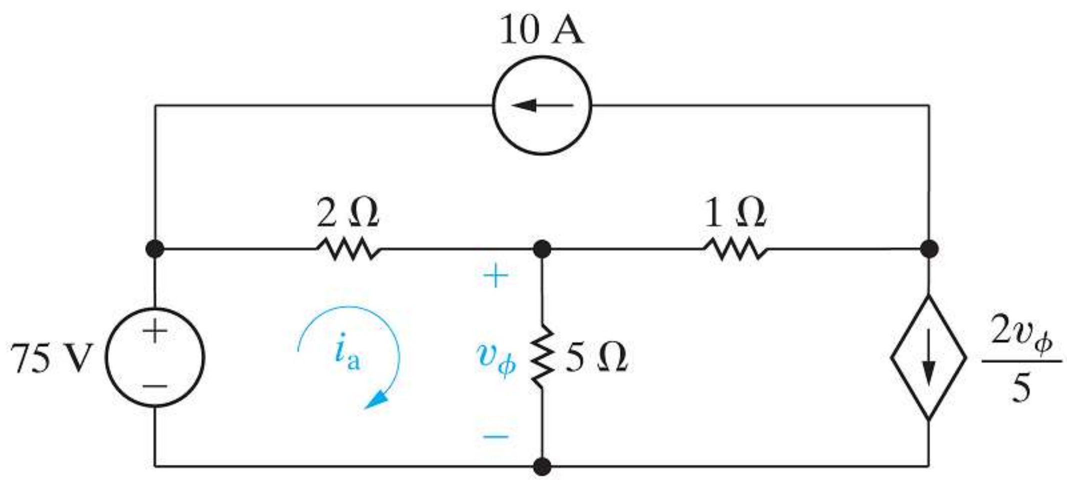
Suppose we define two additional mesh currents, in the clockwise direction, in this circuit. What is the value of the mesh current in the upper mesh?



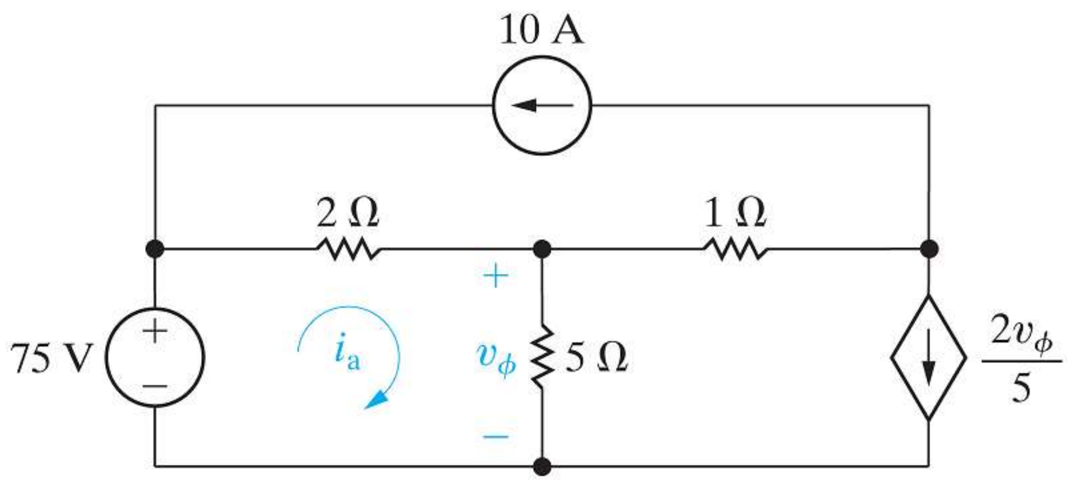
- A. 10 A
- B. –10 A
- C. 75 V / 2 + 3
- D. We cannot tell until we analyze the circuit!

CHAPTER 4 – TECHNIQUES OF CIRCUIT ANALYSIS

The modified mesh current method recipe:

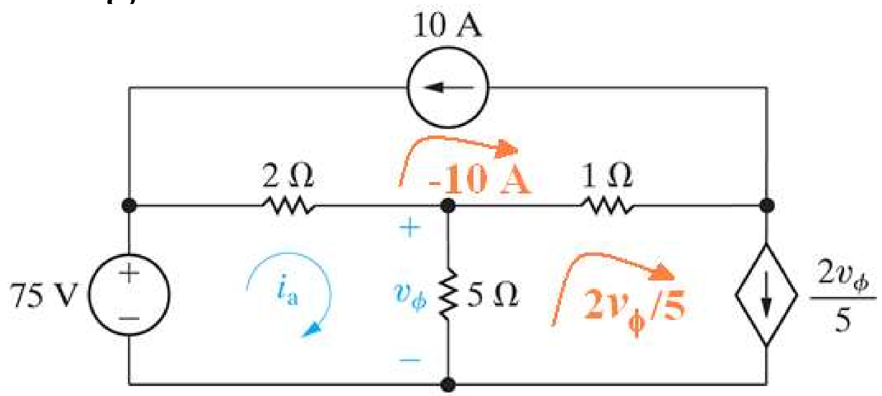
1. Identify the meshes
2. Label each with a mesh current
   a) Are there any current sources on the perimeter of a mesh? If so, label the mesh current with the value of the source
3. Write a KVL equation around each mesh where the mesh current is unknown
   a) Are there any dependent sources? If so, 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

IF WE USE THE REVISED "RECIPE" TO LABEL "KNOWN" MESH CURRENTS, HOW MANY KVL EQUATIONS WILL WE HAVE TO WRITE?



