HW Ch.6 Magnetic Fields in Matter

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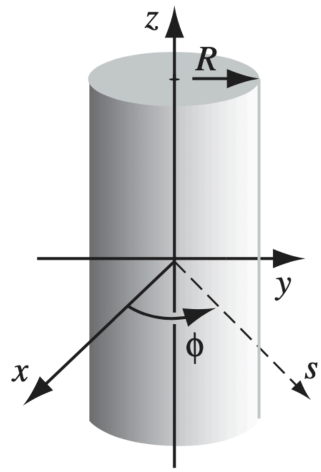
1) **Problem 6.8 (10 pts)**
A long circular cylinder of radius R carries a magnetization $\mathbf{M} = ks^2\hat{\phi}$, where k is a constant, s is the distance from the axis, and $\hat{\phi}$ is the usual azimuthal unit vector.



(a) **(5 pts)** Show the magnetic field (due to $\mathbf{M}$), for points *inside* the cylinder is $\mathbf{B} = \mu_0\mathbf{M}$

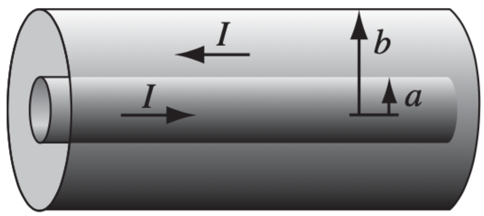
(b) **(5 pts)** Show that the magnetic field (due to $\mathbf{M}$) for points *outside* the cylinder is $\mathbf{B} = 0$

2) **Problem 6.12** **(10 pts)**
An infinitely long cylinder, of radius R, carries a "frozen-in"magnetization, parallel to the axis, $\mathbf{M} = ks\hat{\mathbf{z}}$, where k is a constant and s is the distance from the axis; there is no free current anywhere. Find the magnetic field inside and outside the cylinder by two different methods:

(a) **(5 pts)** As in Sect. 6.2, locate all the bound currents, and calculate the field they produce both inside and outside

(b) **(5 pts)** Use Ampere's law (in the form of Eq. 6.20) to find $\mathbf{H}$, and then get $\mathbf{B}$ from Eq. 6.18 (Notice that the second method is much faster, and avoids any explicit reference to the bound currents.)

3) **Problem 6.16 (15 pts)**
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; in each case, the current distributes itself uniformly over the surface.



(a) **(5 pts)** Calculate the magnetic field **B** (starting from the **H** field, using Ampere' law) between the cylinders ($a < s < b$) and show it can be expressed as

$$\mathbf{B} = \mu_0(1 + \chi_m)\frac{I}{2\pi s}\hat{\phi}$$

(b) **(5 pts)** show that its magnetization between the cylinders can be expressed as $\mathbf{M} = \dfrac{\chi_m I}{2\pi s}\hat{\phi}$

(c) **(5 pts)** Show that the volume and surface bound currents are:

$\mathbf{J}_b = 0$, $\mathbf{K}_b(s = a) = \chi_m I/(2\pi a)\hat{\mathbf{z}}$, and $\mathbf{K}_b(s = b) = -\chi_m I/(2\pi b)\hat{\mathbf{z}}$

Then use this result along with Ampere's law to confirm that they generate the correct field **B** obtained previously