Problems

1.1 An ideal voltage source is described by the function $v(t) = 10e^{-t}$ V. Find the value of this voltage source when (a) $t = 0$ s, (b) $t = 1$ s, (c) $t = 2$ s, (d) $t = 3$ s, (e) $t = 4$ s.

1.2 An ideal voltage source is described by the function $v(t) = 5 \sin(\pi/2)t$ V. Find the value of this voltage source when (a) $t = 0$ s, (b) $t = 1$ s, (c) $t = 2$ s, (d) $t = 3$ s, and (e) $t = 4$ s.

1.3 An ideal voltage source is described by the function $v(t) = 3 \cos(\pi/2)t$ V. Find the value of this voltage source when (a) $t = 0$ s, (b) $t = 1$ s, (c) $t = 2$ s, (d) $t = 3$ s, and (e) $t = 4$ s.

1.4 Find the current in a region when the total charge in the region is described by the function (a) $q(t) = 4e^{-2t}$ C, (b) $q(t) = 3 \sin \pi t$ C, (c) $q(t) = 6 \cos 2\pi t$ C, and (d) $q(t) = 5e^{-4t} \cos 3t$ C.

1.5 An ideal voltage source is described by the function shown in Fig. P1.5. Find the value of this voltage source when (a) $t = 0$ s, (b) $t = 1$ s, (c) $t = 2$ s, (d) $t = 3$ s, and (e) $t = 4$ s.

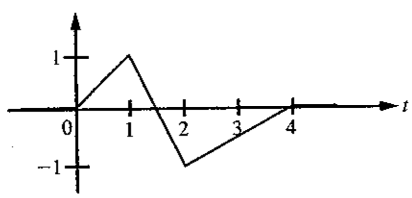

Fig. P1.5

1.6 The total charge $q(t)$ in some region is described by the function shown in Fig. P1.5. Sketch the current $i(t)$ in this region.

1.7 Consider the circuit shown in Fig. P1.7. (a) Given $i_1 = 4$ A, find v_1. (b) Given $i_2 = -2$ A, find v_2. (c) Given $i_3 = 2$ A, find v_3. (d) Given $i_4 = -2$ A, find v_4.

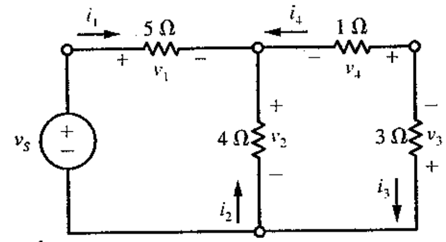

Fig. P1.7

1.8 Consider the circuit in Fig. P1.7. (a) Given $v_1 = 30$ V, find i_1. (b) Given $v_2 = 12$ V, find i_2. (c) Given $v_3 = -9$ V, find i_3. (d) Given $v_4 = -3$ V, find i_4.

1.9 Consider the circuit shown in Fig. P1.7. (a) Given $v_1 = -10$ V, find i_1. (b) Given $i_2 = 1$ A, find v_2. (c) Given $v_3 = 3$ V, find i_3. (d) Given $i_4 = 1$ A, find v_4.

1.10 Consider the circuit in Fig. P1.10. (a) Given $v_1 = -6$ V, find i_1. (b) Given $v_2 = 24$ V, find i_2. (c) Given $v_3 = 11$ V, find i_3. (d) Given $v_4 = 21$ V, find i_4. (e) Given $v_5 = -14$ V, find i_5.

1.11 Consider the circuit shown in Fig. P1.10. (a) Given $i_1 = 1.5$ A, find v_1. (b) Given $i_2 = -4$ A, find v_2. (c) Given $i_3 = 5.5$ A, find v_3. (d) Given $i_4 = 3.5$ A, find v_4. (e) Given $i_5 = 3.5$ A, find v_5.

