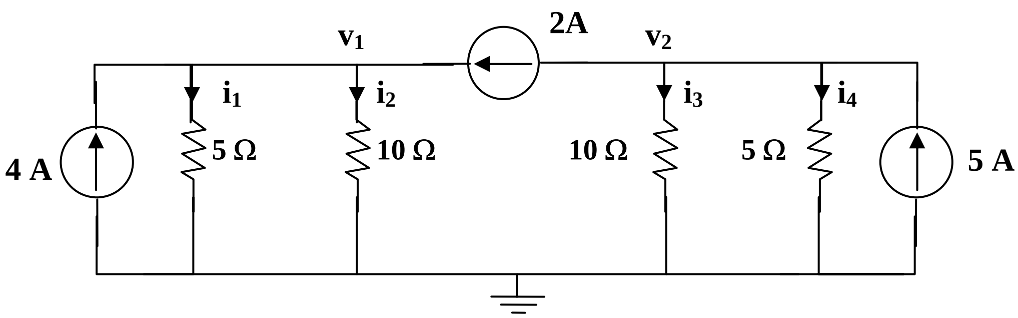
Discussion week 4

Chapter 3, Solution 4.



At node 1,

$$4 + 2 = v_1/(5) + v_1/(10) \longrightarrow v_1 = 20$$

At node 2,

$$5 - 2 = v_2/(10) + v_2/(5) \longrightarrow v_2 = 10$$

$i_1 = v_1/(5) =$ **4 A**, $i_2 = v_1/(10) =$ **2 A**, $i_3 = v_2/(10) =$ **1 A**, $i_4 = v_2/(5) =$ **2 A**

Chapter 3, Solution 5.

Apply KCL to the top node.

$$\frac{30 - v_0}{2k} + \frac{20 - v_0}{5k} = \frac{v_0}{4k} \longrightarrow v_0 = \underline{\mathbf{20\ V}}$$

Chapter 3, Solution 11.

At the top node, KVL gives

$$\frac{V_o - 36}{1} + \frac{V_o - 0}{2} + \frac{V_o - (-12)}{4} = 0$$

$1.75V_o = 33$ or $V_o = 18.857V$

$P_{1\Omega} = (36–18.857)^2/1 = \underline{\mathbf{293.9\ W}}$

$P_{2\Omega} = (V_o)^2/2 = (18.857)^2/2 = \underline{\mathbf{177.79\ W}}$

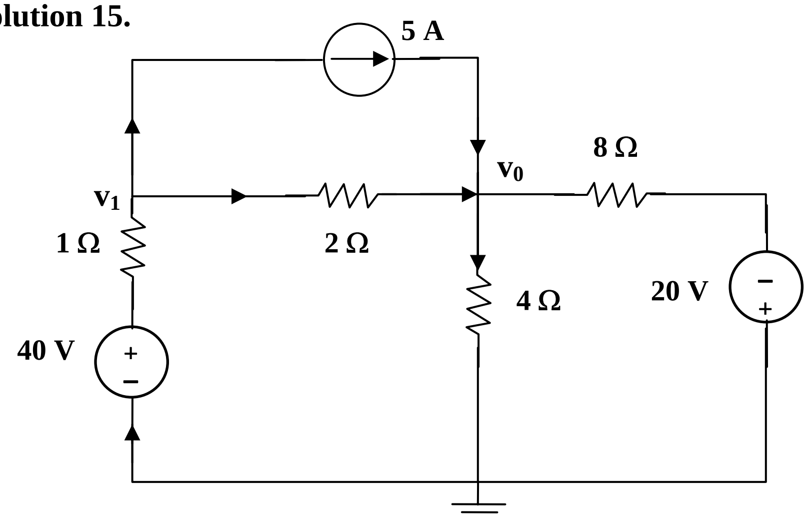
$P_{4\Omega} = (18.857+12)^2/4 = \underline{\mathbf{238\ W}}$.

Chapter 3, Solution 13.

*At node number 2, $[(v_2 + 2) – 0]/10 + v_2/4 = 3$ or v_2 = **8 volts***

But, $I = [(v_2 + 2) – 0]/10 = (8 + 2)/10 = 1$ amp and $v_1 = 8x1$ = **8volts**

Chapter 3, Solution 15.



