Chapter 4

PROBLEMS

Section 4.2 Node Voltage Analysis of Circuits with Current Sources

P 4.2-1 The node voltages in the circuit of Figure P 4.2-1 are $v_1 = -4$ V and $v_2 = 2$ V. Determine i, the current of the current source.
Answer: $i = 1.5$ A

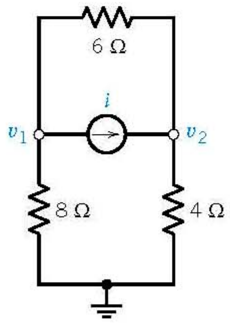

FIGURE P 4.2-1

P 4.2-2 Determine the node voltages for the circuit of Figure P 4.2-2.
Answer: $v_1 = 2$ V, $v_2 = 30$ V, and $v_3 = 24$ V

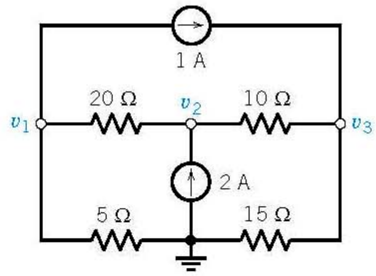

FIGURE P 4.2-2

P 4.2-3 The node voltages in the circuit of Figure P 4.2-3 are $v_1 = 4$ V, $v_2 = 15$ V, and $v_3 = 18$ V. Determine i_1 and i_2, the currents of the current sources.
Answer: $i_1 = -2$ A and $i_2 = 2$ A

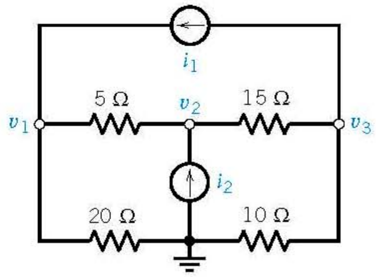

FIGURE P 4.2-3

P 4.2-4 Consider the circuit shown in Figure P 4.2-4. Find values of the resistances R_1 and R_2 that cause the voltages v_1 and v_2 to be $v_1 = 1$ V and $v_2 = 2$ V.

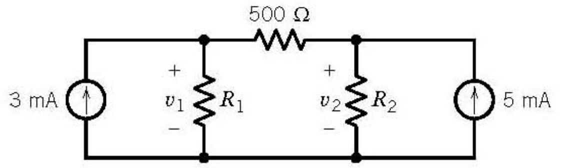

FIGURE P 4.2-4

P 4.2-5 Find the voltage v for the circuit shown in Figure P 4.2-5.
Answer: $v = 21.7$ mV

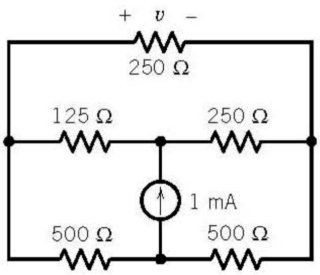

FIGURE P 4.2-5

P4.2-6 Simplify the circuit shown in Figure P 4.2-6 by replacing series and parallel resistors with equivalent resistors; then analyze the simplified circuit by writing and solving node equations. (a) Determine the power supplied by each current source. (b) Determine the power received by the 12-Ω resistor.

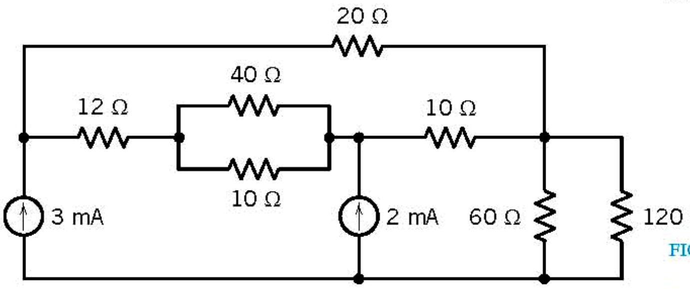

FIGURE P 4.2-6

P4.2-7 The node voltages in the circuit shown in Figure P 4.2-7 are $v_a = 7$ V and $v_b = 10$ V. Determine values of the current source current, i_s, and the resistance, R.

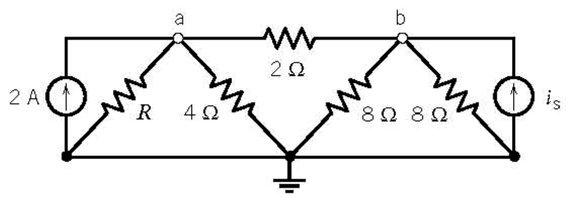

FIGURE P 4.2-7

Section 4.3 Node Voltage Analysis of Circuits with Current and Voltage Sources

P4.3-1 The voltmeter in Figure P 4.3-1 measures v_c, the node voltage at node c. Determine the value of v_c.
Answer: $v_c = 2$ V

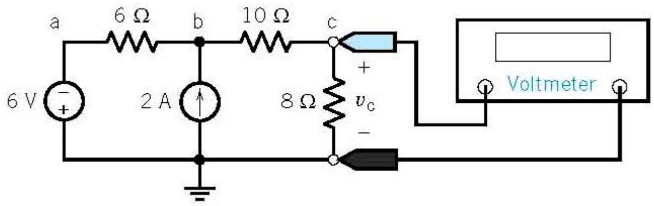

FIGURE P 4.3-1

P4.3-2 The voltages v_a, v_b, v_c, and v_d in Figure P 4.3-2 are the node voltages corresponding to nodes a, b, c, and d. The current i is the current in a short circuit connected between nodes b and c. Determine the values of v_a, v_b, v_c, and v_d and of i.
Answer: $v_a = -12$ V, $v_b = v_c = 4$ V, $v_d = -4$ V, $i = 2$ mA

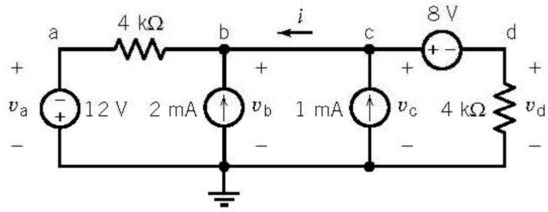

FIGURE P 4.3-2

P4.3-3 Determine the node voltage v_a for the circuit of Figure P 4.3-3.
Answer: $v_a = 7$ V

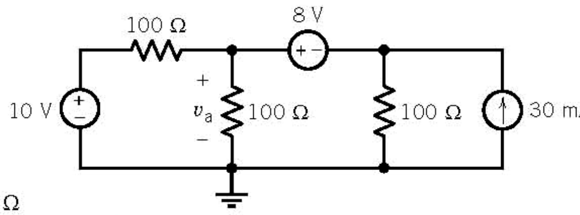

FIGURE P 4.3-3

P4.3-4 Determine the node voltage v_a for the circuit of Figure P 4.3-4.
Answer: $v_a = 4$ V

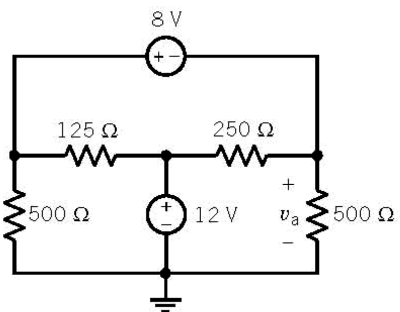

FIGURE P 4.3-4

P 4.3-5 The voltages v_a, v_b, and v_c in Figure P 4.3-5 are the node voltages corresponding to nodes a, b, and c. The values of these voltages are:

$$v_a = 12\text{ V},\ v_b = 9.882\text{ V},\ \text{and}\ v_c = 5.294\text{ V}$$

Determine the power supplied by the voltage source.