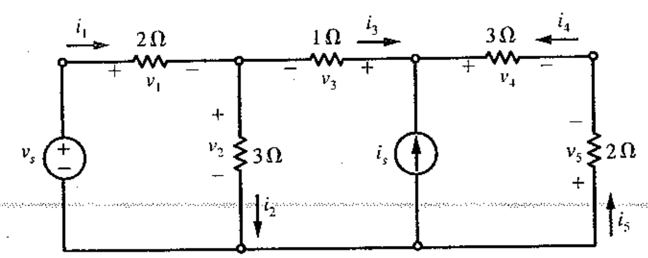

Fig. P1.10

1.12 Consider the circuit shown in Fig. P1.12. (a) Given $i_1 = -4$ A, find v_1. (b) Given $i_2 = 1$ A, find v_2. (c) Given $i_3 = 1$ A, find v_3. (d) Given $i_4 = 2$ A, find v_4.

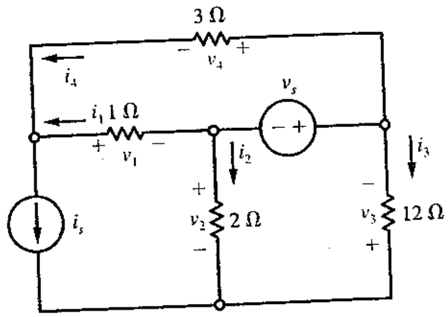

Fig. P1.12

1.13 Consider the circuit in Fig. P1.12. (a) Given $v_1 = -2$ V, find i_1. (b) Given $v_2 = -1$ V, find i_2. (c) Given $v_3 = -6$ V, find i_3. (d) Given $v_4 = 3$ V, find i_4.

1.14 Consider the circuit in Fig. P1.14. (a) Given $i_1 = 3$ A and $v_1 = 6$ V, find R_1. (b) Given $i_2 = 3$ A and $v_2 = -15$ V, find R_2. (c) Given $i_3 = -2$ A and $v_3 = 6$ V, find R_3. (d) Given $i_4 = -1$ A and $v_3 = 6$ V, find R_4.

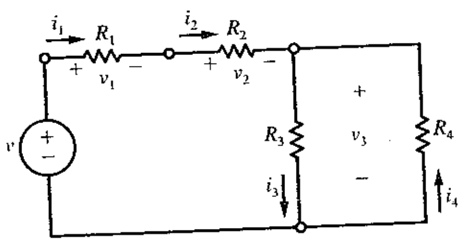

Fig. P1.14

1.15 Consider the circuit in Fig. P1.14. (a) Given $i_1 = 6$ A and $v_1 = 18$ V, find R_1. (b) Given $i_2 = 6$ A and $v_2 = -36$ V, find R_2. (c) Given $i_3 = 4$ A and $v_3 = 16$ V, find R_3. (d) Given $i_4 = -2$ A and $v_3 = 16$ V, find R_4.

1.16 For the circuit shown in Fig. P1.16, find v when (a) $i_s = 1$ A, (b) $i_s = 2$ A, (c) $i_s = 3$ A.

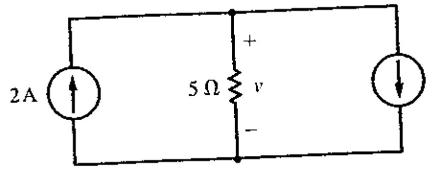

Fig. P1.16

1.17 For the circuit shown in Fig. P1.17, find i when (a) $v_s = 1$ V, (b) $v_s = 2$ V, (c) $v_s = 3$ V.

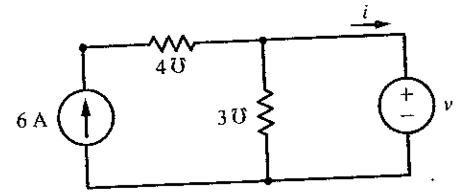

Fig. P1.17

1.18 For the circuit shown in Fig. P1.18, find v_4 when (a) $v_s = 2$ V, (b) $v_s = 4$ V, (c) $v_s = 6$ V.

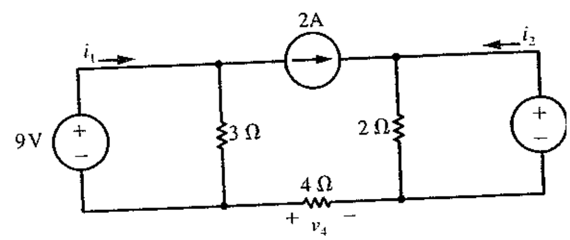

Fig. P1.18

1.19 For the circuit shown in Fig. P1.19, suppose that $i_1 = 6$ A. Use the current-divider formula to determine i_2, i_3, i_4, and i_5.

