UNIVERSITY OF HYDERABAD

School of Physics

I.M.Sc. (2019 Batch)

IP 403 : Electromagnetic Theory-I

End-Semester Examination

Date: Dec. 05, 2022; Time: 10:00 am to 12:15 pm

Total Marks: 45

Answer all the questions.

N.B.: Symbols have their usual meaning.

- 1. Starting from Coulomb's law show that the electric field satisfies $\nabla \times \vec{E} = 0$ and $\nabla \cdot \vec{E} = \frac{\rho(\vec{r})}{\epsilon_0}$ for any arbitrary static charge distribution in the free space.

5 + 5

- 2. Derive boundary conditions for the normal and transverse components of the electric field at the interface of two media as an application of Gauss's law for electrostatics.

3 + 2

- 3. Find the formal solution of the electrostatic potential ($\phi(\vec{r})$) to Poisson's equation $\nabla^2\phi = -\frac{\rho(\vec{r})}{\epsilon_0}$ for the Dirichlet boundary conditions.

10

- 4 A. Determine the dipole moment for the charge distribution with the charge density $\rho(\vec{r}') = q\delta(x')\delta(y')[\delta(z'-a) - 2\delta(z') + \delta(z'+a)]$.

  B. Determine the quadrupole moment Q_{12} for the charge distribution with the charge density $\rho(\vec{r}') = q\delta(x')\delta(y')[\delta(z'-a) - 2\delta(z') + \delta(z'+a)]$.

4 + 6

- 5 A. Consider the electrostatic potential due to an electric dipole as $\phi(\vec{r}) = \frac{1}{4\pi\epsilon_0}\frac{\vec{p}\cdot\vec{r}}{r^3}$. Determine the electric field at $\vec{r}$ due to the dipole.

  B. Consider the electrostatic potential $\phi(\vec{r}) = \frac{q}{4\pi\epsilon_0}\left[\frac{1}{|\vec{r}-d\hat{k}|} - \frac{1}{|\vec{r}+d\hat{k}|}\right]$ $(d > 0)$ for $z > 0$ and $\phi(\vec{r}) = 0$ for $z < 0$. Determine the total charge distributed on the $x - y$ plane.

5 + 5