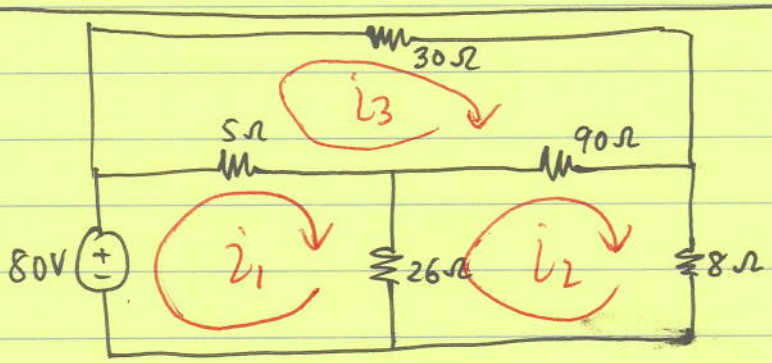
Mesh Current Method

1. Draw a clockwise arrow inside every mesh.
2. Label each arrow $i_1, i_2, i_3, \ldots$
3. Check for special cases (see later)
4. Apply KVL around each mesh
5. Solve resulting equations for $i_1, i_2, i_3, \ldots$

Ex



Find { mesh currents, P_{source}, $P_{8\Omega}$.

Mesh ①: $-80 + 5(i_1 - i_3) + 26(i_1 - i_2) = 0$

Mesh ②: $26(i_2 - i_1) + 90(i_2 - i_3) + 8i_2 = 0$

Mesh ③: $5(i_3 - i_1) + 30i_3 + 90(i_3 - i_2) = 0$

Std form: $i_1(5+26) + i_2(-26) + i_3(-5) = 80$

$i_1(-26) + i_2(26+90+8) + i_3(-90) = 0$

$i_1(-5) + i_2(-90) + i_3(5+30+90) = 0$

$\Rightarrow i_1 = 5A$

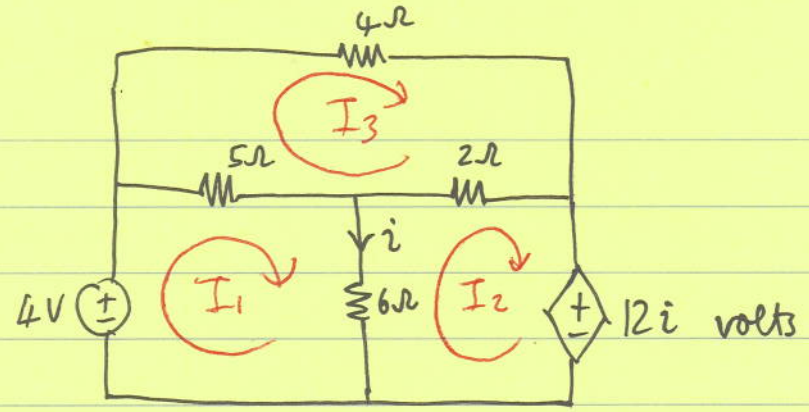
$i_2 = 2.5A$

$i_3 = 2A$

$P_{source} = 80V \times 5A = 400W$

$P_{8\Omega} = (2.5A)^2 \times 8\Omega = 50W$

Ex



mesh ① : $-4 + 5(I_1 - I_3) + 6(I_1 - I_2) = 0$ ..... ①

mesh ② : $6(I_2 - I_1) + 2(I_2 - I_3) + 12i = 0$ ..... ②

mesh ③ : $4I_3 + 2(I_3 - I_2) + 5(I_3 - I_1) = 0$ ..... ③

But $i = I_1 - I_2$, subst in ② :

$$6(I_2 - I_1) + 2(I_2 - I_3) + 12(I_1 - I_2) = 0 \quad \text{--- } ②'$$

Std form: $I_1(5+6) + I_2(-6) + I_3(-5) = +4$

$I_1(-6+12) + I_2(2\overset{+6}{-12}) + I_3(-2) = 0$

$I_1(-5) + I_2(-2) + I_3(4+2+5) = 0$

$$I_1(11) + I_2(-6) + I_3(-5) = 4$$
$$I_1(6) + I_2(-4) + I_3(-2) = 0$$
$$I_1(-5) + I_2(-2) + I_3(11) = 0$$

$$\begin{bmatrix} I_1 \\ I_2 \\ I_3 \end{bmatrix} = \begin{bmatrix} 11 & -6 & -5 \\ 6 & -4 & -2 \\ -5 & -2 & +11 \end{bmatrix}^{-1} \times \begin{bmatrix} 4 \\ 0 \\ 0 \end{bmatrix} = \begin{bmatrix} 6A \\ 7A \\ 4A \end{bmatrix}$$

matrix inverse

or use calculator or Cramer's method.

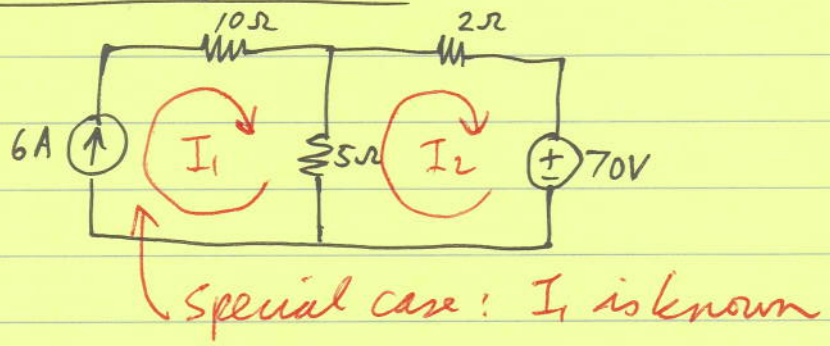
Mesh Current Special Cases

Any current source will always cause a special case.