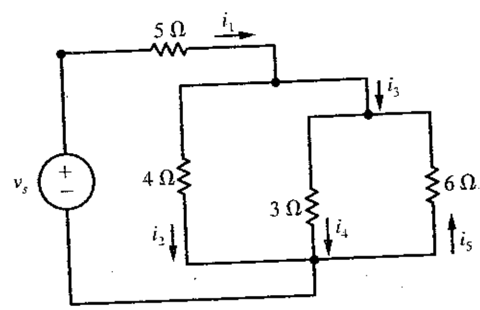

Fig. P1.19

1.20 For the circuit shown in Fig. P1.19, suppos that $i_4 = 4$ A. Use the current-divider formula t determine i_1, i_2, i_3, and i_5.

1.21 For the circuit shown in Fig. P1.19, suppose that $i_2 = -2$ A. Use the current-divider formula to determine i_1, i_3, i_4, and i_5.

1.22 For the circuit given in Fig. P1.19, suppose that $i_5 = 4$ A. Use the current-divider formula to determine i_1, i_2, i_3, and i_4.

1.23 For the circuit shown in Fig. P1.23, suppose that $i_1 = 2$ A. Find v for the case that (a) $i_2 = 1$ A, (b) $i_2 = 2$ A, and (c) $i_2 = 3$ A.

1.24 Consider the circuit shown in Fig. P1.23. Find v when (a) $i_1 = 12$ A and $i_2 = 6$ A, (b) $i_1 = 6$ A and $i_2 = 6$ A, (c) $i_1 = 6$ A and $i_2 = 12$ A.

