Exercise 1-9 Find I_x from the diagram in Fig. E1-9.

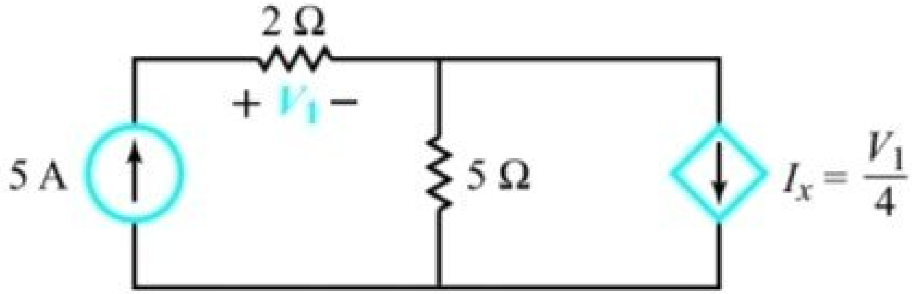


Figure E1-9

Solution:

$$V_1 = 5 \times 2 = 10 \text{ V}$$

$$I_x = \frac{V_1}{4} = 2.5 \text{ A}.$$

Exercise 2-4 If $I_1 = 3$ A in Fig. E2-4, what is I_2?

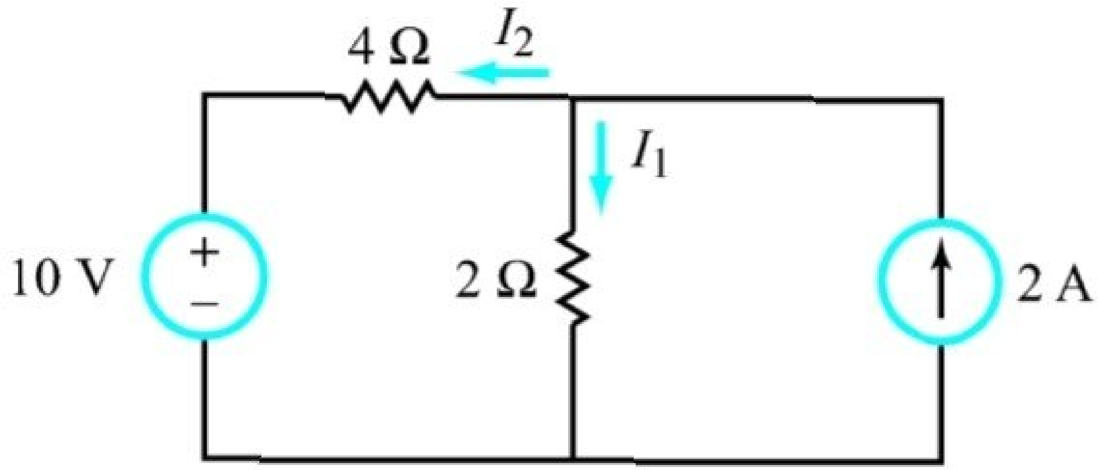


Figure E2-4

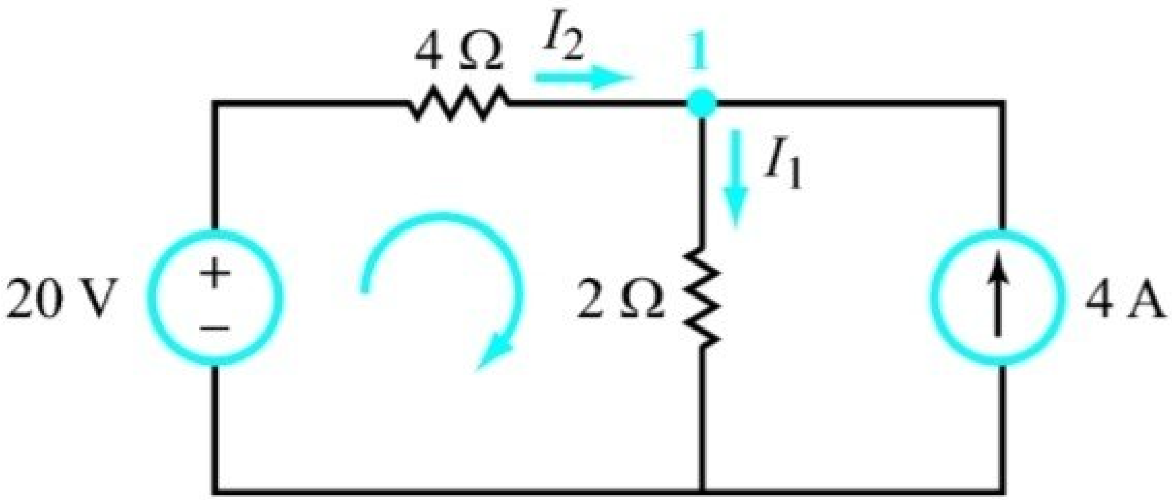
Solution: KCL at the top center node requires that

$$I_1 + I_2 - 2\text{ A} = 0.$$

Hence,

$$I_2 = 2 - I_1 = 2 - 3 = -1\text{ A}.$$

Exercise 2-5 Apply KCL and KVL to find I_1 and I_2 in Fig. E2-5.



Solution: KCL at node 1 requires that

$$I_1 = I_2 + 4.$$

Also, KVL for the left loop is

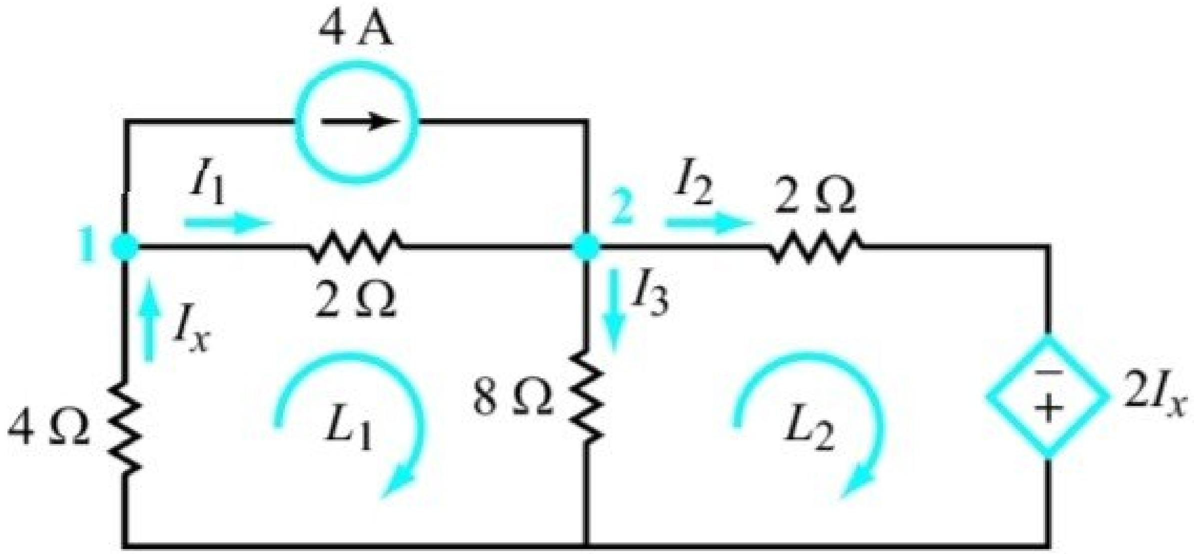
$$-20 + 4I_2 + 2I_1 = 0.$$

Simultaneous solution leads to

$$I_1 = 6 \text{ A}, \qquad I_2 = 2 \text{ A}.$$

Exercise 2-6 Determine I_x in the circuit of Fig. E2-6.

