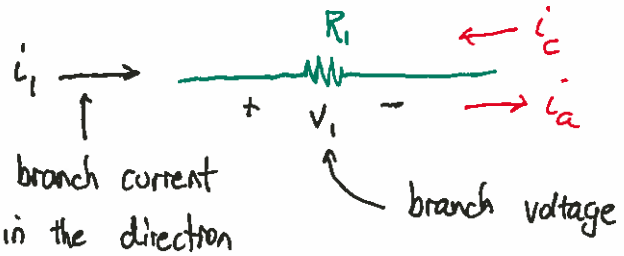


$i_1 = i_a - i_c$

We have $v_1 = i_1 R_1$

$= (i_a - i_c) R_1$

Now sum voltages around mesh a

$$-v_a + (i_a - i_c)R_1 + (i_a - i_b)R_3 = 0$$

or $$i_a(R_1 + R_3) - i_b R_3 - i_c R_1 = v_a$$

Similarly, sum voltages around mesh b.

$$v_b + (i_b - i_a)R_3 + (i_b - i_c)R_2 = 0$$

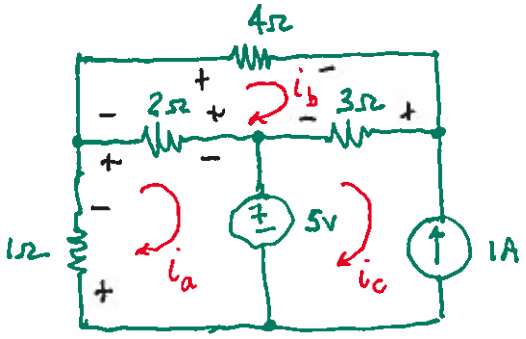
or $$-i_a R_3 + i_b(R_2 + R_3) - i_c R_2 = -v_b$$

Step 3:

Thus, we have two equations in two unknowns i_a, i_b, where we already know $i_c = i_s$

Can now completely solve the circuit.

Example 1: Find the power in the 3Ω resistor.



We know immediately that $i_c = -1\,A$. We have two unknowns i_a, i_b.

Mesh a: $i_a \times 1 + (i_a - i_b) \times 2 + 5 = 0$

Only one mesh current in 1Ω resistor

two mesh currents in 2Ω resistor, opposite in direction.

$$3i_a - 2i_b = -5 \qquad (1)$$

Mesh b: $(i_b - i_a) \times 2 + i_b \times 4 + (i_b - i_c) \times 3 = 0$

only one contributing mesh current.

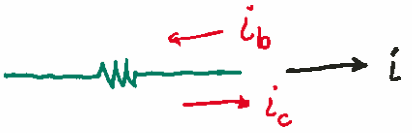
$$-2i_a + 9i_b - 3i_c = 0$$

We know $i_c = -1$, so $-2i_a + 9i_b = -3 \qquad (2)$

Solving equations (1) and (2) gives

$$i_b = -0.826 \text{ A}$$
$$i_a = -2.217 \text{ A}$$

Finally, we need the power in the 3Ω resistor.

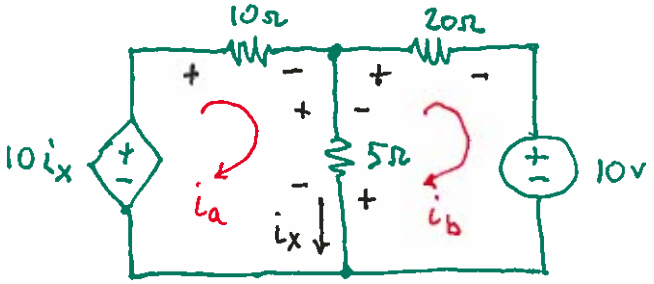


Total branch current

$$i = i_c - i_b$$
$$= -1 - (-0.826)$$
$$= -0.174 \text{ A}$$

$$p = i^2 R = 0.0908 \text{ W}.$$

Example 2: Circuit with a dependent source.



- Note that i_x is a branch current.

Form mesh equations:

Mesh a: $-10i_x + 10i_a + 5(i_a - i_b) = 0$

$$15i_a - 5i_b = 10i_x \qquad (1)$$

Mesh b: $5(i_b - i_a) + 20 i_b + 10 = 0$

$$-5i_a + 25 i_b = -10 \qquad (2)$$

For the dependent voltage source, we need to express i_x in terms of mesh currents. We have

$$i_x = i_a - i_b$$

From equation (1),

$$15 i_a - 5 i_b = 10(i_a - i_b)$$

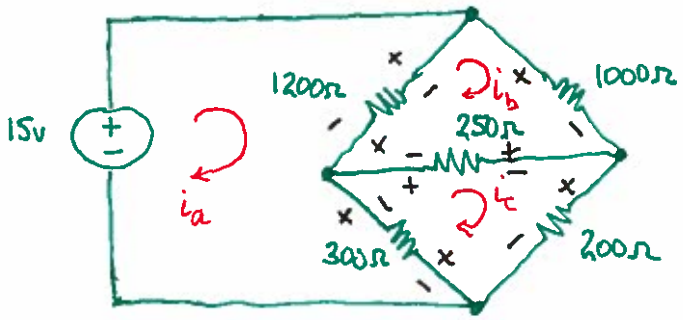
$$5 i_a + 5 i_b = 0 \qquad (3)$$

Solving (2) and (3) gives

$$i_b = -\frac{1}{3} A$$

$$i_a = \frac{1}{3} A$$

Example 3 : Revisit earlier Wheatstone bridge example.



Mesh a: $-15 + (i_a - i_b)1200 + (i_a - i_c)300 = 0$