2016

M.Sc. Part-I Examination

PHYSICS

PAPER—III

Full Marks : 75

Time : 3 Hours

The figures in the margin indicate full marks.

Candidates are required to give their answers in their own words as far as practicable.

Illustrate the answers wherever necessary.

Use separate Answerscripts for Gr. A & Gr. B.

Group—A

[Marks—35]

1. Answer any *three* questions : 2×3

(a) In a source free region if $\vec{A} = \hat{i}\, x^4 + \hat{k}\, z^2\, t^2$, find the expression for the transverse current density J_t.

(b) Write difference between bremsstralung and cherenkov radiation.

(c) What do you mean by 'self force' for an accelerating charged particle ?

(d) What is radiation resistance ?

(e) Show that Laplacian operator is not invariant under L. T.

2. Answer any *three* questions : 3×3

(a) Give difference between Thomson-scattering and Rayleigh-scattering. Under what condition Rayleigh-scattering becomes Thomson-scattering ?

(b) Deduce Lorentz condition in covariant form.

(c) Show that electric charge unlike mass is invariant under L.T. while the charge density like mass is variant.

(d) An alternating field $\vec{E} = \vec{E}_0 \cos \omega t$ is applied to a conductor. Find the displacement current. Snow that the displacement current is $\pi/2$ out of phase to the real current.

3. Answer any *two* questions : 2×10

(a) What is an oscillating dipole ? Show that the power radiated by an electric dipole is proportional to the fourth power of the frequency of oscillation. 2+8

(b) Assuming that the velocity of an accelerated particle is sufficiently small in comparison to C, show that the

Poynting Vector is given by

$$\vec{N} = \frac{1}{4\pi \epsilon_0} \frac{e^2 a^2}{4\pi c^3 R^2} \sin^2 \theta \, \hat{n} .$$

and the total power radiated

$$\rho = \frac{1}{4\pi \epsilon_0} \frac{2}{3} \frac{e^2 a^2}{c^3} .$$

[notations bear their usual meanings] 6+4

(c) (i) Prove that $\vec{E}$ and $\vec{B}$ are perpendicular in one inertial frame, then the change of frame of reference does not affect their orthogonality.

(ii) Show that $E^2 - c^2 B^2$ is invariant under L.T. Give the significance of this result. 4+6

Group—B

[Marks—40]

1. Answer any *five* of the following : 5×2

(a) 'Transition from gas to plasma is not a phase transition in the thermodynamic sense."—explain.

(b) What is B ohm diffusion coefficient ?

(c) What is Landau damping ?

(d) Write expressions for electron and ion plasma frequency.

(e) Write there expressions for Debye-length and give its physical significance.

(f) What are the different types of radiation losses emitted from a plasma.

(g) What do you mean by 'magnetic confinement'?

(h) 'When a gas is ionised by a radio frequency field, the break down voltage is less than that of a dc field voltage required for the purpose.' — Explain.

2. Answer any *two* questions of the following : 2×3

(a) Write briefly about the two instabilities in a plasma.

(b) Find the expression for cyclotron radiation loss by the free charge of a plasma.

(c) Explain the mean free path in plasma.

3. Answer any *one* question : 1×4

(a) Explain the concept of experimental aspects of the toroidal princh effect.

(b) Show the nature of visual phenomenon of current (I) – Voltage (V) characteristics of low pressure dc voltage gas discharge.

4. Answer any *two* questions from the following : 2×10

(a) What are the plasma parameters ? Describe a method with experimental set up for the determination of the electron temperature in a plasma by spectroscopic method. 3+7

(b) Write some application of man made plasma. Deduce the expression for the power delivered to the load

when a plasma jet is introduced perpendicular to magnetic field in MHD energy conversion. 3+7

(c) Find the expression for the diffusion coefficient for ions and electrons with magnetic field. Show that for ions, the diffusion across the magnetic field will be greater as compared to that of electrons. 7+3