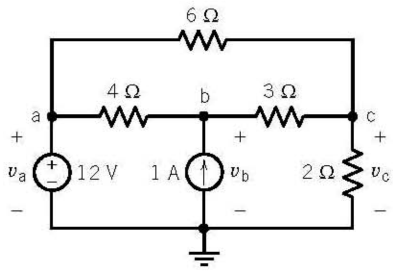

FIGURE P 4.3-5

P4.3-6 The voltmeter in the circuit of Figure P 4.3-6 measures a node voltage. The value of that node voltage depends on the value of the resistance R.

(a) Determine the value of the resistance R that will cause the voltage measured by the voltmeter to be 4 V.

(b) Determine the voltage measured by the voltmeter when $R = 1.2\text{ k}\Omega = 1200\ \Omega$.

Answers: (a) 6 kΩ (b) 2 V

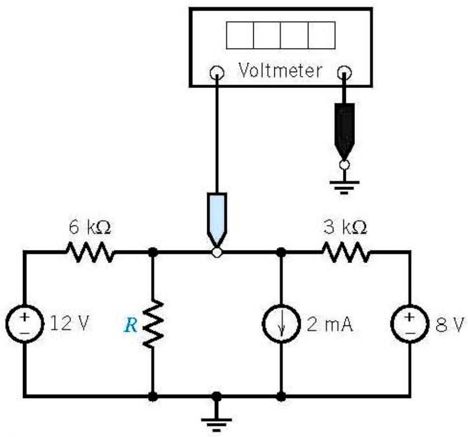

FIGURE P 4.3-6

P 4.3-7 Determine the values of the node voltages, v_1 and v_2, in Figure P 4.3-7. Determine the values of the currents i_a and i_b.

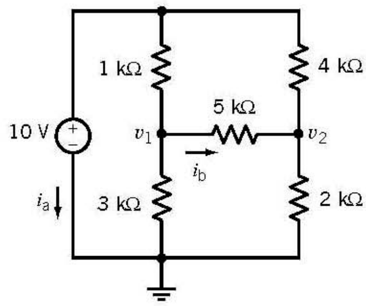

FIGURE P 4.3-7

P 4.3-8 The circuit shown in Figure P 4.3-8 has two inputs, v_1 and v_2, and one output, v_o. The output is related to the input by the equation

$$v_o = av_1 + bv_2$$

where a and b are constants that depend on R_1, R_2 and R_3.

(a) Determine the values of the coefficients a and b when $R_1 = 10\ \Omega$, $R_2 = 40\ \Omega$ and $R_3 = 8\ \Omega$.

(b) Determine the values of the coefficients a and b when $R_1 = R_2$ and $R_3 = R_1 \parallel R_2$.

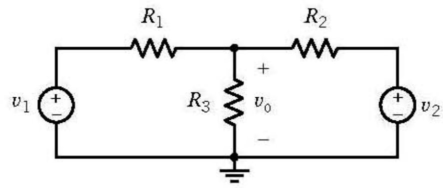

FIGURE P 4.3-8

P 4.3-9 Determine the values of the node voltages of the circuit shown in Figure P 4.3-9.

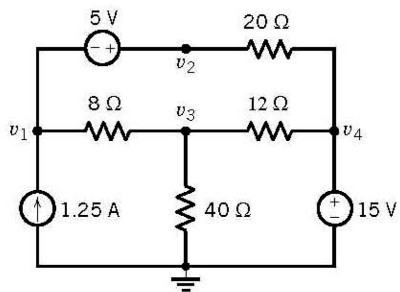

FIGURE P 4.3-9

P 4.3-10 Figure P 4.3-10 shows a measurement made in the laboratory. Your lab partner forgot to record the values of R_1, R_2, and R_3. He thinks that the two resistors were 10-kΩ resistors and the other was a 5-kΩ resistor. Is this possible? Which resistor is the 5-kΩ resistor?

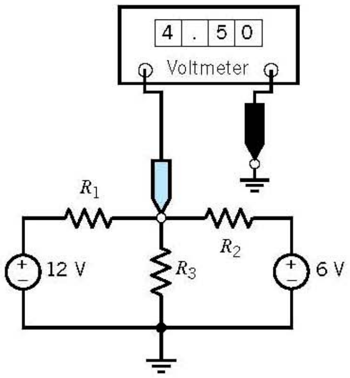

FIGURE P 4.3-10

***P 4.3-11** Determine the values of the node voltages of the circuit shown in Figure P 4.3-11.

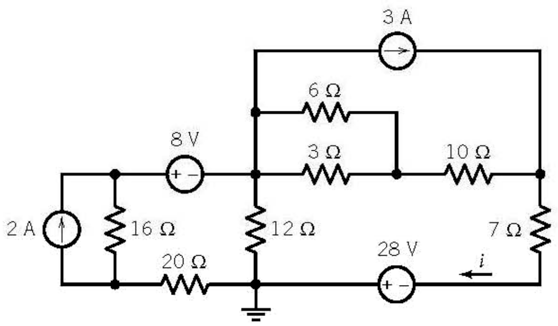

FIGURE P 4.3-11

P 4.3-12 Determine the values of the node voltages of the circuit shown in Figure P 4.3-12.

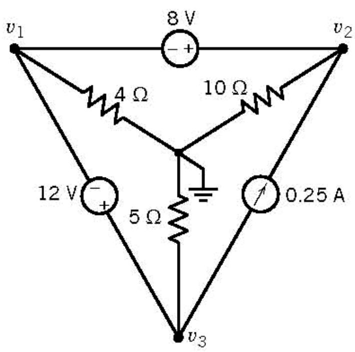

FIGURE P 4.3-12

Section 4.4 Node Voltage Analysis with Dependent Sources

P 4.4-1 The voltages v_a, v_b, and v_c in Figure P 4.4-1 are the node voltages corresponding to nodes a, b, and c. The values of these voltages are:

$$v_a = 8.667 \text{ V}, \ v_b = 2 \text{ V}, \text{ and } v_c = 10 \text{ V}$$

Determine the value of A, the gain of the dependent source.

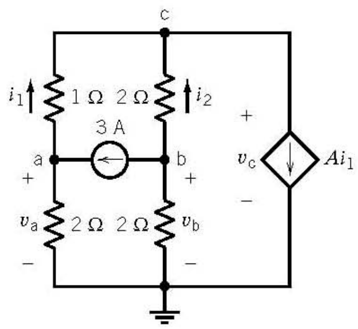

FIGURE P 4.4-1

P 4.4-2 Find i_b for the circuit shown in Figure P 4.4-2.
Answer: $i_b = -12$ mA

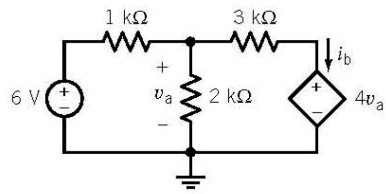

FIGURE P 4.4-2

P 4.4-3 Determine the node voltage v_b for the circuit of Figure P 4.4-3.
Answer: $v_b = 1.5$ V

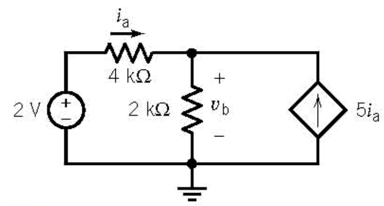

FIGURE P 4.4-3

P 4.4-4 The circled numbers in Figure P 4.4-4 are node numbers. The node voltages of this circuit are $v_1 = 10$ V, $v_2 = 14$ V, and $v_3 = 12$ V.

