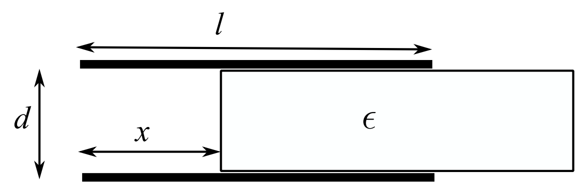
SC217: Electromagnetic Theory | **Assignment 12 Nov.18**
DA-IICT, B.Tech, Sem III | Autumn2019

1. **A slab of linear dielectric material is partially inserted between the plates of a parallel plate capacitor whose area is l^2 and the distance between the plates is d. Find the force by which the slab is sucked inside the capacitor while it is charged to a potential V.**



2. **Consider a charged particle with mass m placed at $(0, -a, 0)$ in a magnetic field $\vec{B} = B\hat{i}$ and has an initial velocity $\vec{v}_0 = v_0\hat{k}$. Derive the equation of trajectory that the particle follows due to the magnetic force and find the condition for which the particle follows a circular motion of radius a.**

3. **For a configuraion of charges and currents confined within a volume $\mathcal{V}$, show that**

$$\int_{\mathcal{V}} \vec{\mathbf{J}} d\tau = \frac{d\vec{\mathbf{p}}}{dt}$$

where $\vec{\mathrm{p}}$ is the total dipole moment.

[Hint: Evaluate $\int_{\mathcal{V}} \vec{\nabla} \cdot (x\vec{J}) d\tau$]

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

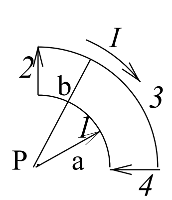


Fig.1

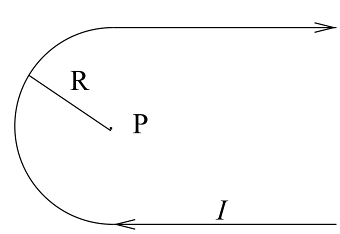


Fig. 2

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

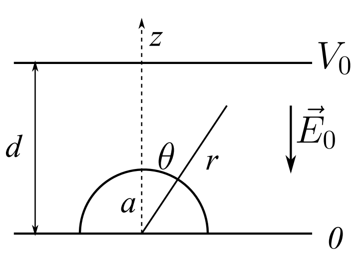
6. **A steady current I flows through a long cylindrical wire of radius a. Find the magnetic field both inside and outside the wire, if**

   (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 cases above.**

7. **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?**



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