

3. Dielectric Cylinder in an Electric Field

An infinitely long cylinder of radius a and dielectric constant ϵ is placed in an initially uniform electric field of strength E_0 . The axis of the cylinder is oriented at a right angle to the direction of the field.

- a) Find the electric potential $\Phi(r; \theta; z)$ both inside and outside of the cylinder, in cylindrical coordinates $(r; \theta; z)$, where the z axis is the axis of the cylinder.
- b) Find the electric fields \mathbf{E} and \mathbf{D} inside the cylinder.
- c) What is the surface polarization (bound charge) density σ_b at $r = a$? What is the volume polarization charge density ρ_b for $r < a$?
- d) What is the electrostatic energy per unit length inside the cylinder?