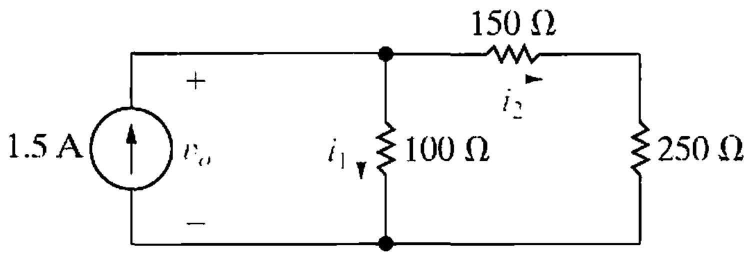
Section 2.4 Kirchoff's Laws:

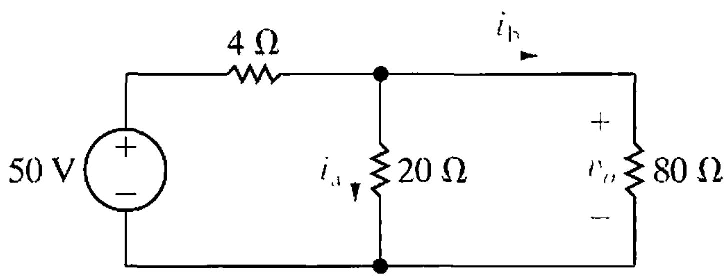
2.18 PSPICE MULTISIM
a) Find the currents i_1 and i_2 in the circuit in Fig. P2.18.
b) Find the voltage v_o.
c) Verify that the total power developed equals the total power dissipated.

Figure P2.18



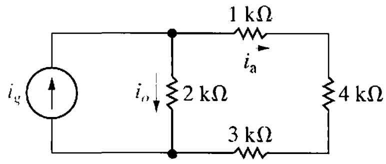
2.19 PSPICE MULTISIM
Given the circuit shown in Fig. P2.19, find
a) the value of i_a,
b) the value of i_b,
c) the value of v_o,
d) the power dissipated in each resistor,
e) the power delivered by the 50 V source.

Figure P2.19



2.20 PSPICE MULTISIM
The current i_a in the circuit shown in Fig. P2.20 is 2 mA. Find (a) i_o; (b) i_g; and (c) the power delivered by the independent current source.

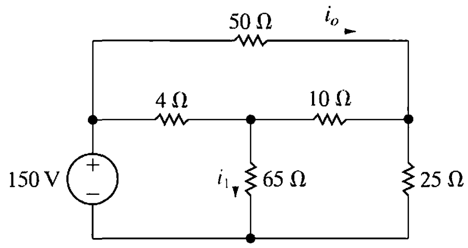
Figure P2.20



2.21 The current i_o in the circuit in Fig. P2.21 is 1 A.
PSPICE MULTISIM

a) Find i_1.
b) Find the power dissipated in each resistor.
c) Verify that the total power dissipated in the circuit equals the power developed by the 150 V source.

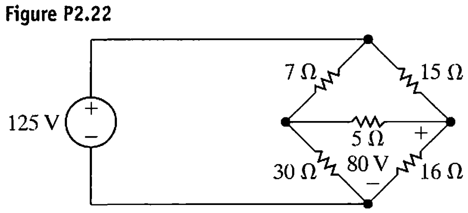
Figure P2.21



2.22 The voltage across the 16 Ω resistor in the circuit in Fig. P2.22 is 80 V, positive at the upper terminal.
PSPICE MULTISIM

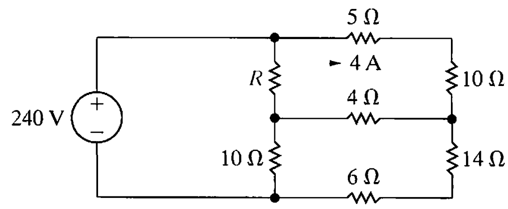
a) Find the power dissipated in each resistor.
b) Find the power supplied by the 125 V ideal voltage source.
c) Verify that the power supplied equals the total power dissipated.

