Electricity and Magnetism - Test 2 - Spring 2013

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 An infinite linear charge with charge density λ is parallel to an infinite grounded planar conductor and is a distance R from the conductor. Compute the force per unit length exerted by the conductor on the linear charge.

Problem 2.2 A hollow cylinder with inner radius a and outer radius b is coaxial with the z axis. The cylinder contains a material with fixed polarization $\vec{P} = P_0\hat{s}$ where P_0 is a constant. Compute the potential difference ΔV_{0b} between the z-axis and the outer edge of the cylinder at $s = b$. Do not assume a linear dielectric, no dielectric is present.

Problem 2.3 A spherical system of radius a has surface charge density $\sigma(a,\theta) = \sigma_0(1+\cos(\theta))$. Compute the potential everywhere under the assumption that the potential at infinity is zero.

Problem 2.4 An infinite rectangular channel $0 < x < a$ and $0 < y < a$ has zero potential on three sides. The fourth side, the side lying in the $x - z$ plane has a potential $V(x, 0, z) = V_0 \sin(\pi x/a)$. Compute the potential in the channel. Note this is a two-dimensional problem which has no z dependence.

Problem 2.5 A cylindrical coaxial cable is formed of an inner conductor with outer radius a and an outer conductor with inner radius c. The cable is partially filled with a dielectric from radius $s = a$ to radius $s = b < c$ with dielectric constant κ. Partially filling a coaxial cable is not unusual because it increases flexibility. A surface charge density σ is applied to the inner conductor. Calculate the potential difference between the conductors.

Problem 2.6 A uniform spherical volume charge density ρ fills the region $r < a$. The volume charge is surrounded by a dielectric with inner radius a and outer radius b with dielectric constant κ. Compute the electric field, the displacement field, and the polarization everywhere.