M.Sc. Examination, 2019

Semester - II

Physics

Paper: MPC-23

(Classical Electrodynamics & Plasma Physics-I)

Time: Three Hours **Full Marks: 40**

Questions are of value as indicated in the margin.

Answer ***any four*** questions

1. What are physical dipole and pure dipole? What is meant by linear dielectric? A sphere of homogeneous linear dielectric material is placed in an otherwise uniform electric field E_0. What is the electric field inside the sphere? 2 + 1 + 7

2. A spherical shell of radius R, carrying a uniform surface charge σ, is set spinning at an angular velocity $\vec{\omega}$. Find out the vector potential it produces at point $P(\vec{r})$. 10

3. A specified charge density $\sigma_0(\theta) = k\cos\theta$ is glued over the surface of a spherical shell of radius R. Find out the resulting potential inside and outside the sphere. What will be the electric field, due to a uniformly polarized sphere of radius R, inside and outside the sphere? 6 + 4

4. Derive the Langevin- Debye formula for the mean effective polarization of a polar gas kept inside an electric field at a temperature T Kelvin. 10

5. Show that the Ampere's law of force between current elements obeys third law of Newton. Derive the Lorentz force experienced by a point charge moving uniformly in a magnetic field. 6+4

6. Discus how the concept of displacement current originated. Show that plane electromagnetic waves propagating through vacuum are transverse in nature and the electric field and the magnetic field associated with such waves are perpendicular to each other. Find out the Poynting vector, energy density and momentum density of monochromatic plane e. m. waves and their average values of these quantities. 3 + 4 + 3

7. Find out the charge distribution and current distribution that would produce the following potentials:

$$V = 0,\ \vec{A} = \begin{cases} \frac{\mu_0 k}{4c}\,[ct - |x|]^2\hat{z} & for\ |x| < ct \\ 0 & for\ |x| > ct \end{cases}$$

Here 'k' is a constant and $c = \frac{1}{\sqrt{\mu_0 \epsilon_0}}$.

Can you comment with reasons, about the nature of the electric and magnetic fields associated with these potentials? 8 + 2