Approval : 9th Senate Meeting

Course Name : Statistical Mechanics

Course Number : PH 522

Credits : 4-0-0-4

Prerequisites : Undergraduate Physics Courses and First course Quantum mechanics and faculty consent.

Intended for : UG/PG

Distribution : Core for I-Ph.D and elective for others

Semester : Even

Preamble : Statistical mechanics use methods of probability to extend the mechanics to many-body systems to make statistical predications about their collective behaviour. It also acts as bridge between thermodynamics and mechanics of constituent particles. Statistical mechanics of ideal gas systems provide basic functioning of the formalisms of statical mechanics. Methods of statistical mechanics serves as essential pre-requisite to many advanced topics in various branches of physics where many body systems are dealt with.

Course Outline **:** This course starts from introducing the concepts of basic probability theory. Next modules explains the connection between the many body mechanics and phase space to probability theory. This course gives to introduction different statistical ensembles. Also introduces to studies of statical behaviour of classical and quantum systems.

Modules :

Probability concepts and examples - random walk problem in one dimension mean values probability distribution for large N. Probability distribution of many variables. (6)

Liouvellie equation- Boltzmann transport equation, Gibbsian ensemble, BBGKY hierarchy, Boltsmann's H-theorem, Maxwell-Boltzmann distribution, Poincare cycle. Phase space and connection between mechanics and statistical mechanics- Microcanonical ensemble. Classical ideal gas. Gibb's paradox. (12)

Canonical ensemble partition function. Helmholtz free energy, Thermodynamics from the partition function. Classical ideal gas- equipartition and virial theorem. Examples Grand canonical ensemble- density and energy fluctuations- Gibbs free energy. (12)

Formulation of quantum statistical mechanics density matrix- micro-canonical, canonical and grand canonical ensembles- Maxwell-Boltzmann , Fermi-Dirac, and Bose-Einstein statistics - comparison Ideal gas in classical and quantum ensembles Ideal Bose systems Examples of quantum ideal gases, Landau diamagnetism, Pauli paramagnetism, quantum Hall effect, phonons in solids, Bose-Einstein condensation, super fluids. (14)

Interacting systems: One dimensional and two dimensional Ising models, lattice gas and binary alloy, Bragg-Willam's approximations. (10 lectures)

Textbooks:

1. Statistical Mechanics, R K Pathria (Academic Press Inc; 3rd Revised edition edition (25 February 2011))

2. Statistical Physics by K Huang (Wiley; Second edition (24 September 2008))

References:

1. Fundamentals of statistical and thermal physics, F. Reif (Waveland Press (1 January 2010))

2. Statistical Physics Part I by L D Landau and E M Lifshitz (Butterworth-Heinemann; 3 edition (22 October 2013))

3. Statistical physics of particles by Mehran Kardar (Cambridge University Press; 1 edition (7 June 2007))

4. The principles of Statistical Mechanics R. C Tolman (Dover Publications Inc.; New edition edition (1 June 1980))