M.Sc. (Physics) (NEP Pattern) Semester-II

02MSCPH3 - DSC-III Paper-III - Classical and Statistical Mechanics

P. Pages : 2 **GUG/S/25/15417**

Time : Three Hours * 3 0 6 6 * Max. Marks : 80

Either:

1. a) Explain the concept of constraints in mechanics. Classify constraints with examples and describe their significance in Lagrangian mechanics. **8**

b) Explain cyclic coordinates and their role in the conservation of physical quantities. Derive expressions for conserved momenta. **8**

OR

e) Derive Lagrange's equation of motion using D'Alembert's principle. Apply it to a simple pendulum and discuss the results. **8**

f) Explain the principle of least action and its relation to Hamilton's principle. Derive Hamilton's equations from the principle of least action. **8**

Either:

2. a) Discuss Poisson brackets and their properties. Prove the invariance of Poisson brackets under a canonical transformation. **8**

b) Derive Hamilton-Jacobi equations and explain their application in solving the motion of a particle in a central force field. **8**

OR

e) Discuss the motion of a rigid body using Euler angles. Derive Euler's equations of motion for a rotating rigid body. **8**

f) What is the theory of small oscillations? Explain its application in the study of vibrational motion in molecules. **8**

Either:

3. a) Describe the concept of phase space and quantum states. How do they relate to statistical physics? **8**

b) State and explain Ludwig Boltzmann's entropy relation. Derive an expression for entropy using this relation. **8**

OR

e) What are the conditions for statistical equilibrium? Explain how chemical potential is determined in an equilibrium system. **8**

f) What are ensembles in statistical mechanics? Explain the significance of microcanonical, canonical and grand canonical ensembles. **8**

Either:

4. a) Derive and explain the Maxwell-Boltzmann distribution law. How does it differ from quantum distribution laws? **8**

b) Explain the concept of the density of states for relativistic and non-relativistic particles. **8**

OR

e) What is Bose-Einstein condensation? Derive an expression for the critical temperature of Bose-Einstein condensation. **8**

f) Derive and explain the Fermi-Dirac distribution law. Compare it with the Maxwell-Boltzmann and Bose-Einstein distributions. **8**

5. Attempt all of the followings.

a) Discuss the applications of Hamilton's equations in classical mechanics. **4**

b) Discuss the transition from a discrete system to a continuous system and its significance in classical mechanics. **4**

c) Explain the Gibbs paradox and derive the Sackur-Tetrode equation for the entropy of an ideal gas. **4**

d) Define Fermi energy and Fermi temperature. Derive an expression for the heat capacity of an electron gas. **4**

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