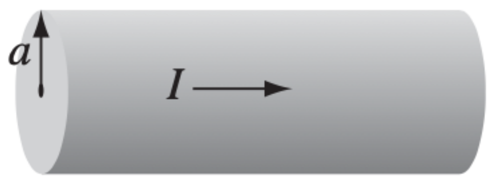
HW Ch.5 Magnetostatics (Part 2)

Show **ALL WORK** to get full/partial credit. Begin each problem on a new page, and clearly label each part of the problem.

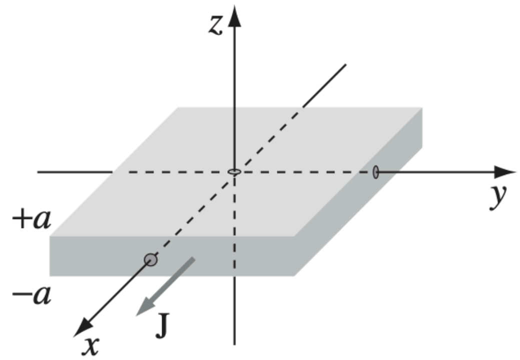
1) **Problem 5.14 (5 pts)**
A steady current I flows down a long cylindrical wire of radius a. Find the magnetic field, both inside and outside the wire, if



(a) The current is uniformly distributed over the outside surface of the wire

(b) The current is distributed in such a way that J is proportional to s, the distance from the axis.

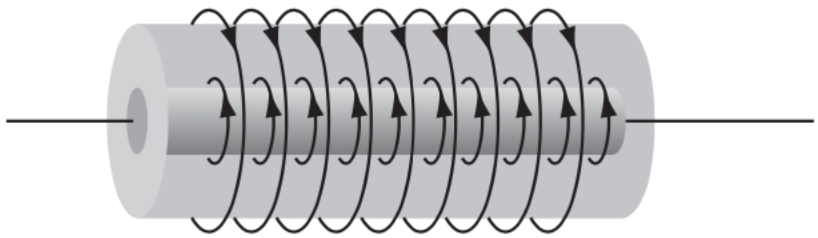
2) **Problem 5.15 (5 pts)**
A thick slab extending from $z = -a$ to $z = +a$ (and infinite in the x and y directions) carries a uniform volume current $\mathbf{J} = J\hat{\mathbf{x}}$.



Find the magnetic field, as a function of z, both inside and outside the slab and show it can be expressed as:

$$\mathbf{B} = \begin{cases} -\mu_0 Ja\hat{\mathbf{y}}, & \text{for } z>+a \\ +\mu_0 Ja\hat{\mathbf{y}}, & \text{for } z<-a \end{cases}$$

3) **Problem 5.16** **(15 pts)**
Two long coaxial solenoids each carry current I, but in opposite directions, as shown below. The inner solenoid (radius a) has n_1 turns per unit length, and the outer one (radius b) has n_2. Find **B** in each of the three regions

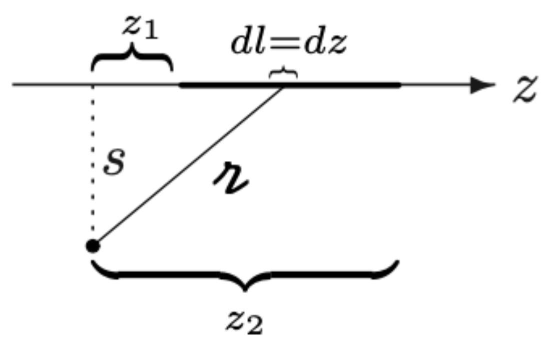


(i) **(5 pts)** inside the inner solenoid

(ii) **(5 pts)** between the inner and outer solenoid

(iii) **(5 pts)** outside both solenoids

4) **Problem 5.23** **(10 pts)**



(a) **(5 pts)** Find the magnetic vector potential of a finite segment of straight wire carrying a current I and show it can be expressed as;
[hint: Put the wire on the z axis, from z_1 to z_2, and use Eq. 5.66.]

$$\mathbf{A} = \frac{\mu_0 I}{4\pi} \ln \left[\frac{z_2 + \sqrt{(z_2)^2 + s^2}}{z_1 + \sqrt{(z_1)^2 + s^2}} \right] \hat{\mathbf{z}}$$

(b) **(5 pts)** Calculate the corresponding magnetic field **B** from the vector potential **A** determined in (a). Check that your answer is consistent with Eq. 5.37

5) **Problem 5.24** **(5 pts)**
Show that current density produced by the vector potential, $\mathbf{A} = k\hat{\phi}$ (where k is a constant), in cylindrical coordinates, is given by:

$$\mathbf{J} = \frac{k}{\mu_0 s^2}\hat{\phi}$$