1.25 Find the variables indicated for the circuits shown in Fig. P1.25.

1.26 Find the variables indicated for the circuits shown in Fig. P1.26. (See p. 48.)

1.27 Find the variables indicated for the circuits shown in Fig. P1.27. (See p. 48.)

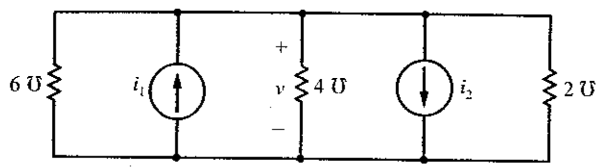

Fig. P1.23

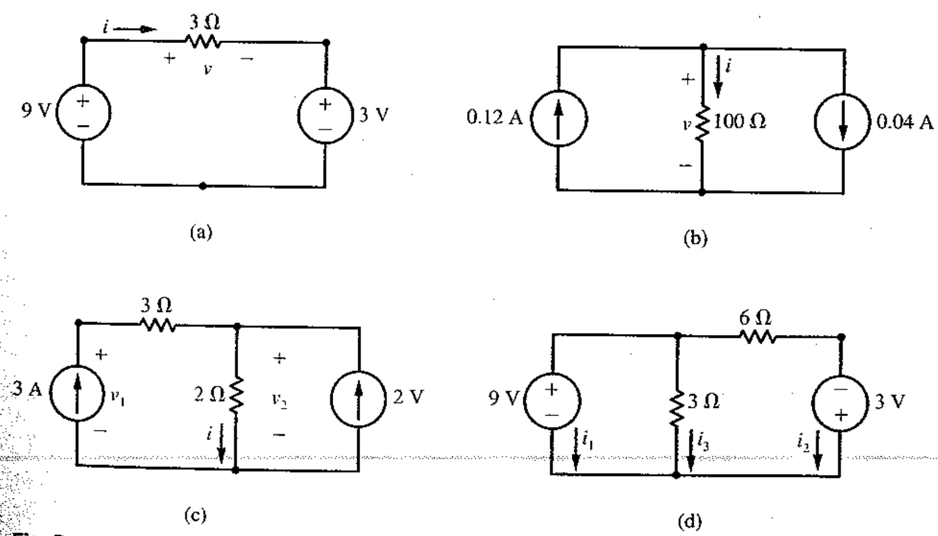

Fig. P1.25 *a-d*

1.28 For the circuit shown in Fig. P1.28, find the variables indicated when R is (a) 2 Ω, (b) 4 Ω, and (c) 6 Ω.

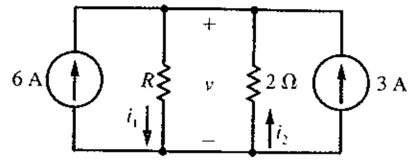

Fig. P1.28

1.29 For the circuit shown in Fig. P1.29, find the variables indicated when R is (a) 2 Ω, (b) 4 Ω, and (c) 6 Ω.

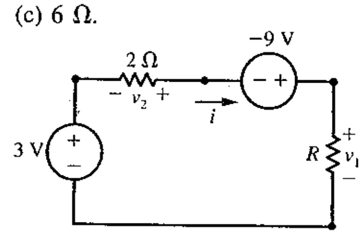

Fig. P1.29

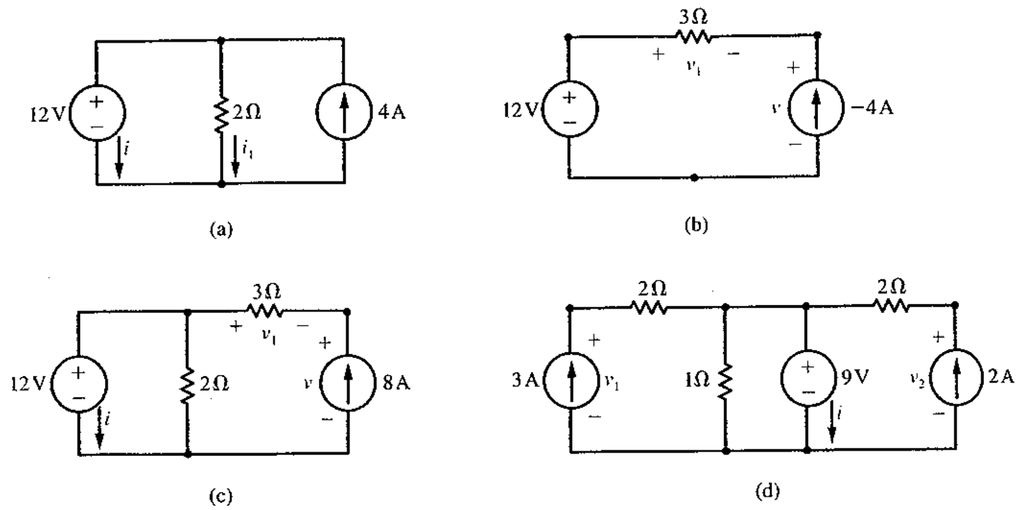

Fig. P1.26 *a-d*

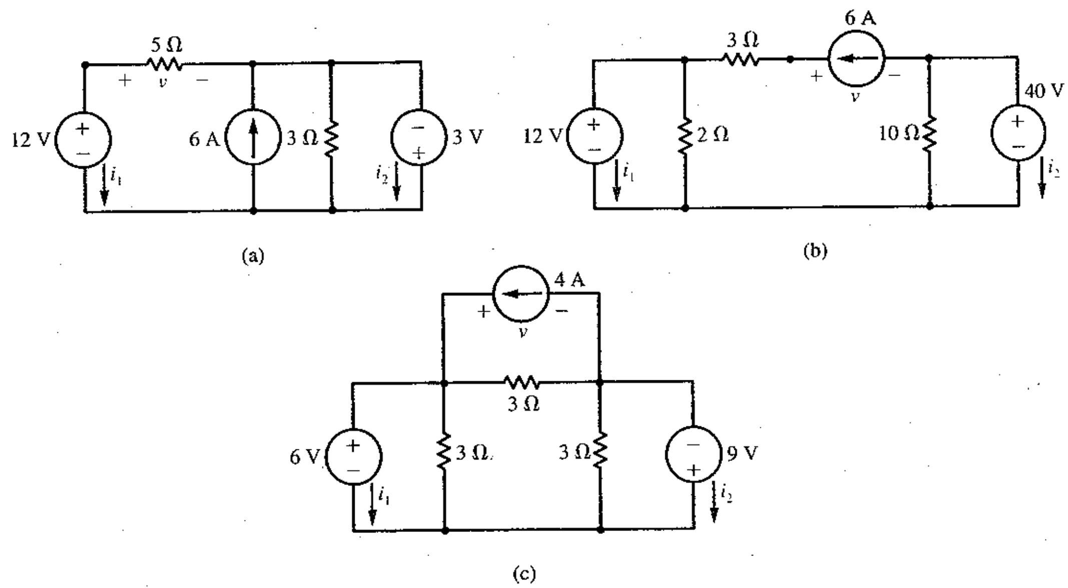

Fig. P1.27 *a-c*

1.30 Find v and i for the series-parallel circuit shown in Fig. P1.30.

1.31 Find v and i for the series-parallel circuit shown in Fig. P1.31.

1.32 Consider the circuit shown in Fig. P1.32. (a) Find i, v_1, v_2, and v_3. (b) Remove the short circuit between a and b (erase it), and find i, v_1, and v_2. (Don't try to find v_3—it can't be done!)

