PHYSICS 4175: Assignment #1

DUE: Thursday January 14, 2016

Problems:

1. **Spherical**

   Find the electric field a distance z from the center of a spherical surface of radius R, which carries a uniform surface charge density σ. Treat the case $z < R$ as well as $z > R$. Determine the electric field by summing all the charges dq. Evaluate the integrals explicity and hence verify the high symmetry solutions from Gauss' law. Express your answers in terms of the total charge Q on the sphere.

2. **Cylindrical**

   A long coaxial cable carries a uniform volume charge density ρ within the inner cylinder (radius a), and a uniform surface charge density on the outer cylindrical shell (radius b). This surface charge is negative and of just the right magnitude so that the cable as a whole is electrically neutral.

   (a) Find the electric field in each of the three regions:

   i. inside the inner cylinder $(0 < x < a; z = 0)$,

   ii. between the cylinders $(a < x < b; z = 0)$,

   iii. outside the cable $(x > b; z = 0)$.

   Determine the electric field by summing all the charges dq. Evaluate the integrals explicity and hence verify the high symmetry solutions from Gauss' law.

   (b) Plot the magnitude of the electric field as a function of r.

3. **Functions**

   Expand the function $F(u) = \left[1 - 2xu + u^2\right]^{-1/2}$ in a Taylor series up to the term in u^3. Note that the coefficients are the first four Legendre polynomials $P_n(x)$. In fact, $F(u)$ is a *generating function* for all the Legendre polynomials: $F(u) = \sum_{n=0}^{\infty} P_n(x)u^n$.