(BOS: 30.5.2017)

Syllabus for B.Sc.(Hons.) I Semester (Physics)
Mechanics-I
Paper Code: PHB152

M.M.:100 **Theory: 48**
Credits: 04
Tutorial: 08

Unit-I: Dynamics and Properties of Matters

Fundamentals of Dynamics: Reference frames. Inertial frames; Galilean transformations; Galilean invariance. Dynamics of a system of particles. Centre of Mass (C.O.M.) and Motion of .C.O.M.
Work and Energy: Conservative and non-conservative forces. Potential energy. Stable and unstable equilibrium. Force as gradient of potential energy.
Collisions: Elastic and inelastic collisions between particles. Centre of Mass and Laboratory frames.
Elasticity: Poisson ratio and determination of Poisson ratio of rubber, Relation between Elastic constants. Twisting torque on a Cylinder or wire.
Fluid Motion: Kinematics of Moving Fluids: Poiseuille's Equation for Flow of a Liquid through a Capillary tube.

Unit-II: Rotational Dynamics, Non-Inertial Systems and Central Force Motion

Rotational Dynamics: Angular momentum of a particle and system of particles. Torque, Principle of conservation of angular momentum. Moment of Inertia. Calculation of moment of inertia for cylindrical and spherical bodies. Kinetic energy of rotation. Motion involving both translation and rotation.
Non-Inertial Systems: Non-inertial frames and fictitious forces. Uniformly rotating frame. Laws of Physics in rotating coordinate systems. Centrifugal force. Coriolis force and its applications.
Central Force Motion: Motion of a particle under a central force field: General principle of central force motion**,** Two-body problem and its reduction to one-body problem, and reduced mass. Differential equation of orbit and its solution and Kepler's Laws.

Unit-III: Oscillations and Waves

Oscillations: Simple Harmonic Oscillations. Differential equation of SHM and its solution. Kinetic energy, potential energy, total energy and their time-average values. Transient and steady states, Damped oscillation. Forced oscillations:, Resonance, sharpness of resonance; power dissipation and Quality Factor.
Wave Motion: Plane and Spherical Waves. Longitudinal and Transverse Waves. Plane Progressive (Travelling) Waves. Wave Equation. Particle and Wave Velocities, energy density and intensity of waves, Differential Equation of waves. Pressure of a Longitudinal Wave.
Superposition of Two Harmonic Waves: Standing (Stationary) Waves. Changes of wave characteristics (displacement, particle velocity, pressure, phase, etc.) with respect to Position and Time. Phase and Group velocities and relation between them.

Unit-IV: Special Theory of Relativity

Michelson-Morley Experiment and its outcome. Postulates of Special Theory of Relativity. Lorentz transformations. Simultaneity and order of events. Lorentz-contraction. Time-dilation. Relativistic transformation of velocity, frequency and wave number. Relativistic addition of velocities. Variation of mass with velocity. Massless Particles. Mass-energy Equivalence. Relativistic Doppler effect. Relativistics.energy and momentum transformation.

Reference Books:

- An introduction to mechanics, D. Kleppner, R.J. Kolenkow, 1973, McGraw-Hill.
- Mechanics, Berkeley Physics, vol.1, C.Kittel, W.Knight, et.al. 2007, Tata McGraw-Hill.
- Physics, Resnick, Halliday and Walker 8/e. 2008, Wiley.
- Analytical Mechanics, G.R. Fowles and G.L. Cassiday. 2005, Cengage Learning.
- Feynman Lectures, Vol. I, R.P.Feynman, R.B.Leighton, M.Sands, 2008, Pearson Education
- Introduction to Special Relativity, R. Resnick, 2005, John Wiley and Sons.
- University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.
- The Physics of Vibrations and Waves, H. J. Pain, 2013, John Wiley and Sons.
- The Physics of Waves and Oscillations, N.K. Bajaj, 1998, Tata McGraw Hill.
- Oscillations and Waves. S. Garg, C. K. Ghosh, S. Gupta, PHI Learning Pvt. Ltd.

Additional Books for Reference

- Mechanics, D.S. Mathur, S. Chand and Company Limited, 2000
- University Physics. F.W Sears, M.W Zemansky, H.D Young 13/e, 1986, Addison Wesley
- Physics for scientists and Engineers with Modern Phys., J.W. Jewett, R.A. Serway, 2010, Cengage Learning
- Theoretical Mechanics, M.R. Spiegel, 2006, Tata McGraw Hill.
- Wave: Berkelay Physics Course, vol. 3, Francis Crawford, 2007, Tata McGraw-Hill

(BOS: 30.5.2017)

Syllabus for B.Sc.(Hons.) II Semester (Physics)
Electricity and Magnetism-I
Paper Code: PHB252

(Credits: Theory-04)
Theory: 48 Lectures, Tutorial: 08

Unit-I: Electric Field and Electric Potential

Electric field: Electric field lines. Electric flux. Gauss' Law. Conservative nature of Electrostatic Field. Electrostatic Potential. Multipole expansion of electrostatic potential, dipole, linear quadrupole and potential due to it. Laplace's and Poisson equations. The Uniqueness Theorem. Electrostatic energy of system of charges. Electrostatic energy of a charged sphere. Conductors in an electrostatic Field. Method of Images and its application to: (1) Plane Infinite Sheet and (2) Sphere.

Unit-II: Magnetic Field

Magnetic Force on (1) point charge (2) current carrying wire (3) between current elements. Definition of **B**, Properties of **B:** Curl and Divergence, Vector potential, Gauss' law of magnetostatics Torque on a current loop in a uniform Magnetic Field, Current Loop as a Magnetic Dipole and its Dipole Moment (Analogy with Electric Dipole), magnetic moment and angular momentum. Ampere's Circuital Law and its application to (1) Solenoid and (2) Toroid.