1.33 Consider the series-parallel circuit shown in Fig. P1.33. (a) Find V_s when $v_1 = 2$ V. (b) Find V_s when $i_3 = 3$ A. (c) Find V_s when $i_5 = 4$ A. (d) What is the resistance $R_{eq} = V_s/i$ loading the battery for part (a)? For part (b)? For part (c)?

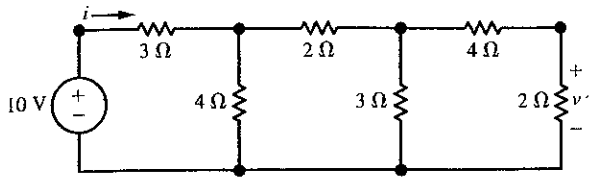

Fig. P1.30

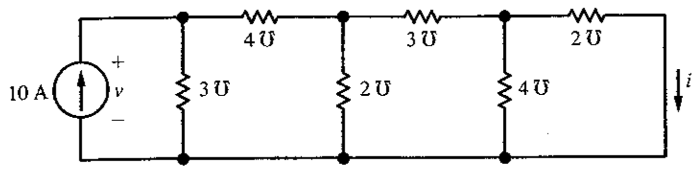

Fig. P1.31

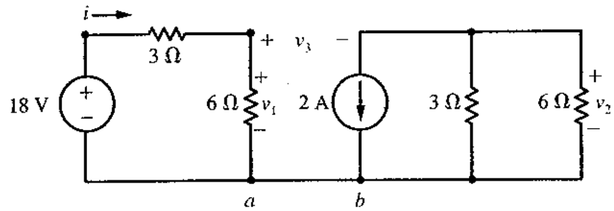

Fig. P1.32

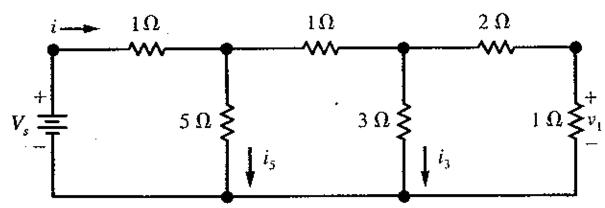

Fig. P1.33

1.34 Consider the nonseries-parallel circuit shown in Fig. P1.34. (a) When $R = \frac{1}{2}\ \Omega$, then $v_1 = 6$ V. Determine the resistance $R_{eq} = V_s/i$ loading the battery.

1.35 Consider the nonseries-parallel circuit shown in Fig. P1.34. When $R = 4\ \Omega$, then $v_1 = 4$ V. Determine the resistance $R_{eq} = V_s/i$ loading the battery.

1.36 Consider the nonseries-parallel circuit shown in Fig. P1.34. Determine R and the resistance $R_{eq} = V_s/i$ loading the battery when $v_1 = 3$ V.

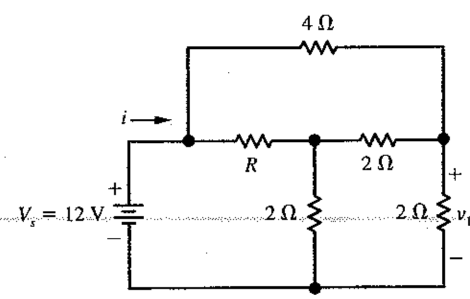

Fig. P1.34

1.37 The nonseries-parallel circuit shown in Fig. P1.37 is known as a **twin-T network**. (a) When $R_1 = 1\ \Omega$ and $R_2 = 3\ \Omega$, then $v_2 = 6$ V. Determine the resistance $R_{eq} = V_s/i$ loading the battery.

