PG - Physics

SEMESTER -I

CC I - MATHEMATICAL PHYSICS

Internal: 25 **Subject Code : PPA**
External : 75 **Exam Hours: 3**

OBJECTIVE

- To learn various mathematical concepts and techniques in vector space, groups and functions of special types to solve physical problems.

Unit I Vector Analysis 18hrs

Concept of vector and scalar fields – Gradient, divergence, curl and Laplacian – Vector identities – Line integral, surface integral and volume integral – Gauss theorem, Green's theorem, Stoke's theorem and their applications – Definitions in linear independence of vectors.

Unit II Matrix Theory and Tensors 18hrs

Matrix Theory: Characteristic equation of a matrix – Eigen values and eigenvectors – Cayley –Hamilton theorem -Reduction of a matrix to diagonal form – Jacobi method.

Tensors: Contra variant, covariant and mixed tensors – Rank of a tensor – Symmetric and antisymmetric tensors – Contraction of tensor – Quotient law.

Unit III Group Theory 18hrs

Basic definitions – Multiplication table – Subgroups, cosets and classes – Point and space groups – Homomorphism and isomorphism – Reducible and irreducible representations – Schur's lemma -- The great orthogonality theorem (qualitative treatment without proof) – Formation of character table of C2v and C3v -- Elementary ideas of rotation groups.

Unit IV Complex Analysis 18hrs

Cauchy-Riemann conditions – Complex integration – Cauchy's integral theorem and integral formula – Taylor's and Laurent's series – Residues and singularities - Cauchy's residue theorem.

Unit V Special Functions 18hrs

Basic properties of gamma and beta functions -- Legendre, Bessel, Laugerre and Hermite differential equation: Series solution, generating function, recurrence relations and orthogonality relations.

Books for Study (Relevant chapters from)

1. B.D. Gupta, *Mathematical Physics* (Vikas Pub., Noida, 2015) 4th edition.
2. A.K. Sexena, *Mathematical Physics* (Narosa, New Delhi, 2015).
3. A.W. Joshi, *Matrices and Tensors in Physics* (New Age, New Delhi, 2006).
4. H.K. Dass and Rama Verma, *Mathematical Physics* (S. Chand, New Delhi ,2008).

Books for Reference

1. L.A. Pipes and L.R. Harvill, *Applied Mathematics for Engineers and Physicists* (McGraw Hill, Singapore, 1967).
2. B.V. Ramana*, Higher Engineering Mathematics* (MaGraw Hill, New Delhi, 2013).
3. G. Aruldhas, *Molecular Structure and Spectroscopy* (PHI, New Delhi, 2009).

SEMETER – I

CC II - CLASSICAL DYNAMICS AND RELATIVITY

Internal: 25 **Subject Code : PPB**

External : 75 **Exam Hours: 3**

OBJECTIVE

- To learn various mathematical techniques of classical mechanics and their applications to physical systems and introduce relativistic dynamics.

Unit I Fundamental Principles and Lagrangian Formulation 18hrs

Mechanics of a particle and a system of particles – Conservation laws – Constraints – Generalized- coordinates – D'Alembert's principle and Lagrange's equation - Hamilton's principle – Lagrange's equations of motion-– Conservation theorems and symmetry properties – Applications to linear harmonic oscillator and Atwood's machine.

Unit II Motion under Central Force 18hrs

Conservation of energy and angular momentum – Inverse square law – Kepler's problem – Virial theorem – Scattering in a central force field – Artificial satellites – Geo stationary satellites – Eccentricity of orbit of satellites – Escape velocity.

Unit III Rigid Body Dynamics and Oscillatory Motion 18hrs

Euler's angles – Moments and products of inertia – Euler's equations - Symmetrical top – Theory of small oscillations – Normal modes and frequencies – Linear triatomic molecule – Wave equation and motion – Phase velocity – Group velocity - Dispersion.

Unit IV Hamilton's Formulation 18hrs

Hamilton's canonical equations of motion – Hamilton's equations from variational principle – Principle of least action – Canonical transformations – Poission bracket – Hamilton--Jacobi method – Action and angle variables – Kepler's problem in action-angle variables – Applications to compound pendulum and charged particles in an electromagnetic field.

