

Homework 1

Due Tuesday, October 4th in class

1. The portion of the z axis for which $|z| < 2$ carries a nonuniform line charge density of $10|z|$ nC/m, and $\rho_L = 0$ elsewhere. Determine \mathbf{E} in free space at: (a) (0,0,4); (b) (0,4,0).
2. Within the spherical shell, $3 < r < 4$ m, the electric flux density is given as $\mathbf{D} = 5(r - 3)^3 \mathbf{a}_r$ C/m². (a) What is the volume charge density at $r = 4$? (b) What is the electric flux density at $r = 4$? (c) How much electric flux leaves the sphere $r = 4$? (d) How much charge is contained within the sphere $r = 4$?
3. A parallel plate capacitor consists of two perfect conducts separated by a distance x . The dielectric constant of the medium in between the two plates is ϵ . The area of the two plates A is large enough so that the fringe effect is negligible. The mass of each plate is m . The upper plate is allowed to move up and down, but not horizontally. The lower plate is fixed on the substrate.

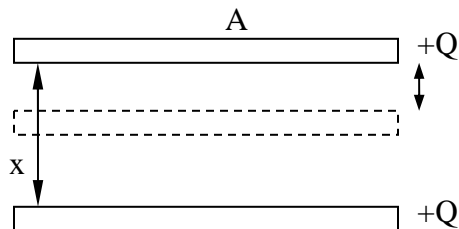


Figure 1.

Calculate the charge Q necessary to keep the upper plate at rest.

4. An electric quadrupole consists of four point charges of equal magnitude Q . The four point charges form a square with side-length d . The upper point charges are positive and the lower ones are negative, as shown in **Figure 2**. Find the positions where the magnitude of the \mathbf{E} field takes its local minimum.

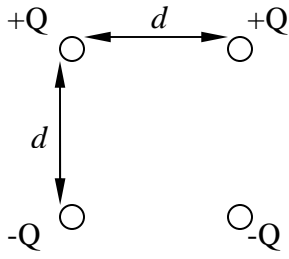
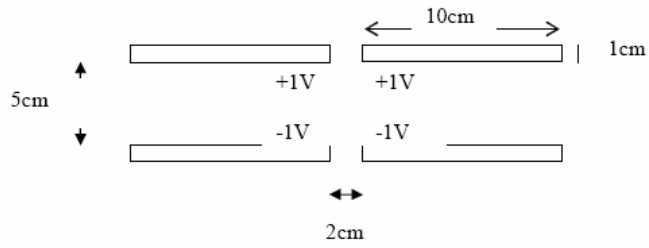


Figure 2.

5. Use *Femlab* to plot the magnitude of the E-field for the following two systems. The plates are assumed to be perfect conductors.

(a)



(b)

