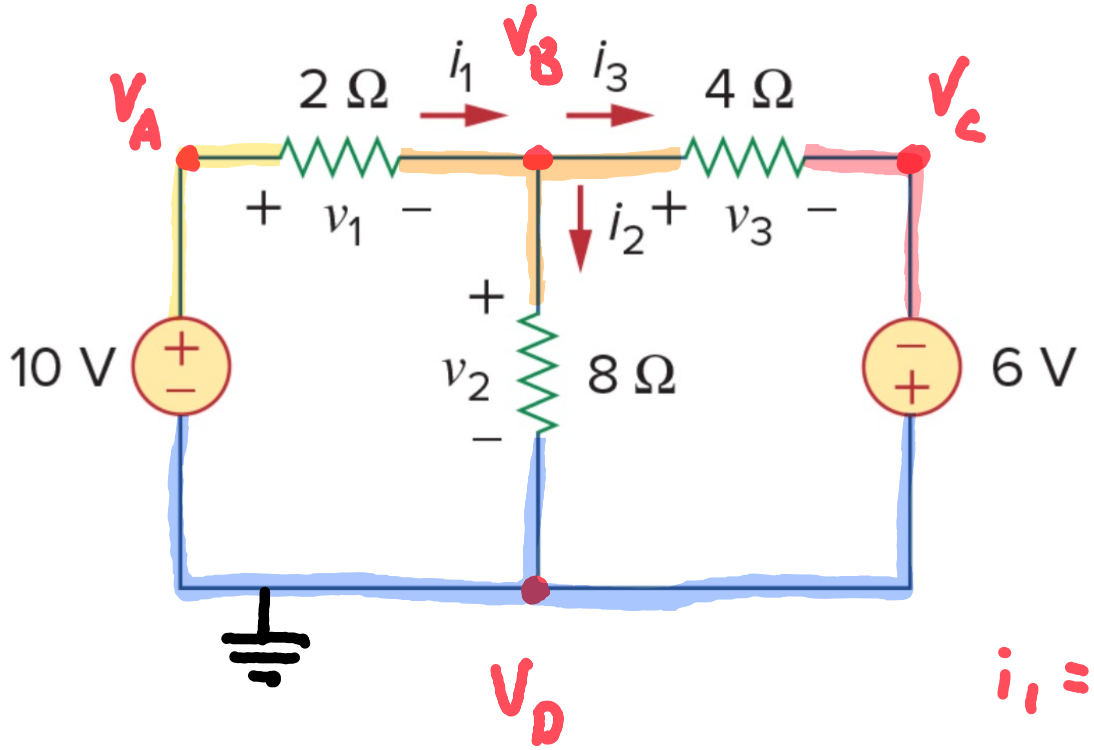
Last Class…

Using node voltage analysis, find the i_1, i_2, and i_3



$V_A = 10\,V$ $\quad$ $V_C = -6\,V$

$V_B =$ $\quad$ $V_D = 0\,V$

KCL @ V_B

$i_1 = i_2 + i_3$

$i_1 = \frac{1}{2} V_A = 5\,A$

$i_2 = i_1 - i_3$

$i_3 = \frac{1}{4} V_C = -\frac{3}{2}\,A$

$i_2 = 5 + \frac{3}{2} = \frac{13}{2}\,A$

$$\boxed{\begin{aligned} i_1 &= 5A \\ i_2 &= \tfrac{13}{2}A \\ i_3 &= -\tfrac{3}{2}A \end{aligned}}$$

THE OHIO STATE UNIVERSITY

COLLEGE OF ENGINEERING

Mesh Current Analysis

This Lecture…

- Learning Objectives:
  - Apply the mesh-current analysis technique to linear electric circuits.
  - Identify a super-mesh.
  - Apply the mesh-current technique to analyze electric circuits that contain super-meshes.

Mesh Current Analysis

Mainly used to solve for mesh currents.

