Example 9.14

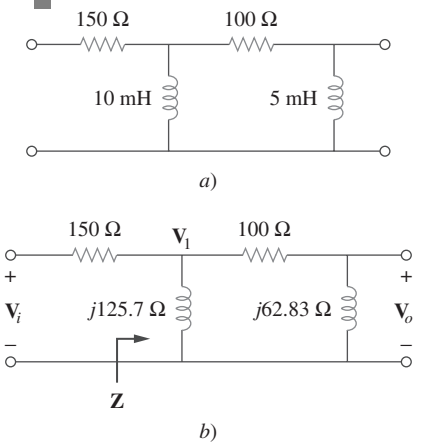

Figure 9.35
For example 9.14.

Referring to the circuit shown in Figure 9.35 a), calculate the Phase Shift produced at 2 kHz.

Answer:
At 2 kHz, the inductances of 10 mH and 5 mH are transformed in the impedance.

$$10\text{ mH} \quad \Rightarrow \quad X_L = \omega L = 2\pi \times 2 \times 10^3 \times 10 \times 10^{-3} = 40\pi = 125.7\ \Omega$$

$$5\text{ mH} \quad \Rightarrow \quad X_L = \omega L = 2\pi \times 2 \times 10^3 \times 5 \times 10^{-3} = 20\pi = 62.83\ \Omega$$

Consider the circuit of Figure 9.35 b). Z impedance is the combination parallel operation of $j125.7\ \Omega$ y $100 + j62.83\ \Omega$. so,

$$\mathbf{Z} = j125.7 \parallel (100 + j62.83) = \frac{j125.7(100 + j62.83)}{100 + j188.5} = 69.56\angle 60.1°\ \Omega \qquad \textbf{(9.14.1)}$$

When applying the voltage division,

$$\mathbf{V}_1 = \frac{\mathbf{Z}}{\mathbf{Z} + 150}\mathbf{V}_i = \frac{69.56\angle 60.1°}{184.7 + j60.3}\mathbf{V}_i = 0.3582\angle 42.02°\ \mathbf{V}_i \qquad \textbf{(9.14.2)}$$

and

$$\mathbf{V}_o = \frac{j62.832}{100 + j62.832}\mathbf{V}_1 = 0.532\angle 57.86°\ \mathbf{V}_1 \qquad \textbf{(9.14.3)}$$

By combining equations (9.14.2) and (9.14.3),

$$\mathbf{V}_o = (0.532\angle 57.86°)(0.3582\angle 42.02°)\ \mathbf{V}_i = 0.1906\angle 100°\ \mathbf{V}_i$$

Which indicates that the output is around 19% of the input in magnitude, but it advances to the entrance in 100 °. If the circuit ends in a charge, this will affect the phase shift

Practice Problem 9.14

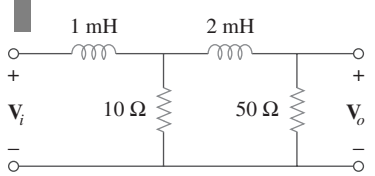

Figure 9.36
For the practice problem 9.14.

Refer to RL circuit of Figure 9.36. If 1 V is applied, find the magnitude and the phase shift produced at 5 kHz. Specify whether the displacement phase is advance or delayed.

Answer: 0.172, 120.4°, delayed