Figure P2.22



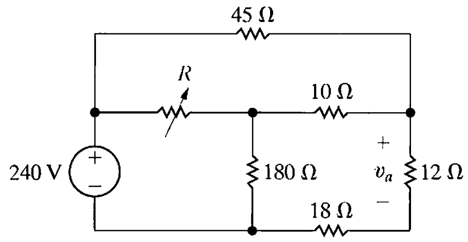
2.23 For the circuit shown in Fig. P2.23, find (a) R and (b) the power supplied by the 240 V source.
PSPICE MULTISIM

Figure P2.23



2.24 The variable resistor R in the circuit in Fig. P2.24 is adjusted until v_a equals 60 V. Find the value of R.
PSPICE MULTISIM

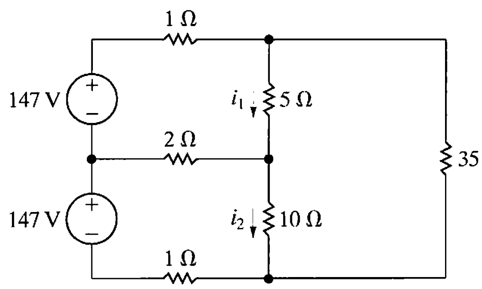
Figure P2.24



2.25 The currents i_1 and i_2 in the circuit in Fig. P2.25 are 21 A and 14 A, respectively.

a) Find the power supplied by each voltage source.
b) Show that the total power supplied equals the total power dissipated in the resistors.

Figure P2.25



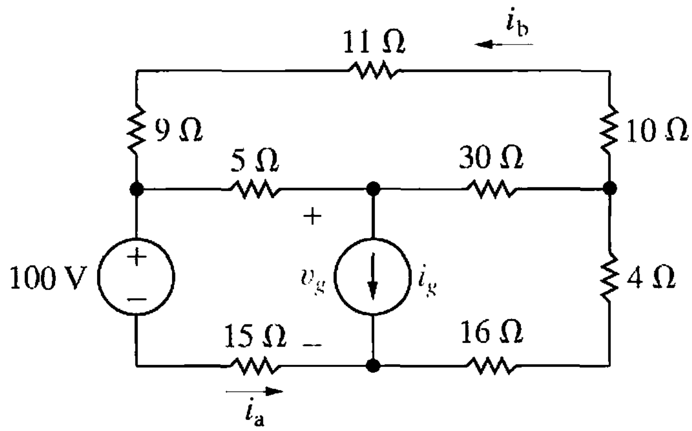
2.26 The currents i_a and i_b in the circuit in Fig. P2.26 are 4 A and −2 A, respectively.
PSPICE MULTISIM

a) Find i_g.
b) Find the power dissipated in each resistor.

c) Find v_g.

d) Show that the power delivered by the current source is equal to the power absorbed by all the other elements.

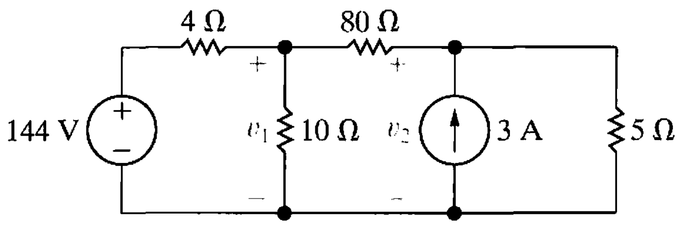
Figure P2.26



Section 4.2 Nodal Analysis:

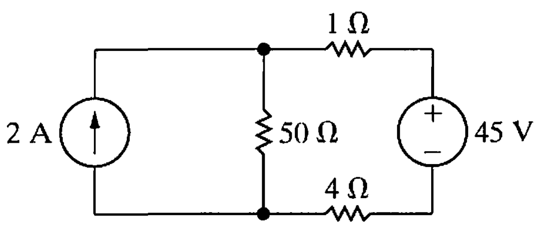
4.6 Use the node-voltage method to find v_1 and v_2 in the circuit in Fig. P4.6.
PSPICE
MULTISIM

Figure P4.6



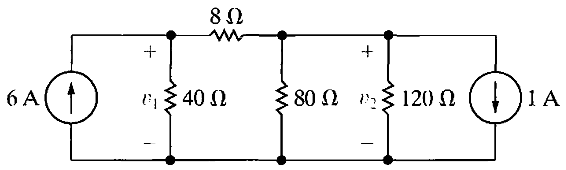
4.7 Use the node-voltage method to find how much power the 2 A source extracts from the circuit in Fig. P4.7.
PSPICE
MULTISIM

Figure P4.7



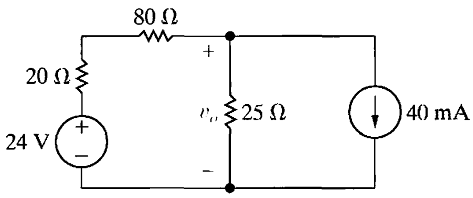
4.8 Use the node-voltage method to find v_1 and v_2 in the circuit shown in Fig. P4.8.
PSPICE MULTISIM

Figure P4.8



4.9 Use the node-voltage method to find v_o in the circuit in Fig. P4.9.
PSPICE MULTISIM

Figure P4.9

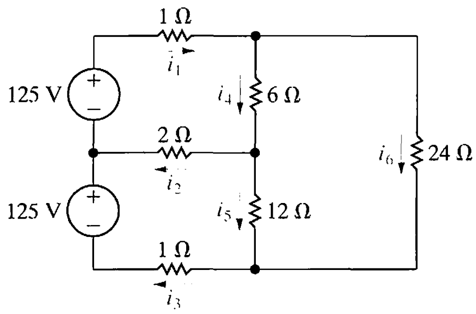


4.10 a) Find the power developed by the 40 mA current source in the circuit in Fig. P4.9.
PSPICE MULTISIM
b) Find the power developed by the 24 V voltage source in the circuit in Fig. P4.9.
c) Verify that the total power developed equals the total power dissipated.