Unit-III: Dielectric & Magnetic Properties of Matter

Dielectric Properties of Matter: Electric Field in matter. Polarization, Polarization Charges. Electrical Susceptibility and Dielectric Constant. Capacitance of an isolated conductor. Capacitor (parallel plate, spherical, cylindrical) filled with dielectric. Displacement vector **D**. Relations between **E**, **P** and **D**. Gauss' Law in dielectrics.

Magnetic Properties of Matter: Three magnetic vectors **B, M** and **H** and relation among them**.** Magnetic Susceptibility and permeability, Gauss's law of magnetostatics. Theory of magnestism (Qualitative idea), Curie-Weiss law of ferromagnetism, **B-H** curves: hysteresis and demagnetisation.

Unit-IV: Electrical Circuits and Network Theorems and Electromagnetic Waves

Electromagnetic Waves: Maxwell's Equations. Displacement current. Wave Equations. Plane Waves in Dielectric Media. Poynting Theorem and Poynting Vector.

Electrical Circuits: AC Circuits: Kirchhoff's laws for AC circuits. Complex Reactance and Impedance. Series LCR Circuit: (1) Resonance, (2) Power Dissipation and (3) Quality Factor, and (4) Band Width. Parallel LCR Circuit.

Network theorems: Ideal Constant-voltage and Constant-current Sources. Network Theorems: Thevenin theorem, Norton theorem, Superposition theorem, Maximum Power Transfer theorem. Applications to dc circuits.

Reference Books:

1. Fundamentals of Physics: Electricity and Magnetism, Halliday, Resnick, Walker, 2011, Wiley India pvt. Ltd.
2. Electricity and Magnetism, Edward M. Purcell, 1986 McGraw-Hill Education
3. Introduction to Electrodynamics, D.J. Griffiths, 3rd Edn., 1998, Benjamin Cummings.
4. Feynman Lectures Vol.2, R.P.Feynman, R.B.Leighton, M. Sands, 2008, Pearson Education
5. Electricity and Magnetism, Chattopadhyay, D. and Rakshit, P.C. (New Central Book Agency (P) Ltd.)
6. Electricity and Magnetism, K. K. Tewari, S. Chand & Company Ltd.

Syllabus for B.Sc.(Hons.) III Semester (Physics)
Waves and Optics
Paper Code: PHB-351

(Credits: Theory-02)
Theory: 24 Lectures, Tutorial: 04

Unit-I: Superposition of Harmonic Oscillations and Harmonic Waves

Superposition of Collinear Harmonic oscillations: Linearity and Superposition Principle. Superposition of two collinear oscillations having (1) equal frequencies and (2) different frequencies (Beats). Superposition of N collinear Harmonic Oscillations with (1) equal phase differences and (2) equal frequency differences.
Superposition of two perpendicular Harmonic Oscillations: Graphical and Analytical Methods. Lissajous Figures (1:1 and 1:2) and their uses.

Unit-II: Polarization of electromagnetic waves

Description of Linear, Circular and Elliptical Polarization. Uniaxial and Biaxial Crystals. Light Propagation in Uniaxial Crystal. Double Refraction. Polarization by Double Refraction. Nicol Prism. Ordinary and extraordinary refractive indices. Production and detection of Plane, Circularly and Elliptically Polarized Light. Phase Retardation Plates: Quarter-Wave and Half-Wave Plates. Analysis of Polarized Light. Rotatory Polarization.

Unit-III: Interference

Wave Optics: Definition and properties of wave front. Huygens Principle. Temporal and Spatial Coherence.

Interference: Division of amplitude and wavefront. Fresnel's Biprism. Fringes of equal inclination (Haidinger Fringes); Fringes of equal thickness (Fizeau Fringes). Newton's Rings. Measurement of wavelength and refractive index.

Interferometer: Michelson Interferometer- Idea of form of fringes (No theory required), Determination of Wavelength, Wavelength Difference, Fabry-Perot interferometer.

Unit-IV: Diffraction

Fraunhofer diffraction: Review of single slit and double slit. Circular aperture(qualitative), Multiple slits. Diffraction grating. Resolving power of grating.

Fresnel Diffraction: Fresnel's Half-Period Zones for Plane Wave. Zone Plate: Multiple Foci of a Zone Plate. Fresnel diffraction pattern of a straight edge.

Reference Books

- Fundamentals of Optics, F.A. Jenkins and H.E. White, 1981, McGraw-Hill
- Principles of Optics, Max Born and Emil Wolf, 7th Edn., 1999, Pergamon Press.
- Optics, Ajoy Ghatak, 2008, Tata McGraw Hill
- The Physics of Vibrations and Waves, H. J. Pain, 2013, John Wiley and Sons.
- The Physics of Waves and Oscillations, N.K. Bajaj, 1998, Tata McGraw Hill.

(BOS: 30.5.2017)

Syllabus for B.Sc.(Hons.) III Semester (Physics)
Analog Systems and Applications-I
Paper Code: 353

(Credits: Theory-02)
Theory: 24 Lectures, Tutorial: 04

Unit-I: Bipolar Junction Transistors and Amplifiers

n-p-n and p-n-p Transistors. Physical Mechanism of Current Flow. Characteristics of CB, CE and CC Configurations. Active, Cutoff and Saturation Regions. Current gains α and β. Relations between α and β. h-parameter Equivalent Circuit. Analysis of a single-stage CE amplifier using Hybrid Model. Input and Output Impedance. Current, Voltage and Power Gains.

Unit-II: Transistor Biasing and Feedback

Load Line analysis of Transistors. DC Load line and Q-point. Fixed Bias and Voltage Divider Bias.

Principle of Feedback. Effects of Negative Feedback on Input Impedance, Output Impedance, Gain, Stability, Distortion and Noise.

Unit-III: RC Coupled Amplifiers, FET and Oscillators

RC-coupled amplifier and its frequency response.

Construction of JFET. Idea of Channel Formation. Different Regions of I-V Curves. Definitions of r_d and g_m. Basic construction of MOSFET and its Working, Enhancement and Depletion Modes.