Case ①: Current source at outside edge of circuit
⇒ Known Mesh Current.

Case ②: Current source inside circuit
⇒ Supermesh

Case ① Known Mesh Current



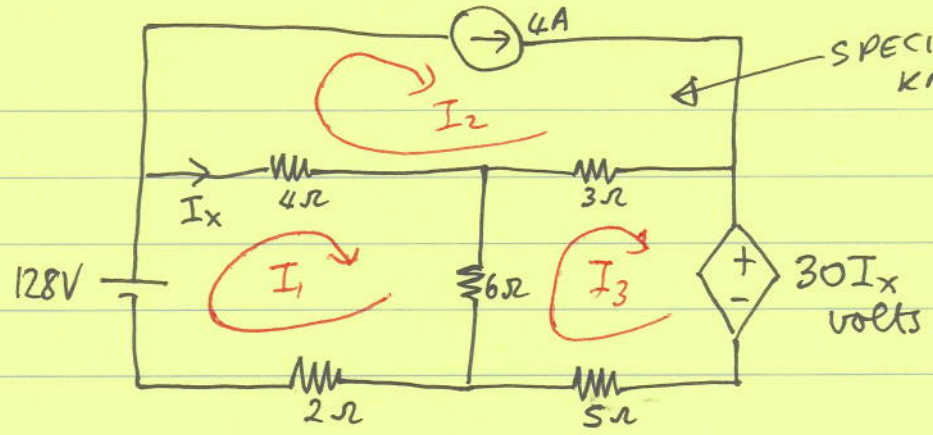
loop ①: $I_1 = 6$

loop ②: $5(I_2 - I_1) + 2I_2 + 70 = 0$

Std form: $\begin{cases} I_1(1) + I_2(0) = 6 \\ I_1(-5) + I_2(5+2) = -70 \end{cases}$

$\Rightarrow \begin{cases} I_1 = 6\,A \\ I_2 = -5.714\,A \end{cases}$

Ex



mesh ①: $-128 + 4(I_1 - I_2) + 6(I_1 - I_3) + 2I_1 = 0$

(K) mesh ②: $I_2 = 4$

mesh ③: $5I_3 + 6(I_3 - I_1) + 3(I_3 - I_2) + 30I_x = 0$

But $I_x = I_1 - I_2$

③′: $5I_3 + 6(I_3 - I_1) + 3(I_3 - I_2) + 30(I_1 - I_2) = 0$

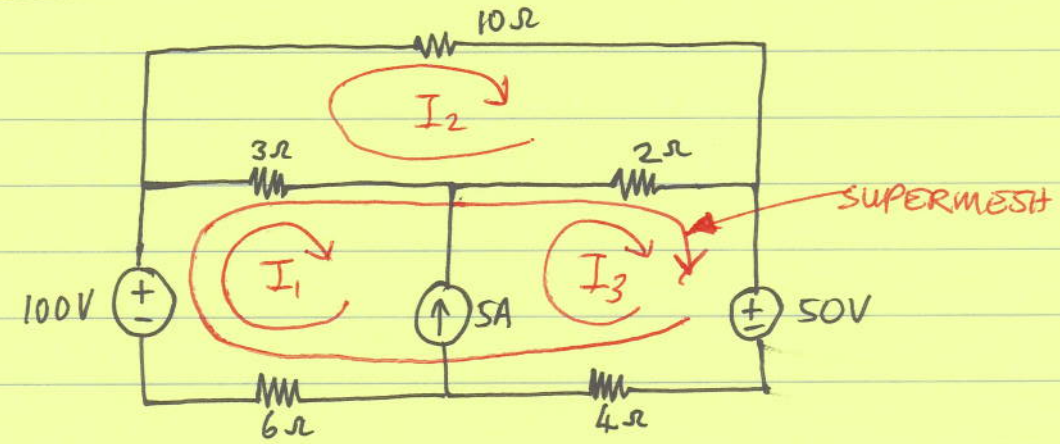
Std form:
$$\begin{cases} I_1(4+6+2) + I_2(-4) + I_3(-6) = +128 \\ I_1(0) + I_2(1) + I_3(0) = 4 \\ I_1(-6+30) + I_2(-3-30) + I_3(5+6+3) = 0 \end{cases}$$

$\Rightarrow$ $I_1 = 9A$

$I_2 = 4A$

$I_3 = -6A$

Case ②: SUPERMESH



Current source inside circuit ⇒ SUPERMESH.
Combine both meshes plus the current source into a supermesh.

Mesh ②: $3(I_2-I_1)+10\cdot I_2+2(I_2-I_3)=0$

Supermesh: $\begin{cases} -100+3(I_1-I_2)+2(I_3-I_2)+50+4I_3+6I_1=0 \\ I_3-I_1=5 \quad \leftarrow \text{for the current source} \end{cases}$

Std form: $I_1(-3)+I_2(3+10+2)+I_3(-2)=0$

$I_1(3+6)+I_2(-3-2)+I_3(2+4)=100-50$

$I_1(-1)+I_2(0)+I_3(1)=5$

$\Rightarrow$ $I_1 = 1.75\ A$

$I_2 = 1.25\ A$

$I_3 = 6.75\ A$