P5.65. **a.** Sketch a power triangle for an inductive load, label the sides, and show the power angle. **b.** Repeat for a capacitive load.

P5.65 See Figure 5.23 in the book.

***P5.67.** Consider the circuit shown in Figure P5.67. Find the phasor current **I**. Find the power, reactive power, and apparent power delivered by the source. Find the power factor and state whether it is lagging or leading.

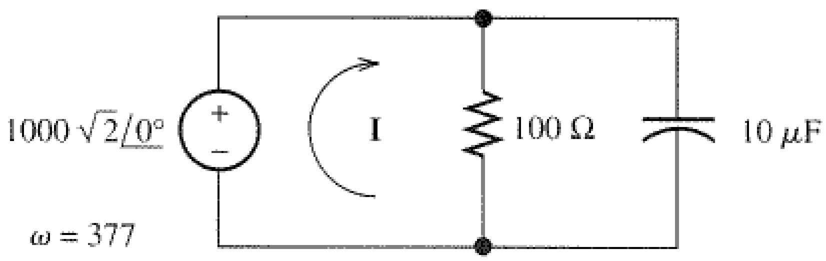

Figure P5.67

P5.67*

$$\mathbf{I} = \frac{1000\sqrt{2}\angle 0^\circ}{100} + \frac{1000\sqrt{2}\angle 0^\circ}{-j265.3} = 14.14 + j5.331 = 15.11\angle 20.66^\circ$$

$$P = V_{rms} I_{rms} \cos\theta = 10 \text{ kW}$$

$$Q = V_{rms} I_{rms} \sin\theta = -3.770 \text{ kVAR}$$

$$\text{Apparent power} = V_{rms} I_{rms} = 10.68 \text{ kVA}$$

$$\text{Power factor} = \cos(20.66^\circ) = 0.9357 = 93.57\% \text{ leading}$$

P5.81. Find the power, reactive power, and apparent power delivered by the source in Figure P5.81. Find the power factor and state whether it is leading or lagging.

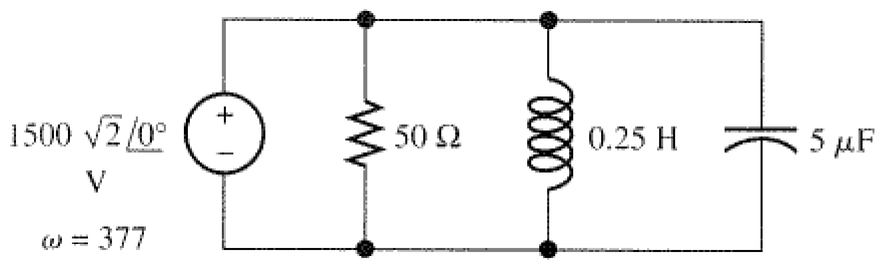

Figure P5.81

P5.81

$$P = \frac{(V_{rms})^2}{R} = \frac{1500^2}{50} = 45000 \text{ W}$$

$$Q = Q_L + Q_C = \frac{(V_{rms})^2}{X_L} + \frac{(V_{rms})^2}{X_C} = \frac{1500^2}{94.25} + \frac{1500^2}{(-530.5)}$$

$$Q = 19630 \text{ VAR}$$

$$\text{Apparent power} = \sqrt{P^2 + Q^2} = 49095 \text{ VA}$$

$$\text{Power factor} = \frac{P}{\text{Apparent power}} = 91.65\% \text{ lagging}$$

***P5.91.** The Thévenin equivalent of a two-terminal network is shown in Figure P5.91. The frequency is $f = 60$ Hz. We wish to connect a load across terminals a–b that consists of a resistance and a capacitance in parallel such that the power delivered to the resistance is maximized. Find the value of the resistance and the value of the capacitance.

