Example: Consider the circuit shown in Figure 1. Find the value of the current source current, $I_a$.

![Figure 1](image1.png) The circuit considered in this example.

Solution: Figure 2 shows the circuit from Figure 1 after replacing the ammeter by an equivalent short circuit and labeling the current measured by the ammeter. This circuit can be analyzed using mesh equations or using node equations. We will do both.

First, consider analyzing the circuit in Figure 2 using mesh equations. Figure 3 shows the circuit after labeling the mesh currents, $i_1$ and $i_2$.

![Figure 2](image2.png) The circuit from Figure 1 after replacing the ammeter by a short circuit.

![Figure 3](image3.png) The circuit from Figure 2 after labeling the meshes.
The mesh current \( i_2 \) flows through the short circuit that replaced the ammeter. The reference direction of \( i_2 \) does not agree with the reference direction of the current measured by the ammeter, so

\[
i_2 = -0.75 \text{ A}
\]

The mesh current \( i_1 \) flows through the current source. The reference direction of \( i_2 \) does not agree with the reference direction of the current source current, so

\[
i_1 = -I_a
\]

Apply KVL to the right mesh to get

\[
2 + 6i_2 + 2(i_2 - i_1) = 0 \quad \Rightarrow \quad 2 + 6(-0.75) + 2(-0.75 - (-I_a)) = 0 \quad \Rightarrow \quad I_a = 2 \text{ A}
\]

Next, consider analyzing the circuit in Figure 2 using node equations. Figure 4 shows the circuit after selecting a reference node and numbering the other nodes. Let \( v_1 \) and \( v_2 \) denote the node voltages at node 1 and node 2, respectively.

The current measured by the ammeter is equal to the current in the 6 \( \Omega \) resistor. The voltage across the 6 \( \Omega \) resistor can be determined using Ohm’s Law. The voltage across the 6 \( \Omega \) resistor can also be expressed in terms of the node voltages. Doing both gives

\[
6(0.75) = 0 - v_2 \quad \Rightarrow \quad v_2 = -4.5 \text{ V}
\]

The voltage of the voltage source can be expressed in terms of the node voltages as

\[
2 = v_1 - v_2 \quad \Rightarrow \quad 2 = v_1 - (-4.5) \quad \Rightarrow \quad v_1 = -2.5 \text{ V}
\]

Apply KCL to the supernode to get

\[
I_a + \frac{v_1}{2} = 0.75 \quad \Rightarrow \quad I_a + \frac{-2.5}{2} = 0.75 \quad \Rightarrow \quad I_a = 2 \text{ A}
\]

As expected, this value of current source current agrees with the value calculated using mesh equations.

**Figure 4** The circuit from Figure 2 after labeling the nodes. (The encircled numbers are node numbers.)