4.11 A 50 Ω resistor is connected in series with the 40 mA current source in the circuit in Fig. P4.9.
PSPICE MULTISIM
a) Find v_o.
b) Find the power developed by the 40 mA current source.
c) Find the power developed by the 24 V voltage source.
d) Verify that the total power developed equals the total power dissipated.
e) What effect will any finite resistance connected in series with the 40 mA current source have on the value of v_o?

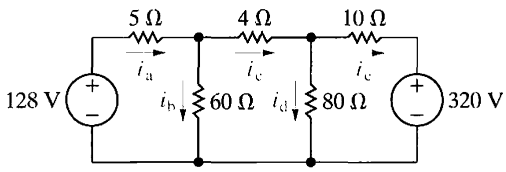
4.12 The circuit shown in Fig. P4.12 is a dc model of a residential power distribution circuit.
PSPICE MULTISIM
a) Use the node-voltage method to find the branch currents $i_1 - i_6$.
b) Test your solution for the branch currents by showing that the total power dissipated equals the total power developed.

Figure P4.12



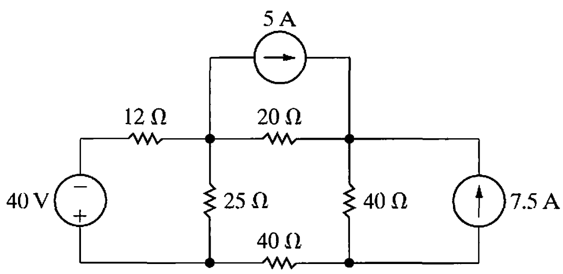
4.13 a) Use the node-voltage method to find the branch currents $i_a - i_e$ in the circuit shown in Fig. P4.13.
PSPICE MULTISIM
b) Find the total power developed in the circuit.

Figure P4.13



4.14 Use the node-voltage method to find the total power dissipated in the circuit in Fig. P4.14.
PSPICE MULTISIM

Figure P4.14

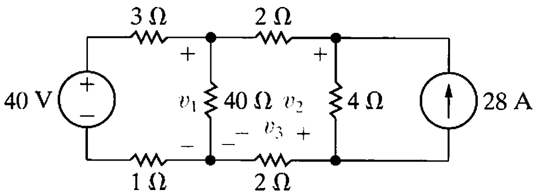


4.15 a) Use the node-voltage method to find v_1, v_2, and v_3 in the circuit in Fig. P4.15.

PSPICE MULTISIM

b) How much power does the 40 V voltage source deliver to the circuit?

Figure P4.15

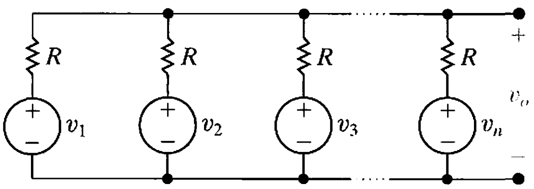


4.16 a) Use the node-voltage method to show that the output voltage v_o in the circuit in Fig. P4.16 is equal to the average value of the source voltages.

PSPICE MULTISIM

b) Find v_o if $v_1 = 100$ V, $v_2 = 80$ V, and $v_3 = -60$ V.

Figure P4.16

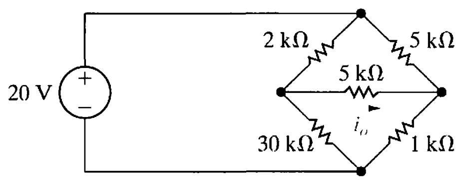


Section 4.4

4.21 Use the node-voltage method to find i_o in the circuit in Fig. P4.21.

PSPICE MULTISIM

Figure P4.21

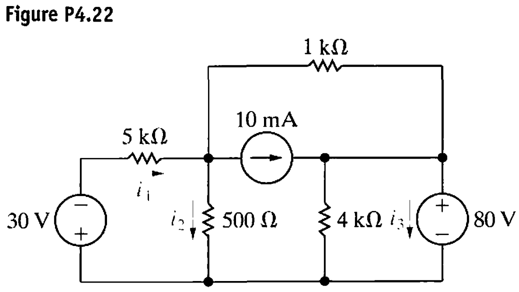


4.22 a) Use the node-voltage method to find the branch currents i_1, i_2, and i_3 in the circuit in Fig. P4.22.