Barkhausen's Criterion for self-sustained oscillations. RC Phase shift oscillator, Hartley oscillators.

Unit-IV: Operational Amplifier and its Applications

Operational Amplifiers (Black Box approach). Characteristics of an Ideal and Practical Op-Amp. (IC 741). CMRR. Slew Rate and concept of Virtual ground.

(1) Inverting and non-inverting amplifiers, (2) Adder, (3) Subtractor, (4) Differentiator, (5) Integrator, (6) Log amplifier, (7) Zero crossing detector (8) Wein bridge oscillator.

Reference Books:

- Elements of Electronics, M.K. Bagde, S.P. Singh and Kamal Singh, 2002, S. Chand & Company Ltd.
- Integrated Electronics, J. Millman and C.C. Halkias, 1991, Tata Mc-Graw Hill.
- Electronics: Fundamentals and Applications, J.D. Ryder, 2004, Prentice Hall.
- OP-Amps and Linear Integrated Circuit, R. A. Gayakwad, 4th edition, 2000, Prentice Hall
- Electronic Devices, 7/e Thomas L. Floyd, 2008, Pearson India

(BOS: 30.5.2017)

Syllabus for B.Sc.(Hons.) IV Semester (Physics)
ELEMENTS OF MODERN PHYSICS – I
Paper Code: PHB453

(Credits: Theory-02)
Theory: 24 Lectures, Tutorials:04

Unit-I: Quantum Mechanics I

Blackbody Radiation: Planck's concept, Planck's radiation formula; Quantum theory of light: Photo-electric effect and Compton scattering; De Broglie wavelength and matter waves; wave-particle duality, Heisenberg uncertainty principle and its applications.

Unit-II: Quantum Mechanics II

Physical interpretation of wave function, probabilities and normalization; Schrodinger equation for non-relativistic particles (steady-state form); momentum and energy operators; stationary states; probability current densities in one dimension.
One dimensional infinitely rigid box- energy eigenvalues and eigenfunctions, normalization, idea of quantum mechanical tunneling.

Unit-III: Nuclear and Particle Physics

Nuclear Structure and Transformation: Size and structure of atomic nucleus; NZ graph, binding energy. Radioactivity: radioactive decay, mean life and half-life; idea of alpha decay; beta decay-energy released, gamma decay.

Particle physics: Particle interactions and their basic features, Leptons, Hadrons.

Unit-IV: Lasers

Lasers: Characteristics of laser beam, spontaneous and stimulated emissions, optical pumping and population inversion, Einstein's A and B coefficients. Metastable states, three-level and four-level lasers (Qualitative); Ruby laser and He-Ne laser; Applications of lasers.

Reference Books:

- Concepts of Modern Physics, Arthur Beiser, 2002, McGraw-Hill.
- Introduction to Modern Physics, Rich Meyer, Kennard, Coop, 2002, Tata McGraw Hill
- Introduction to Quantum Mechanics, David J. Griffith, 2005, Pearson Education.
- Physics for scientists and Engineers with Modern Physics, Jewett and Serway, 2010, Cengage Learning.
- Quantum Mechanics: Theory & Applications, A.K.Ghatak & S.Lokanathan, 2004, Macmillan
- Modern Physics: Kenneth S. Krane, 1996, John Wiley & Sons.

Additional Books for Reference

- Modern Physics, J.R. Taylor, C.D. Zafiratos, M.A. Dubson, 2004, PHI Learning.
- Theory and Problems of Modern Physics, Schaum`s outline, R. Gautreau and W. Savin, 2nd Edn, Tata McGraw-Hill Publishing Co. Ltd.
- Quantum Physics, Berkeley Physics, Vol.4. E.H.Wichman, 1971, Tata McGraw-Hill Co.
- Basic ideas and concepts in Nuclear Physics, K.Heyde, 3rd Edn., Institute of Physics Pub.
- Six Ideas that Shaped Physics: Particle Behave like Waves, T.A.Moore

Syllabus for B.Sc.(Hons.) IV Semester (Physics)
THERMAL PHYSICS
Paper Code: PHB-452

(Credits:02)
Theory: 24 Lectures, Tutorial: 04

(*Include related problems for each topic*)

Unit-I: Zeroth and First Law of Thermodynamics

Extensive and intensive Thermodynamic. Variables, Thermodynamic Equilibrium, Zeroth Law of Thermodynamics and Concept of Temperature, Concept of Work and Heat, State Functions, First Law of Thermodynamics and its differential form, Internal Energy, Applications of First Law: General Relation between C_P and C_V, Work Done during Isothermal and Adiabatic Processes, Compressibility and Expansion Co-efficient.

Unit-II: Second Law of Thermodynamics

Reversible and Irreversible process. Carnot's Cycle, Carnot engine. Refrigerator. 2nd Law of Thermodynamics: Kelvin-Planck and Clausius Statements and their Equivalence.
Entropy: Concept of Entropy, Clausius Theorem. Clausius Inequality, Second Law of Thermodynamics in terms of Entropy. Entropy Changes in Reversible and Irreversible processes. Temperature–Entropy diagrams for Carnot's Cycle. Third Law of Thermodynamics.
Thermodynamic Potentials: Internal Energy, Enthalpy, Helmholtz Free Energy, Gibb's Free Energy. Phase Transitions. Clausius Clapeyron Equation and Ehrenfest equations. Maxwell's Thermodynamic Relations.

Unit-III: Kinetic Theory of Gases

Distribution of Velocities: Maxwell-Boltzmann Law of Distribution of Velocities in an Ideal Gas. Mean, RMS and Most Probable Speeds. Degrees of Freedom. Law of Equipartition of Energy (No proof required). Specific heats of Gases.
Molecular Collisions: Mean Free Path. Collision Probability. Estimates of Mean Free Path. Transport Phenomenon in Ideal Gases: (1) Viscosity, (2) Thermal Conductivity and (3) Diffusion. Brownian Motion and its Significance.