1.38 For the twin-T network shown in Fig. P1.37, suppose that $R_2 = \frac{3}{4}\ \Omega$ and $v_2 = 3$ V. Determine R_1 and the resistance $R_{eq} = V_s/i$ loading the battery.

1.39 Shown in Fig. P1.39 is a nonseries-parallel connection known as a **bridge circuit**. When $R_1 = 10\ \Omega$ and $R_2 = 1\ \Omega$, then $v_1 = 10$ V. Find v_2, i, v_3, and the resistance $R_{eq} = V_s/i_s$ loading the voltage source.

1.40 For the bridge circuit shown in Fig. P1.39, when $R_1 = 2\ \Omega$ and $R_2 = 4\ \Omega$, then $v_1 = 4$ V. Find v_2, i, v_3, and the resistance $R_{eq} = V_s/i_s$ loading the voltage source.

1.41 For the bridge circuit shown in Fig. P1.39, when the current $i = 0$ A, we say that the bridge is **balanced**. Under what condition (find an expression relating R_1 and R_2) will this bridge be balanced?

1.42 For the circuit shown in Fig. P1.42, find i_1 when (a) $K = 2$, (b) $K = 3$, and (c) $K = 4$.

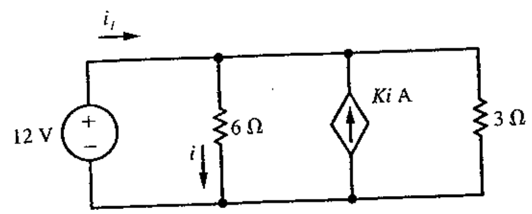

Fig. P1.42

1.43 The circuit shown in Fig. P1.43 contains a **voltage-dependent voltage source** as well as a current-dependent current source. Find i_1 when (a) $K = -3$, (b) $K = -1.5$, and (c) $K = 1.5$.

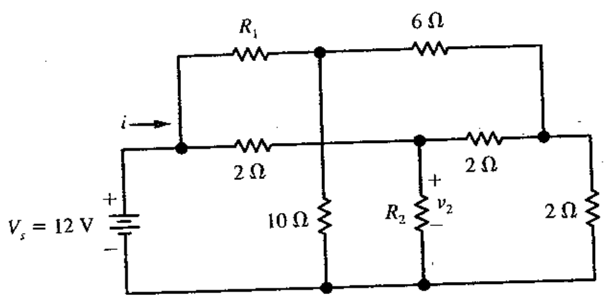

Fig. P1.37

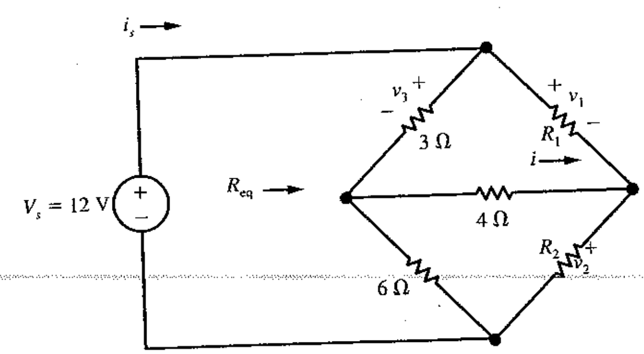

Fig. P1.39

1.44 Consider the circuit shown in Fig. P1.44. Find v when (a) $K = 2$, and (b) $K = 4$.

1.45 Consider the circuit shown in Fig. P1.45. Find i when (a) $K = 2$, and (b) $K = 4$.

1.46 Consider the circuit shown in Fig. P1.46. (a) Find the resistance $R_{eq} = v_1/i_1$. (b) Find the voltage v_2 in terms of the applied voltage v_1.

