Mesh-Current Circuit Analysis Method

The following outlines the mesh-current circuit analysis method.

Step 1 – Identify all meshes (loops that do not enclose any other loops) and label a mesh current for each loop.

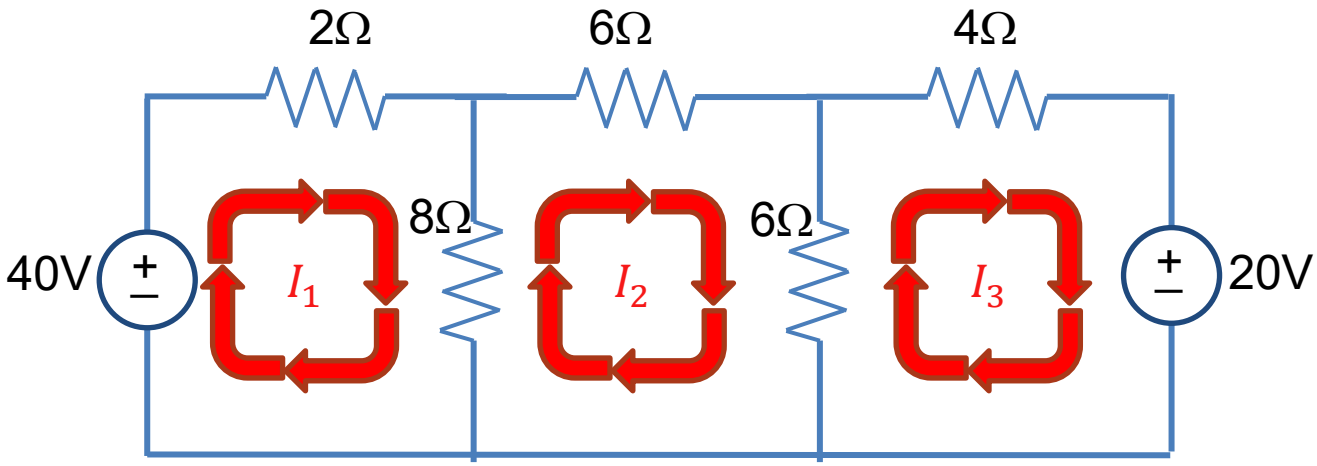
Step 2 - Identify voltages across all resistors in each mesh and write in terms of mesh currents.

Step 3 – Use KVL to write an equation for each mesh.

Step 4 – Solve for unknowns

Step 5 – Write actual currents through various elements in terms of mesh currents.

Mesh-Current Circuit Analysis Method



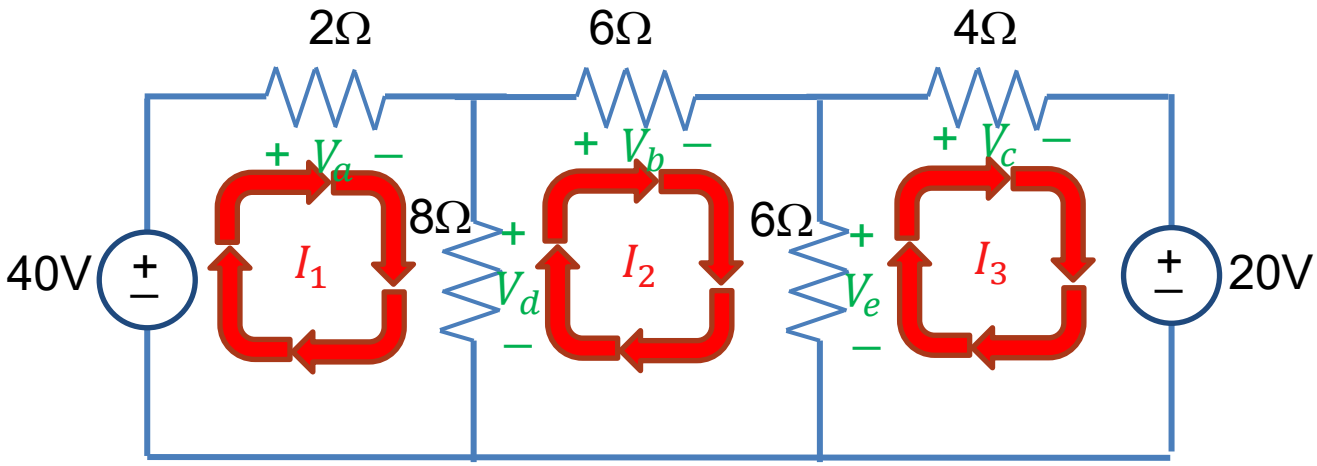
Step 1 – Identify all meshes (loops that do not enclose any other loops) and label a mesh current for each loop.