Unit-III: Real Gases
Behavior of Real Gases. TheVirial Equation. Critical Constants. Continuity of Liquid and Gaseous State. Boyle Temperature. Van der Waal's Equation of State for Real Gases. Values of Critical Constants. Law of Corresponding States. Free Adiabatic Expansion of a Perfect Gas. Joule-Thomson Porous Plug Experiment. Joule-Thomson Effect for Real and Van der Waal Gases. Temperature of Inversion. Joule-Thomson Cooling.

Reference Books:

- Heat and Thermodynamics, M.W. Zemansky, Richard Dittman, 1981, McGraw-Hill.
- A Treatise on Heat, Meghnad Saha, and B.N.Srivastava, 1958, Indian Press
- Thermal Physics, S. Garg, R. Bansal and Ghosh, 2nd Edition, 1993, Tata McGraw-Hill
- Modern Thermodynamics with Statistical Mechanics, Carl S. Helrich, 2009, Springer.
- Thermodynamics, Kinetic Theory & Statistical Thermodynamics, Sears & Salinger. 1988, Narosa.
- Concepts in Thermal Physics, S.J. Blundell and K.M. Blundell, 2nd Ed., 2012, Oxford University Press.

(BOS: 30.5.2017)

Syllabus for B.Sc.(Hons.) IV Semester (Physics)
(FOR STUDENTS OF OTHER MAINS)

Open Elective: Elements of Modern Physics
Paper Code : PHB491

(Credits: Theory-02)
Theory: 24 Lectures, Tutorials:4

Unit-I: Particle and Waves
Photoelectric effect. Quantum Theory of Light. Compton effect. Pair production. X-Ray Diffraction. De Broglie waves. Davisson-Germer experiment.

Unit-II: Quantum Mechanics
Wave Function, Normalization, Probability, Schrödinger's equation, expectation value. Particle in a box. Harmonic oscillator.

Unit-III: Lasers
Some remarkable properties of light beam, stimulated absorption, spontaneous emission, stimulated emission, pumping, population inversion, three-level laser, four-level laser, ruby laser, helium-neon gas laser.

Unit-IV: Nuclear Physics and Elementary Particles
Nuclear Physics: Radioactive decay, half-life, radiometric dating, alpha decay, beta decay, gamma decay, nuclear fission, nuclear reactors, fusion reactors.
Elementary Particles: Interactions and particles, leptons, hadrons, elementary particle quantum numbers, quarks.

Reference Books:

- Concepts of Modern Physics, Arthur Beiser, 2002, McGraw-Hill.
- Introduction to Modern Physics, Rich Meyer, Kennard, Coop, 2002, Tata McGraw Hill
- Introduction to Quantum Mechanics, David J. Griffith, 2005, Pearson Education.
- Physics for scientists and Engineers with Modern Physics, Jewett and Serway, 2010, Cengage Learning.
- Quantum Mechanics: Theory & Applications, A.K.Ghatak & S.Lokanathan, 2004, Macmillan.

Syllabus for B.Sc.(Hons.) V Semester (Physics) **OLD**

Mathematical Physics

Paper Code: PHB551

(Credits: Theory-04)
Theory: 48 Lectures, Tutorials: 08

The emphasis of course is on applications in solving problems of interest to physicists. The students are to be examined entirely on the basis of problems, seen and unseen.

Unit-I: Vector Calculus and Orthogonal Curvilinear Coordinates

Vector Differentiation: Directional derivatives and normal derivative. Gradient of a scalar field and its geometrical interpretation. Divergence and curl of a vector field. Del and Laplacian operators. Vector identities, Gradient, divergence, curl and Laplacian in spherical and cylindrical coordinates.

Vector Integration: Flux of a vector field. Gauss' divergence theorem, Green's and Stokes Theorems and their applications (no rigorous proofs).

Orthogonal Curvilinear Coordinates: Orthogonal Curvilinear Coordinates. Derivation of Gradient, Divergence, Curl and Laplacian in Cartesian, Spherical and Cylindrical Coordinate Systems.

Unit-II: Fourier Series, and Integrals Transforms

Fourier Series: Dirichlet Conditions (Statement only). Expansion of periodic functions in a series of sine and cosine functions and determination of Fourier coefficients. Complex representation of Fourier series. Expansion of functions with arbitrary period.

Integrals Transforms: Fourier Transforms: Fourier Integral theorem. Fourier Transform. Examples. Fourier transform of trigonometric,Gaussian, finite wave train & other functions. Three dimensional Fourier transforms with examples. Application of Fourier Transforms to differential equations: One dimensional Wave and Diffusion/Heat Flow Equations.

Laplace Transforms: Laplace Transform (LT) of Elementary functions. Properties of LTs: Change of Scale Theorem, Shifting Theorem. LTs of Derivatives and Integrals of Functions, Derivatives and Integrals of LTs. LT of Unit Step function, Dirac Delta function, Periodic Functions. Convolution Theorem. Inverse LT. Application of Laplace Transforms to Differential Equations: Damped Harmonic Oscillator, Simple Electrical Circuits.

Unit-III: Frobenius Method and Special Functions

Legendre, Bessel, Hermite and Laguerre Differential Equations. Properties of Legendre Polynomials: Rodrigues Formula, Generating Function, Orthogonality. Simple recurrence relations. Expansion of function in a series of Legendre Polynomials. Bessel Functions of the First Kind: Generating Function, simple recurrence relations. Zeros of Bessel Functions and Orthogonality.

Unit-IV: Complex Analysis

Functions of Complex Variables. Analyticity and Cauchy-Riemann Conditions. Examples of analytic functions. Singular functions: poles and branch points, order of singularity, branch cuts. Integration of a function of a complex variable. Cauchy's Inequality. Cauchy’s Integral formula. Simply and multiply connected region. Laurent and Taylor’s expansion. Residues and Residue Theorem. Application in solving Definite Integrals.