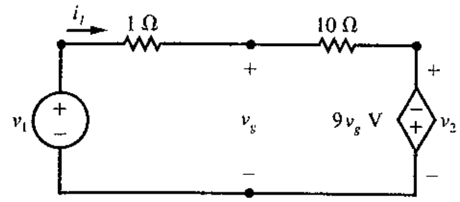

Fig. P1.46

1.47 Consider the circuit shown in Fig. P1.47. (a) Find the resistance $R_{eq} = v_1/i_1$. (b) Use voltage division to find v in terms of v_g. (c) Find the voltage v_2 in terms of the applied voltage v_1.

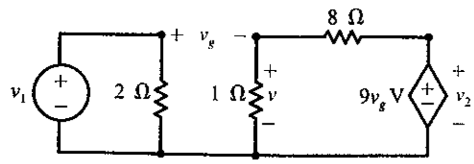

Fig. P1.47

1.48 For the circuit shown in Fig. P1.48, suppose that $R = 10\ \Omega$. Determine (a) v_s, and (b) $R_{eq} = v_s/i_s$.

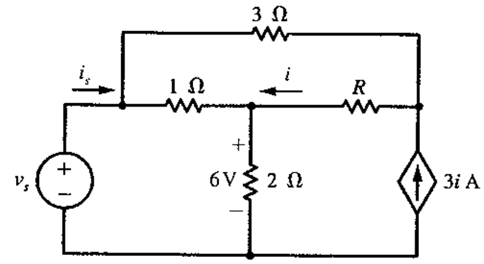

Fig. P1.48

1.49 For the circuit shown in Fig. P1.48, suppose that $R = 8\ \Omega$. Determine (a) v_s, and (b) $R_{eq} = v_s/i_s$.

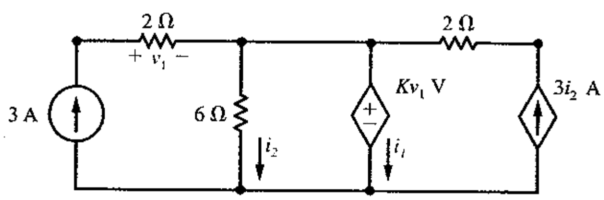

Fig. P1.43

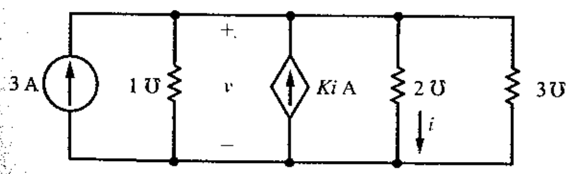

Fig. P1.44

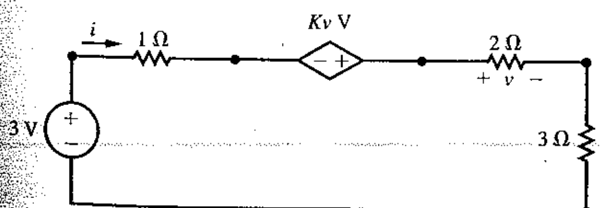

Fig. P1.45

1.50 For the circuit shown in Fig. P1.50, suppose that $R = 5\ \Omega$. Determine (a) i_s, and (b) $R = v_s/i_s$.

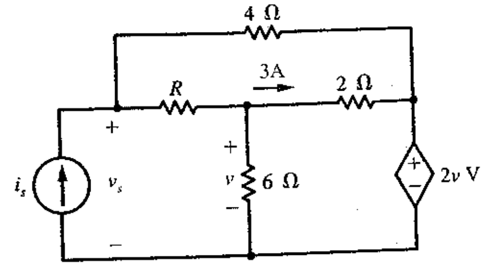

Fig. P1.50

1.51 For the circuit shown in Fig. P1.50, suppose that $R = 3\ \Omega$. Determine (a) i_s, and (b) $R_{eq} = v_s/i_s$.

1.52 The circuit shown in Fig. P1.52 is a single field-effect transistor (FET) amplifier in which the input is v_1 and the output is v_2. The portion of the circuit in the shaded box is an approximate model of an FET. (a) Find v_{gs} in terms of v_1. (b) Find v_2 in terms of v_1. (c) Find v_2 when $v_1 = 0.1 \cos 120\pi t$ V.

