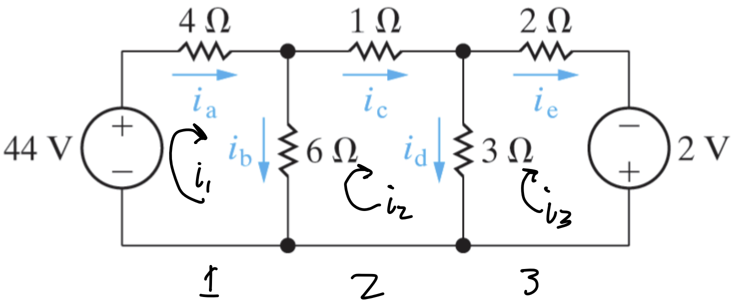
4.32 Solve **Problem 4.12** using the mesh-current method.

Figure P4.12



for loop 1:

$+44V + 4i_1 + 6(i_1 - i_2) = 0$

$10i_1 - 6i_2 + 44 = 0$

loop 2:

$1(i_2) + 6(i_2 - i_1) + 3(i_2 - i_3) = 0$

$-6i_1 + 10i_2 - 3i_3 = 0$

loop 3:

$2V + 2(i_3) + 3(i_3 - i_2) = 0$

$-3i_2 + 5i_3 = -2$

Using Matrix to solve

$$\left[\begin{array}{ccc|c} 10 & -6 & 0 & -44 \\ -6 & 10 & -3 & 0 \\ 0 & -3 & 5 & -2 \end{array}\right] \Rightarrow \begin{array}{l} i_1 = -8 \\ i_2 = -6 \\ i_3 = -4 \end{array}$$

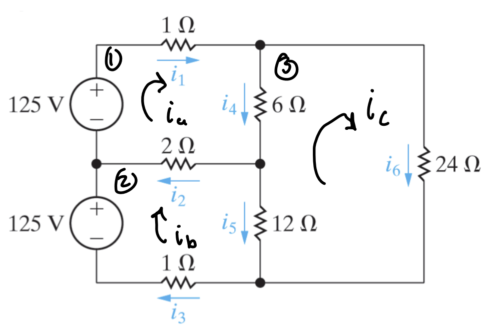
a) $\boxed{\begin{array}{ll} i_a = 8A & i_b = i_a - i_c = 2A \\ i_c = 6A & i_d = i_c - i_e = 2A \\ i_e = 4A & \end{array}}$

$P_1 = -44(8) = -352W$

$P_3 = -2(4) = -8W$

b) $\boxed{\text{The total power is } -360W}$

4.33 Solve **Problem 4.14** using the mesh-current method.



loop 1: $1(i_a) + 6(i_a - i_c) + 2(i_a - i_b) - 125 = 0$

$9i_a - 2i_b - 6i_c = 125$

loop 2: $1(i_b) + 12(i_b - i_c) + 2(i_b - i_a) - 125 = 0$

$-2i_a + 15i_b - 12i_c = 125$

loop 3: $24i_c + 6(i_c - i_a) + 12(i_c - i_b) = 0$

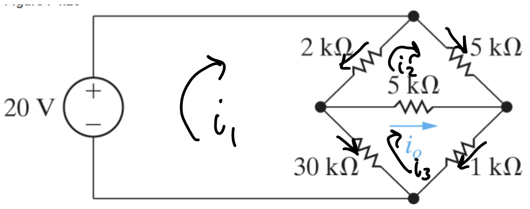
$-6i_a - 12i_b + 42i_c = 0$

Solving w/ matrix:

$$\left[\begin{array}{ccc|c} 9 & -2 & -6 & 125 \\ -2 & 15 & -12 & 125 \\ -6 & -12 & 42 & 0 \end{array}\right] \Rightarrow \begin{array}{l} i_a = 23.76A \\ i_b = 18.43A \\ i_c = 8.66A \end{array}$$

$\boxed{\begin{array}{ll} i_1 = 23.76A & i_2 = i_a - i_b = 5.33A \\ i_3 = 18.43A & i_4 = i_a - i_c = 15.1A \\ i_6 = 8.66A & i_5 = i_b - i_c = 9.77A \end{array}}$

