7^{th} Homework
Due December 4, 2009

1. Consider a conducting spherical shell of radius R. The sphere is divided into two equal hemispheres. The top hemisphere is kept at a potential V_0 and the lower hemisphere is at a potential $-V_0$.

   (a) Find the electrostatic potential everywhere in space?

   (b) What is the charge density on the surface of the sphere?

   (c) If the sphere (the charge distribution with it) is rotating with an angular frequency ω around an axis passing through the middle of the hemispheres, what is the magnetic dipole moment of the sphere?

   (d) What is the magnetic field created at a distance much larger than the radius of the sphere?

2. Consider two circular wires of radius R. Suppose they are placed on top of each other such that their axis lies on top of each other. The distance between their centers is d. Assume that each wire carries a current I running in opposite directions.

   (a) Calculate the first non-zero term in the multipole expansion of the vector potential.

   (b) What is the magnetic field due to this multipole?

   (c) Plot the magnetic field lines

3. Consider an infinite wire that carries a current I. Assume that there is parallel plate capacitor on the wire. Since the current carries charges to the capacitor, the electric field between the plates change. Calculate the rate of change of the electric field inside the capacitor. What is the rate of change of total electric flux between the plates of the capacitor?

4. Show that the discontinuity in the derivative of the vector potential over a surface charge density is given by?

$$\frac{\partial \vec{A}_{above}}{\partial n} - \frac{\partial \vec{A}_{below}}{\partial n} = -\mu_0 \vec{K} \tag{1}$$

5. Consider a sphere that has a uniform magnetization $\vec{M}$. What is the vector potential created due to this magnetization? What is the magnetic field?