PHY3323: ELECTROMAGNETISM I

Problem set 10, (due Nov. 12, 2008)

PROBLEM 1

The space between the plates of a parallel-plate capacitor is filled with three slabs of linear dielectrics as shown on Figure 1. Slabs 1, 2, and 3 have thickness d_1, d_2, and d_3 respectively and dielectric constants ϵ_1, ϵ_2, and ϵ_3. The free charge density on the top plate is σ and on the bottom plate is $-\sigma$.

(a) Find the electric displacement $\vec{D}$ in each slab.

(b) Find the electric field $\vec{E}$ in each slab.

(c) Find the polarization $\vec{P}$ in each slab.

(d) Find the potential difference between the plates.

(e) Find all surface bound charges and volume bound charges in the system.

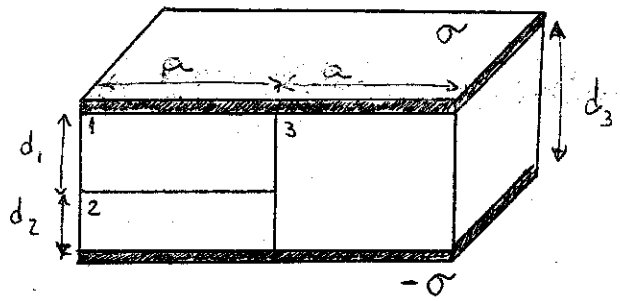

Fig. 1

PROBLEM 2

Two long coaxial cylindrical metal tubes (inner radius a, outer radius b, and length l) stand vertically in a tank of dielectric oil (susceptibility χ_e, mass density ρ). To what height (h) does the oil rise in the space between the tubes if the total free surface charge on the outer surface is Q_f and on the inner surface is $-Q_f$.

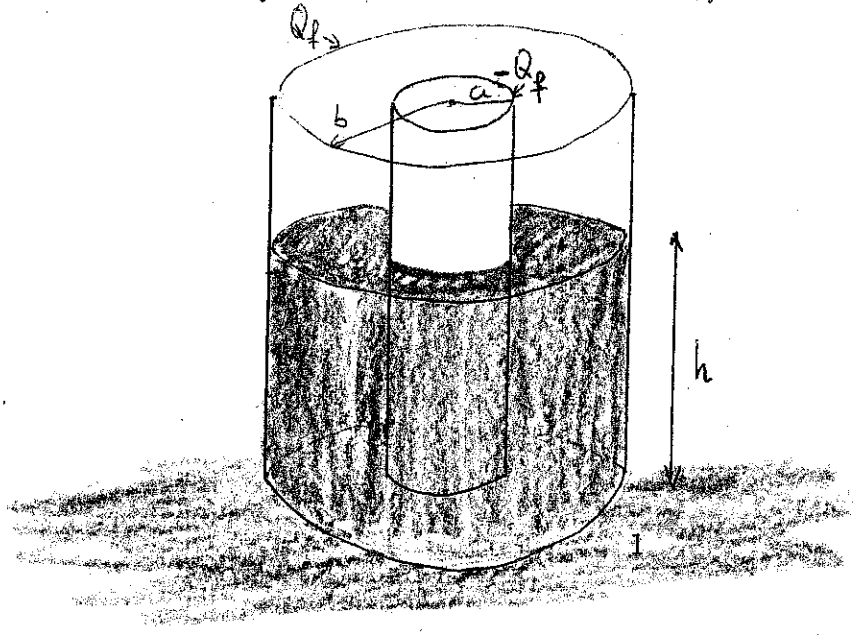

Fig. 2