Chapter 4

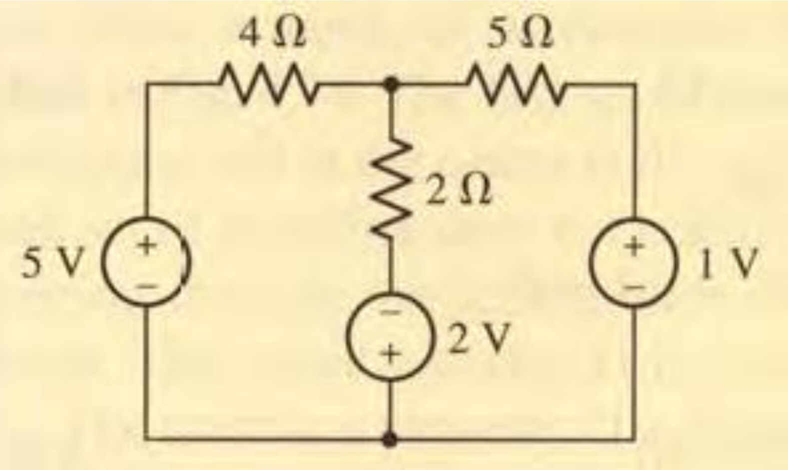
Basic Nodal and Mesh Analysis

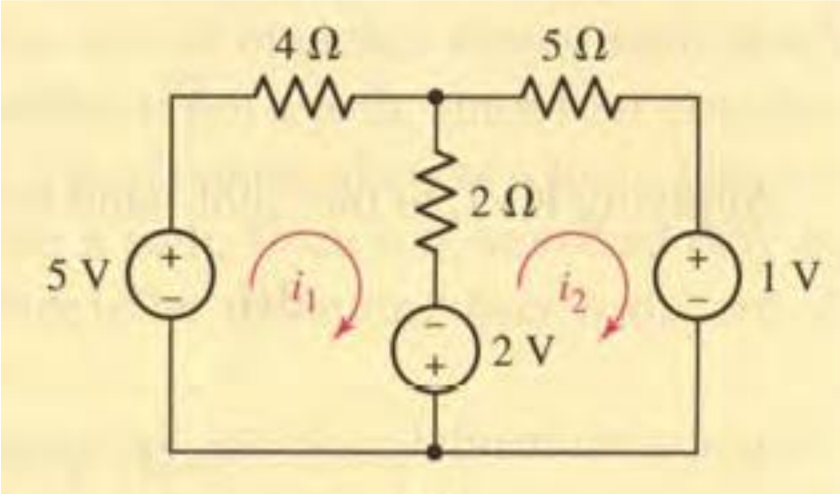
MESH ANALYSIS

Summary of Basic Mesh Analysis Procedure

1. **Determine if the circuit is a planar circuit.** If not, perform nodal analysis instead.
2. **Count the number of meshes** (M). Redraw the circuit if necessary.
3. **Label each of the M mesh currents.** Generally, defining all mesh currents to flow clockwise results in a simpler analysis.
4. **Write a KVL equation around each mesh.** Begin with a convenient node and proceed in the direction of the mesh current. Pay close attention to "−" signs. If a current source lies on the periphery of a mesh, no KVL equation is needed and the mesh current is determined by inspection.
5. **Express any additional unknowns such as voltages or currents other than mesh currents in terms of appropriate mesh currents.** This situation can occur if current sources or dependent sources appear in our circuit.
6. **Organize the equations.** Group terms according to mesh currents.
7. **Solve the system of equations for the mesh currents** (there will be M of them).

Determine the power supplied by the 2 V source of Fig. 4.17*a*.





KVL at mesh 1

$$-5 + 4i_1 + 2(i_1 - i_2) - 2 = 0$$

KVL at mesh 2

$$+2 + 2(i_2 - i_1) + 5i_2 + 1 = 0$$

Rearranging and grouping terms,

$$6i_1 - 2i_2 = 7$$

and

$$-2i_1 + 7i_2 = -3$$

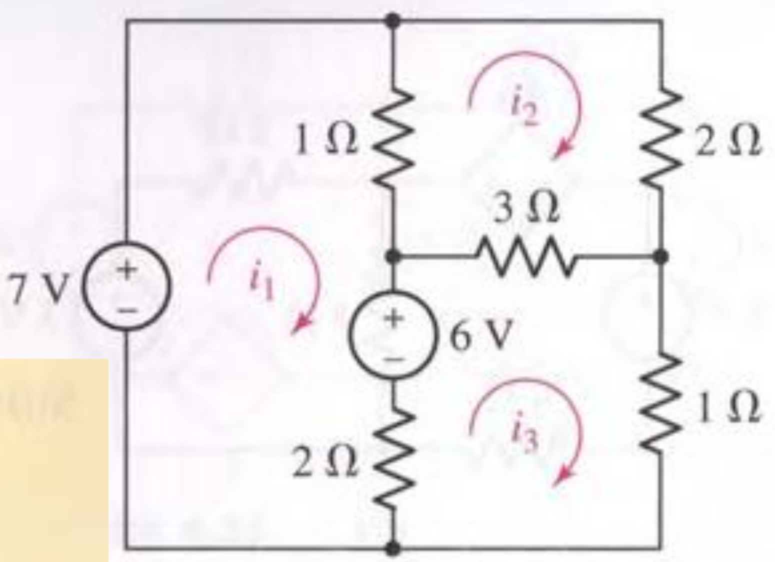
Solving, $i_1 = \frac{43}{38} = 1.132$ A and $i_2 = -\frac{2}{19} = -0.1053$ A.

