36.7. Visualize: Figure EX36.7 shows a simple one-capacitor circuit.

Solve: **(a)** The capacitive reactance at $\omega = 2\pi f = 2\pi(100 \text{ Hz}) = 628.3$ rad/s is

$$X_C = \frac{1}{\omega C} = \frac{1}{(628.3 \text{ rad/s})(0.30\times10^{-6} \text{ F})} = 5305\ \Omega$$

$$\Rightarrow I_C = \frac{V_C}{X_C} = \frac{10 \text{ V}}{5.305\times10^{3}\ \Omega} = 1.88\times10^{-3} \text{ A} = 1.88 \text{ mA}$$

(b) The capacitive reactance at $\omega = 2\pi(100 \text{ kHz}) = 628{,}300$ rad/s is

$$X_C = \frac{1}{\omega C} = \frac{1}{(6.283\times10^{5} \text{ rad/s})(0.30\times10^{-6} \text{ F})} = 5.305\ \Omega$$

$$\Rightarrow I_C = \frac{V_C}{X_C} = \frac{10 \text{ V}}{5.305\ \Omega} = 1.88 \text{ A}$$

Assess: Using reactance is just like using resistance in Ohm's law. Because $X_C \propto \omega^{-1}$, X_C decreases with an increase in ω, as observed above.

36.18. Solve: (a) For a simple one-inductor circuit,

$$I_L = \frac{V_L}{X_L} = \frac{V_L}{2\pi fL}$$

If the frequency is doubled, the new current will be

$$I'_L = \frac{V_L}{2\pi(2f)L} = \frac{I_L}{2} = 5.0 \text{ mA}$$

(b) If the voltage is doubled, the current will double to 20 mA.
(c) If the voltage is doubled and the frequency is halved, the current will quadruple to 40 mA.

36.19. Visualize: Figure EX36.14 shows a simple one-inductor circuit.

Solve: **(a)** The peak current through the inductor is

$$I_L = \frac{V_L}{X_L} = \frac{V_L}{\omega L} = \frac{V_L}{2\pi f L} = \frac{10\text{ V}}{2\pi(100\text{ Hz})(20\times10^{-3}\text{ H})} = 0.80\text{ A}$$

(b) At a frequency of 100 kHz instead of 100 Hz as in part (a), the reactance will increase by a factor of 1000 and thus the current will decrease by a factor of 1000. Thus, $I_L = 0.80$ mA.

36.50. Visualize: Please refer to Figure P36.50.

Solve: **(a)** The resonance frequency of the circuit is

$$\omega = \frac{1}{\sqrt{LC}} = \frac{1}{\sqrt{(10\times10^{-3}\text{ H})(10\times10^{-6}\text{ F})}} = 3160\text{ rad/s} \Rightarrow f = \frac{\omega}{2\pi} = 5.0\times10^{2}\text{ Hz}$$

(b) At resonance, $X_L = X_C$. So, the peak values are

$$I = \frac{\mathcal{E}_0}{R} = \frac{10\text{ V}}{10\ \Omega} = 1.0\text{ A} \Rightarrow V_R = IR = (1.0\text{ A})(10\ \Omega) = 10.0\text{ V}$$

$$\Rightarrow V_L = IX_L = I\omega L = (1.0\text{ A})(3160\text{ rad/s})(10\times10^{-3}\text{ H}) = 32\text{ V}$$

(c) The instantaneous voltages must satisfy $v_R + v_C + v_L = \mathcal{E}$. But v_C and v_L are out of phase at resonance and cancel. Consequently, it is entirely possible for their peak values V_C and V_L to exceed $\mathcal{E}_0$. $V_R + V_C + V_L = \mathcal{E}_0$ is *not* a requirement of an AC circuit.

36.51. Visualize: Please refer to Figure P36.51.

Solve: **(a)** The resonance frequency of the circuit is

$$\omega = \frac{1}{\sqrt{LC}} = \frac{1}{\sqrt{(1.0\times10^{-3}\text{ H})(1.0\times10^{-6}\text{ F})}} = 3.2\times10^{4}\text{ rad/s} \Rightarrow f = \frac{\omega}{2\pi} = 5.0\times10^{3}\text{ Hz}$$

(b) At resonance $X_L = X_C$. So, the peak values are

$$I = \frac{\mathcal{E}_0}{R} = \frac{10\text{ V}}{10\ \Omega} = 1.0\text{ A} \Rightarrow V_R = IR = (1.0\text{ A})(10\ \Omega) = 10.0\text{ V}$$

$$\Rightarrow V_C = IX_C = I\left(\frac{1}{\omega C}\right) = \frac{1.0\text{ A}}{(3.16\times10^{4}\text{ rad/s})(1.0\times10^{-6}\text{ F})} = 32\text{ V}$$

(c) The instantaneous voltages must satisty $v_R + v_C + v_L = \mathcal{E}$. But v_C and v_L are out of phase at resonance and cancel. Consequently, it is entirely possible for their peak values V_C and V_L to exceed $\mathcal{E}_0$. $V_R + V_C + V_L = \mathcal{E}_0$ is *not* a requirement of an AC circuit.

36.52. Visualize: Please refer to Figure P36.52. When the frequency is very small, $X_C = 1/\omega C$ becomes very large and $X_L = \omega L$ becomes very small. So, the branch in the circuit with the capacitor has a very large impedance and most of the current flows through the branch with the inductor. When the frequency is very large, the reverse is true and most of the current flows through the branch with the capacitor.

Solve: (a) When the frequency is very small, the branch with the inductor has a very small X_L, so $Z \cong R$. The current supplied by the emf is

$$I_{rms} = \frac{10\text{ V}}{100\ \Omega} = 0.10\text{ A}$$

(b) When the frequency is very large, the branch with the capacitor has a very small X_C, so $Z \cong R$. The current supplied by the emf is

$$I_{rms} = \frac{10\text{ V}}{50\ \Omega} = 0.20\text{ A}$$