VE230 HW3

Due: Tuesday 11th June, 2019

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

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 $\mathbf{P}$ 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. 3–41 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 $P(r_o, 45°, z)$ 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?

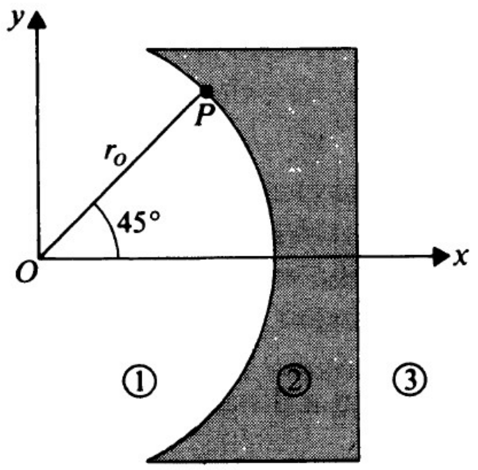

FIGURE 3–41
A dielectric lens (Problem P.3–28).

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_{r1} for $r_i < r < b$ and ϵ_{r2} for $b < r < r_o$. Determine its capacitance per unit length.

P.3–43 Prove that Eqs. (3–180) for stored electrostatic energy hold true for any two-conductor capacitor.

$$\boxed{W_e = \tfrac{1}{2}CV^2 \qquad \text{(J).}} \qquad (3\text{–}180a)$$

$$\boxed{W_e = \tfrac{1}{2}QV \qquad \text{(J)}} \tag{3–180b}$$

$$\boxed{W_e = \frac{Q^2}{2C} \qquad \text{(J).}} \tag{3–180c}$$

[redacted]