1.53 The circuit shown in Fig. P1.53 is a single bipolar junction transistor (BJT) amplifier in which the input is v_1 and the output is v_2. The portion of the circuit in the shaded box is an approximate model of a BJT in the common-emitter configuration. (a) Find i_b in terms of the input voltage v_1. (b) Find the output voltage v_2 in terms of v_1. (c) Find v_2 when $v_1 = 0.1 \cos 120\pi t$ V.

1.54 The circuit shown in Fig. P1.54 is another single bipolar junction transistor (BJT) amplifier in which the input is v_1 and the output is v_2. The portion in the shaded box is an approximate model of a BJT in the common-base configuration. (a) Find i_e in terms of the input voltage v_1. (b) Find the output voltage v_2 in terms of v_1. (c) Find v_1 when $v_1 = 0.1 \cos 120\pi t$ V.

1.55 For the circuit given in Fig. 1.51 on p. 34, $v = 12$ V, $i_1 = 4$ A, and $i_2 = 6$ A. Determine the power absorbed by each element in the circuit.

1.56 For the circuit given in Fig. 1.52 on p. 36, $v = 24$ V. Determine the power absorbed by each element in the circuit.

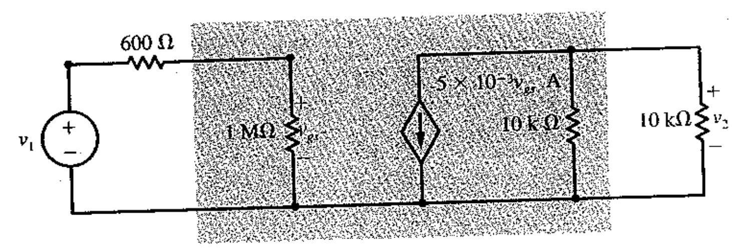

Fig. P1.52

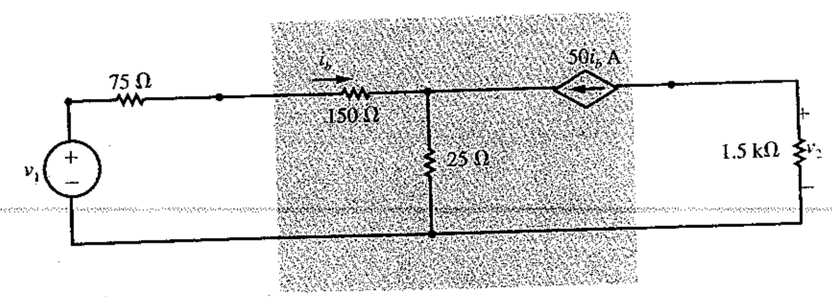

Fig. P1.53

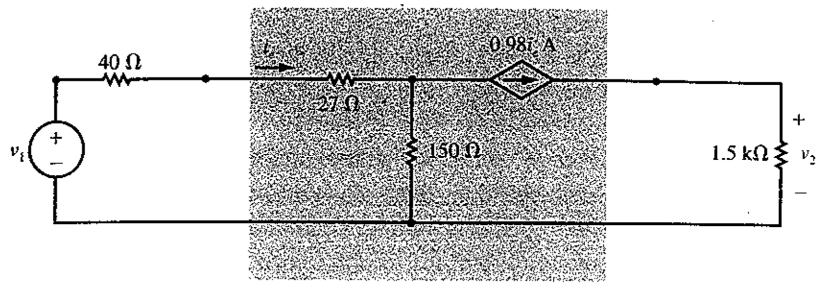

Fig. P1.54

1.57 For the circuit given in Fig. 1.53 on p. 37, $i = 24$ A. Determine the power absorbed by each element in the circuit.

1.58 For the circuit given in Fig. P1.42, determine the power absorbed by each element when (a) $K = 2$, and (b) $K = -2$.

1.59 For the circuit shown in Fig. P1.44, determine the power absorbed by each element given that (a) $K = 2$ and $v = 1.5$ V; (b) $K = 4$ and $v = -1.5$ V.

1.60 For the circuit shown in Fig. P1.45, determine the power absorbed by each element given that (a) $K = 2$ and $i = 1.5$ A; (b) $K = 4$ and $i = -1.5$ A.