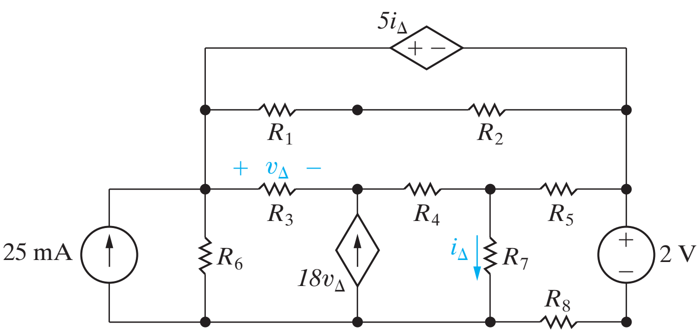
Problems

Section 4.1

4.1 For the circuit shown in Fig. P4.1, state the numerical value of the number of (a) branches, (b) branches where the current is unknown, (c) essential branches, (d) essential branches where the current is unknown, (e) nodes, (f) essential nodes, and (g) meshes.

Figure P4.1



4.2 a) If only the essential nodes and branches are identified in the circuit in Fig. P4.1, how many simultaneous equations are needed to describe the circuit?

b) How many of these equations can be derived using Kirchhoff's current law?

c) How many must be derived using Kirchhoff's voltage law?

d) What two meshes should be avoided in applying the voltage law?

4.3 Assume the voltage v_s in the circuit in Fig. P4.3 is known. The resistors $R_1 - R_7$ are also known.

a) How many unknown currents are there?

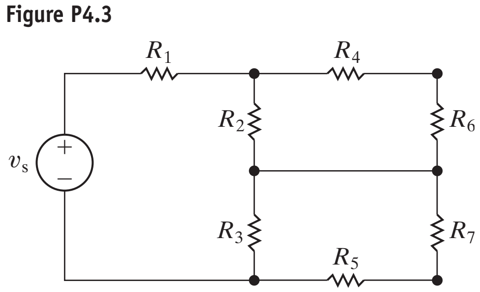
b) How many independent equations can be written using Kirchhoff's current law (KCL)?

c) Write an independent set of KCL equations.

d) How many independent equations can be derived from Kirchhoff's voltage law (KVL)?

e) Write a set of independent KVL equations.

Figure P4.3



4.4 A current leaving a node is defined as positive.

a) Sum the currents at each node in the circuit shown in Fig. P4.3.

b) Show that any one of the equations in (a) can be derived from the remaining three equations.

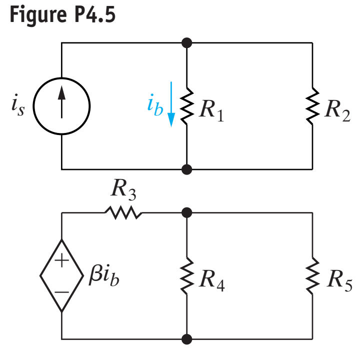
4.5 a) How many separate parts does the circuit in Fig. P4.5 have?

b) How many nodes?

c) How many branches are there?

d) Assume that the lower node in each part of the circuit is joined by a single conductor. Repeat the calculations in (a)–(c).

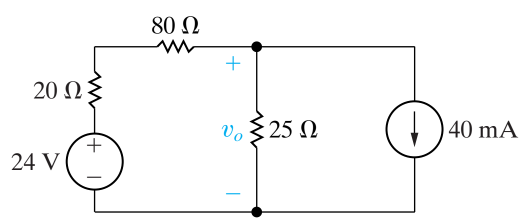
Figure P4.5



Section 4.2

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

Figure P4.6



4.7 a) Find the power developed by the 40 mA current source in the circuit in Fig. P4.6.
PSPICE MULTISIM

b) Find the power developed by the 24 V voltage source in the circuit in Fig. P4.6.

c) Verify that the total power developed equals the total power dissipated.

4.8 A 50 Ω resistor is connected in series with the 40 mA current source in the circuit in Fig. P4.6.
PSPICE MULTISIM

a) Find v_o.

b) Find the power developed by the 40 mA current source.

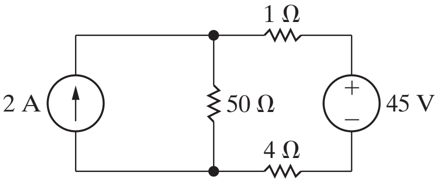
c) Find the power developed by the 24 V voltage source.

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?

4.9 PSPICE MULTISIM Use the node-voltage method to find how much power the 2 A source extracts from the circuit in Fig. P4.9.

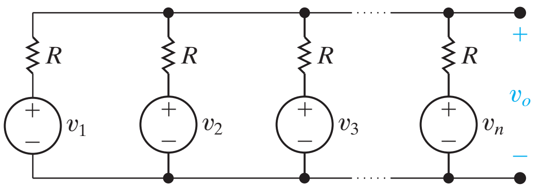
Figure P4.9



4.10 PSPICE MULTISIM a) Use the node-voltage method to show that the output voltage v_o in the circuit in Fig. P4.10 is equal to the average value of the source voltages.

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

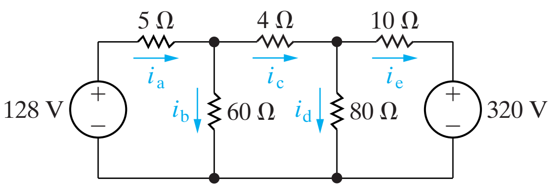
Figure P4.10



4.11 PSPICE MULTISIM a) Use the node-voltage method to find the branch currents $i_a - i_e$ in the circuit shown in Fig. P4.11.

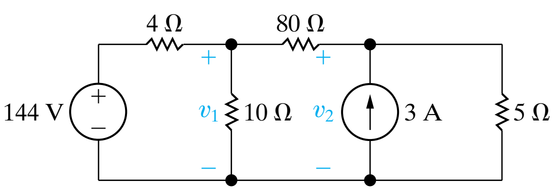
b) Find the total power developed in the circuit.

Figure P4.11



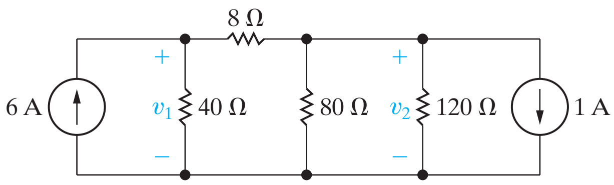
4.12 PSPICE MULTISIM Use the node-voltage method to find v_1 and v_2 in the circuit in Fig. P4.12.

Figure P4.12



4.13 PSPICE MULTISIM Use the node-voltage method to find v_1 and v_2 in the circuit shown in Fig. P4.13.

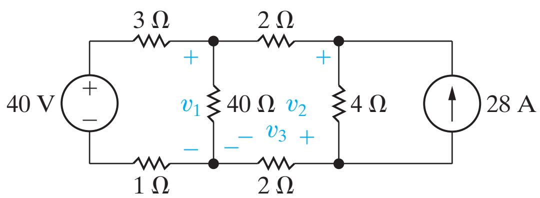
Figure P4.13



4.14 PSPICE MULTISIM a) Use the node-voltage method to find v_1, v_2, and v_3 in the circuit in Fig. P4.14.

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

Figure P4.14

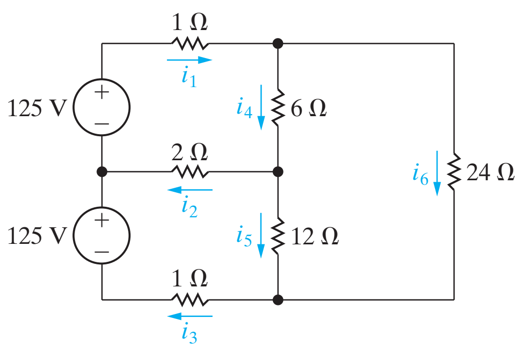


4.15 PSPICE MULTISIM The circuit shown in Fig. P4.15 is a dc model of a residential power distribution circuit.

a) Use the node-voltage method to find the branch currents $i_1 - i_6$.

