DETAILS OF SYLLABUS

FIRST SEMESTER

PH51101: CLASSICAL MECHANICS

Credits: 04 **Teaching Scheme:05 Hrs/Week**

Prerequisites: Knowledge of Newtonian Mechanics, Knowledge of solving elementary differential equations.

Course Details:

UNIT-I: Rigid body motion: **(10 Hours)**
Inertial and Non-inertial frames of reference, orthogonal transformations, The Euler's angles, Euler's theorems on the motion of a rigid body, infinitesimal rotations, The Coriolis Force.
Conservation laws:
Lagrangian Formulation, Velocity dependent potentials and Dissipation Function, Conservation theorems and Symmetry properties, Homogeneity and Isotropy of space and Conservation of linear and Angular momentum, Homogeneity of time and Conservation of energy.

UNIT-II : Hamiltonian Formulation: **(10 Hours)**
Calculus of variations and Euler Lagranges equation, Brachistochrone problem, Hamiltons principle, Extension of Hamiltons principle to nonholonomic systems, Legendre transformation and the Hamilton equations of motion, Physical significance of Hamiltonian, Derivation of Hamiltons equations of motion from a variational principle, Rouths procedure, Variation, Principle of least action.

UNIT III **(10 Hours)**
Canonical transformations:
Canonical Transformation, Types of generating function, Conditions for Canonical Transformation, Integral invariance of Poincare, Poissons theorem, Poisson and Lagrange bracket, Poisson and Lagrange Brackets as canonical invariant, Infinitesimal canonical Transformation and conservation theorems, Liouvilles theorem.

UNIT-IV **(10 Hours)**
Hamilton -Jacobi Theory:
Hamilton - Jacobi equation for Hamiltons principal function, Harmonic oscillator and Kepler problem by Hamilton - Jacobi method, Action angle variables for completely separable system, Kepler problem in Action angle variables, Geometrical optics and wave mechanics.

Unit-V
Rigid body dynamics: **(10 Hours)**
Angular Momentum and kinetic energy of motion about a point: The Inertia Tensor and momentum of Inertia, Eigenvalues of Inertia Tensor and the principal axis transformation. The heavy symmetrical top with one point fixed.

Small oscillation:
Problem of small oscillations, Example of two coupled oscillators, General theory of small oscillations, Normal coordinates and Normal modes of vibration, Free vibrations of a linear tri-atomic molecule.

TEXT BOOKS:
1. Classical Mechanics, H. Goldstein, C. P. Poole and J. L. Safko, Addison Wesley, 3rd edition,2011
2. Mechanics , L.D. Landau and E.M. Lifshitz, Butterworth-Heinenann, 3rd edition, 2000
3. Classical Mechanics, Rana and Joag, Tata McGraw-Hill Education,1st edition, 2001

REFERENCE BOOKS:
1. Classical Mechanics, H. C. Corben & P. Stehle, Dover Publications, 2nd edition, 2013
2. Analytical Mechanics, L. Hand and J. Finch, Cambridge University Press, 1st edition, 2012
3. Classical Mechanics , J.C. Upadhyaya, Himalay Publishing House, 1st edition, 2013
4. A Treatise on the Analytical Dynamics of Particles and Rigid Bodies, E.T.Whittaker, Cambridge University Press, 4th edition, 1999

Course Outcomes:

After completing this course the students should be able to:

1. Classify the motion of rigid bodies on the basis of frames of reference and the conservation laws by Lagrangian mechanics.
2. Formulate problems on the variational principle by the use of Hamiltonian.
3. Apply the canonical tranformations and brackets for the mechanics of systems of particles.
4. Interprete the equations of motion for mechanical systems for planar and spatial cases using Hamilton-Jacobi formalism.
5. Understand the stability and deviations from equilibrium of the mechanical systems.

PH51102: MATHEMATICAL PHYSICS

Credits: 04 **Teaching Scheme: 05 Hrs/Week**

Prerequisites: Knowledge of elementary complex number, elementary differential equations and their solutions, different types of Mathematical functions.

