**Example 1:**
Consider the circuit shown in Figure 1. The input to the circuit is the current of the current source, \(i_s(t)\). The output is the voltage across the right-hand coil, \(v_o(t)\). Determine the steady-state output voltage, \(v_o(t)\).

![Figure 1](image)

**Figure 1** The circuit considered in Example 1.

**Solution:** The input current is a sinusoid and the circuit is at steady state. The output voltage is also a sinusoid and has the same frequency as the input current. Consequently, the circuit can be represented in the frequency domain, using phasors and impedances. Figure 2 shows the frequency domain representation of the circuit from Figure 1.

![Figure 2](image)

**Figure 2** The circuit from Figure 1, represented in the frequency domain, using impedances and phasors.

The circuit in Figure 2 consists of a single mesh. The mesh current is equal to the current source \(I_s(\omega)\). The current \(I_s(\omega)\) enters the dotted end of both coils, consequently the voltage across the right hand coil is given by

\[
V_o(\omega) = j10I_s(\omega) + j5I_s(\omega) = j15I_s(\omega) = j15(0.707\angle47^\circ)
\]

\[
= (15\angle90^\circ)(0.707\angle47^\circ)
\]

\[
= (15)(0.707)\angle(90 + 47)^\circ
\]

\[
= 10.605\angle137^\circ \text{ V}
\]

In the time domain, the output voltage is given by

\[
v_o(t) = 10.6 \cos(5t + 137^\circ) \text{ V}
\]
Example 2:
Consider the circuit shown in Figure 3. The input to the circuit is the current of the current source, \( i_s(t) \). The output is the voltage across the right-hand coil, \( v_o(t) \). Determine the steady-state output voltage, \( v_o(t) \).

Figure 3 The circuit considered in Example 2.

Solution: The circuit shown in Figure 3 is very similar to the circuit shown in Figure 1. There is only one difference: the dot of the right-hand coil is located at the bottom of the coil in Figure 3 and at the top of the coil in Figure 1. As in Example 1, our first step is to represent the circuit in the frequency domain, using phasors and impedances. Figure 4 shows the frequency domain representation of the circuit from Figure 3.

Figure 4 The circuit from Figure 3, represented in the frequency domain, using impedances and phasors.

The circuit in Figure 4 consists of a single mesh. The mesh current is equal to the current source \( I_s(\omega) \). The current \( I_s(\omega) \) enters the dotted end of the left-hand coil and enters the undotted end of the right-hand coil. Consequently the voltage across the right-hand coil is given by

\[
V_o(\omega) = j \cdot 10 \cdot I_s(\omega) - j \cdot 5 \cdot I_s(\omega) = j \cdot 5 \cdot (0.707\angle47^\circ)
\]

\[
= (5\angle90^\circ)(0.707\angle47^\circ)
\]

\[
= (5)(0.707)(\angle(90 + 47)^\circ)
\]

\[
= 3.535\angle137^\circ \text{ V}
\]

In the time domain, the output voltage is given by

\[
v_o(t) = 3.535 \cos(5t + 137^\circ) \text{ V}
\]