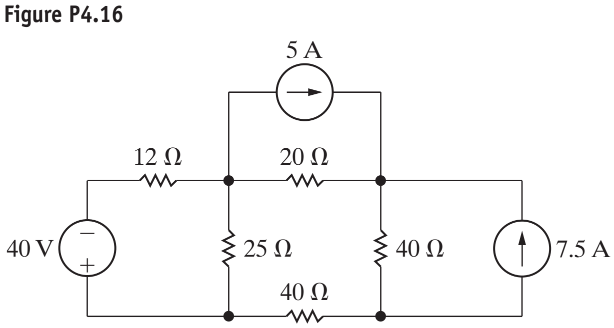
b) Test your solution for the branch currents by showing that the total power dissipated equals the total power developed.

Figure P4.15



4.16 PSPICE MULTISIM Use the node-voltage method to find the total power dissipated in the circuit in Fig. P4.16.

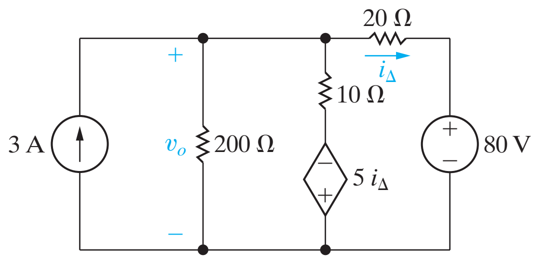
Figure P4.16



Section 4.3

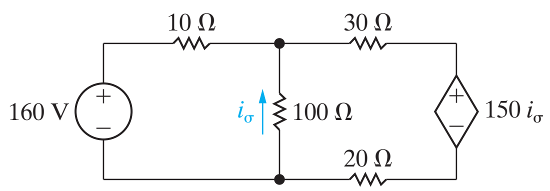
4.17 PSPICE MULTISIM
a) Use the node-voltage method to find v_o in the circuit in Fig. P4.17.
b) Find the power absorbed by the dependent source.
c) Find the total power developed by the independent sources.

Figure P4.17



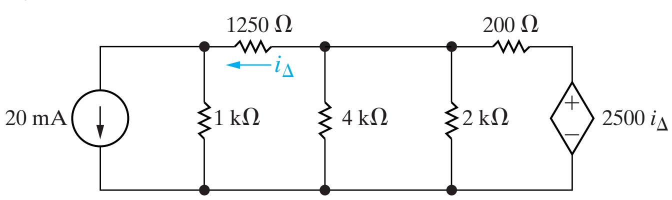
4.18 PSPICE MULTISIM
Use the node-voltage method to calculate the power delivered by the dependent voltage source in the circuit in Fig. P4.18.

Figure P4.18



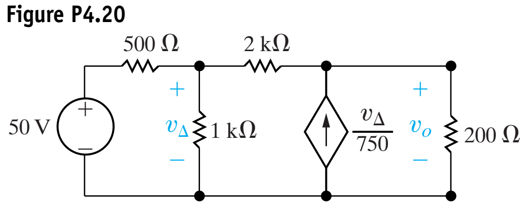
4.19 PSPICE MULTISIM
a) Use the node-voltage method to find the total power developed in the circuit in Fig. P4.19.
b) Check your answer by finding the total power absorbed in the circuit.

Figure P4.19



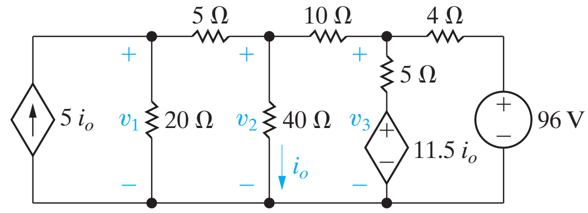
4.20
a) Use the node voltage method to find v_o for the circuit in Fig. P4.20.
b) Find the total power supplied in the circuit.

Figure P4.20



4.21 PSPICE MULTISIM
a) Find the node voltages v_1, v_2, and v_3 in the circuit in Fig. P4.21.
b) Find the total power dissipated in the circuit.

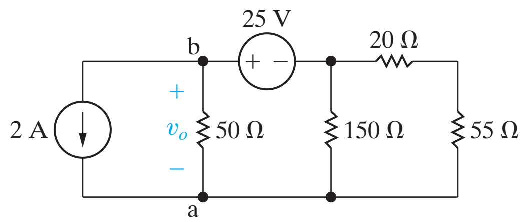
Figure P4.21



Section 4.4

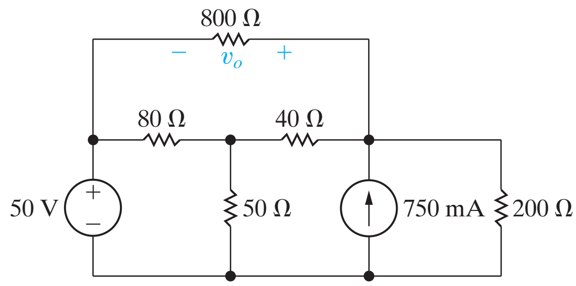
4.22 PSPICE MULTISIM
a) Use the node-voltage method to find v_o and the power delivered by the 2 A current source in the circuit in Fig. P4.22. Use node a as the reference node.
b) Repeat part (a), but use node b as the reference node.
c) Compare the choice of reference node in (a) and (b). Which is better, and why?

Figure P4.22



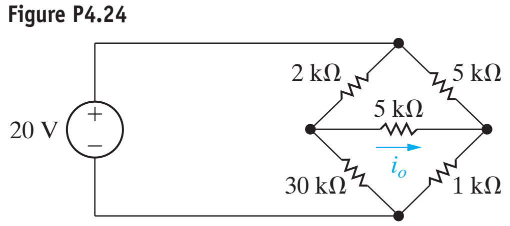
4.23 PSPICE MULTISIM
Use the node-voltage method to find the value of v_o in the circuit in Fig. P4.23.

Figure P4.23



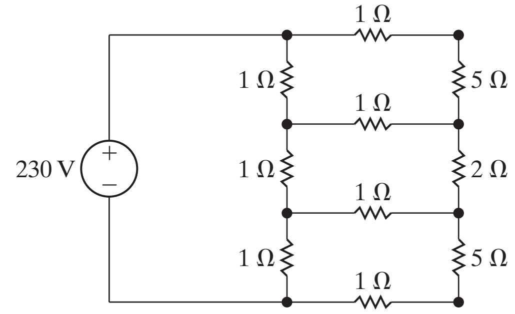
4.24 PSPICE MULTISIM
Use the node-voltage method to find i_o in the circuit in Fig. P4.24.

Figure P4.24



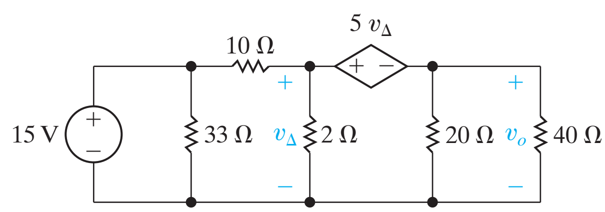
4.25
a) Use the node-voltage method to find the power dissipated in the 2 Ω resistor in the circuit in Fig. P4.25.
b) Find the power supplied by the 230 V source.

Figure P4.25



4.26 Use the node-voltage method to find v_o in the circuit in Fig. P4.26.
PSPICE MULTISIM

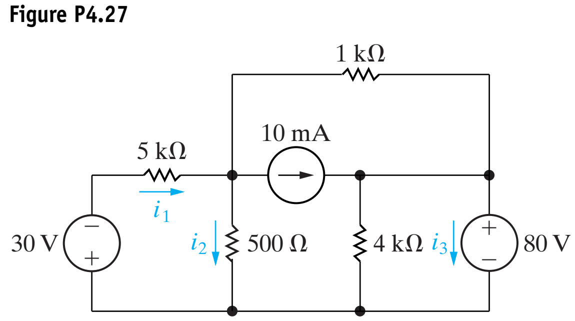
Figure P4.26



4.27 a) Use the node-voltage method to find the branch currents i_1, i_2, and i_3 in the circuit in Fig. P4.27.
PSPICE MULTISIM

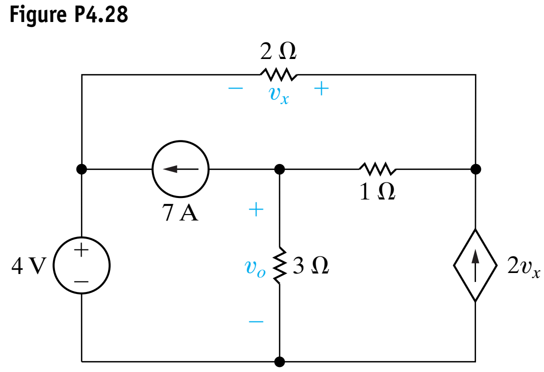
b) Check your solution for i_1, i_2, and i_3 by showing that the power dissipated in the circuit equals the power developed.