PSPICE MULTISIM

b) Check your solution for i_1, i_2, and i_3 by showing that the power dissipated in the circuit equals the power developed.

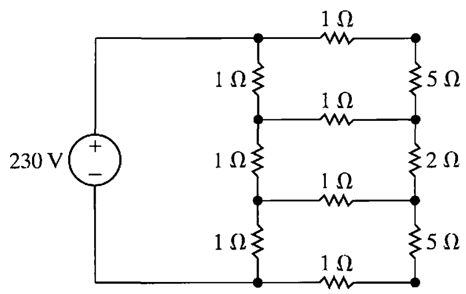
Figure P4.22



4.23 a) Use the node-voltage method to find the power dissipated in the 2 Ω resistor in the circuit in Fig. P4.23.

b) Find the power supplied by the 230 V source.

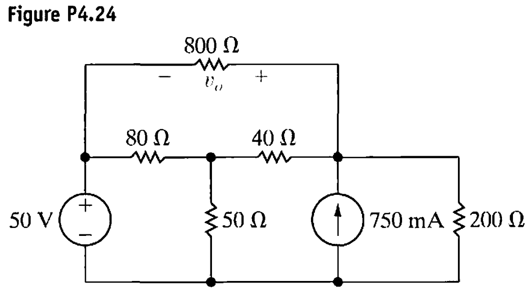
Figure P4.23



4.24 Use the node-voltage method to find the value of v_o in the circuit in Fig. P4.24.

PSPICE MULTISIM

Figure P4.24



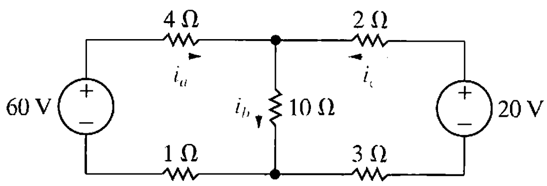
Section 4.5 Mesh Analysis:

4.31 Solve Problem 4.12 using the mesh-current method.

4.32 Solve Problem 4.13 using the mesh-current method.

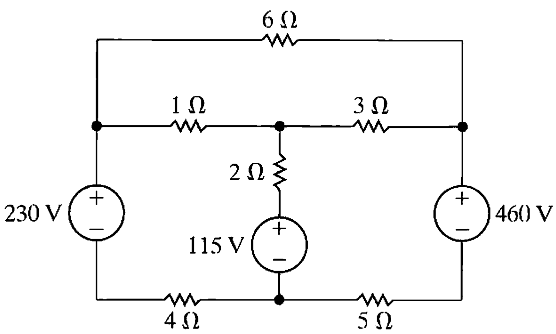
4.33 PSPICE MULTISIM
a) Use the mesh-current method to find the branch currents i_a, i_b, and i_c in the circuit in Fig. P4.33.
b) Repeat (a) if the polarity of the 60 V source is reversed.

Figure P4.33



4.34 PSPICE MULTISIM
a) Use the mesh-current method to find the total power developed in the circuit in Fig. P4.34.
b) Check your answer by showing that the total power developed equals the total power dissipated.

Figure P4.34



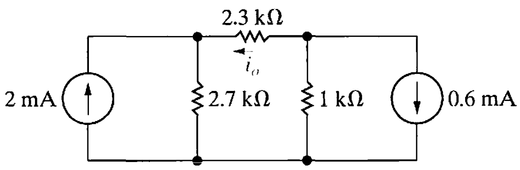
4.35 Solve Problem 4.21 using the mesh-current method.

4.36 Solve Problem 4.23 using the mesh-current method.

Section 4.9 Thevenin and Norton Equivalents

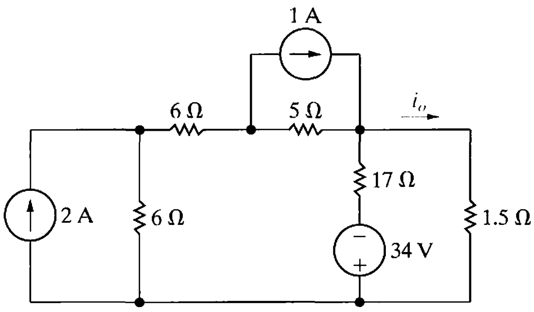
4.59 PSPICE MULTISIM
a) Use a series of source transformations to find the current i_o in the circuit in Fig. P4.59.
b) Verify your solution by using the node-voltage method to find i_o.

