SC217: Electromagnetic Theory — Assignment 12 — Nov 21-25

DA-IICT, B.Tech, Sem III — Autumn2016

1. A plane wire loop of irregular shape is situated so that part of it is in a uniform magnetic field $\vec{\mathbf{B}}$. The field is perpendicular to the plane of the loop. The loop carries a current I. Find the magnetic force on the loop.

2. Find the magnetic field at point P for each of the steady current configurations shown below

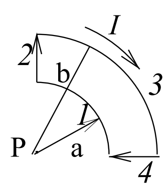

Fig.1

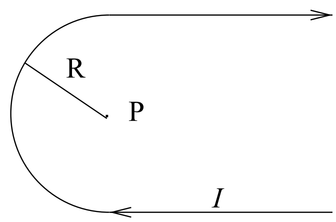

Fig. 2

3. Two parallel, infinite line charges λ, a distance d apart are moving at a constant velocity $\vec{\mathbf{v}}$. The direction of $\vec{\mathbf{v}}$ is along the line charges. How great would v have to be in order for the magnetic attraction to balance the electrical repulsion?

4. Magnetostatics treats the source current (the one that sets up the field) and the recipient current (the one that experiences the force) so asymmetrically that it is by no means obvious that the magnetic force between the current loops is consistent with the Newton's third law. Show that the force on loop 2 due to loop 1 can be written as

$$\vec{\mathbf{F}}_2 = -\frac{\mu_0}{4\pi} I_1 I_2 \oint \oint \frac{\hat{\mathbf{r}}_{12}}{r_{12}^2} \vec{\mathbf{dl}}_1 \cdot \vec{\mathbf{dl}}_2$$

where $\vec{\mathbf{r}}_{12} = \vec{\mathbf{r}}_2 - \vec{\mathbf{r}}_1$.

5. **A steady current I flows through 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.**

   (c) **Find the vector potential in both the above cases.**

6. **Two very large metal plates are held a distance d apart, one at potential 0, the other at potential V_0. A small metal hemisphere (radius $a << d$) is placed on the grounded plate, so that its potential is likewise 0. If the region between the plates is filled with weakly conducting material of uniform conductivity σ, what current flows to the hemisphere?**