Figure P4.27



4.28 Use the node-voltage method to find the value of v_o in the circuit in Fig. P4.28.
PSPICE MULTISIM

Figure P4.28



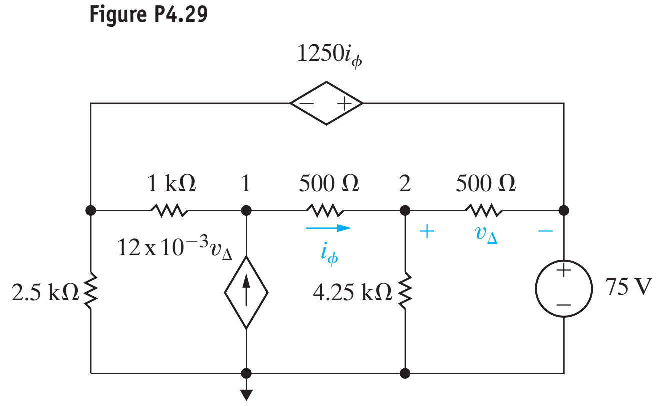
4.29 Assume you are a project engineer and one of your staff is assigned to analyze the circuit shown in Fig. P4.29. The reference node and node numbers given on the figure were assigned by the analyst. Her solution gives the values of v_1 and v_2 as 105 V and 85 V, respectively.

a) What values did the analyst use for the left-most and right-most node voltages when writing KCL equations at nodes 1 and 2?

b) Use the values supplied by the analyst to calculate the total power developed in the circuit and the total power dissipated in the circuit.

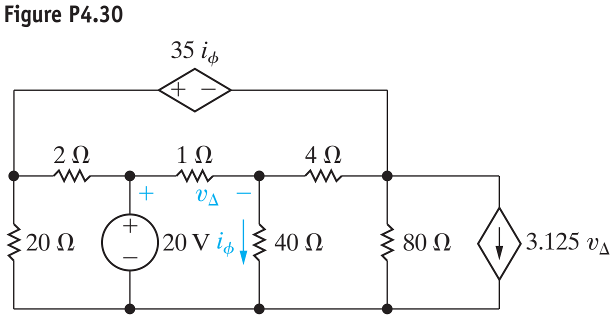
c) Do you agree with the solution submitted by the analyst?

Figure P4.29



4.30 Use the node-voltage method to find the power developed by the 20 V source in the circuit in Fig. P4.30.
PSPICE MULTISIM

Figure P4.30

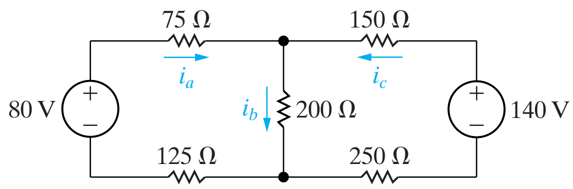


4.31 Show that when Eqs. 4.16, 4.17, and 4.19 are solved for i_B, the result is identical to Eq. 2.25.

4.32 a) Use the mesh-current method to find the branch currents i_a, i_b, and i_c in the circuit in Fig. P4.32.
PSPICE MULTISIM

b) Repeat (a) if the polarity of the 140 V source is reversed.

Figure P4.32



Section 4.5

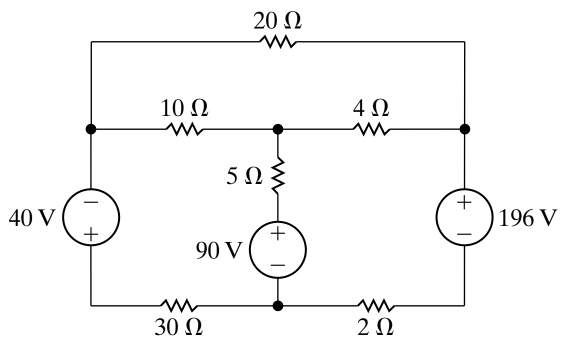
4.33 Solve Problem 4.11 using the mesh-current method.

4.34 Solve Problem 4.15 using the mesh-current method.

4.35 Solve Problem 4.24 using the mesh-current method.

4.36 PSPICE MULTISIM
a) Use the mesh-current method to find the total power developed in the circuit in Fig. P4.36.
b) Check your answer by showing that the total power developed equals the total power dissipated.

Figure P4.36



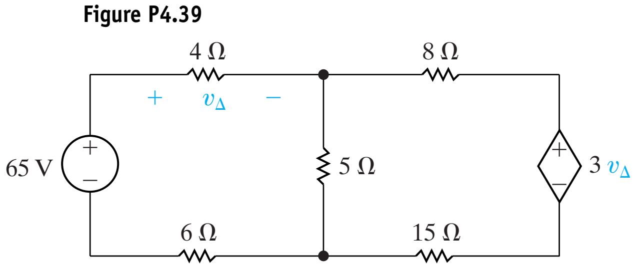
4.37 Solve Problem 4.25 using the mesh-current method.

Section 4.6

4.38 Solve Problem 4.18 using the mesh-current method.

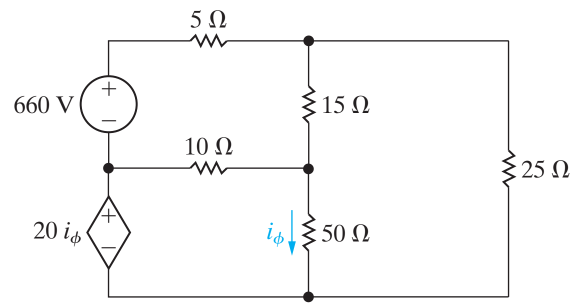
4.39 PSPICE MULTISIM Use the mesh-current method to find the power dissipated in the 15 Ω resistor in the circuit in Fig. P4.39.

Figure P4.39



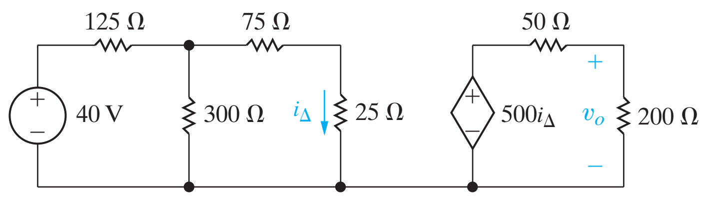
4.40 PSPICE MULTISIM Use the mesh-current method to find the power delivered by the dependent voltage source in the circuit seen in Fig. P4.40.

Figure P4.40



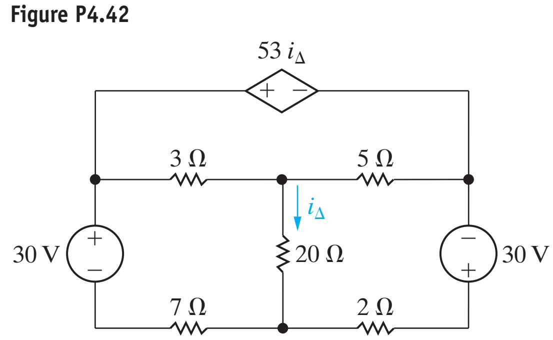
4.41 PSPICE MULTISIM
a) Use the mesh-current method to find v_o in the circuit in Fig. P4.41.
b) Find the power delivered by the dependent source.

Figure P4.41



4.42 PSPICE MULTISIM Use the mesh-current method to find the power developed in the dependent voltage source in the circuit in Fig. P4.42.

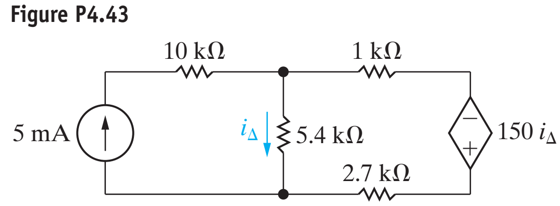
Figure P4.42



Section 4.7

4.43 PSPICE MULTISIM
a) Use the mesh-current method to solve for i_Δ in the circuit in Fig. P4.43.
b) Find the power delivered by the independent current source.
c) Find the power delivered by the dependent voltage source.