Figure P4.59



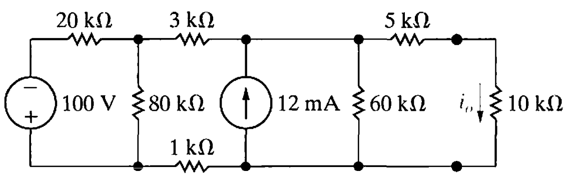
4.60 PSPICE MULTISIM
a) Use a series of source transformations to find i_o in the circuit in Fig. P4.60.
b) Verify your solution by using the mesh-current method to find i_o.

Figure P4.60



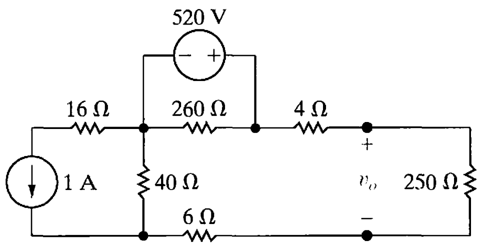
4.61 PSPICE MULTISIM
a) Find the current in the 10 kΩ resistor in the circuit in Fig. P4.61 by making a succession of appropriate source transformations.
b) Using the result obtained in (a), work back through the circuit to find the power developed by the 100 V source.

Figure P4.61



4.62 PSPICE MULTISIM
a) Use source transformations to find v_o in the circuit in Fig. P4.62.
b) Find the power developed by the 520 V source.
c) Find the power developed by the 1 A current source.
d) Verify that the total power developed equals the total power dissipated.

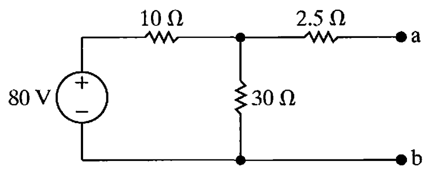
Figure P4.62



Section 4.10 Thevenin and Norton Equivalents

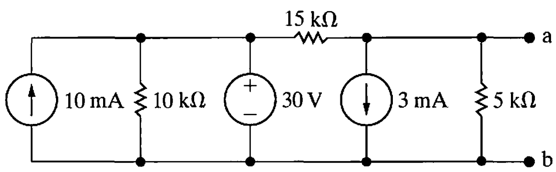
4.63 PSPICE MULTISIM
Find the Thévenin equivalent with respect to the terminals a,b for the circuit in Fig. P4.63.

Figure P4.63



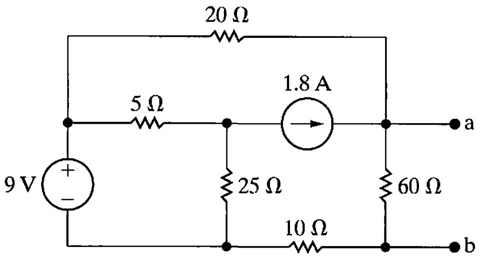
4.64 PSPICE MULTISIM
Find the Norton equivalent with respect to the terminals a,b in the circuit in Fig. P4.64.

Figure P4.64



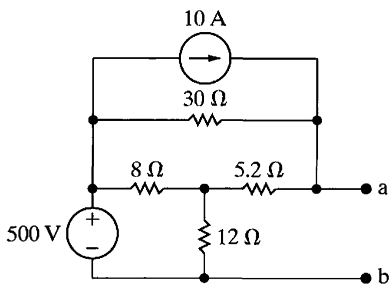
4.65 PSPICE MULTISIM
a) Find the Thévenin equivalent with respect to the terminals a,b for the circuit in Fig. P4.65 by finding the open-circuit voltage and the short-circuit current.
b) Solve for the Thévenin resistance by removing the independent sources. Compare your result to the Thévenin resistance found in (a).

Figure P4.65



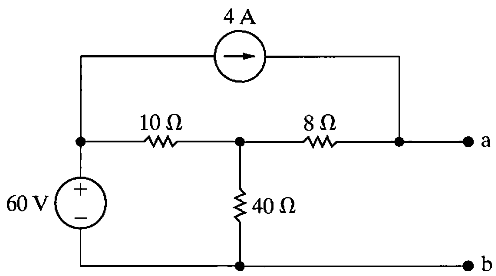
4.66 Find the Thévenin equivalent with respect to the terminals a,b for the circuit in Fig. P4.66.
PSPICE MULTISIM

Figure P4.66



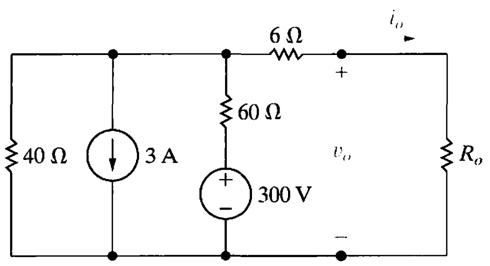
4.67 Find the Norton equivalent with respect to the terminals a,b for the circuit in Fig. P4.67.
PSPICE MULTISIM

Figure P4.67



4.68 Determine i_o and v_o in the circuit shown in Fig. P4.68 when R_o is a resistor from Appendix H whose value is less than 100 Ω.
PSPICE MULTISIM

Figure P4.68



4.69 An automobile battery, when connected to a car radio, provides 12.5 V to the radio. When connected to a set of headlights, it provides 11.7 V to the headlights. Assume the radio can be modeled as a 6.25 Ω resistor and the headlights can be modeled as a 0.65 Ω resistor. What are the Thévenin and Norton equivalents for the battery?

