47. (a) We denote the $\vec{B}$-fields at point P on the axis due to the solenoid and the wire as $\vec{B}_s$ and $\vec{B}_w$, respectively. Since $\vec{B}_s$ is along the axis of the solenoid and $\vec{B}_w$ is perpendicular to it, $\vec{B}_s \perp \vec{B}_w$, respectively. For the net field $\vec{B}$ to be at 45° with the axis we then must have $B_s = B_w$. Thus,

$$B_s = \mu_0 i_s n = B_w = \frac{\mu_0 i_w}{2\pi d} \ ,$$

which gives the separation d to point P on the axis:

$$d = \frac{i_w}{2\pi i_s n} = \frac{6.00\,\text{A}}{2\pi(20.0 \times 10^{-3}\,\text{A})(10\,\text{turns/cm})} = 4.77\ \text{cm} \ .$$

(b) The magnetic field strength is

$$\begin{aligned} B &= \sqrt{2}B_s \\ &= \sqrt{2}(4\pi \times 10^{-7}\,\text{T}\cdot\text{m/A})(20.0 \times 10^{-3}\,\text{A})(10\,\text{turns}/0.0100\,\text{m}) \\ &= 3.55 \times 10^{-5}\ \text{T} \ . \end{aligned}$$