MASTER OF SCIENCE

(PHYSICS)

PHM-6111

MATHEMATICAL PHYSICS-I

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Block-I: Theory of Functions of a Complex Variable

Unit-1: Fundamentals of Complex Analysis- Analyticity and Cauchy-Reimann Conditions, Cauchy's integral theorem and formula

Unit-2: Advanced Topics in Complex Analysis - Taylor's series and Laurent's series expansion, Zeros and singular points, Multi valuedfunctions, Branch Points and Cuts

Unit-3: Exploring Complex Analysis- Reimann Sheets and surfaces, Residues, Cauchy's Residue theorem, Jordan's Lemma

Unit-4: Complex Integration- Evaluation of definite integrals, Principal Value, Bromwich contour integrals.

Block-II: Fourier Transform

Unit-5: Transforms- Fourier transform, Sine, Cosine and Complex transforms with examples, Definition,Properties and Representations of Dirac Delta Function

Unit-6: Analyzing Fourier Transforms- Properties of Fourier Transforms, Transforms of derivatives

Unit-7: Exploring Fourier Transforms- Parseval's Theorem, Convolution Theorem, Momentum representation, Applications to Partial differential equations,

Unit-8: Discrete Fourier Transform- Discrete Fourier transform, Introduction to Fast Fourier transform

Block-III: Laplace Transforms

Unit-9: Power of Laplace Transform- Laplace transform,

Unit-10: Laplace Transform- Properties and examples of Laplace Transform

Unit-11: Convolution Theorem- Convolution theorem and its applications,

Unit-12: Differential Equations with Laplace Transform Method- Laplace transform method of solving differential equations.

Block-IV: Green's Functions

Unit-13: Introduction to Green's function method, Green's function as a solution to Poisson's equation with a point source

Unit-14: symmetry of Green's function, forms of Green's functions, spherical polar coordinate expansion,

Unit-15: Quantum Mechanical Scattering- Neuman Series as well as Green's Function Solutions, Eigen function expansion,

Unit-16: One dimensional case, integral-differential equation, linear Harmonic oscillator, Green's function and Dirac delta function

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Block I: Classical ensemble theory

Unit 1: Quantum Statistical Mechanics of Identical Particles- Quantum statistical mechanics of identical particles, Condition for statistical equilibrium,

Unit 2: Symmetry, Probability, and Quantum Ensembles- Symmetry of wave function, Postulate of equal a prior probability, Random Walk, Ensemblein quantum statistics,

Unit 3: Grand Canonical Ensemble & Quantum Distributions- Grand Canonical Ensemble, Partition function, Quantum distribution functions (Bose-Einstein and Fermi-Dirac),

Unit 4: Derivation via Grand Partition Function- Derivation of distribution laws using grand partition function.

Block II: Quantum ensemble theory

Unit 5: Phase Space, Liouville's Theorem, and Microcanonical Gas Theory- Phase space and Liouville's theorem, Micro canonical ensemble theory and its application to ideal gas of monatomic particles

Unit 6: Canonical Ensemble: Thermodynamics and Ideal Gas Dynamics- Canonical ensemble and its thermodynamics, partition function, classical ideal gas incanonical ensemble theory, energy fluctuations,

Unit 7: Gibbs Paradox, Sackur-Tetrode Equation, and Quantum Ensembles- Gibbs paradox and its solution, Sackur-Tetrode equation, a system of quantum harmonic oscillators as canonical ensemble, Grand canonical ensemble,

Unit 8: Statistical Quantities and Ideal Gas in Grand Canonical Ensemble- Significance of statistical quantities, classical ideal gas in grand canonical ensemble theory.

Block III: Ideal Bose systems

Unit 9: Ideal Bose Gas and Bose-Einstein Condensation: Fundamentals and Thermodynamics- Basic concepts and thermodynamic behaviour of an ideal Bose gas, Bose-Einstein condensation,

Unit 10: Blackbody Radiation and Ideal Fermi Systems: Thermodynamic Behavior- Blackbody radiation-Planck's formula, Ideal Fermi systems: thermodynamic behavior of an idealFermi gas,

Unit 11: Heat Capacity of Free-Electron Gas at Low Temperatures: Insights and Discussion- Discussion of heat capacity of a free-electron gas at low temperatures,

Unit 12: Electron Gas in Metals: Exploring the H-Theorem- Electron gas in metals, H-theorem.

Block IV: Phase transition

Unit 13: Phase Transitions: Ising Model and Critical Fluctuations- Phase transitions, Ising model, Thermodynamic fluctuations, Critical exponents,

Unit 14: Thermodynamic Limit and Random Walk Dynamics- Thermodynamic limit and its importance Random Walk

Unit 15: Brownian Motion, Diffusion, and Fluctuation-Dissipation- Brownian motion, Diffusion equation, Fluctuation-Dissipation theorem.

Unit 16: Universality in Phase Transitions: Ising vs. Heisenberg Models- Concepts of universality of phase transitions, Ising and Heisenberg models

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