PHY-CC-101- Classical Mechanics **Credits: 04**
L 3 P 0 T 1

UNIT I

Mechanics of a system of particles– Conservation laws of linear momentum, Angular momentum and energy of a particle and body, Energy equation and the total potential energy of a system of particles.
The Langrangian Formalism- Constraints and their classifications, Generalized coordinates. Virtual displacement, D'Alembert's principle and Lagrangian equations of motion with few examples.
Force field- Two-body central force problem, Kepler's problem and scattering by a central field. Exercises.

UNIT II

Hamilton's variational principle, Hamilton's Canonical equations of motion, Examples (i) the simple harmonic oscillator. (ii) Hamiltonian for a free particle in different coordinates (iii) Hamiltonian for electromagnetic force (iv) coupled oscillators. Cyclic coordinates. Physical significance of the Hamiltonian function. Derivation of Hamilton's equations from variational Principle and Lagrange's equations.

UNIT III

Equations of canonical transformations, properties and generating functions of four special type of canonical transformations examples of Canonical transformations, Poisson brackets; properties of Poisson brackets, angular momentum and Poisson bracket relations. Equation of motion in the Poisson bracket notation. Invariance of P.B. under canonical transformations.
The Hamilton-Jacobi equation, example of the harmonic oscillator treated by the Hamilton-Jacobi method.

UNIT IV

Mechanics of rigid bodies: Degrees of freedom of a free rigid body, Angular momentum and kinetic energy of rigid body, Moment of inertia, principal moments of inertia, products of inertia, the inertia tensor. Euler equations of motion for a rigid body. Torque free motion of a rigid body. Euler angles, angular velocity of a rigid body.
Small Oscillations: General formalism, Eigen-value equation, normal coordinates and normal modes.

Suggested References:

1. Classical Mechanics by N.C. Rana and P.S. Joag (Tata McGraw-Hill, 1991)
2. Classical Mechanics by H. Goldstein (Addison Wesley, 2000)
3. Mechanics by L.D. Landau and E. M. Lifschz (Pergamon, 1976)
4. Classical Mechanics of Particles and Rigid Bodies by K. C. Gupta (John Wiley, 1988)
5. Classical Dynamics of particles and systems Marrion and Thornton.
6. An introduction to Mechanics, Daniel Kleppner and Robert Kolenkow, Cambridge University Press
7. Upadhaya J.C., Classical mechanics, Himalaya Publishing House, Mumbai. 2006.
8. Analytical Mechanics by Louis N. Hand and Janet D. Finch, Cambridge University Press

PHY-CC- 102-Mathematical Methods in Physics

Credits:04
L 3 P 0 T 1

UNIT I

Vector analysis: The gradient, divergence and Gauss's theorem (No proof, applications only) curl of a vector field and Stoke's theorem (No proof, applications only), Orthogonal curvilinear coordinates, tangent and normal vectors, Gradient, Curl, divergence and Laplacian in spherical and cylindrical polar co-ordinates.
Matrices: Vector Spaces, Linear dependence and independence, Bases, dimensionality, linear transformations, inverse of matrices, similarity transformations, System of linear equations (Particular cases and General), The Eigen value problems.

UNIT II

Fourier series and Integral Transforms

Fourier Series: Definition, Properties, Convergence, Application of Fourier series, Fourier Integral and Fourier transform and inverse Fourier transform, Convolution theorem, Parseval's theorem, Laplace transform and its properties, convolution theorem, inverse Laplace transforms, solution of differential equations using Laplace transforms, Fourier transform & Laplace transform of distributions

UNIT III

Differential equations

Regular and irregular singular points of a second order ordinary differential equation. Series solutions– Frobinius method. Series solution of Bessel, Lauguerre, Hermite and Legendre differential equations. Recurrence relations, generating functions and Rodrigue's formula, series expansion of an arbitrary function. The gamma and beta function. Definition and properties.

