Physics 334 **Electromagnetic Theory II** **Spring 2010**

Problem A

A sphere of radius R is made up of a linear dieletric material with dielectric constant ϵ_r. Embedded in the sphere is a uniform free charge density ρ_f. Outside the sphere there is no free charge. Determine the displacement field $\mathbf{D}$, the electric field $\mathbf{E}$, the bound charge ρ_b, and the charge ρ both inside and outside the sphere.

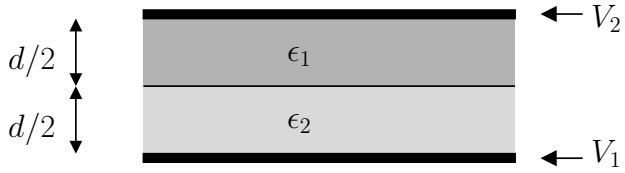
Problem B

(a) Check that your solutions for $\mathbf{D}$ and $\mathbf{E}$ in Problem A satisfy the appropriate boundary conditions at the surface of the sphere.

(b) Check that your solutions for $\mathbf{B}$ and $\mathbf{H}$ in Problem 6.17 satisfy the appropriate boundary conditions at the surface of the wire.

Problem C

Two parallel conducting plates are separated by a distance d and are held at electric potentials V_1 and V_2, as shown in the diagram. Assume $V_2 > V_1$. The region between the plates is filled with two equal sized slabs of linear dielectric materials, with permeabilities ϵ_1 and ϵ_2.



(a) Assume that the boundary surface between the dielectrics has no free charge on it. Calculate the $\mathbf{D}$ and $\mathbf{E}$ fields in the region between the plates. Also calculate the bound charge density ρ_b in both dielectrics, and the surface bound charge σ_b at the interface between them.

(b) Repeat part (a), but now with a free charge density σ_f on the interface between the dielectrics.

Problem D

Show that the electromagnetic force density Eq. (8.18) can be written as Eq. (8.21) by using the definition of the Maxwell stress tensor, Eq. (8.19).