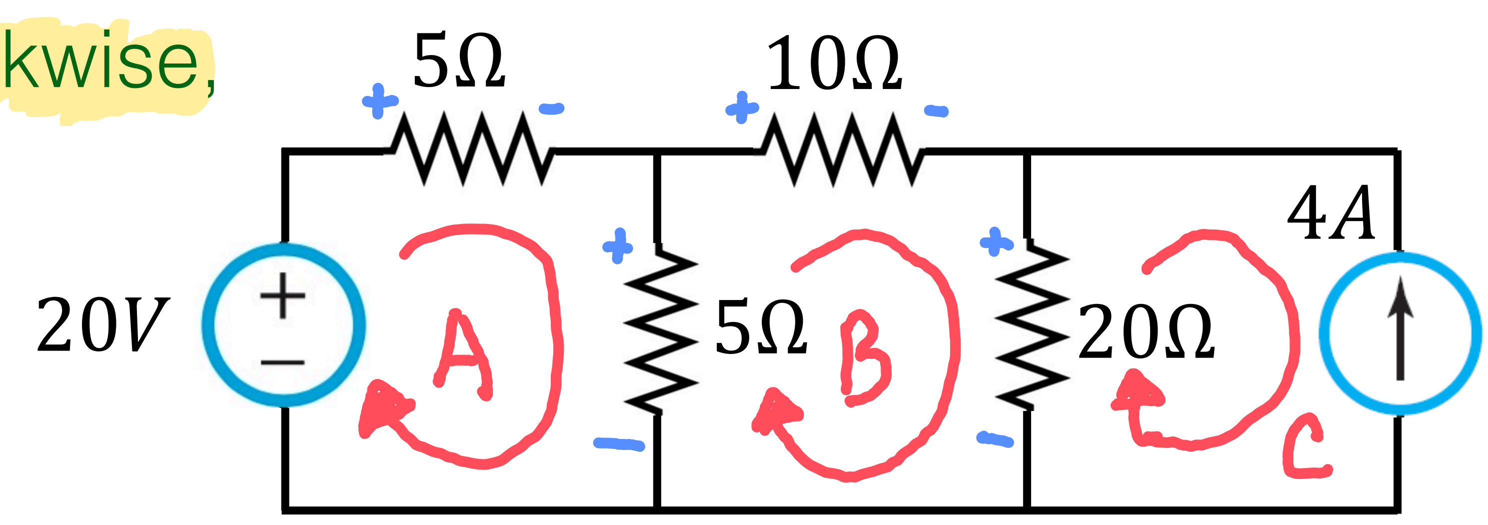
1. Identify how many meshes there are and assign variables to each of them.
2. Identify if the current on any of the meshes is known.

   if a current source is only part of 1 mesh

   $i_c = -4A$

3. Assign voltage signs to each element.

- It is important to be consistent in choosing the direction of current flow.
- Define mesh currents clockwise, for convenience.



