Four Examples

1. Determine the value of the current that is measured by the meter in this circuit.

Solution

We can label the circuit as shown.

The subscripts suggest a numbering of the circuit elements. Apply KVL to node the left mesh to get

\[ 15i_1 + 25i_1 - 20 = 0 \quad \Rightarrow \quad i_1 = \frac{20}{40} = 0.5 \text{ A} \]

Apply KVL to node the left mesh to get

\[ v_2 - 25i_1 = 0 \quad \Rightarrow \quad v_2 = 25i_1 = 25(0.5) = 12.5 \text{ V} \]

Apply KCL to get \( i_m = i_2 \). Finally, apply Ohm’s law to the 50 Ω resistor to get

\[ i_m = i_2 = \frac{v_2}{50} = \frac{12.5}{50} = 0.25 \text{ A} \]
2. Determine the value of the current that is measured by the meter in this circuit.

Solution

We can label the circuit as shown.

The subscripts suggest a numbering of the circuit elements. Ohm’s law to the $8 \, \Omega$ resistor to get

$$i_1 = \frac{v_1}{8}$$

Apply KCL at the top node of the CCCS to get

$$i_1 + 0.25v_1 = i_2 \quad \Rightarrow \quad i_2 = i_1 + 0.25v_1 = \frac{v_1}{8} + 0.25v_1 = 0.375v_1$$

Ohm’s law to the $8 \, \Omega$ resistor to get

$$v_2 = 12i_2 = 12\left(0.375v_1\right) = 4.5v_1$$

Apply KVL to the outside to get

$$v_1 + v_2 - 20 = 0 \quad \Rightarrow \quad v_1 + 4.5v_1 = 20 \quad \Rightarrow \quad v_1 = \frac{20}{5.5} = 3.636 \, \text{V}$$

Apply KCL to get $i_m = i_2$. Finally, apply Ohm’s law to the $12 \, \Omega$ resistor to get

$$i_m = i_2 = \frac{v_2}{12} = \frac{4.5v_1}{12} = \frac{4.5(3.636)}{12} = 1.634 \, \text{A}$$
3. Determine the value of the voltage that is measured by the meter in this circuit

\[ i_1 \quad 48 \, \Omega \]
\[ + \quad 24 \, V \quad 5 \, i_1 \quad 4 \, \Omega \]
\[ \quad \text{Voltmeter} \]

**Solution**

We can label the circuit as shown.

The subscripts suggest a numbering of the circuit elements. Ohm’s law to the 48 Ω resistor to get

\[ v_1 = 48i_1 \]

Apply KCL at the top node of the CCCS to get

\[ i_1 + 5i_1 = i_2 \quad \Rightarrow \quad i_2 = 6i_1 \]

Ohm’s law to the 4 Ω resistor to get

\[ v_m = 4i_2 = 4(6i_1) = 24i_1 \]

Apply KVL to the outside loop to get

\[ v_1 + v_m - 24 = 0 \quad \Rightarrow \quad 48i_1 + 24i_1 = 24 \quad \Rightarrow \quad i_1 = \frac{24}{72} = \frac{1}{3} \, \text{A} \]

Finally,

\[ v_m = 24i_1 = 24 \left( \frac{1}{3} \right) = 8 \, \text{V} \]
4. Determine the value of the voltage that is measured by the meter in this circuit.

Solution
We can label the circuit as shown.

The subscripts suggest a numbering of the circuit elements. Apply KCL at the top node of the current source to get

\[ i_1 = i_2 + 0.25 \]

Ohm’s law to the resistors to get

\[ v_1 = 20i_1 \text{ and } v_2 = 60i_2 = 60(i_1 - 0.25) = 60i_1 - 15 \]

Apply KVL to the outside to get

\[ v_2 + 80i_1 + v_1 = 0 \quad \Rightarrow \quad (60i_1 - 15) + 80i_1 + 20i_1 = 0 \quad \Rightarrow \quad i_1 = \frac{15}{160} = 0.09375 \text{ A} \]

Finally,

\[ v_m = 80i_1 = 80(0.09375) = 7.5 \text{ V} \]