Unit V Relativistic Mechanics 18hrs

Reviews of basic ideas of special relativity – Energy momentum four -vector – Minkowski's four-dimensional space – Lorentz transformation as rotation in Minkowski's space – Composition of Lorentz transformation about two orthogonal directions – Thomas precession – Elements of general theory of relativity.

Books for Study

1. H. Goldstein, C.P. Poole and J.L. Safko, *Classical Mechanics* (Pearson Education and Dorling Kindersley, New Delhi, 2007).
2. S.L. Gupta, V. Kumar and H.V. Sharma, *Classical Mechanics* (Pragati Prakashan, Meerut, 2001).
3. N.C. Rana and P.S. Joag, *Classical Mechanics* (Tata McGraw-Hill, New Delhi, 1991).

Books for Reference

1. V.B. Bhatia, *Classical Mechanics* (Narosa, New Delhi, 1997).
2. T.L. Chow, *Classical Mechanics* (John-Wiley, New York, 1995).

SEMESTER - I

CC III - ELECTRONICS

Internal: 25 **Subject Code : PPC**

External : 75 **Exam Hours: 3**

OBJECTIVE

- To understand the working of advanced semiconductor devices and digital circuits and the utility of OP-AMP and learn the basics of integrated circuit fabrication, applications of timer IC-555 and building block of digital systems.

Unit I Semiconductor Devices **15hrs**

Varactor, Schottky, tunnel, Gunn, optoelectronic, LASER, LED and photo diodes – Depletion and enhancement type MOSFFT– Characteristics of UJT,UJT Relaxation Oscillator and SCR –SCR as a Switch– Power control DIAC and TRIAC.

Unit II Operation Amplifier **15hrs**

Wien bridge and phase-shift oscillators– Triangular, saw-tooth and square-waves generators – Schmitt trigger– Voltage control oscillator Phase-locked loops -- Weighted resistor and binary R-2R ladder digital to analog converters -- Counter type and successive approximation analog to digital converters -- Solving simultaneous and differential equations

Unit III Digital Circuits-I **15hrs**

Digital comparator – Parity generator/checker – Data selector -- BCD to decimal decoder –Seven segment decoder – Encoders – RS, JK, D and JK master-slave flip-flops.

Unit IV Digital Circuits-II **15hrs**

Serial-in serial-out, serial-in parallel-out and parallel-in serial-out shift registers – Synchronous, asynchronous, ring and up/down (using mod 10) counters - Multiplexers(1-8) – Demultiplexers(8-1).

Unit V IC Fabrication and IC Timer **15hrs**

Basic monolithic ICs – Epitaxial growth – Masking – Etching impurity diffusion – Fabricating monolithic resistors, diodes, transistors, inductors and capacitors – Circuit layout – Contacts and inter connections – Charge coupled device – Applications of CCDs - 555 timer: Description of the functional diagram, applications of monostable and astable operations..

Books for Study (Relevant chapters in)

1. T.F. Schubert, E.M. Kim, *Active and Nonlinear Electronics* (John Wiley, New York, 1996).
2. L. Floyd, *Electronic Devices* (Pearson Education, New York, 2004).
3. J. Millman, C. Halkias and C.D. Parikh*, Integrated Electronics, Analog and Digital Circuits and Systems* (TMGH, 2010).
4. D.P. Leach and A.P. Malvino, *Digital Principals and Applications* (Tata McGraw-Hill, New Delhi, 2006).
5. R.A. Gayakwad, *Op-Amps & Linear Integrated Circuits* (Printice Hall, New Delhi, 1999).

Books for Reference

1. R.L. Geiger, P.E. Allen and N.R Strader, *VLSI Design Techniques for Analog and Digital Circuits* (McGraw--Hill, Singapore, 1990).
2. D. Roy Choudhury and S.B. Jain, *Linear Integrated Circuit* (New Age International Publications, New Delhi, 2010).
3. D. Chattopadhyay and P.C. Rakshit, *Electronics Fundamentals and Applications* (New Age International Publications, New Delhi, 2010).

SEMESTRE – I

CC IV- METHODS OF SPECTROSCOPY

Internal: 25 **Subject Code : PPD**

External : 75 **Exam Hours: 3**

OBJECTIVE

- To familiarize with the basic principles of various spectroscopic techniques and their applications in the determination of atomic structure, chemical composition and physical properties of materials.

