Set #8 - for Tuesday, December 9

Read

HR&K, Vol. 2	Ch. 33 (pay attention to the examples)
Purcell	Ch. 6
Feynman, Vol. 2	Ch. 15

Solve

From HR&K

Ch. 33: Exercise 33; Problems 2, 8, 11, 13, **Extra Credit**: 5, 14

From Purcell

Ch. 6: Problems 6.31, 6.43, 6.44, 6.50, 6.51, 6.65

Problem 1. ***Helmholtz coils***

Consider two axial loops which carry currents in the same direction, as shown below.

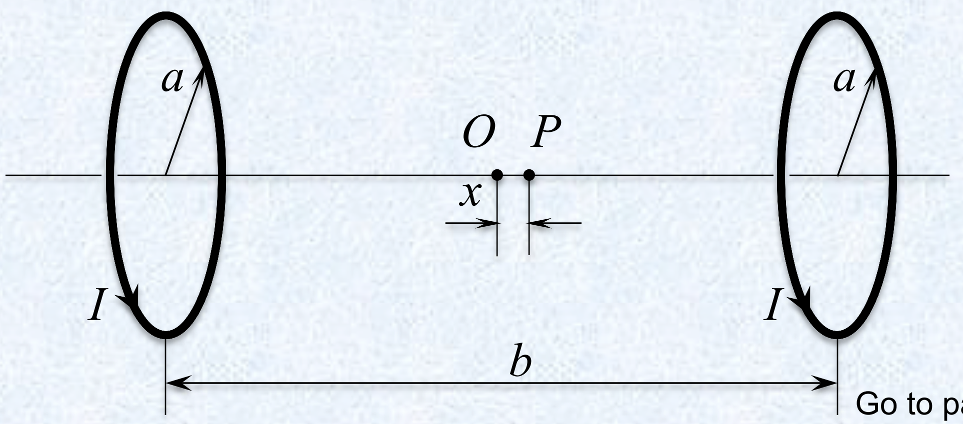
(a) Find the magnetic field at point P on the axis of the loops and a distance x from the midpoint O.

(b) Expand the expression for the field in a power series, retaining terms to order x^2.

(c) What relationship must exist between a and b such that the x^2 terms vanish? What is the significance of this?

(d) Show that the field created by the coils to this order and under the condition established in (c) is given by

$$B = \frac{8I}{5^{\frac{3}{2}} a\varepsilon_0 c^2}.$$



Go to page 2

Set #8 - for Tuesday, December 9

Problem 2 (extra credit). In the lecture it was shown that at large distances from a current loop (magnetic dipole), the vector potential is given by:

$$\vec{A} = \frac{\mu_0}{4\pi}\frac{\vec{\mu}\times\vec{r}}{r^3}$$

where $\vec{\mu}$ is the magnetic dipole moment. Show that the magnetic field due to this dipole is:

$$\vec{B} = \frac{\mu_0}{4\pi}\left[-\frac{\vec{\mu}}{r^3} + \frac{3(\vec{\mu}\cdot\vec{r})\vec{r}}{r^5}\right]$$

Problem 3. A long solid dielectric cylinder of radius a is permanently polarized so that the polarization is everywhere radially outward, with a magnitude proportional to the distance from the axis of the cylinder, i.e., $\vec{P} = P_o\frac{\vec{r}}{2}$. The cylinder is rotated with constant angular velocity ω about its axis. What is the magnetic field on the axis of the cylinder, at points not too close to the ends?

Good Luck, Dr. B