Figure P4.43

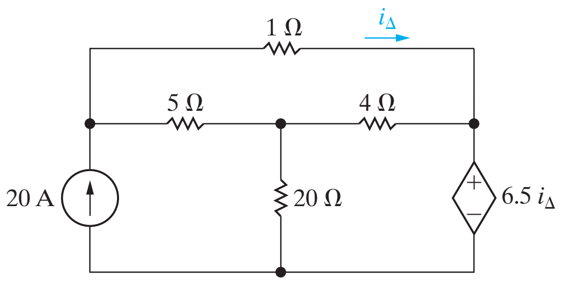


4.44 Solve Problem 4.13 using the mesh-current method.

4.45 Solve Problem 4.21 using the mesh-current method.

4.46 Use the mesh-current method to find the total power developed in the circuit in Fig. P4.46.
PSPICE
MULTISIM

Figure P4.46

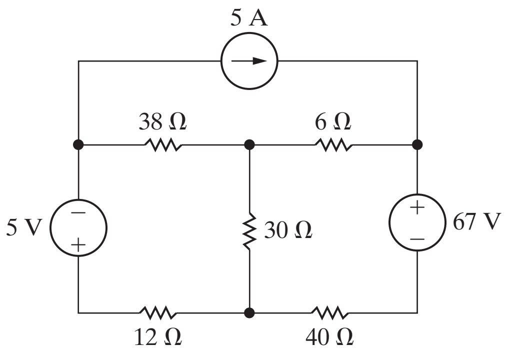


4.47 a) Use the mesh-current method to find how much power the 5 A current source delivers to the circuit in Fig. P4.47.

b) Find the total power delivered to the circuit.

c) Check your calculations by showing that the total power developed in the circuit equals the total power dissipated

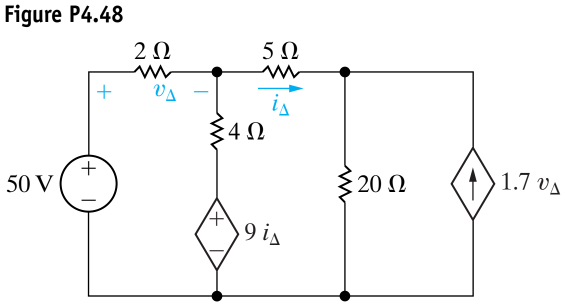
Figure P4.47



4.48 a) Use the mesh-current method to determine which sources in the circuit in Fig. P4.48 are generating power.
PSPICE
MULTISIM

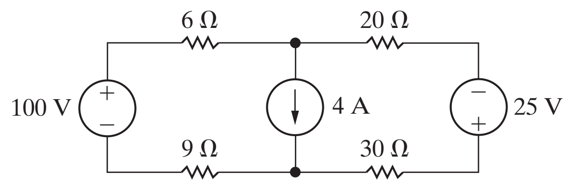
b) Find the total power dissipated in the circuit.

Figure P4.48



4.49 Use the mesh-current method to find the total power dissipated in the circuit in Fig. P4.49.
PSPICE
MULTISIM

Figure P4.49



4.50 a) Assume the 100 V source in the circuit in Fig. P4.49 is changed to 67.5 V. Find the total power dissipated in the circuit.

b) Repeat (a) with the 4 A current source replaced by a short circuit.

c) Explain why the answers to (a) and (b) are the same.

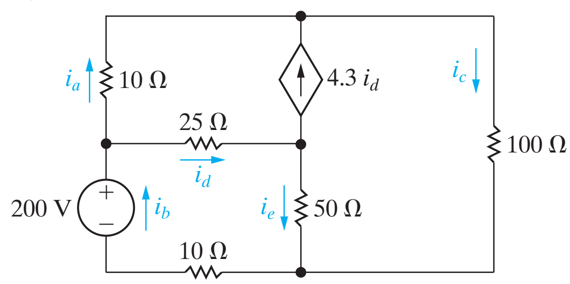
c) Now assume you wish to change the value of the 25 V source, instead of the 100 V source, in the circuit in Fig. P4.49 to get the same power dissipated by the current source that you found in (a) and (b). Use the results in part (c) to calculate the new value of this voltage source.

4.51 Solve Problem 4.27 using the mesh-current method.

4.52 a) Use the mesh-current method to find the branch currents in $i_a - i_e$ in the circuit in Fig. P4.52.
PSPICE
MULTISIM

b) Check your solution by showing that the total power developed in the circuit equals the total power dissipated.

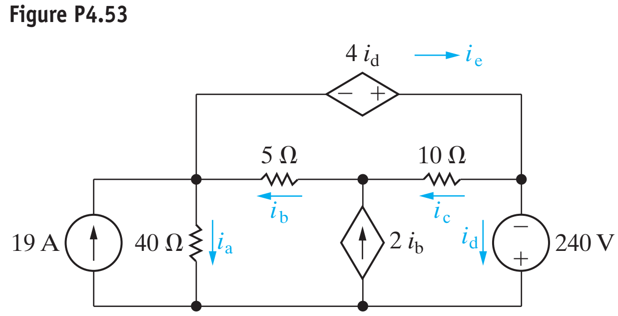
Figure P4.52



4.53 a) Find the branch currents $i_a - i_e$ for the circuit shown in Fig. P4.53.
PSPICE
MULTISIM

b) Check your answers by showing that the total power generated equals the total power dissipated.

Figure P4.53



Section 4.8

4.54 Assume you have been asked to find the power dissipated in the horizontal 1 kΩ resistor in the circuit in Fig. P4.54.
PSPICE
MULTISIM

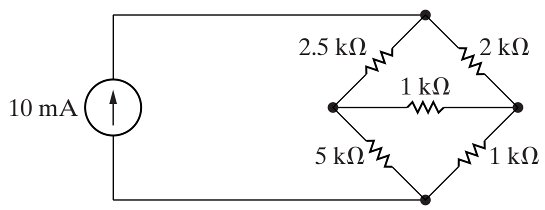
a) Which method of circuit analysis would you recommend? Explain why.

b) Use your recommended method of analysis to find the power dissipated in the horizontal 1 kΩ resistor.

c) Would you change your recommendation if the problem had been to find the power developed by the 10 mA current source? Explain.

d) Find the power delivered by the 10 mA current source.

Figure P4.54



4.55 A 4 kΩ resistor is placed in parallel with the 10 mA current source in the circuit in Fig. P4.54. Assume you have been asked to calculate the power developed by the current source.
PSPICE
MULTISIM

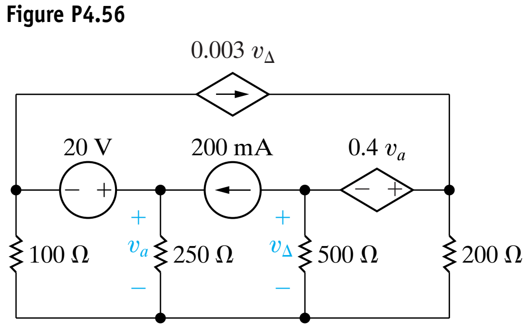
a) Which method of circuit analysis would you recommend? Explain why.

b) Find the power developed by the current source.

4.56 a) Would you use the node-voltage or mesh-current method to find the power absorbed by the 20 V source in the circuit in Fig. P4.56? Explain your choice.
PSPICE
MULTISIM

b) Use the method you selected in (a) to find the power.

Figure P4.56

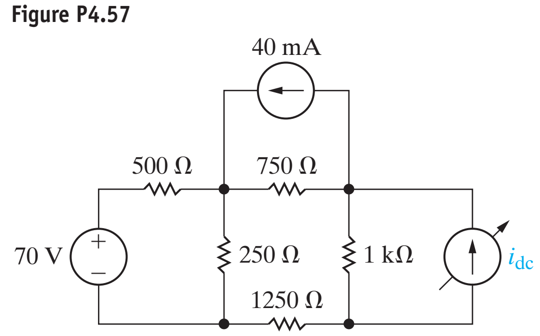


4.57 The variable dc current source in the circuit in Fig. P4.57 is adjusted so that the power developed by the 40 mA current source is zero. You want to find the value of i_{dc}.
PSPICE
MULTISIM

a) Would you use the node-voltage or mesh-current method to find i_{dc}? Explain your choice.

b) Use the method selected in (a) to find i_{dc}.

