Chapter 9, Solution 40.

In the circuit of Fig. 9.47, find $i_o(t)$ when:

(a) $\omega = 1$ rad/s
(b) $\omega = 5$ rad/s
(c) $\omega = 10$ rad/s

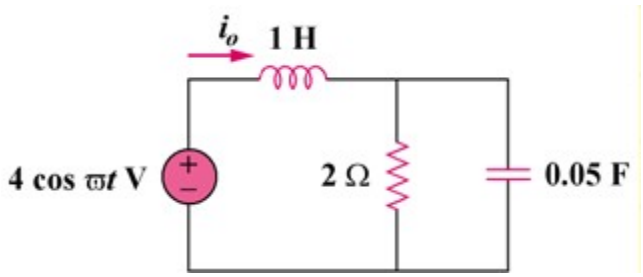

Figure 9.47
For Prob. 9.40.

Solution

(a) For $\omega = 1$,

$$1\text{ H} \longrightarrow j\omega L = j(1)(1) = j$$

$$0.05\text{ F} \longrightarrow \frac{1}{j\omega C} = \frac{1}{j(1)(0.05)} = -j20$$

$$\mathbf{Z} = j + 2 \,||\, (-j20) = j + \frac{-j40}{2 - j20} = 1.98 + j0.802$$

$$\mathbf{I}_o = \frac{\mathbf{V}}{\mathbf{Z}} = \frac{4\angle 0^\circ}{1.98 + j0.802} = \frac{4\angle 0^\circ}{2.136\angle 22.05^\circ} = 1.872\angle -22.05^\circ$$

Hence,

$$i_o(t) = \mathbf{1.872\cos(t - 22.05^\circ)\text{ A}}$$

(b) For $\omega = 5$,

$$1\text{ H} \longrightarrow j\omega L = j(5)(1) = j5$$

$$0.05\text{ F} \longrightarrow \frac{1}{j\omega C} = \frac{1}{j(5)(0.05)} = -j4$$

$$\mathbf{Z} = j5 + 2 \,||\, (-j4) = j5 + \frac{-j4}{1 - j2} = 1.6 + j4.2$$

$$\mathbf{I}_o = \frac{\mathbf{V}}{\mathbf{Z}} = \frac{4\angle 0°}{1.6 + j4} = \frac{4\angle 0°}{4.494\angle 69.14°} = 0.89\angle -69.14°$$

Hence,

$$i_o(t) = \mathbf{890\cos(5t - 69.14°)\ mA}$$

(c) For $\omega = 10$,

$$1\text{ H} \longrightarrow j\omega L = j(10)(1) = j10$$

$$0.05\text{ F} \longrightarrow \frac{1}{j\omega C} = \frac{1}{j(10)(0.05)} = -j2$$

$$\mathbf{Z} = j10 + 2 \,||\, (-j2) = j10 + \frac{-j4}{2 - j2} = 1 + j9$$

$$\mathbf{I}_o = \frac{\mathbf{V}}{\mathbf{Z}} = \frac{4\angle 0°}{1 + j9} = \frac{4\angle 0°}{9.055\angle 83.66°} = 0.4417\angle -83.66°$$

Hence,

$$i_o(t) = \mathbf{441.7\cos(10t - 83.66°)\ mA}$$