The current flowing out of the positive reference terminal of the 2 V source is $i_1 - i_2$. Thus, the 2 V source supplies $(2)(1.237) = 2.474$ W.

Use mesh analysis to determine the three mesh currents in the circuit of Fig. 4.19.

Applying KVL at the three meshes

$$-7 + 1(i_1 - i_2) + 6 + 2(i_1 - i_3) = 0$$
$$1(i_2 - i_1) + 2i_2 + 3(i_2 - i_3) = 0$$
$$2(i_3 - i_1) - 6 + 3(i_3 - i_2) + 1i_3 = 0$$



Simplifying,

$$3i_1 - i_2 - 2i_3 = 1$$
$$-i_1 + 6i_2 - 3i_3 = 0$$
$$-2i_1 - 3i_2 + 6i_3 = 6$$

and solving, we obtain $i_1 = 3$ A, $i_2 = 2$ A, and $i_3 = 3$ A.

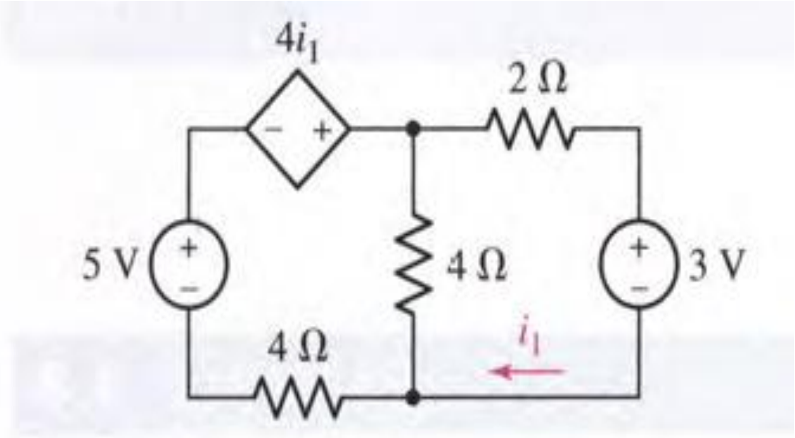
Determine the current i_1 in the circuit

For the left mesh, KVL yields

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

and for the right mesh we find

$$4(i_1 - i_2) + 2i_1 + 3 = 0$$



(a)

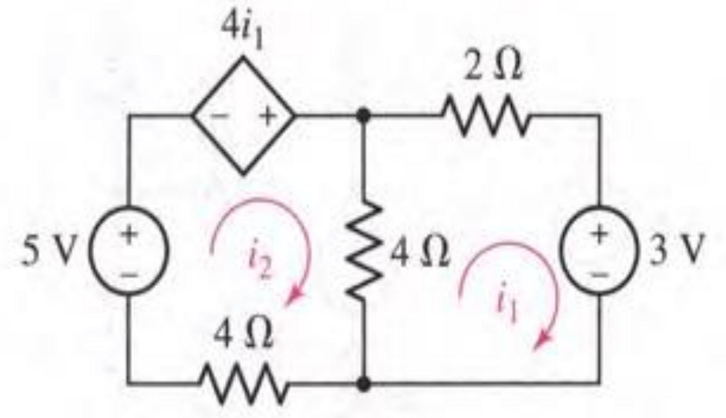
Grouping terms, these equations may be written more compactly as