Solution:



$$
\begin{array}{ll}
\text{KCL @ node 1:} & I_x = I_1 + 4 \\
\text{KCL @ node 2:} & I_1 + 4 = I_2 + I_3 \\
\text{KVL Loop 1:} & 4I_x + 2I_1 + 8I_3 = 0 \\
\text{KVL Loop 2:} & -8I_3 + 2I_2 - 2I_x = 0
\end{array}
$$

We have four equations with four unknowns. Simultaneous solution leads to

$$I_x = 1.33.$$

Exercise 2-7 Apply resistance combining to simplify the circuit of Fig. E2-7 so as to find I. All resistor values are in ohms.

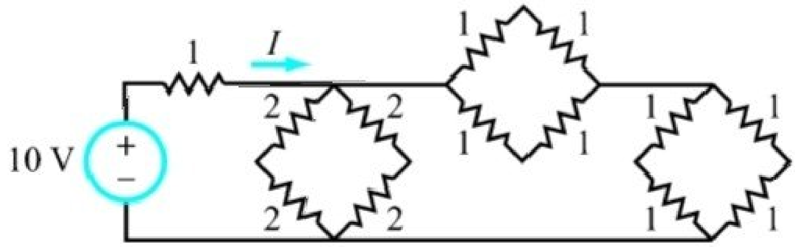
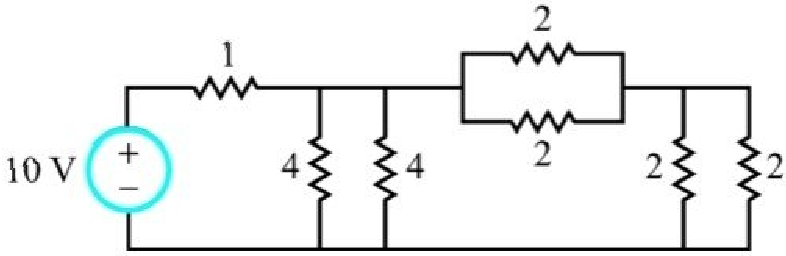
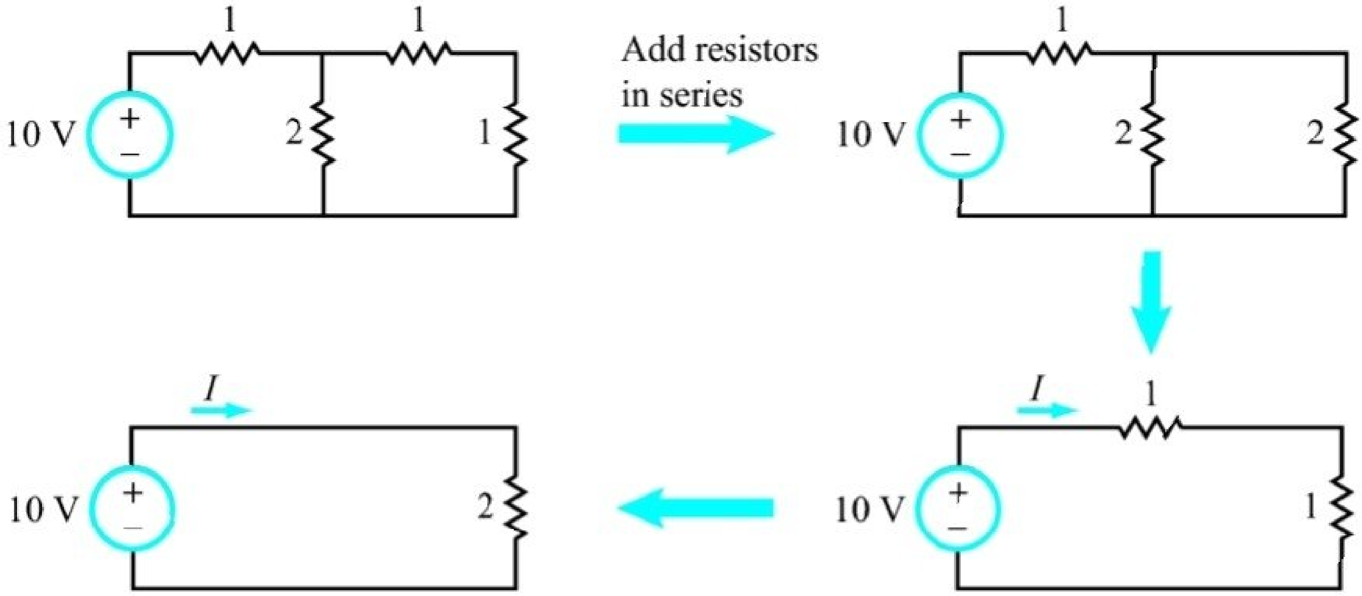


Figure E2-7

Solution: Combining all resistors that are in series will result in the following circuit:



Combining all resistors that are in parallel will result in:



$$I = \frac{10\text{ V}}{2\ \Omega} = 5\text{ A}.$$

Exercise 2-8 Apply source transformation to the circuit in Fig. E2-8 to find I.