Reference Books:

- Mathematical Methods for Physicists, G.B. Arfken, H.J. Weber, F.E. Harris, 2013, 7th Edn., Elsevier.
- An introduction to ordinary differential equations, E.A. Coddington, 2009, PHI learning
- Differential Equations, George F. Simmons, 2007, McGraw Hill.
- Mathematical Tools for Physics, James Nearing, 2010, Dover Publications.
- Mathematical methods for Scientists and Engineers, D.A. McQuarrie, 2003, Viva Book

- Advanced Engineering Mathematics, D.G. Zill and W.S. Wright, 5 Ed., 2012, Jones and Bartlett Learning
- Advanced Engineering Mathematics, Erwin Kreyszig, 2008, Wiley India.
- Essential Mathematical Methods, K.F.Riley & M.P.Hobson, 2011, Cambridge Univ.
- Fourier Analysis by M.R. Spiegel, 2004, Tata McGraw-Hill.
- Mathematics for Physicists, Susan M. Lea, 2004, Thomson Brooks/Cole.
- Differential Equations, George F. Simmons, 2006, Tata McGraw-Hill.
- Partial Differential Equations for Scientists & Engineers, S.J. Farlow, 1993, Dover Pub.

Syllabus for B.Sc.(Hons.) V Semester (Physics) OLD
Quantum Mechanics and Applications
Paper Code: PHB552

(Credits: Theory-04)
Theory: 48 Lectures, Tutorials:8

Unit-I: Schrodinger Equation

Time dependent Schrodinger equation: Time dependent Schrodinger equation and dynamical evolution of a quantum state; Properties of Wave Function. Interpretation of Wave Function Probability and probability current densities in three dimensions; Conditions for Physical Acceptability of Wave Functions. Normalization. Linearity and Superposition Principles. Eigenvalues and Eigenfunctions. Position, momentum and Energy operators; Commutator of position and momentum operators; Expectation values of position and momentum operators. Wave Function of a Free Particle.

Time independent Schrodinger equation-Hamiltonian, stationary states and energy eigenvalues; expansion of an arbitrary wavefunction as a linear combination of energy eigenfunctions; General solution of the time dependent Schrodinger equation in terms of linear combinations of stationary states; Application to spread of Gaussian wave-packet for a free particle in one dimension; wave packets, Fourier transforms and momentum space wavefunction; Position-momentum uncertainty principle.

Unit-II: General discussion of bound states in an arbitrary potential

Continuity of wave function, boundary condition and emergence of discrete energy levels; application to one-dimensional problem-square well potential; Quantum mechanics of simple harmonic oscillator-energy levels and energy eigenfunctions using Frobenius method; Hermite polynomials; ground state, zero point energy & uncertainty principle.

Unit-III: Quantum Theory of Atoms

Quantum Theory of Hydrogen-like Atoms: Time independent Schrodinger equation in spherical polar coordinates; separation of variables for second order partial differential equation; angular momentum operator and quantum numbers; Radial wavefunctions from Frobenius method; shapes of the probability densities for ground and first excited states. Orbital angular momentum quantum numbers l and m; s, p, d,.. shells. Space quantization. Electron Spin and Spin Angular Momentum. Larmor’s Theorem. Spin Magnetic Moment. Stern-Gerlach Experiment. Electron Magnetic Moment and Magnetic Energy, Gyromagnetic Ratio and Bohr Magneton.

Unit-IV: Atoms in External Fields and Many Electron Atoms

Atoms in External Magnetic Fields:- Normal and Anomalous Zeeman Effect. Paschen Back and Stark Effect (Qualitative Discussion only).

Many Electron Atoms: Pauli’s Exclusion Principle. Symmetric & Antisymmetric Wave Functions. Periodic table. Fine structure. Spin orbit coupling. Spectral Notations for Atomic States. Total angular momentum. Vector Model. Spin-orbit coupling in atoms- L-S and J-J couplings. Hund’s Rule. Term symbols. Spectra of Hydrogen and Alkali Atoms (Na etc.).

Reference Books:

- A Text book of Quantum Mechanics, P.M.Mathews and K.Venkatesan, 2^{nd} Ed., 2010, McGraw Hill
- Quantum Mechanics, Robert Eisberg and Robert Resnick, 2^{nd} Edn., 2002, Wiley.
- Quantum Mechanics, Leonard I. Schiff, 3^{rd} Edn. 2010, Tata McGraw Hill.
- Quantum Mechanics, G. Aruldhas, 2^{nd} Edn. 2002, PHI Learning of India.
- Quantum Mechanics, Bruce Cameron Reed, 2008, Jones and Bartlett Learning.
- Quantum Mechanics: Foundations & Applications, Arno Bohm, 3^{rd} Edn., 1993, Springer
- Quantum Mechanics for Scientists & Engineers, D.A.B. Miller, 2008, Cambridge University Press
- Quantum Mechanics – Concepts and Applications , N Zettili , Wiley.

Additional Books for Reference

- Quantum Mechanics, Eugen Merzbacher, 2004, John Wiley and Sons, Inc.
- Introduction to Quantum Mechanics, D.J. Griffith, 2^{nd} Ed. 2005, Pearson Education
- Quantum Mechanics, Walter Greiner, 4^{th} Edn., 2001, Springer

Syllabus for B.Sc.(Hons.) V Semester (Physics) **OLD**

Solid State Physics

Paper Code: PHB553

(Credits: Theory-02)

Theory: 24 Lectures, Tutorials: 04 Lectures

Unit-I Crystal Structure and Elementary Lattice Dynamics

Crystal Structure: Solids: Amorphous and Crystalline Materials. Lattice Translation Vectors. Lattice with a Basis – Central and Non-Central Elements. Unit Cell. Miller Indices. Reciprocal Lattice. Types of Lattices. Brillouin Zones. Diffraction of X-rays byCrystals. Bragg's Law. Atomic and Geometrical Factor.