Course Details:

Unit-I :Complex analysis: **(12 Hours)**

Cauchy's integral theorem, Cauchy's integral formula, Taylor's and Laurent's series, Calculus of Residues: Cauchy's Residue theorem, Zeroes and Singularities of complex functions, simple poles, Evaluation of definite integrals, Generalised functions, Dirac's -delta function ; Representation by Gaussian function, Integral representation, Relation to Step function.

Unit-II: Differential equations: **(12 Hours)**

Linear ordinary differential equations of first & second order: singularities of differential equations and their classification, Power series method and Frobenius extended power series method of solving differential equations.

Special functions: Solution of Bessel, Legendre, Laguerre, Hermite, Hypergeometric and confluent Hypergeometric equations and their properties, Generating functions, Recurrence relations and Rodrigues Formula.

Unit- III : Partial Differential equations: **(10 Hours)**

Partial differential equations (Laplace, wave and heat equations in two and three dimensions), Greens function, Solution of inhomogeneous partial differential equation by Green function method. Fourier series, Fourier and Laplace transforms.

Unit-IV : Tensor analysis: **(8 Hours)**
Contravariant, Covariant and Mixed Tensors, Addition and subtraction of Tensors. Direct product, Inner product and Contraction of Tensors, Levi-Civita Tensor, Metric Tensor, Christoffel symbol.

Unit-V: Groups and Group representation: **(8 Hours)**

Definition of groups, Finite groups, Examples from solid state physics, Sub groups and classes, Group Representation, Characters, Infinite groups and Lie groups, Lie algebra, Application, Irreducible representation of SU(2),SU(3)and O(3).

Text Books:

1. Mathematical Methods for Physicists: George Arfken Hans, Weber Frank, E. Harris, 7th Edition, Academic Press, 2012
2. Mathematical Physics: H K Das, Dr. R. Verma, S. Chand Publications, 2012

Reference Books:

1. Mathematical Physics with Classical Mechanics: Satya Prakash, 6th Edition, Sultan Chand & Sons, 2014
2. Mathematical Physics: P K Chattopadhyay, Second Edition, New Age International, 2013
3. Mathematical Methods for Physics and Engineering: K. F. Riley, M. P. Hobson and S. J. Bence, Third Edition, Cambridge University Press, 2006

Course Outcomes:

After completing this course the students should be able to :

1. Understand the use of residue theorem to evaluate complex definite integrations.

2. Interpret differential equation in Physical Sciences by power series and frobenius method and their related generating functions.

3. Apply Greens function to solve inhomogeneous partial differential equation.

4. Apply Fourier and Laplace transformations to solve differential equation.

5. Explain tensor along with their classifications and its basic operations.

6. Apply group theory to solve some mathematical problems of interest in physics.

PH51103: CLASSICAL ELECTRODYNAMICS

Credits: 04 **Teaching Scheme:** 05 Hrs/Week

Prerequisites: Basic Knowledge of Laws of Electrostatics and Magnetostatics.

Course Details:

UNIT – I: Maxwell's Equations and Conservation laws: **(12 Hours)**

Introduction to Electromagnetism, Maxwell's equations in free space and linear isotropic media, boundary conditions on the fields at interfaces, Poisson's equation and Laplace's equation, Vector and scalar potentials, Lorentz and Coulomb Gauge, Gauge invariance, Lorentz invariance of Maxwell's equation, , Poynting's theorem and conservation of energy and momentum.

UNIT – II : Electromagnetic waves: **(14 Hours)**
Plane electromagnetic waves in non conducting medium, Electromagnetic waves in conductors, Solution of the wave equation by Green's function formalism, Reflection and refraction of electromagnetic waves at a plane surface between dielectrics, Linear and circular polarisation, Polarisation by reflection, Group velocity, Frequency dispersion characteristics of dielectrics, conductors and plasma, Kramer-Kronig Relation.
Waveguides: TE and TM modes in dielectric slab waveguides, cylindrical cavities and wave guide, modes in rectangular waveguide, resonant cavities.

UNIT – III : Radiation Systems: **(8 Hours)**

Fields and radiation of a localized oscillating source: electric and magnetic dipole fields and radiation, center fed linear antenna with sinusoidal current, scattering by a small dielectric sphere in long wavelength limit, Rayleigh Scattering.

