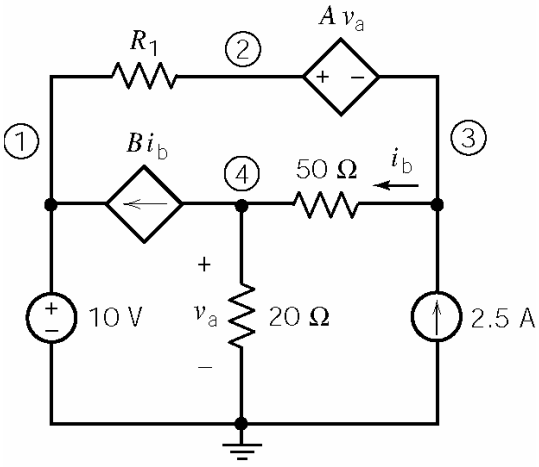
Example

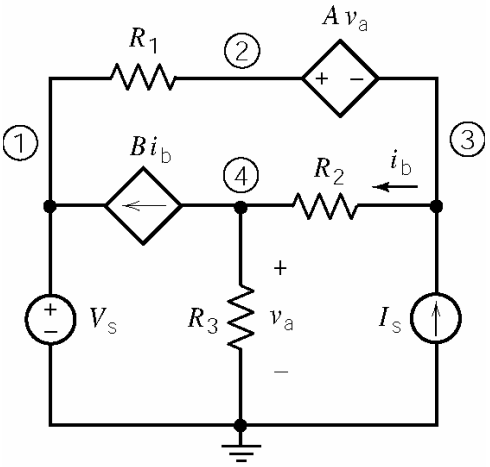


The voltages v_1, v_2, v_3 and v_4 are the node voltages corresponding to nodes 1, 2, 3 and 4. The values of these voltages are

$$v_1 = 10 \text{ V}, \quad v_2 = 75 \text{ V}, \quad v_3 = -15 \text{ V} \quad \text{and} \quad v_4 = 22.5 \text{ V}$$

Determine the values of the gains of the dependent sources, A and B, and of the resistance R_1.

Solution:



Express the controlling voltage and current of the dependent sources in terms of the node voltages:

$$v_a = v_4 = 22.5 \text{ V}$$

and

$$i_b = \frac{v_3 - v_4}{R_2} = \frac{-15 - 22.5}{50} = -0.75$$

Express the dependent voltage source voltage in terms of the node voltages:

$$v_2 - v_3 = A v_a = A v_4$$

so

$$A = \frac{v_2 - v_3}{v_4} = \frac{75 - (-15)}{22.5} = 4 \text{ V/V}$$

Apply KCL to the supernode corresponding to the dependent voltage source

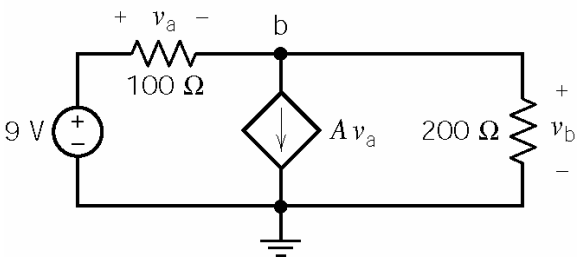
$$\frac{v_2 - v_1}{R_1} + \frac{v_3 - v_4}{R_2} = I_s \quad \Rightarrow \quad \frac{75 - 10}{R_1} + \frac{-15 - 22.5}{50} = 2.5 \quad \Rightarrow \quad R_1 = 20 \ \Omega$$

Apply KCL at node 4:

$$\frac{v_3 - v_4}{R_2} = \frac{v_4}{R_3} + B\frac{v_3 - v_4}{R_2} \quad \Rightarrow \quad \frac{-15 - 22.5}{50} = \frac{22.5}{20} + B\frac{-15 - 22.5}{50} \quad \Rightarrow \quad B = 2.5 \text{ A/A}$$

Example

The value of the node voltage at node b in the circuit is $v_b = 18$ V.



(a) Determine the value of *A*, the gain of the dependent source.
(b) Determine the power supplied by the dependent source.

Solution

(a) Express the controlling voltage of the dependent source in terms of the node voltages:

$$v_a = 9 - v_b$$

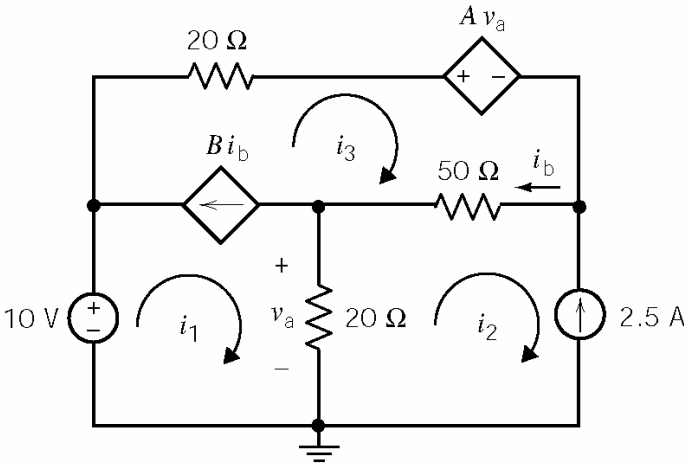
Apply KCL at node b to get

$$\frac{9 - v_b}{100} = A\left(9 - v_b\right) + \frac{v_b}{200} \quad \Rightarrow \quad A = \frac{18 - 3v_b}{200\left(9 - v_b\right)} = 0.02$$

(b) The power supplied by the dependent source is

$$-\left(Av_a\right)v_b = -\left(0.02\left(9 - 18\right)\right)\left(18\right) = 3.24 \text{ W}$$

Example



The currents i_1, i_2 and i_3 are the mesh currents corresponding to meshes 1, 2 and 3. The values of these currents are

$$i_1 = -1.375 \text{ A}, \quad i_2 = -2.5 \text{ A} \quad \text{and} \quad i_3 = -3.25 \text{ A}$$

Determine the values of the gains of the dependent sources, *A* and *B*.

Solution:

Express the controlling voltage and current of the dependent sources in terms of the mesh currents:

$$v_a = 20\left(i_1 - i_2\right) = 20\left(-1.375 - \left(-2.5\right)\right) = 22.5$$

and

$$i_b = i_3 - i_2 = -3.25 - \left(-2.5\right) = -0.75 \text{ A}$$

Express the current source currents in terms of the mesh currents:

$$i_2 = -2.5 \text{ A}$$

and

$$i_3 - i_1 = B i_b \quad \Rightarrow \quad -1.375 - \left(-2.5\right) = B\left(-0.75\right) \quad \Rightarrow \quad B = 2.5 \text{ A/A}$$

Apply KVL to the supermesh corresponding to the dependent current source

$$0 = 20\, i_3 + A v_a + 50\, i_b + v_a - 10 = 20\left(-3.25\right) + A\left(22.5\right) + 50\left(-0.75\right) + 22.5 - 10 \quad \Rightarrow \quad A = 4 \text{ V/V}$$