Figure P4.57



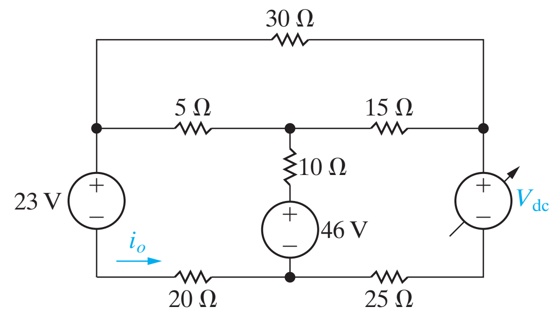
4.58 The variable dc voltage source in the circuit in Fig. P4.58 is adjusted so that i_o is zero.
PSPICE
MULTISIM

a) Would you use the node-voltage or mesh-current method to find V_{dc}? Explain your choice.

b) Find the value of V_{dc}, using the method selected in (a).

c) Check your solution by showing the power developed equals the power dissipated.

Figure P4.58

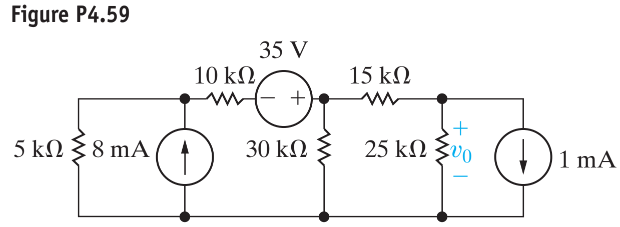


Section 4.9

4.59 a) Make a series of source transformations to find the voltage v_0 in the circuit in Fig. P4.59.

b) Verify your solution using the mesh-current method.

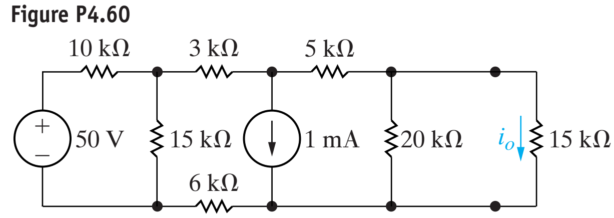
Figure P4.59



4.60 a) Find the current i_o in the circuit in Fig. P4.60 by making a succession of appropriate source transformations.
PSPICE
MULTISIM

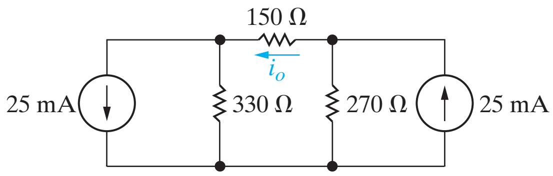
b) Using the result obtained in (a), work back through the circuit to find the power developed by the 50 V source.

Figure P4.60



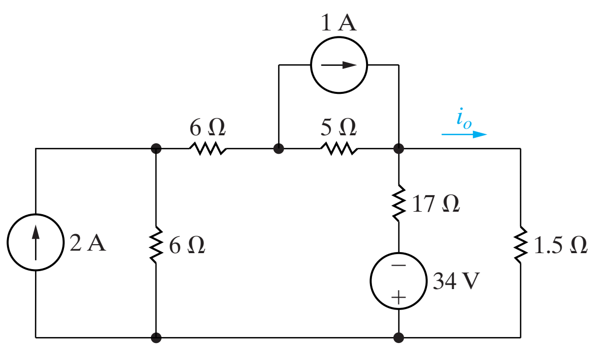
4.61 PSPICE MULTISIM
a) Use source transformations to find the current i_o in the circuit in Fig. P4.61.
b) Verify your solution by using the node-voltage method to find i_o.

Figure P4.61



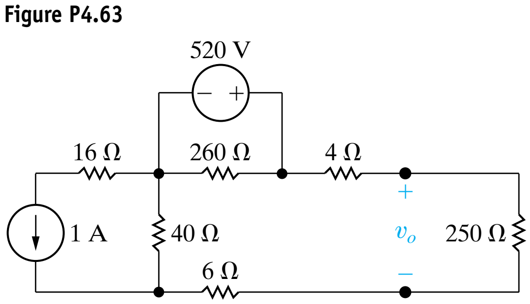
4.62 PSPICE MULTISIM
a) Use a series of source transformations to find i_o in the circuit in Fig. P4.62.
b) Verify your solution by using the mesh-current method to find i_o.

Figure P4.62



4.63 PSPICE MULTISIM
a) Use source transformations to find v_o in the circuit in Fig. P4.63.
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.

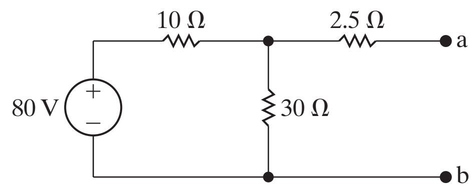
Figure P4.63



Section 4.10

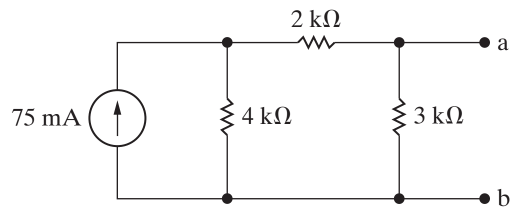
4.64 PSPICE MULTISIM Find the Thévenin equivalent with respect to the terminals a,b for the circuit in Fig. P4.64.

Figure P4.64



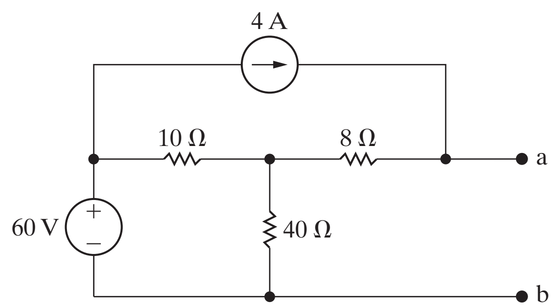
4.65 Find the Norton equivalent with respect to the terminals a,b for the circuit in Fig. P4.65.

Figure P4.65



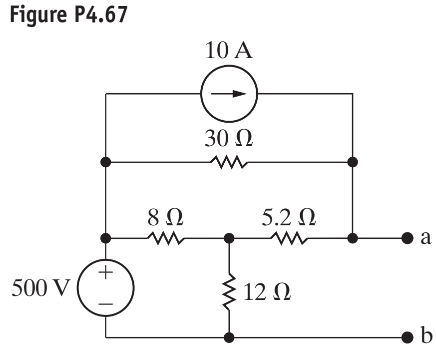
4.66 PSPICE MULTISIM Find the Norton equivalent with respect to the terminals a,b for the circuit in Fig. P4.66.

Figure P4.66



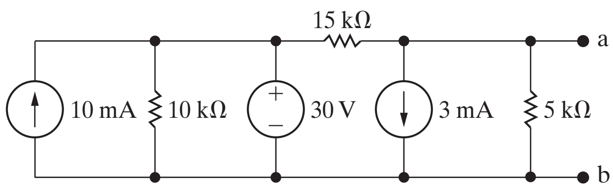
4.67 PSPICE MULTISIM Find the Thévenin equivalent with respect to the terminals a,b for the circuit in Fig. P4.67.

Figure P4.67



4.68 PSPICE MULTISIM Find the Norton equivalent with respect to the terminals a,b in the circuit in Fig. P4.68.

Figure P4.68



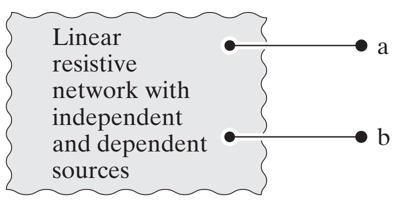
4.69 A Thévenin equivalent can also be determined from measurements made at the pair of terminals of interest. Assume the following measurements were made at the terminals a,b in the circuit in Fig. P4.69.

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.

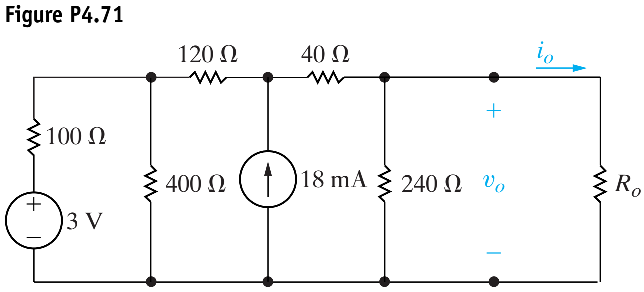
Figure P4.69



4.70 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?

