Department of Physics, Shiv Nadar Institution of Eminence
Spring 2025
PHY102: Introduction to Physics-II
Tutorial – 12

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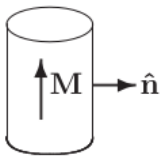
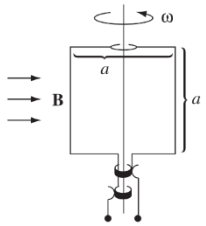
1. If $\vec{B}$ is uniform show that $\vec{A} = -\frac{1}{2}\left(\vec{r} \times \vec{B}\right)$, where $\vec{r}$ is the position vector of the point in question. Show that $\vec{\nabla}.\vec{A} = 0$ and $\vec{\nabla} \times \vec{A} = \vec{B}$.

2. A thin disk of radius a carrying uniform surface charge density σ is rotating with constant angular velocity ω about its axis (z-axis). Suppose there is a uniform magnetic field $\vec{B} = B\hat{j}$. Show that the torque acting on the disk is of magnitude $\frac{1}{4}\pi\sigma\omega B a^4$.

3. An infinitely long circular cylinder carries a uniform magnetization **M** parallel to its axis. Find the magnetic field (due to **M**) inside and outside the cylinder.



4. A square loop (side a) is mounted on a vertical shaft and rotated at angular velocity ω (see figure below). A uniform magnetic field B points to the right. Find the $\mathcal{E}(t)$ for this alternating current generator.



5. A metal bar of mass m slides frictionless on two parallel conducting rails a distance *l* apart. A resistor R connected across the rails and a uniform magnetic field B, pointing into the page, fills the entire region.
(a) If the bar moves to the right a speed *v*, what is the current in the resistor? In what direction does it flow?
(b) What is the magnetic force on the bar? In what direction?
(c) If the bar starts out with a speed v_0 at time $t = 0$, and is the left to slide, what is its speed at a time later time *t*?
(d) The initial kinetic energy of the bar was ½ mv_0^2. Check the energy delivered to the resistor is exactly ½ mv_0^2.