M.Sc. I Semester - I

1PHY-1: MATHEMATICAL PHYSICS

UNIT-I : Matrix Algebra :- Vector spaces and transformations, the algebra of matrix, partitioning of matrices. The eigen value problem. Functions of aMatrix, Kronecker sum and product of matrices, Matrices in classical and quantum mechanics.

UNIT-II : The Complex Variables : Complex variables and their representation, functions of a Complex variable, Analyticity, Harmonic functions, Cauchy's integral theorem and integral formula, series expansion, Taylor and Laurent series, Residue theorem.

UNIT-III : Differential Equations of the Second Order : Linear differential equation with variable coefficients, Series, Solution, The Legendre equation, Legendre function of the second kind, Generating function, Rodrigue's formula, Orthogonality of generating functions, Recurrence relations.

UNIT-IV : Bessel Differential Equation : Bessel's function of the third kind (Hankel function), Generating function, Recurrence relations, Orthogonality of bessel;s function, Hermite differential equation, Hermite polynomials, Generating function, Recurrence relations, Rodrigue's formula, Orthogonalaity of Hermite Polynomials.

UNIT-V : Integral Transforms : Laplace Transforms - Properties of Laplace transform, differential equation method of finding Laplace transform, Inverse Laplace transform. Fourier Transforms – Fourier Series, properties of Fourier Series, Fourier integral, Fourier transform of derivatives, Applications of Fourier transform.

Reference Books :

1. Matrices and Tensors in Physics (2nd Edition), A.W.Joshi, Wiley Eastern Limited.
2. Mathematical Physics, Satya Prakash, S.Chand & Sons.
3. Mathematical Physics, Kalani and Hemrajani, Himalaya Publishing House.
4. Introduction to Mathematical Physics, Charlie Harper, Prentice Hall India Pvt.Ltd.
5. Mathematical Physics (17th Edition), B.S.Rajput, Pragati Prakashan, Meerut.
6. Mathematical Physics, Sisodia, Kachava, Khamesra, Dashora Ramesh Book Dept., Jaipur.
7. Mathematical Physics, P.K.Chottopadhyay, New Age International (P.) Ltd.
8. Mathematical Physics, (2nd Rev.Edition), B.D.Gupta, Vikas Publishing House, New Delhi.
9. Mathematical Methods for Physics George Arfken Wiley Eastern
10. Mathematical Physics Vol. 1 & 2, Joglekar University Press.
11. Laplace Transform Seymour, Lipschutz, Schaum Outline Series
12. Fourier Series Seymour, Lipschutz, Schaum Outline Series

1PHY-2 : CLASSICAL MECHANICS

UNIT-I : Elementary survey of Classical Mechanics: Newtonian mechanics for single particle and system of particles, Types of the forces and the single particle system examples, Limitation of Newton's program, conservation laws viz Linear momentum,

Angular Momentum & Total Energy, work-energy theorem; open systems (with variable mass). Principle of Virtual work, D'Alembert's principle' applications,
UNIT-II : Constraints; Definition, Types, cause & effects, Need, Justification for realizing constraints on the system, Difficulties introduced by imposing constraints on the system, Examples of constraints, Introduction of
generalized coordinates justification. Lagrange's equations; Linear generalized potentials, Generalized coordinates and momenta & energy; Gauge function for Lagrangian and its gauge invariance;.
UNIT-III : Cyclic coordinates, Integrals of the motion, Concepts of symmetry, homogeneity and isotropy, Invariance under Galilean transformations Hamilton's equation of motion: Legendre's dual transformation, Principle of least action; derivation of equations of motion; variation and end points; Hamilton's principle and characteristic functions; Hamilton-Jacobi equation.
UNIT-IV : Central force: Definition and properties, Two-body central force problem, closure and stability of circular orbits; general analysis of orbits; Kepler's laws and equation,Classification of orbits, diffential equation of orbit, Varial Theorem.
UNIT-V : Canonical transformation; generating functions; Properties; group property; examples; infinitesimal
generators; Poisson bracket; Poisson theorems; angular momentum PBs; Transition from discret to continuous
system, small oscillations (longitudinal oscillations in elastic rod) ; normal modes and coordinates

Reference Books.

1. Classical Mechanics, by N C Rana and P S Joag (Tata Mc-Graw-Hill, 1971)
2. Classical mechanics, by H Goldstein (addison Wesley, 1980)
3. Mechanics, by A Sommerfeld (Academic Press, 1952)
4. Introduction to Dynamics, by I Perceival and D Richards (Cambridge Univ. Press. 1982).
5. Classical Mechanics by J.C.Upadhaya (Himalaya Pub).
6. Classical Mechanics by Waghmare (West Wiley)
7. Mathematical Physics - by B.D.Gupta (Vikas Pub.)

1PHY-3 : QUANTUM MECHANICS-I

UNIT-I : Review of (i) failure of classical ideas – photoelectric effect, Compton effect, blackbody radiation, atomic spectra, (ii) wave-particle duality, (iii) Heisenberg uncertainty relation and (iv) wave function; Schrodinger's equation, probability, probability current and continuity equation; Wave packets,
minimum uncertainty Gaussian wave packets, group velocity and dispersion, simple one-dimensional problems
– infinite and finite potential wells, tunneling probabilities; One-dimensional harmonic oscillator.

