M.Sc-I SEMESTER

Total Teaching Hours=50

Course PHCT 1.1: Mathematical Methods of Physics and Computer Programming – I

Unit I **13 hrs**

Special functions:

Helmholtz equation, separation of variables in sperical and cylidrical coordinates, series solutions – Frobenius method. Legendre functions: Legendre polynomials, Rodrigue's formula; generating function and recursion relations; Orthogonality and normalization; associated Legendre functions, spherical harmonics. Bessel functions : Bessel functions of the first kind, recursion relations, Orthogonality

Hermite functions:

Hermite polynomials, generating function, recursion relations; Orthogonality.

Laguerre functions:

Laguerre and associated Lauguerre polynomials, recursion relations; Orthogonality. Applications of special functions to problems in physics.

Unit II **12 hrs**

Matrices:

orthogonal, Hermitian, and unitary matrices; Eigenvectors and Eigen values, digitalization of matrices, Matrix representation of linear operators, Eigenvalues and Eigenvectors of operators, simultaneous Eigen vectors and commutativity, applications to physical problems

Integral Transforms :

Fourier transform: Definition, Fourier integral; inverse transform; Fourier transform of derivatives; convolution, Parseval's theorem; applications.

Laplace Transform :

Definition and properties, Laplace transform of elementary functions, laplace transform of derivative and integral of a function, laplace transform of Dirac Delta function, Convolution theorem.

Inverse Laplace Transform by partial fraction expansion :

Linear unrepeated and repeated factors. Application of Laplace Transform for solution of differential equations and problems in physics.

Unit III **12 hrs**

Tensors:

Coordinate transformation in linear spaces, curvilinear coordinates and their transformation; definition and types of tensors, contravariant and covariant tensors, symmetric and anti symmetric tensors, Tensor algebra : equality, addition and subtraction, tensor multiplication, outer product; contraction of indices, inner product, quotient theorem, Kronecker delta, lowering and raising of rank of tensors, the metric tensor**;** Christoffel symbols. Tensors in physics**.**

Unit IV **13 hrs**

Programming in C :

Basic structure of C Programming, keywords and identifiers, constants, variables, data types, declaration of variables, Assigning values to variables, Defining symbolic constants. Operators :Arithmetic, Relational, Logical, Assignment, Increment and decrement operators, Conditional, Arithmetic expressions, Operator precedence and associatively, Mathematical functions, Formatted input and output statements. Decision making (Branching and looping) with IF, IF. ELSE, ELSE..IF ladder, switch, GOTO, WHILE, DO and FOR statements. One and two dimensional arrays, C Functions and their types, category and calling of a function, integer and non-integer, function, Programming on numerical methods

Text Books

1. Mathematical Methods for physicists (4th edition) : George Arfken & Hans J. Weber, Academic Press, San Diego (1995).
2. Mathematical Methods in Physical Sciences (2nd edition): Mary L. Boas, John Wiley & Sons, New York (1983).
3. Mathematical Physics : P. K. Chatopadhyay, Wiley Eastern Ltd., New Delhi (1990).
4. Introduction to Mathematical Physics: Charlie Harper, Prentice-Hall of India Pvt. Ltd., New Delhi (1995)
5. Matrices and Tensors in Physics (3rd edition): A.W. Joshi, New Age International (P) Ltd. Publishers, New Delhi (2000).
6. Elements of Group Theory for Phyicists(3rd Edition): A.W.Joshi.,Wiley Eastern limited (1982).
7. Programming in ANSI – C (2nd Edition) : E. Balgurusamy, Tata McGraw – Hill Pub. Company, New Delhi (1992).

Reference Books :

1. Mathematical Methods for Physics and Engineering : K. F. Riley, M. P. Hobson and S. J. Bence, Cambridge Univ. Press Cambridge (1998).
2. Advanced Mathematics in Physics and Engineering : Arthur Bronwell, Mc Graw-Hill Book Company, New York (1953).
3. Group theory and its Applications to Physical Problems: M.Hammermesh,Addision-Wesley, Mass (1962).
4. Schaum's Outline Series : Vector Analysis and Introduction to Tensor Analysis: M.R. Speigel, McGraw-Hill Company, Singapore (1983).
5. The 'C' Programming Language (2nd Edition) : Brain. W Kernighan and Dennis. M. Righie Prentice – Hall of India Pvt. Ltd., New Delhi (1998)
6. Schaum's Outline Series : Programming with C (2nd Edition) : B. S.Gottfried, Tata Mc Graw – Hill Pub. Company, New Delhi (1998).

