Electrodynamics

Quiz || April 24, 2020 || Time: 10:00 – 11:30

You must mail / upload your solutions by 11:30 am. If you face difficulty in uploading, you **could also mail** them to subhadip.mitra@iiit.ac.in with a cc to cyrin.neeraj@research.iiit.ac.in . The **subject of the mail** should be **"EM:Quiz <your roll number> <your name>".** In case you have **some difficulty with your connection, you must alert us before 11:30 am by calling or with an SMS**. You may call 040-6653-1587.

1. Identify the best/correct answer. [2 x 4]

A) $\int_V (r^2 + 2e^{r^2}) \cdot \vec{\nabla}\left(\frac{\hat{r}}{r^2}\right) d\tau$ is equal to

a) 0 b) π c) 2π d) 8π

B) The energy of a continuous charge distribution is given as $W = \int \frac{\rho V}{2} d\tau$. This can be written as $W = \frac{\epsilon_0}{2} \int_{\text{all space}} E^2 d\tau$ because when r becomes large,

a) The surface term becomes constant b) The surface term goes like $(1/r)$
c) The surface term goes like $(1/r^2)$ d) The surface term goes like (r^2)

C) The potential of an octopole goes like

a) $1/r^2$ b) $1/r^3$ c) $1/r^4$ d) $1/r^8$

D) Let S be a sphere centered at $\vec{r}$. If there is no charge on or within it then Laplace's equation implies

a) $V(\vec{r}) = \frac{1}{4\pi R^3} \oint_S V d\tau$ b) $V(\vec{r}) = \frac{1}{4\pi R^2} \oint_S V d\tau$

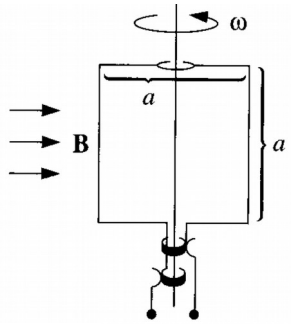
c) $V(\vec{r}) = \frac{1}{4\pi R^2} \oint_S \vec{\nabla} V \cdot d\vec{a}$ d) $V(\vec{r}) = \frac{1}{4\pi R^2} \oint_S V da$

2. Show that the electric field of a dipole can be written as

$$\vec{E}_{\text{dip}}(\vec{r}) = \frac{1}{4\pi\epsilon_0} \frac{3(\vec{p}\cdot\hat{r})\hat{r} - \vec{p}}{r^3}$$ [3]

3. A constant current *I* is passing through a long metallic rod of radius *R*. The current is uniformly distributed and the metal is weakly diamagnetic (i.e, the dipoles will lineup anti-parallel to the field). Find $\vec{H}$ inside and outside the rod. [3]

4. The square loop shown below is rotating with a constant angular velocity ω. The magnetic field $\vec{B}$ is also constant. Find $\mathcal{E}(t)$. [3]



5. A wire of radius a carries a constant current I, uniformly distributed over its cross section. A narrow gap in the wire of width $w \ll a$ forms a parallel-plate capacitor. Find the magnetic field in the gap at a distance $s < a$ from the axis. [3]