Indian Institute of Science Education and Research, Trivandrum

PHY-321   Statistical mechanics

Course outline

    I.   Review of thermodynamics

    II.   Basics of statistical Mechanics
  - A. Definition of state of system: Macroscopic and Microscopic
  - B. Connection between Microstate and Macrostate
  - C. Concept of ensemble

    III.   Systems with constant energy: Microcanonical ensemble
  - A. Maximum probability postulate and Boltzmann entropy (Microcanonical ensemble)
  - B. Application of Boltzmann entropy formula to simple systems

    IV.   Systems with varying energy: Canonical ensemble
  - A. Boltzmann probability distribution law
  - B. Canonical Ensemble
  - C. Difference between microcanonical and canonical ensemble
  - D. Partition function
  - E. Gibbs entropy and relation to Boltzmann entropy
  - F. Validity of canonical ensemble

    V.   Systems with varying energy and number: Grand-canonical ensemble
  - A. Need for the definition of chemical potential
  - B. Mathematical definition of chemical potential
  - C. Grand-canonical Ensemble
  - D. Grand-partition function

    VI.   Application of canonical ensemble to discrete systems
  - A. Einstein model of solids
  - B. Paramagnetic systems in external magnetic field
  - C. Interacting spin systems -- 1-D Ising model

    VII.   Application of canonical ensemble to continuous systems
  - A. Ideal monoatomic and polyatomic gases
  - B. Black-body radiation
  - C. Debye model of solids

    VIII.   Semi-classical partition function
  - A. Cluster expansion
  - B. Non-ideal gases

    IX.   Quantum ideal gases[1]
  - A. Bose-Einstein
  - B. Fermi-Dirac

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[1] Depends on the pace of the lectures.

C. Applications

References

The course outline is a superposition of several books. In particular**,**

1. R. K. Pathria, Statistical Mechanics
2. Kerson Huang, Statistical Mechanics, John Wiley
3. F. Mandl, Statistical Physics, Wiley (II edition)
4. H. B. Callen, Thermodynamics and introduction to thermostatistics, Wiley

Assignment guidelines

1. One assignment every 4 lectures. Return date will be mentioned on the assignment.
   Any deadline extension should be told the next day of receiving the assignment.

2. Please make sure that you do the assignment by yourself. You are free to consult your classmates, seniors/Ph.D. students and make sure you understand the concept. To know whether you have indeed done the assignment, time to time I will ask questions to some of you.

3. **Do not take assignments to other faculty members and ask them to solve for you.** Faculty members have solved assignments during their student times! It is your time to solve the assignments.

4. There will be surprise test during the class hour.

Course Schedule

1. Upto First mid-semester exam: I -- III (starting of IV)
2. Between I and II mid-sem exam: IV -- VI
3. Between II mid-sem and end-sem exam: VII - IX