Chapter 4 – techniques of circuit analysis

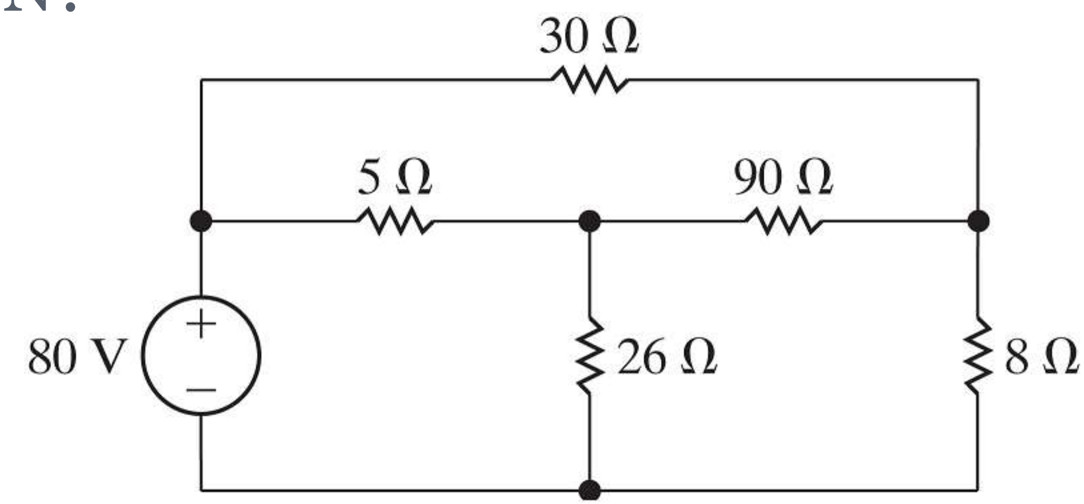
The mesh current method:

- The dual of the node voltage method
- Uses KVL equations around meshes
- Solves directly for currents
- Special cases for dependent sources and for current sources in a mesh.

The basic mesh current method recipe:

1. Identify the meshes
2. Label each with a mesh current
3. Write a KVL equation around each mesh
4. Put equations in standard form and solve
5. Check your solutions by balancing power
6. Calculate quantities of interest

How many meshes does this circuit contain?



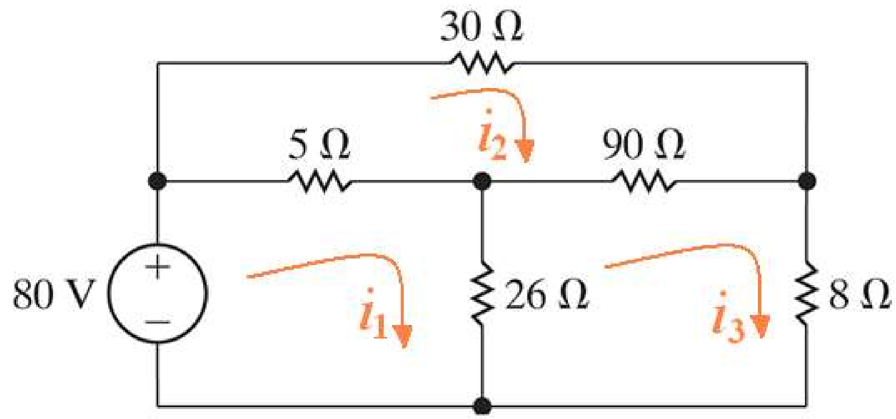
A. 1

B. 2

C. 3

D. 4

Find the power associated with the voltage source and the 8 Ω resistor, using the mesh current method.



$$i_1 \text{ mesh}: -80+5(i_1-i_2)+26(i_1-i_3)=0$$

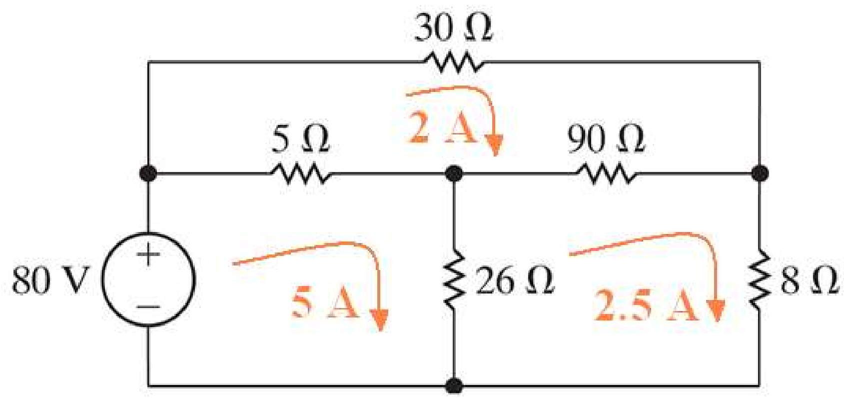
$$i_2 \text{ mesh}: 30(\mathrm{i}_2)+90(i_2-i_3)+5(i_2-i_1)=0$$

