Roll No. : .....

Total No. of Questions : **11**] [Total No. of Printed Pages : **4**

BPP–1097

M.Sc. (Previous) Examination, 2022

PHYSICS

Paper – II

(Statistical Mechanics, Electrodynamics and Plasma Physics)

*Time : **3** Hours*] [*Maximum Marks : **75***

Section–A **(Marks : 2 × 10 = 20)**

Note :– Answer all *ten* questions (Answer limit **50** words). Each question carries **2** marks.

Section–B **(Marks : 5 × 5 = 25)**

Note :– Answer all *five* questions. Each question has internal choice (Answer limit **200** words). Each question carries **5** marks.

Section–C **(Marks : 10 × 3 = 30)**

Note :– Answer any *three* questions out of five (Answer limit **500** words). Each question carries **10** marks.

Section–A

1. (i) Define statistical distribution function for a system of particles.

   (ii) Define density matrix in statistical mechanics for a system of particles obeying quantum mechanics.

(iii) Write the physical meaning of a canonical partition function.

(iv) At high temperatures, an ideal gas obey Boltzmann statistics. Justify.

(v) How Bose-Einstein condensation differs from ordinary vapour condensation ?

(vi) Define Fermi temperature for an Ideal Fermi Gas.

(vii) Write the equation of state of a hard sphere gas in virial form.

(viii) Explain the relation between Brownian motion and fluctuations in a fluid.

(ix) For a given applied force, the radiation losses are largest for electrons in charged particle accelerator. Explain.

(x) Define Pinched plasma.

Section–B

2. Calculate the expression for free energy, entropy and internal energy for a system in canonical ensemble with energies 0 and 6.

Or

For a system in Grand canonical ensemble, show that :

$$\frac{PV}{RT} = \ln Z$$

where Z is the grand partition function and P,V, T have standard meaning.

3. Distinguish among the postulates of Maxwell-Boltzmann, Bose-Einstein and Fermi-Dirac Statistics.

Or

Derive an expression for critical temperature for an ideal base gas.

4. For Brownian motion, show that the ensemble average of radial vector r is given by :

$$<r^2(t)> = 6\ Dt$$

where D is diffusion coefficient and t is time.

Or

Show that the homogeneous Maxwell equations $\vec{\nabla}.\vec{B}=0$ and $\vec{\nabla}\times\vec{E}+\frac{1}{C}\frac{\partial\vec{B}}{\partial t}=0$, can be written in terms of dual field strength-Tensor $\mathcal{F}^{\alpha\beta}$ as :

$$\overset{\partial}{\alpha}\mathcal{F}^{\alpha\beta}=0$$

5. For a charged particle in a uniform static magnetic induction $\vec{B}$, show that the action integral for this transverse motion is given by :

$$J=\frac{e}{C}(B\pi a^2)$$

where e is electric charge, C is speed of light and paticles orbital radius is a.

Or

Consider a uniform cylindrical column of plasma with a surrounding magnetic field. Explain the instabilities when there are departures in shape from the cylindrical cylinder of constant radius.

6. For a system of charged particles and electromagnetic fields, show that the differential continuity equation or conservation law is given by :

$$\frac{\partial u}{\partial t}+\vec{\nabla}.\vec{S}=-\vec{J}.\vec{E}$$

where u is total energy density, $\vec{S}$ is Poynting vector, $\vec{J}$ is current and $\vec{E}$ is electric field.

Or

Derive expressions for Coulomb and Lorentz gauge and explain their physical meaning.

Section–C

7. State and prove Liouville's theorem. Relate it to statistical equilibrium.

8. Discuss the behaviour of a degenerate Fermi gas at sufficiently low temperatures and derive expressions for Fermi energy and pressure.

9. Derive an expression for total power radiated for an accelerated charge having angular distribution. Explain your result.

10. Discuss Landau theory of phase transition. Explain critical indices.

11. Write short notes on the following relevant for magnetoplasma wave phenomenon :
    (a) CMA diagram
    (b) Faraday rotation