E33-9 For a single long straight wire, $B = \mu_0 i/2\pi d$ but we need a factor of "2" since there are two wires, then $i = \pi dB/\mu_0$. Finally

$$i = \frac{\pi dB}{\mu_0} = \frac{\pi(0.0405\,\mathrm{m})(296,\mu\mathrm{T})}{(4\pi\times10^{-7}\mathrm{N/A^2})} = 30\,\mathrm{A}$$

E33-15 We imagine the ribbon conductor to be a collection of thin wires, each of thickness dx and carrying a current di. di and dx are related by $di/dx = i/w$. The contribution of one of these thin wires to the magnetic field at P is $dB = \mu_0\, di/2\pi x$, where x is the distance from this thin wire to the point P. We want to change variables to x and integrate, so

$$B = \int dB = \int \frac{\mu_0 i\, dx}{2\pi w x} = \frac{\mu_0 i}{2\pi w}\int \frac{dx}{x}.$$

The limits of integration are from d to $d + w$, so

$$B = \frac{\mu_0 i}{2\pi w} \ln\left(\frac{d+w}{d}\right).$$

P33-14 (a) According to Eq. 33-34, the magnetic field inside the wire *without a hole* has magnitude $B = \mu_0 ir/2\pi R^2 = \mu_0 jr/2$ and is directed radially. If we superimpose a second current to create the hole, the additional field at the center of the hole is zero, so $B = \mu_0 jb/2$. But the current in the remaining wire is

$$i = jA = j\pi(R^2 - a^2),$$

so

$$B = \frac{\mu_0 ib}{2\pi(R^2 - a^2)}.$$

P34-8 (a) $d\Phi_B/dt = B\,dA/dt$, but dA/dt is $\Delta A/\Delta t$, where ΔA is the area swept out during one rotation and $\Delta t = 1/f$. But the area swept out is πR^2, so

$$|\mathcal{E}| = \frac{d\Phi_B}{dt} = \pi f B R^2.$$

(b) If the output current is i then the power is $P = \mathcal{E} i$. But $P = \tau\omega = \tau 2\pi f$, so

$$\tau = \frac{P}{2\pi f} = iBR^2/2.$$

P34-13 Assume that E does vary as the picture implies. Then the line integral along the path shown *must* be nonzero, since $\vec{\mathbf{E}} \cdot \vec{\mathbf{l}}$ on the right is not zero, while it is along the three other sides. Hence $\oint \vec{\mathbf{E}} \cdot d\vec{\mathbf{l}}$ is non zero, implying a change in the magnetic flux through the dotted path. But it doesn't, so $\vec{\mathbf{E}}$ cannot have an abrupt change.

E36-8 In each case apply $\mathcal{E} = L\Delta i/\Delta t$.

(a) $\mathcal{E} = (4.6\,\mathrm{H})(7\,\mathrm{A})/(2\times10^{-3}\mathrm{s}) = 1.6\times10^{4}\mathrm{V}$.

(b) $\mathcal{E} = (4.6\,\mathrm{H})(2\,\mathrm{A})/(3\times10^{-3}\mathrm{s}) = 3.1\times10^{3}\mathrm{V}$.

(c) $\mathcal{E} = (4.6\,\mathrm{H})(5\,\mathrm{A})/(1\times10^{-3}\mathrm{s}) = 2.3\times10^{4}\mathrm{V}$.

P36-2 (a) Since ni is the net current per unit length and is this case i/W, we can simply write $B = \mu_0 i/W$.

(b) There is only one loop of wire, so

$$L = \phi_B/i = BA/i = \mu_0 i\pi R^2/Wi = \mu_0 \pi R^2/W.$$

P36-3 Choose the y axis so that it is parallel to the wires and directly between them. The field in the plane between the wires is

$$B = \frac{\mu_0 i}{2\pi}\left(\frac{1}{d/2+x} + \frac{1}{d/2-x}\right).$$

The flux per length l of the wires is

$$\begin{aligned}
\Phi_B &= l\int_{-d/2+a}^{d/2-a} B\,dx = l\frac{\mu_0 i}{2\pi}\int_{-d/2+a}^{d/2-a}\left(\frac{1}{d/2+x} + \frac{1}{d/2-x}\right) dx,\\
&= 2l\frac{\mu_0 i}{2\pi}\int_{-d/2+a}^{d/2-a}\left(\frac{1}{d/2+x}\right) dx,\\
&= 2l\frac{\mu_0 i}{2\pi}\ln\frac{d-a}{a}.
\end{aligned}$$

The inductance is then

$$L = \frac{\phi_B}{i} = \frac{\mu_0 l}{\pi}\ln\frac{d-a}{a}.$$