

PHYS 3320 Electricity & Magnetism I
Fall 2018
Assignment 7

1. Two infinitely long concentric cylinders have inner and outer radii a_1 and a_2 , and R_1 and R_2 respectively. ($a_1 < a_2 < R_1 < R_2$) The inner cylinder carries a current I_1 in the direction out of the plane of the diagram, and the outer cylinder carries a current I_2 in the same direction.
 - a. What is the magnetic field
 - i. for $r < a_1$
 - ii. for $a_1 < r < a_2$
 - iii. for $a_2 < r < R_1$
 - iv. for $R_1 < r < R_2$
 - v. for $r > R_2$
 - b. How would your answers change if the outer cylinder carries a current I_2 in the opposite direction?

2. In the previous problem the region $a_2 < r < R_1$ is now filled with a non-ferromagnetic material of relative permeability μ_r .
 - a. How does this change the answers above?
 - b. Would it matter if the material were paramagnetic rather than diamagnetic?

3. A sphere of radius R has a uniform magnetization $\mathbf{M} = M_0 \mathbf{k}$.
 - a. Find the equivalent bound currents.
 - b. Calculate the total magnetic moment of the sphere
 - i. from the magnetization
 - ii. from the bound currents, and show that the answers are the same.

4. A large object has a uniform magnetization $\mathbf{M} = M_0 \mathbf{k}$. A small spherical hole in the material has a radius R .
 - a. Find the bound currents.
 - b. Show that the magnetic field at the centre of the sphere is equal to $-\frac{2}{3}\mu_0\mathbf{M}$.