UNIT – IV : Radiations by moving charges: **(8 Hours)**

Lienard - Wiechert potential and field due to a point charge, Field of a moving charge, Radiated power from an accelerated charge at low velocities, Larmour's power formula, Angular distribution of radiation from an accelerated charge, Thomson scattering of radiation.

UNIT – V : Relativistic Electrodynamics: **(8 Hours)**
The four vector notation, Lorentz transformation of particle kinematics, covariant formulation of Maxwell's equations, electromagnetic field tensor, covariant definitions of electromagnetic energy and momentum, transformation of electromagnetic field components.

Text Books:
1. Introduction to Electrodynamics - D.J. Griffiths, Pearson Education Ltd. 3rd Edition, New Delhi, 1991.
2. Classical Electrodynamics - J.D. Jackson, John & Wiley Sons Pvt. Ltd, New York, 2004.
3. Classical Theory of Electrodynamics - L.D. Landau and E.M. Lifshitz, Addison, Wesley, 3rd Edition, 1971.

Reference Books:
1. Introduction to Electrodynamics - A. Z. Capri and P.V.Panat, Narosa Publishing House 2010.
2. Classical electricity & Magnetism- Panofsky and Phillips, Addison Wesley, 2nd Edition, 1989
3. Classical Electromagnetic Radiation - J.B. Marion, Academic Press, New Delhi, 1995.
4. Classical Electricity and Magnetism - Wolfgang K. H. Panofsky and Melba Phillips, Dover Publications, 2nd Edition 2005

Course Outcome:

After completing this course the students should be able to :

1. Design of Maxwell's equation and their applications in electromagnetic potentials and Gauge transformations.
2. Explain the propagation of plane electromagnetic wave in different media.
3. Understand electromagnetic fields and radiation of a localized oscillating source (antenna).
4. Compute radiated power of moving charges in an electromagnetic field .
5. Formulate electrodynamic problems in relativistically covariant form in four-dimensional coordinates.

PH51104: QUANTUM MECHANICS-I

Credits: 04 **Teaching Scheme:** 05 Hrs/Week

Pre-Requisites: Knowledge of Historical development of Quantum Mechanics, Wave-particle duality, Schrodinger equation (time dependent and time independent).

Course Details:

Unit-I: General principle of Quantum mechanics (8 Hours)
Linear vector space formulation: Linear vector space (LVS) and its generality. Vectors: Scalar product, Basis vectors, Linear independence, Hilbert space formalism for quantum mechanics, Bra and Ket vectors, Dual space, Bra-Ket algebra, Linear superposition of general quantum states, Completeness and Orthogonal relation, Schmidt's orthonormalisation procedure.

Unit-II : Operator (12Hours)
Eigen value and Eigen vectors of Linear, Adjoint, Hermitian, Unitary, Inverse, Antilinear operators, Complete set of compatible operators, Simultaneous Measurement , Noncommutativity and uncertainty relation, Projection operator, Matrix representation of vectors and operators, Eigen value equation and Expectation value, Algebraic result on Eigen values, Transformation of basis vectors, Unitary transformation of vectors and operators, infinitesimal and finite unitary transformation, Continuous representation position and Momentum space wave function.

Unit-III : Quantum Dynamics (10 Hours)
Time evolution of quantum states, Time evolution of operators and its properties, Schrodinger picture, Heisenberg picture, Dirac/Interaction picture, Equation of motion, Conservation Laws, Operator method of solution of 1D Harmonic oscillator, Time evolution and matrix representation of creation and annihilation operators.

Unit-IV : Rotation and orbital angular momentum (12Hours)
Rotation matrix, Angular momentum operators as the generation of rotation, Components of angular momentum L_x, L_y, L_z and L^2 and their commutator relations, Raising and lowering operators (L_+ and L_-), L_x, L_y, L_z and L^2 in spherical polar co-ordinates, Eigen value and Eigen function of L_z, L^2(operator method), Spherical harmonics, matrix representation of of L_+, L_- and L^2, Spin angular momentum: Spin 1/2 particle, Pauli spin matrices and their properties Eigen values and Eigen function, Spinor transformation under rotation.
Total angular momentum (J), Eigen value problem of J_z and J^2, Total Angular momentum matrices.