$$i_3 \text{ mesh}: 8(\mathrm{i}_3)+26(i_3-i_1)+90(i_3-i_2)=0$$

$$\text{Standard form}: \begin{aligned} \mathrm{i}_1(5+26)+\mathrm{i}_2(-5)+\mathrm{i}_3(-26) &= 80 \\ \mathrm{i}_1(-5)+\mathrm{i}_2(30+90+5)+\mathrm{i}_3(-90) &= 0 \\ \mathrm{i}_1(-26)+\mathrm{i}_2(-90)+\mathrm{i}_3(8+26+90) &= 0 \end{aligned}$$

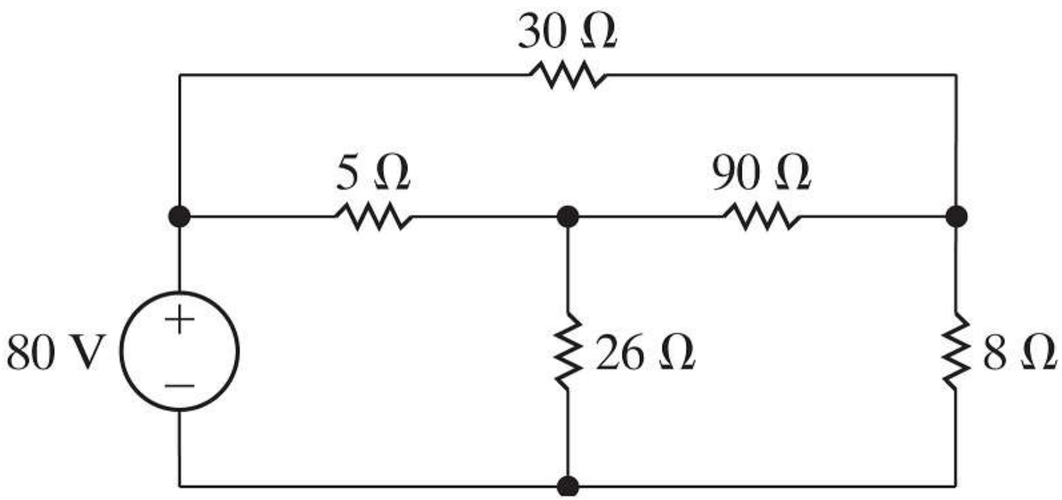
$$\text{Solution}: i_1 = 5\text{ A};\quad i_2 = 2\text{ A};\quad i_3 = 2.5\text{ A}$$

Power balance:



Component	Equation	p [W]
80 V	$-(5)(80)$	–400
5 Ω	$(5 - 2)^2(5)$	45
90 Ω	$(2.5 - 2)^2(90)$	22.5
30 Ω	$(2)^2(30)$	120
26 Ω	$(5 - 2.5)^2(26)$	162.5
8 Ω	$(2.5)^2(8)$	50

If you were asked to use the Node Voltage method, how many equations would you write and solve?



A. 3 KCL, 0 constraint
B. 2 KCL, 1 constraint
C. 1 KCL, 2 constraint
D. 2 KCL, 0 constraint

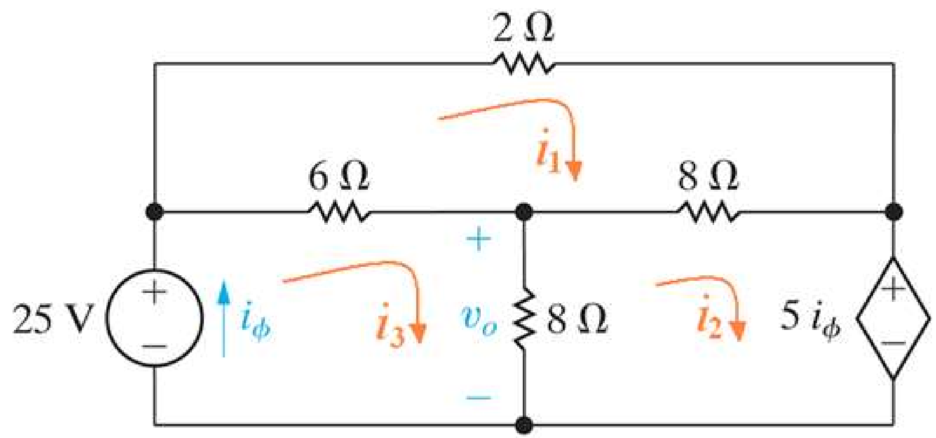
Mesh current method, special cases:

- Dependent sources
- Current source on the perimeter of a mesh
- Current source shared between two meshes

The modified mesh current method recipe:

1. Identify the meshes
2. Label each with a mesh current
3. Write a KVL equation around each mesh
   a) Are there any dependent sources? If so, write a constraint equation defining the controlling quantity for the dependent source
4. Put equations in standard form and solve
5. Check your solutions by balancing power
6. Calculate quantities of interest

Find v_o using the mesh current method.



i_1 mesh: $2i_1 + 8(i_1 - i_2) + 6(i_1 - i_3) = 0$

i_2 mesh: $5i_\phi + 8(i_2 - i_3) + 8(i_2 - i_1) = 0$

i_3 mesh: $-25 + 6(i_3 - i_1) + 8(i_3 - i_2) = 0$

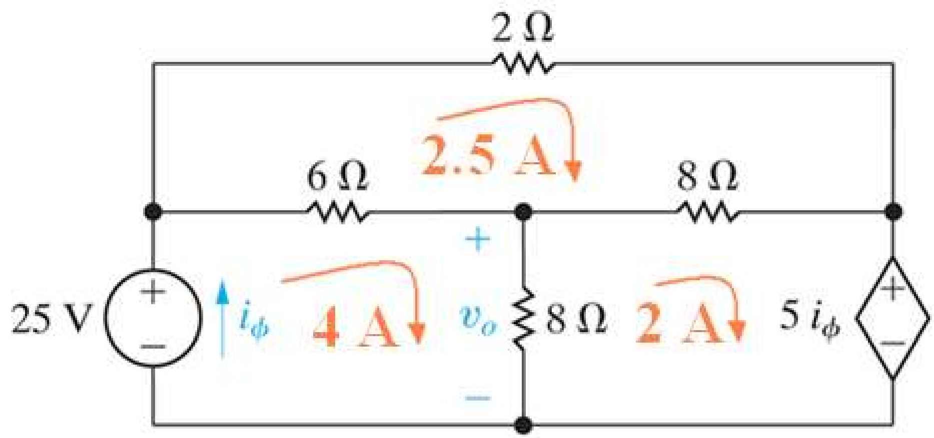
constraint: $i_\phi = i_3$

Standard form:

$$
\begin{aligned}
i_1(2+8+6) + i_2(-8) + i_3(-6) &= 0 \\
i_1(-8) + i_2(8+8) + i_3(5-8) &= 0 \\
i_1(-6) + i_2(-8) + i_3(6+8) &= 25
\end{aligned}
$$

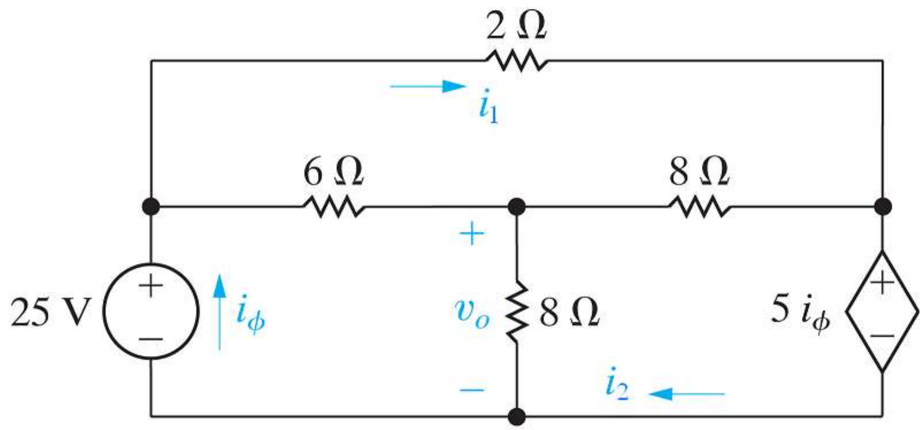
Solution: $i_1 = 2.5\text{ A};\quad i_2 = 2\text{ A};\quad i_3 = i_\phi = 4\text{ A}$

Power balance:



Component	Equation	p [W]
25 V	–(4)(25)	–100
Dep. source	(2)[5(4)]	40
6 Ω	$(4 - 2.5)^2(6)$	13.5
2 Ω	$(2.5)^2(2)$	12.5
8 Ω (middle)	$(4 - 2)^2(8)$	32
8 Ω (right)	$(2 - 2.5)^2(8)$	2

IF $i_\phi = 4$ A, $i_1 = 2.5$ A, AND $i_2 = 2$ A, WHAT IS THE CURRENT IN THE MIDDLE 8 Ω RESISTOR FROM + TO –?



A. 2 A
B. 4 A
C. 4.5 A
D. 6 A