P32.4 $L = \frac{N\Phi_B}{I} \to \Phi_B = \frac{LI}{N} = \boxed{240\ \text{nT}\cdot\text{m}^2}$ through each turn

P32.6 From $|\varepsilon| = L\left(\frac{\Delta I}{\Delta t}\right)$, we have $L = \frac{\varepsilon}{(\Delta I/\Delta t)} = \frac{24.0\times 10^{-3}\ \text{V}}{10.0\ \text{A/s}} = 2.40\times 10^{-3}\ \text{H}$.

From $L = \frac{N\Phi_B}{I}$, we have $\Phi_B = \frac{LI}{N} = \frac{(2.40\times 10^{-3}\ \text{H})(4.00\ \text{A})}{500} = \boxed{19.2\ \mu\text{T}\cdot\text{m}^2}$.

P32.22

$$I = I_{\max}\left(1 - e^{-t/\tau}\right):\ 0.980 = 1 - e^{-3.00\times 10^{-3}/\tau}$$

$$0.020\ 0 = e^{-3.00\times 10^{-3}/\tau}$$

$$\tau = -\frac{3.00\times 10^{-3}}{\ln(0.020\ 0)} = 7.67\times 10^{-4}\ \text{s}$$

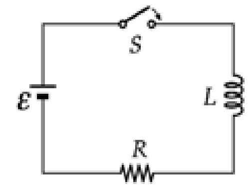

FIG. P32.22

$$\tau = \frac{L}{R},\ \text{so}\ L = \tau R = \left(7.67\times 10^{-4}\right)(10.0) = \boxed{7.67\ \text{mH}}$$

P32.36 From Equation 32.7, $I = \frac{\varepsilon}{R}\left(1 - e^{-Rt/L}\right)$.

(a) The maximum current, after a long time t, is $I = \frac{\varepsilon}{R} = 2.00\ \text{A}$.

At that time, the inductor is fully energized and .

(b)

(c)

(d) $U = \frac{LI^2}{2} = \frac{(10.0\ \text{H})(2.00\ \text{A})^2}{2} = \boxed{20.0\ \text{J}}$

P32.38 The total magnetic energy is the volume integral of the energy density, $u = \frac{B^2}{2\mu_0}$.

Because B changes with position, u is not constant. For $B = B_0\left(\frac{R}{r}\right)^2$, $u = \left(\frac{B_0^2}{2\mu_0}\right)\left(\frac{R}{r}\right)^4$.

Next, we set up an expression for the magnetic energy in a spherical shell of radius r and thickness dr. Such a shell has a volume $4\pi r^2 dr$, so the energy stored in it is

$$dU = u\left(4\pi r^2 dr\right) = \left(\frac{2\pi B_0^2 R^4}{\mu_0}\right)\frac{dr}{r^2}.$$

We integrate this expression for $r = R$ to $r = \infty$ to obtain the total magnetic energy outside the sphere. This gives

$$U = \boxed{\frac{2\pi B_0^2 R^3}{\mu_0}} = \frac{2\pi\left(5.00\times 10^{-5}\ \text{T}\right)^2\left(6.00\times 10^6\ \text{m}\right)^3}{\left(1.26\times 10^{-6}\ \text{T}\cdot\text{m/A}\right)} = \boxed{2.70\times 10^{18}\ \text{J}}.$$

P32.39 $I_1(t) = I_{max} e^{-\alpha t} \sin \omega t$ with $I_{max} = 5.00 \text{ A}$, $\alpha = 0.025\,0 \text{ s}^{-1}$, and $\omega = 377 \text{ rad/s}$

$$\frac{dI_1}{dt} = I_{max} e^{-\alpha t}(-\alpha \sin \omega t + \omega \cos \omega t).$$

At $t = 0.800 \text{ s}$,

$$\frac{dI_1}{dt} = (5.00 \text{ A/s}) e^{-0.0200}\left[-(0.025\,0)\sin(0.800(377)) + 377\cos(0.800(377))\right]$$

$$\frac{dI_1}{dt} = 1.85 \times 10^3 \text{ A/s}.$$

Thus, $\varepsilon_2 = -M\frac{dI_1}{dt}$: $\quad M = \frac{-\varepsilon_2}{dI_1/dt} = \frac{+3.20 \text{ V}}{1.85 \times 10^3 \text{ A/s}} = \boxed{1.73 \text{ mH}}$.

P32.51 (a) $f = \frac{1}{2\pi\sqrt{LC}} = \frac{1}{2\pi\sqrt{(0.082\,0 \text{ H})(17.0 \times 10^{-6} \text{ F})}} = \boxed{135 \text{ Hz}}$

(b) $Q = Q_{max} \cos \omega t = (180\ \mu\text{C})\cos(847 \times 0.001\,00) = \boxed{119\ \mu\text{C}}$

(c) $I = \frac{dQ}{dt} = -\omega Q_{max} \sin \omega t = -(847)(180)\sin(0.847) = \boxed{-114 \text{ mA}}$

P32.54 (a) $\omega_d = \sqrt{\frac{1}{LC} - \left(\frac{R}{2L}\right)^2} = \sqrt{\frac{1}{(2.20 \times 10^{-3})(1.80 \times 10^{-6})} - \left(\frac{7.60}{2(2.20 \times 10^{-3})}\right)^2} = 1.58 \times 10^4 \text{ rad/s}$

Therefore, $\quad f_d = \frac{\omega_d}{2\pi} = \boxed{2.51 \text{ kHz}}$.

(b) $R_c = \sqrt{\frac{4L}{C}} = \boxed{69.9\ \Omega}$