8/21/13
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Solutions to Problem 7.33

(a) * Recall that $\vec{E} = \frac{\mu_0 \omega}{2\pi} I_0 \sin(\omega t) \ln\left(\frac{a}{s}\right) \hat{z}$

* $\frac{\partial \vec{E}}{\partial t} = \frac{\mu_0 \omega^2}{2\pi} I_0 \cos(\omega t) \ln\left(\frac{a}{s}\right) \hat{z}$

* $\boxed{\vec{J}_d \equiv \epsilon_0 \frac{\partial \vec{E}}{\partial t} = \frac{\omega^2}{2\pi c^2} I_0 \cos(\omega t) \ln\left(\frac{a}{s}\right) \hat{z}}$

(b) * $I_d = \int d\vec{a} \cdot \vec{J}_d = \int_0^{2\pi} d\phi \int_0^a ds\, s * \frac{\omega^2}{2\pi c^2} I_0 \cos(\omega t) \ln\left(\frac{a}{s}\right) = \frac{\omega^2}{c^2} I_0 \cos(\omega t) * \frac{s^2}{2}\left[\ln\left(\frac{a}{s}\right) + \frac{1}{2}\right]\Big|_0^a$

$= \boxed{\frac{a^2 \omega^2}{4c^2} I_0 \cos(\omega t)}$

(c) * $\frac{I_d}{I} = \frac{a^2 \omega^2}{4c^2} << 1$

* to make $\frac{I_d}{I} = \frac{1}{100}$ with $a = 2 \cdot 10^{-3}\,m \Rightarrow \boxed{\omega = \frac{c}{5a} = 3 \cdot 10^{10}\,Hz}$