(a) Determine the value of the current i_b.
(b) Determine the value of r, the gain of the CCVS.

Answers: (a) -2 A (b) 4 V/A

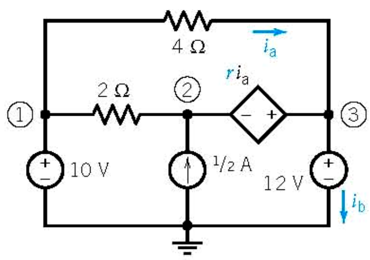

FIGURE P 4.4-4

P 4.4-5 Determine the value of the current i_x in the circuit of Figure P 4.4-5.

Answer: $i_x = 2.4$ A

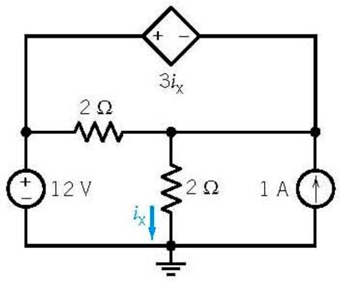

FIGURE P 4.4-5

P 4.4-6 Determine the power supplied by the 12-V voltage source in Figure P 4.4-6.

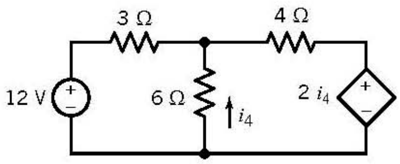

FIGURE P 4.4-6

P 4.4-7 Determine the value of the current i_c in Figure P 4.4-7.

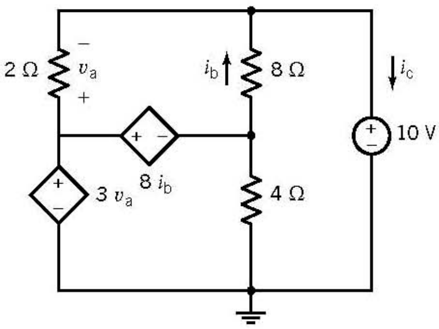

FIGURE P 4.4-7

P 4.4-8 Determine the value of the power supplied by the dependent source in Figure P 4.4-8.

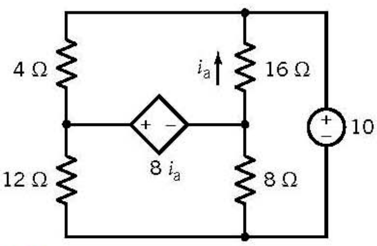

FIGURE P 4.4-8

P 4.4-9 The node voltages in the circuit shown in Figure P 4.4-9 are

$$v_1 = 4 \text{ V},\ v_2 = 0 \text{ V},\ \text{and } v_3 = -6 \text{ V}$$

Determine the values of the resistance, R, and of the gain, b, of the CCCS.

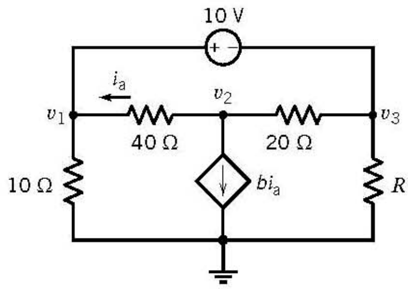

FIGURE P 4.4-9

P 4.4-10 The value of the node voltage at node b in the circuit shown in Figure P 4.4-10 is $v_b = 18$ V.

(a) Determine the value of A, the gain of the dependent source.

(b) Determine the power supplied by the dependent source.

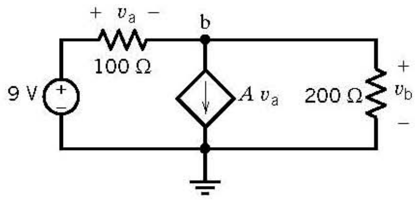

FIGURE P 4.4-10

***P 4.4-11** Determine the power supplied by the dependent source in the circuit shown in Figure P 4.4-11.

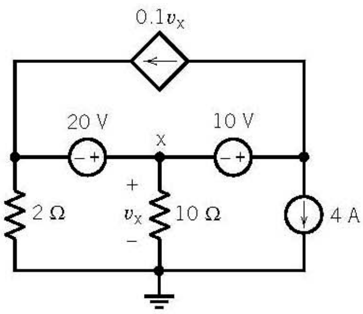

FIGURE P 4.4-11

***P 4.4-12** Determine values of the node voltages, v_1, v_2, v_3, v_4, and v_5, in the circuit shown in Figure P 4.4-12.

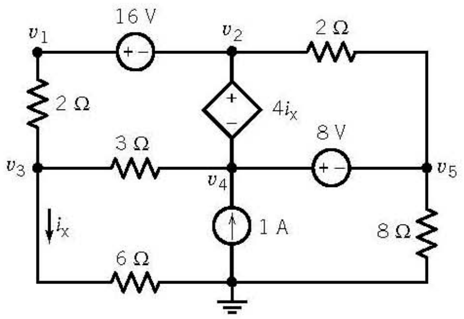

FIGURE P 4.4-12

***P 4.4-13** Determine values of the node voltages, v_1, v_2, v_3, v_4, and v_5, in the circuit shown in Figure P 4.4-13.

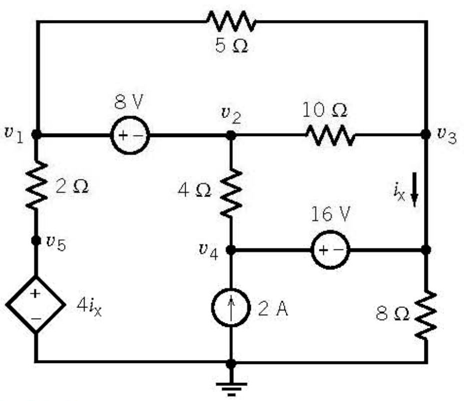

FIGURE P 4.4-13

***P 4.4-14** Determine values of the node voltages, v_1, v_2, v_3, and v_4, in the circuit shown in Figure P 4.4-14.

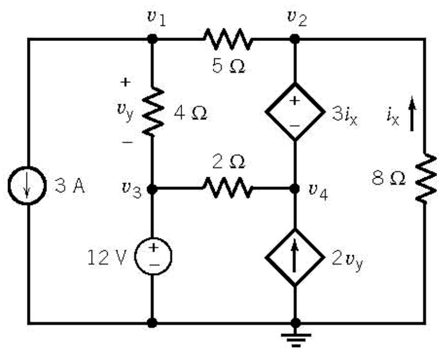

FIGURE P 4.4-14

P 4.4-15 The voltages v_1, v_2, v_3, and v_4 are the node voltages corresponding to nodes 1, 2, 3, and 4 in Figure P 4.4-15. Determine the values of these node voltages.

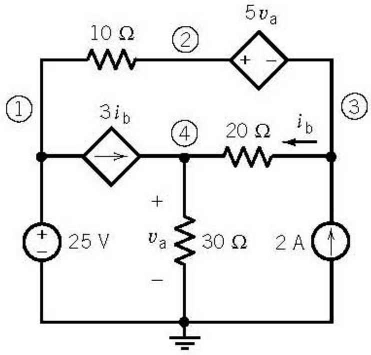

FIGURE P 4.4-15

P 4.4-16 The voltages v_1, v_2, v_3, and v_4 in Figure P 4.4-16 are the node voltages corresponding to nodes 1, 2, 3, and 4. The values of these voltages are

$$v_1 = 10\,\text{V},\ v_2 = 75\,\text{V},\ v_3 = -15\,\text{V, and } v_4 = 22.5\,\text{V}$$

Determine the values of the gains of the dependent sources, A and B, and of the resistance R_1.