- A. 3
- B. 2
- C. 1
- D. 0

Find i_a using the mesh current method.



$$i_a \text{ mesh}: \; -75 + 2(i_a - (-10)) + 5\left(i_a - \frac{2v_\phi}{5}\right) = 0$$

$$\text{constraint}: \; v_\phi = 5\left(i_a - \frac{2v_\phi}{5}\right)$$

$$\text{Std. form}: \quad \mathrm{i_a}(2+5) + v_\phi(-2(5)/5) \quad = 75 - 20$$

$$\mathrm{i_a}(5) + v_\phi(-2/5 - 1) \qquad = 0$$

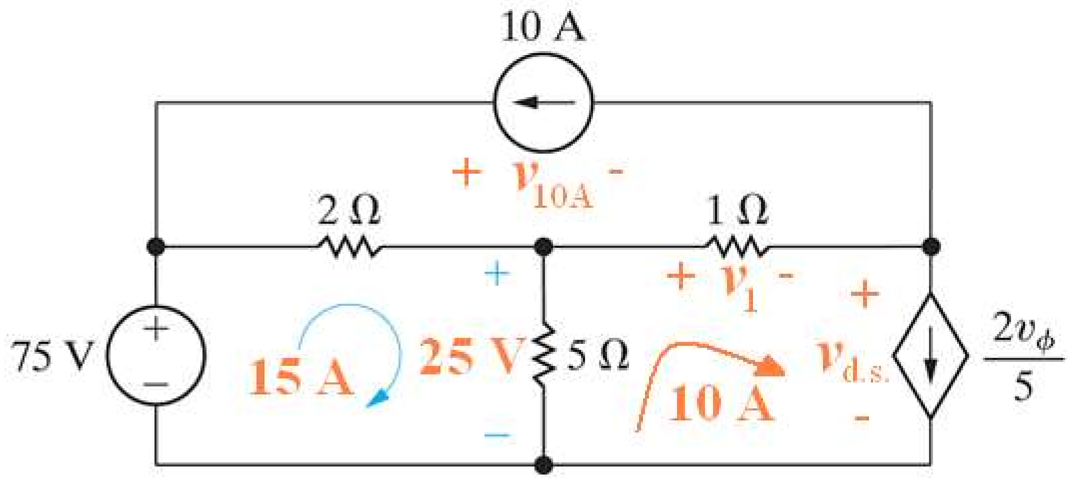
$$\text{Solving}: \; i_a = 15 \text{ A}; \quad \mathrm{v}_\phi = 25 \text{ V}$$

Power balance:

$$v_1 = (-10-10)/1 = -20\ \text{V}$$

$$v_{ds} = v_1 + v_\phi = -20 + 25 = 5\ \text{V}$$

$$v_{10A} = 75 - v_{ds} = 75 - 5 = 70\ \text{V}$$

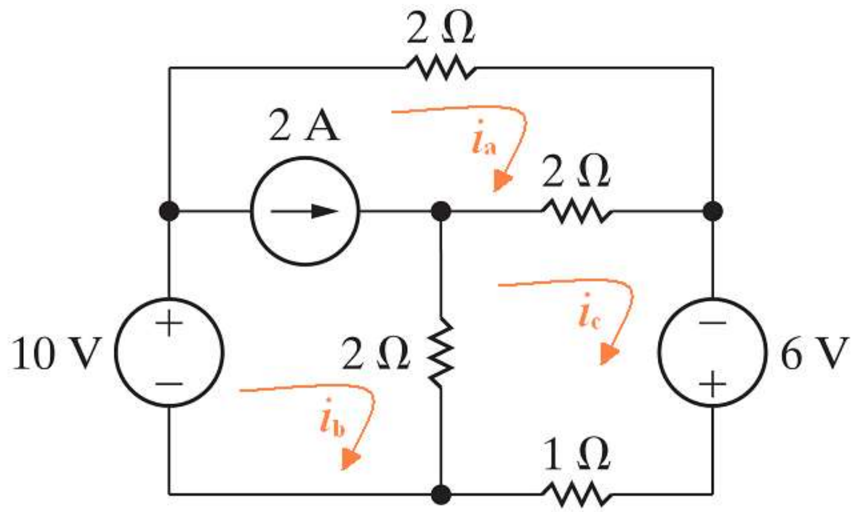


Component	Equation	p [W]
75 V	–(15)(75)	–1125
Dep. source	(5)(10)	50
10 A	–(70)(10)	–700
2 Ω	$(15+10)^2(2)$	1250
1 Ω	$(10+10)^2(1)$	400
5 Ω	$25^2/5$	125

