Physics 370 **Homework 3** **Due Friday, February 9, 2018**

Reading assignment: Griffiths pages 59-75.

Problem 1 A thin circular wire ring of radius R lies in the $z = 0$ plane with its center at the origin, and carries a total charge Q distributed uniformly on its circumference. Find the electric field a distance z above the center (on the z-axis).

Problem 2 A flat circular disc of radius R lies in the xy plane with its center at the origin. The disc carries a uniform (constant) surface charge density σ. Find the electric field a distance z above the center. Check that your answer is the expected one for $z \gg R$. Also give your result in the limit $z \ll R$. In each of these two limiting cases, keep the leading non-zero term.

Problem 3 A hollow spherical shell carries charge density $\rho = kr^2$ in the region $a \leq r \leq b$. Use Gauss' Law in integral form to find the electric field in the three regions: (i) $r < a$, (ii) $a < r < b$, (iii) $r > b$. Check your answers by computing $\vec{\nabla} \cdot \vec{\mathbf{E}}$ everywhere. Make a graph of $|\vec{\mathbf{E}}|$ as a function of r.

Problem 4 Consider a very thin spherical shell with radius R, carrying charge $-2Q$ on its surface. There is also a point charge Q located at $r = 0$ (the center of the sphere). Use Gauss' Law in integral form to find the electric field everywhere.

Problem 5 Suppose that in some region of space the electric field is found to be $\vec{\mathbf{E}} = kr^2\hat{r}$, in *cylindrical* coordinates. (k is some constant.)

(a) What are the metric system units of k?

(b) Find the charge density ρ in the region.

(c) Find the total charge enclosed in a cylinder of radius R and length L, centered on the z axis, using Gauss' Law in integral form applied to the given $\vec{\mathbf{E}}$.

(d) Find the total charge enclosed in a cylinder of radius R and length L, again. But this time do it by integrating the result you found in part (b).