

Physics 106C: Electromagnetism

Homework 5: Magnetic Materials

DUE: Thursday, May 17 2001

Remember: Late homework will be granted 50% credit UNLESS PRIOR ARRANGEMENTS ARE MADE WITH ME OR A TA. If you have an extension, please indicate who granted it clearly on the top of the paper OR YOU WILL NOT GET FULL CREDIT. Note that for the rest of Phys106, you must solve integrals analytically, or by looking them up in a table, but you may not use Mathematica.

Reading Assignment: Jackson Chapter 5.7 - 5.11

1. Jackson, problem 5.6 (This is a classic problem, and is easy if you remember to use superposition).

2. A short circular cylinder of radius R and length L carries a frozen-in uniform magnetization \mathbf{M} parallel to its axis. Find the bound current. Make careful sketches of \mathbf{M} , \mathbf{B} , and \mathbf{H} assuming $L = 2R$.

3. A coaxial cable consists of two very long cylindrical tubes, separated by linear insulating material of magnetic susceptibility χ_m . A current I flows down the inner conductor and returns along the outer one. The current is distributed uniformly over the surface. Find the magnetic field in the region between the tubes. Calculate the magnetization and bound currents and confirm that they generate the correct field.

4. A magnetic dipole \mathbf{m} is imbedded at the center of a uniform sphere of radius R made of a linear magnetic material of permeability μ . Show that the magnetic field inside the sphere is

$$B = \frac{\mu}{4\pi} \left\{ \frac{1}{r^3} [3(\mathbf{m} \cdot \hat{\mathbf{e}}_r) \hat{\mathbf{e}}_r - \mathbf{m}] + \frac{2(\mu_o - \mu) \mathbf{m}}{(2\mu_o + \mu) R^3} \right\} \quad (1)$$

Find also the field outside the sphere.