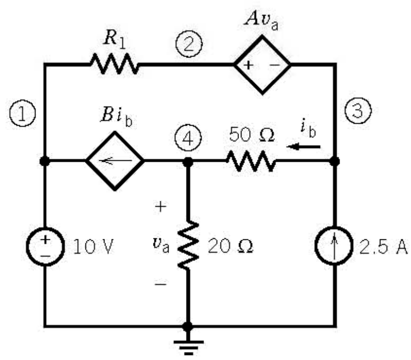

FIGURE P 4.4-16

P 4.4-17 The voltages v_1, v_2, and v_3 in Figure P 4.4-17 are the node voltages corresponding to nodes 1, 2, and 3. The values of these voltages are

$$v_1 = 12\,\text{V},\ v_2 = 21\,\text{V, and } v_3 = -3\,\text{V}$$

(a) Determine the values of the resistances R_1 and R_2.

(b) Determine the power supplied by each source.

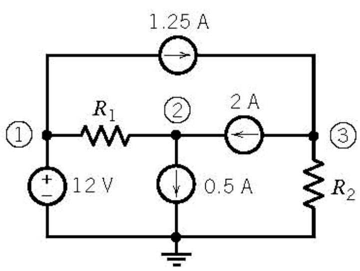

FIGURE P 4.4-17

P4.4-18 The voltages v_1, v_2, and v_3 in Figure P 4.4-18 are the node voltages corresponding to nodes 1, 2, and 3. The values of these voltages are

$$v_1 = 12\text{ V}, v_2 = 9.6\text{ V}, \text{and } v_3 = -1.33\text{ V}$$

(a) Determine the values of the resistances R_1 and R_2.

(b) Determine the power supplied by each source.

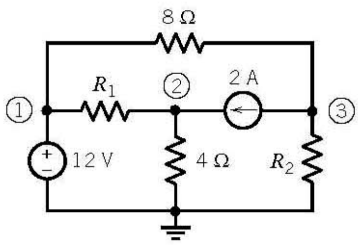

FIGURE P 4.4-18

Section 4.5 Mesh Current Analysis with Independent Voltage Sources

P 4.5-1 Determine the mesh currents, i_1, i_2, and i_3, for the circuit shown in Figure P 4.5-1.
Answers: $i_1 = 3$ A, $i_2 = 2$ A, and $i_3 = 4$ A

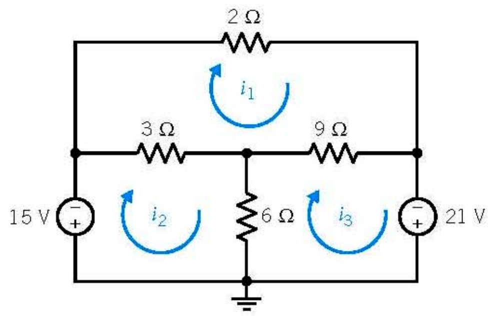

FIGURE P 4.5-1

P4.5-2 The values of the mesh currents in the circuit shown in Figure P 4.5-2 are $i_1 = 2$ A, $i_2 = 3$ A, and $i_3 = 4$ A. Determine the values of the resistance R and of the voltages v_1 and v_2 of the voltage sources.
Answers: $R = 12\ \Omega$, $v_1 = -4$ V, and $v_2 = -28$ V

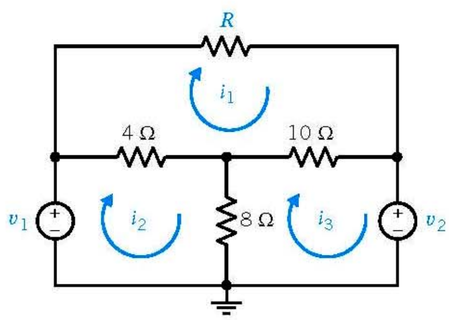

FIGURE P 4.5-2

P 4.5-3 The currents i_1 and i_2 in Figure P 4.5-3 are the mesh currents. Determine the value of the resistance R required to cause $v_a = -6$ V.
Answer: $R = 4\ \Omega$

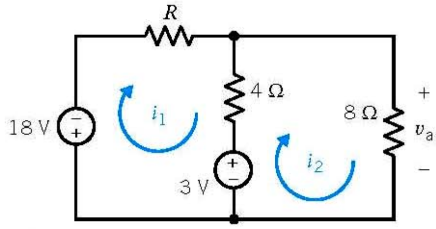

FIGURE P 4.5-3

P 4.5-4 Determine the mesh currents, i_a and i_b, in the circuit shown in Figure P 4.5-4.

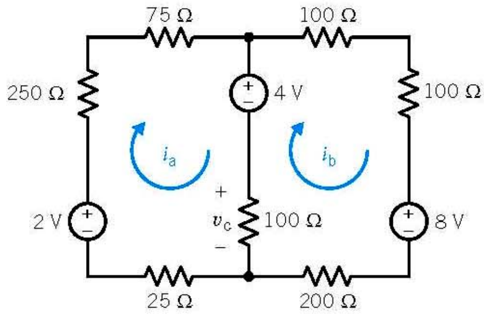

FIGURE P 4.5-4

P 4.5-5 Find the current i for the circuit of Figure P 4.5-5.
Hint: A short circuit can be treated as a 0-V voltage source.

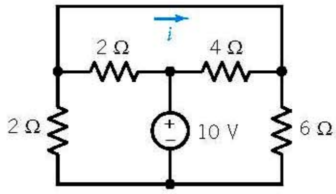

FIGURE P 4.5-5

P4.5-6 Simplify the circuit shown in Figure P 4.5-6 by replacing series and parallel resistors by equivalent resistors. Next, analyze the simplified circuit by writing and solving mesh equations. (a) Determine the power supplied by each source. (b) Determine the power absorbed by the 30-Ω resistor.

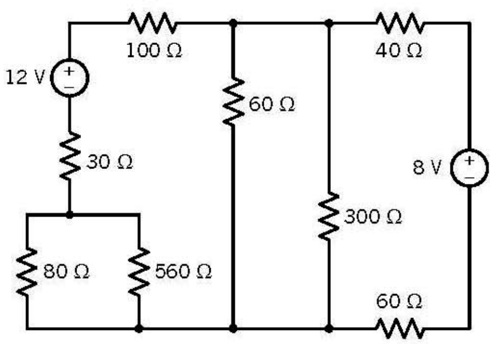

FIGURE P 4.5-6

Section 4.6 Mesh Current Analysis with Current and Voltage Sources

P 4.6-1 Find i_b for the circuit shown in Figure P 4.6-1.
Answer: $i_b = 0.6$ A

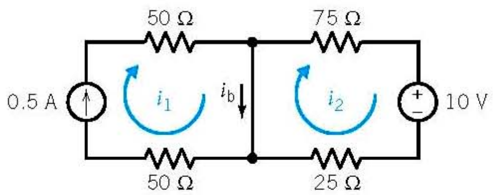

FIGURE P 4.6-1

P 4.6-2 Find v_c for the circuit shown in Figure P 4.6-2.
Answer: $v_c = 15$ V

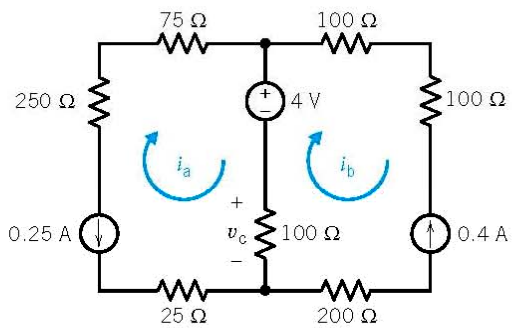

FIGURE P 4.6-2

P 4.6-3 Find v_2 for the circuit shown in Figure P 4.6-3.
Answer: $v_2 = 2$ V

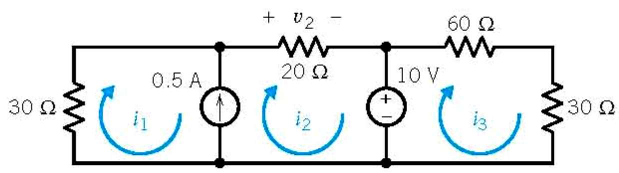

FIGURE P 4.6-3

P 4.6-4 Find v_c for the circuit shown in Figure P 4.6-4.