Addition of angular momentum:
Addition of angular momenta and C.G. Coefficients, Angular momentum states for composite system in the angular momenta (1/2,1/2) and(1,1/2).

UNIT-V : Motion in Spherical symmetric Field (8 Hours)

Hydrogen atom, Reduction to one dimensional one body problem, Radial equation, Energy Eigen value and Eigen function, Degeneracy, Radial probability distribution.

Relativistic Quantum Mechanics: Klein-Gordon equation, drawbacks of Klein-Gordon equation, Dirac equation, Dirac gamma matrices, properties of Dirac gamma matrices (no derivation), Free particle solution of Dirac equation.

Text Books:
1. Quantum Mechanics Concepts and Applications - Nouredine Zettili, 2nd Edition, 2009.
2. Introduction to Quantum Mechanics- David J. Griffith, Cambridge University Press, 2nd Edition, 2004.
3. Lectures on Quantum Field Theory - Ashok Das, World Scientific, 2nd Edition, 2008.

Reference Books:
1. Quantum Mechanics - S. Gasiorowicz, Wiley, 3rd Edition, 2003.
2. Quantum Mechanics - J. J. Sakurai, J. Napolitano, Cambridge University Press , 2nd Edition, 2011.
3. Quantum Mechanics - R. Shankar, Springer, 2nd Edition, 2008.
5. Quantum Mechanics (Non Relativistic theory) - L.D. Landau and E. M. Lifshitz, Pergamon Press, 3rd Edition, 1977.
6. Introductory Quantum Mechanics, R. L. Liboff, Pearson Press, 3rd Edition, 2009.
7. Advanced Quantum Mechanics- J. J. Sakurai, Pearson Press, 1st Edition, 2006.

Course Outcome:

After completing this course the students should be able to :

1. Identify orthogonal and normalized basis vectors by applying the concept of bra-ket vectors of Hilbert space.
2. Apply quantum mechanical operators with their corresponding eigen value and proper interpretaion of unitary transformation associated with quantum mechanics.
3. Design the time evolution of quantum state with its conservation properties.
4. Use operator formalism of Quantum Mechanics to solve one dimensional harmonic oscillator problem.
5. Predict the orbital, spin as well total angular momentum operator and C.G. coefficients for a composite system.
6. Determine the eigen value and eigen function for Hydrogen atom in a spherically symmetric potential and for a free particle.

7. Outline the basic concept of relativistic Quantum Mechanics through Klein-Gordon and Dirac equation.

PH51205 : ELECTROMAGNETICS AND OPTICS LAB

Credits: 06 **Teaching Scheme:** 06 Hrs/Week

Experiment Details:

1. Determination of wavelength of monochromatic light by Michelson's Interferometer.
2. Estimation of thickness of air film between half silvered plates by Febryparot Interferometer.
3. Analysis of elliptically polarized light Babinet Compensator.
4. Determination of Brewster's angle of glass slab.
5. Verification of Malus' Law by rotating analyser.
6. Measurement of Magnetic field by current carrying coil.
7. Determination of charge of electron by Milikans oil drop experiment.
8. Estimation of charge to mass ratio (e/m) of the electron by Thomson's experiment.
9. Determination of magnetic properties from B-H curve of a given Ferromagnet.
10. Determination of Inductance and Capacitance by Maxwell's L/C Bridge.

Course Outcome:

After completing this course the students should be able to:

1. Understand the fundamental concepts of interference and polarization of light.
2. Determine the key electric and magnetism properties of materials .

PH51211 (GENERAL PHYSICS LABORATORY)

Credits: 04 **Teaching Scheme:** 04 Hrs/Week

Experiment Details:

1. Determination of Young's modulus of glass by Cornu's method.
2. Evaluation of the magnetic susceptibility of a paramagnetic solution using Quinck's tube method.
3. Evaluation of the magnetic susceptibility of a paramagnetic solution using Gouy's method.
4. Estimation of dielectric constant of a ferroelectric material by plate capacitor.
5. Determination of Hall coefficient of a semiconductor material using Hall apparatus.
6. Determination of Rydberg's constant by constant deviation spectrometer.
7. Determination of Surface tension of liquid by capillary rise method.
8. Find the thermal conductivity of material by Lee's Disc method.
9. Calibration of an oscilloscope.
10. Illustrate discrete energy levels of Argon by Frank Hertz experiment.