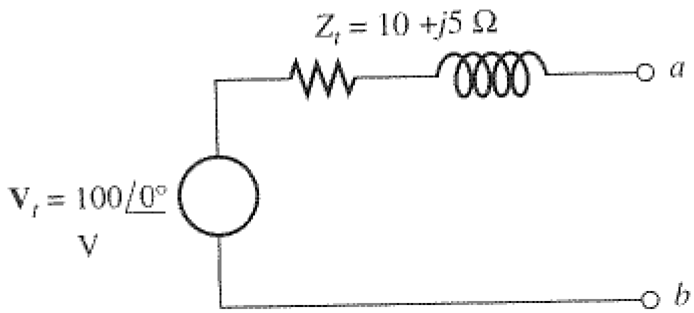

Figure P5.91

P5.91* For maximum power transfer, the impedance of the load should be the complex conjugate of the Thévenin impedance:

$$Z_{load} = 10 - j5$$

$$Y_{load} = 1/Z_{load} = 0.08 + j0.04$$

$$Y_{load} = 1/R_{load} + j\omega C_{load} = 0.08 + j0.04$$

Setting real parts equal:

$$1/R_{load} = 0.08 \qquad R_{load} = 12.5\ \Omega$$

Setting imaginary parts equal:

$$\omega C_{load} = 0.04 \qquad C_{load} = 106.1\ \mu\text{F}$$

P6.24. In Chapter 4, we used the time constant to characterize first-order *RC* circuits. Find the relationship between the half-power frequency and the time constant.

P6.24 The time constant is given by $\tau = RC$ and the half-power frequency is $f_B = \dfrac{1}{2\pi RC}$. Thus, we have $f_B = \dfrac{1}{2\pi\tau}$.

***P6.25.** An input signal given by

$$v_{\text{in}}(t) = 5\cos(500\pi t) + 5\cos(1000\pi t) + 5\cos(2000\pi t)$$

is applied to the lowpass *RC* filter shown in Figure P6.25. Find an expression for the output signal.

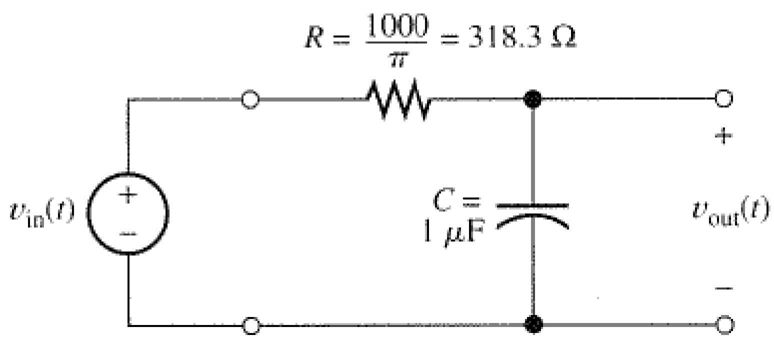

Figure P6.25

P6.25* The half-power frequency of the filter is

$$f_B = \frac{1}{2\pi RC} = 500\,\text{Hz}$$

The transfer function is given by Equation 6.9 in the text:

$$H(f) = \frac{1}{1 + j(f/f_B)}$$

The given input signal is

$$v_{in}(t) = 5\cos(500\pi t) + 5\cos(1000\pi t) + 5\cos(2000\pi t)$$

which has components with frequencies of 250, 500, and 1000 Hz.

Evaluating the transfer function for these frequencies yields:

$$H(250) = \frac{1}{1 + j(250/500)} = 0.8944\angle -26.57^\circ$$

$$H(500) = 0.7071\angle -45^\circ$$

$$H(1000) = 0.4472\angle -63.43^\circ$$

Applying the appropriate value of the transfer function to each component of the input signal yields the output:

$$v_{out}(t) = 4.472\cos(500\pi t - 26.57^\circ) + 3.535\cos(1000\pi t - 45^\circ)$$
$$+ 2.236\cos(2000\pi t - 63.43^\circ)$$

***P10.8.** A diode operates in forward bias and is described by Equation 10.4, with $V_T = 0.026$ V. For $v_{D1} = 0.600$ V, the current is $i_{D1} = 1$ mA. For $v_{D2} = 0.680$ V, the current is $i_{D2} = 10$ mA. Determine the values of I_s and n.

P10.8* The approximate form of the Shockley Equation is $i_D = I_s \exp(v_D / nV_T)$.