Notes:

- Mesh currents are not necessarily actual currents that you can measure anywhere in the circuit.

- You can make your mesh currents go clockwise or counterclockwise, or some CW and others CCW. It doesn't matter.

Mesh-Current Circuit Analysis Method



$$V_a = 2(I_1) \qquad V_b = 6(I_2) \qquad V_c = 4(I_3)$$

$$V_d = 8(I_1 - I_2) \qquad V_e = 6(I_2 - I_3)$$

Step 2 - Identify voltages across all resistors in each mesh and write in terms of mesh currents.

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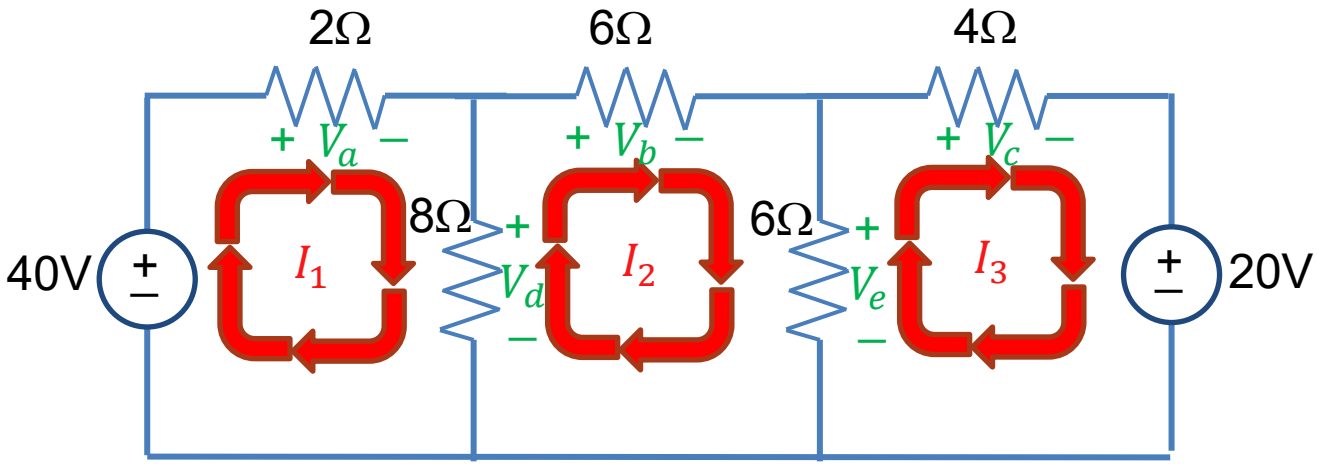