Unit I Atomic Spectroscopy 15hrs

Quantum states of an electron in atom – Hydrogen atom spectrum – Electron spin -- Stern—Gerlach experiment – Spin-orbit interaction – Two electron system -- LS-JJ coupling schemes – Spectroscopic terms and selection rules - Hyperfine structure – Zeeman and Paschen—Back effect of one and two electron systems – Selection rules – Stark effect.

Unit II Microwave and Infrared Absorption Spectroscopies 15hrs

Microwave Spectroscopy: Rotation of diatomic molecules – Rotational spectra of polyatomic molecules – Spectrum of non rigid rotator – Experimental technique – Polyatomic molecules – Linear, symmetric top and asymmetric top molecules.

Infrared Absorption Spectroscopy: Vibrating diatomic molecule – Anharmonic oscillator – Diatomic vibrating rotator – Vibration-rotation spectrum of carbon monoxide – Influence of rotation on the spectrum of polyatomic molecules – Linear and symmetric top molecules.

Unit III Raman Spectroscopy 15hrs

Quantum theory of Raman effect –Pure rotational Raman spectra – Linear molecules – Symmetric top molecules – Vibration Raman spectra – Rotational fine structure – Structural determination – Raman spectra –Instrumentation – Raman effect and molecular structure – Raman activity of molecular vibrations

Unit IV Nuclear Magnetic Resonance Spectroscopy 15hrs

Basic principles –Quantum theory of NMR- Bloch equations and solutions – Shielding and deshielding effects – Chemical shift – Spin lattice and spin-spin relaxation– Coupling constants – Experimental technique – Double coil method – Structural diagnosis and hydrogen bonding.

Unit V Electronic and ESR Spectroscopy 15hrs

Electronic spectroscopy of molecules: Electronic spectra of diatomic molecules -- The Franck-

Condon principle – Dissociation energy and dissociation products – Rotational fine structure of

electronic vibration transitions.

ESR: Theory of ESR – Resonance conditions – Experimental study – ESR spectrometer – Crystalline solids and free radicals in solution – Determination of g factor.

Books for Study

1. C.N. Banwell, *Fundamentals of Molecular Spectroscopy* (McGraw Hill, New York, 1981).
2. G. Aruldhas, *Molecular Structure and Spectroscopy* (Prentice Hall, New Delhi, 2006).
3. D.N. Sathyanarayana, *Vibrational* Spectroscopy (New Age International, New Delhi, 2015).

Books for Reference

1. J. Michael Hollas, *Modern Spectroscopy* (Wiley India, New Delhi, 2004).
2. B.P. Straughan and S. Walker, *Spectroscopy* Volumes I--III (Chapman and Hall, New York, 1976).

SEMESTER – I

CC V -PHYSICS PRACTICAL I (GENERAL AND ELECTRONICS)

Internal: 40 **Subject Code : PPEY**

External : 60 **Exam Hours : 3**

OBJECTIVE

- Experimental determination of certain Physical constants and properties and verification of characteristics and applications of electronic components and devices.

Any **TWELVE** experiments (Six experiments from each part)

A. General Experiments

1. Determination of q, n, σ by elliptical fringes method
2. Determination of Stefan's constant
3. Determination of bulk modulus of a liquid by ultrasonic wave propagation
4. Determination of Rydberg's constant
5. Study of Hall effect in a semiconductor
6. Determination of dielectric constant at high frequency by Lecher wire
7. Michelson interferometer – Determination of wavelength of monochromatic source.
8. Determination of wavelength of monochromatic source using biprism
9. Charge of an electron by spectrometer
10. Dissociation energy of iodine molecule -- Absorption spectrum
11. BH loop – Energy loss of a magnetic material – Anchor ring using B.G./CRO
12. Determination of e/m of an electron by magnetron method
13. Photoelectric effect- Determination of Planck's Constant

B. Electronics Experiments

1. Construction of dual regulated power supply
2. Astable and monostable multivibrators using IC555
3. Characteristics of UJT
4. Characteristics of SCR
5. Design and study of Wein bridge oscillator using op-amp
6. Design and study of square and triangular waves generators using op-amp
7. Up/down counter using mod 10
8. Saw Tooth and Stair case waves generators using –OPAMP

SEMESTER - II

CC VI – ELECTROMAGNETIC THEORY

Internal: 25 **Subject Code : PPF**

External : 75 **Exam Hours: 3**

OBJECTIVE

- To learn the theory for the fields produced by stationary and moving charge and charged systems and propagation of electromagnetic fields.