4.35 Solve **Problem 4.26** using the mesh-current method.



loop 1: $-20v + 2k(i_1 - i_2) + 30k(i_1 - i_3) = 0$

$$32k\,i_1 - 2k\,i_2 - 30k\,i_3 = 20$$

loop 2: $2k(i_2 - i_1) + 5k\,i_2 + 5k(i_2 - i_3) = 0$

$$-2k\,i_1 + 12k\,i_2 - 5k\,i_3 = 0$$

loop 3: $30k(i_3 - i_1) + 5k(i_3 - i_2) + 1k\,i_3 = 0$

$$-30k\,i_1 - 5k\,i_2 + 36k\,i_3 = 0$$

Solving using matrix

$$\left[\begin{array}{ccc|c} 32k & -2k & -30k & 20 \\ -2k & 12k & -5k & 0 \\ -30k & -5k & 36k & 0 \end{array}\right] \Rightarrow \begin{array}{l} i_1 = 0.0055A \\ i_2 = 0.003A \\ i_3 = 0.005A \end{array}$$

$$i_o = i_3 - i_2 = 0.005\ A$$

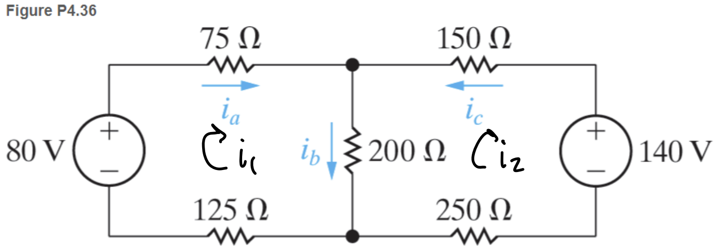
$$\boxed{i_o = 2\ mA}$$

4.36 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. P4.36**.

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

Figure P4.36



Loop 1:

$$-80v + 75i_1 + 200(i_1 - i_2) + 125i_1 = 0$$

$$400i_1 - 200i_2 = 80$$

Loop 2:

$$140V + 150i_2 + 250i_2 + 200(i_2 - i_1) = 0$$

$$-200i_1 + 600i_2 = -140$$

Solving (a) w/ matrix

$$\left[\begin{array}{cc|c} 400 & -200 & 80 \\ -200 & 600 & -140 \end{array}\right] \Rightarrow \begin{array}{l} i_1 = 0.1A \\ i_2 = -0.2A \end{array}$$

A) $\boxed{\begin{array}{l} i_a = 0.1\ A \\ i_b = (i_1 - i_2) = 0.3\ A \\ i_c = 0.2\ A \end{array}}$

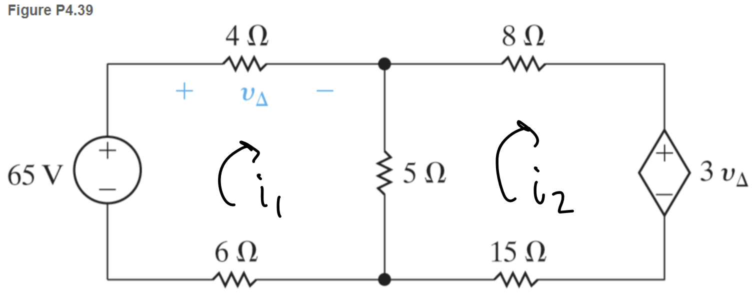
W/ reversed polarity

$$\left[\begin{array}{cc|c} 400 & -200 & 80 \\ -200 & 600 & 140 \end{array}\right] \quad \begin{array}{l} i_1 = 0.38 \\ i_2 = 0.36 \end{array}$$

b) $\boxed{\begin{array}{l} i_a = 0.38\ A \\ i_b = i_1 - i_2 = 0.02A \\ i_c = -0.36\ A \end{array}}$

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



loop 1

$$-65+4i_1+6i_1+5(i_1-i_2)=0$$

$$15i_1-5i_2=65$$

loop 2

$$3(4i_1)+8i_2+15i_2+5(i_2-i_1)=0$$

$$7i_1+28i_2=0$$

Solving w/ matrix

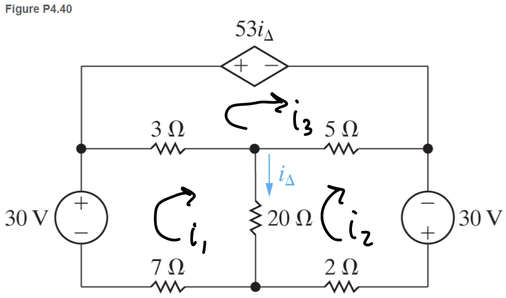
$$\left[\begin{array}{cc|c} 15 & -5 & 65 \\ 7 & 28 & 0 \end{array}\right] \quad i_1=4 \quad i_2=-1$$

$$V_\Delta = 4(4)=16$$

$$\boxed{P_{15}=(-1)^2(15)=15W}$$

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

Figure P4.40



$$i_\Delta = (i_1-i_2)$$

loop 1:

$$3(i_1-i_3)+20(i_1-i_2)+7i_1)=30$$

$$30i_1-20i_2-3i_3=30$$

loop 2:

$$5(i_2-i_3)+20(i_2-i_1)+2i_2=30$$

$$-20i_1+27i_2-5i_3=30$$

loop 3:

$$53(i_1-i_2)+3(i_3-i_1)+5(i_3-i_2)=0$$

$$50i_1-58i_2+8i_3=0$$

$$\begin{bmatrix} 30 & -20 & -3 & 30 \\ -20 & 27 & -5 & 30 \\ 50 & 48 & 8 & 0 \end{bmatrix} \Rightarrow \begin{array}{l} i_1=52A \\ i_2=60A \\ i_3=110A \end{array}$$

$$P=53(i_1-i_2)i_3=-46640W$$

$$\boxed{P=46640W}$$

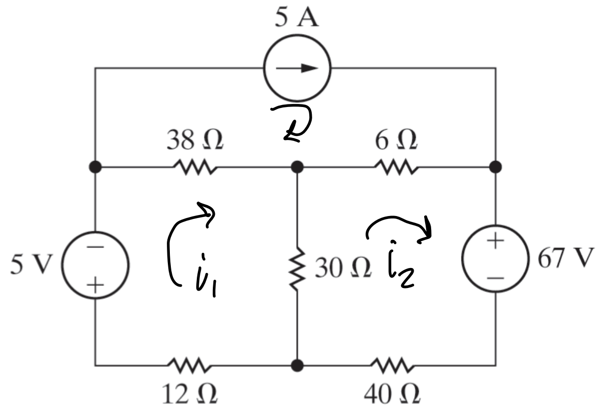
4.45

a) Use the mesh-current method to find how much power the 5 A current source delivers to the circuit in Fig. P4.45.

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 P4.45



loop 1:

$$5V + 38(i_1-5) + 30(i_1-i_2) + 12i_1 = 0$$

$$80i_1 - 30i_2 = 185$$

loop 2:

$$67V + 6(i_2-5) + 30(i_2-i_1) + 40i_2 = 0$$

$$-30i_1 + 76i_2 = -37$$

$$\left[\begin{array}{cc|c} 80 & -30 & 185 \\ -30 & 76 & -37 \end{array}\right] \Rightarrow \begin{array}{l} i_1 = 2.5A \\ i_2 = 0.5A \end{array}$$

$$V = 38(2.5-5) + 6(0.5-5) = -122V$$

$$P = IV = (-122)(5) = -610W$$

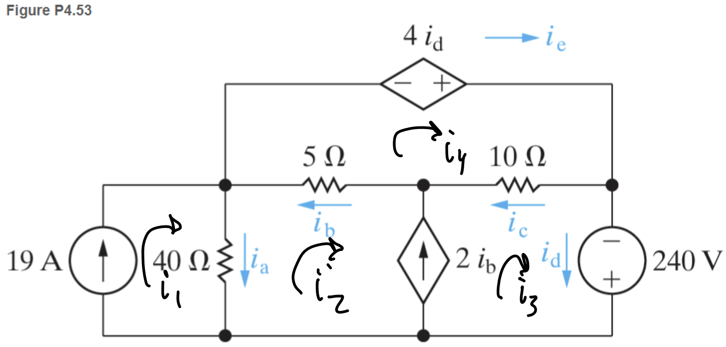
$$\boxed{P = 610W}$$

4.53 PSPICE MULTISIM

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

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

Figure P4.53



$$i_1 = 19A$$

$$i_3 - i_2 = 2i_b \qquad i_b = i_4 - i_2$$

$$i_3 - i_2 = 2i_4 - 2i_2$$

$$i_2 + i_3 - 2i_4 = 0$$

loop 2+3

$$40(i_2 - i_1) + 5(i_2 - i_4) + 10(i_3 - i_4) - 240 = 0$$

$$45i_2 + 10i_3 - 15i_4 = 240 + 40i_1 = 1000$$

loop 4

$$-4i_3 + 10(i_4 - i_3) + 5(i_4 - i_2) = 0$$

$$-5i_2 - 14i_3 + 15i_4 = 0$$

$$\left[\begin{array}{ccc|c} 1 & 1 & -2 & 0 \\ 45 & 10 & -15 & 1000 \\ -5 & -14 & 15 & 0 \end{array}\right] \Rightarrow \begin{array}{l} i_2 = 26A \\ i_3 = 10A \\ i_4 = 18A \end{array}$$

$$\boxed{\begin{array}{l} i_a = i_1 - i_2 = -7A \\ i_b = i_4 - i_2 = -8A \\ i_c = i_4 - i_3 = 8A \\ i_d = i_3 = 10A \\ i_e = i_4 = 18A \end{array}}$$