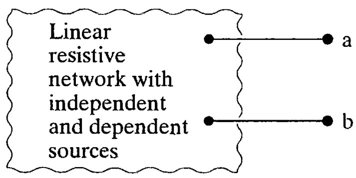
4.70 A Thévenin equivalent can also be determined from measurements made at the pair of terminals of interest. Assume the following measurements were made at the terminals a,b in the circuit in Fig. P4.70.

When a 20 Ω resistor is connected to the terminals a,b, the voltage v_{ab} is measured and found to be 100 V.

When a 50 Ω resistor is connected to the terminals a,b, the voltage is measured and found to be 200 V.

Find the Thévenin equivalent of the network with respect to the terminals a,b.

Figure P4.70

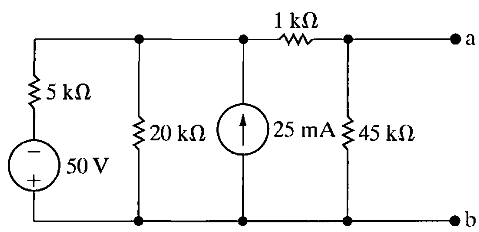


4.71 A voltmeter with a resistance of 85.5 kΩ is used to measure the voltage v_{ab} in the circuit in Fig. P4.71.
PSPICE MULTISIM

a) What is the voltmeter reading?

b) What is the percentage of error in the voltmeter reading if the percentage of error is defined as [(measured − actual)/actual] × 100?

Figure P4.71

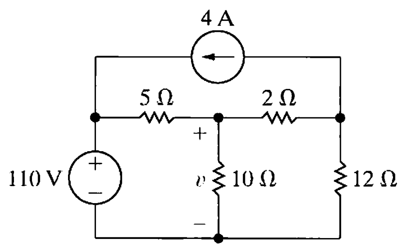


Section 4.13 Superposition

4.91 PSPICE MULTISIM a) Use the principle of superposition to find the voltage v in the circuit of Fig. P4.91.

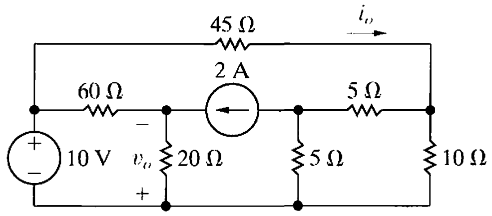
b) Find the power dissipated in the 10 Ω resistor.

Figure P4.91



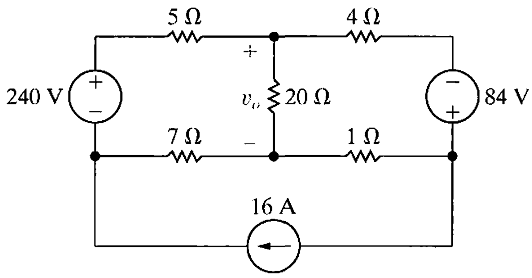
4.92 Use superposition to solve for i_o and v_o in the circuit in Fig. P4.92.

Figure P4.92



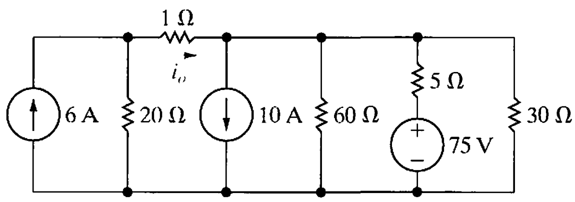
4.93 PSPICE MULTISIM Use the principle of superposition to find the voltage v_o in the circuit in Fig. P4.93.