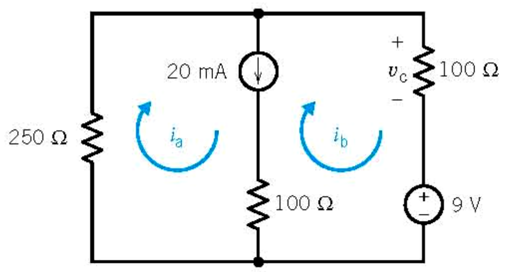

FIGURE P 4.6-4

P 4.6-5 Determine the value of the voltage measured by the voltmeter in Figure P 4.6-5.
Answer: 8 V

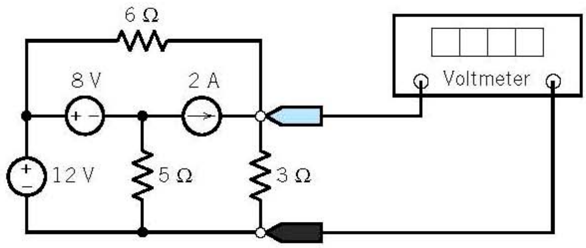

FIGURE P 4.6-5

P 4.6-6 Determine the value of the current measured by the ammeter in Figure P 4.6-6.
Hint: Write and solve a single mesh equation.
Answer: −5/6 A

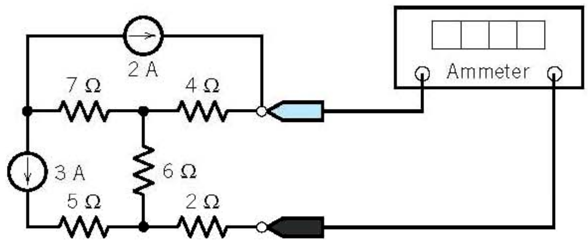

FIGURE P 4.6-6

P 4.6-7 The currents i_1, i_2, and i_3 in Figure P 4.6-7 are the mesh currents. Determine the value of the resistance R.

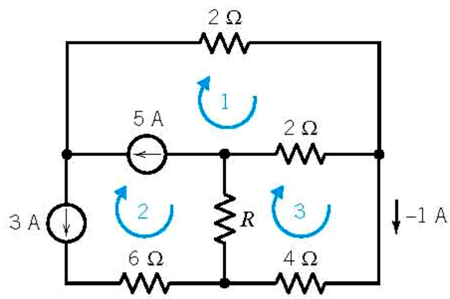

FIGURE P 4.6-7

P 4.6-8 Determine values of the mesh currents, i_1, i_2, and i_3, in the circuit shown in Figure P 6.7-8.

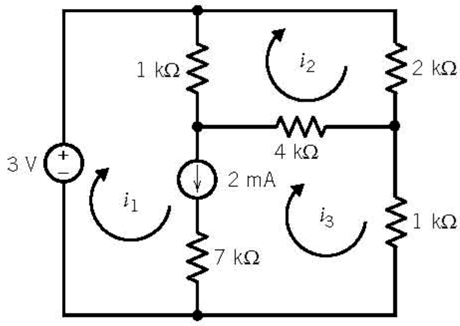

FIGURE P 4.6-8

***P 4.6-9** The circuit shown in Figure P 4.6-9 has three inputs: i_x, i_y and v_z. The output of the circuit is i_o. The output is related to the inputs by

$$i_o = a\, i_x + b\, i_y + c\, v_z$$

where a, b, and c are constants. Determine the values of a, b, and c.

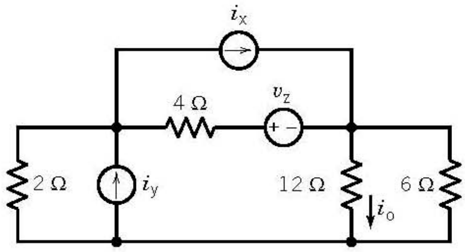

FIGURE P 4.6-9

P 4.6-10 The mesh currents in the circuit shown in Figure P 4.6-10 are

$$i_1 = -2.2213\text{ A},\ i_2 = 0.7787\text{ A, and } i_3 = 0.0770\text{ A}$$

(a) Determine the values of the resistances R_1 and R_3.

(b) Determine the value of the power supplied by the current source.

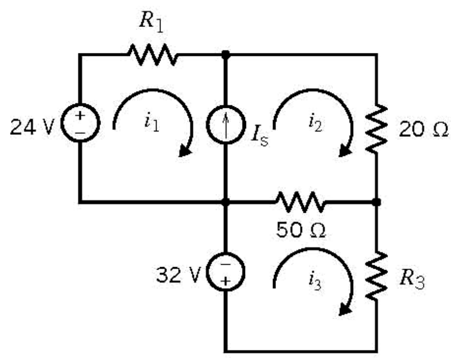

FIGURE P 4.6-10

P 4.6-11 Determine the value of the voltage measured by the voltmeter in Figure P 4.6-11.
Hint: Apply KVL to a supermesh to determine the current in the 2-Ω resistor.
Answer: 4/3 V

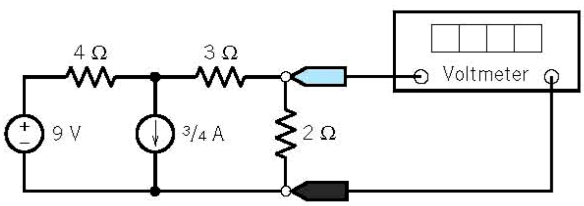

FIGURE P 4.6-11

P 4.6-12 Determine the value of the current measured by the ammeter in Figure P 4.6-12.
Hint: Apply KVL to a supermesh.
Answer: −0.333 A

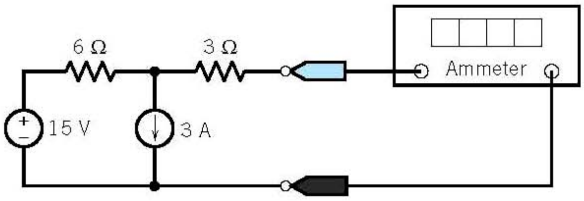

FIGURE P 4.6-12

Section 4.7 Mesh Current Analysis with Dependent Sources

P 4.7-1 Find v_2 for the circuit shown in Figure P 4.7-1.
Answer: $v_2 = 10$ V

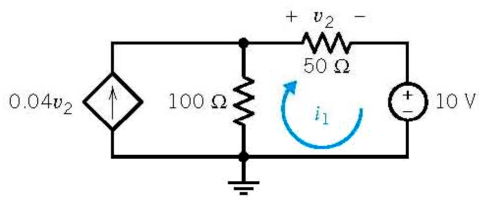

FIGURE P 4.7-1

P 4.7-2 Determine the mesh current i_a for the circuit shown in Figure P 4.7-2.
Answer: $i_a = -48$ mA

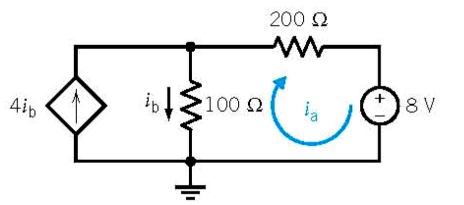

FIGURE P 4.7-2

P 4.7-3 Find v_o for the circuit shown in Figure P 4.7-3.
Answer: $v_o = 2.5$ V

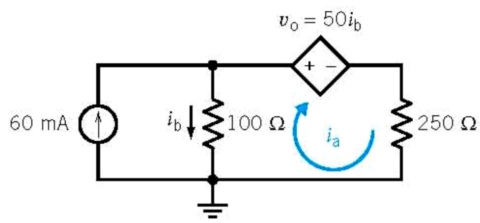

FIGURE P 4.7-3

P 4.7-4 Determine the mesh current i_a for the circuit shown in Figure P 4.7-4.

