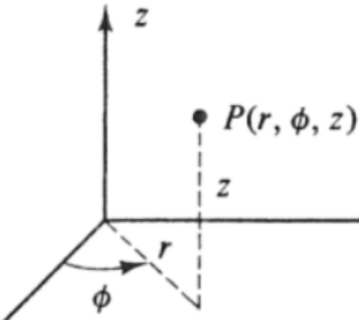
ELEN 3401 Electromagnetics
Problem Set #4

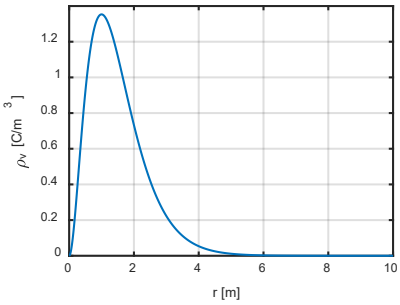
DUE: Friday Feb 28
Please include your name and UNI on the assignment

Problem 1: Charge Density and D in Cylindrical Coordinates

In a certain region of space, the charge density is given in cylindrical coordinated by the function:

$$\rho_v(r,\phi,z) = 10r^2e^{-2r} \quad \frac{C}{m^3}$$





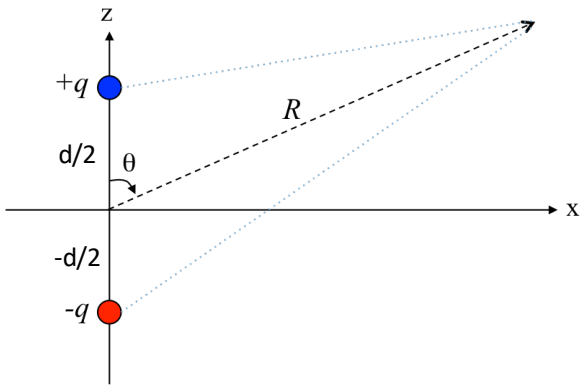
Apply Gauss's law to find **D**(r,ϕ,z)

Problem 2: Electric dipole

Two equal and opposite point charges, q and $-q$ are located at: (0, 0 , *d/2*) and (0, 0, *-d/2*), respectively as shown in the figure below. This arrangement is known as an *electric dipole*.

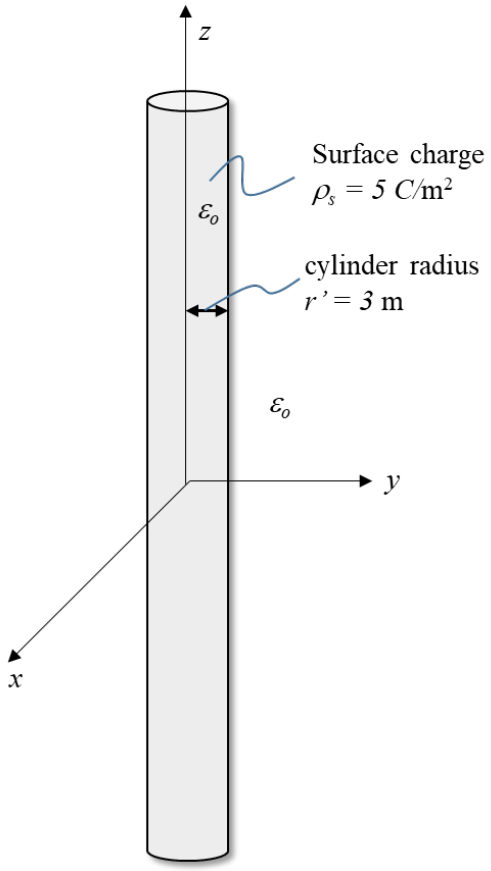
Use first-order Taylor expansions to show that the total electric field due to this electric dipole at large distances from the origin as compared to the dipole separation, *d*, is given approximately by:

$$\boldsymbol{E} \approx \frac{qd}{4\pi\varepsilon_0 R^3}\left(2\cos\theta\,\hat{\boldsymbol{R}} + \sin\theta\,\hat{\boldsymbol{\theta}}\right)$$



Problem 3: Charge distribution electric field

A very long, thin cylindrical shell of radius $r' = 3$ meters in free space has a surface charge density equal to +5 C/m^2. ($\rho_s = +5$ C/m^2), as shown in the figure below.



a. Obtain the electric flux density (**D**) (magnitude and direction) *inside* the cylinder (for $r' < 3$m). Plot and label the electric field, **E** for this region.

b. Obtain the electric field flux density (magnitude and direction) *outside* the cylinder (for $r' > 3$m). Plot and label the electric field, **E** for this region.