UNIT-II : General formalism of quantum mechanics – linear vector spaces and operators; Representations of states and dynamical variables; Hermitean operators, eigenstates and eigenvalues, completeness of eigenstates; Dirac bra and ket notation, matrix representation of operators; Change of bases and unitary transformations; Diagonalization of the hamiltonian.
UNIT-III : Simple harmonic oscillator using energy representation - raising and lowering operators; Angular momentum and central forces; Representation of angular momentum operators and hamiltonian in spherical coordinates; Hydrogen electron wave functions and energy states - principal, orbital and magnetic quantum numbers, Laguerre polynomials and spherical harmonics; Spatial nature of hydrogen electron orbitals.
UNIT-IV: Pauli spin matrices, angular momentum algebra; Simultaneous eigenstates of L2 and Lz, L+ and L- operators; Addition of angular momenta; Application to spin-orbitals of hydrogen, Clebesch-Gordan coefficients, examples of simple cases.
UNIT-V : Symmetry and constants of motion, time evolution, commutators, complete sets of commuting physical observables; Schrodinger, Heisenberg and Interaction Pictures; Variational principle, Helium atom, WKB approximation, slowly varying potentials.

Books

1. Quantum Mechanics, L I Schiff.
2. Quantum Mechanics, Eugene Merzbacher (John-Wiley, 3rd Ed, 2005)
3. Quantum Mechanics, P M Mathews and K Venkatesan (Tata- McGraw Hill, 1976)
4. Quantum Physics, S. Gasiorowicz (John-Wiley)
5. Quantum Mechanics, L. D. Landau and E. M. Lifshitz

1PHY-4 COMPUTATIONAL METHODS AND PROGRAMMING

UNIT -I : Methods for determination of zeroes of linear and nonlinear equations and transcendental equations, convergence of solutions. Solution of simulataneous linear equations, Gauss elimination, Pivoting, Iterative method, Matrix inversion.
UNIT-II : Eigen values and Eigen vectors of matrices, Power and Jacobi methods.Finite differences, Interpolation with equally spaced and unevenly spaced points, curve fitting, Least squares fitting, Cubic spline fitting. Numerical differentiation and integration, Newton-Cotes formulae, Error estimates, Gauss methods
UNIT-III : Random variate, Monte Carlo evaluation of integrals, Methods of importance sampling, Random walk and metropolis methods. Numerical solution of ordinary differential equations, Eular and Runge Kutta methods, Predictor and Corrector methods, Elementary ideas of solutions of partial differential equations.
Unit-IV : Introduction to programming and study of logic. Elementary information about digital computer principles, compilers, interprets and operating system. C-Programming, Flow charts, C character set, Identifiers and key words, Data types, Declarations, Expressions, statements and symbolic constants, input output statements,

Pre-processors commands, storage types, automatic external, register and static variables.

Unit-V : Operators and Expressions : Arithmetic, unary, logical, bitwise, assignment and conditional operators. Control statements : While, do-while for statements. Nested groups. If-else, switch, break, continue and goto statements, comma operators. Arrays : Defining and processing. Passing arrays to a function. Multidimensional arrays, Functions : Defining and accessing. Passing arguments. Function Prototypes. Recursion. Library functions. Static functions.

TEXT AND REFERENCES BOOKS

1. Introductory methods of numerical analysis Sastry
2. Numerical analysis Rajaraman
3. Computer oriented numerical methods Rajaraman
4. A first course in computational Physics, Paul L. DeVries & Javier E. Hasbun (Jones & Barlett Pub.
5. Mastering C by Venugopal, Prasad, TMH.
6. Complete reference with C, Tata McGraw Hill.
7. C Programming, E-Balagurusamy, Tata McGraw Hill.
8. Schaums outline of theory and Problems of programming with C. Gottfried.
9. Let us C by Kanetkar.

1PHY-5 : LABORATORY COURSE -1

It is necessary to perform atleast seven experiments from the list given below.
The experiments based on theory course are desirable.

1) Develop and execute a program to obtain volumes and areas of regular bodies and figures.
2) Develop and execute a program to convert temperature from one system to other system (at least three).
3) Develop and execute a program to fit a straight line to experimental data.
4) Develop and execute a program to fit exponential function to experimental results.
5) Develop and Execute a program to obtain integral of a tabular function.
6) Develop and execute a program to obtain inverse of a matrix.
7) Develop and execute a program to obtain roots of a polynomial by
a) Newton-Raplson Method and b) Bisection Method.
8) Develop and execute a program to obtain product of two matrices.
9) Develop and execute a program to obtain solution of differential equation by a) Euler and B) Runge Kutta Method.
10) Develop and execute a program to obtain value of an equation using subroutine.

1PHY-6 : LABORATORY COURSE -2

It is necessary to perform atleast seven experiments from the list given below.
The experiments based on theory course are desirable.

1) Measurement of wavelength of He-Ne laser using ruler

2) Measurement of thickness of a thin wire using laser.
3) To study the Faraday effect using He-Ne laser.
4) Experiments using Babinator.
5) Develop and Execute a program to obtain integral of a function.
6) To measure the intensity distribution across the laser beam.
7) To study the florescence spectrum of a dye
8) Study of Electron spin resonance spectrometer.
9) Determination of h/e by using photocell.
10) Chi-square test
11) To determine Range of Beta particles in Aluminium.
12) Random nature of radioactivity.
13) Determination of wavelength of sodium light using Fabry Perot Etalon.