Problem 3.10 The circuit in Fig. P3.10 contains a dependent current source. Determine the voltage V_x.

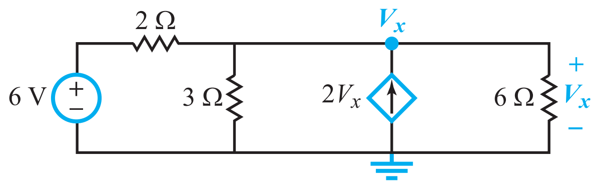


Figure P3.10: Circuit for Problem 3.10.

Solution: In terms of the node voltage V_x, KCL gives

$$\frac{V_x - 6}{2} + \frac{V_x}{3} - 2V_x + \frac{V_x}{6} = 0,$$

whose solution leads to

$$V_x = -3 \text{ V}.$$

Problem 3.12 The magnitude of the dependent current source in the circuit of Fig. P3.12 depends on the current I_x flowing through the 10-Ω resistor. Determine I_x.

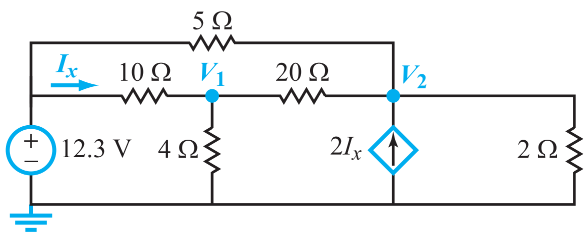


Figure P3.12: Circuit for Problem 3.12.

Solution: In terms of the designated node voltages V_1 and V_2, KCL gives:

$$\text{Node 1:} \quad \frac{V_1 - 12.3}{10} + \frac{V_1}{4} + \frac{V_1 - V_2}{20} = 0 \tag{1}$$

$$\text{Node 2:} \quad \frac{V_2 - V_1}{20} + \frac{V_2 - 12.3}{5} + \frac{V_2}{2} - 2I_x = 0 \tag{2}$$

In addition,

$$I_x = \frac{12.3 - V_1}{10}. \tag{3}$$

Solution of the three equations leads to:

$$V_1 = 3.8 \text{ V}, \qquad V_2 = 5.8 \text{ V}, \qquad I_x = 0.85 \text{ A}.$$

Problem 3.17 Determine V_x in the circuit of Fig. P3.17.

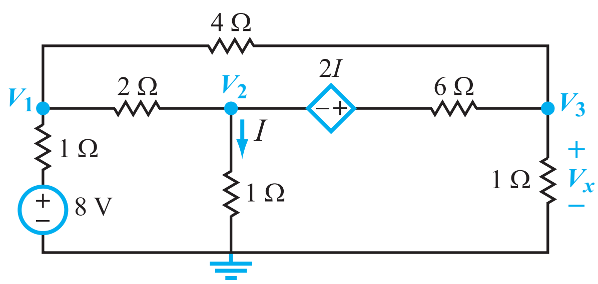


Figure P3.17: Circuit for Problems 3.17 and 3.18.

Solution: The node equations for designated nodes V_1, V_2, and V_3 are:

$$\frac{V_1 - 8}{1} + \frac{V_1 - V_2}{2} + \frac{V_1 - V_3}{4} = 0, \tag{1}$$

$$\frac{V_2 - V_1}{2} + \frac{V_2 + 2I - V_3}{6} + \frac{V_2}{1} = 0, \tag{2}$$

$$\frac{V_3 - 2I - V_2}{6} + \frac{V_3}{1} + \frac{V_3 - V_1}{4} = 0, \tag{3}$$

and the current I is related to V_2 by

$$I = \frac{V_2}{1} = V_2. \tag{4}$$

The solution of the simultaneous equations gives

$$V_1 = 5.18 \text{ V}, \qquad V_2 = 1.41 \text{ V}, \qquad V_3 = 1.41 \text{ V},$$

and

$$V_x = V_3 = 1.41 \text{ V}.$$

Problem 3.23 Determine V in the circuit of Fig. P3.23 using mesh analysis.

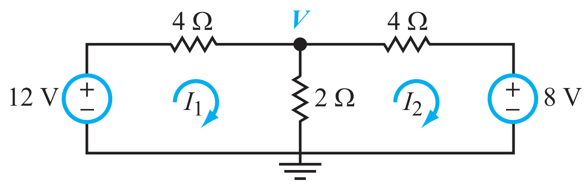


Figure P3.23: Circuit for Problem 3.23.

