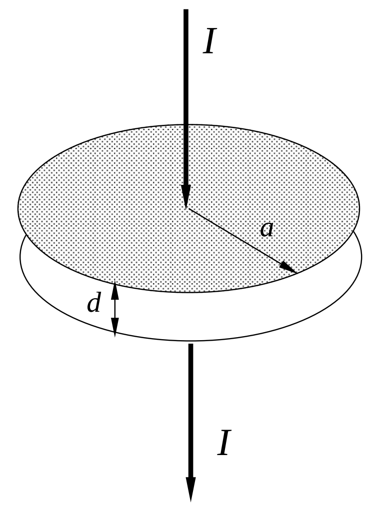
1. An ideal capacitor consists of two circular plates of radius a separated by a distance d surrounded by vacuum. Assume the E-field is uniform between the plates (i.e., neglect the fringing field at the edge of the plates). The capacitor is being charged by a constant current I.



   (a) Find the electric field between the plates as a function of time.

   (b) Find the displacement current density between the plates. Using Ampère's law find the magnetic field $\vec{\mathbf{B}}(r)$ between the plates (i.e., for any $r < a$) generated by the displacement current. Clearly state or show the direction of $\vec{\mathbf{B}}(r)$.

   (c) Find the Poynting vector on the circumference of the capacitor. Is energy entering or leaving the capacitor?

   (d) Integrate $\vec{\mathbf{S}} \cdot \hat{\mathbf{n}}$ over the cylindrical edge of the capacitor to find the energy flowing *into* the capacitor. Show that the result is equal to the *time rate of change* in the electric energy stored between the capacitor plates. (Use the electric energy density $\frac{1}{2}\,\vec{\mathbf{E}} \cdot \vec{\mathbf{D}}$ to find the total electric energy between the plates.)

2. Consider an infinite solenoid with radius R and N turns per meter filled with linear magnetic material (relative permeability $K_m \gg 1$). The current flowing around the solenoid is increasing, producing an increasing magnetic field which I name $\dot{B}$.

   (a) Calculate the magnetic energy stored in a length ℓ of the solenoid.

   (b) The changing magnetic field will induce an electric field. Find $\vec{\mathbf{E}}$ everywhere (inside and outside the solenoid). Provide a drawing that shows the direction of $\vec{\mathbf{E}}$.

   (c) Using $\vec{\mathbf{E}}$ and $\vec{\mathbf{H}}$ just inside the solenoid, calculate the Poynting vector (direction and magnitude).

   (d) Show that the rate of increase in the magnetic energy in a length ℓ of the solenoid matches the rate of energy inflow via the Poynting vector.