1.31 Repeat Problem 1.30, but this time determine current $i_{R_2}(t)$.

Solution: The source phasor voltage is

$$\widetilde{V}_s = 25e^{-j45^\circ} \quad \text{(V)}.$$

In the phasor domain, the inductor has an impedance

$$j\omega L = j4 \times 10^4 \times 10.4 \times 10^{-3} = j16\ \Omega.$$

The parallel combination of R_2 and $j\omega L$ is

$$Z = \frac{R_2(j\omega L)}{R_2 + j\omega L} = \frac{j\omega L R_2}{R_2 + j\omega L}.$$

Current $\tilde{I}$ is given by

$$\begin{aligned}
\tilde{I} = \frac{\widetilde{V}_s}{R_1 + Z} &= \frac{\widetilde{V}_s}{R_1 + \dfrac{j\omega L R_2}{R_2 + j\omega L}} \\
&= \frac{\widetilde{V}_s(R_2 + j\omega L)}{R_1 R_2 + jR_1\omega L + j\omega L R_2} \\
&= \frac{25e^{-j45^\circ}(30 + j16)}{20 \times 30 + j16 \times 20 + j16 \times 30} \\
&= \frac{25e^{-j45^\circ} \times 34e^{j28.1^\circ}}{600 + j800} \\
&= \frac{850e^{-j16.9^\circ}}{1000e^{j53.1^\circ}} = 0.85e^{-j70^\circ} \quad \text{(A)}.
\end{aligned}$$

By current division,

$$\begin{aligned}
\tilde{I}_{R_2} &= \frac{\tilde{I}(j\omega L)}{R_2 + j\omega L} \\
&= \frac{0.85e^{-j70^\circ}(j16)}{30 + j16} \\
&= \frac{13.6e^{j20^\circ}}{34e^{j28.1^\circ}} = 0.4e^{-j8.1^\circ} \quad \text{(A)}.
\end{aligned}$$

The time-domain equivalent is

$$\begin{aligned}
i_{R_2}(t) &= \mathfrak{Re}[\tilde{I}_{R_2} e^{j\omega t}] \\
&= \mathfrak{Re}[0.4e^{-j8.1^\circ} e^{j\omega t}] \\
&= 0.4\cos(4 \times 10^4 t - 8.1^\circ) \quad \text{(A)}.
\end{aligned}$$