

M.G. Science Institute – B.Sc. – Physics Curriculum OBE Pattern

Semester 6 Major Course- 361T (Major Course – 4 Credits)

Semester: 6	Course No.: 361(T)	Course Code: PHM 361(T) Course Title- Statistical Mechanics-Mathematical Physics-Quantum Mechanics-Plasma Physics
Credits: 4	1 Session = 1 hour	Course Category: Major Paper

Course Objectives

To understand and analyze the Bose Einstein and Fermi-Dirac distribution function and apply them in various many body systems

To apply the method of separation of variables to solve partial differential equations in different coordinate systems commonly used in physics.

To evaluate the eigenvalue problems of the quantum harmonic oscillator and interpret the role of operators, commutation relations, and spherical harmonics in quantum mechanics.

To study the interaction of plasma with magnetic field. Using statistical mechanics different nonlinear phenomena in plasma is analysed

Course Outcomes:

On successful completion of the course the learner will be able to

CO	COURSE OUTCOMES	Bloom's Verb
CO-1	Analyse Bose Einstein and Fermi Dirac Distributions: Symmetry of wave functions, Calculate the results for Partition function for Diatomic Molecules.	Apply Analyze
CO-2	Strong understanding of how to model, classify, and solve key partial differential equations (PDEs) that describe important physical phenomena. Apply the method of separation of variables to solve common PDEs like the heat, wave, and Laplace Equations. Develop the ability to apply, PDEs as mathematical models for physical and engineering problems.	Understand Apply Analyze
CO-3	To evaluate the eigenvalue problems of the quantum harmonic oscillator and interpret the role of operators, commutation relations, and spherical harmonics that is connected with the most important fundamental concept of angular momentum in quantum mechanics.	Apply Analyze
CO-4	Understanding the detailed behavior of plasma in magnetic field. Also analyze the production and propagation of different types of waves in plasma. The fundamental Boltzmann equation is used in plasma to study some basic nonlinear phenomena like Landau damping and Plasma Sheath.	Understand Apply Analyze

M.G. Science Institute – B.Sc. – Physics Curriculum OBE Pattern

Unit No.	Unit Contents	Sessions Allotted
1	<p>Formulation of Quantum Statistics: Density matrix, Liouville's theorem in Quantum Statistical Mechanics, Condition for Statistical equilibrium, Ensemble in Quantum Mechanics, Problems</p> <p>Bose Einstein and Fermi Dirac Distributions: Symmetry of wave functions, the Quantum Distribution functions, the Boltzmann limit of Boson and Fermions Gases, Evaluation of the Partition function, Partition function for Diatomic Molecules (a) translation partition function (b) rotational partition function (c) vibration partition function (d) electronic partition function Equation of state for an Ideal gas, The quantum mechanical Para-magnetic susceptibility.</p>	15 Hours
2	<p>Mathematical Physics Some partial differential equations in physics, the method of Separation of variables, separation of Helmholtz equation in Cartesian coordinates, in spherical polar and cylindrical Coordinates, Laplace's equation in various coordinates, Choice of coordinate system and separability of a partial differential equation, Parabolic coordinates system, Prolate Spheroidal coordinates system, various examples based on the separation of variables.</p>	15 Hours
3	<p>Quantum Mechanics: Exactly soluble Eigenvalue problems General Formalism of wave mechanics: The uncertainty principle, states with minimum value for uncertainty product, Commuting observables, Removal of Degeneracy, Evolution of system with time, constants of the motion, Non- interacting & interacting systems, systems of identical particles. Introduction, the simple harmonic oscillator, the Schrödinger equation and energy eigenvalues, the energy eigenfunctions, properties of stationary states, the abstract operator method, the angular momentum operators, the eigenvalue equation for L^2, separation of variables, admissibility conditions on solutions, eigenvalues, the eigenfunctions, Spherical harmonics, Physical interpretation, Parity.</p>	15 Hours
4	<p>Plasma Physics: Characteristics of plasma in magnetic field: Description of plasma as gas mixture, Properties of plasma in a magnetic field, Force on plasma in magnetic field, Current in magnetized plasma, Diffusion in a magnetic field, Collisions in fully ionized magnetoplasma, Pinch effect, Oscillations and waves in the Plasma. Application of Boltzmann-Vlasov equation on plasma: Distribution function, Homogeneous, Inhomogeneous, Isotropic and Anisotropic distribution functions, Boltzmann equation, Debye screening, Equilibrium distribution function and Boltzmann's H-theorem, Application of B-V equation to longitudinal waves: Dispersion relations, Initial value problem: Landau damping, Cyclotron damping, Excitation, two-stream instability: Beam plasma instability, Pinch instability, Plasma sheath, Non-linear effects</p>	15 Hours

Unit-1 Statistical Mechanics

Text Book: Fundamentals of Statistical Mechanics by B. B. Laud, New Age International Publishers Chapter-7-Article Nos.: 7.1 - 7.4 ; Chapter-8- 8.1 -8.7

Unit -2 Mathematical Physics

Text Book: Mathematical Physics by P.K. Chattopadhyay, New Age International Publishers (2006) Article Nos.: Chapter 2: 2.1, 2.2 (A – E), 2.3, A.3 (3, 4)

Reference Books: Mathematical Methods for Physicists by G. Arfken, Academic Press

M.G. Science Institute – B.Sc. – Physics Curriculum OBE Pattern

Mathematical Methods in the Physical Sciences by Mary L. Boas, Wiley India Pvt. Ltd.

Unit-3 Quantum mechanics

Text Book: A Text Book of Quantum Mechanics by P. M. Mathews and K. Venketeshan, Tata McGraw-Hill Publishing Co. Ltd.

Article Nos.: Chapter 3: 3.11 to 3.16, Chapter 4: 4.1 to 4.4, 4.6 to 4.11

Reference Book: 1. Quantum Mechanics: Theory and Applications by A. Ghatak and S. Lokanathan, Macmillan India Limited.

Unit-4 Plasma Physics

Text book: Elements of Plasma Physics by S. N. Goswami, New Central Book Agency (P) Ltd.

Chapter-2-Article Nos.: 2.1 – 2.12, Chapter-3-Article Nos 3.1 – 3.8, Chapter-4-Article Nos 4.1 – 4.12 (Excluding 4.4)

Reference Book:

Introduction to Plasma Physics by F.F. Chen, Plenum Press, 2nd ed