Elementary Lattice Dynamics: Lattice Vibrations and Phonons: Linear Monoatomic and Diatomic Chains. Acoustical and Optical Phonons. Qualitative Description of the Phonon Spectrum in Solids. Dulong and Petit's Law, Einstein and Debye theories of specific heat of solids. T3 law

Unit-II Magnetic Properties of Matter and Dielectric Properties of Materials

Magnetic Properties of Matter: Dia-, Para-, Ferri- and Ferromagnetic Materials. Classical Langevin Theory of dia– and Paramagnetic Domains. Quantum Mechanical Treatment of Paramagnetism. Curie's law, Weiss's Theory of Ferromagnetism and Ferromagnetic Domains. Discussion of B-H Curve. Hysteresis and Energy Loss.

Dielectric Properties of Materials: Polarization. Local Electric Field at an Atom. Depolarization Field. Electric Susceptibility. Polarizability. Clausius Mosotti Equation. Classical Theory of Electric Polarizability. Normal and Anomalous Dispersion. Cauchy and Sellmeir relations. Langevin-Debye equation. Complex Dielectric Constant. Optical Phenomena. Application: Plasma Oscillations, Plasma Frequency, Plasmons, TO modes.

Unit- III Ferroelectric Properties of Materials and Superconductivity

Ferroelectric Properties of Materials: Structural phase transition, Classification of crystals, Piezoelectric effect, Pyroelectric effect, Ferroelectric effect, Electrostrictive effect, Curie-Weiss Law, Ferroelectric domains, PE hysteresis loop.

Superconductivity: Experimental Results. Critical Temperature. Critical magnetic field. Meissner effect. Type I and type II Superconductors, London's Equation and Penetration Depth. Isotope effect. Idea of BCS.

Unit- IV Elementary Band Theory

Kronig Penny model. Band Gap. Conductor, Semiconductor (P and N type) and insulator. Conductivity of Semiconductor, mobility, Hall Effect. Measurement of conductivity (04 probe method) & Hall coefficient.

References Books:

- Introduction to Solid State Physics, Charles Kittel, 8th Edition, 2004, Wiley India Pvt. Ltd.
- Elements of Solid State Physics, J.P. Srivastava, 2nd Edition, 2006, Prentice-Hall of India
- Introduction to Solids, Leonid V. Azaroff, 2004, Tata Mc-Graw Hill
- Solid State Physics, N.W. Ashcroft and N.D. Mermin, 1976, Cengage Learning
- Solid-state Physics, H. Ibach and H. Luth, 2009, Springer
- Elementary Solid State Physics, 1/e M. Ali Omar, 1999, Pearson India
- Solid State Physics, M.A. Wahab, 2011, Narosa Publication.

Syllabus for B.Sc.(Hons.) V Semester (Physics)

OLD

Applied Optics
Paper Code: PHB554

(Credits: 02)

Theory: 24 Lectures, Tutorial:04

Theory includes only qualitative explanation. Minimum five experiments should be performed covering minimum three sections.

Unit-I: Sources and Detectors

Lasers, Spontaneous and stimulated emissions, Theory of laser action, Einstein's coefficients, Light amplification, Characterization of laser beam, He-Ne laser, Semiconductor lasers.

Unit-II: Fourier Optics and Fourier Transform Spectroscopy

Fourier Optics : Concept of Spatial frequency filtering, Fourier transforming property of a thin Lens.

Fourier Transform Spectroscopy: Fourier Transform Spectroscopy (FTS) is a powerful method for measuring emission and absorption spectra, with wide application in atmospheric remote sensing, NMR spectrometry and forensic science.

Unit-III: Holography

Basic principle and theory: coherence, resolution, Types of holograms, white light reflection hologram, application of holography in microscopy, interferometry, and character recognition

Unit-IV: Photonics

Fibre Optics: Optical fibres and their properties, Principal of light propagation through a fibre, The numerical aperture, Attenuation in optical fibre and attenuation limit, Single mode and multimode fibres, Fibre optic sensors: Fibre Bragg Grating

Reference Books:

- Fundamental of optics, F. A. Jenkins & H. E. White, 1981, Tata McGraw hill. 71
- LASERS: Fundamentals & applications, K.Thyagrajan & A.K.Ghatak, 2010, Tata McGraw Hill
- Fibre optics through experiments, M.R.Shenoy, S.K.Khijwania, et.al. 2009, Viva Books
- Nonlinear Optics, Robert W. Boyd, (Chapter-I), 2008, Elsevier.
- Optics, Karl Dieter Moller, Learning by computing with model examples, 2007, Springer.
- Optical Systems and Processes, Joseph Shamir, 2009, PHI Learning Pvt. Ltd.

- Optoelectronic Devices and Systems, S.C. Gupta, 2005, PHI Learning Pvt. Ltd.
- Optical Physics, A.Lipson, S.G.Lipson, H.Lipson, 4th Edn., 1996, Cambridge Univ. Press

Syllabus for B.Sc.(Hons.) V Semester (Physics)
Mathematical Physics
Paper Code: PHB-

(Credits: Theory-04)
Theory: 48 Lectures, Tutorials: 08

The emphasis of course is on applications in solving problems of interest to physicists. The students are to be examined entirely on the basis of problems, seen and unseen.

Unit-I: Complex Analysis
Functions of Complex Variables. Analyticity and Cauchy-Riemann Conditions. Examples of analytic functions. Singular functions: poles and branch points, order of singularity, branch cuts. Integration of a function of a complex variable. Cauchy's Inequality. Cauchy's Integral formula. Simply and multiply connected region. Laurent and Taylor's expansion. Residues and Residue Theorem. Application in solving Definite Integrals.

