19. An inductor (L = 400 mH), a capacitor (C = 4.43 μF), and a resistor (R = 500 Ω) are connected in series. A 50.0-Hz AC source produces a peak current of 250 mA in the circuit. (a) Calculate the required peak voltage ΔV_{max}. (b) Determine the phase angle by which the current leads or lags the applied voltage.

20. At what frequency does the inductive reactance of a 57.0-μH inductor equal the capacitive reactance of a 57.0-μF capacitor?

21. A series AC circuit contains the following components: R = 150 Ω, L = 250 mH, C = 2.00 μF and a source with ΔV_{max} = 210 V operating at 50.0 Hz. Calculate the (a) inductive reactance, (b) capacitive reactance, (c) impedance, (d) maximum current, and (e) phase angle between current and source voltage.

22. A sinusoidal voltage $\Delta v(t)$ = (40.0 V) sin(100t) is applied to a series RLC circuit with L = 160 mH, C = 99.0 μF, and R = 68.0 Ω. (a) What is the impedance of the circuit? (b) What is the maximum current? (c) Determine the numerical values for I_{max}, ω, and ϕ in the equation $i(t) = I_{max} \sin(\omega t - \phi)$.

23. An RLC circuit consists of a 150-Ω resistor, a 21.0-μF capacitor, and a 460-mH inductor, connected in series with a 120-V, 60.0-Hz power supply. (a) What is the phase angle between the current and the applied voltage? (b) Which reaches its maximum earlier, the current or the voltage?

P33.19

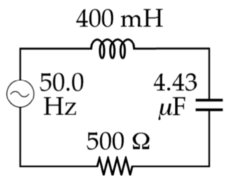

FIG. P33.19

(a) $X_L = \omega L = 2\pi(50.0)(400\times10^{-3}) = 126\ \Omega$

$$X_C = \frac{1}{\omega C} = \frac{1}{2\pi(50.0)(4.43\times10^{-6})} = 719\ \Omega$$

$$Z = \sqrt{R^2 + (X_L - X_C)^2} = \sqrt{500^2 + (126-719)^2} = 776\ \Omega$$

$$\Delta V_{max} = I_{max} Z = (250\times10^{-3})(776) = \boxed{194\ \text{V}}$$

(b) $\phi = \tan^{-1}\left(\frac{X_L - X_C}{R}\right) = \tan^{-1}\left(\frac{126-719}{500}\right) = \boxed{-49.9°}$. Thus, the $\boxed{\text{Current leads the voltage.}}$

P33.20 $\omega L = \frac{1}{\omega C} \to \omega = \frac{1}{\sqrt{LC}} = \frac{1}{\sqrt{(57.0\times10^{-6})(57.0\times10^{-6})}} = 1.75\times10^4\ \text{rad/s}$

$$f = \frac{\omega}{2\pi} = \boxed{2.79\ \text{kHz}}$$

P33.21 (a) $X_L = \omega L = 2\pi\left(50.0\ \text{s}^{-1}\right)\left(250\times10^{-3}\ \text{H}\right) = \boxed{78.5\ \Omega}$

(b) $X_C = \dfrac{1}{\omega C} = \left[2\pi\left(50.0\ \text{s}^{-1}\right)\left(2.00\times10^{-6}\ \text{F}\right)\right]^{-1} = \boxed{1.59\ \text{k}\Omega}$

(c) $Z = \sqrt{R^2 + \left(X_L - X_C\right)^2} = \boxed{1.52\ \text{k}\Omega}$

(d) $I_{max} = \dfrac{\Delta V_{max}}{Z} = \dfrac{210\ \text{V}}{1.52\times10^3\ \Omega} = \boxed{138\ \text{mA}}$

(e) $\phi = \tan^{-1}\left[\dfrac{X_L - X_C}{R}\right] = \tan^{-1}(-10.1) = \boxed{-84.3°}$

P33.22 (a) $Z = \sqrt{R^2 + \left(X_L - X_C\right)^2} = \sqrt{68.0^2 + (16.0 - 101)^2} = \boxed{109\ \Omega}$

$X_L = \omega L = (100)(0.160) = 16.0\ \Omega$

$X_C = \dfrac{1}{\omega C} = \dfrac{1}{(100)\left(99.0\times10^{-6}\right)} = 101\ \Omega$

(b) $I_{max} = \dfrac{\Delta V_{max}}{Z} = \dfrac{40.0\ \text{V}}{109\ \Omega} = \boxed{0.367\ \text{A}}$

(c) $\tan\phi = \dfrac{X_L - X_C}{R} = \dfrac{16.0 - 101}{68.0} = -1.25$:

$\phi = -0.896\ \text{rad} = -51.3°$

$\boxed{I_{max} = 0.367\ \text{A}}$ $\boxed{\omega = 100\ \text{rad/s}}$ $\boxed{\phi = -0.896\ \text{rad} = -51.3°}$

P33.23 $X_L = 2\pi fL = 2\pi(60.0)(0.460) = 173\ \Omega$

$X_C = \dfrac{1}{2\pi fC} = \dfrac{1}{2\pi(60.0)\left(21.0\times10^{-6}\right)} = 126\ \Omega$

(a) $\tan\phi = \dfrac{X_L - X_C}{R} = \dfrac{173\ \Omega - 126\ \Omega}{150\ \Omega} = 0.314$

$\phi = 0.304\ \text{rad} = \boxed{17.4°}$

(b) Since $X_L > X_C$, ϕ is positive; so $\boxed{\text{voltage leads the current}}$.