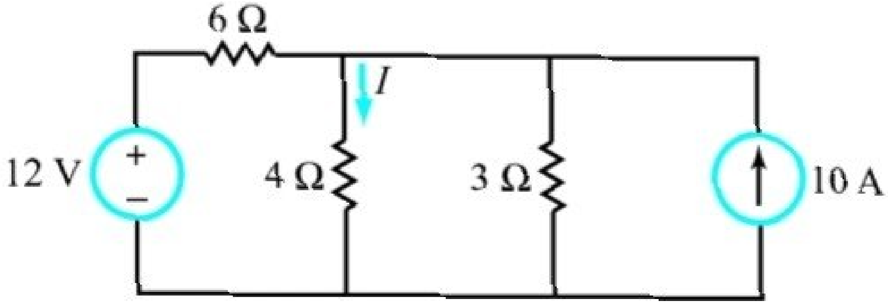
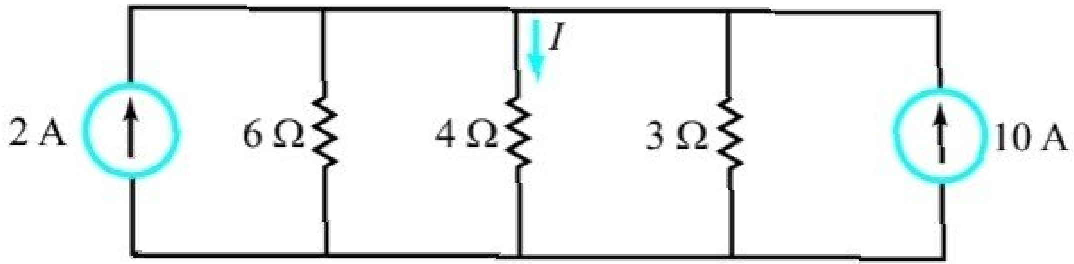
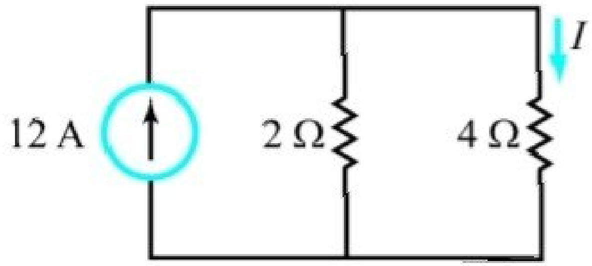


Figure E2-8

Solution: Apply source transformation to the 12-V source and 6-Ω resistor:



Combine current sources and combine 3-Ω and 6-Ω resistors, while leaving 4-Ω alone



Current division gives

$$I = \frac{12 \times 2}{2+4} = 4 \text{ A}.$$

Exercise 2-9 For each of the circuits shown in Fig. E2-9, determine the equivalent resistance between terminals (a, b).

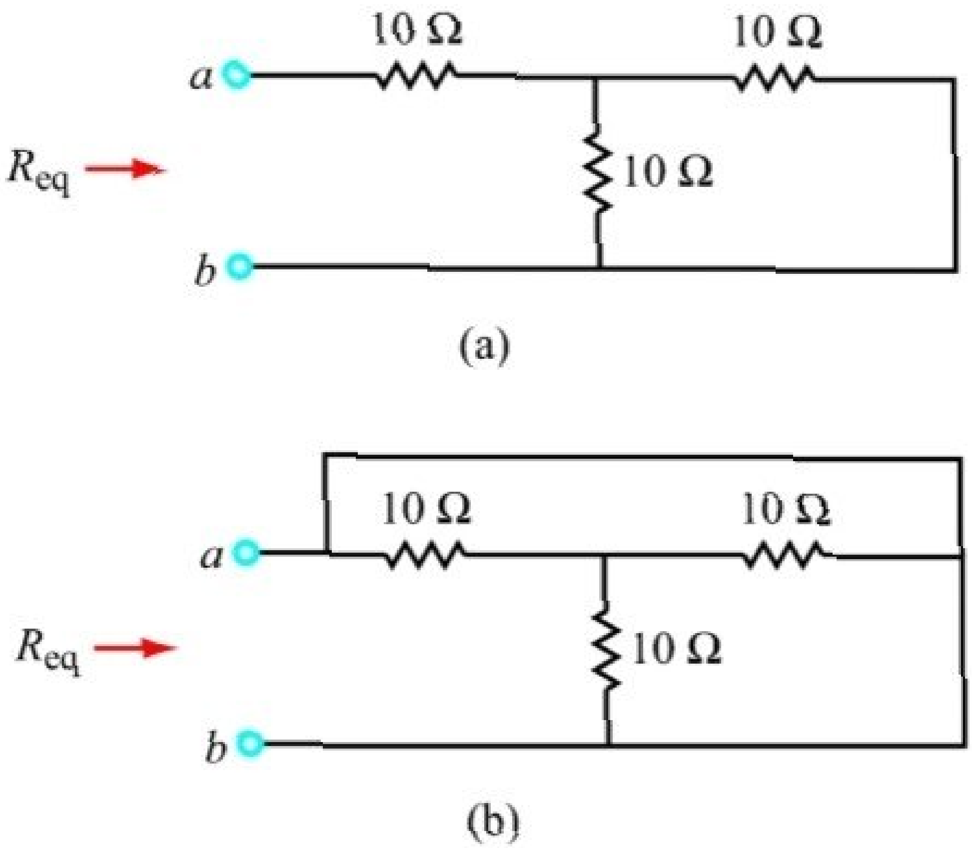
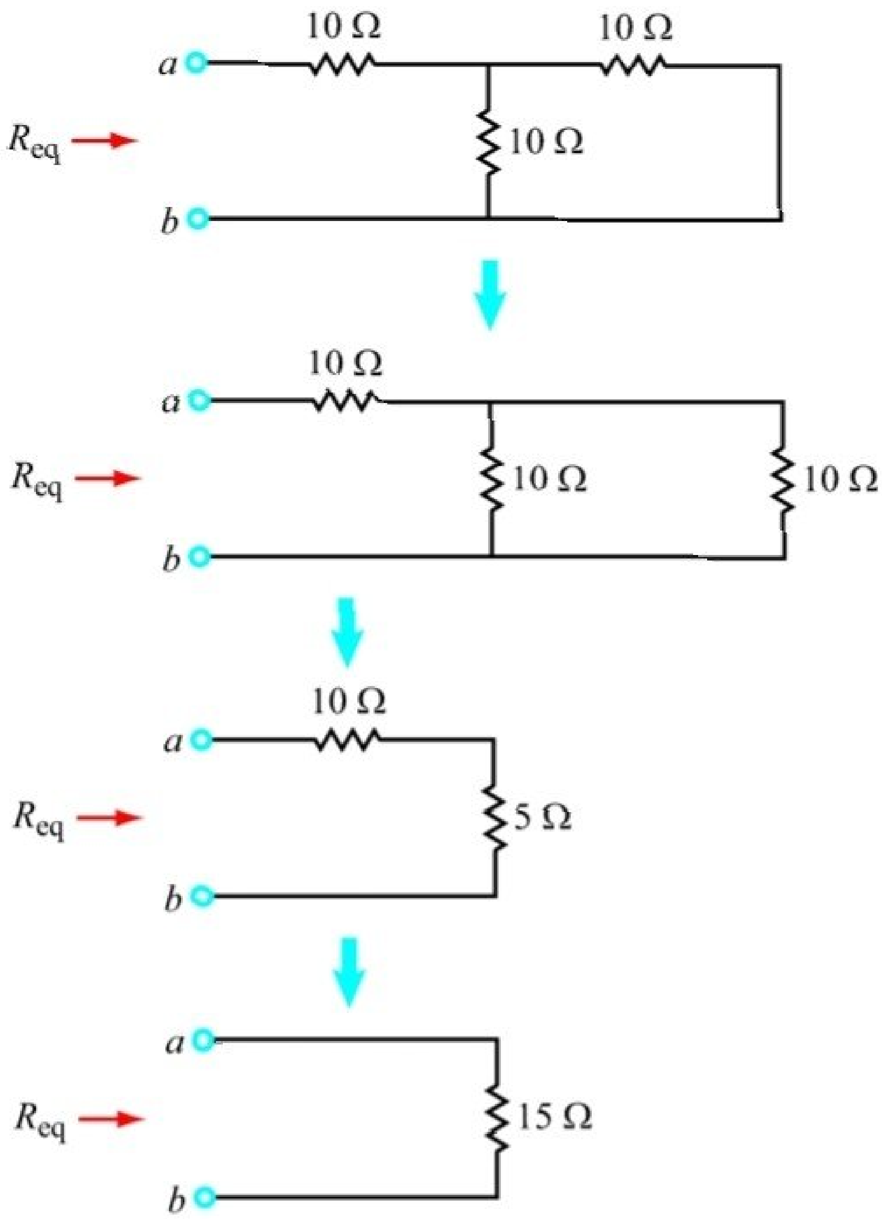