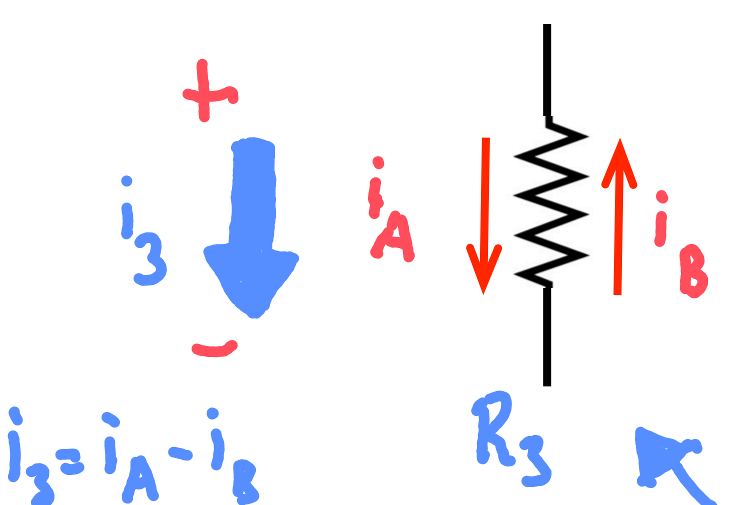
Mesh Current Analysis

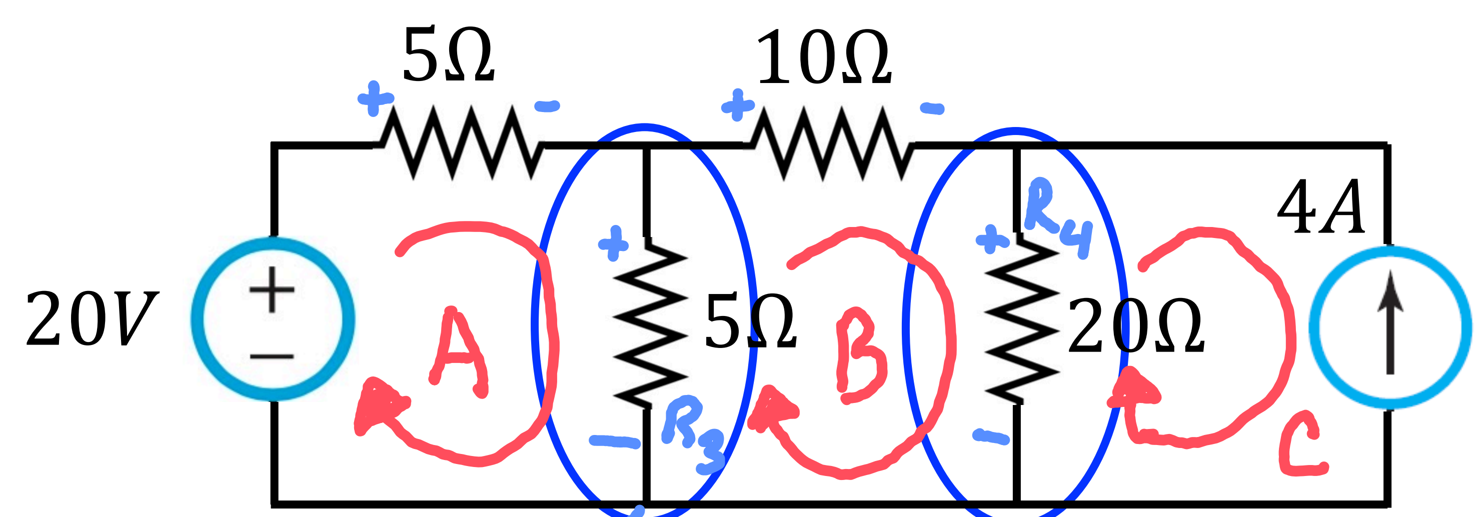
1. Identify how many meshes there are and assign variables to each of them.

2. Identify if the current on any of the meshes is known.

3. Assign voltage signs to each element.

We are assuming that current on mesh a is higher than current on mesh b.





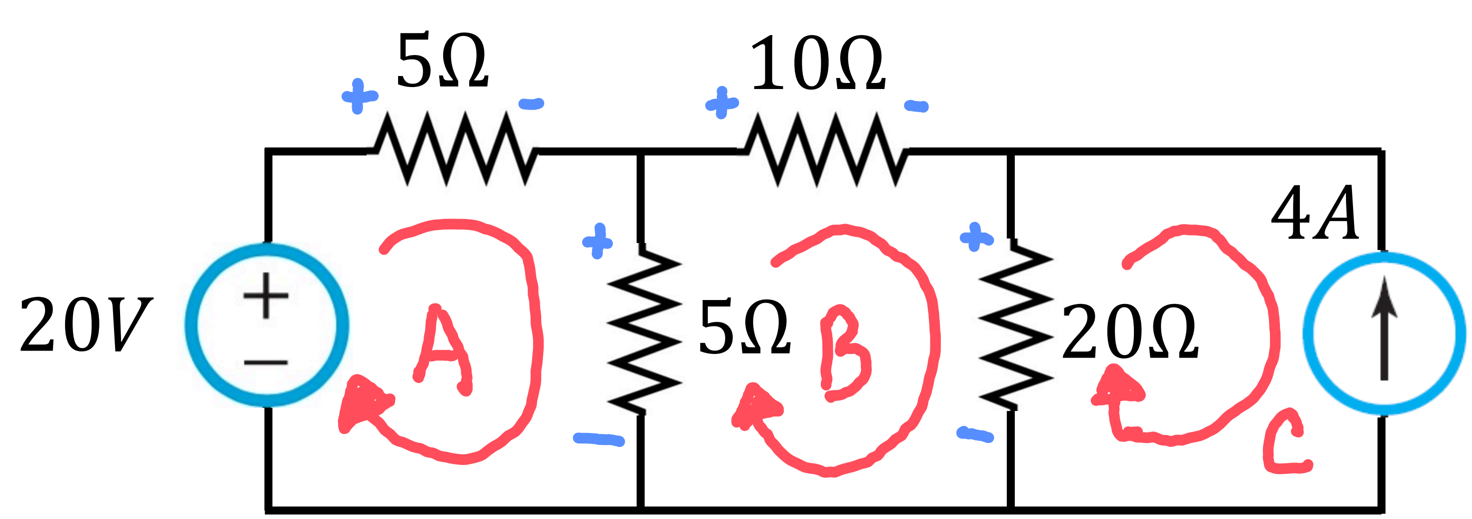
Mesh Current Analysis

1. Identify how many meshes there are and assign variables to each of them.
2. Identify if the current on any of the meshes is known.
3. Assign voltage signs to each element.
4. Apply KVL to all the remaining meshes.
5. Solve.