Answer: $i_a = -24$ mA

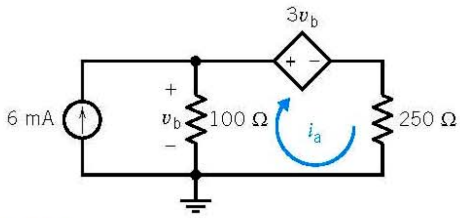

FIGURE P 4.7-4

P 4.7-5 Although scientists continue to debate exactly why and how it works, the process of utilizing electricity to aid in the repair and growth of bones—which has been used mainly with fractures—may soon be extended to an array of other problems, ranging from osteoporosis and osteoarthritis to spinal fusions and skin ulcers.

An electric current is applied to bone fractures that have not healed in the normal period of time. The process seeks to imitate natural electrical forces within the body. It takes only a small amount of electric stimulation to accelerate bone recovery. The direct current method uses an electrode that is implanted at the bone. This method has a success rate approaching 80 percent.

The implant is shown in Figure P 4.7-5*a* and the circuit model is shown in Figure P 4.7-5*b*. Find the energy delivered to the cathode during a 24-hour period. The cathode is represented by the dependent voltage source and the 100-kΩ resistor.

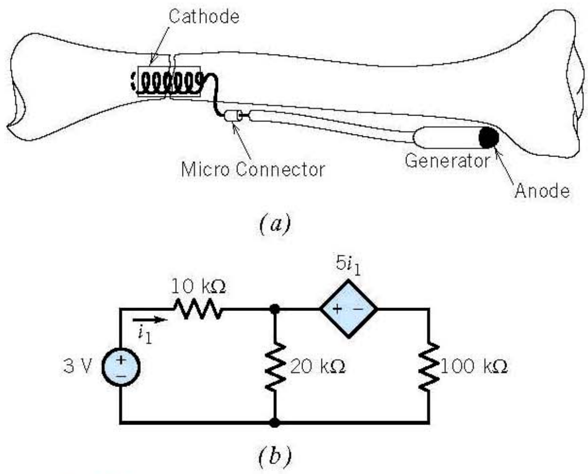

FIGURE P 4.7-5 (*a*) Electric aid to bone repair. (*b*) Circuit model.

P 4.7-6 The model of a bipolar junction transistor (BJT) amplifier is shown in Figure P 4.7-6.

(a) Determine the gain v_o/v_i.

(b) Calculate the required value of g in order to obtain a gain $v_o/v_i = -170$ when $R_L = 5$ kΩ, $R_1 = 100$ Ω, and $R_2 = 1$ kΩ.

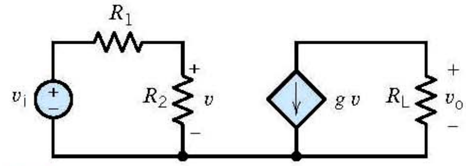

FIGURE P 4.7-6

P 4.7-7 The currents i_1, i_2 and i_3 are the mesh currents of the circuit shown in Figure P 4.7-7. Determine the values of i_1, i_2, and i_3.

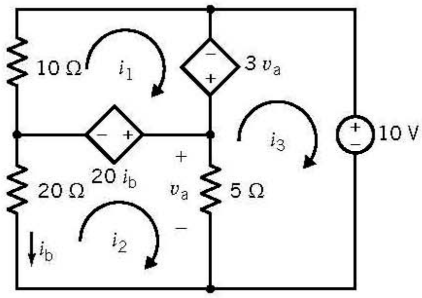

FIGURE P 4.7-7

P 4.7-8 Determine the value of the power supplied by the dependent source in Figure P 4.7-8.

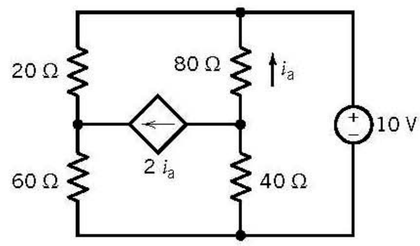

FIGURE P 4.7-8

P 4.7-9 Determine the value of the resistance R in the circuit shown in Figure P 4.7-9.

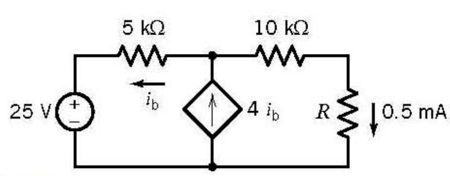

FIGURE P 4.7-9

P4.7-10 The circuit shown in Figure P 4.7-10 is the small signal model of an amplifier. The input to the amplifier is the voltage source voltage, v_s. The output of the amplifier is the voltage v_o.

(a) The ratio of the output to the input, v_o/v_s, is called the gain of the amplifier. Determine the gain of the amplifier.

(b) The ratio of the current of the input source to the input voltage, i_b/v_s, is called the input resistance of the amplifier. Determine the input resistance.

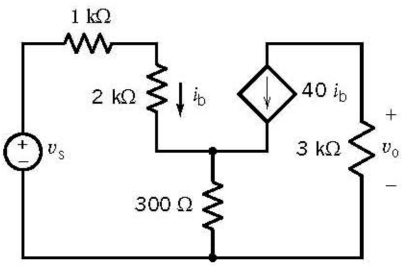

FIGURE P 4.7-10

P 4.7-11 Determine values of the mesh currents i_1, i_2, i_3, and i_4 in the circuit shown in Figure P 4.7-11.

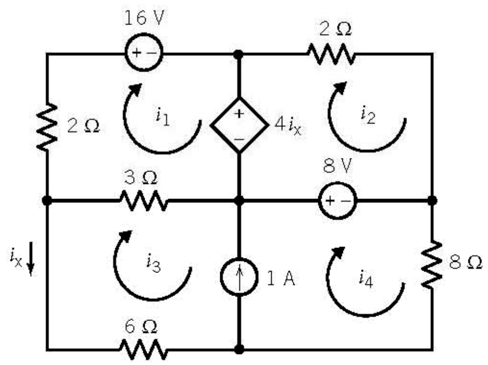

FIGURE P 4.7-11

P 4.7-12 Determine the values of the mesh currents of the circuit shown in Figure P 4.7-12.

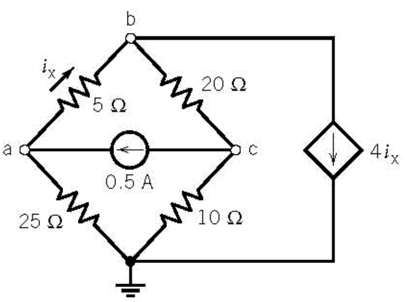

FIGURE P 4.7-12

P 4.7-13 The currents i_1, i_2, and i_3 are the mesh currents corresponding to meshes 1, 2, and 3 in Figure P 4.7-13. Determine the values of these mesh currents.