Unit I Electrostatics and Polarization 18 hrs

Gauss's law – Field due to an infinite, straight, uniformly charged wire – Multipole expansion of a charge distribution -- Field inside a uniformly polarized sphere – Electric field inside a dielectric – Electric displacement and polarizability – Claussius-Mossotti relation – Polarization of polar molecules and Langevin equation and Debye relation – Electrostatic energy.

Unit II Boundary Value Problems in Electrostatics 18 hrs

Boundary conditions – Potential at a point between the plates of a spherical capacitor – Potential at a point due to uniformly charged disc – Method of image charges – Point charge in the presence of a grounded conducting sphere- Point charge in the presence of a charged, insulated conducting sphere -- Conducting sphere in a uniform electric field – Laplace equation in rectangular coordinates.

Unit III Magneto statics 18 hrs

Magnetic scalar and vector potentials – Magnetic dipole in a uniform field – Magnetization current – Magnetic intensity – Magnetic susceptibility and permeability – Hysteresis – Correspondences in electrostatics and magneto statics.

Unit IV Field Equations and Conservation Laws 18 hrs

Continuity equation – Displacement current – Maxwell's equations and their physical significance – Poynting theorem – Energy in electromagnetic fields – Electromagnetic potentials – Maxwell's equations in terms of electromagnetic potentials – Lorentz and Coulomb gauges.

Unit V Electromagnetic Waves and Wave Propagation 18 hrs

Electromagnetic waves in free space – Propagation of electromagnetic waves in isotropic dielectrics and in anisotropic dielectrics – Reflection and refraction of electromagnetic waves: Kinematic and dynamic properties – TM and TE modes – Propagation in rectangular waveguides – Cavity resonator.

Books for Study

1. J.D. Jackson*, Classical Electrodynamics* (John-Wiley, New York, 1999) 3rd edition
2. K.K. Chopra and G.C. Agarwal, *Electromagnetic Theory* (K. Nath & Co., Meerut).
3. E.C. Jordan and K.G. Balmain, *Electromagnetic Waves and Radiating Systems* (PHI, New Delhi, 2015).

Books for Reference

1. D.J. Griffiths, *Introduction to Electrodynamics* (Pearson, Essex, 2014) 4th edition.
2. T.L. Chow, *Electromagnetic Theory* (Jones and Bartlett Learning, 2012).

SEMESTER - II

CC VII - QUANTUM MECHANICS

Internal: 25 **Subject Code : PPG**

External : 75 **Exam Hours : 3**

OBJECTIVE

- To learn the fundamental concepts and certain theoretical methods of quantum mechanics and their applications to microscopic systems.

Unit I Schrödinger Equation and General Formulation 18 hrs

Schrödinger equation and its plane wave solution – Physical meaning and conditions on the wave function – Expectation values– Hermitian operators and their Properties – Commutator relations -- Uncertainty relation-- Bra and Ket vectors – Hilbert space – Schrödinger, Heisenberg and interaction pictures.

Unit II Exactly Solvable Systems 18 hrs

Linear harmonic oscillator: Solving the one-dimensional Schrödinger equation and abstract operator method – Particle in a box -- Rectangular barrier potential –Rigid rotator – Hydrogen atom.

Unit III Approximation Methods 18 hrs

Time-independent perturbation theory: Non-degenerate (first-order) and degenerate perturbation theories -- Stark effect – WKB approximation and its application to tunneling problem and quantization rules**.**

Time-dependent perturbation theory: Constant and harmonic perturbations – Transition probability – Sudden approximation.

Unit IV Scattering Theory and Angular Momentum 18 hrs

Scattering theory: Scattering amplitude and cross-section – Green's function approach -- Born approximation and its application to square-well and screened-Coulomb potentials.

Angular momentum: Components of orbital angular momentum – Properties of **L** and $\mathbf{L^2}$ **--** Eigen pairs of $\mathbf{L^2}$ **and** Lz– Spin angular momentum.