Figure E2-9

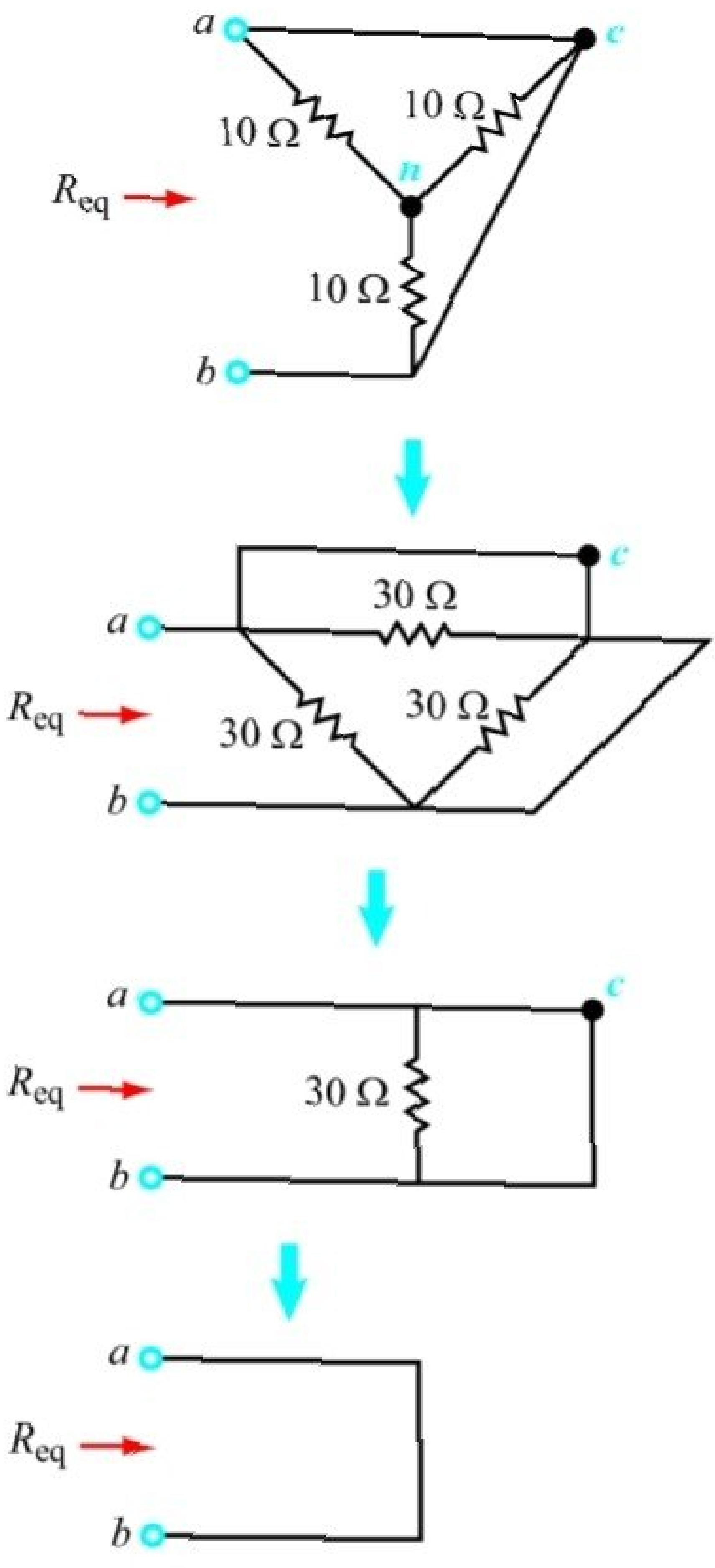
Solution:

(a)



$R_{eq} = 15\ \Omega.$

(b) Applying Y-Δ transformation



$R_{eq} = 0.$

Exercise 2-11 Determine I in the two circuits of Fig. E2-11. Assume $V_F = 0.7$ V for all diodes.

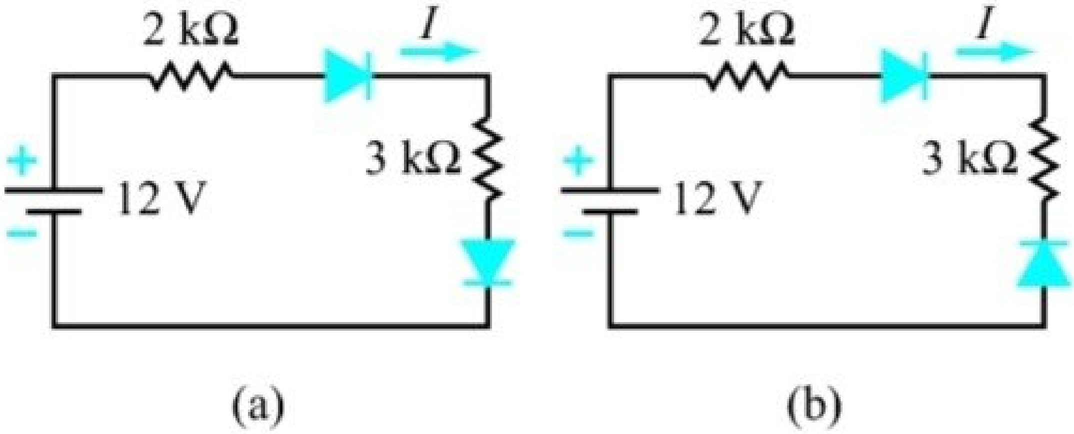


Figure E2-11

Solution:

(a) With $V_F = 0.7$ V, KVL around the loop gives

$$-12 + 2 \times 10^3 I + 0.7 + 3 \times 10^3 I + 0.7 = 0,$$

which leads to

$$I = \frac{12 - 1.4}{5 \times 10^3} = 2.12 \text{ mA}.$$

(b) Since the diodes are biased in opposition to one another, no current can flow in the circuit. Hence

$$I = 0.$$

Exercise 3-1 Apply nodal analysis to determine the current I.