Total Teaching hours =50

Course PHCT 1.2: Classical Mechanics

Unit I **15 hrs**

Lagrangian Mechanics:

Constraints, generalized co-ordinates, D'Alembert's principle, Lagrange equation from D'Alemberts Principle, Velocity dependent potentials and dissipation function. Applications of Lagrangian formulation.Hamilton's principle, Derivation of Lagrange's equation from Hamilton's Principle. Symmetry and conservation laws: momentum conservation, cyclic coordinates, angular momentum conservation and conservation of energy.

Unit II **13 hrs**

Motion in central force field:

Equivalent one body problem, motion in central force field, general features of motion, Equations of motion and first integrals. Motion in inverse square law of force field. Equation of orbit. Elliptic orbits, hyperbolic orbits & parabolic orbits. Elastic scattering in central force field, laboratory and centre of mass co-ordinate systems. Rutherford scattering.

Unit III: **12 hrs**

Hamiltonian Mechanics and Brackets :

Legendre transformation and Hamilton equations of motion: conservation theorem and physical significance of Hamiltonian. Derivation of Hamilton's equation from a variation principle: principle of least action. Lagrange and Poisson brackets, Equation of motion in Poisson bracket notation.

Unit IV **10 hrs**

Hamilton-Jacobi Theory:

Hamilton-Jacobi equation of motion for Hamilton's principle and characteristic functions, Harmonic oscillator problem as example of Hamilton-Jacobi method. Seperation of variable in H-J Action angle variables, Harmonic Oscillator in action angle variable, Kepler problems in action angle variable.

Text Books:

1. Classical Mechanics: H.Goldstein, Narosa Publishing Pvt. Ltd. (1998)
2. Introduction to Classical Mechanics: R. G. Takwale & P. S. Puranik.-Tata McGraw Hill, New Delhi (1997)

Reference Books:

1. Classical Mechanics :H.Goldstein, C.Poole & J.Safko. Third edition. Pearson Education Asia (2002).
2. Classical Mechanics: N. C. Rana and P. S. Joag, Tata McGraw Hill, NewDelhi (1991)
3. Classical Dynamics of Particles and Systems: J. B. Marion, Academic Press (1964)
4. Classical Mechanics of Particles and Rigid Bodies: Kiran. C. Gupta, - New Age International (1998)
5. Classical Mechanics : Aruldas
6. Classical Mechanics : B. A. Kajali and T Shivalingaswamy Himalaya publishing house (2018)

Total Teaching hours =50

Course PHCT 1.3 : Electronics (General)

Unit I **13 hrs**

Op-Amp:

Difference amplifier, Operational Ampifier, Ideal characteristics, Negative feedback in Op-amp, effect of feedback on gain and bandwidth. Voltage amplifier, current amplifier, summing amplifier, differentiator, integrator and instrumentation amplifier, Op-Amp Comparator, Schmit's Trigger, Op-Amp IC 741 specifications and pin- layout

Signal generators:

Basic principles, OP-Amp-RC oscillator circuits, Wien bridge oscillator, phase shift oscillator, Triangular wave generator. Timer IC-555: block diagram , pin-layout of IC 555. Timer 555 in Astable and Monostable Mode, Simple applications.

Unit II **13 hrs**

Digital Electronics :

Boolean operations and expressions, Boolean analysis of logic gates, simplification of Boolean expression. Karnaugh map: two, three and four variable map, product of sums (POS) and sum of products (SOP) simplification.

Digital logic Gates:

AND, OR, NOT, NAND and NOR gates, Universal building blocks ,AND-OR and NAND-NOR implementation of Boolean Expressions. Logic gate operation with pulse waveforms.

Unit III **12 hrs**

Digital Circuits:

Flip Flops – Edge triggered flipflops, D ,T, SR, JK, Master Slave JK flipflops

Combinational circuits: Adders, Subtractors, Multiplexer, Demultiplexer, Encoder, Decoder.