Course Outcomes:

After completing this course the students should be able to :

1. Evaluate the fundamental quantities of materials associated with mechanical, thermal, magnetic and dielectric properties.
2. Understand of basic knowledge of spectroscopy and associated transition in atomic spectra.
3. Understand the fluid characteristics such as surface tension by capillary method.
4. Acquire knowledge of construction and working principle oscilloscope through calibration.

SECOND SEMESTER

PH51106: CONDENSED MATTER PHYSICS

Credits: 04 **Teaching Scheme:** 05 Hrs/Week

Prerequisites: Basic knowledge on crystal structures and system.

Course Details:

Unit-I : Crystal structure (12 Hours)
Crystal Structure: Crystallographic Directions and Planes, Miller Indices, Inter Planner Spacing, Linear Density, planar density, Density Computation. Simple Cubic (SC), Face Centered Cubic (FCC), Body Centre Cubic (BCC) Structure, Wigner-Seitz Cell, Packing Fraction, Primitive Cell. Hexagonal Closed Packed (HCP) Structure: Packing Fraction, Unit Cell volume, NaCl, CsCl, Diamond, ZnS Structure.

X-Ray Diffraction: Bragg's Law, Scattering wave Amplitude, Reciprocal Lattice vectors. Diffraction Condition in reciprocal lattice, Laue Equation, Ewald Construction, Brillouin Zone, structure factor, Form Factor.

Unit-II : Lattice dynamics (10 Hours)
Phonons and lattice vibrations, Vibrations of monoatomic and diatomic lattices, dispersion, Optics & acoustic modes, Quantum of lattice vibrations and phonon, Phonon momentum, Inelastic scattering of neutron and photons by phonons, Thermal properties of insulators Lattice heat capacity, Debye & Einstein model, Anharmonic Crystal interactions, Thermal conductivity & thermal expansion.
Free electron Fermi gas:
Free electron gas in three dimensions, Heat capacity of electron gas, electrical and thermal conductivity of metals (Drude model).

Unit-III: Band theory and Semiconductor Physics (10Hours)
Electrons in periodic potential, Bloch theorem, Kronig Penney model, Origin of band gap, Effective mass of electrons, Density of states and Fermi-Dirac distribution function Thermal equilibrium
Equilibrium distribution of electrons & holes: Concentrations of electrons and holes, The np product (Intrinsic and Extrinsic), General theory of n and p, Energy-band diagram and Fermi-level, Variation of E_F with doping concentration and temperature. Carrier concentrations at extremely high and low temperatures: complete ionization, partial ionization and freeze-out.

Unit-IV: Dielectrics (10 Hours)
Introduction, Review of basic formulae, Dielectric constant and displacement vector -different kinds of polarization-local electric field-Lorentz field-Clausius-Mossatti relation- expressions for electronic, ionic and dipolar polarizability, Ferroelectricity and Peizo electricity (basic differences with applications).

Magnetism: Review of basic formulae -classification of magnetic materials-Langevin theory of diamagnetism, para-magnetism and Ferromagnetism –domains-Weiss molecular field theory (classical)-Heisenberg exchange interaction theory-. Antiferro-magnetism and ferrimagnetism (basic differences only).

Unit-V: Superconductivity (8 Hours)
Experimental survey, Meisners effect, Type-I & Type-II superconductors, Thermodynamics of superconductors, London theory, Josephson's effect, Basic concepts of cooper pairing in BCS theory, Ginz-Landau Theory, Applications of superconductors, High T_c superconductors and recent theories.

Text Books:
1. Introduction to solid state physics- C. Kittel, John Wiley & Sons, 8th edition, 2016
2. Solid State physics -A. Omar, Pearson, 1st edition, 2014
3. Semiconductor device: Physics and Technology: S. M. Sze, Wiley India Private Limited; 2nd edition, 2009.

