(i) Printed Pages : 3 Roll No. .....

(ii) Questions : 9 Sub. Code : 3225

Exam. Code : 4721

M.Sc. 1st Semester

1125

PHYSICS

Paper– Phy-6004 : Classical Electrodynamics –I

Time Allowed : Three Hours] [Maximum Marks : 60

Note:– Attempt **one** question each from Units I to IV. Unit V is compulsory. Attempt **five** questions in all.

UNIT–I

1. (a) Determine the expression for the scaler potential of a spherically symmetric charge distribution given by :

$$q\frac{r^2}{a^2}(e^{-r/a}-e^{-2r/a})$$ 6

(b) Show that :

$$\nabla^2\left[\frac{1}{|X-X'|}\right]=-4\pi\delta(X-X')$$ 6

2. (a) Show that the force of interaction between two current carrying circuits is equal and opposite. 6

(b) Determine the divergence of magnetic field produced from a current carrying circuit. 6

UNIT–II

3. (a) Deduce the relation between electric susceptibility and molecular polarizability for a dielectric. Further deduce the Clausius–Mossotti relation. 6

   (b) Deduce the temperature dependence of the molecular polarizability of a polar molecule. 6

4. (a) Justify the uniqueness theorem of the solution of Laplace's equation. Explain the principle of method of images. 4,2

   (b) Show that there is a potential drop of $4\pi D$ across a dipole layer distribution of strength D (X). 6

UNIT–III

5. (a) State and conceptually explain all the Maxwell's equations. 6

   (b) Deduce the conservation law of momentum from Maxwell's equation for an electromagnetic field. Explain the law in terms of its physical significance. 5,1

6. (a) Describe the propagation of an electromagnetic wave through a conducting medium. Discuss the scenario when conduction current is larger than displacement current. 4,2

   (b) Describe in detail, quantitatively, the propagation of an electromagnetic wave through a rarefied plasma. 6

UNIT–IV

7. (a) Estimate the pressure exerted by a plane electromagnetic wave on plane dielectric medium when it is incident at a normal angle. 6

(b) Show that it is possible for electromagnetic wave to propagate in a hollow metal pipe of rectangular cross-section. What is cutoff frequency ? 6

8. (a) Find the total power emitted by a charge oscillating according to harmonic law, $x = x_0 \cos \omega_0 t$. 6

(b) Calculate the total radiated power by a dipole antenna. 6

UNIT–V

(Compulsory question)

9. (a) Explain, conceptually, the displacement current.

(b) How is TE mode distinct from TM mode ?

(c) Explain, conceptually, the energy conservation law for an electromagnetic field.

(d) Explain the role of gauge transformation in electrodynamics.

(e) Discuss the concept of total internal reflection and its possible applications.

(f) Explain the physics of a resonant cavity. 6×2=12