Nodes 1 and 2 form a supernode so that $v_1 = v_2 + 10$ (1)

At the supernode, $2 + 6v_1 + 5v_2 = 3\ (v_3 - v_2)$ ⟶ $2 + 6v_1 + 8v_2 = 3v_3$ (2)

At node 3, $2 + 4 = 3\ (v_3 - v_2)$ ⟶ $v_3 = v_2 + 2$ (3)

Substituting (1) and (3) into (2),

$$2 + 6v_2 + 60 + 8v_2 = 3v_2 + 6 \longrightarrow v_2 = \frac{-56}{11}$$

$$v_1 = v_2 + 10 = \frac{54}{11}$$

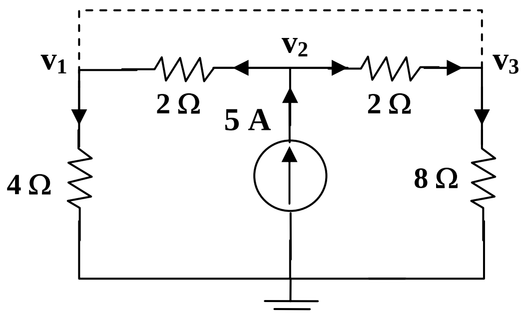
$i_0 = 6v_i =$ **<u>29.45 A</u>**

$$P_{65} = \frac{v_1^2}{R} = v_1^2 G = \left(\frac{54}{11}\right)^2 6 = \underline{\mathbf{144.6\ W}}$$

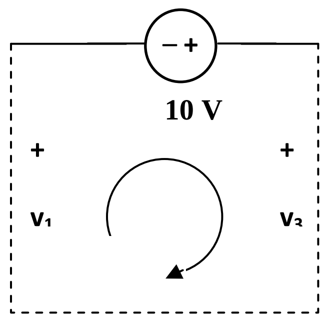
$P_{55} = v_2^2 G = \left(\frac{-56}{11}\right)^2 5 =$ **129.6 W**

$P_{35} = (v_L - v_3)^2 G = (2)^2 3 =$ **12 W**

Chapter 3, Solution 18.



(a)



(b)

At node 2, in Fig. (a), $5 = \frac{v_2 - v_1}{2} + \frac{v_2 - v_3}{2}$ ⟶ $10 = - v_1 + 2v_2 - v_3$ (1)

At the supernode, $\frac{v_2 - v_1}{2} + \frac{v_2 - v_3}{2} = \frac{v_1}{4} + \frac{v_3}{8}$ ⟶ $40 = 2v_1 + v_3$ (2)

From Fig. (b), $- v_1 - 10 + v_3 = 0$ ⟶ $v_3 = v_1 + 10$ (3)

Solving (1) to (3), we obtain $v_1 =$ **10 V**, $v_2 =$ **20 V** $= v_3$

Chapter 3, Solution 19.

At node 1,

$$5 = 3 + \frac{V_1 - V_3}{2} + \frac{V_1 - V_2}{8} + \frac{V_1}{4} \longrightarrow 16 = 7V_1 - V_2 - 4V_3 \qquad (1)$$

At node 2,

$$\frac{V_1 - V_2}{8} = \frac{V_2}{2} + \frac{V_2 - V_3}{4} \longrightarrow 0 = -V_1 + 7V_2 - 2V_3 \qquad (2)$$

At node 3,

$$3 + \frac{12 - V_3}{8} + \frac{V_1 - V_3}{2} + \frac{V_2 - V_3}{4} = 0 \longrightarrow -36 = 4V_1 + 2V_2 - 7V_3 \quad (3)$$

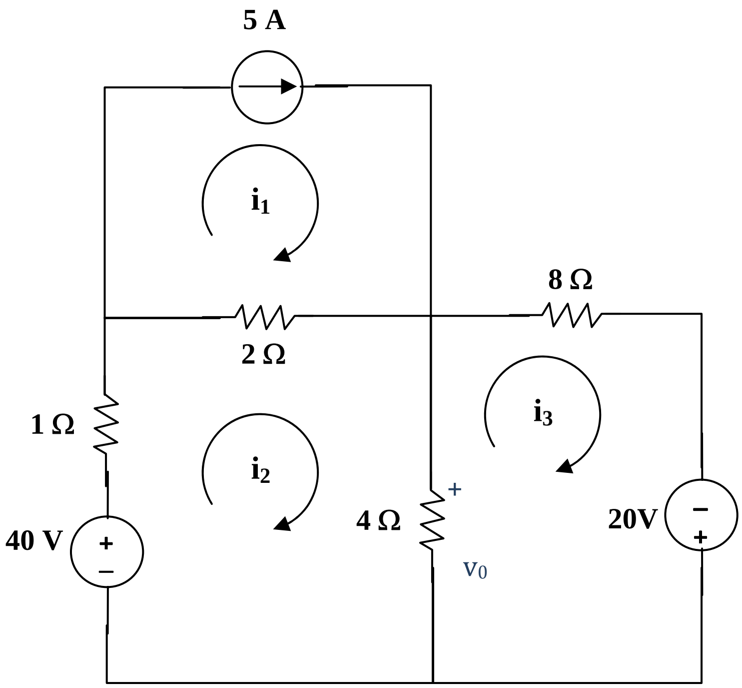
From (1) to (3),

$$\begin{pmatrix} 7 & -1 & -4 \\ -1 & 7 & -2 \\ 4 & 2 & -7 \end{pmatrix}\begin{pmatrix} V_1 \\ V_2 \\ V_3 \end{pmatrix} = \begin{pmatrix} 16 \\ 0 \\ -36 \end{pmatrix} \longrightarrow AV = B$$

Using MATLAB,

$$V = A^{-1}B = \begin{bmatrix} 10 \\ 4.933 \\ 12.267 \end{bmatrix} \longrightarrow \underline{V_1 = 10\text{ V},\ V_2 = 4.933\text{ V},\ V_3 = 12.267\text{ V}}$$

Chapter 3, Solution 51.