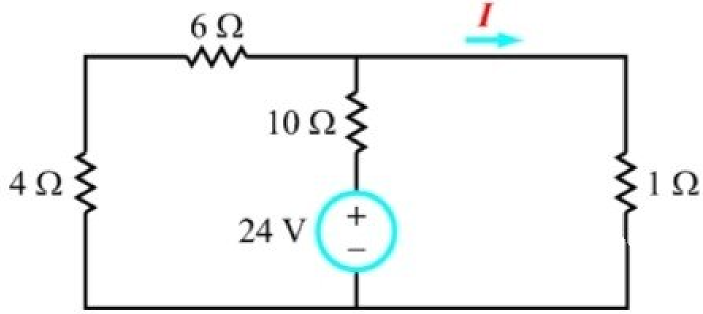
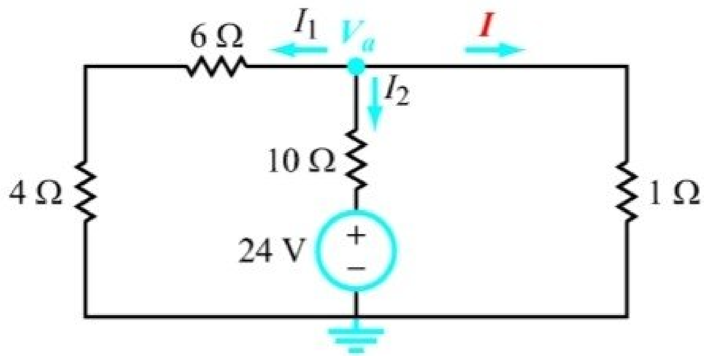


Figure E3-1

Solution:



$$I_1 + I_2 + I = 0$$

$$I_1 = \frac{V_a}{10}, \qquad I_2 = \frac{V_a - 24}{10}, \qquad I_3 = \frac{V_a}{1}$$

Hence,

$$\frac{V_a}{10} + \frac{V_a - 24}{10} + V_a = 0,$$

$$V_a\left(\frac{1}{10} + \frac{1}{10} + 1\right) = \frac{24}{10},$$

which leads to

$$V_a = 2 \text{ V}, \qquad I = \frac{V_a}{1} = 2 \text{ A}.$$

Exercise 3-2 Apply nodal analysis to find V_a.

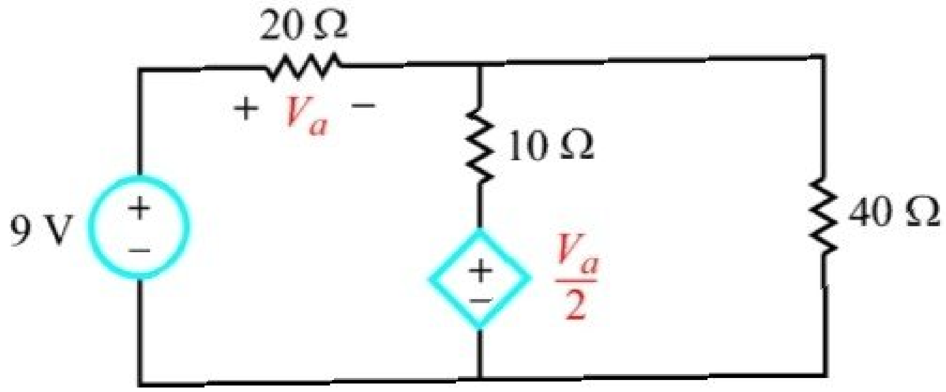
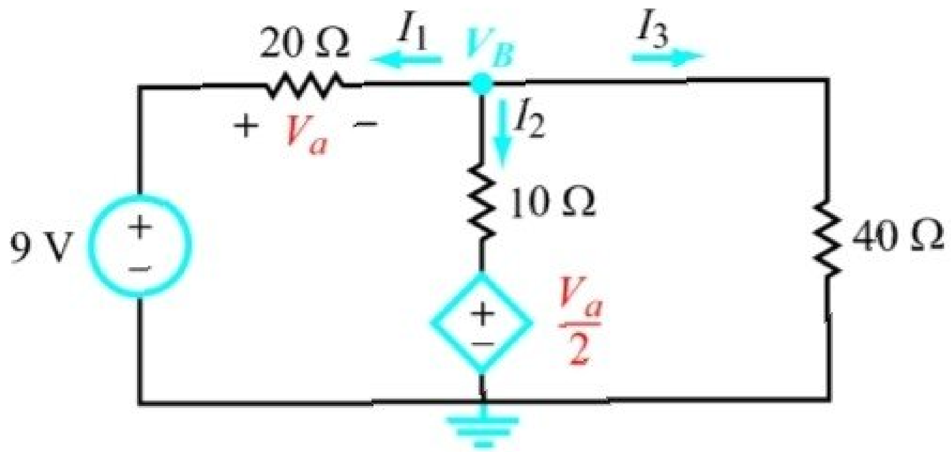


Figure E3-2

Solution:



$$I_1 + I_2 + I_3 = 0$$

$$I_1 = \frac{V_B - 9}{20}, \qquad I_2 = \frac{V_B - \frac{V_a}{2}}{10}, \qquad I_3 = \frac{V_B}{40}.$$

Hence,

$$\frac{V_B - 9}{20} + \frac{V_B - \frac{V_a}{2}}{10} + \frac{V_B}{40} = 0.$$

Also,

$$V_A = 9 - V_B.$$

Solution gives: $V_a = 5$ V.

Exercise 3-4 Apply mesh analysis to determine I.

