

## VE230 Homework 3

2021 Summer

**P.3-22** The polarization in a dielectric cube of side  $L$  centered at the origin is given by  $\mathbf{P} = P_0(\mathbf{a}_x x + \mathbf{a}_y y + \mathbf{a}_z z)$ .

- Determine the surface and volume bound-charge densities
- 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  $\mathbf{P}$  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  $\mathbf{E}_1$  in region 1 is  $\mathbf{a}_x 2y - \mathbf{a}_y 3x + \mathbf{a}_z (5 + z)$ , what do we also know about  $\mathbf{E}_2$  and  $\mathbf{D}_2$  in region 2? Can we determine  $\mathbf{E}_2$  and  $\mathbf{D}_2$  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  $\mathbf{E}_1$  at point  $P(r_0, 45^\circ, z)$  in region 1 is  $\mathbf{a}_r 5 - \mathbf{a}_\phi 3$ , what must be the dielectric constant of the lens in order that  $\mathbf{E}_3$  in region 3 is parallel to the  $x$ -axis?

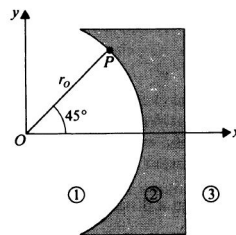


Figure 1: A dielectric lens

**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  $\epsilon_{r1}$  for  $r_i < r < b$  and  $\epsilon_{r2}$  for  $b < r < r_o$ . Determine its capacitance per unit length.