Reference Books:
1. Principles of condensed matter physics- P.M. Chaikin and T.C. Lubensky, Cambridge University Press, 3rd Edition, 2000.
2. Solid state physics, S. O. Pilli, New Age International, 6th edition, 2006
3. Solid state physics- Dan Wei, Cengauge Learning, 1st edition, 2008.
4. Quantum theory of solid State -J.Callaway, Academic Press, 2nd Edition, 1991
5.Semiconductor Physics and Devices (Basic Principles), Donal A Neamen, Tata McGraw-Hill, 3rd Edition 2012.)

Course Outcome:

After completing this course the students should be able to:

1. Understand various aspects of materials related to crystallography.
2. Interpret phonon vibrations in various lattice and their effects in heat capacity of solid.
3. Analyse semiconductor behaviour under different conditions in fundamental research
4. Explain the dielectric and magnetic behaviour of novel materials and their applications.
5. Utilize the knowledge of fundamental aspects of superconductor to understand the recent advances in the field.

PH51107: QUANTUM MECHANICS-II

Credits: 04 **Teaching Scheme:** 05 Hrs/Week

Pre-Requisites: Operator formalism of solving one-dimensional harmonic oscillator, Eigen value and eigen function of hydrogen atom, Addition of angular momenta (C.G. Coefficients).

Course Details:

Unit-I: Approximation Method for stationary states (10 Hours)
Rayleigh Schrodinger Method for Time-independent Non degenerate Perturbation theory, First and second order correction, perturbed harmonic oscillator, Anharmonic oscillator, The stark effect, Quadratic Stark effect and polarizability, Degenerate perturbation theory, Removal of Degeneracy.

Unit-II ; Application of Time independent degenerate perturbation Theory to Hydrogen atom (10 Hours)
Parity selection rule, Linear stark effect of hydrogen atom, Spin orbit Coupling, Relativistic correction, Fine structure of Hydrogen like atom, Normal and anomalous Zeeman effect, The strong- field Zeeman effect, The weak-field Zeeman effect and Lande's g-factor. Elementary ideas about field quantization and particle processes

Unit-III: Variational and WKB- Methods (10 Hours)
General formalism, Application of variational method for 1D harmonic oscillator problem, Validity of WKB approximation method, Connection Formulas, Bohr quantisation rule, Application to Harmonic oscillator, Bound states for potential well with one rigid wall and two rigid walls, Tunnelling through potential Barrier, Alpha Decay and Gamow's factor, Cold emission.

Unit-IV: Time dependent perturbation Theory (10 Hours)
Transition probability, Constant and harmonic perturbation, Fermi golden rule and Electric dipole Radiation and Selection Rule, Spontaneous emission. Basic principle of LASER and MASER

Unit-V: Scattering Theory (10 Hours)
Scattering amplitude and Cross section, Born approximation, Application to Coulomb and Screened Coulomb potential, Partial wave analysis for elastic and inelastic Scattering. Effective range and Scattering length, Optical theorem, Black Disc Scattering, Hard sphere Scattering.

Text Books:

1. Quantum Mechanics Concepts and Applications - Nouredine Zettili, 2nd Edition 2009.
2. Introduction to Quantum Mechanics- David J. Griffith, Cambridge University Press, 2nd Edition, 2004.
3. Quantum Mechanics - A. Ghatak and S. Lokanathan, Kluwer Academic Publisher, London, 5th Edition, 2004.

Reference Books:

1. Quantum Mechanics - S. Gasiorowicz, Wiley, 3rd Edition, 2003
2. Quantum Mechanics - J. J. Sakurai, J. Napolitano, Cambridge University Press, 2nd Edition, 2011
3. Quantum Mechanics - R. Shankar, Springer, 2nd Edition, 2008.
4. Quantum Mechanics (Non Relativistic theory) - L.D. Landau and E. M. Lifshitz, Pergamon Press, 3rd Edition, 1977
5. Introductory Quantum Mechanics, R. L. Liboff, Pearson Press, 3rd Edition, 2009.

Course Outcomes:

After completing this course the students should be able to:

1. Understand non-exact solutions for stationary states through time independent non-degenerate perturbation theory.
2. Interpret the non-exact problems pertaining to stark effect and Zeeman Effect by the knowledge of time independent degenerate perturbation theory.
3. Determine Eigen value of non exact solutions by applying Variational and WKB-approximation method.
4. Apply the concept of lasing action for LASER and MASER by time dependent perturbation theory.
5. Identify scattering cross-section for a scattering system by using partial wave analysis of elastic and inelastic scattering.

