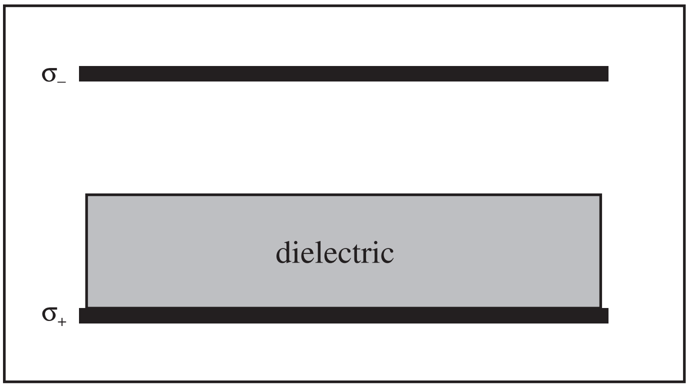
Electricity and Magnetism - Test 2 - Spring 2010

Work four of the six problems. Place the problems in the order you wish them graded. The first two problems form the first half test; the second two problems form the second half test.

Problem 2.1 A system of current has a vector potential of $\vec{A} = \gamma s^2 \hat{\phi}$ in cylindrical coordinates. Find the current that could have resulted in $\vec{A}$. Is the current a valid magnetostatic current?

Problem 2.2 The infinite rectangular region $-a < z < a$ contains volume current density $\vec{J} = \gamma z \hat{x}$ where gamma is a constant. Find the magnetic field everywhere.

Problem 2.3 A linear dielectric slab with dielectric constant ϵ_r is placed between two infinite parallel planes of charge with charge density $\pm\sigma$. Find $\vec{D}$, $\vec{E}$, $\vec{P}$, and ρ_b in the dielectric, and the bound charge density on the top and bottom surface of the dielectric.



Problem 2.4 A potential of $V_0 \cos(\theta)$ is established on the inner surface of a spherical dielectric with inner radius a and outer radius b. The dielectric constant of the material is ϵ_r. Find the potential for $r > a$. You may report a system of equations that needs to be solved to find the coefficients of the potential functions. Actually solving these equations turns out to be quite messy. These equations should be a set of simple linear, non-differential equations.

Problem 2.5 A disk with surface charge density γ/s, inner radius a and outer radius b is spun at angular velocity ω about an axis through its center. Find the magnetic field at the center of the disk.

Problem 2.6 A spherical system has polarization $\vec{P} = \gamma r^2 \hat{r}$ for radius $r < a$ and $\vec{P} = 0$ for $r > a$. Find the electric field everywhere.