UNIT IV

Complex Analysis

Functions of a complex variable, Analytic functions, Cauchy-Riemann relations, Conjugate and harmonic nature of the real and imaginary parts of an analytic function, Cauchy's theorem, Cauchy's integral formula, Taylor and Laurent expansions, classification of singularities, residue theorem, Evaluation of definite integrals, The Point at Infinity; Residues at Infinity, Dispersion relations and causality, method of steepest descents

Suggested References

1. Applied Mathematics for Engineers and Physicists by Pipes and Harvill. III Edition Mc Graw Hill International Book Company (1970).
2. Matrices and Tensors in Physics - A.W. Joshi. II Edition. Wiley Eastern Ltd.
3. Mathematical Physics - Eugene Butkov. Addision - Wesley-Publishing company
4. Mathematical Physics for Physicists - George B. Arfken and Hans J. Weber. Fourth Edition. Prism Books Pvt. Ltd., Bangalore (1994)
5. Mathematical physics by M L Boas.Wiley publishers
6. Vector analysis by Murry R spigel. Schaums outline.

PHY-CC-103-Quantum Mechanics I **Credits: 04**
L 3 P 0 T 1

UNIT I

Review: Inadequacy of classical Physics, wave packets and uncertainty relations. Wavefunctions, probability densities, probability current, Schrodinger equation, Expectation values, One dimensional potential problems- Particle in a box, Potential barriers, Tunnelling. Linear harmonic oscillator (one and three Dimensional).

UNIT II

General formalism of Quantum Mechanics

Postulates of quantum mechanics: Representation of states and dynamical variables, observables, self-adjoint operators, eigen functions and eigen values, degeneracy, Dirac delta function, Completeness and closure property, Physical interpretation of eigen values, eigen functions and expansion co-efficients, eigen values and eigen functions of momentum operator.

Linear vector spaces, elements of Hilbert space, Dirac's bra-ket notation, dynamical variables and linear operators, projection operators, unit operator, Hermitian and unitary operators, matrix representation of an operator, change of basis, unitary transformation. Eigen values and eigen functions of simple harmonic oscillator by operator method.

Time development of a quantum mechanical system, Schrödinger, Heisenberg and interaction pictures, Heisenberg's equation of motion.

UNIT III

Angular Momentum:

Angular Momentum- Orbital, Spin and total angular momentum operators. Eigen values and eigen functions of L2 and Lz operators, ladder operators L+ and L-, Pauli spin matrices, their Commutation relations, angular momentum as a generator of infinitesimal rotations, matrix representation of J in lj,m> basis. Addition of angular momenta, Computation of Clebsch-Gordon co-efficients in simple cases (J1=1/2, J2=1/2), Hydrogen atom, Stern-Gerlach experiment

UNIT IV

Identical Particles

Many particle systems, systems of identical particles, ex-change degeneracy, symmetrization postulate, construction of symmetric and anti-symmetric wave functions from unsymmetrized functions. The Pauli Exclusion Principle.

Suggested References

1. A Text-book of Quantum Mechanics by P.M.Mathews and K.Venkatesan.
2. Quantum mechanics by A.Ghatak and S.Lokanathan
3. Quantum Mechanics by L.I.Schiff
4. Modern Quantum mechanics by J.J.Sakurai
5. Quantum Mechanics by L.D. Landau and E. M. Lifschz (Pergamon)
6. Introduction to Quantum Mechanics by by David J.Griffiths
7. Introductory Quantum mechanics by Granier, Springer Publication.

PHY-CC-104-LAB I **Credits: 04**
L 0 P 4 T 0

The list for experiments is as given below. The students will have perform at least 08 experiments:

1. To study the characteristics and dead time of a G.M. Counter
2. Hall Effect

   Determination of Hall Voltage and RH

   Determination of mobility of charge carriers and carrier concentration
3. To determine the Wavelength of laser by Fresnel Biprism
4. To determine the band gap of semiconductor from temperature dependence of resistivity using Four Probe Method
5. To determine e/m by Thomson /Helical Method
6. To study Meissner Effect
7. Experiments with Phoenix kit
8. To determine Plank's Constant (Photo Cell method)
9. Michelson Interferometer
10. To study Attenuation coefficient using GM Counter
11. Study of Lissajous Figures
12. To design and study the characteristics of BJT
13. To design and study the characteristics of FET
14. To design and study of Operational amplifier (IC-741): summer, inverting/non-inverting amplifier.

