PHY 103: General Physics 2 (2014 – 2015, Semester – I)

Department of Physics
Indian Institute of Technology - Kanpur

Assignment-6

Note: The questions marked with circles are to be solved by the students as Home Work. These will not be solved in the tutorials. The students are encouraged to clear any doubts on these questions during the office hours of tutors.

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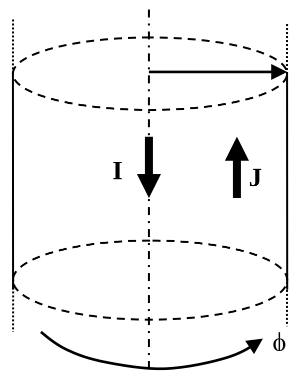
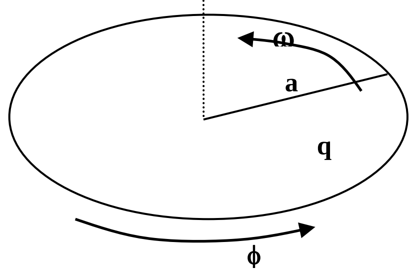
1. (a) Calculate the magnetic field on the axis of a rectangular loop of wire of sides 2a and 2b carrying a current I. (b) What is the magnetic field for a square loop when (a = b = w) and at the point z on the axis?. (c) Verify that it reduces to the field of a dipole, with the appropriate dipole moment, when **z >> w**. (d) From the expression deduced in (b), what is the magnetic field at the centre of the square loop?.

2. An infinite cylinder of radius *a* carries a current of density: $\vec{j} = j_o\left(\frac{r}{a}\right)\hat{z}$. A thin wire, which carries the same current is placed along the cylinder axis. The current in the wire flows in the opposite direction to that of the cylinder (see figure below). (a) Compute the magnetic field $\vec{B}$ which arises as a result of the current distribution carried by the cylinder. (b) Demonstrate that the divergence of the magnetic field $\vec{B}$, found in (a) vanishes.



3. Consider a disc of radius a. The disc carries a charge q, which is uniformly spread over its surface. The disc rotates at an angular velocity ω around the normal to its center (see figure below) (a) What is the surface current density K at a distance r from the center? (b) Compute the magnetic field at the center of the disc. (c) Calculate the magnetic moment of the rotating disc.



4. A spherical shell of radius **a** carries a surface charge density σ. The shell rotates around the $\hat{z}$ axis at an angular velocity **ω**. (a) Find the surface current density (b) Calculate the magnetic moment of the rotating spherical shell. (c) Calculate the torque exerted on the shell, for a situation where it is completely embedded in an external magnetic field $\vec{B} = B_o\hat{x}$. Repeat your calculation for the case in which $\vec{B} = B_o\hat{z}$. Do both ways using direct calculation from the definition of torque and using the formula $N = \vec{m} \times \vec{B}$.