Problem set 06

Problem 1

Current I flows uniformly in an infinitely long wire with radius a. The material of the wire is linear with susceptibility χ_m. Find the magnetic field everywhere and all relevant bound currents, and the net bound current flowing in the wire.

Problem 2

A sphere of radius a has the permanent magnetization

$$\mathbf{M} = M_0 \, \hat{\mathbf{a}}_z \left(\frac{r}{a} \right)^2 .$$

For systems without free currents one often uses the concepts of magnetic charge densities, due to the similarity to electrostatics. These are $\rho_m = -\nabla \cdot \mathbf{M}$ for the bulk and $\sigma_m = \hat{\mathbf{n}} \cdot \mathbf{M}$ for the surface.

(a) Find the magnetic charge density in the sphere.

(b) Find the magnetic surface charge density on the sphere.

(c) Find the bound surface current density on the sphere.

(d) Find the bound bulk current density in the sphere.

(e) Calculate the total magnetic moment of the sphere.

Problem 3

Two long thin coaxial cylinders with radii a and b carry equal, but opposite currents. Between the cylinders is a material with magnetic susceptibility χ_m. Find the fields $\mathbf{H}$, $\mathbf{B}$, and $\mathbf{M}$ everywhere.

The problem is due Monday February 24 2025 at 20:00