad G_{31} = -1, \quad G_{32} = -0.25$

$i_1 = 20, \quad i_2 = 5$, and $i_3 = 10 - 5 = 5$

The node-voltage equations are:

$$\begin{bmatrix} 1.75 & -0.25 & -1 \\ -0.25 & 1 & -0.25 \\ -1 & -0.25 & 1.25 \end{bmatrix} \begin{bmatrix} v_1 \\ v_2 \\ v_3 \end{bmatrix} = \begin{bmatrix} 20 \\ 5 \\ 5 \end{bmatrix}$$

Chapter 4, Solution 33.

(a) $R_{Th} = 10||40 = 400/50 =$ **8 ohms**

$V_{Th} = (40/(40 + 10))20 =$ **16 V**

(b) $R_{Th} = 30||60 = 1800/90 =$ **20 ohms**

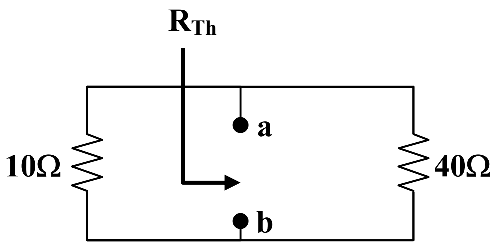
$$2 + (30 - v1)/60 \quad = \quad v_1/30, \quad \text{and} \quad v_1 \quad = \quad V_{Th}$$

$$120 + 30 - v_1 \quad = \quad 2v_1, \quad \text{or} \quad v_1 \quad = \quad 50\ V$$

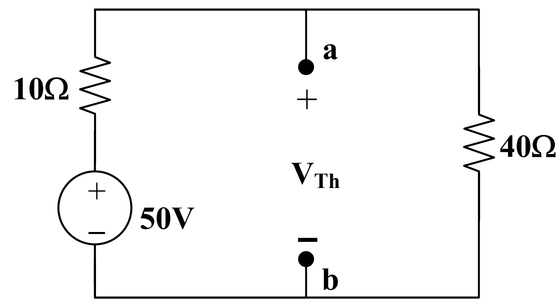
$$V_{Th} \quad = \quad \underline{\mathbf{50\ V}}$$

Chapter 4, Solution 36.

Remove the 30-V voltage source and the 20-ohm resistor.



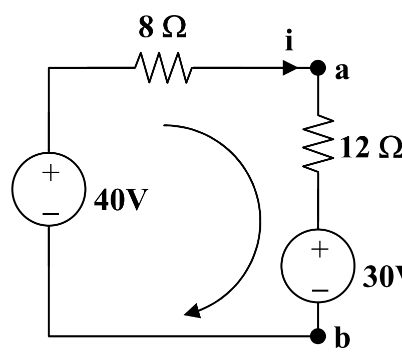
(a)



(b)

From Fig. (a), $R_{Th} = 10||40 = 8$ ohms

From Fig. (b), $V_{Th} = (40/(10 + 40))50 = 40V$



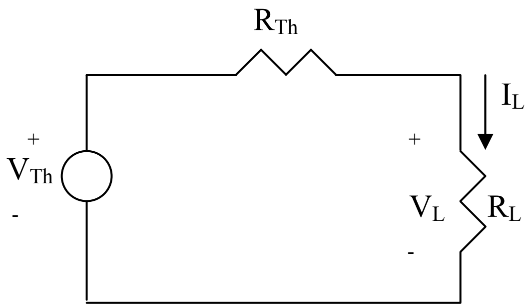
(c)

The equivalent circuit of the original circuit is shown in Fig. (c). Applying KVL,

$$30 - 40 + (8 + 12)i = 0, \text{ which leads to } i = \underline{\mathbf{500mA}}$$

Chapter 4, Solution 84.

Let the equivalent circuit of the battery terminated by a load be as shown below.



For open circuit,

$R_L = \infty, \quad \longrightarrow \quad V_{Th} = V_{oc} = V_L = \underline{10.8\text{ V}}$

When $R_L = 4$ ohm, V_L=10.5,

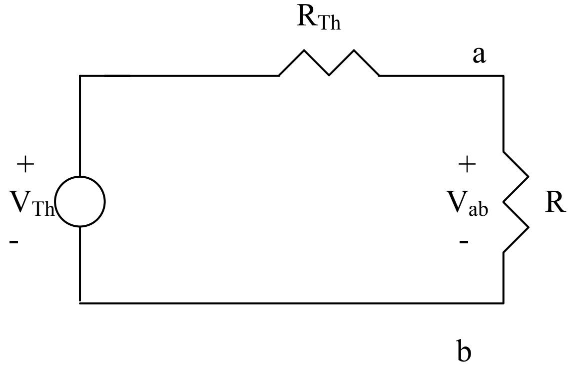
$$I_L = \frac{V_L}{R_L} = 10.8/4 = 2.7$$

But

$$V_{Th} = V_L + I_L R_{Th} \quad \longrightarrow \quad R_{Th} = \frac{V_{Th} - V_L}{I_L} = \frac{12 - 10.8}{2.7} = \underline{0.4444\Omega}$$

Chapter 4, Solution 85.

(a) Consider the equivalent circuit terminated with R as shown below.



$$V_{ab} = \frac{R}{R + R_{Th}} V_{Th} \longrightarrow 6 = \frac{10}{10 + R_{Th}} V_{Th}$$

or

$$60 + 6R_{Th} = 10V_{Th} \qquad (1)$$

where R_{Th} is in k-ohm.

Similarly,

$$12 = \frac{30}{30 + R_{Th}} V_{Th} \longrightarrow 360 + 12R_{Th} = 30V_{Th} \qquad (2)$$

Solving (1) and (2) leads to

$\underline{V_{Th} = 24 \text{ V}, \; R_{Th} = 30k\Omega}$

(b) $V_{ab} = \frac{20}{20 + 30}(24) = \underline{9.6 \text{ V}}$