Semester-III

Course No. MPC-31

(Credit-4)

Statistical Mechanics

Lectures: 50

Full marks: 50

1. **Basic Concept:** Random walk and statistical basis of thermodynamics; phase space and ensembles; Liouville's theorem. (3)
2. **The microcanonical ensemble:** Statistical interpretation of temperature and entropy; the equipartition and virial theorem; classical ideal gas; Gibbs paradox; Sackur-Tetrode equation. (3)
3. **The canonical ensemble:** 'l'he equilibriurn between a system and a heat reservoir; partition function; Energy fluctuations in canonical ensemble; Applications; Negative temperature. (5)
4. **The grand canonical ensemble:** The equilibrium between a system and a heat reservoir; Density and energy fluctuations in the grand canonical ensemble; critical opalescence; Applications. (5)
5. **Quantum statistical mechanics:** Density matrix; Density matrix for different ensembles, Applications; Bose-Einstein and Fermi-Dirac distributions, Statistics of the occpation numbers. (5)
6. **Ideal Bose System:** Thermodynamic behavior of an ideal Bose gas; Bose-Einstein condensation; Liquid helium; Bose condensation in gases, Phonons. (5)
7. **Thermodynamic behavior of an ideal Fermi gas:** A degenerate electron gas; white dwarf and Chandrasekhar limit, Magnetic behavior of an ideal Fermi gas. (4)
8. **Chemical reaction:** The condition for chemical equilibrium; the law of mass action; Ionization equilibrium; Saha ionization formula. (4)
9. **Imperfect gases:** Cluster expansion for classical gas; Calculation of partition function for low densities; Equation of state and virial coefficients; The van der Waal's equation. (5)
10. **Phase transitions and Critical Phenomena:** Qualitative description and classification of phase transitions; Ising model and lattice gas; critical exponents; order parameter, correlation function and fluctuation dissipation theorem; scaling hypothesis and scale invariance. (6)

References:

1. Statistical Mechanies - R.K. Patharia
2. Statistical Mechanics - K. Huang
3. Fundamentals of statistical and thermal physics – Reif
4. Statistical Physics (III) - Landau and Lifshitz
5. Statistical Mechanics and Properties of matter – E.S.R Gopal
6. Statistical Mechanics - B.K. Agarwal and Melvin Eisner