Counters :

synchronous, asynchronous, Modulo-n-counters: mod-8, mod-16 and decimal counters.

Shift Registers :

Serial- in, Serial-out (left and right Shift Registers), Parallel in series out Shift Register, universal shift registors, Ring and Johnson counter.

Unit IV **12 hrs**

A/D and D/A Conversion Circuits:

Introduction, flash counter type, successive approximation type and dual slope converter, conversion errors. Binary Weighted converter, R-2R Ladder converter, characteristic properties of Converters.

Text Books:

1. Operational Amplifier and Linear IC's: Robert F. Coughlin and Frederick F. Driscoll, PHI publications (1994).
2. Op-Amps and linear Integrated Circuits :R Gayakwad, PHI publications, New Delhi (2000).
3. Digital Principles and Applications: A.P. Malvino and D. Leach, TMH Publications (1991).
4. Digital fundamentals – 8th edition: Thomas L Floyd, Pearson Education (2003) Floyd, Electronic Devices, Pearson, Seventh Edition (2009).

Reference Books:

1. Microelectronics Circuits: Adel S. Sedra and Kenneth C. Smith, Oxford University Press (1991).
2. Digital Computer fundamentals, Thomas C. Bartee, McGraw Hill Ltd. (1977).
3. Digital Logic and Computer Design: Morris Mano. Prentice Hall of India Pvt.Ltd New Delhi (2000).
4. Logic Circuit Design: Alan W. Shaw, Sanders College Publication Company (1999).
5. Logic Design : Godse and Godse
6. Electronic Devices : Thomas Floyd Pearson publication

Total Teaching hours =50

Course PHCT 1.4: Condensed Matter Physics (General)

Unit I **13 hrs**

Crystal Structure :

Lattice translational vectors and lattices, basis and crystal structure, primitive and non-primitive cells, fundamental types of lattices, Miller indices. Symmetry elements, point groups and space groups. Equation for interplanar distances in orthorhombic ,cubic and tetragonal systems. Examples of simple crystal structures : NaCl, diamond and ZnS

Crystal diffraction and reciprocal lattice:

Bragg's law, reciprocal lattice vectors, diffraction conditions, Laue equations, Ewald sphere, Brillouin zones. Atomic form factor, structure factor and its calculations in simple cases. Experimental methods of diffraction : Single Crystal and Powder diffraction XRD, Debye scherer method.

Unit II **12 hrs**

Crystal binding :

Inter atomic forces, types of bonding: covalent, ionic, metallic, hydrogen and Van der Waals; cohesive energy, compressibility and bulk modulus. Ionic Crystals : Madelung-energy.

Lattice vibrations and thermal properties:

Vibrations of one-dimensional monoatomic and diatomic lattices, properties of lattice waves, phonons. Einstein and Debye models of lattice heat capacity. Lattice thermal conductivity.

Unit III **12 hrs**

Free electron model of metals :

Free electron Fermi gas in three dimensions, Fermi surface. fermi-Dirac distribution. Heat capacity of electron gas. Electrical conductivity and Ohm's law, Mattheissen's rule. Thermal conductivity, Wiedemann Franz law.

Energy bands in solids :

Origin and Magnitude of energy gap, Bloch functions. Born Von Karman boundary conditions, Kronig- Penney model. Number of states in a band. Distinction between metals, insulators and semiconductors. Concept of holes. Equation of motion for electrons and holes. Effective mass of electrons and holes.

Unit IV **13 hrs**

Semiconductors:

Elemental and compound semiconductors, band structure of real semiconductors. Extrinsic semiconductors: binding energy of impurity atoms, impurity levels, population of impurity levels, carrier concentration, Fermi energy and their dependence on impurity concentration and temperature.

Superconductivity :

Phenomena of persistant current, Meissner effect and magnetic effect on superconductivity, high-temperature superconductors. Applications.

Magnetic properties :

Magnetic susceptibility, classification of materials, Langevin theory of diamagnetism classical and quantum theory of paramagnetism and dimagnestism. Curie law; Curie – Weiss law.

Defects in solids :

Types of imperfections, Schottky and Frenkel defects and their concentrations, dislocations. Determination of activation energy from conductivity of NaCl.