4.71 PSPICE MULTISIM Determine i_o and v_o in the circuit shown in Fig. P4.71 when R_o is a resistor from Appendix H such that $100\ \Omega \leq R_o < 200\ \Omega$.

Figure P4.71

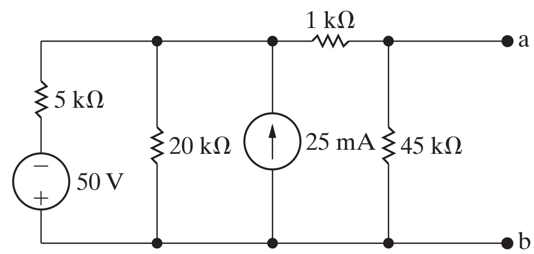


4.72 PSPICE MULTISIM A voltmeter with a resistance of 85.5 kΩ is used to measure the voltage v_{ab} in the circuit in Fig. P4.72.

a) What is the voltmeter reading?

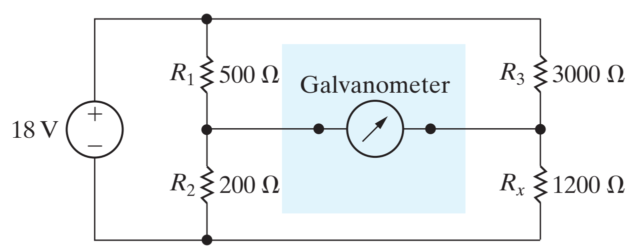
b) What is the percentage of error in the voltmeter reading if the percentage of error is defined as [(measured − actual)/actual] × 100?

Figure P4.72



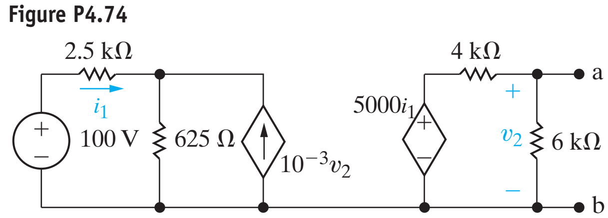
4.73 PSPICE MULTISIM The Wheatstone bridge in the circuit shown in Fig. P4.73 is balanced when R_3 equals 3000 Ω. If the galvanometer has a resistance of 50 Ω, how much current will the galvanometer detect, when the bridge is unbalanced by setting R_3 to 3003 Ω? (*Hint:* Find the Thévenin equivalent with respect to the galvanometer terminals when R_3 = 3003 Ω. Note that once we have found this Thévenin equivalent, it is easy to find the amount of unbalanced current in the galvanometer branch for different galvanometer movements.)

Figure P4.73



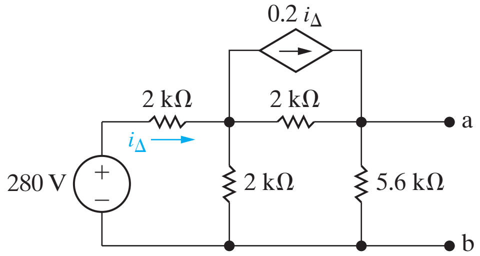
4.74 PSPICE MULTISIM Determine the Thévenin equivalent with respect to the terminals a,b for the circuit shown in Fig. P4.74.

Figure P4.74



4.75 Find the Norton equivalent with respect to the terminals a,b for the circuit seen in Fig. P4.75.
PSPICE MULTISIM

Figure P4.75

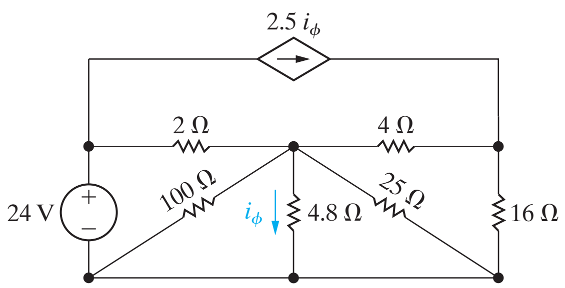


4.76 When an ammeter is used to measure the current i_ϕ in the circuit shown in Fig. P4.76, it reads 6 A.
PSPICE MULTISIM

a) What is the resistance of the ammeter?

b) What is the percentage of error in the current measurement?

Figure P4.76



Section 4.11

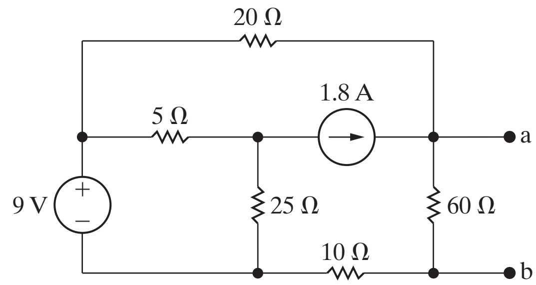
4.77 a) Find the Thévenin equivalent resistance with respect to the terminals a,b in the circuit in Fig. P4.64 without finding either the open circuit voltage or the short circuit current.

b) Find the Norton equivalent resistance with respect to the terminals a,b in the circuit in Fig. P4.66 without finding either the open circuit voltage or the short circuit current.

4.78 a) Find the Thévenin equivalent with respect to the terminals a,b for the circuit in Fig. P4.78 by finding the open-circuit voltage and the short-circuit current.
PSPICE MULTISIM

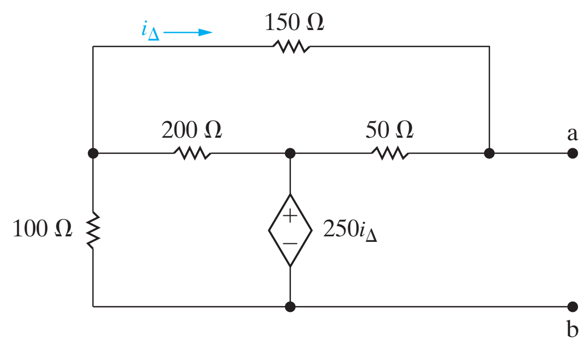
b) Solve for the Thévenin resistance by removing the independent sources. Compare your result to the Thévenin resistance found in (a).

Figure P4.78



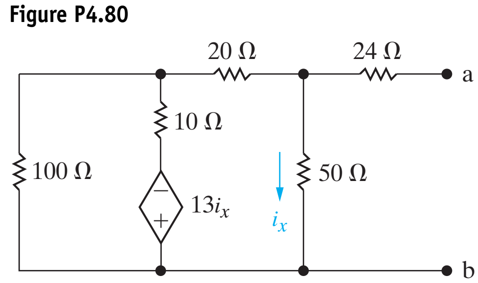
4.79 Find the Thévenin equivalent with respect to the terminals a,b in the circuit in Fig. P4.79.

Figure P4.79



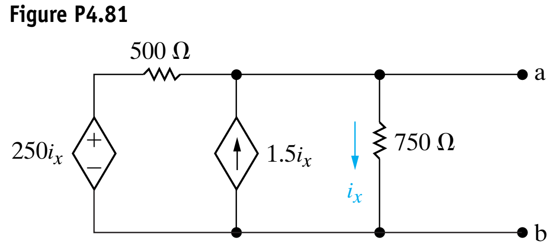
4.80 Find the Thévenin equivalent with respect to the terminals a,b in the circuit in Fig. P4.80.

Figure P4.80



4.81 Find the Norton equivalent with respect to the terminals a,b for the circuit seen in Fig. P4.81.

Figure P4.81



Section 4.12

4.82 The variable resistor in the circuit in Fig. P4.82 is adjusted for maximum power transfer to R_o.

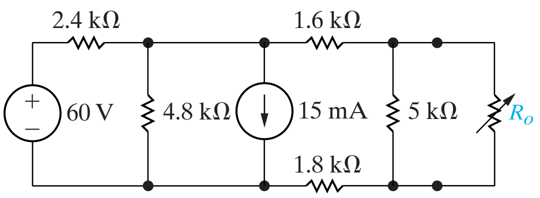
PSPICE MULTISIM

a) Find the value of R_o.

b) Find the maximum power that can be delivered to R_o.

c) Find a resistor in Appendix H closest to the value in part (a). How much power is delivered to this resistor?

