Physics 505 **Fall 2007**

Homework Assignment #9 — Due Thursday, November 15

Textbook problems: Ch. 5: 5.19, 5.21, 5.22, 5.27

5.19 A magnetically "hard" material is in the shape of a right circular cylinder of length L and radius a. The cylinder has a permanent magnetization M_0, uniform throughout its volume and parallel to its axis.

a) Determine the magnetic field $\vec{H}$ and magnetic induction $\vec{B}$ at all points on the axis of the cylinder, both inside and outside.

b) Plot the ratios $\vec{B}/\mu_0 M_0$ and $\vec{H}/M_0$ on the axis as functions of z for $L/a = 5$.

5.21 A magnetostatic field is due entirely to a localized distribution of permanent magnetization.

a) Show that

$$\int \vec{B} \cdot \vec{H}\, d^3x = 0$$

provided the integral is taken over all space.

b) From the potential energy (5.72) of a dipole in an external field, show that for a continuous distribution of permanent magnetization the magnetostatic energy cna be written

$$W = \frac{\mu_0}{2} \int \vec{H} \cdot \vec{H}\, d^3x = -\frac{\mu_0}{2} \int \vec{M} \cdot \vec{H}\, d^3x$$

apart from an additive constant, which is independent of the orientation or position of the various constituent magnetized bodies.

5.22 Show that in general a long, straight bar of uniform cross-sectional area A with uniform lenghwise magnetization M, when placed with its flat end against an infinitely permeable flat surface, adheres with a force given approximately by

$$F \simeq \frac{\mu_0}{2} A M^2$$

Relate your discussion to the electrostatic considerations in Section 1.11.

5.27 A circuit consists of a long thin conducting shell of radius a and a parallel return wire of radius b on axis inside. If the current is assumed distributed uniformly throughout the cross section of the wire, calculate the self-inductance per unit length. What is the self-inductance if the inner conductor is a thin hollow tube?