

**Title:** Statistical Mechanics 1

**Instructor:** Anupam Kundu

**Venue:** Emmy Noether Lecture hall

**First Class:** 8th January at 4:00pm - 5:30 pm

**Timings:** Wednesday and Friday (time to be decided in the first class)

- 1) Recap of Fundamentals of thermodynamics, Probability, distributions (single and multi variables), Conditional probability, moments, cumulants, moment generating functions.
  - 2) Foundations of equilibrium statistical mechanics
    - Liouville's equation, microstate, macrostate, phase space
  - 3) Partition functions, connection to thermodynamical free energies, Response functions
  - 4) Examples: Non-interacting systems
    - Classical ideal gas, Harmonic oscillator, paramagnetism, adsorption, 2 level systems, molecules, more non-standard examples.
  - 5) Formulation of quantum statistical mechanics
    - Quantum micro states, Quantum macro-states, density matrix.
  - 6) Quantum statistical mechanical systems
    - Dilute polyatomic gases, Vibrations of solid, Black body radiation
  - 7) Quantum ideal gases
    - Hilbert space of identical particles
    - Fermi gas, Pauli paramagnetism
    - Bose gas, BEC
    - Revisit phonons, photons
    - Landau diamagnetism
  - 8) Interacting classical gas
    - Virial expansions
    - Cumulant expansions
    - Liquid state physics
    - Van-der Waals equation
  - 9) Introduction to phase transitions
    - Examples of phase transitions, Phase diagrams
    - Thermodynamic limits
    - Peierls argument
    - Ising models, Mean field theory, correlations
    - Simulation methods
- If time permits the some topics from the below*
- 10) Dynamics: Basics of Kinetic theory, H-theorem, Transport coefficients, Stochastic evolutions: Langevin equations, Jump processes, Fokker-Planck/Master equations

Books:

M. Kardar, Statistical Physics of Particles  
R. K. Pathria, Statistical mechanics  
K. Huang, Statistical mechanics  
J. M. Sethna, Statistical Mechanics: Entropy,  
Order Parameters and Complexity

M. Kardar, Statistical Physics of fields

Landau & Lifshitz Statistical Mechanics

+ some other books and papers, references of which will be provided in the class.