Figure P4.93



4.94 PSPICE MULTISIM Use the principle of superposition to find the current i_o in the circuit shown in Fig. P4.94.

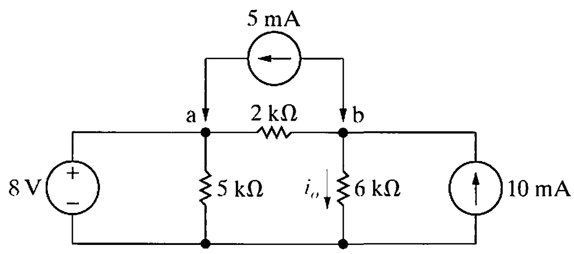
Figure P4.94



4.95 PSPICE MULTISIM a) In the circuit in Fig. P4.95, before the 5 mA current source is attached to the terminals a,b, the current i_o is calculated and found to be 3.5 mA. Use superposition to find the value of i_o after the current source is attached.

b) Verify your solution by finding i_o when all three sources are acting simultaneously.

Figure P4.95



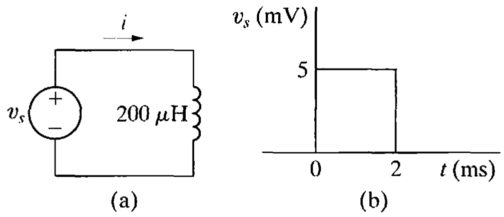
Inductors

6.3 The voltage at the terminals of the 200 μH inductor in Fig. P6.3(a) is shown in Fig. P6.3(b). The inductor current i is known to be zero for $t \leq 0$.
PSPICE MULTISIM

a) Derive the expressions for i for $t \geq 0$.

b) Sketch i versus t for $0 \leq t \leq \infty$.

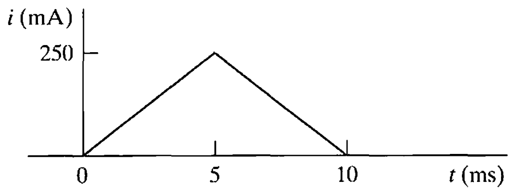
Figure P6.3



6.4 The triangular current pulse shown in Fig. P6.4 is applied to a 20 mH inductor.
PSPICE MULTISIM

a) Write the expressions that describe $i(t)$ in the four intervals $t < 0$, $0 \leq t \leq 5$ ms, 5 ms $\leq t \leq$ 10 ms, and $t > 10$ ms.

Figure P6.4



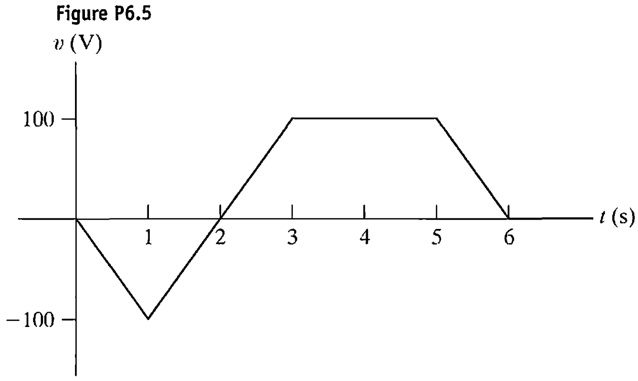
6.5 The current in and the voltage across a 5 H inductor are known to be zero for $t \leq 0$. The voltage across the inductor is given by the graph in Fig. P6.5 for $t \geq 0$.

a) Derive the expression for the current as a function of time in the intervals $0 \leq t \leq 1$ s, 1 s $\leq t \leq$ 3 s, 3 s $\leq t \leq$ 5 s, 5 s $\leq t \leq$ 6 s, and 6 s $\leq t < \infty$.

b) For $t > 0$, what is the current in the inductor when the voltage is zero?

c) Sketch i versus t for $0 \leq t < \infty$.

Figure P6.5



Section 6.2 Capacitors

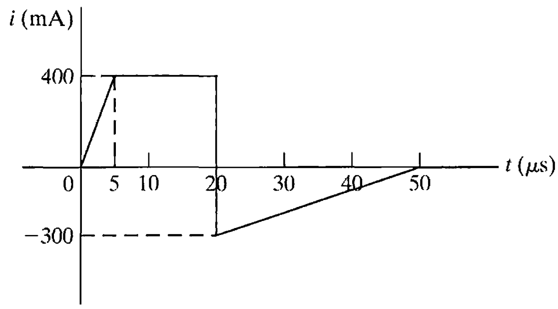
6.14 The current shown in Fig. P6.14 is applied to a 0.25 μF capacitor. The initial voltage on the capacitor is zero.
PSPICE MULTISIM

a) Find the charge on the capacitor at $t = 15$ μs.

b) Find the voltage on the capacitor at $t = 30$ μs.

c) How much energy is stored in the capacitor by this current?