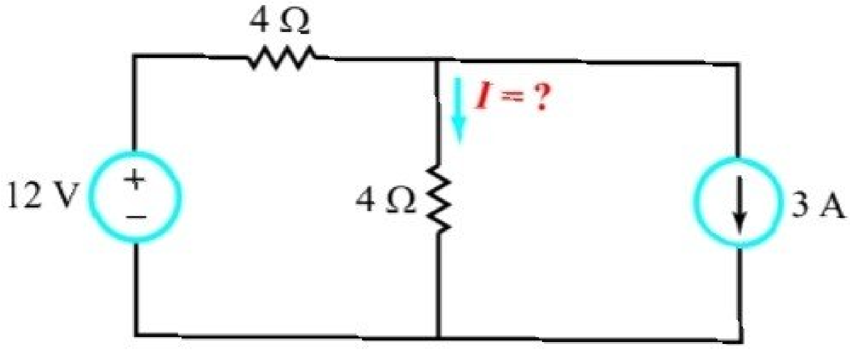
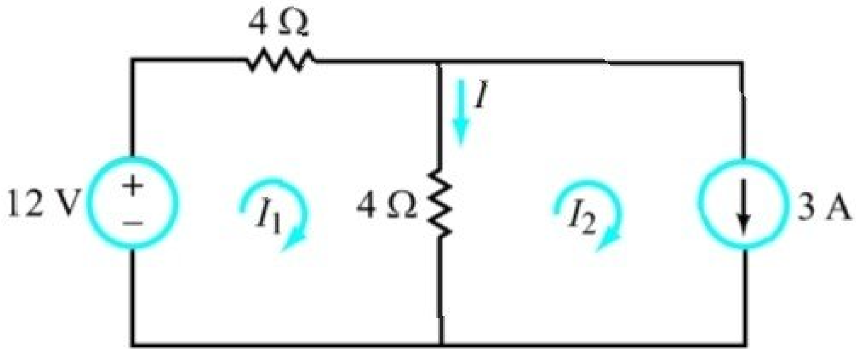


Figure E3-4

Solution:



Mesh 1: $-12 + 4I_1 + 4(I_1 - I_2) = 0$
Mesh 2: $I_2 = 3$ A

$$4I_1 + 4I_1 - 4 \times 3 = 12$$
$$8I_1 = 24$$
$$I_1 = 3 \text{ A.}$$
$$\Longrightarrow \quad I = I_1 - I_2 = 3 - 3 = 0.$$

Exercise 3-5 Determine the current I in the circuit of Fig. E3-5.

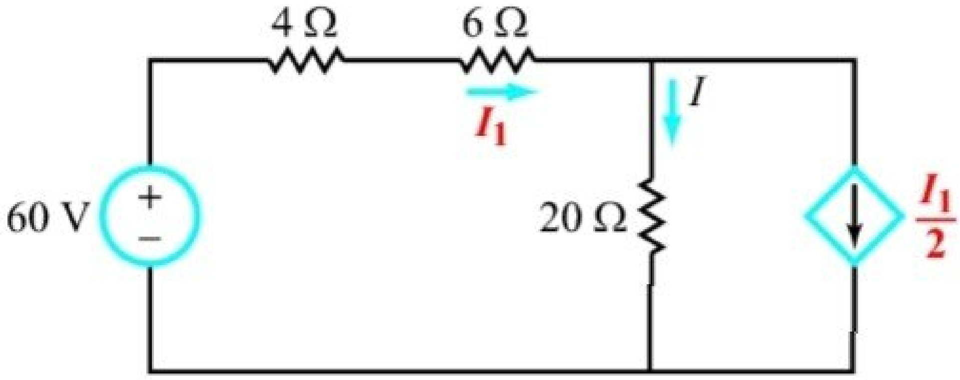
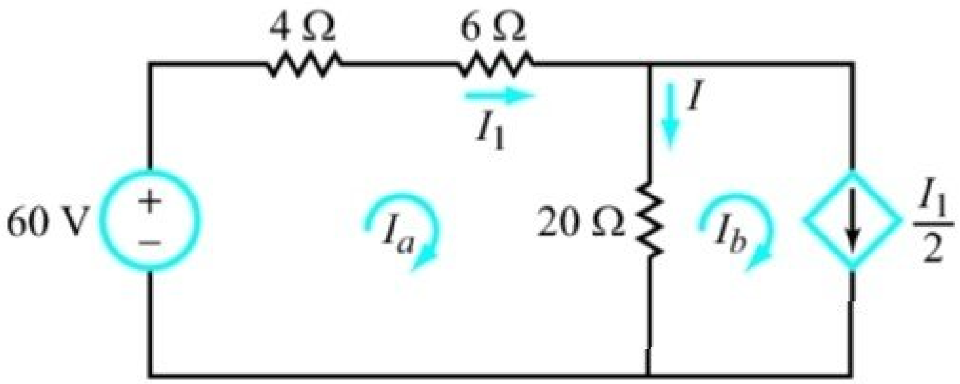


Figure E3-5

Solution:



$$\text{Mesh 1:} \quad -60 + 10I_a + 20(I_a - I_b) = 0$$

$$\text{Mesh 2:} \quad I_b = \frac{I_1}{2}$$

Also,

$$I_1 = I_a.$$

Hence,

$$I_b = \frac{I_a}{2},$$

$$-60 + 10I_a + 20\left(I_a - \frac{I_a}{2}\right) = 0,$$

which simplifies to

$$20I_1 = 60$$

or

$$I_a = 3 \text{ A},$$

$$I = I_a - I_b = I_a - \frac{I_a}{2} = \frac{I_a}{2} = \frac{3}{2} = 1.5 \text{ A}.$$

Exercise 3-6 Apply mesh analysis to determine I in the circuit of Fig. E3-6.

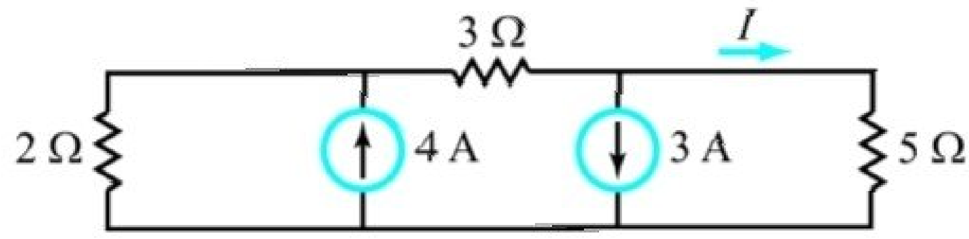
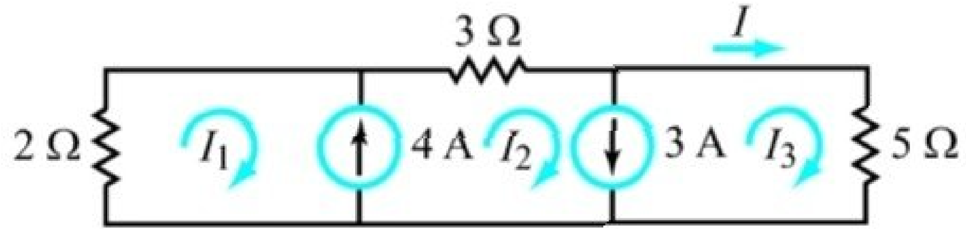


Figure E3-6

Solution:



Outside mesh: $2I_1 + 3I_2 + 5I_3 = 0$.