PH51108: STATISTICAL PHYSICS

Credits: 04 **Teaching Scheme:** 05 Hrs/Week

Pre-requisites: Basic concepts of theory of Thermodynamics and Probabilistic approach of Quantum Mechanics.

Course Details:

UNIT-I : Classical statistical mechanics (12 Hours)
Binomial Distribution of probability, Poisson's Distribution, Gaussian distribution, Random walk problem, Phase space,Macroscopic and Microscopic states,Statistical ensemble,Liouvilles theorem, Micro canonical Ensemble,Equi-partition theorem, Classical ideal gas, Gibbs paradox.

UNIT-II Canonical and Grand Canonical ensemble (10 Hours)
Canonical ensemble, Probability distribution, Partition function, Calculation of thermodynamic parameter, Classical Ideal gas and energy fluctuation

Grand canonical ensemble, the chemical potential, Probability distribution,Partition function,Calculation of thermodynamic parameter and gas equation, density fluctuation

UNIT-III: Quantum statistical mechanics (10 Hours)
The density matrix, Ensembles in quantum mechanics: Micro canonical Ensemble, Canonical Ensemble and Grand Canonical Ensemble, Ideal gas: micro canonical and grand canonical ensemble, Equation of state for Bose gas and Fermi gas

UNIT-IV: Bose and Fermi gas (10 Hours)

Photons, phonons, Debye-specific heat, electronic specific heat, Bose-Einstein Condensation,

Fermi energy, Ground state, Low temperature properties, Mean energy of fermions at absolute zero, Theory of White – Dwarfs (without derivation)

UNIT-V : Phase Transition and Ising model (8 Hours):
Thermodynamics description of Phase Transitions, Phase Transitions of second kind, Landau theory of phase transition beyond mean field, Definition of the Ising model, one dimensional Ising model.

Text Books:

1. Statistical physics, K. Huang, 2nd edition, Willy Student edition 2014.
2. Fundamental of statistical & thermal physics, F. Reif, 1st Indian edition, Levant Books, 2010.
3. Fundamental of statistical mechanics, B. B. Laud, 2nd Edition, New age international Pvt. Ltd, 2012.

Reference Books:

1. Statistical physics, Landau and Lifsitz, 3rd Edition, Pergamon Press, 2013
2. Elementary statistical physics, C.Kittel, John Wiley & Sons, Inc.2008.
3. Statistical mechanics - A set of lectures, R.P.Feynman, The Benjamin publishing company, Inc. (2008)
4. Introduction to Statistical Physics, Kerson Huang, Taylor & Francis, 2002.

Course Outcomes:

After completing this course the students should be able to:

1. Understand the concept of statistical physics and thermodynamics as logical consequences of the postulates of statistical mechanics.
2. Interpret the concept of types of ensembles and calculation of general probability statements for variety of situation of physical interest.
3. Analyze the problems involving gases at low temperature or high densities and problems encountered in connection with the indistinguishable particles.
4. Apply Fermi-Dirac and Bose-Einstein statistics to different physical systems.
5. Apply different model for phase transitions through statistical techniques to simulate the structure of a physical substance.

PH51109: NUMERICAL METHODS AND COMPUTATIONAL TECHNIQUES

Credits: 03 **Teaching Scheme:** 04 Hrs/Week

Pre-requisites: Basic concepts of mathematical operations associated with determinants and Matrix.

UNIT-I : Root Finding (8 Hours)

Errors and approximations in Numerical Computation, significant digits, Numerical solution of algebraic and transcendental equations by simple iteration method, Bisection method, Regula-falsi method (method of false position), Newton-Raphson method .

UNIT-II : Systems of Equations (8 Hours)
Solution of simultaneous linear system of equations by Cramer's Rule, Gauss-elimination method, Gauss-Jordan method, Matrix inversion by Gauss-Jordan method, Iterative method for solving linear equations by Gauss-Jacobin and Gauss-Seidel method, Methods for solution of Eigen value problems.

