VE230   Homework 3
2020 Summer

P.3-22 The polarization in a dielectric cube of side L centered at the origin is given by $\boldsymbol{P} = P_0(\boldsymbol{a_x}x + \boldsymbol{a_y}y + \boldsymbol{a_z}z)$.
a) Determine the surface and volume bound-charge densities
b) Show that the total bound charge is zero.

P.3-23 Determine the electric field intensity at the center of a small spherical cavity cut out of a large block of dielectric in which a polarization **P** exists.

P.3-25 Assume that the z=0 plane separates two lossless dielectric regions with $\epsilon_{r1} = 2$ and $\epsilon_{r2} = 3$. If we know that $\boldsymbol{E_1}$ in region 1 is $\boldsymbol{a_x}2y - \boldsymbol{a_y}3x + \boldsymbol{a_z}(5+z)$, what do we also know about $\boldsymbol{E_2}$ and $\boldsymbol{D_2}$ in region 2? Can we determine $\boldsymbol{E_2}$ and $\boldsymbol{D_2}$ at any point in region 2? Explain.

P.3-28 Dielectric lenses can be used to collimate electromagnetic fields. In Fig.1 the left surface of the lens is that of a circular cylinder, and the right surface is a plane. If $\boldsymbol{E_1}$ at point $P(r_0, 45°, z)$ in region 1 is $\boldsymbol{a_r}5 - \boldsymbol{a_\phi}3$, what must be the dielectric constant of the lens in order that $\boldsymbol{E_3}$ in region 3 is parallel to the x-axis?
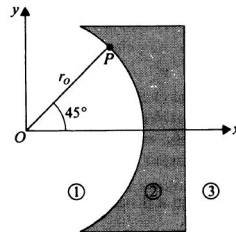

Figure 1: A dielectric lens

P.3-32 The radius of the core and the inner radius of the outer conductor of a very long coaxial transmission line are r_i and r_o, respectively. The space between the conductors is filled with two coaxial layers of dielectrics. The dielectric constants of the dielectrics are ϵ_{r_1} for $r_i < r < b$ and ϵ_{r2} for $b < r < r_o$. Determine its capacitance per unit length.