Solution:

$$\text{Mesh 1:} \qquad -12 + 4I_1 + 2(I_1 - I_2) = 0$$

$$\text{Mesh 2:} \qquad 2(I_2 - I_1) + 4I_2 + 8 = 0$$

Solution is:

$$I_1 = \frac{28}{16} \text{ A}, \qquad I_2 = \frac{-12}{16} \text{ A}.$$

$$V = 2(I_1 - I_2) = 2\left(\frac{28}{16} + \frac{12}{16}\right) = 5 \text{ V}.$$

Problem 2.35 Simplify the circuit to the right of terminals (a, b) in Fig. P2.35 to find R_{eq}, and then determine the amount of power supplied by the voltage source. All resistances are in ohms.

Solution:

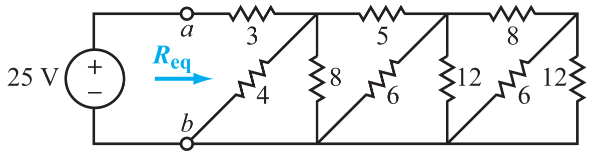
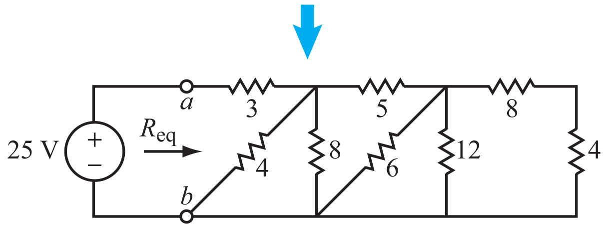
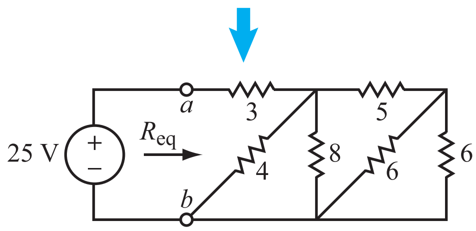
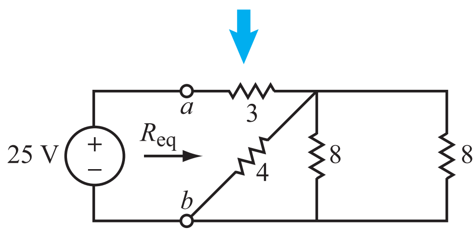


Figure P2.35: Circuit for Problem 2.35.

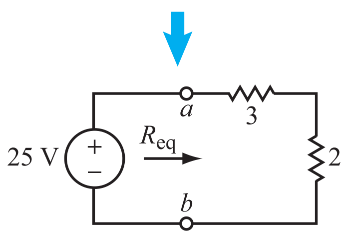




12 || 12 = 6



5 + 6 || 6 = 5 + 3 = 8



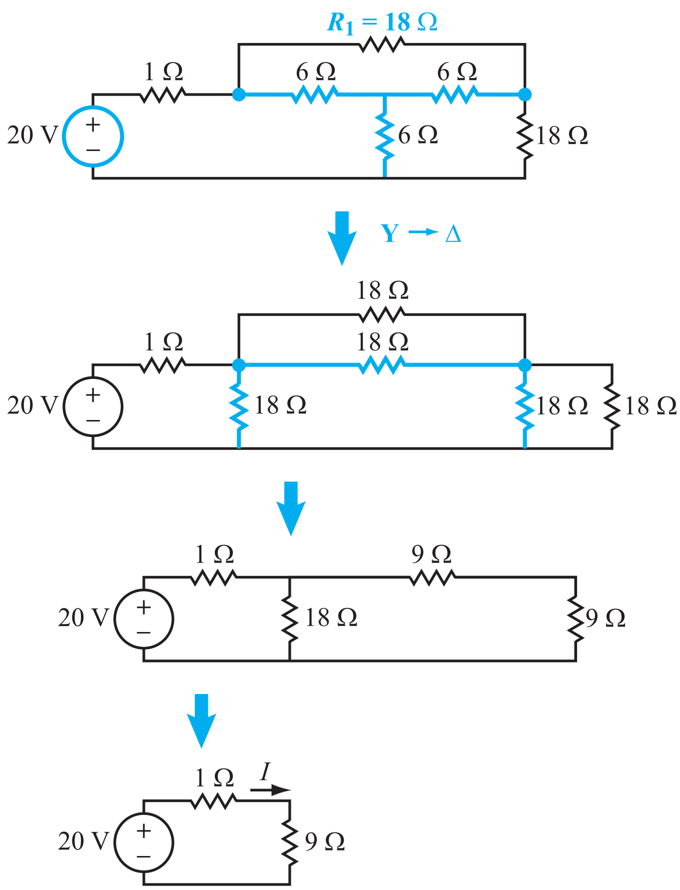
8 || 8 || 4 = 2

$$R_{eq} = 3 + 2 = 5\ \Omega$$

$$P = \frac{V^2}{R_{eq}} = \frac{(25)^2}{5} = 125\text{ W.}$$

Problem 2.41 Find the power supplied by the generator in Fig. P2.41.