Also,

$$I_2 - I_1 = 4 \text{ A}, \qquad I_2 - I_3 = 3 \text{ A}.$$

Hence,

$$I_1 = I_2 - 4 = (I_3 + 3) - 4 = I_3 - 1$$
$$I_2 = I_3 + 3$$

$$2(I_3 - 1) + 3(I_3 + 3) + 5I_3 = 0$$
$$10I_3 = 2 - 9$$
$$I_3 = -0.7 \text{ A}$$

$$I = I_3 = -0.7 \text{ A}.$$

Exercise 3-7 Apply the node-analysis by-inspection method to generate the node voltage matrix for the circuit in Fig. E3-7.

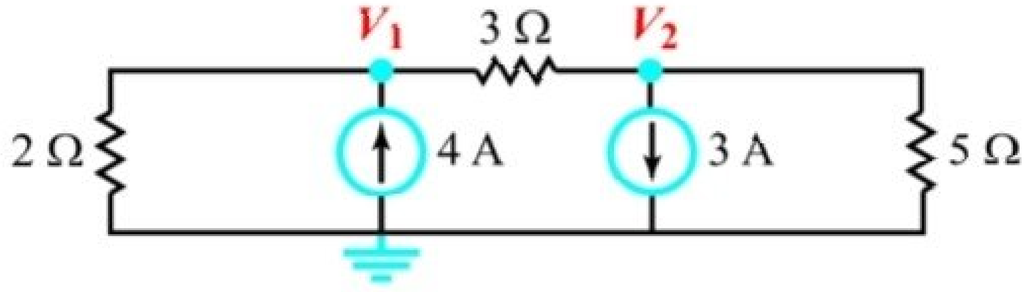


Figure E3.7

Solution:

$$G_{11} = \frac{1}{3} + \frac{1}{2} = \frac{5}{6}, \qquad G_{22} = \frac{1}{3} + \frac{1}{5} = \frac{8}{15}, \qquad G_{11} = \frac{5}{6},$$

$$G_{12} = -\frac{1}{3} = G_{21}, \qquad G_{22} = \frac{8}{15}.$$

Hence,

$$\begin{bmatrix} \frac{5}{6} & -\frac{1}{3} \\ -\frac{1}{3} & \frac{8}{15} \end{bmatrix} \begin{bmatrix} V_1 \\ V_2 \end{bmatrix} = \begin{bmatrix} 4 \\ -3 \end{bmatrix}.$$

By MATLAB software,

$$\begin{bmatrix} V_1 \\ V_2 \end{bmatrix} = \begin{bmatrix} 3.4\text{ V} \\ -3.5\text{ V} \end{bmatrix}.$$

Exercise 3-8 Use the by-inspection method to generate the mesh current matrix for the circuit in Fig. E3-8.

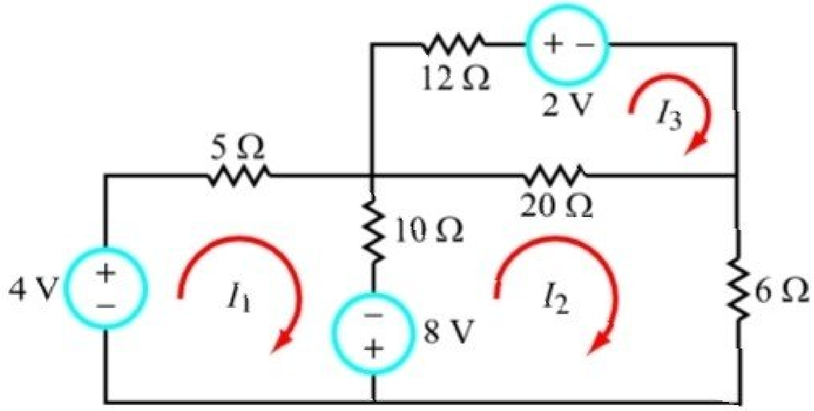


Figure E3-8

Solution:

$$R_{11} = 5 + 10 = 15$$
$$R_{22} = 10 + 20 + 6 = 36$$
$$R_{33} = 20 + 12 = 32$$
$$R_{12} = R_{21} = -10$$
$$R_{13} = R_{31} = 0$$
$$R_{23} = R_{32} = -20$$

Hence,

$$\mathbf{R} = \begin{bmatrix} 15 & -10 & 0 \\ -10 & 36 & -20 \\ 0 & -20 & 32 \end{bmatrix}$$

$$\mathbf{V} = \begin{bmatrix} 8 + 4 = 12 \\ -8 \\ -2 \end{bmatrix}$$

$$\mathbf{I} = \mathbf{R}^{-1}\mathbf{V} = \begin{bmatrix} 0.7505 \\ -0.0743 \\ -0.1089 \end{bmatrix}$$

$$\therefore \quad I_1 = 0.75 \text{ A}$$
$$I_2 = -0.07 \text{ A}$$
$$I_3 = -0.11 \text{ A}$$

Exercise 3-9 Apply the source-superposition method to determine the current I in the circuit of Fig. E3-9.

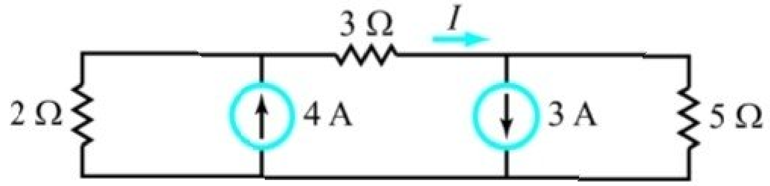
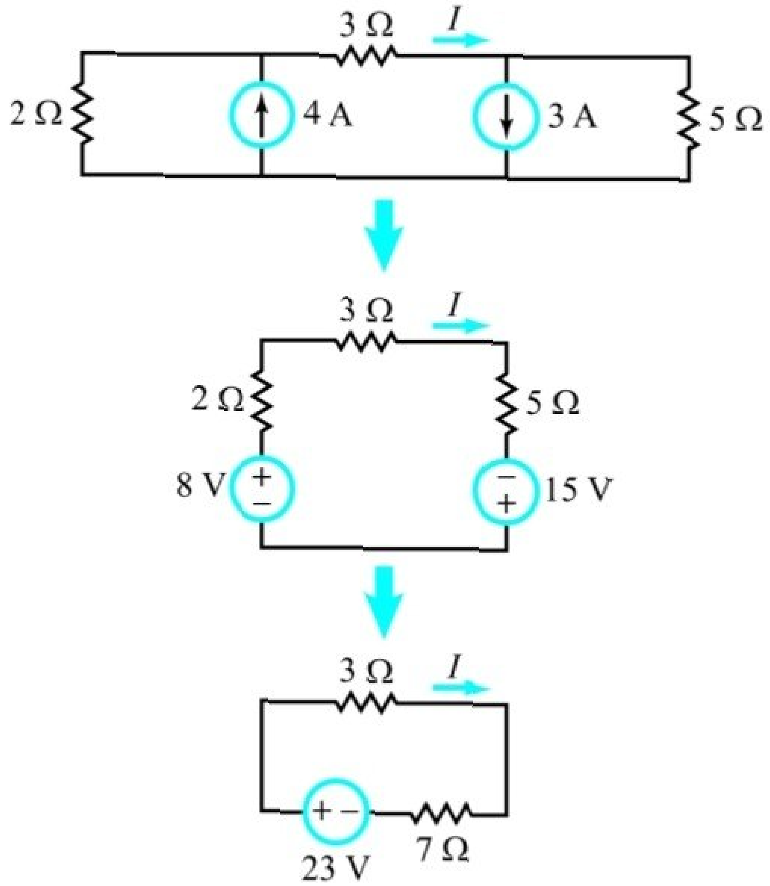