Unit-II: Vector Calculus and Orthogonal Curvilinear Coordinates
Vector Differentiation: Directional derivatives and normal derivative. Gradient of a scalar field and its geometrical interpretation. Divergence and curl of a vector field. Del and Laplacian operators. Vector identities, Gradient, divergence, curl and Laplacian in spherical and cylindrical coordinates.
Vector Integration: Flux of a vector field. Gauss' divergence theorem, Green's and Stokes Theorems and their applications (no rigorous proofs).
Orthogonal Curvilinear Coordinates: Orthogonal Curvilinear Coordinates. Derivation of Gradient, Divergence, Curl and Laplacian in Cartesian, Spherical and Cylindrical Coordinate Systems.

Unit-III: Fourier Series, and Integrals Transforms

Fourier Series: Dirichlet Conditions (Statement only). Expansion of periodic functions in a series of sine and cosine functions and determination of Fourier coefficients. Complex representation of Fourier series. Expansion of functions with arbitrary period.
Integrals Transforms: Fourier Transforms: Fourier Integral theorem. Fourier Transform. Examples. Fourier transform of trigonometric,Gaussian, finite wave train & other functions. Three dimensional Fourier transforms with examples. Application of Fourier Transforms to differential equations: One dimensional Wave and Diffusion/Heat Flow Equations.
Laplace Transforms: Laplace Transform (LT) of Elementary functions. Properties of LTs: Change of Scale Theorem, Shifting Theorem. LTs of Derivatives and Integrals of Functions, Derivatives and Integrals of LTs. LT of Unit Step function, Dirac Delta function, Periodic Functions. Convolution Theorem. Inverse LT. Application of Laplace Transforms to Differential Equations: Damped Harmonic Oscillator, Simple Electrical Circuits.

Unit-IV: Frobenius Method and Special Functions
Legendre, Bessel, Hermite and Laguerre Differential Equations. Properties of Legendre Polynomials: Rodrigues Formula, Generating Function, Orthogonality. Simple recurrence relations. Expansion of function in a series of Legendre Polynomials. Bessel Functions of the First Kind: Generating Function, simple recurrence relations. Zeros of Bessel Functions and Orthogonality.

Reference Books:

- Mathematical Methods for Physicists, G.B. Arfken, H.J. Weber, F.E. Harris, 2013, 7th Edn., Elsevier.
- An introduction to ordinary differential equations, E.A. Coddington, 2009, PHI learning
- Differential Equations, George F. Simmons, 2007, McGraw Hill.
- Mathematical Tools for Physics, James Nearing, 2010, Dover Publications.
- Mathematical methods for Scientists and Engineers, D.A. McQuarrie, 2003, Viva Book
- Advanced Engineering Mathematics, D.G. Zill and W.S. Wright, 5 Ed., 2012, Jones and Bartlett Learning

- Advanced Engineering Mathematics, Erwin Kreyszig, 2008, Wiley India.
- Essential Mathematical Methods, K.F.Riley & M.P.Hobson, 2011, Cambridge Univ.
- Fourier Analysis by M.R. Spiegel, 2004, Tata McGraw-Hill.
- Mathematics for Physicists, Susan M. Lea, 2004, Thomson Brooks/Cole.
- Differential Equations, George F. Simmons, 2006, Tata McGraw-Hill.
- Partial Differential Equations for Scientists & Engineers, S.J. Farlow, 1993, Dover Pub.

(BOS: 21.05.18)

Syllabus for B.Sc. (Hons.) V Semester (Physics)

Applied Optics (PHB-)

(Credits: 02)

Theory: 24 Lectures, Tutorial: 04

Unit-I: Sources and Detectors

Lasers: Spontaneous and stimulated emissions, Theory of laser action, Einstein's coefficients, Light amplification, Characterization of laser beam, Semiconductor lasers. Detectors**:** Light dependent resistor (LDR) and photodiode.

Unit-II: Holography

Basic Principle and Theory: Coherence, Resolution, Recording and reconstruction processes of hologram, Types of holograms, White light reflection hologram, Application of holography in microscopy and interferometry.

Unit-III: Photonics

Fibre Optics: Optical fibres and their properties, Principle of light propagation through a fibre, Numerical aperture, Attenuation in optical fibre and attenuation limit, Single mode and multimode fibres, Fibre optic sensors: Liquid level sensor and fibre Bragg grating.

Unit-IV: Fourier Optics and Fourier Transform Spectroscopy

Fourier Optics: Concept of Spatial frequency filtering, Fourier transforming property of a thin lens.

Fourier Transform Spectroscopy: Representation of spectra, Basic elements of absorption and emission spectroscopy, Fourier Transform Spectroscopy (FTS) and its applications.

Reference Books:

- Fundamental of Optics, F. A. Jenkins & H. E. White, 1981, Tata McGraw hill.
- LASERS: Fundamentals & Applications, K.Thyagrajan &A. K. Ghatak, 2010, Tata McGraw Hill
- Optics, A. Ghatak, 2010, Tata McGraw Hill Education Pvt. Ltd.
- Fibre optics through experiments, M. R. Shenoy, S. K. Khijwania, et.al. 2009, Viva Books
- Nonlinear Optics, Robert W. Boyd, (Chapter-I), 2008, Elsevier.
- Fundamentals of Molecular Spectroscopy, C. N. Benwell and E. M. McCash, 2013, McGraw Hill Education (India) Pvt. Ltd.
- Solid state electronic devices, B. G. Streetman and S. K. Banerjee, 2009, PHI Learning Pvt. Ltd.

- Optoelectronic Devices and Systems, S. C. Gupta, 2005, PHI Learning Pvt. Ltd.
- Optical Physics, A. Lipson, S. G. Lipson, H. Lipson, 4th Edn., 1996, Cambridge Univ. Press

Syllabus for B.Sc.(Hons.) V Semester (Physics)
Solid State Physics
Paper Code: PHB-

(Credits: Theory-02)
Theory: 24 Lectures, Tutorials: 04 Lectures

Unit-I Crystal Structure

Amorphous and crystalline materials; Concept of lattice, unit cell, Wigner-Seitz cell, Bravais lattices, Crystal planes and Miller indices, Interplanar spacing; Packing fraction for *sc, bcc* and *fcc* structures; Common crystal structures (NaCl and CsCl); Concept of reciprocal lattice, X-ray diffraction and Bragg's law.

