Engineering 5812 Assignment 2 Due: Noon, Friday, Jan. 27, 2012
(Coulomb's Law and Electric Field Intensity)

1. Determine the following: (a) the total charge in the region on the z-axis where $0 \leq z \leq 10$ cm for a line charge density of $\rho_\ell = 2z$ C/m; (b) the total charge on a circular disc of radius $\rho = a$ if the charge density is given by $\rho_s = \rho_{s0} e^{-\rho} \sin^2 \phi$ C/m^2 where ρ_{s0} is a constant; (c) the total charge contained in a cylindrical volume defined by $\rho \leq 2$ m, $0 \leq z \leq 3$ m for a volume charge density of $\rho_v = 10\rho z$ mC/m^3; and (d) the total charge contained in the cone defined by $r \leq 2$ m, $0 \leq \theta \leq \pi/4$ for a charge density of $\rho_v = 20r^2 \cos^2 \theta$ mC/m^3.

2. A point charge $q_1 = 4$ μC is at $P_1(1 \text{ cm}, 1 \text{ cm}, 0)$ and a point charge q_2 is at $P_2(0, 0, 4 \text{ cm})$. What should q_2 be so that the electric field intensity, $\vec{E}$, at $P_3(0, 2 \text{ cm}, 0)$ has no y-component?

3. Two point charges of equal and non-negligible mass m and equal charge Q are suspended at a common point by two threads of negligible mass and length ℓ in free space (see diagram). Let the string tension be symbolized by T and the magnitude of the electric force on each charge be symbolized by F_e. Show that at equilibrium the inclination angle α of each thread to the vertical is related to the other parameters by the equation

$$Q^2 = 16\pi\epsilon_0 mg\ell^2 \sin^2 \alpha \tan \alpha$$

where g is the gravitational acceleration. If α is very small, show that

$$\alpha = \sqrt[3]{\frac{Q^2}{16\pi\epsilon_0 mgl^2}} \, .$$

4. Electric charge of density $\rho_\ell = 5$ μC/m is distributed along the arc $\rho = 2$ cm, $0 \leq \phi \leq \pi/4$, $z = 0$. Find the electric field intensity at (i) $(0, 0, z)$ and then at (ii) the origin, (iii) $z = 5$ cm and (iv) $z = -5$ cm.

5. Three infinite line charges of charge density as shown are all parallel to the z axis. The two right triangles are congruent. Show that the the electric field intensity at the origin is zero.

Diagram for Problem 3

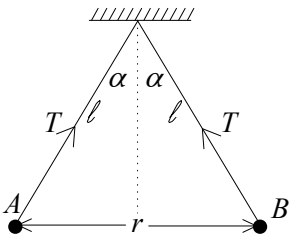

Diagram for Problem 5