Solution:

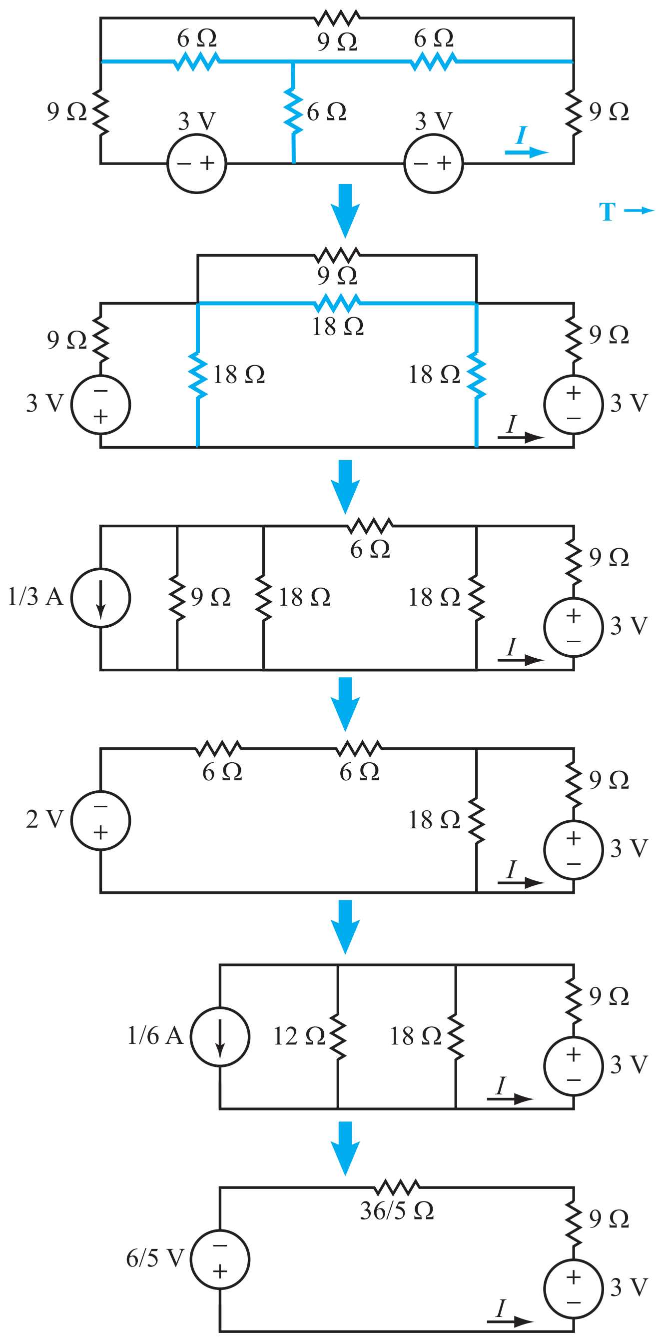


$$I = \frac{20}{10} = 2 \text{ A}$$

$$P = VI = 20 \times 2 = 40 \text{ W}.$$

Problem 2.43 Find I in the circuit of Fig. P2.43.

Solution:



T → Π Transformation

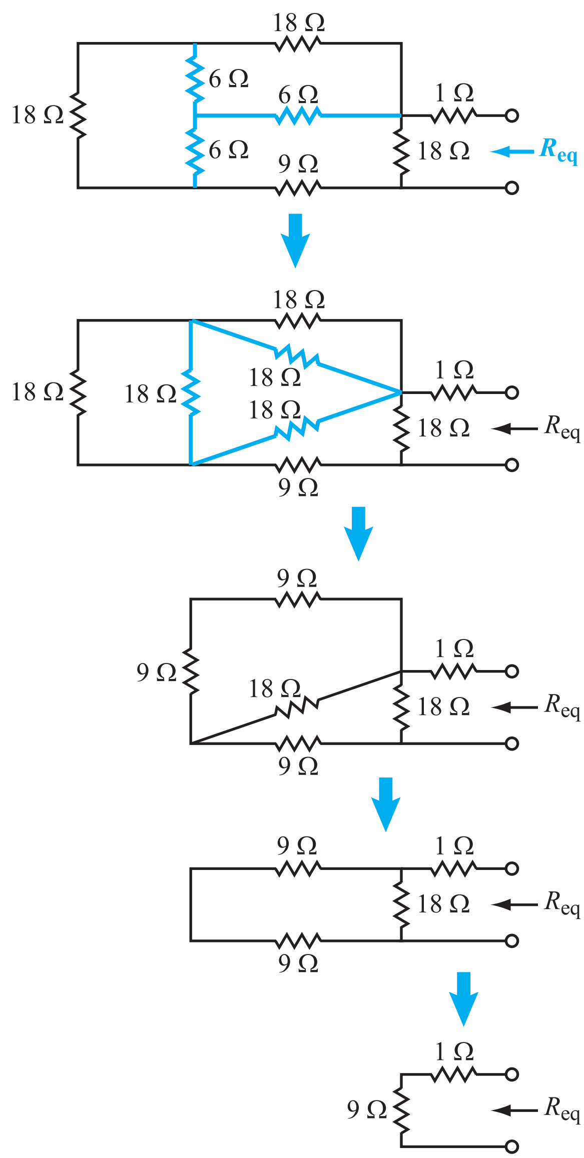
$9 \parallel 8 = 6$

$18 \parallel 12 = \dfrac{36}{5}$

$$I = \frac{3 + \frac{6}{5}}{9 + \frac{36}{5}} \simeq 0.26 \text{ A.}$$

Problem 2.47 Find R_{eq} for the circuit in Fig. P2.47.

Solution:



$$R_{eq} = 9 + 1 = 10\ \Omega.$$

Problem 3.5 Apply nodal analysis to determine the voltage V_R in the circuit of Fig. P3.5.

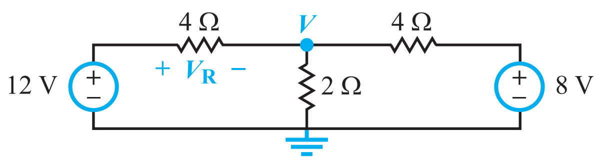


Figure P3.5: Circuit for Problem 3.5.

Solution: At node V:

$$\frac{V-12}{4}+\frac{V}{2}+\frac{V-8}{4}=0,$$

which leads to

$$V = 5 \text{ V}.$$

Hence,

$$V_R = 12 - V = 12 - 5 = 7 \text{ V}.$$

Problem 2.52 Determine V_1 in the circuit of Fig. P2.52. Assume $V_F = 0.7$ V for all diodes.

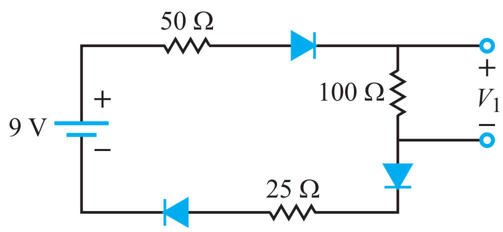


Figure P2.52: Circuit for Problem 2.52.

Solution:

$$I = \frac{9 - 3(0.7)}{50 + 100 + 25} \simeq 0.04 \text{ A},$$

$$V_1 = 100I = 4 \text{ V}.$$

Problem 3.9 Apply nodal analysis to find node voltages V_1 to V_3 in the circuit of Fig. P3.9 and then determine I_x.

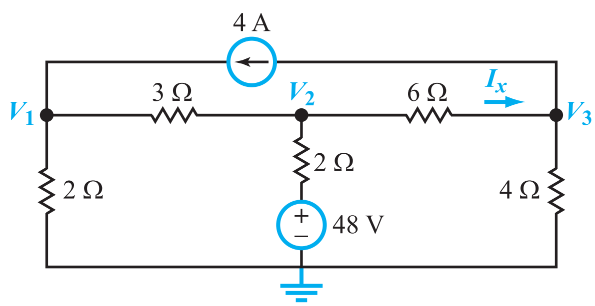


Figure P3.9: Circuit for Problem 3.9.

Solution: At nodes V_1, V_2, and V_3:

$$\text{Node 1:} \quad \frac{V_1}{2} + \frac{V_1 - V_2}{3} - 4 = 0 \tag{1}$$

$$\text{Node 2:} \quad \frac{V_2 - V_1}{3} + \frac{V_2 - 48}{2} + \frac{V_2 - V_3}{6} = 0 \tag{2}$$

$$\text{Node 3:} \quad \frac{V_3 - V_2}{6} + \frac{V_3}{4} + 4 = 0 \tag{3}$$

Simplification of the three equations leads to:

$$5V_1 - 2V_2 = 24 \tag{4}$$

$$-2V_1 + 6V_2 - V_3 = 144 \tag{5}$$

$$-2V_2 + 5V_3 = -48 \tag{6}$$

Simultaneous solution of Eqs. (4)–(6) leads to:

$$V_1 = \frac{84}{5} \text{ V}, \qquad V_2 = 30 \text{ V}, \qquad V_3 = \frac{12}{5} \text{ V}.$$

Hence,

$$I_x = \frac{V_2 - V_3}{6} = \frac{30 - 12/5}{6} = 4.6 \text{ A}.$$