Loop 1: $40 = V_a + V_d$

$40 = 2I_1 + 8(I_1 - I_2)$

Loop 2: $V_d = V_b + V_e$

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

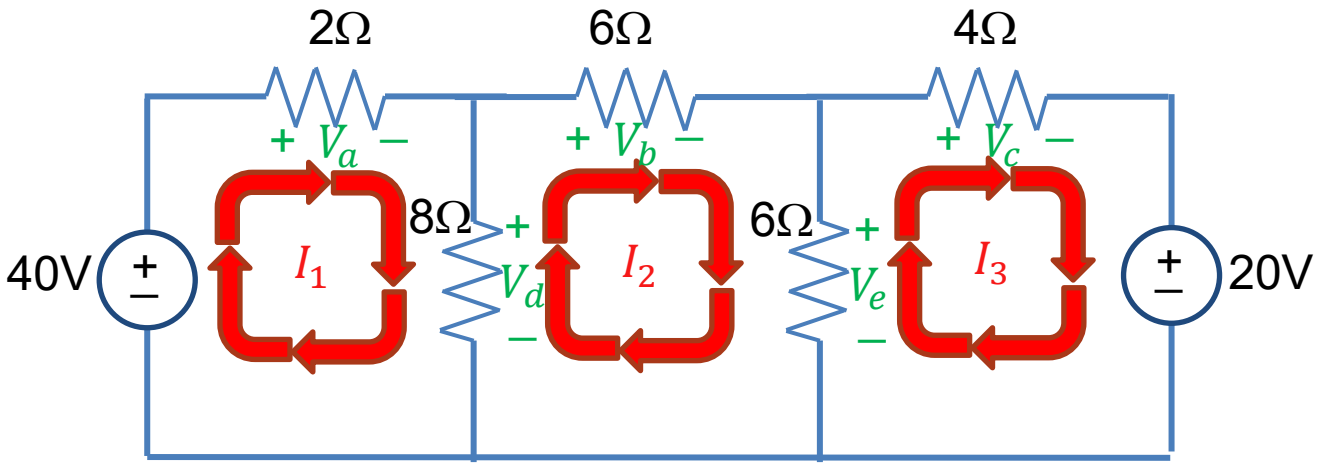
$$\begin{bmatrix} 10 & -8 & 0 \\ 8 & -20 & 6 \\ 0 & -6 & 10 \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \\ I_3 \end{bmatrix} = \begin{bmatrix} 40 \\ 0 \\ -20 \end{bmatrix}$$

Loop 3: $V_e = V_c + 20$

$6(I_2 - I_3) = 4I_3 + 20 = 0$

Step 3 – Use KVLs to write an equation for each mesh.

Mesh-Current Circuit Analysis Method



$$\begin{bmatrix} 10 & -8 & 0 \\ 8 & -20 & 6 \\ 0 & -6 & 10 \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \\ I_3 \end{bmatrix} = \begin{bmatrix} 40 \\ 0 \\ -20 \end{bmatrix}$$

$$I_1 = 5.6,\ I_2 = 2,\ I_3 = -0.8$$

Step 4 – Solve for unknowns

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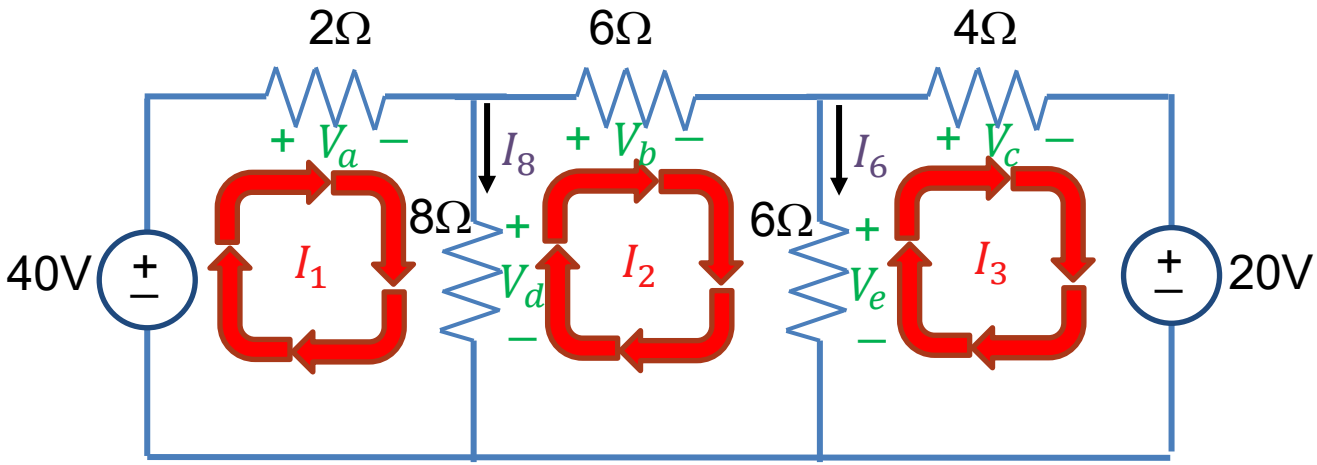


