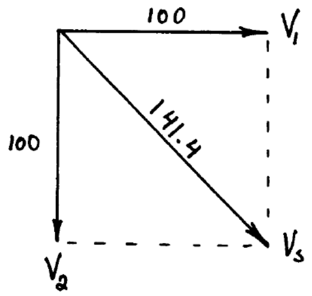
P5.12* $I_{rms} = \sqrt{\frac{1}{T}\int_0^T i^2(t)dt} = \sqrt{\frac{1}{4}\left(\int_0^2 25dt + \int_2^4 4dt\right)} = 3.808\ A$

P5.22*

$$v_1(t) = 100\cos(\omega t)$$
$$v_2(t) = 100\sin(\omega t) = 100\cos(\omega t - 90^\circ)$$
$$\mathbf{V}_1 = 100\angle 0^\circ = 100$$
$$\mathbf{V}_2 = 100\angle -90^\circ = -j100$$
$$\mathbf{V}_s = \mathbf{V}_1 + \mathbf{V}_2 = 100 - j100 = 141.4\angle -45^\circ$$
$$v_s(t) = 141.4\cos(\omega t - 45^\circ)$$



$\mathbf{V}_2$ lags $\mathbf{V}_1$ by 90°
$\mathbf{V}_s$ lags $\mathbf{V}_1$ by 45°
$\mathbf{V}_s$ leads $\mathbf{V}_2$ by 45°

P5.25 $V_m = 15\ \text{V} \qquad T = 20\ \text{ms}$

$$f = \frac{1}{T} = 50\ \text{Hz} \qquad \omega = 2\pi f = 100\pi\ \text{rad/s}$$
$$\theta = -360^\circ \frac{t_{max}}{T} = 72^\circ$$
$$v(t) = 15\cos(100\pi t + 72^\circ)\ \text{V}$$
$$\mathbf{V} = 15\angle 72^\circ\ \text{V}$$
$$V_{rms} = \frac{15}{\sqrt{2}} = 10.61\ \text{V}$$

P5.34 (a) Notice that the current is a sine rather than a cosine.

$\mathbf{V} = 100\angle 30^\circ \quad \mathbf{I} = 2.5\angle -60^\circ \quad Z = \frac{\mathbf{V}}{\mathbf{I}} = 40\angle 90^\circ = j40$

Because Z is pure imaginary and positive, the element is an inductance.

$\omega = 200 \qquad L = \frac{|Z|}{\omega} = 200\ \text{mH}$

(b) Notice that the voltage is a sine rather than a cosine.

$\mathbf{V} = 100\angle -60^\circ \quad \mathbf{I} = 4\angle 30^\circ \quad Z = \frac{\mathbf{V}}{\mathbf{I}} = 25\angle -90^\circ = -j25$

Because Z is pure imaginary and negative, the element is a capacitance.

$\omega = 200 \qquad C = \frac{1}{|Z|\omega} = 200\ \mu\text{F}$

(c) $\mathbf{V} = 100\angle 30^\circ \quad \mathbf{I} = 5\angle 30^\circ \quad Z = \frac{\mathbf{V}}{\mathbf{I}} = 20\angle 0^\circ = 20 + j0$

Because Z is pure real, the element is a resistance of 20 Ω.

5.35 (a) From the plot, we see that $T = 4$ ms, so we have $f = 1/T = 250$ Hz and $\omega = 500\pi$. Also, we see that the current lags the voltage by 1 ms or

90°, so we have an inductance. . Finally, $\omega L = V_m / I_m = 5000\ \Omega$, from which we find that $L = 3.183$ H.

(b) From the plot, we see that $T = 16$ ms, so we have $f = 1/T = 62.5$ Hz and $\omega = 125\pi$. Also, we see that the current leads the voltage by 4 ms or 90°, so we have a capacitance. Finally, $1/\omega C = V_m / I_m = 2500\ \Omega$, from which we find that $C = 1.019\ \mu$F.

P5.36 (a) $Z = \dfrac{\mathbf{V}}{\mathbf{I}} = 20\angle -90^\circ = -j20$

Because Z is pure imaginary and negative, the element is a capacitance.