For loop 1, $i_1 = 5A$ (1)

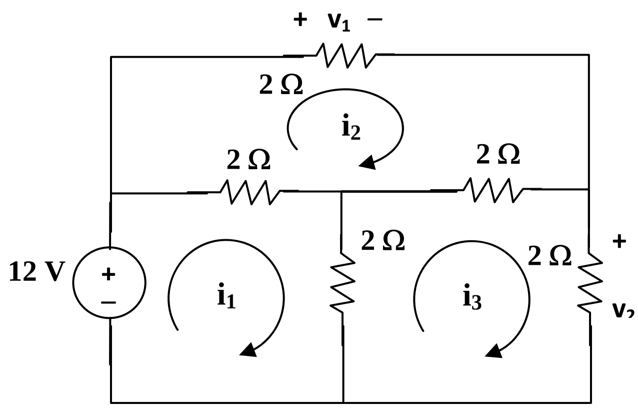
For loop 2, $-40 + 7i_2 - 2i_1 - 4i_3 = 0$ which leads to $50 = 7i_2 - 4i_3$ (2)

For loop 3, $-20 + 12i_3 - 4i_2 = 0$ which leads to $5 = - i_2 + 3\ i_3$ (3)

Solving with (2) and (3), $i_2 = 10$ A, $i_3 = 5$ A

And, $v_0 = 4(i_2 - i_3) = 4(10 - 5) =$ **<u>20 V</u>**.

Chapter 3, Solution 56.



For loop 1, $12 = 4i_1 - 2i_2 - 2i_3$ which leads to $6 = 2i_1 - i_2 - i_3$ (1)

For loop 2, $0 = 6i_2 - 2i_1 - 2\,i_3$ which leads to $0 = -i_1 + 3i_2 - i_3$ (2)

For loop 3, $0 = 6i_3 - 2i_1 - 2i_2$ which leads to $0 = -i_1 - i_2 + 3i_3$ (3)

In matrix form (1), (2), and (3) become,

$$\begin{bmatrix} 2 & -1 & -1 \\ -1 & 3 & -1 \\ -1 & -1 & 3 \end{bmatrix} \begin{bmatrix} i_1 \\ i_2 \\ i_3 \end{bmatrix} = \begin{bmatrix} 6 \\ 0 \\ 0 \end{bmatrix}$$

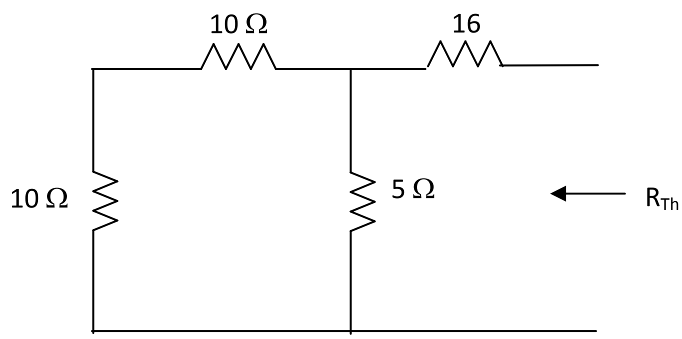
$$\Delta = \begin{vmatrix} 2 & -1 & -1 \\ -1 & 3 & -1 \\ -1 & -1 & 3 \end{vmatrix} = 8, \quad \Delta_2 = \begin{vmatrix} 2 & 6 & -1 \\ -1 & 3 & -1 \\ -1 & 0 & 3 \end{vmatrix} = 24$$

$$\Delta_3 = \begin{vmatrix} 2 & -1 & 6 \\ -1 & 3 & 0 \\ -1 & -1 & 0 \end{vmatrix} = 24 \text{, therefore } i_2 = i_3 = 24/8 = 3\text{A},$$

