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

![Figure 1](image1.png)

**Figure 1** The circuit considered in this example.

**Solution:** The inputs to this circuit are the voltage of the independent voltage source and the current of the independent current source. The response of this circuit is the voltage measured by the voltmeter. The two inputs work together to produce a response that has a value of 9 V. This circuit can be analyzed using superposition to separate the part of the response caused by the voltage source from the part of the response caused by the current source.

Figure 2 shows the circuit from Figure 1 after replacing the voltmeter by an equivalent open circuit and labeling the voltage measured by the voltmeter.

Figure 3a shows the circuit used to determine, $v_1$, the part of the response caused by the voltage source. The current source current is set to zero to determine the part of the response caused by the voltage source. Consequently, the current source is replaced by an open circuit, i.e. a zero current source, in Figure 3a.

Figure 3b shows the circuit used to determine, $v_2$, the part of the response caused by the current source. The voltage source voltage is set to zero to determine the part of the response caused by the current source. Consequently, the voltage source is replaced by a short circuit, i.e. a zero voltage source, in Figure 3b.

![Figure 2](image2.png)

**Figure 2** The circuit from Figure 1 after replacing the voltmeter by a open circuit.
Figure 3 The circuit from Figure 2 after using superposition. (a) The response to the voltage source acting alone. (b) The response to the current source acting alone.

Apply voltage division to the circuit in Figure 3a to get

\[ v_1 = \frac{4}{16 + 20 + 4} (-6) = -0.6 \text{ V} \]

Use current division in Figure 3b to get

\[ i_b = \frac{16}{16 + (20 + 4)} I_a = \frac{2}{5} I_a \]

The Ohm’s Law gives

\[ v_2 = 4 i_b = 4 \left( \frac{2}{5} I_a \right) = \frac{8}{5} I_a = 1.6 I_a \]

The response to both sources working together is equal to the sum of the responses to the individual sources working separately. Consequently,

\[ 9 = v_1 + v_2 = -0.6 + 1.6 I_a \quad \Rightarrow \quad I_a = 6 \text{ A} \]