Step 1 → 3 meshes

Step 2 → know 1 mesh

Step 4 → 2 meshes left



4. KVL @ A

$$20 = V_1 + V_3$$

KVL @ B

$$V_2 = V_3 + V_4$$

5.1 Apply Ohm's Law $V = IR$

KVL @ A

$$20 = 5i_1 + 5i_3$$

KVL @ B

$$10i_2 = 5i_3 + 20i_4$$

5.2 Write resistor current as a combination of mesh currents

$i_1 = i_A$

$i_2 = i_B$

$i_3 = i_A - i_B$

$i_4 = i_C - i_B = -4 - i_B$

5.3 Plug 5.2 into 5.1

<u>KVL@A</u>

$20 = 5i_A - 5(i_A - i_B)$

$20 = 10i_A - 5i_B$

<u>KVL@B:</u>

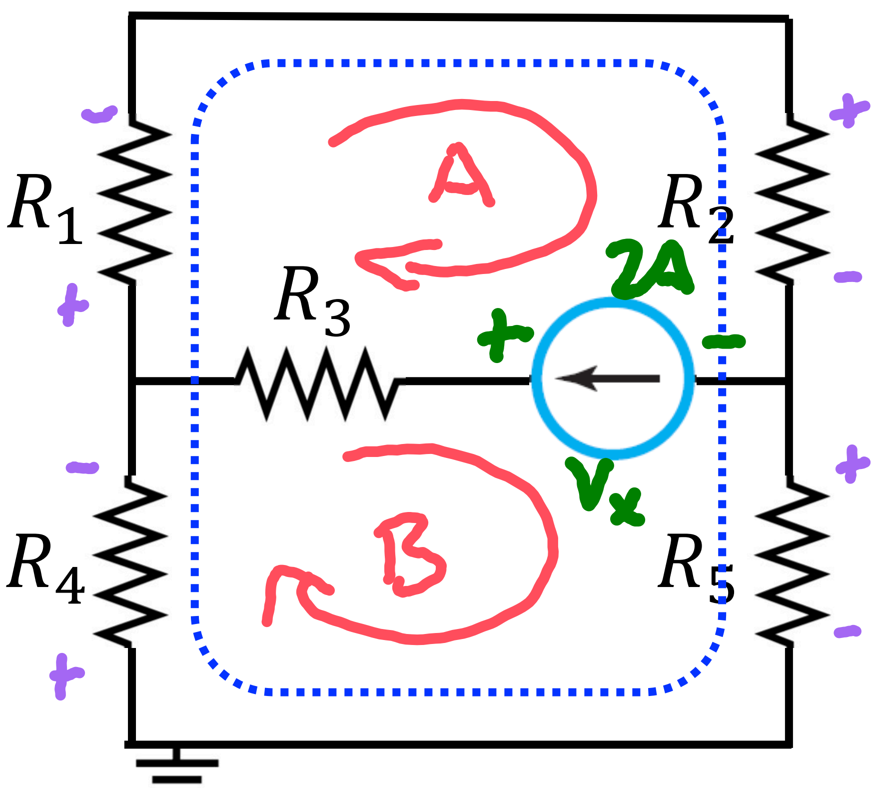
$10i_B = 5(i_A - i_B) + 20(-4 - i_B)$

$10i_B = 5i_A - 5i_B - 80 - 20i_B$

$10i_B = 5i_A - 25i_B - 80$

Super-mesh

- Current source between adjacent meshes.



- We do not know the voltage across the current source.
- "Remove the branch with shared current source."
- DO NOT change mesh currents.