Figure P4.82



4.83 What percentage of the total power developed in the circuit in Fig. P4.82 is delivered to R_o when R_o is set for maximum power transfer?

PSPICE MULTISIM

4.84 a) Calculate the power delivered for each value of R_o used in Problem 4.71.

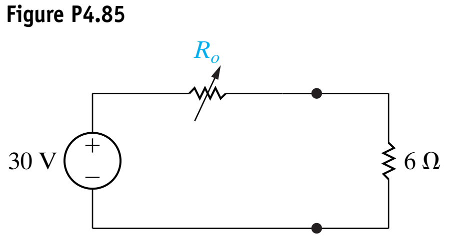
b) Plot the power delivered to R_o versus the resistance R_o.

c) At what value of R_o is the power delivered to R_o a maximum?

4.85 a) Find the value of the variable resistor R_o in the circuit in Fig. P4.85 that will result in maximum power dissipation in the 6 Ω resistor. (*Hint:* Hasty conclusions could be hazardous to your career.)

b) What is the maximum power that can be delivered to the 6 Ω resistor?

Figure P4.85



4.86 A variable resistor R_o is connected across the terminals a,b in the circuit in Fig. P4.75. The variable resistor is adjusted until maximum power is transferred to R_o.

PSPICE MULTISIM

a) Find the value of R_o.

b) Find the maximum power delivered to R_o.

c) Find the percentage of the total power developed in the circuit that is delivered to R_o.

d) Find the resistor from Appendix H closest in value to the R_o. from part (a).

e) Find the percentage of the total power developed in the circuit that is delivered to the resistor in part (d).

4.87 The variable resistor (R_o) in the circuit in Fig. P4.87 is adjusted until it absorbs maximum power from the circuit.

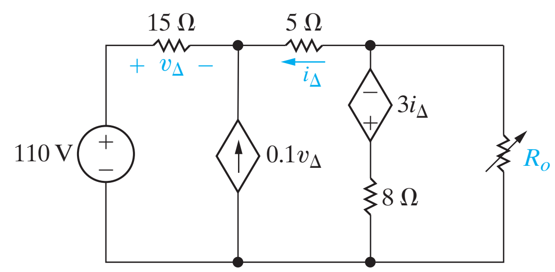
PSPICE MULTISIM

a) Find the value of R_o.

b) Find the maximum power.

c) Find the percentage of the total power developed in the circuit that is delivered to R_o.

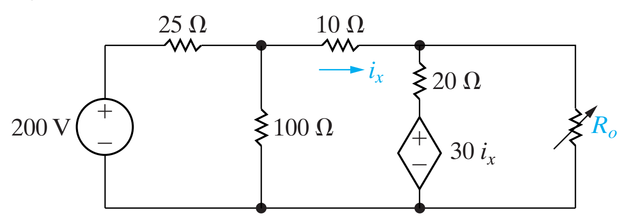
Figure P4.87



4.88 The variable resistor (R_o) in the circuit in Fig. P4.88 is adjusted until the power dissipated in the resistor is 250 W. Find the values of R_o that satisfy this condition.

PSPICE MULTISIM

Figure P4.88



4.89 The variable resistor in the circuit in Fig. P4.89 is adjusted for maximum power transfer to R_o.

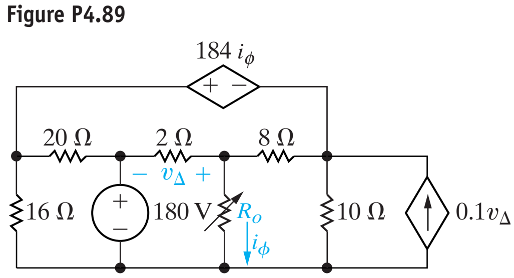
PSPICE MULTISIM

a) Find the numerical value of R_o.

b) Find the maximum power delivered to R_o.

c) How much power does the 180 V source deliver to the circuit when R_o is adjusted to the value found in (a)?

Figure P4.89



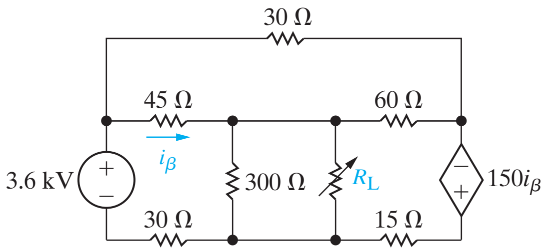
4.90 The variable resistor (R_L) in the circuit in Fig. P4.90 is adjusted for maximum power transfer to R_L.

PSPICE
MULTISIM

a) Find the numerical value of R_L.

b) Find the maximum power transferred to R_L.

Figure P4.90



4.91 The variable resistor (R_o) in the circuit in Fig. P4.91 is adjusted for maximum power transfer to R_o.

PSPICE
MULTISIM

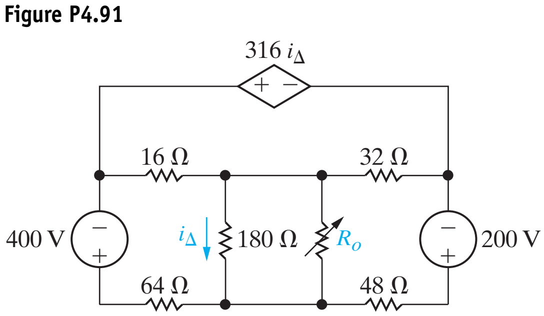
a) Find the value of R_o.

b) Find the maximum power that can be delivered to R_o.

c) What percentage of the total power developed in the circuit is delivered to R_o found in part(a)?

d) If R_o is selected from Appendix H, which resistor value will result in the greatest amount of power delivered to R_o?

Figure P4.91



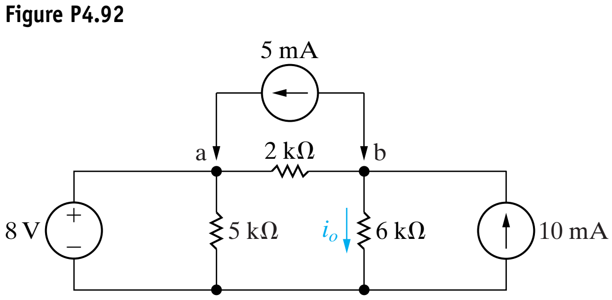
Section 4.13

4.92 a) In the circuit in Fig. P4.92, 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.

PSPICE
MULTISIM

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

Figure P4.92

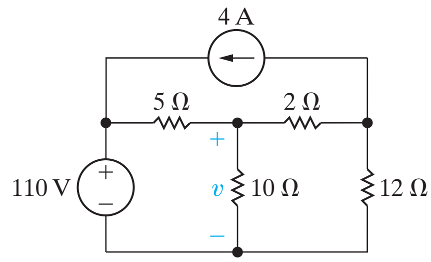


4.93 a) Use the principle of superposition to find the voltage v in the circuit of Fig. P4.93.

PSPICE
MULTISIM

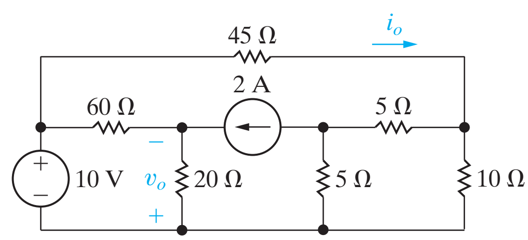
b) Find the power dissipated in the 10 Ω resistor.