PHY-DCEC-101-Electronics **Credits: 04**
L 3 P 0 T 1

UNIT I

Semiconducting Materials, conduction in semi-conductors, equilibrium charge carrier concentrations in intrinsic semiconductors and extrinsic semiconductors, Fermi energy in intrinsic and extrinsic semiconductors, diode built in voltage, junction capacitance,
PN junction diode, diode equation, zener diodes, Zener and avalanche breakdowns, tunnel diode, LED, varactor diode, Schottky barrier, Laser diode, Photodiodes and Solar cell. High frequency devices: Gunn diode, IMPATT diode.

UNIT II

Fundamentals of operation of UJT and BJT, Analysis of CE amplifier using h-parameters, The T-network equivalent circuit, constants of CB and CE amplifier using emitter, base, collector resistance, Biasing technique to BJT, stabilization factor, temperature stabilization, operating point, fixed bias, emitter feedback bias, voltage feedback bias.
Field Effect Transistors (FET) and MOS-FET: Structure, Working, Derivations of the equations for I-V characteristics under different conditions.

UNIT III

Feedback Principle Negative feedback, effect of negative feedback on input/output resistances, voltage gain, gain stabilization, band width, voltage series feedback, voltage shunt feedback applied to BJT.
Oscillators: Oscillator operation, Phase shift Oscillator, Wien-bridge Oscillator, Hartley Oscillator.

UNIT IV

Block diagram of an operational amplifier – Characteristics of an ideal operational amplifier – comparison with 741 – Operational amplifier as a open loop amplifier - Limitations of open loop configuration – Operational amplifier as a feedback amplifier: closed loop gain, input impedance, output impedance of inverting and non-inverting amplifiers - Voltage follower - Differential amplifier: voltage gain. Applications of op-amp: Linear applications– Phase and frequency response of low pass, high pass and band pass filters(first order), summing amplifier– inverting and non-inverting configurations, subtractor, difference summing amplifier, Integrator. Non–linear applications: comparators, positive and negative clippers, positive and negative clampers

Suggested References

1. John D. Ryder, Electronic Fundamentals and Applications.
2. Millman and Halkins; Electronic Devices and Circuits
3. Ben G. Streetman : Solid State Electronic Devices
4. Boylested and Nashelsky; Electronics Devices and Circuit theory
5. Gaekwad R.A., Operational amplifiers and linear integrated circuits, Prentice-Hall of India,New Delhi, 1993.
6. Malvino A.P. and Leach D.P., Digital principles and applications, 4th Edn.

PHY-DCEC-102-Computational Physics **Credits: 04**

L 3 P 0 T 1

Unit I

Stochastic Processes:

Theory of random walks and simulation of random walks in one, two and three dimensions. Elementary idea sand simulations of self-avoiding walks, additive and multiplicative stochastic
processes, Brownian motion and fractional Brownian motion.

Uit II

Percolation theory:

Percolation theory and simulation by Hoshen-Kopelman algorithm; Application to simple lattice models in Physics.

Unit III

Simulations of physical models:

Elementary ideas of: (a) Time-average and Molecular dynamics; Dynamical equations and physical potentials; Verlet algorithm (b) Ensemble average and Monte Carlo methods; Metropolis algorithm.
Introduction to the simulations of: (a) Ising model in magnetism (b) Bak-Tang-Wiesenfeld model in studies of self-organized criticality.

Unit IV

Combinatorial optimization problems:

Classification of problems; examples of optimization problems: traveling salesman problem (TSP) and satisfiability (k-SAT) problem; heuristic methods of solutions and simulated annealing technique.

Suggested References

1. D. Frenkel & B. Smit, Understanding Molecular Simulation.
2. D. Stauffer, Introduction to Percolation Theory.
3. M. Plischke & B. Bergersen, Equilibrium Statistical Physics.
4. W. H. Press, B. P. Flannery, S. A. Teukolsky and W. T. Vetterling, Numerical recipes in C: The Art of Scientific Computing.