The node voltage method has a "special case" when a circuit has a super node – a voltage source that is the only component in a branch connecting two non-reference essential nodes. The mesh current method has a special case for "super meshes", which exist when

A. A voltage source is on the perimeter of a mesh ✗
B. A current source is on the perimeter of a mesh ✗
C. A voltage source is shared between two meshes ✗
D. A current source is shared between two meshes ✓

This circuit has a super mesh created from the two meshes with the following mesh currents:



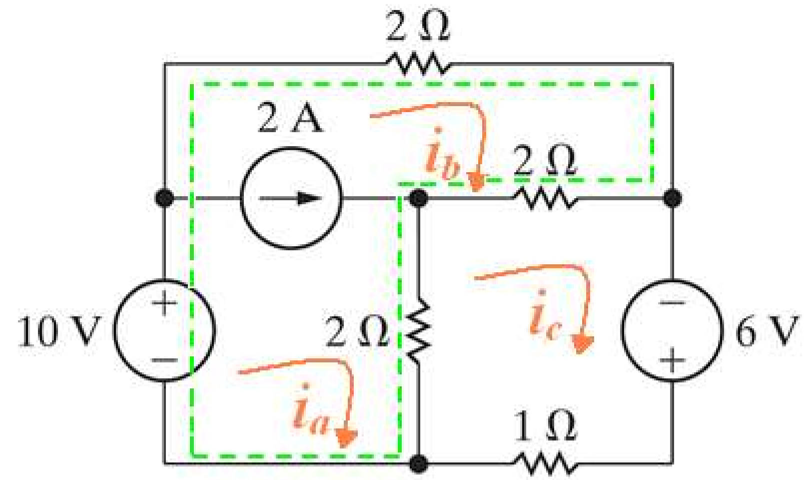
A. i_a and i_b
B. i_a and i_c
C. i_b and i_c
D. i_a and i_b and i_c

Chapter 4 – techniques of circuit analysis

The modified mesh current method recipe:

1. Identify the meshes
2. Label each with a mesh current
   a) Are there any current sources on the perimeter of a mesh? If so, label the mesh current with the value of the source
   b) Are there any current sources shared between two meshes? If so, create a supermesh by combining the two meshes and erasing the current source temporarily
3. Write a KVL equation around each supermesh and each single mesh where the mesh current is unknown
   a) Are there any dependent sources? If so, write a constraint equation defining the controlling quantity for the dependent source
   b) Are there any supermeshes? If so, write a supermesh constraint equation
4. Put equations in standard form and solve
5. Check your solutions by balancing power
6. Calculate quantities of interest

Find the power absorbed by the 1 Ω resistor using the mesh current method.



$$\text{supermesh}: \; -10 + 2i_b + 2(i_b - i_c) + 2(i_a - i_c) = 0$$

$$i_c \text{ mesh}: \; -6 + 1i_c + 2(i_c - i_a) + 2(i_c - i_b) = 0$$

$$\text{SM constraint}: \; 2 = i_a - i_b$$

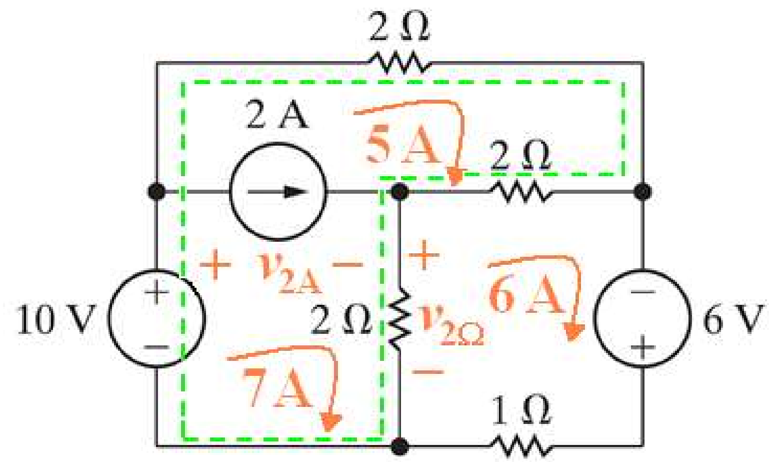
$$\text{Std form}: \quad \begin{aligned} i_a(2) + i_b(2+2) + i_c(-2-2) &= 10 \\ i_a(-2) + i_b(-2) + i_c(1+2+2) &= 6 \\ i_a(1) + i_b(-1) + i_c(0) &= 2 \end{aligned}$$

$$\text{Solving}: \; i_a = 7\text{ A}; \quad i_b = 5\text{ A}; \quad i_c = 6\text{ A};$$

Power balance:

$$v_{2\Omega} = (7-6)(2) = 2\ \text{V}$$

$$v_{2\text{A}} = 10 - v_{2\Omega} = 8\ \text{V}$$



Component	Equation	p [W]
10 V	–(7)(10)	–70
6 V	–(6)(6)	–36
2 A	(2)(8)	16
2 Ω (top)	$(5)^2(2)$	50
2 Ω (right)	$(5-6)^2(2)$	2
2 Ω (middle)	$(7-6)^2(2)$	2
1 Ω	$(6)^2(1)$	36