6^{rd} HOMEWORK
Due April 17, 2008

1. At an initial time, a charged particle is at some point P in a magnetic field and it has an initial velocity. Under the influence of the magnetic field, the particle moves to a point P'. If you now reverse the velocity of the particle, will it trace its orbit and return to the point P?

2. Helmholts coils are often used to make reasonable uniform magnetic field in laboratories. These coils consist of two thin circular rings of wire parallel to each other and on a common axis, the z-axis. The rings have radius R and they are separated by a distance which is also R. The rings carry equal currents in the same direction.

   (a) Find the magnetic field at any point of the z axis.

   (b) Show that dB/dz and d^2B/dz^2 are both zero at the middle.

3. A steady current I flows around a wire bent into a square of side L. Find the magnetic field at a distance z from the center of the square on a line perpendicular to the face of the square. Show that if $z >> L$, your answer reduces to $B_z = (\mu_0/2\pi)\mu/z^3$, with a magnetic moment $\mu = IL^2$.

4. Consider a long solenoid and a long straight wire along its axis, both carrying some current. Describe the field lines within the solenoid.

5. A current I flows in a thin wire bent into a circle of radius R. The axis of the circle coincides with the z axis. What is the value of the integral $\int \vec{B} \cdot d\vec{l}$ along the z axis from $z = -\infty$ to $z = +\infty$?

6. A Coaxial cable consists of a long cylindirical copper wire of radius r_1 surrounded by a cylindirical shell of inner radius r_2, outer radius r_3. The wire, and the shell carry equal and opposite currents I uniformly distributed over their volumes. Find formulas for the magnetic field in each of the regions $r < r_1$, $r_1 < r < r_2$, $r_2 < r < r_3$, $r > r_3$

7. A thin flexible wire carrying a current I hangs in a uniform magnetic field $\vec{B}$. A weight atteched to one end of the wire provides a tension T. Within the magnetic field, the wire will adopt the shape of an arc of circle.

(a) Show that the radius of this arc of circle is $r = T/BI$

(b) Show that if we remove the wire and launch a particle of charge $-q$ from a point P on the wire with momentum $p = qT/I$ in the direction of the wire, it will move along the same arc of circle. (This means that the wire can be used to simulate the orbit of the particle. Experimental physicists sometimes use such wires to check the orbits of particles through system of magnets.)