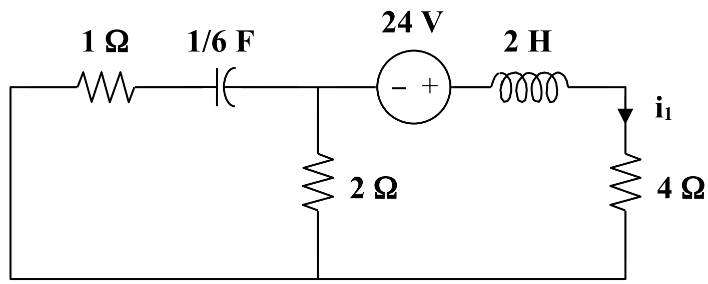
Chapter 10, Solution 47.

Let $i_o = i_1 + i_2 + i_3$, where i_1, i_2, and i_3 are respectively due to the 24-V dc source, the ac voltage source, and the ac current source. For i_1, consider the circuit in Fig. (a).



(a)

Since the capacitor is an open circuit to dc,

$$i_1 = \frac{24}{4+2} = 4 \text{ A}$$

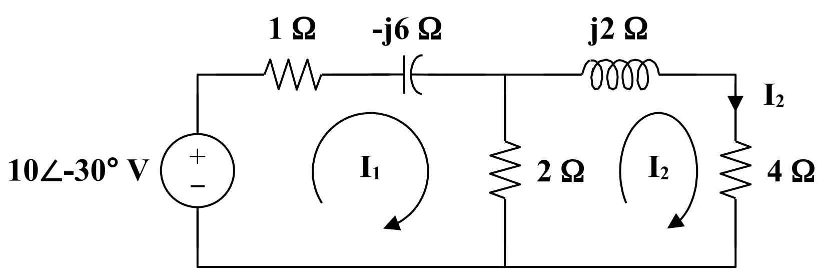
For i_2, consider the circuit in Fig. (b).

$$\omega = 1$$

$$2 \text{ H} \longrightarrow j\omega L = j2$$

$$\frac{1}{6}\text{F} \longrightarrow \frac{1}{j\omega C} = \text{-}j6$$

For mesh 1,



(b)

$$\text{-}10\angle\text{-}30° + (3 - j6)\mathbf{I}_1 - 2\mathbf{I}_2 = 0$$

$$10\angle\text{-}30° = 3(1 - 2j)\mathbf{I}_1 - 2\mathbf{I}_2 \qquad (1)$$

For mesh 2,

$$0 = \text{-}2\mathbf{I}_1 + (6 + j2)\mathbf{I}_2$$

$$\mathbf{I}_1 = (3 + j)\mathbf{I}_2 \qquad (2)$$

Substituting (2) into (1)

$$10\angle\text{-}30° = 13 - j15\mathbf{I}_2$$

$$\mathbf{I}_2 = 0.504\angle 19.1°$$

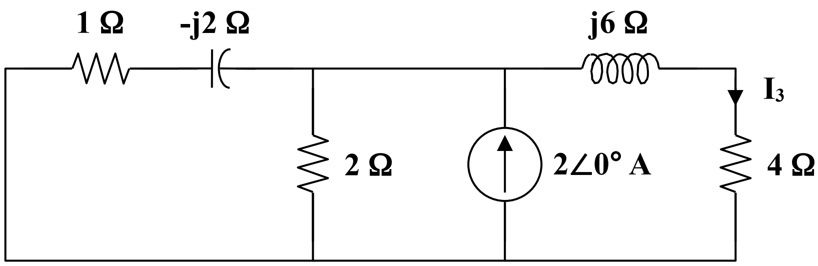
Hence, $i_2 = 0.504\sin(t + 19.1°)$ A

For i_3, consider the circuit in Fig. (c).

$\omega = 3$

$2\text{ H} \longrightarrow j\omega L = j6$

$$\frac{1}{6}\text{ F} \longrightarrow \frac{1}{j\omega C} = \frac{1}{j(3)(1/6)} = -j2$$



(c)

$$2 \,||\, (1 - j2) = \frac{2(1 - j2)}{3 - j2}$$

Using current division,

$$\mathbf{I}_3 = \frac{\frac{2(1-j2)}{3-j2} \cdot (2\angle 0°)}{4 + j6 + \frac{2(1-j2)}{3-j2}} = \frac{2(1-j2)}{13 + j3}$$

$$\mathbf{I}_3 = 0.3352\angle -76.43°$$

Hence $i_3 = 0.3352\cos(3t - 76.43°)$ A

Therefore, $i_o =$ **[4 + 0.504 sin(t + 19.1°) + 0.3352 cos(3t – 76.43°)] A**