KVL @ A $V_3 + V_1 + V_2 = V_x$ KVL @ B: $-V_3 - V_4 - V_5 = V_x$

Instead of KVL @ A and B:

① Auxiliar Eqn:

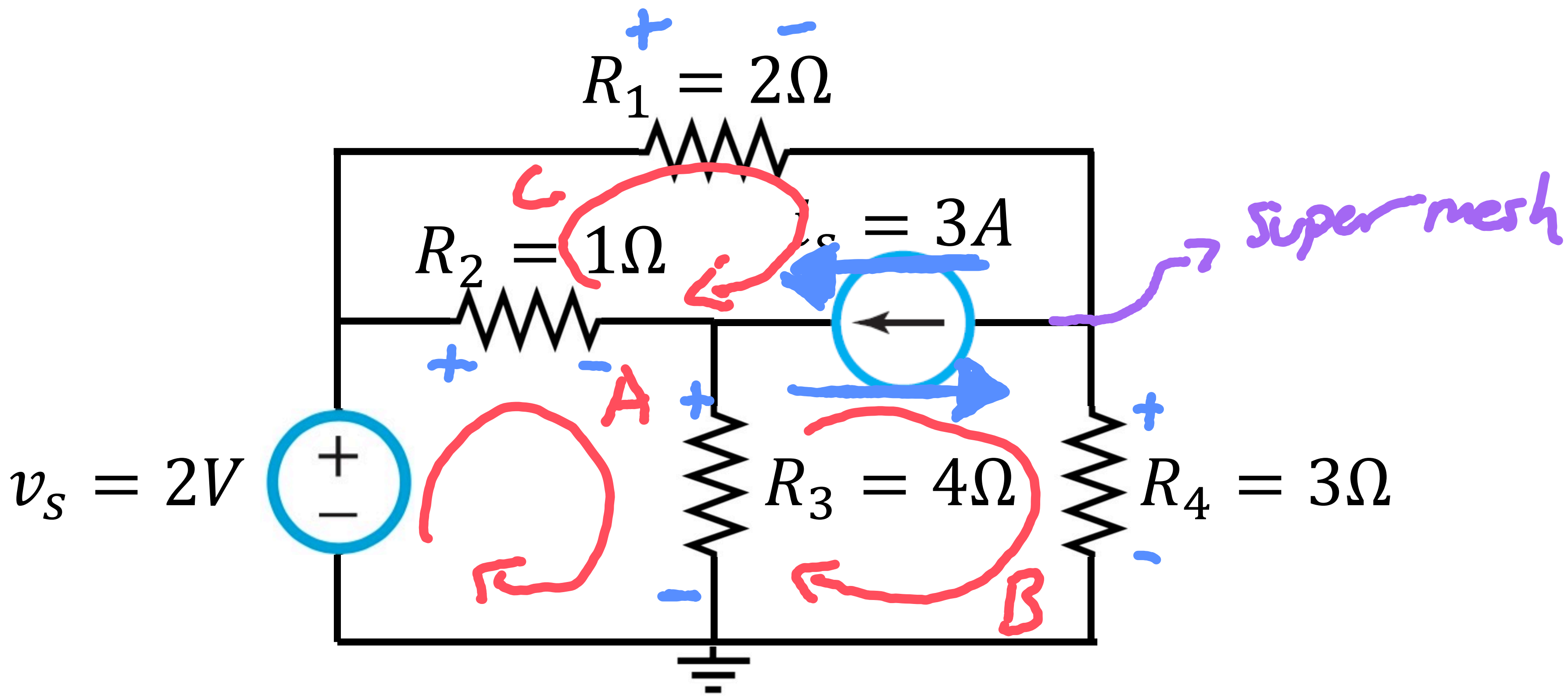
$2 = i_A - i_B$

② KVL @ Super-Mesh

$V_4 + V_1 + V_2 + V_5 = 0$

Example

Using mesh current analysis, find the voltage v_3 across the 4Ω resistor.



KVL @ A:

$2 = V_2 + V_3$

Auxiliar Eqn:

$3 = i_c - i_B$

KVL @ Super-Mesh BC:

rises = drops

$V_3 + V_2 = V_1 + V_4$

Ohm's Law

$i_1 = i_c$ $\quad$ $i_3 = i_a - i_b$

$i_2 = i_a - i_c$ $\quad$ $i_4 = i_b$

$$4i_3 + i_2 = 2i_1 + 3i_4$$

KCL @ A:

$$2 = i_A - i_C + 4(i_A - i_B)$$

$$2 = 5i_A - i_C - 4i_B$$

KCL @ Super-Mesh:

$$4(i_A - i_B) + i_A - i_C = 2i_C + 3i_B$$

$$5i_A - 7i_B - 3i_C = 0$$

$$V_3 = 4i_3 = 4(i_A - i_B)$$