PHYDSC-352T

STATISTICAL MECHANICS AND PLASMA PHYSICS

Contact Hours: 60

Full Marks = 100 [ESE (70) CCA(30)]

Course objective: *This course aims to introduce statistical mechanics and introductory plasma physics to the students. This course will enable the students to understand the connection between the macroscopic observations of physical systems and microscopic behaviour of atoms and molecules through statistical mechanics.*

Unit 1:

Microstates and macrostates, Phase Space, Entropy and Thermodynamic Probability, Maxwell-Boltzmann Distribution Law, Concept of statistical ensemble - Micro-canonical, Canonical and Grand canonical ensemble. Basic idea of partition functions, Expressions of different thermodynamical quantities (e.g. Free energy, pressure, average energy, entropy, Specific heat) in terms of partition function. **(12 Lectures)**

Unit 2:

Properties of Thermal Radiation. Kirchhoff's law. Blackbody Radiation, Spectral Distribution of Black Body Radiation. Wein's law & Rayleigh Jeans law (No derivation), Ultraviolet catastrophe. Planck's Quantum Postulates. Planck's Law of Blackbody Radiation and its derivation. Deduction of (1) Wien's Distribution Law, (2) Rayleigh-Jeans Law, (3) Stefan-Boltzmann Law, (4) Wien's Displacement law from Planck's law. Saha's Ionization Formula (qualitative idea only). **(12 Lectures)**

Unit 3:

Entropy of mixing and Gibb's paradox, Resolution of Gibb's paradox, Concept of identical particles, Limitation of classical statistics. Fermions and Bosons. Bose-Einstein distribution function and its behaviour with temperature, Basic idea of phenomenon of Bose-Einstein condensation (Qualitative description), Calculation of various thermodynamical quantities of photon gas (black body radiation). **(12 Lectures)**

Unit 4:

Fermi-Dirac distribution function and its behaviour with temperature, Basic idea of Fermi surface and fermi energy, Calculation of various thermodynamical quantities of free electron gas; Classical limits and distinguishing features of classical and quantum statistics. Basic idea of degenerate Fermi gas. Comparison of three distribution laws and their properties. **(13 Lectures)**

Unit 5:

Plasma: Its definition, composition and characteristics, microscopic and macroscopic descriptions of plasma. Difference between ordinary gas and plasma, Plasma Parameters, Concept of Debye shielding distance, Quassi-neutrality in plasma, Dielectric constant of plasma, Production of plasma through collisions, Plasma Diagnostics - Single probe method, magnetic confinement of plasma. Solar corona and Solar wind. **(11 Lectures)**

Expected learning outcomes: *At the end of this course the students are expected to understand the concepts of microstate, macrostate, ensemble, phase space, thermodynamic probability and partition function, understand the combinatory studies of particles with their nature and conditions which lead to the three different distribution laws, develop the ability to derive radiation laws of black body radiation. Students are also expected to learn Gibb's paradox & its resolution, understand the macroscopic properties of degenerate photon gas and degenerate fermi gas. Finally, the students are expected to know the basic ideas of plasma state of matter with ideas of composition, behaviour, magnetic confinement etc.*

Reference Books:

i. Thermodynamics, Kinetic Theory & Statistical Thermodynamics, Sears & Salinger. 1988, Narosa.
ii. Statistical Mechanics, R.K. Pathria, Butterworth Heinemann: 2nd Ed., 1996, Oxford University Press.
iii. Statistical Physics, Berkeley Physics Course, F. Reif, 2008, Tata McGraw-Hill.
iv. Statistical and Thermal Physics, S. Lokanathan and R.S. Gambhir. 1991, Prentice Hall.
v. Thermodynamics, Kinetic Theory and Statistical Thermodynamics, Francis W. Sears and Gerhard L. Salinger, 1986, Narosa.
vi. An Introduction to Statistical Mechanics & Thermodynamics, R.H. Swendsen, 2012, Oxford Univ. Press.
vii. Introduction to Plasma Physics & Controlled fusion, Francis F. Chen, Springer.
viii. Elements of Plasma Physics, S. N. Goswami, NCBA, Publisher.
ix. Text book of Plasma Physics, Suresh Chandra, CBS Publishers & Distributors Pvt, Ltd.

PHYDSC353T

SOLID STATE PHYSICS

Contact Hours: 60

Full Marks = 100 [ESE (70) CCA(30)]

Course objective: *This course aims to introduce the basic phenomena in solid state physics. On successful completion of this course the students would be able to elucidate the main features of crystal lattices and phonons, understand the elementary lattice dynamics and its influence on the properties of materials, describe the main features of the physics of electrons in solids; explain the dielectric ferroelectric and magnetic properties of solids and understand the basic concept in superconductivity.*

Unit 1:

Crystal Structure: Solids: Amorphous and Crystalline Materials. Lattice Translation Vectors. Unit Cell, Lattice with a Basis, Types of Lattices, Bravais lattice, symmetry, point groups and space groups. Miller Indices. Reciprocal Lattice. Brillouin Zones. Diffraction of X-rays by Crystals. Bragg's Law. Theory of Laue Spots. **(11 Lectures)**