Unit V Relativistic Quantum Mechanics 18 hrs

Klein--Gordon equation for a free particle and its solution – Dirac equation for a free particle and Dirac matrices -- Charge and current densities – Plane wave solution – Negative energy states – Zitterbewegung – Spin of a Dirac particle – Spin-orbit coupling.

Books for Study

1.V. Devanathan, *Quantum Mechanics*, Naroso Publishing House (2005)

2.S. Rajasekar and R.Velusamy, *Quantum Mechanics I: The Fundamentals* (CRC Press, Boca Raton, 2015).

3.A.K.Ghatak and S.Lokanathan, *Quantum Mechanics: Theory & Applications* (Macmillan, Chennai, 2004)5th Edi.

Books for Reference

1. R. Shankar, *Principles of Quantum Mechanics* (Springer, New Delhi, 2007).

2. L. Schiff, *Quantum Mechanics* (Tata McGraw Hill, New Delhi, 2014) 4th edition.

3. P.M.Mathews &K.Venkatesan, *A Text Book of Quantum Mechanics* (Tata Mc Graw Hill, NewDelhi,1987).

SEMESTER - II

EC I - MICROPROCESSOR AND MICRO CONTROLLER

Internal: 25 **Subject Code : PPE1**

External : 75 **Exam Hours : 3**

OBJECTIVE

- To learn basic principles of architecture and functioning of microprocessor and microcontroller and programming and interfacing aspects of them.

Unit I Microprocessor Architecture and Interfacing 15 hrs

Intel 8085 microprocessor architecture – Pin configuration – Instruction cycle – Timing diagram – Instruction and data formats – Addressing modes -- Memory mapping and I/O mapping I/O scheme-- Memory mapping I/O interfacing --Data transfer schemes -- Synchronous and asynchronous data transfer – Interrupt driven data transfer - Interrupts of Intel 8085.

Unit II Assembly Language Programs (8085 only) 15 hrs

BCD arithmetic –Addition and subtraction two 8-bit and 16-bit numbers--Largest and smallest numbers in a data set – Ascending order and descending order –Sum of a series of a 8-bit numbers – Sum of a series of multibyte decimal numbers – Square root of a number – Block movement of data -- Time delay –Square-wave generator.

Unit III Peripheral Devices and Microprocessor Applications 15 hrs

Generation of control signals for memory and I/O devices - I/O ports -- Programmable peripheral interface – Architecture of 8255A -Control word— Programmable interrupt controller (8259) 8279- Key board interfacing- Programmable counter- Intel 8253 -Architecture, control word and operation – Block diagram and interfacing of analog to digital converter (ADC 0800) – Digital to analog converter (DAC 0800)– Stepper motor – Traffic control.

Unit IV Microcontroller 8051 15 hrs

Features of 8051– Architecture –Pin configuration –Memory organization External data and program memory -- Counters and timers – Serial data input/output– Interrupt structure – External interrupts – Addressing modes -- Comparison between microprocessor and microcontroller.

Unit V 8051 Instruction Set and Programming 15 hrs

Instruction set – Data transfer, arithmetic and logical instructions – Boolean variable manipulation instructions – Program and machine control instructions – Simple programs – Addition and subtraction of two 8-bit and 16-bit numbers – Division – Multiplication -- Largest number in a set – Sum of a set of numbers.

Books for Study

1. B. Ram, *Fundamentals of Microprocessor and Microcomputers* (Dhanpat Rai Pub.,New Delhi,2006).

2. R. Gaonkar, *Microprocessor Architecture, Programming and Applications with 8085* (Penram International Publishing , Mumbai, 2006) 5th edition.

Books for Reference

1. M.A. Mazidi, J.G. Mazidi and R.D. Mckinlay, *The 8051 Microcontroller and Embbeded Systems using Assembly and C* (Dorling Kindersley, New Delhi, 2013).

2. A.P. Godse and D.A. Godse, *Microprocessors and Microcontrollers* (Technical Pub., Pune, 2008).

3. K. Ayala, *The Microcontroller* (Cengage Learning India, New Delhi, 2013) 3rd edition.

SEMESTER - II

EC II - NUMERICAL METHODS AND C++ PROGRAMMING

Internal: 25 **Subject Code : PPE2**

External : 75 **Exam Hours: 3**

OBJECTIVE

- To learn numerical methods of computing certain mathematical quantities, construction and evaluation of a function and solution of an ordinary differential equation and C++ computer programming necessary for numerical simulation of physical problems.