Figure E3-9

Solution:



$$I = \frac{23}{3+7} = 2.3 \text{ A}.$$

Exercise 3-10 Apply source superposition to determine V_{out} in the circuit of Fig. E3-10.

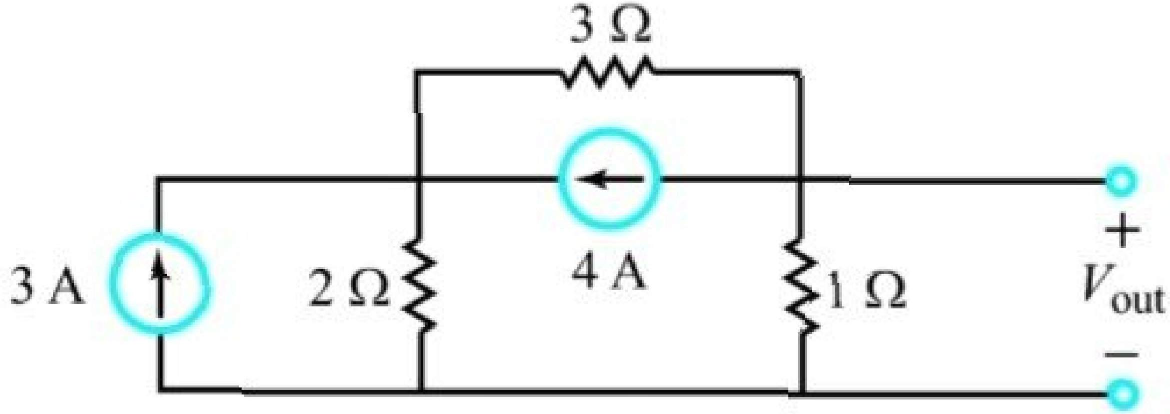
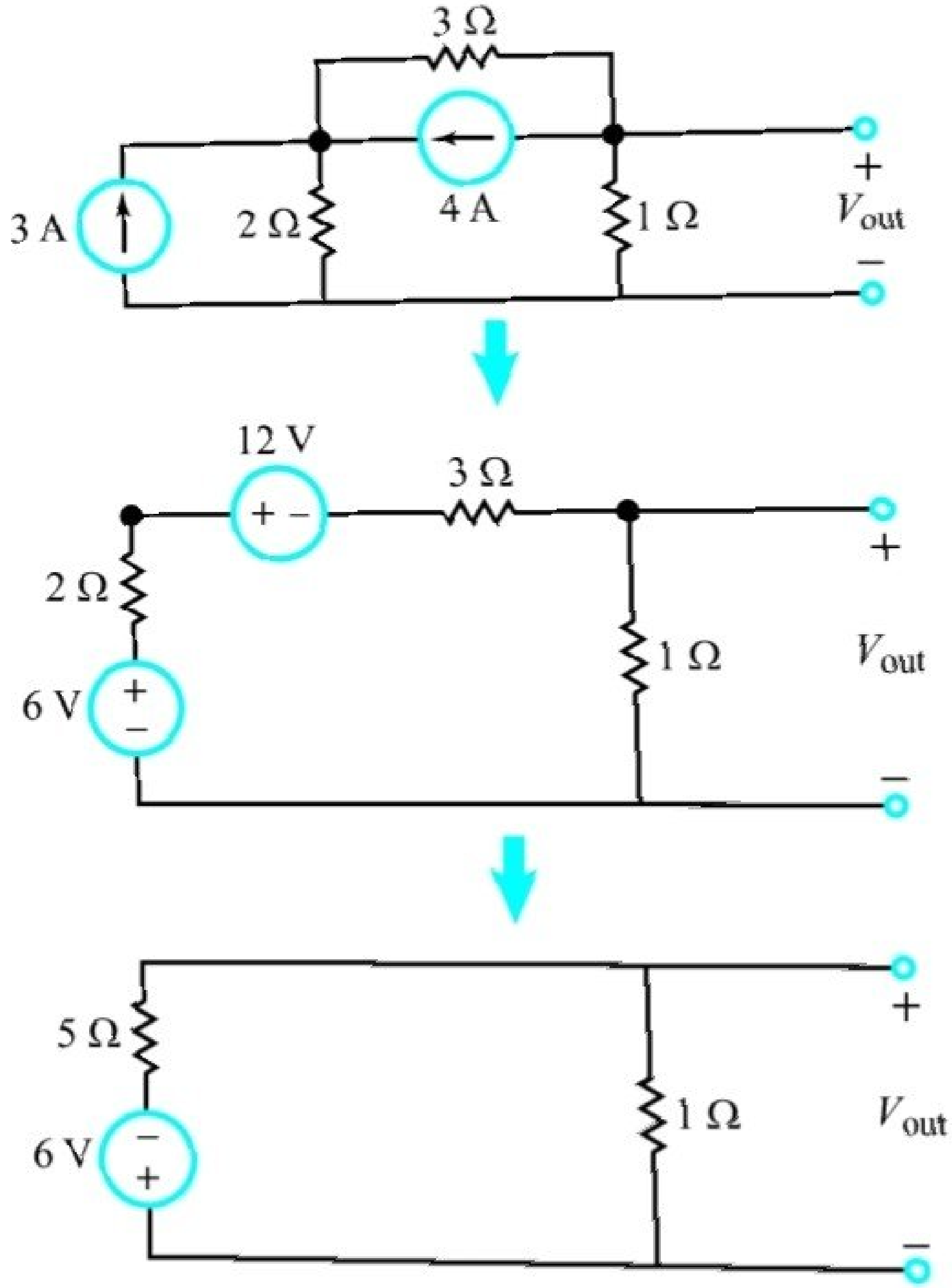


Figure E3-10

Solution:



By voltage division,

$$V_{out} = \frac{-6 \times 1}{5+1} = -1 \text{ V}.$$