Figure P4.93



4.94 Use superposition to solve for i_o and v_o in the circuit in Fig. P4.94.

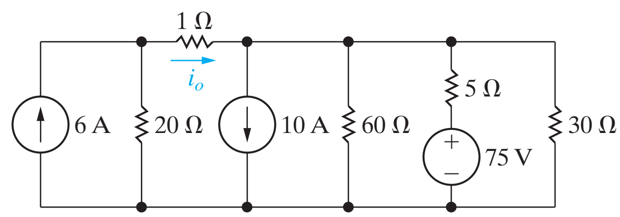
Figure P4.94



4.95 Use the principle of superposition to find the current i_o in the circuit shown in Fig. P4.95.

PSPICE
MULTISIM

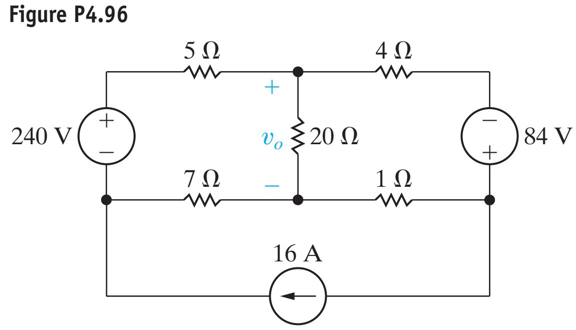
Figure P4.95



4.96 Use the principle of superposition to find the voltage v_o in the circuit in Fig. P4.96.

PSPICE
MULTISIM

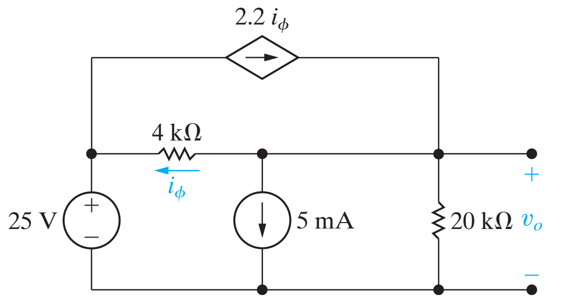
Figure P4.96



4.97 Use the principle of superposition to find v_o in the circuit in Fig. P4.97.

PSPICE
MULTISIM

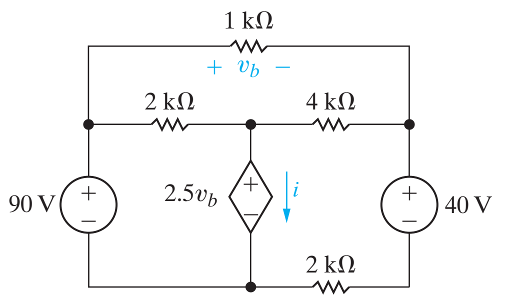
Figure P4.97



4.98 Use the principle of superposition to find the current i in the circuit of Fig. P4.98.

PSPICE
MULTISIM

Figure P4.98



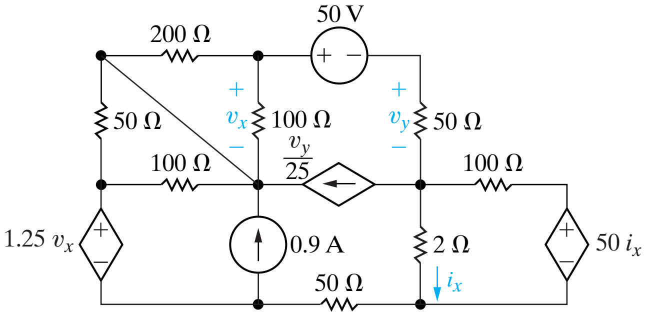
Sections 4.1–4.13

4.99 Assume your supervisor has asked you to determine the power developed by the 50 V source in the circuit in Fig. P4.99. Before calculating the power developed by the 50 V source, the supervisor asks you to submit a proposal describing how you plan to attack the problem. Furthermore, he asks you to explain why you have chosen your proposed method of solution.

a) Describe your plan of attack, explaining your reasoning.

b) Use the method you have outlined in (a) to find the power developed by the 50 V source.

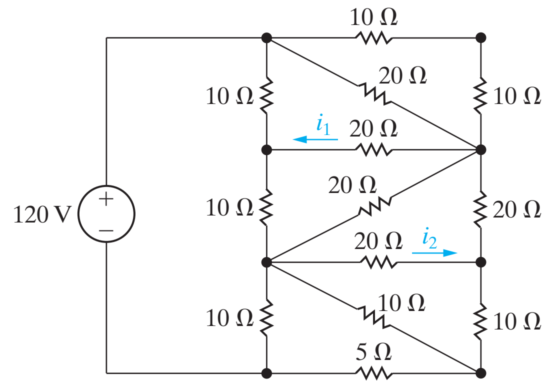
Figure P4.99



4.100 Find i_1 and i_2 in the circuit in Fig. P4.100.

PSPICE
MULTISIM

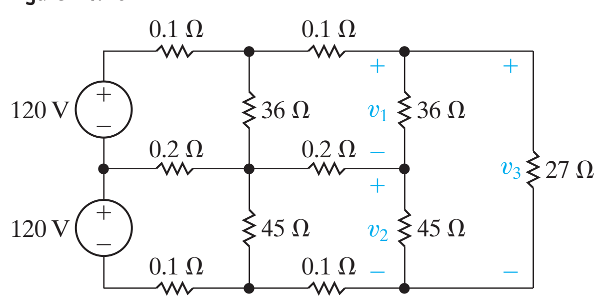
Figure P4.100



4.101 Find v_1, v_2, and v_3 in the circuit in Fig. P4.101.

PSPICE
MULTISIM

Figure P4.101



4.102 Two ideal dc voltage sources are connected by electrical conductors that have a resistance of r Ω/m, as shown in Fig. P4.102. A load having a resistance of R Ω moves between the two voltage sources. Let x equal the distance between the load and the source v_1, and let L equal the distance between the sources.

a) Show that

$$v = \frac{v_1 RL + R(v_2 - v_1)x}{RL + 2rLx - 2rx^2}.$$

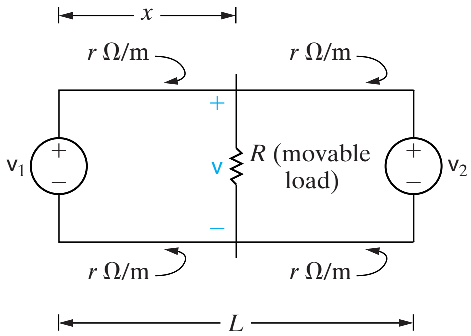
b) Show that the voltage v will be minimum when

$$x = \frac{L}{v_2 - v_1}\left[-v_1 \pm \sqrt{v_1 v_2 - \frac{R}{2rL}(v_1 - v_2)^2}\right].$$

c) Find x when $L = 16$ km, $v_1 = 1000$ V, $v_2 = 1200$ V, $R = 3.9$ Ω, and $r = 5 \times 10^{-5}$ Ω/m.

d) What is the minimum value of v for the circuit of part (c)?

Figure P4.102



4.103 PSPICE MULTISIM Laboratory measurements on a dc voltage source yield a terminal voltage of 75 V with no load connected to the source and 60 V when loaded with a 20 Ω resistor.

a) What is the Thévenin equivalent with respect to the terminals of the dc voltage source?

b) Show that the Thévenin resistance of the source is given by the expression

$$R_{\text{Th}} = \left(\frac{v_{\text{Th}}}{v_o} - 1\right)R_{\text{L}},$$

where

$v_{\text{Th}} =$ the Thévenin voltage,

$v_o =$ the terminal voltage corresponding to the load resistance R_{L}.

4.104 DESIGN PROBLEM For the circuit in Fig. 4.69 derive the expressions for the sensitivity of v_1 and v_2 to changes in the source currents I_{g1} and I_{g2}.

4.105 PRACTICAL PERSPECTIVE PSPICE MULTISIM Assume the nominal values for the components in the circuit in Fig. 4.69 are: $R_1 = 25\ \Omega$; $R_2 = 5\ \Omega$; $R_3 = 50\ \Omega$; $R_4 = 75\ \Omega$; $I_{g1} = 12$ A; and $I_{g2} = 16$ A. Predict the values of v_1 and v_2 if I_{g1} decreases to 11 A and all other components stay at their nominal values. Check your predictions using a tool like PSpice or MATLAB.

4.106 PRACTICAL PERSPECTIVE Repeat Problem 4.105 if I_{g2} increases to 17 A, and all other components stay at their nominal values. Check your predictions using a tool like PSpice or MATLAB.

4.107 PRACTICAL PERSPECTIVE PSPICE MULTISIM Repeat Problem 4.105 if I_{g1} decreases to 11 A and I_{g2} increases to 17 A. Check your predictions using a tool like PSpice or MATLAB.

4.108 PRACTICAL PERSPECTIVE Use the results given in Table 4.2 to predict the values of v_1 and v_2 if R_1 and R_3 increase to 10% above their nominal values and R_2 and R_4 decrease to 10% below their nominal values. I_{g1} and I_{g2} remain at their nominal values. Compare your predicted values of v_1 and v_2 with their actual values.