UNIT-III : Interpolation (8 Hours)
Newton's forward and backward interpolation formulae, Lagrange's interpolation formula, Newton's divided difference formula, Inverse interpolation, Newton's forward and backward interpolation formula,

UNIT-IV : Numerical Differentiation and Integration (8 Hours)
Numerical integration by Trapezoidal rule, Simpson's rule, Gaussian quadrature formulae (2-point,3-point and 4-point), Numerical solution of ordinary differential equation using Taylor Series method, Euler method, Modification of Euler's method, Picard's method, Runge-Kutta method of order two and four,

UNIT-V : Computational Methods (8 Hours)
Introduction to Unix, C/C++ Programming, Fortran and MATLAB, Latex, Elementary treatment of Monte Carlo Method, Solutions to Nonlinear Equations.

Text Books:
1. "Numerical methods in Science and Engineering: a practical approach", S. Rajasekaran, S. Chand and company Ltd., New Delhi, (2013).
2. "Numerical Methods for Engineers", Steven Chapra and Raymond Canale, McGraw-Hill, 6th edition (2009).
3. "Introductory methods for Numerical Analysis", S. S. Sastry, , PHI publication 5th Edition (2012),
4. "C Programming", E. Balagurusamy, 6th Edition, Tata McGraw-Hill (2010)

Reference Books:
1. Numerical Methods for Mathematics, Science and Engineering, J. H. Mathews, , PHIPrentice-Hall India, 2nd Edition, (2005)

2. Introduction to MATLAB 7.4, J Palm William III, Tata Mc Graw-Hill Publications, New Delhi, 2nd edition (2004)
3. Computer Programming in Fortran 77, V. Rajaraman, PHI Learning Pvt. Ltd (1997).
4. Rudra Pratap-"Getting Started With Matlab: A Quick Introduction For Scientists And Engineers, Oxford University Press, 7th Edition (2016)

Course Outcome:

After completing this course the students should be able to:

1. Understand the implications of error and approximations.
2. Apply numerical techniques to solve linear equations.
3. Apply techniques to solve systems of equations using typical matrix methods.
4. Apply the basic of interpolation techniques.
5. Compute numerical differentiation and integration using interpolation.
6. Compile algorithm for solving various numerical problems.

PH51210: NUMERICAL METHODS AND COMPUTATIONAL TECHNIQUES LABORATORY

Credits: 03 **Teaching Scheme:** 03 Hrs/Week

Experiment Details:

1. Write a program for transpose of a square matrix.
2. Write a program for solution of quadratic equation.
3. Write a program to solve simple algebraic equation by Newton- Raphson Method.
4. Write a program to solve a transcendental equation using Bi-section method.
5. Write a program to solve simultaneous linear system of equations by Gauss - elimination method.
6. Write a program to solve simultaneous linear system of equations by Gauss- Jordan method.
7. Write a program to solve numerical integration by Trapezoidal method.
8. Write a program to solve numerical integration by Simpson’s method.
9. Write a program to solve ordinary differential equation by Runge-Kutta Method.
10. Write a program to solve ordinary differential equation by Eulers Method.

Course Outcome:

Design stable algorithms for solving numerical problems using various techniques.

PH61223: MODERN PHYSICS LAB

Credits: 06 **Teaching Scheme:** 06 Hrs/Week

Experiment Details:

1. Measurements of Lande splitting factor using electron spin resonance spectrometer.
2. Determination of the resistivity of semiconductor by Four-probe method.
3. Estimation of excitation potential of Argon by Franck-Hertz Experiment.
4. Determination of mobility of a semiconductor by Hall apparatus.
5. Evaluation of dielectric constant and curie temperature of ferroelectric ceramics
6. Estimation of energy band gap and diffusion potential of PN junction.
7. Determination of Planck's constant by total radiation method
8. Verification of Richardson's $T^{3/2}$ law.
9. Verification of
   (i) Plateau Characteristics
   (ii) Inverse Square law
   (iii) Absorption co-efficient of beta-ray and gamma-rays in Aluminium foils
   (iv) Dead time characteristics by single source and double source methods.

   Using GM counter.
10. Determination of vibrational frequencies of stokes and antistokes line of given sample using Raman spectroscopy.

Course Outcome:

CO: Knowledge on semiconductor physics, magnetism, dielectric, atomic and molecular physics.