A bolt of lightning strikes the ground at point A near a tall metal fence. Assume the bolt is straight and vertical.

(a) If the peak current is 33,000 A, what is the peak magnetic field at point B?

\[ B = \frac{\mu_0 I_{\text{peak}}}{2\pi d} = \frac{4\pi \times 10^{-7} \text{Tm/A}}{2\pi \times 0.200 \text{m}} \]

\[ = 3.3 \times 10^{-2} \text{T} \]

(b) If the current rises from zero to its peak in 0.35 ms, what is the current induced in a square of the metal fence that is 2.00 m on a side. The resistance around the square is 0.15 \( \Omega \). Assume the current increase is linear.

\[ \frac{\mu_0 I y}{2\pi} \int_{0.200}^{2.20} \frac{d\Phi_B}{r} = \frac{\mu_0 I y}{2\pi} \ln \left( \frac{2.20}{0.200} \right) = \frac{4\pi \times 10^{-7} \times 33,000 \times 2.06 \ln(2.20)}{2\pi} \]

\[ = 0.03165 \]

\[ |E| = \left| \frac{0.03165}{0.35 \times 10^{-8}} \right| \]

\[ E = 90.43 \]

\[ I = \frac{E}{R} = \frac{90.43}{0.15} = 602.8 \]

\[ I = 603 \text{ A} \]
\((c)\) \(d = 5.20 \text{ cm} = 0.052 \text{ m}\)
\[ R = \frac{d}{2} = 0.026 \text{ m} \]

\[ J(R) = J_0 \left( 1 - \alpha R^2 \right) \]
\[ J(0.026) = 0 = J_0 \left( 1 - \alpha \cdot (0.026)^2 \right) \]

\[ \Rightarrow \alpha = \frac{1}{R^2} = \frac{1}{(0.026)^2} \]
\[ \alpha = 1479 \]
\[ \alpha = \left[ 8.4 \times 10^8 \frac{1}{\text{m}^2} \right] \]

\[(d)\]
\[ I = \int_{0}^{0.026} J_0 \left( 1 - \alpha R^2 \right) dA = \int_{0}^{0.026} J_0 \left( 1 - \alpha R^2 \right) 2\pi K dR \]
\[ = 2\pi J_0 \left( \frac{R^2}{2} - \alpha \frac{R^4}{4} \right) \bigg|_{0}^{0.026} \]
\[ I_{\text{peak}} = 2\pi J_0 \left( \frac{(0.026)^3}{2} - \frac{(0.026)^4}{4} \right) \]

\[ \Rightarrow \ J_0 = \frac{2 I_{\text{peak}}}{\pi (0.026)^2} \]
\[ = 3.109 \times 10^7 \]

\[ J_0 \approx 3.11 \times 10^7 \frac{\text{A}}{\text{m}^2} \]