Taking the ratio of currents for two different voltages, we have

$$\frac{i_{D1}}{i_{D2}} = \frac{\exp(v_{D1}/nV_T)}{\exp(v_{D2}/nV_T)} = \exp\left[(v_{D1} - v_{D2})/nV_T\right]$$

Solving for n we obtain:

$$n = \frac{v_{D1} - v_{D2}}{V_T \ln(i_{D1}/i_{D2})} = \frac{0.600 - 0.680}{0.026 \ln(1/10)} = 1.336$$

Then we have

$$I_s = \frac{i_{D1}}{\exp(v_{D1}/nV_T)} = 3.150 \times 10^{-11} \text{ A}$$

P10.14. Suppose we have a junction diode operating at a constant temperature of 300 K. With a forward current of 1 mA, the voltage is 600 mV. Furthermore, with a current of 10 mA, the voltage is 700 mV. Find the value of n for this diode.

P10.14 Using the approximate form of the Shockley Equation, we have

$$10^{-3} = I_s \exp(0.600/nV_T) \qquad (1)$$

$$10^{-2} = I_s \exp(0.700/nV_T) \qquad (2)$$

Dividing the respective sides of Equation (2) by those of Equation (1), we have

$$10 = \frac{I_s \exp(0.700/nV_T)}{I_s \exp(0.600/nV_T)} = \exp(-0.100/nV_T)$$

$$\ln(10) = 0.100/nV_T$$

$$n = 0.100/\left[V_T \ln(10)\right] = 1.670$$

P10.36. Find the values of I and V for the circuits of Figure P10.36, assuming that the diodes are ideal.

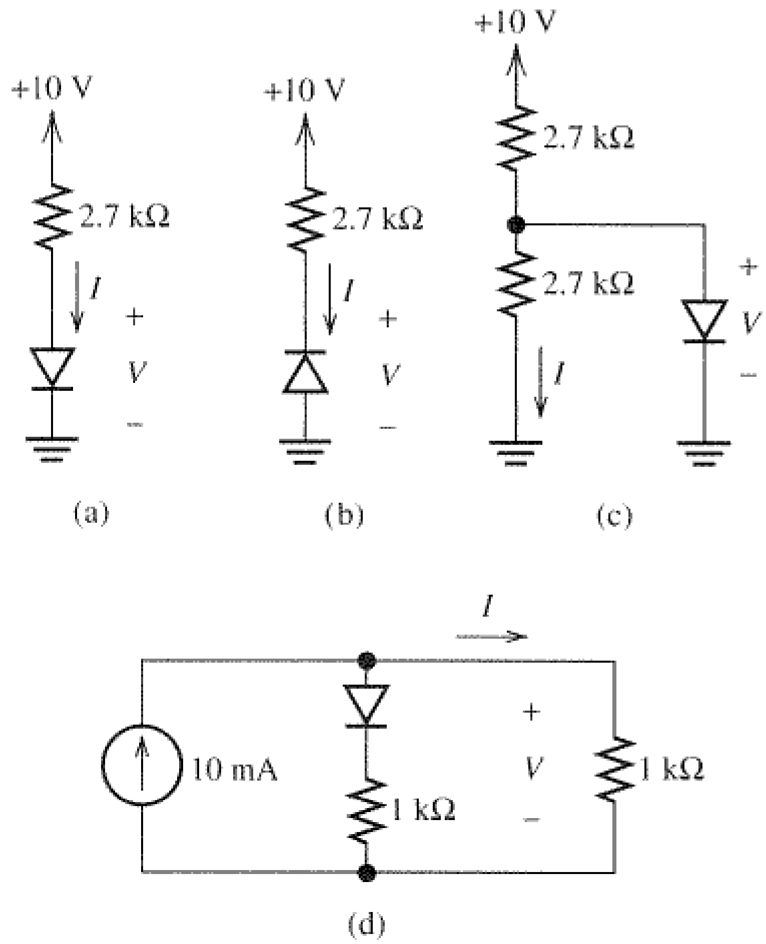

Figure P10.36

P10.36 (a) The diode is on, $V = 0$ and $I = \frac{10}{2700} = 3.70$ mA.

(b) The diode is off, $I = 0$ and $V = 10$ V.

(c) The diode is on, $V = 0$ and $I = 0$.

(d) The diode is on, $I = 5$ mA and $V = 5$ V.