HW9

Due Tuesday Nov. 30, 2010

1. Consider a uniformly magnetized sphere of radius a.

(a) Find the pole density everywhere.

(b) Find the **B** field everywhere.

(c) Find the **H** field everywhere.

2. A small magnetic dipole of dipole moment $\boldsymbol{m}$ is placed at the origin with a general orientation not along any coordinate axis.

(a) Find the vector potential $\boldsymbol{A}$ at a location $\boldsymbol{r}$.

(b) Show that the $\boldsymbol{B}(\boldsymbol{r})$ field is

$$\boldsymbol{B}(\boldsymbol{r}) = (\mu_o/4\pi r^3)[3(\boldsymbol{m} \bullet \boldsymbol{r_1})\, \boldsymbol{r_1} - \boldsymbol{m}]$$

3. A sphere of radius a has its center at the origin. The sphere has been magnetized such that $\boldsymbol{M} = M(r)\, \boldsymbol{r_1}$, where $\boldsymbol{r_1}$ is the unit vector in the radial direction, $M(r)$ is a function of scalar r, and $M(0)$ is finite. Assuming that there is no free current anywhere,

(a) Find the equivalent volume and surface current density.

(b) Find $\boldsymbol{B}$ field inside the sphere.

(c) Find $\boldsymbol{H}$ field inside the sphere.

(d) Find $\boldsymbol{H}$ field at the surface but just outside of it.

4. A cylinder of length l and a circular cross-section of radius a has its axis along the z-axis. The cylinder has been magnetized such that $\boldsymbol{M} = M_o\, \boldsymbol{i}$, where $\boldsymbol{i}$ is the unit vector along the x-axis and M_o is a constant. Find and sketch the equivalent current density everywhere.

5. Consider a circular cylinder of radius a and length l. A total charge Q is distributed uniformly inside the cylinder. The cylinder is rotated about its long axis with an angular speed of ω. Find the magnetic moment of the system.

6. Consider a very long coaxial cable consisting of a solid inner conductor of radius a and an infinitely thin outer conductor of radius b. In between, a linear-isotropic-homogenous material with a magnetic permeability of $\mu = \mu_r\, \mu_o$, where μ_r is a constant greater than 1.

(a) Find $\boldsymbol{B}$ field everywhere.

(b) Find $\boldsymbol{H}$ field everywhere.