Figure P6.14



6.16 The rectangular-shaped current pulse shown in Fig. P6.16 is applied to a 0.1 μF capacitor. The initial voltage on the capacitor is a 15 V drop in the reference direction of the current. Derive the expression for the capacitor voltage for the time intervals in (a)–(d).
PSPICE MULTISIM

a) $0 \leq t \leq 10$ μs;

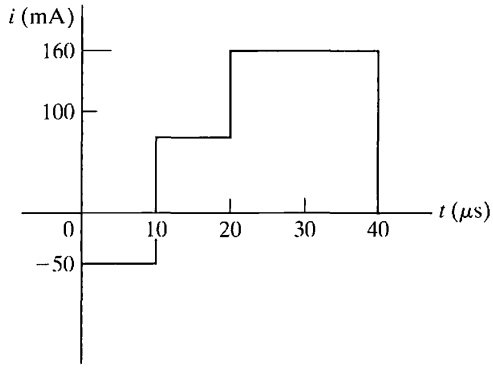
b) 10 μs $\leq t \leq$ 20 μs;

c) 20 μs $\leq t \leq$ 40 μs

d) 40 μs $\leq t < \infty$

e) Sketch $v(t)$ over the interval −10 μs $\leq t \leq$ 50 μs.

Figure P6.16



6.17 A 20 μF capacitor is subjected to a voltage pulse having a duration of 1 s. The pulse is described by the following equations:

$$v_c(t) = \begin{cases} 30t^2 \text{ V}, & 0 \leq t \leq 0.5 \text{ s}; \\ 30(t-1)^2 \text{ V}, & 0.5 \text{ s} \leq t \leq 1 \text{ s}; \\ 0 & \text{elsewhere.} \end{cases}$$

Sketch the current pulse that exists in the capacitor during the 1 s interval.

Section 7.1 RL Circuits

7.1 In the circuit in Fig. P7.1, the voltage and current expressions are

$$v = 160e^{-10t}\ \text{V}, \quad t \geq 0^+;$$

$$i = 6.4e^{-10t}\ \text{A}, \quad t \geq 0.$$

Find

a) R.

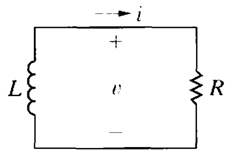
b) τ (in milliseconds).

c) L.

d) the initial energy stored in the inductor.

e) the time (in milliseconds) it takes to dissipate 60% of the initial stored energy.

Figure P7.1



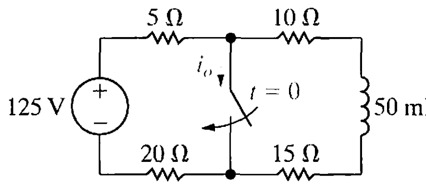
7.3 The switch in the circuit in Fig. P7.3 has been open for a long time. At $t = 0$ the switch is closed.
PSPICE MULTISIM

a) Determine $i_o(0^+)$ and $i_o(\infty)$.

b) Determine $i_o(t)$ for $t \geq 0^+$.

c) How many milliseconds after the switch has been closed will the current in the switch equal 3 A?

Figure P7.3



7.4 The switch in the circuit in Fig. P7.4 has been closed for a long time before opening at $t = 0$.
PSPICE MULTISIM

a) Find $i_1(0^-)$ and $i_2(0^-)$.

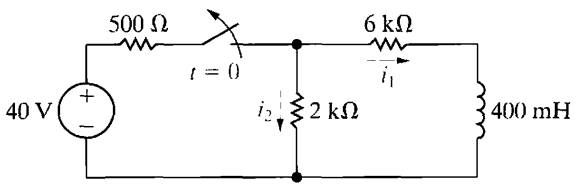
b) Find $i_1(0^+)$ and $i_2(0^+)$.

c) Find $i_1(t)$ for $t \geq 0$.

d) Find $i_2(t)$ for $t \geq 0^+$.

e) Explain why $i_2(0^-) \neq i_2(0^+)$.

Figure P7.4



Section 7.2 RC Circuits

7.21 In the circuit in Fig. P7.21 the voltage and current expressions are

$$v = 72e^{-500t}\ \text{V}, \quad t \geq 0;$$

$$i = 9e^{-500t}\ \text{mA}, \quad t \geq 0^+.$$

Find

a) R.

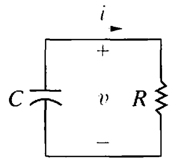
b) C.

c) τ (in milliseconds).

d) the initial energy stored in the capacitor.

e) how many microseconds it takes to dissipate 68% of the initial energy stored in the capacitor.

Figure P7.21



7.23 The switch in the circuit in Fig. P7.23 has been in position a for a long time and $v_2 = 0$ V. At $t = 0$, the switch is thrown to position b. Calculate

a) i, v_1, and v_2 for $t \geq 0^+$.

b) the energy stored in the capacitor at $t = 0$.

c) the energy trapped in the circuit and the total energy dissipated in the 25 kΩ resistor if the switch remains in position b indefinitely.

Figure P7.23