Unit I Curve Fitting and Interpolation 15 hrs

Curve fitting: Method of least-squares - Straight-line fit -- Exponential and power-law fits.

Interpolation: Newton interpolation polynomial: Linear interpolation, Higher-order polynomials and first-order divided differences – Gregory--Newton interpolation polynomials – Lagrange interpolation.

Unit II Solutions of Linear and Nonlinear Equations 15 hrs

Simultaneous linear equations: Upper triangular form and back substitution – Augmented matrix -- Gauss elimination method -- Jordan's modification -- Inverse of a matrix by Gauss--Jordan method.

Roots of nonlinear equations: Newton--Raphson method -- Termination criteria -- Pitfalls – Order of convergence.

Unit III Numerical Integration and Differentiation 15 hrs

Numerical integration: Trapezoidal and Simpson's 1/3 rules -- Errors in the formulae -- Composite trapezoidal and Simpson's 1/3 rules -- Errors in the formulae.

Numerical differentiation: Two-and four-point formulae for first-order derivative -- Three- and five-point formulae for second-order derivative.

Unit IV Programming in C++ 15 hrs

Constants and variables -- I/O operators and statements -- Header files -- Main function – Conditional statements -- Switch statement -- Void function -- Function program -- For, while and do-while statements -- Break, continue and go to statements - Arrays.

Unit V PROGRAMMING in C^{++} (18 HRS) 15 hrs

1. Least-squares curve fitting – Straight-line fit
2. Least-squares curve fitting – Exponential fit
3. Real roots of one-dimensional nonlinear equations -- Newton Raphson method
4. Complex roots of one-dimensional nonlinear equations -- Newton Raphson method
5. Interpolation – Lagrange method
6. Numerical integration – Composite trapezoidal rule
7. Numerical integration – Composite Simpson’s 1/3 rule

Books for Study (Relevant chapters in)

1. J. R. Hubbard, *Programming with C++* (McGraw-Hill, New Delhi, 2006).
2. E. Balagurusamy, *Objected Oriented Programming in C++* (McGraw Hill, New Delhi, 2013) 6th edition.
3. Introductory Methods of Numerical analysis – S.S. Sastry, Prentice – Hall of India, NewDelhi (2003) 3rd Edition.
4. J.H. Mathews, *Numerical Methods for Mathematics, Science and Engineering* (Prentice-Hall of India, New Delhi, 1998).
5. P.B. Patil and U.P. Verma, *Numerical Computational Methods* (Narosa, New Delhi, 2013).

Books for Reference

1. M.K. Jain, S.R.K. Iyengar and R.K. Jain, *Numerical Methods for Scientific and Engineering Computation* (New Age International, New Delhi, 1993).

SEMESTER - II
CC VIII - PHYSICS PRACTICAL II
(MICRPROCESSOR AND PROGRAMMING)

Internal: 40 **Subject Code : PPHY**
External : 60 **Exam Hours: 3**

OBJECTIVE

- To develop programming skills of microprocessor and C++ programming in solving some mathematical problems and their applications.
-

Any **FIFTEEN** experiments (At least SIX experiments from each part)

A. Microprocessor (8085)

1. Finding the largest and smallest numbers in a data array
2. Arranging a set of numbers in ascending and descending orders
3. Study of multibyte decimal addition
4. Study of multibyte decimal subtraction
5. Interfacing hexa key board (IC 8212)
6. Study of seven segment display
7. Study of DAC interfacing (DAC 0900)
8. Study of ADC interfacing (ADC 0809)
9. Traffic control system
10. Control of stepper motor using microprocessor

C. C++ Programming

1. Least-squares curve fitting – Straight-line fit
2. Least-squares curve fitting – Exponential fit
3. Real roots of one-dimensional nonlinear equations -- Newton Raphson method
4. Complex roots of one-dimensional nonlinear equations -- Newton Raphson method
5. Interpolation – Lagrange method
6. Numerical integration – Composite trapezoidal rule
7. Numerical integration – Composite Simpson's 1/3 rule