Text Books:

1. Introduction to Solid State Physics: C.Kittel.Wiley Eastern Ltd., Bangalore (1976).
2. Elementary Solid State Physics : M.A. Omar.Addison-Wesley Pvt.,Ltd., New Delhi (1993).
3. Solid State Physics: A.J. Dekker, Macmillan India Ltd., Bangalore, (2000).
4. Solid State Physics : F.W.Ashcroft & N.D. Mermin. Saunders College Publishing, NewYork (1976).
5. Solid State Physics by M, A. Wahab, Narosa Publication, New Delhi (2000)

Reference Books :

1. Introduction to Solids : L.V. Azaroff. McGraw-Hill inc, New york (1960).
2. Solid State and Semiconductor Physics: J.P.McKelvey. Harper and Row, Newyork (1966).
3. Elements of solid state Physics, 2nd Edition, J. P. Srivastava, PHI, Learning PVT LTD, New Delhi, (2009)

Courses in Practicals PHCP 1.5 & CP1.6

Each practical is of 4 hrs per week and with 4 Credits

PHCP 1.5: Practical-I

1. Analysis of X-ray diffraction Pattern.
2. Study of Interference and Diffraction by means of He-Ne laser
3. Study of the performance of G.M. Counter and measurement of dead time by double source method.
4. Astable and monostable multivibrators using IC 555
5. Programming using 'C'
6. Thermistor Characteristics
7. Op Amp Amplifier- Inverting and Non Inverting

PHCP 1.6: Practical II:

1. R-2R ladder network D/A converter and its characteristics
2. Variable Duty Cycle Generator using IC-555.
3. Study of Zeeman Effect : Determination of e/m for an electron
4. Study of beta ray attenuation in matter.
5. Determination of Energy gap of Semiconductor by resistively measurement (4-probe method).
6. Study of the performance of G.M. Counter and measurement of dead time by variable area method.
7. Structure factor calculation of simple crystal structure

(New experiments may be introduced each year)

Reference : (for practicals **1.5 & 1.6**)

1. Microelectronics Circuits : Adel S. Sedra and Kenneth C.Smith, Oxford University Press (1991).
2. Electronic devices and circuits: R.Boylstead and Nashalsky : PHI publications (1999).
3. Electronics Principles: A.P.Malvino, TMH Publications (1984).
4. Operational Amplifier and Linear IC's: Robert F. Coughlin and Frederick F. Driscoll, PHI publications (1994).
5. Op-Amps and Linear Integrated Circuits : R. Gayakwad, PHI publications, New Delhi (2000).
6. Elementary Solid Satte Physics : M.A.Omar, Addison Wisley Pub.Ltd. New Delhi (1993).
7. X-ray Diffraction : B.D.Cullity, Addison-Wisley Ltd. New York (1972).
8. Introduction to Solid State Physics: C.Kittel, Wiley Eastern Ltd. Bangalore (1976).
9. Laboratory Manuals.
10. Advanced Practical physics : (9th Edition) B.C.Worsnop & H.T. Flint Methuen & Co.Ltd.Lond (1951).
11. Instrumental Methods of Analysis : (6th Edition) H.H. Willard, L.L.Merrit, J.A. Dean & F.A. Settle, J.K. Jain for CBS Publishers (1986).
12. Optics (2nd Edition) A.K. Gathak Tata Mc Graw Hill Pub. Comp.Ltd New Delhi (1977).
13. Experimental Spectroscopy (3rd ed): Ralph A.Sawyer, Dover Pub, N.Y. (1950).
14. Lab Manuals/Books/Charts.
15. Experiments in Modern Physics : A.C. Melissions academic press (NY)(1966).
16. Experiments in Nuclear Science, ORTEC Applications Note. ORTEC,(1971) (Available in Nuclear Physics Laboratory).
17. Practical Nucleonics: F.J.Pearson., and R.R. Dsborne, E7 F.N. Spon Ltd(1960).
18. The Atomic Nucleus: R.D.Evans, Tata McGraw Hill Pub.comp.Ltd(1960).
19. Nuclear Radiation Detectors: S.S.Kapoor and V.S.Ramamurthy,Wiely Eastern Limited(1986).
20. Experimental Nucleonics: E.Bleuler and G.J.Goldsmith, Rinehart & Co.Inc.(NY).(1958).