$v_1 = 2i_2 =$ **<u>6 volts</u>**, $v = 2i_3 =$ **<u>6 volts</u>**

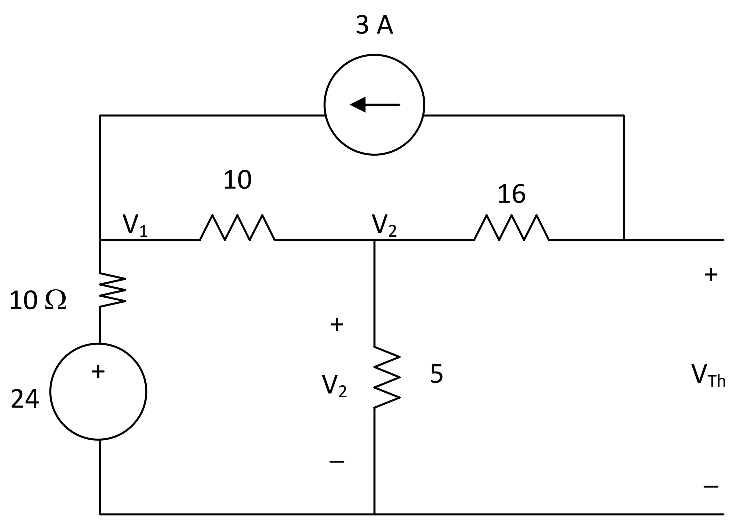
Chapter 4, Solution 39.

We obtain R_{Th} using the circuit below.



$$R_{Th} = 16 + 20 // 5 = 16 + \frac{20x5}{25} = \underline{20 \ \ \Omega}$$

To find V_{Th}, we use the circuit below.



At node 1,

$$\frac{24 - V_1}{10} + 3 = \frac{V_1 - V_2}{10} \longrightarrow 54 = 2V_1 - V_2 \qquad (1)$$

At node 2,

$$\frac{V_1 - V_2}{10} = 3 + \frac{V_2}{5} \longrightarrow 60 = 2V_1 - 6V_2 \qquad (2)$$

Substracting (1) from (2) gives

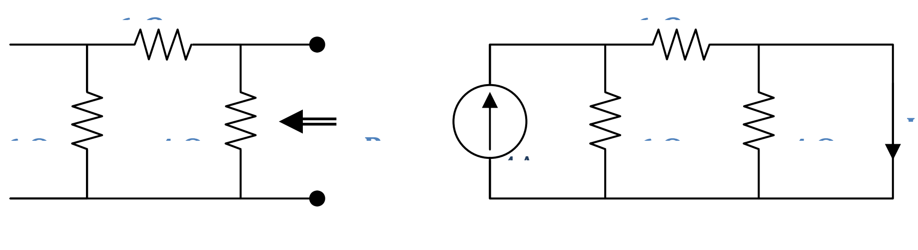
$$6 = -5V_1 \longrightarrow V_2 = 1.2 \text{ V}$$

But

$$-V_2 + 16x3 + V_{Th} = 0 \longrightarrow V_{Th} = \underline{-49.2 \text{ V}}$$

Chapter 4, Solution 45.

For R_N, consider the circuit in Fig. (a).



R_N = (6 + 6)||4 = **3 ohms**

For I_N, consider the circuit in Fig. (b). The 4-ohm resistor is shorted so that 4-A current is equally divided between the two 6-ohm resistors. Hence,

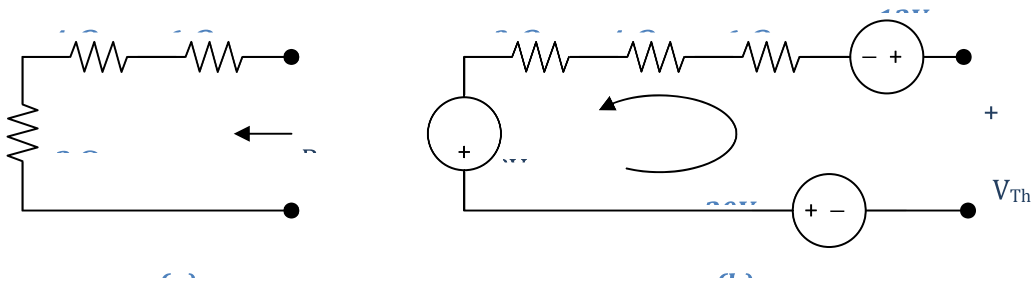
I_N = 4/2 = **2 A**

Chapter 4, Solution 72.

(a) R_{Th} and V_{Th} are calculated using the circuits shown in Fig. (a) and (b) respectively.

From Fig. (a), $R_{Th} = 2 + 4 + 6 = $ **<u>12 ohms</u>**

From Fig. (b), $-V_{Th} + 12 + 8 + 20 = 0$, or $V_{Th} = $ **<u>40 V</u>**



(b) $i = V_{Th}/(R_{Th} + R) = 40/(12 + 8) = $ **<u>2A</u>**

(c) For maximum power transfer, $R_L = R_{Th} = $ **<u>12 ohms</u>**

(d) $p = V_{Th}^2/(4R_{Th}) = (40)^2/(4x12) = $ **<u>33.33 watts</u>**.