MESH ANALYSIS

Circuit terminologies: (Loops, Mesh)

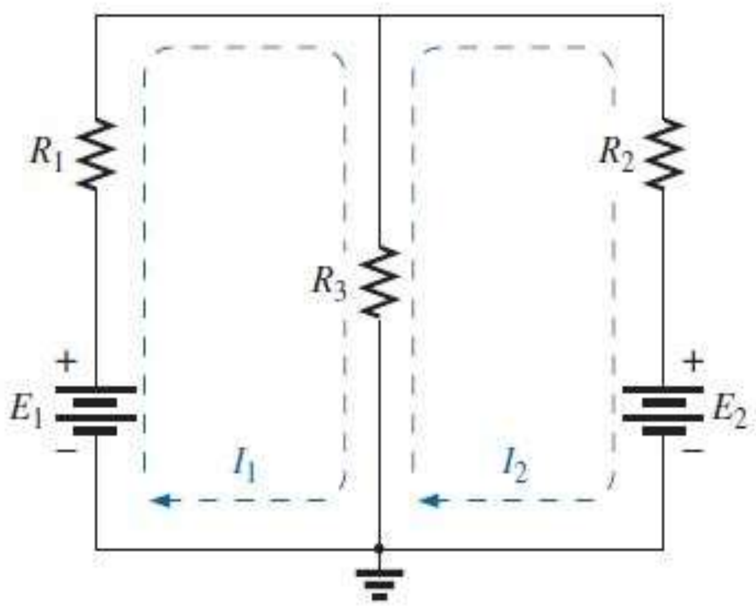
- **Loop:** Any close path in in the electrical circuit is called loop
- **Mesh:** A closed path in the circuit which does not enclose any other close path inside it is called mesh.

MESH ANALYSIS (GENERAL APPROACH)

Mesh analysis—is actually an extension of the branch-current analysis approach just introduced.

The number of mesh currents required to analyze a network will equal the number of "windows" of the configuration

The current through *R*3 is simply the difference between *I*1 and *I*2, with the direction of the larger. This is demonstrated in the examples to follow



MESH ANALYSIS (GENERAL APPROACH)

Mesh Analysis Procedure

1. Assign a distinct current in the clockwise direction to each independent, closed loop of the network.

2. Indicate the polarities within each loop for each resistor as determined by the assumed direction of loop current for that loop.

3. Apply Kirchhoff's voltage law around each closed loop in the clockwise direction.

a. If a resistor has two or more assumed currents through it, the total current through the resistor is the difference of the two currents.

b. The polarity of a voltage source is unaffected by the direction of the assigned loop currents.

4. Solve the resulting simultaneous linear equations for the assumed loop currents

MESH ANALYSIS (GENERAL APPROACH)

EXAMPLE 8.11 Consider the same basic network as in Example 8.9, now appearing as Fig. 8.30.

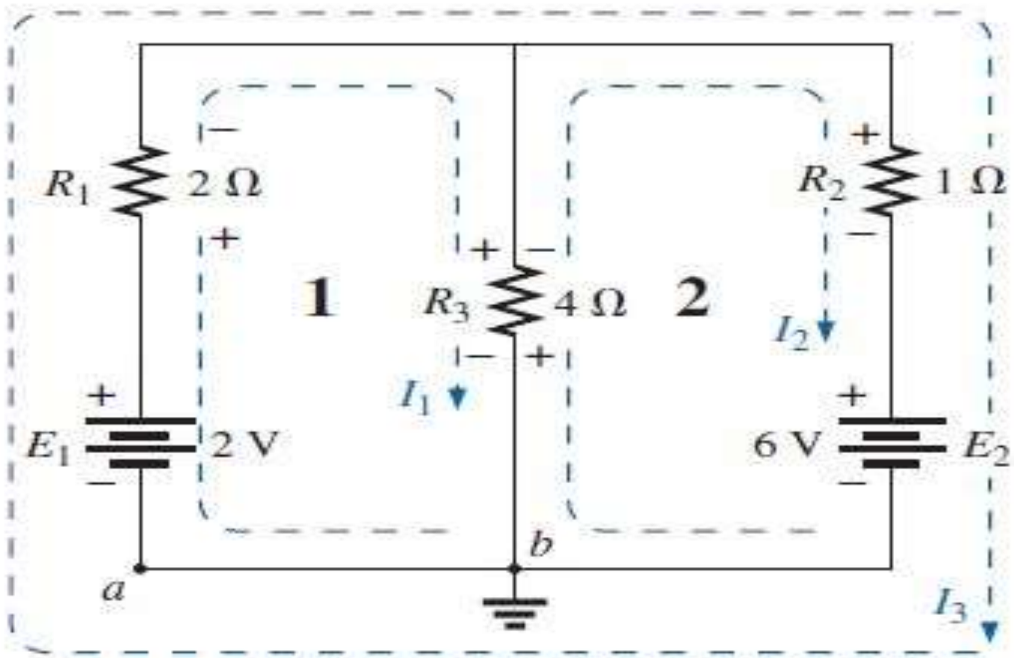


FIG. 8.30
Defining the mesh currents for a "two-window" network.

