IISER Pune - Course Content

Semester	JAN 2025
Open to Semester	6,12,22,32
Course Code	PH3234
Course title	Statistical Mechanics I *
Nature of Course	LT - lecture and Tutorial
Credit	4
Coordinator and participating faculty (if any)	**Dr. Ushasi Roy**
Pre-requisites	Basic knowledge in Classical and Quantum Mechanics
Objectives	Objectives: Microscopic Formulation of Thermodynamics for both Classical and Quantum Systems Outcome: Understanding of the basic principles governing statistical mechanics and the connection with macroscopic thermodynamics, ideas to calculate the statistical properties of simple systems
Course content	CLASSICAL STATISTICAL MECHANICS Fundamental Postulates of Classical Statistical Mechanics, Thermal Equilibrium, Thermodynamic Equilibrium, Probability and Random Variables, Probability Distributions, Moment and Cumulant Generating Functions, Cluster Theorem, Random Walk, Standard Deviation, Relative Fluctuation, Law of Large Numbers, Central Limit Theorem, Ergodic Hypothesis, Postulate of Equal Apriori Probability, Relation to Equilibrium, Density of States, Phase Space, Liouville*s theorem, BBGKY Hierarchy, Boltzmann equation, H theorem, Microstates, Macrostates, Information and Entropy, Statistical Basis of Thermodynamics Definition of Temperature, Partition Function, Density Function [7 classes] Ensembles — Microcanonical Ensemble, Laws of Thermodynamics Thermodynamic Limit, Equipartition Theorem, Euler’s Theorem, Specific Heat, Thermodynamic Stability, Mean Field Theory, Classical Ideal Gas, Gibbs Paradox, Mixing Entropy, Two Level System Canonical Ensemble, Canonical Partition Function, Energy

	Fluctuation in Canonical Ensemble Grand Canonical Ensemble, Chemical Potential, Fugacity, Density Fluctuation in Grand Canonical Ensemble, Maxwell Construction, Maxwell-Boltzmann Distribution [15 Classes] QUANTUM STATISTICAL MECHANICS Fundamental Postulates of Quantum Statistical Mechanics, Density Matrix, Ensembles in Quantum Statistical Mechanics, Ideal Fermi Gas, Landau Diamagnetism, Pauli Paramagnetism, Ideal Bose Gas, Photons, Phonons, Bose-Einstein Condensation [12 classes] Ising Model, some introductory ideas of other on-lattice (and off-lattice models) and their wide applications, Interacting systems, Phase Transition [3 Classes] Reflections and some applications/examples in a nutshell What did we learn in the course? — Rapid recapitulation Statistical Mechanics beyond the notion of Thermodynamics. What type of real-life research problems we might be able to tackle? — some introductory examples [2 classes]
Evaluation / Assessment	End Sem - 40% Mid Sem - 30% Assignments/Tutorials -30%
Suggested readings	1. Statistical Mechanics — Kerson Huang 2. Statistical Physics of Particles — Mehran Kardar 3. Statistical Mechanics — R. K. Pathria 4. Fundamentals of Statistical and Thermal Physics — F. Reif 5. Statistical Physics — Landau Lifshitz
When Next	
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