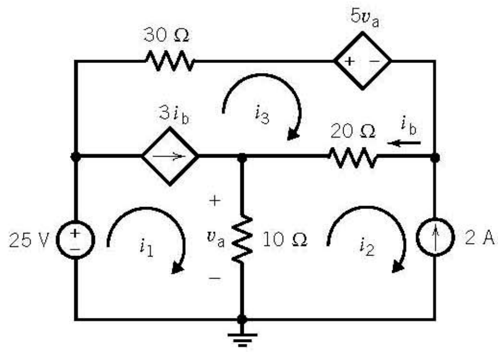

FIGURE P 4.7-13

P 4.7-14 The currents i_1, i_2, and i_3 are the mesh currents corresponding to meshes 1, 2, and 3 in Figure P 4.7-14. The values of these currents are

$$i_1 = -1.375 \text{ A}, i_2 = -2.5 \text{ A}, \quad \text{and} \quad i_3 = -3.25 \text{ A}$$

Determine the values of the gains of the dependent source, A and B.

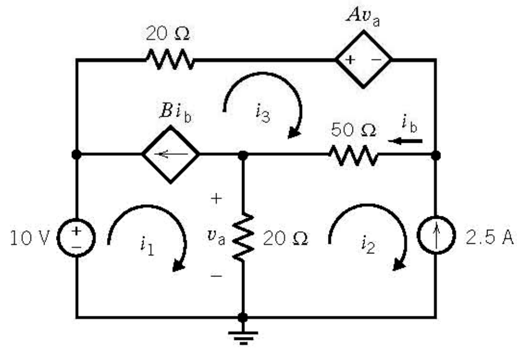

FIGURE P 4.7-14

P 4.7-15 Determine the current i in the circuit shown in Figure P 4.7-15.

Answer: $i = 3$ A

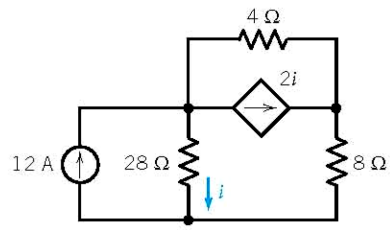

FIGURE P 4.7-15

Section 4.8 The Node Voltage Method and Mesh Current Method Compared

***P 4.8-1** The circuit shown in Figure P 4.8-1 has two inputs, the voltage source voltages, v_1 and v_2. The circuit has one output, the dependent source voltage, v_o. Design this circuit so that the output is related to the inputs by

$$v_o = 2v_1 + 0.5v_2$$

Hint: Determine the required values of A, R_1, R_2, R_3, and R_4.

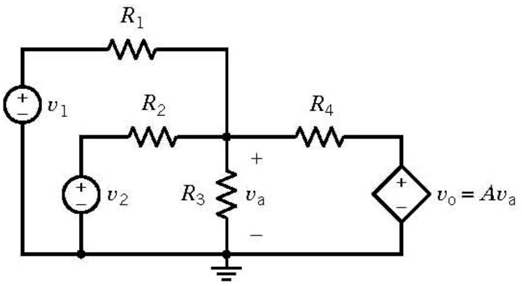

FIGURE P 4.8-1

P 4.8-2 The circuit shown in Figure P 4.8-2 has two inputs, v_s and i_s, and one output v_o. The output is related to the inputs by the equation

$$v_o = ai_s + bv_s$$

where a and b are constants to be determined. Determine the values a and b by (a) writing and solving mesh equations and (b) writing and solving node equations.

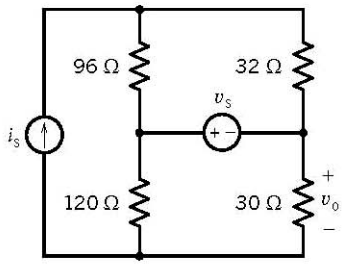

FIGURE P 4.8-2

P4.8-3 Determine the power supplied by the dependent source in the circuit shown in Figure P 4.8-3 by writing and solving (a) node equations and (b) mesh equations.

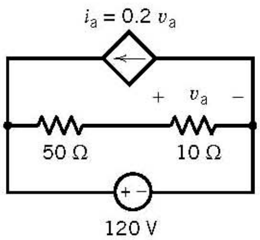

FIGURE P 4.8-3

Section 4.10 How Can We Check . . . ?

P 4.10-1 Computer analysis of the circuit shown in Figure P 4.10-1 indicates that the node voltages are $v_a = 5.2$ V, $v_b = -4.8$ V, and $v_c = 3.0$ V. Is this analysis correct?
Hint: Use the node voltages to calculate all the element currents. Check to see that KCL is satisfied at each node.

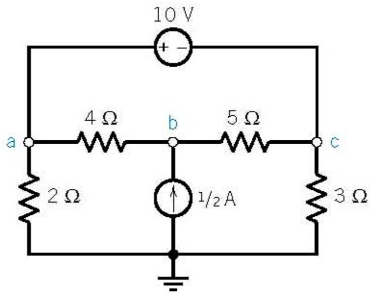

FIGURE P 4.10-1

P4.10-2 An old lab report asserts that the node voltages of the circuit of Figure P 4.10-2 are $v_a = 4$ V, $v_b = 20$ V, and $v_c = 12$ V. Are these correct?

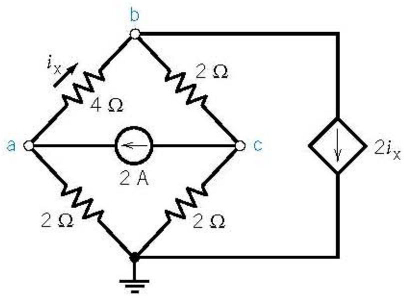

FIGURE P 4.10-2

P 4.10-3 Your lab partner forgot to record the values of R_1, R_2, and R_3. He thinks that two of the resistors in Figure P 4.10-3 had values of 10 kΩ and that the other had a value of 5 kΩ. Is this possible? Which resistor is the 5-kΩ resistor?

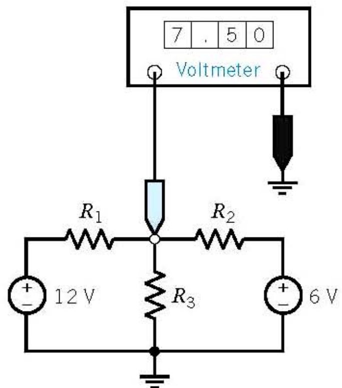

FIGURE P 4.10-3

P 4.10-4 Computer analysis of the circuit shown in Figure P 4.10-4 indicates that the node voltages are $v_1 = -8$ V, $v_2 = -20$ V, and $v_3 = -6$ V. Verify that this analysis is correct.
Hint: Use the node voltages to calculate the element currents. Verify that KCL is satisfied at each node.

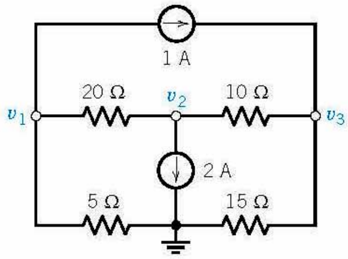

FIGURE P 4.10-4

P 4.10-5 Computer analysis of the circuit shown in Figure P 4.10-5 indicates that the mesh currents are $i_1 = 2$ A, $i_2 = 4$ A, and $i_3 = 3$ A. Verify that this analysis is correct.