MESH ANALYSIS (GENERAL APPROACH)

SOLUTION:

Step 1: Two loop currents (*I*1 and *I*2) are assigned in the clockwise direction in the windows of the network. A third loop (*I*3) could have been included around the entire network, but the information carried by this loop is already included in the other two.

Step 2: Polarities are drawn within each window to agree with assumed current directions. Note that for this case, the polarities across the 4 _ resistor are the opposite for each loop current.

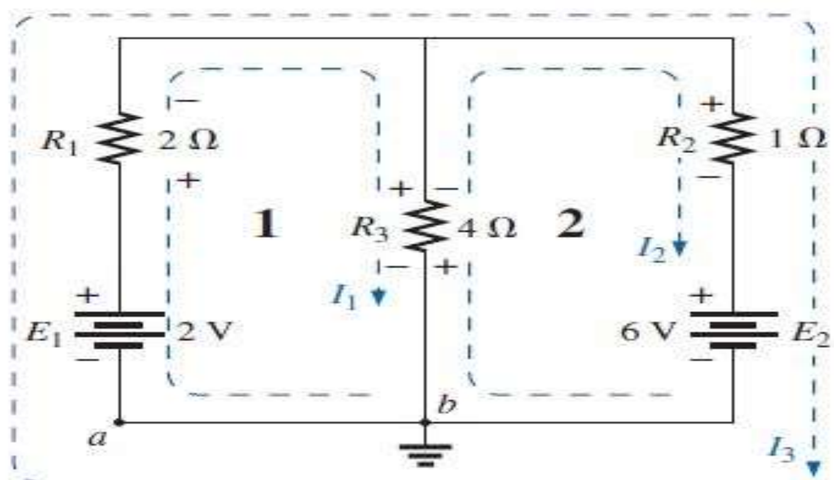


FIG. 8.30
Defining the mesh currents for a "two-window" network.

MESH ANALYSIS (GENERAL APPROACH)

SOLUTION:

Step 3: Kirchhoff's voltage law is applied around each loop in the clockwise direction.

loop 1: $+E_1 - V_1 - V_3 = 0$ (clockwise starting at point a)

$$+2\text{ V} - (2\ \Omega)\, I_1 - \overbrace{(4\ \Omega)\underbrace{(I_1 - I_2)}_{\substack{\text{Total current}\\ \text{through}\\ 4\ \Omega\text{ resistor}}}}^{\substack{\text{Voltage drop across}\\ 4\ \Omega\text{ resistor}}} = 0$$

Subtracted since I_2 is opposite in direction to I_1.

loop 2: $-V_3 - V_2 - E_2 = 0$ (clockwise starting at point b)

$$-(4\ \Omega)(I_2 - I_1) - (1\ \Omega)I_2 - 6\text{ V} = 0$$

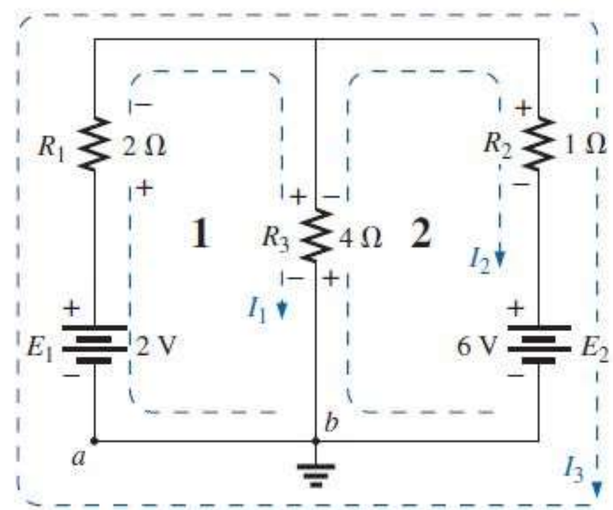


FIG. 8.30
Defining the mesh currents for a "two-window" network.