$$-8i_1 + 8i_2 = 5$$

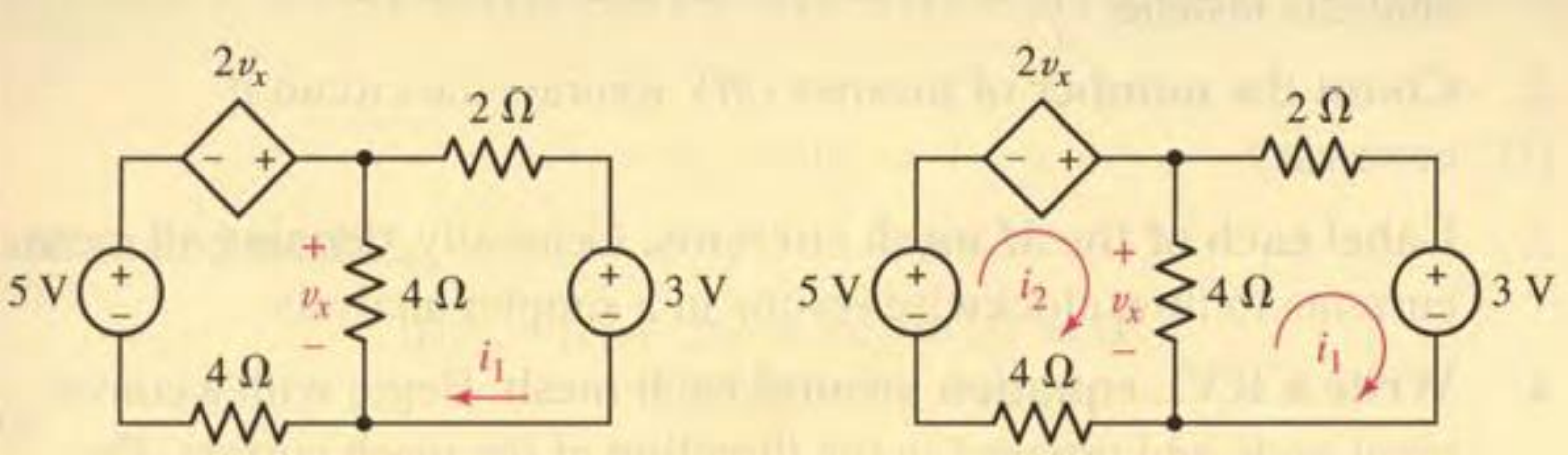
and

$$6i_1 - 4i_2 = -3$$

Solving, $i_2 = 375$ mA, so $i_1 = -250$ mA.



Determine the current i_1 in the circuit



For the left mesh, KVL now yields

$$-5 - 2v_x + 4(i_2 - i_1) + 4i_2 = 0$$

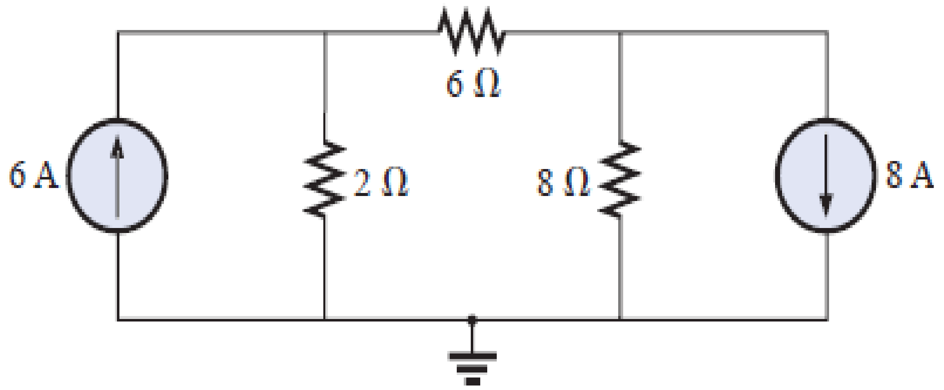
and for the right mesh we find the same as before, namely

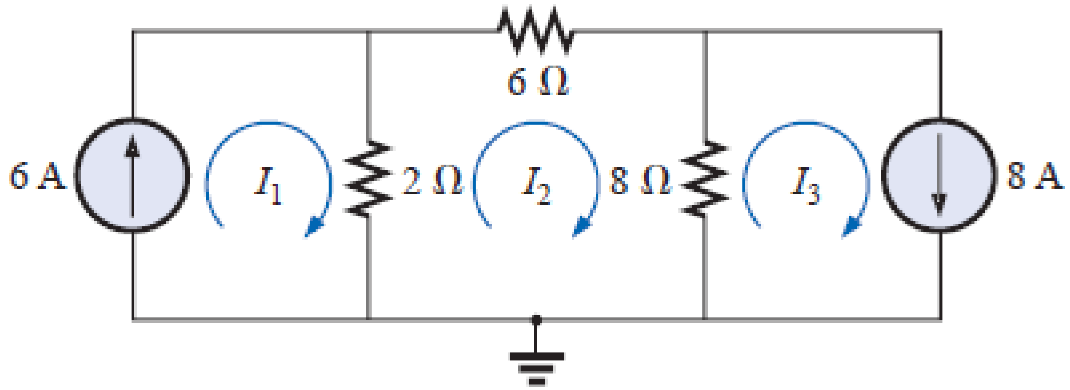
$$4(i_1 - i_2) + 2i_1 + 3 = 0$$

$$v_x = 4(i_2 - i_1)$$

Solving, we find that $i_1 = 1.25$ A.

Find mesh currents





$$I_1 = 6\text{ A}$$

$$I_3 = 8\text{ A}$$

KVL at mesh 2

$$2(I_2 - I_1) + 6I_2 + 8(I_2 - I_3) = 0$$

$$-2I_1 + 16I_2 - 8I_3 = 0$$

$$-2(6) + 16(I_2) - 8(8) = 0$$

$$-12 + -64 + 16(I_2) = 0$$

$$-76 + 16(I_2) = 0$$

$$I_2 = \frac{76}{16} = 4.75A$$

$$I_{2\Omega}\downarrow = I_1 - I_2 = 6\text{ A} - 4.75\text{ A} = \mathbf{1.25\text{ A}}$$

$$I_{8\Omega}\uparrow = I_3 - I_2 = 8\text{ A} - 4.75\text{ A} = \mathbf{3.25\text{ A}}$$