Special Problem 5-3.9

A perfectly conducting cylinder of **infinite** length is centered along the *z*-axis. This cylinder has a radius of 2 m.

At the surface of this conducting cylinder is free charge, with a density:

$$\rho_s(\bar{r}) = 4\varepsilon_0 \quad C/m^2$$

The conducting cylinder is completely surrounded by a dielectric with permittivity $\varepsilon = 3\varepsilon_0$.

It is known that the electric field in the **dielectric** has the form:

$$\mathbf{E}(\bar{r}) = \frac{A}{\rho}\hat{a}_\rho + \frac{B}{\rho}\hat{a}_z$$

where *A* and *B* are **unknown constants**.

1. Find the electric field $\mathbf{E}(\bar{r})$ in the dielectric (i.e. the **numeric** values of constants *A* and *B*).

2. Determine the **dipole density** in the dielectric, expressed as average dipole moment/unit volume.

3. What is the electric field **inside** the perfect conductor?