1. Consider a circular parallel plate capacitor with radius, R, and separation, d. Take $R \gg d$, so you can ignore any fringing. At some instant of time the capacitor has charge, Q, with current, $I = \frac{dQ}{dt}$, increasing the charge.

![Capacitor Diagram](image)

a. What is the electric field inside the capacitor as a function of the charge, Q? (If you don’t trust your memory, use Gauss’ law.)

$$E = \frac{Q}{\varepsilon_0 \pi R^2}$$  (direction shown)

b. Use Ampere’s law to find the magnetic field inside the capacitor a distance, $r \leq R$, from the center axis due to the displacement current ($\varepsilon_0 \frac{dE}{dt}$) as a function of the current, I.

$$B \cdot 2\pi r = \mu_0 I \cdot \frac{r^2}{R^2} \Rightarrow B = \frac{\mu_0 I}{2\pi r \frac{r^2}{R^2}}$$  

(c) Calculate the power delivered to the capacitor by integrating the Poynting vector ($\hat{S} = (\hat{E} \times \hat{B})/\mu_0$) over the area surrounding the interior of the capacitor.

$$\hat{S} = \frac{1}{\mu_0} (\hat{E} \times \hat{B})$$, note $\hat{E} \times \hat{B}$ is directed into the capacitor.

$$P = \int dA \cdot \hat{S} = \frac{d}{\mu_0 \varepsilon_0 \pi R^2} \frac{dQ}{dt} = \frac{(\frac{Q}{\varepsilon_0 \pi R^2}) \cdot d \cdot I}{\mu_0}$$