STATISTICAL MECHANICS

PROF. DIPANJAN CHAKRABORTY
Department of Physics
IISER Mohali

TYPE OF COURSE : Rerun | Core | UG/PG
COURSE DURATION : 12 Weeks (24 Jan' 22 - 15 Apr' 22)
EXAM DATE : 24 Apr 2022

PRE-REQUISITES : Classical Mechanics, Mathematical Methods, Quantum Mechanics

INTENDED AUDIENCE : Students in their BS-MS curriculum, BSc,/MSc. and first year PhD

COURSE OUTLINE :
The course provides a fundamental understanding of Thermodynamics and Statistical Mechanics. It starts with the fundamental concepts of thermodynamics and builds on its foundation, the principles of statistical mechanics. It does not require a prior exposure to the topics.

ABOUT INSTRUCTOR :
Prof. Dipanjan Chakraborty completed his graduation from Presidency University (formerly Presidency College), Kolkata in 2001, followed by MSc. in Physics from IIT Kanpur. He got his PhD degree from Jadavpur University, Kolkata in 2010. Subsequently he did two post-doctoral stints in ITP, Leipzig, Germany and MPI-IS, Stuttgart, Germany. He joined the Physics department at IISER Mohali in 2013.

COURSE PLAN :

Week 1: Introduction to Thermodynamics the idea of macroscopic and microscopic variables with examples

Week 2: First law and perpetual machines of first kind. Concept of exact and inexact differentials (for example heat and work).

Week 3: Extensive property of Entropy and Internal Energy. Euler theorem and Gibbs Duhem relation from this.

Week 4: Stability criteria for thermodynamic systems. Concavity of entropy and convexity of internal energy.

Week 5: Microcanonical Ensemble: Concept of classical probability density Liouville equation, incompressible flow in phase

Week 6: Canonical ensemble: Understanding what is a canonical ensemble and why we need it connecting it with thermodynamics.

Week 7: Grand canonical ensemble. Probability density in grand canonical ensemble. Fluctuations and their significance.

Week 8: Grand canonical ensemble. Probability density in grand canonical ensemble. Fluctuations and their significance.(Cont'd)

Week 9: Quantum statistical mechanics: concept of averages in quantum stat. mech.

Week 10: N-particle wavefunction and canonical density matrix for N-particles. Concept of symmetric and anti-symmetric wave functions symmetry and permutation operator.

Week 11: Grand canonical formulation of non-interacting Fermions and Bosons.

Week 12: Bosons: The ideal Bose gas and derivation of thermodynamic quantities in terms of Bose integrals. Bose-Einstein condensation. Specific heat of a Bose gas. Harmonically trapped Bose gas.