DEPARTMENT OF PHYSICS
INDIAN INSTITUTE OF TECHNOLOGY, MADRAS

PH1020 Physics II

Tutorial 3 (12.2.2018)

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1. Consider a spherical medium of radius a and dielectric constant $\epsilon_r^{(1)}$, carrying uniform free-charge distribution ρ. It is surrounded by a medium of dielectric constant $\epsilon_r^{(2)}$. If the two mediums are linear dielectrics, then find (i) the bound volume-charge density everywhere in space, and (ii) the bound surface-charge density on the surface of the sphere.

2. A cylindrical coaxial cable has conducting surfaces at $s = a$ and $s = 4a$, which carry uniform surface charge densities σ_0 and $-\sigma_0/4$, respectively. Two linear dielectric media with dielectric constants $\epsilon_r^{(1)}$ and $\epsilon_r^{(2)}$ fill the regions $a < s \leq 2a$ and $2a < s < 4a$, respectively. (a) Find the energy density between $a < s \leq 2a$.(b) Determine the ratio of the magnitude of the polarization just inside and just outside the boundary at $s = 2a$. (c) Sketch $|\mathbf{E}|$ as a function of s in the interval $0 < s \leq 5a$. Given $\epsilon_r^{(1)} = 1.5$ and $\epsilon_r^{(2)} = 2$.

3. Consider a wire of length $2l$ and radius a, centered at the origin and its symmetry axis being the $z-$axis. The wire carries a uniform polarization $\mathbf{P} = P_0\hat{e_z}$, with P_0 constant. (a) Find the surface and volume bound-charge densities. (b) Electric field on the positive $z-$axis. Check that it satisfies appropriate boundary condition at $z = L$. (c) Sketch the magnitude of the electric field at the origin as function of $\frac{a}{L}$

4. At the planar boundary between two dielectrics with dielectric constants, $= 3$ and $\epsilon_r^{(2)} = 2$, electric field $E_1 = 1200V/m$ in medium 1 makes an angle $\theta = 45^0$ with the normal to the boundary. Find the electric field in medium 2 and also the polarization charge density on the interface.