$I_1 = 5.6A,\ \ I_2 = 2A,\ \ I_3 = -0.8A$

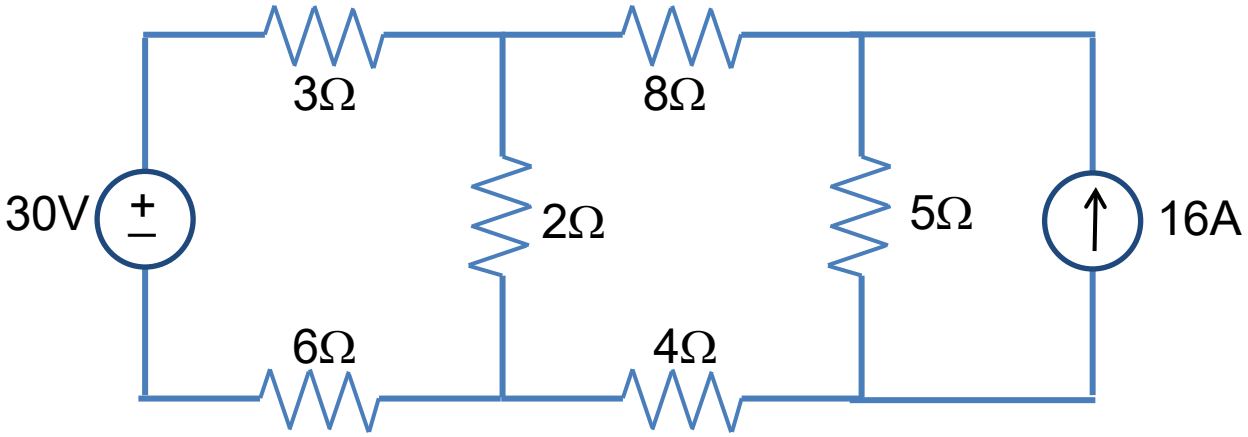
$I_8 = I_1 - I_2 = 5.6 - 2 = 3.6A$

$I_6 = I_2 - I_3 = 2 - (-0.8) = 2.8A$

Step 5 – Write actual currents through various elements in terms of mesh currents.

In-Class Example: Text Assessment Problem 4.10 (M-C method w/ current sources)

Use the mesh current method to find the power dissipated in the 2Ω resistor.



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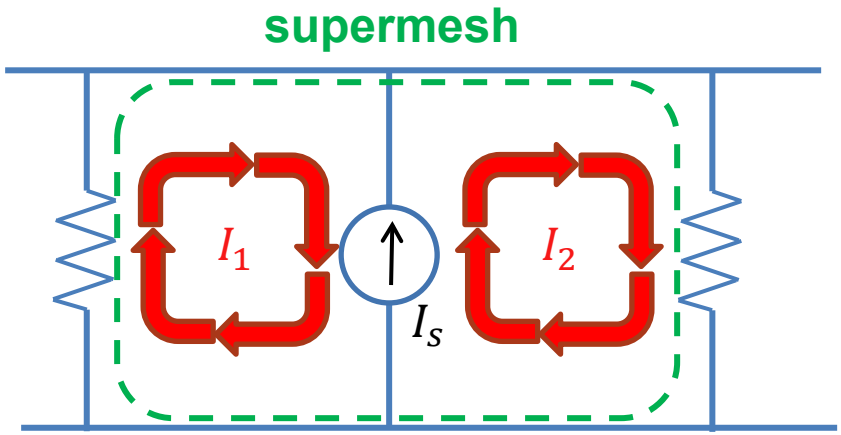

For circuits where a current source falls in a mesh where we need to use KVL, we can run into problems since the voltage across the current source may not be known. We can use a "supermesh" to avoid needing to know the voltage across a current source.

- Within the supermesh: $I_s = I_2 - I_1$
- Around the supermesh: Do KVL

Example

Find the power dissipated in the 1Ω resistor.