PHYSICS

PHY : 201

CLASSICAL ELECTRODYNAMICS .

Full Marks: 80

Time: 3 Hours

The figures in the margin indicates full marks for the questions :

1. Answer the following questions   1x5=5

   (a) An electromagnetic wave is travelling in arbitrary direction $\hat{r}$ with frequency ω . Write the equation of electric and magnetic field vector of the wave.

   (b) Find the solution of Laplace's equation in one dimensions (in Cartesian coordinate).

   (c) What do you mean by plasma?

   (d) What are the three conditions to be satisfied by ionised gas to be called a plasma?

   (e) Sketch the trajectory of charged particle in uniform electromagnetic field.

2. Answer the following questions   2x5=10

   (a) How does the external electric field shielded in plasma?

   (b) Explain why sky is blue?

   (c) Show that when a free charge P_f is put on a conductor, it decays exponentially as
   $$\frac{\sigma t}{\varepsilon}$$
   where symbols have their usual meaning.

PTO

(d) Find the fields, charge and current distribution corresponding to the potentials

$$V(\vec{r},t) = 0, \qquad \vec{A}(\vec{r},t) = -\frac{1}{4\pi\varepsilon_0}\frac{qt}{r^2}\hat{r}$$

(e) Establish a relation between refractive index and dielectric constant (assume). $\mu \approx \mu_0$).

3. Answer the following questions (any five)   5x5=25

(a) Find the expressions for retarded potentials for a moving point charge q, moving with velocity v

(b) What is Debye shielding? Find an expression for Debye shielding length.

(c) Derive Maxwell's equation in covariant form.

(d) Find the expression for cut-off frequency in TE$_{mn}$ mode in rectangular wave guide whose dimensions are a and b.
(use and

$$[\frac{\partial^2}{\partial x^2} + \frac{\partial^2}{\partial y^2} + (\frac{\omega}{c})^2 - k^2]B_z = 0$$

$$[\frac{\partial^2}{\partial x^2} + \frac{\partial^2}{\partial y^2} + (\frac{\omega}{c})^2 - k^2]E_z = 0)$$

(e) Find the Gauge transformation equations for potentials and write the significance of Gauge transformation.

(f) Show that Maxwell's first and fourth equations can be expressed in terms of electromagnetic field strength tensor $F_{\mu\nu}$ as

$$\frac{\partial F_{\mu\nu}}{\partial x_\nu} = \mu_0 J_\mu$$

4. Answer the following questions (any four)   10x4=40

(a) What is Rayleigh scattering? Find an expression for scattering cross section for Rayleigh scattering.

(b) Five metal plates of a cubical box of sides of length *a* are welded together and grounded. The top metal plate is insulated from the others, and held at a constant potential V$_o$. Find the potential inside the box.

(c) Assuming there is no charge on the surface, find the potential inside and outside the hollow sphere of radius R, whose surface is kept at potential $V_0(\theta) = k\sin^2\left(\frac{\theta}{2}\right)$.

(d) Calculate the Poynting vector and total power radiated by an accelerated point charge q with acceleration $\vec{a}$.

(e) A straight wire carries current

$$I(t) = \begin{cases} 0, for\ t \le 0 \\ kt, for\ t > 0 \end{cases}$$

Find electric and magnetic field at a distance s from the wire.

****