$\omega = 1000 \qquad C = \dfrac{1}{|Z|\omega} = 50\ \mu\text{F}$

(b) $Z = \dfrac{\mathbf{V}}{\mathbf{I}} = 10\angle 90^\circ = j10$

Because Z is pure imaginary and positive, the element is an inductance.

$\omega = 1000 \qquad L = \dfrac{|Z|}{\omega} = 10\text{ mH}$

(c) $Z = \dfrac{\mathbf{V}}{\mathbf{I}} = 20\angle 0^\circ = 20$

Because Z is pure real, the element is a resistance of 20 Ω.

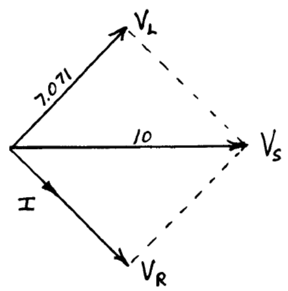
P5.38*

$$\mathbf{I} = \frac{\mathbf{V}_s}{R + j\omega L} = \frac{10\angle 0^\circ}{100 + j100} = 70.71\angle -45^\circ\text{ mA}$$

$$\mathbf{V}_R = R\mathbf{I} = 7.071\angle -45^\circ\text{ V}$$

$$\mathbf{V}_L = j\omega L\mathbf{I} = 7.071\angle 45^\circ\text{ V}$$

$\mathbf{I}$ lags $\mathbf{V}_s$ by 45°



P5.45*

$$\mathbf{I}_s = 10\angle 0^\circ \text{ mA}$$

$$\mathbf{V} = \mathbf{I}_s \frac{1}{1/R + 1/j\omega L + j\omega C}$$

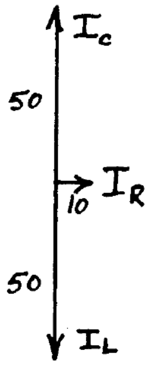
$$= 10^{-2} \frac{1}{1/1000 - j0.005 + j0.005}$$

$$= 10\angle 0^\circ \text{ V}$$

$$\mathbf{I}_R = \mathbf{V}/R = 10\angle 0^\circ \text{ mA}$$

$$\mathbf{I}_L = \mathbf{V}/j\omega L = 50\angle -90^\circ \text{ mA}$$

$$\mathbf{I}_C = \mathbf{V}(j\omega C) = 50\angle 90^\circ \text{ mA}$$



The peak value of $i_L(t)$ is five times larger than the source current! This is possible because current in the capacitance balances the current in the inductance (i.e., $\mathbf{I}_L + \mathbf{I}_C = 0$).

5.46

$$\mathbf{I}_s = 0.5\angle{-90^\circ}$$

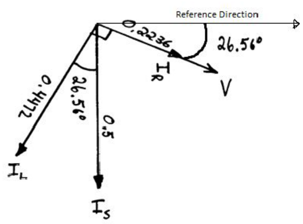
$$\mathbf{V} = \mathbf{I}_s \frac{1}{1/200 + 1/j100}$$

$$= 44.72\angle{-26.56^\circ}$$

$$\mathbf{I}_R = \mathbf{V}/R = 0.2236\angle{-26.56^\circ}$$

$$\mathbf{I}_L = \mathbf{V}/j\omega L = 0.4472\angle -116.56^\circ$$

$\mathbf{V}$ leads $\mathbf{I}_s$ by 63.44°



P5.51

$$Z_{total} = j\omega L + \frac{1}{1/R + j\omega C}$$

$$= j100 + \frac{1}{0.01 + j0.01}$$

$$= j100 + 50 - j50$$

$$= 50 + j50$$

$$= 70.71\angle 45^\circ$$

$$\mathbf{I} = \frac{100\angle 0^\circ}{Z_{total}} = 1.414\angle -45^\circ$$

$$\mathbf{I}_R = \mathbf{I}\frac{Z_C}{R + Z_C} = (1.414\angle -45^\circ) \times \frac{-j100}{100 - j100}$$

$$= 1\angle -90^\circ$$

$$\mathbf{I}_C = \mathbf{I}\frac{R}{R + Z_C} = (1.414\angle -45^\circ) \times \frac{100}{100 - j100}$$

$$= 1\angle 0^\circ$$