Hint: Use the mesh currents to calculate the element voltages. Verify that KVL is satisfied for each mesh.

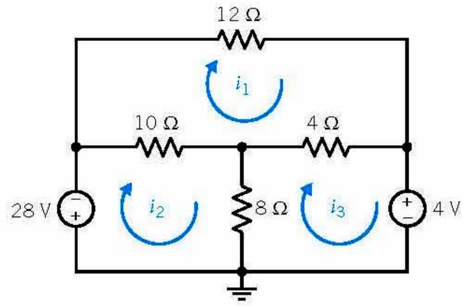

FIGURE P 4.10-5

PSpice Problems

SP 4-1 Use PSpice to determine the node voltages of the circuit shown in Figure SP 4-1.

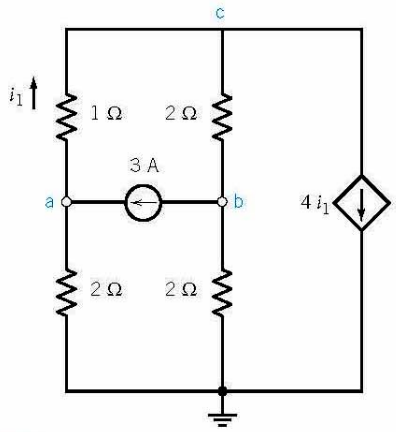

FIGURE SP 4-1

SP 4-2 Use PSpice to determine the mesh currents of the circuit shown in Figure SP 4-2.

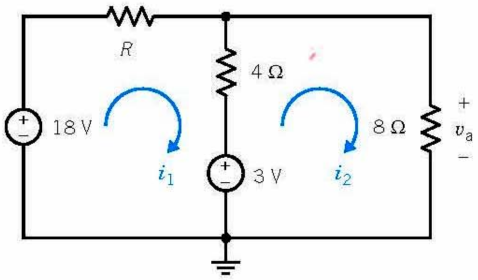

FIGURE SP 4-2

SP 4-3 The voltages v_a, v_b, v_c, and v_d in Figure SP 4-3 are the node voltages corresponding to nodes a, b, c and d. The current i is the current in a short circuit connected between nodes b and c. Use PSpice to determine the values of v_a, v_b, v_c, and v_d and of i.

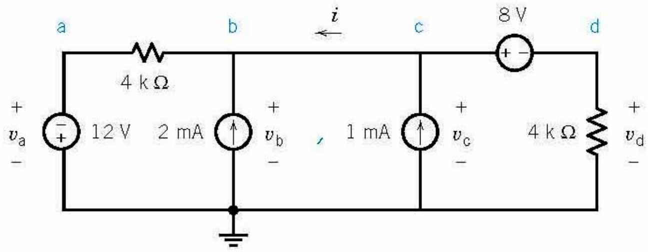

FIGURE SP 4-3

SP 4-4 Determine the current, i, shown in Figure SP 4-4.
Answer: $i = 0.56$ A

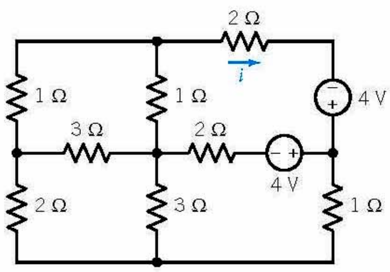

FIGURE SP 4-4

Design Problems

DP 4-1 An electronic instrument incorporates a 15-V power supply. A digital display is added that requires a 5-V power supply. Unfortunately, the project is over budget and you are instructed to use the existing power supply. Using a voltage divider, as shown in Figure DP 4-1, you are able to obtain 5 V. The specification sheet for the digital display shows that the display will operate properly over a supply voltage range of 4.8 V to 5.4 V. Furthermore, the display will draw 300 mA (I) when the display is active and 100 mA when quiescent (no activity).

(a) Select values of R_1 and R_2 so that the display will be supplied with 4.8 V to 5.4 V under all conditions of current I.

(b) Calculate the maximum power dissipated by each resistor, R_1 and R_2, and the maximum current drawn from the 15-V supply.

(c) Is the use of the voltage divider a good engineering solution? If not, why? What problems might arise?

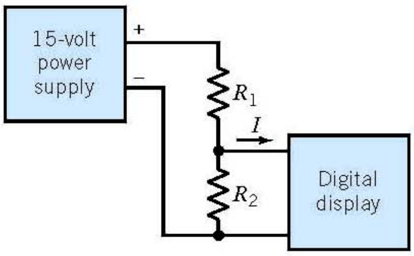

FIGURE DP 4-1

DP 4-2 For the circuit shown in Figure DP 4-2, it is desired to set the voltage at node a equal to 0 V in order to control an electric motor. Select voltages v_1 and v_2 in order to achieve $v_a = 0$ V when v_1 and v_2 are less than 20 V and greater than zero and $R = 2\ \Omega$.

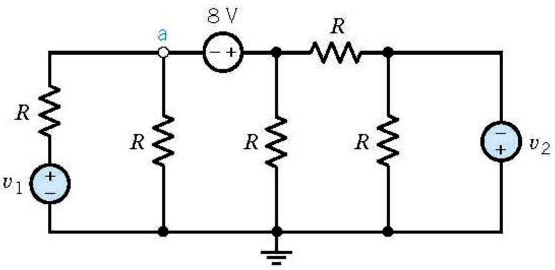

FIGURE DP 4-2

DP 4-3 A wiring circuit for a special lamp in a home is shown in Figure DP 4-3. The lamp has a resistance of 2 Ω, and the designer selects $R = 100\ \Omega$. The lamp will light when $I \geq 50$ mA but will burn out when $I > 75$ mA.

(a) Determine the current in the lamp and determine if it will light for $R = 100\ \Omega$.

(b) Select R so that the lamp will light but will not burn out if R changes by ±10 percent because of temperature changes in the home.

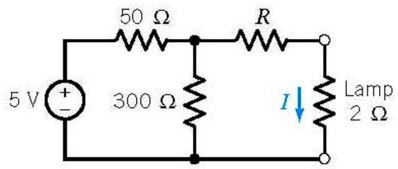

FIGURE DP 4-3 A lamp circuit.

DP 4-4 In order to control a device using the circuit shown in Figure DP 4-4, it is necessary that $v_{ab} = 10$ V. Select the resistors when it is required that all resistors be greater than 1 Ω and $R_3 + R_4 = 20\ \Omega$.

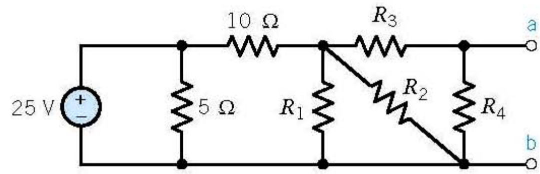

FIGURE DP 4-4

DP 4-5 The current i shown in the circuit of Figure DP 4-5 is used to measure the stress between two sides of an earth fault line. Voltage v_1 is obtained from one side of the fault, and v_2 is obtained from the other side of the fault. Select the resistances R_1, R_2, and R_3 so that the magnitude of the current i will remain in the range between 0.5 mA and 2 mA when v_1 and v_2 may each vary independently between +1 V and +2 V ($1\text{ V} \leq v_n \leq 2\text{ V}$).

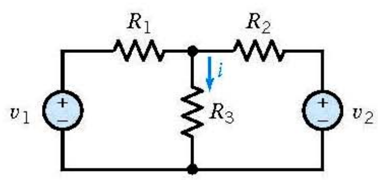

FIGURE DP 4-5 A circuit for earth fault line stress measurement.