MESH ANALYSIS (GENERAL APPROACH)

SOLUTION:

Step 4: The equations are then rewritten as follows (without units for clarity):

$$\text{loop 1:} \quad +2 - 2I_1 - 4I_1 + 4I_2 = 0$$
$$\text{loop 2:} \quad -4I_2 + 4I_1 - 1I_2 - 6 = 0$$

and

$$\text{loop 1:} \quad +2 - 6I_1 + 4I_2 = 0$$
$$\text{loop 2:} \quad -5I_2 + 4I_1 - 6 = 0$$

or

$$\text{loop 1:} \quad -6I_1 + 4I_2 = -2$$
$$\text{loop 2:} \quad +4I_1 - 5I_2 = +6$$

Applying determinants results in

$$I_1 = -1\,\text{A} \quad \text{and} \quad I_2 = -2\,\text{A}$$

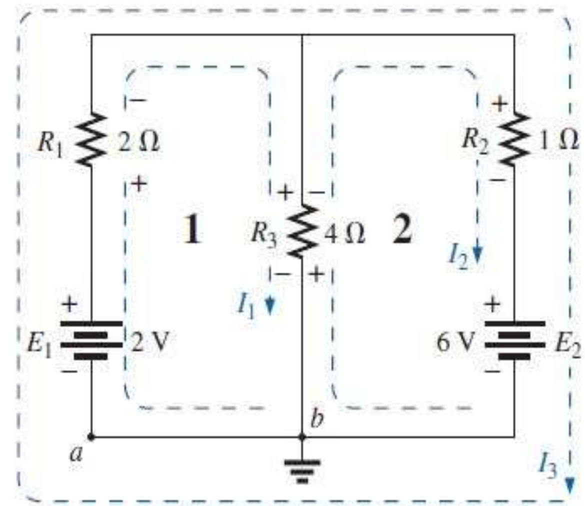


FIG. 8.30
Defining the mesh currents for a "two-window" network.

The minus signs indicate that the currents have a direction opposite to that indicated by the assumed loop current.

MESH ANALYSIS (GENERAL APPROACH)

EXAMPLE 8.12 Find the current through each branch of the network in Fig. 8.31.

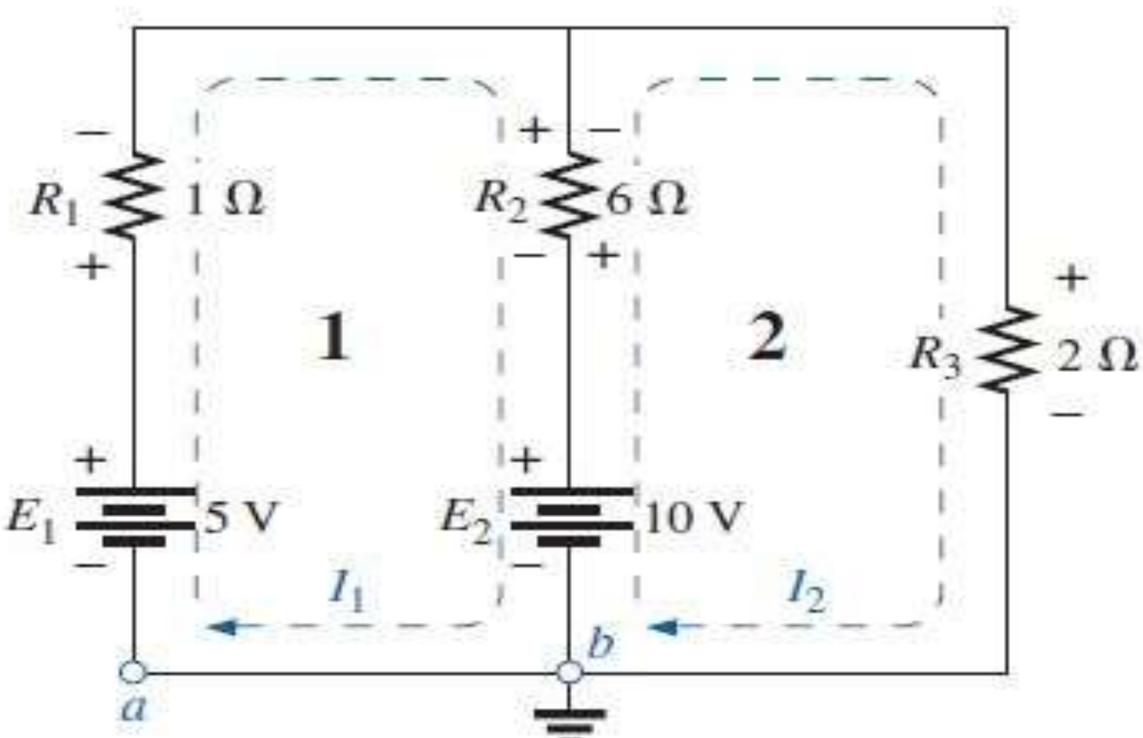


FIG. 8.31
Example 8.12.