Homework set 4 (David K. Cheng, Fundamentals of Engineering Electromagnetics)

P. 3-16 A positive point charge Q is at the center of a shpherical dielectric shell of an inner radius R_i and an outer radius R_o. The dielectric constant of the shell is ε_r. Determine $\mathbf{E}, V, \mathbf{D},$ and $\mathbf{P}$ as functions of the radial distance R.

P. 3-17 c) If a 10-(mm) thick plexiglass is inserted between the plates, what is the maximum voltage that can be applied to the plates without a breakdown?

P. 3-19 Dielectric lenses can be used to collimate electromagnetic fields. In Fig. 3-30 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 $P(r_0, 45°, z)$ 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?

P. 3-21 Assume that the outer conductor of the cylindrical capacitor in Example 3-16 is grounded and that the inner conductor is maintained at a potential V_0.

P. 3-27 A parallel-plate capacitor of width w, length L, and separation d has a solid dielectric slab of permittivity ε in the space between the plates. The capacitor is charged to a voltage V_0 by a battery, as indicated in Fig. 3-32. Assuming that the dielectric slab is withdrawn to the position shown and the switch is opened, determine the force acting on the slab.

P. 3-31 An infinite conducting cone of half-angle α is maintained at potential V_0 and insulated from a grounded conducting plane, as illustrated in Fig. 3-33. Determine

a) the potential distribution $V(\theta)$ in the region $\alpha < \theta < \pi/2$,
b) the electric field intensity in the region $\alpha < \theta < \pi/2$, and
c) the charge densities on the cone surface and on the grounded plane.

P. 3-32 For a positive point charge Q located at a distance d from each of two grounded perpendicular conducting half-planes shown in Fig. 3-34, find the expressions for

a) the potential and the electric field intensity at an arbitrary point P(x,y), and
b) the surface charge densities induced on the two half-planes.

P. 3-35 The axis of a long two-wire parallel transmission line are 2 (cm) apart. The wires have a radius 3 (mm) and are maintained at potentials +100 (V) and -100 (V). Find

a) the location of the equivalent line charges relative to the wire axes,
b) the equivalent line charge density of each wire, and
c) the electric field intensity at a point midway between the wires,