**Electromagnetism, Relativity & Particles — Homework Problems**

1. **Reading Assignment**
   Read Good, Chapter 2, and Chapter 3.1-3.4.

2. **Field of a Uniformly Charged Disk**
   (Good 2.20) A thin disk with uniform surface charge $\sigma$ and radius $a$ lies in the $x-y$ plane, centered on the $z$ axis. Find the electric field vector $\mathbf{E}(0, 0, z)$ for a point on the $z$ axis, located at a distance $z$ from the disk. Plot your result, and discuss the limits $z \to 0$ and $z \to \infty$.

3. **Field at Center of Hemisphere**
   (Good 2.19) A hemispherical surface (radius $R$) is uniformly charged (surface charge density $\sigma$). Find the electric field vector $\mathbf{E}(0)$ at the center of the hemisphere (the point that has constant distance $R$ from all points on the hemisphere).

4. **Application of Gauss’ Law for a Uniformly Charged Cylinder**
   (Good 2.16) Find the field $\mathbf{E}(r)$ inside and outside an infinite cylinder of radius $R$ and uniform charge density $\rho$ that extends along the $z$ axis. Express your result also in terms of the linear charge density $\lambda = Q/l$. (See Figure 2.30.)

5. **Field Inside a Spherical Cavity**
   (Good 2.27)$^*$ A spherical cavity (radius $R/2$) is carved out from a uniformly charged sphere (charge density $\rho$, radius $R$), so that the cavity both touches the surface and the center of the large sphere (see Figure 2.34). Find the field $\mathbf{E}(r)$ in the cavity, and show that it is uniform. (Hint: Use the superposition principle, and exploit the fact that the field inside a homogeneous charge distribution grows linearly with the distance from the center.)

6. **Field of Four Charges**
   Four equal point charges $q$ are arranged at the corners of a square (side $a$) that is centered on the $x-y$ plane, as shown in the figure.

   ![Diagram of four charges](image)

   (a) Write down an expression for the electric field $\mathbf{E}(r)$ at a point $(x, y)$ in the $x-y$ plane. (4 P.)
   (b) Use a symmetry argument to show that the electric field along the $x$ axis (A) points in direction of the $x$ axis, and that the field along the diagonal (D) is parallel to the diagonal itself. (4 P.)
   (c) Plot the field strength along axis and diagonal using Mathematica (or similar software). Comment on the result. (12 P.)