Unit-II Crystal bonding and Lattice Dynamics

Bonding in solids: Interatomic forces and cohesive energy; ionic, covalent, metallic, vander waals' and hydrogen bonds.

Elementary Lattice Dynamics: Lattice vibrations, linear one dimensional monatomic and diatomic chains, acoustical and optical branches; Dulong and Petit's law, Einstein and Debye theories of specific heat of solids.

Unit- III Magnetic Properties of Materials and Superconductivity

Magnetic Properties: Dia-, para-, ferro-, antiferro- and ferrimagnetisms (qualitative only); Langevin classical theory of dia and paramagnetism; Weiss's theory of ferromagnetism and ferromagnetic domains; hysteresis loop.

Superconductivity: Discovery of superconductivity, Meissner effect, Critical magnetic field, persistent current, penetration depth, type I and type II superconductors; idea of BCS theory.

Unit- IV Free electron and Band theories of Solids

Drude model: Electrical and thermal conductivities of metals, Hall effect: Hall coefficient and Applications; Failure of free electron theory; Band theory: Kronig Penny model, band structure of conductor, semiconductor (p and n type) and insulator.

References Books:

- Introduction to Solid State Physics, Charles Kittel, 8th Edition, 2004, Wiley India Pvt. Ltd.
- Elements of Solid State Physics, J.P. Srivastava, 2nd Edition, 2006, Prentice-Hall of India
- Solid State Physics, N.W. Ashcroft and N.D. Mermin, 1976, Cengage Learning
- Elementary Solid State Physics, 1/e M. Ali Omar, 1999, Pearson India
- Solid State Physics, M.A. Wahab, 2011, Narosa Publication

(BOS: 21.05.18)

Syllabus for B.Sc.(Hons.) V Semester (Physics)
Quantum Mechanics and its Applications
Paper Code: PHB-

(Credits: Theory-04)
Theory: 48 Lectures, Tutorials: 8

Unit-I: Mathematical tools and Postulates of Quantum Mechanics

Hilbert Space, Wave functions and its properties, Operators, Hermitian, Unitary, Commutator Algebra, Eigenvalues and Eigen functions, Dirac Bra Ket Notation, Postulates of Quantum Mechanics, Observables and operators, Expectation Values, Time dependent Schrodinger equation, General solution in terms of linear combinations of stationary states, Application to spread of Gaussian wave-packet for a free particle in one dimension, wave packets.

Unit-II: Tunnelling, Finite Square Well Potential & Harmonic Oscillator

Tunnelling through Potential Step, Potential Barrier, Finite one-dimensional problem-square well potential, Bound state solutions, Solution of simple harmonic oscillator- Energy levels and Eigen functions using Frobenious method, Hermite polynomials; Ground state, Zero point energy

Unit-III: Quantum Theory of Hydrogen Atom

Time independent Schrodinger equation in spherical polar coordinates; Separation of variables for second order partial differential equation; Angular momentum operator and quantum numbers; Radial wavefunctions from Special function, Shapes of the probability densities for ground and first excited states, Concept of spin and Stern-Gerlach experiment

Unit-IV: Quantum Computation

Complex Vector Space, Inner Product and Hilbert Space, Tensor product of Vector Spaces, Bits and and Qubits, Classical Gates, Reversible Gates, Landauer Principle, Toffoli and Fredkin Gates, Quantum Gates, Bloch Sphere, Universal Quantum Gates, Hadamard, Controlled Not and Phase shift Gates, Deutsch Gate, No Cloning theorem (idea)

Books:

- Introduction to Quantum Mechanics, D.J. Griffith, 2nd Ed. 2005, Pearson Education
- Quantum Mechanics - Concepts and Applications, N Zettili , 2009, Wiley.
- Quantum Mechanics Theory and Applications by A Ghatak & S Lokanathan, McGraw Hill Ed.
- Quantum Computing For Computer Scientists N.S. Yanofsky & M A Mannucci, Cambridge University Press, 2008

Syllabus for B.Sc.(Hons.) V Semester (Physics)
Digital Systems and Applications
Paper Code: PHB555

(Credits: Theory-04)
Theory: 48 Lectures, Tutorial:08

Unit-I: CRO, ICs and Digital Circuits

Introduction to CRO: Block Diagram of CRO. Electron Gun, Deflection System and Time Base. Deflection Sensitivity. Applications of CRO: (1) Study of Waveform, (2) Measurement of Voltage, Current, Frequency, and Phase Difference.

Integrated Circuits (Qualitative treatment only): Active & Passive components. Discrete components. Wafer. Chip. Advantages and drawbacks of ICs. Scale of integration: SSI, MSI, LSI and VLSI (basic idea and definitions only). Classification of ICs. Examples of Linear and Digital lCs.

Digital Circuits: Difference between Analog and Digital Circuits. Binary Numbers. Decimal to Binary and Binary to Decimal Conversion. BCD, Octal and Hexadecimal numbers. AND, OR and NOT Gates (realization using Diodes and Transistor). NAND and NOR Gates as Universal Gates. XOR and XNOR Gates and application as Parity Checkers.

Unit-II: Boolean algebra, Data processing circuits and Arithmetic Circuits

Boolean algebra: De Morgan's Theorems. Boolean Laws. Simplification of Logic Circuit using Boolean Algebra. Fundamental Products. Idea of Minterms and Maxterms. Conversion of a Truth table into Equivalent Logic Circuit by (1) Sum of Products Method and (2) Karnaugh Map.
Data processing circuits: Basic idea of Multiplexers, De-multiplexers, Decoders, Encoders.
Arithmetic Circuits: Binary Addition. Binary Subtraction using 2's Complement. Half and Full Adders. Half & Full Subtractors, 4-bit binary Adder/Subtractor.

Unit-III: Sequential Circuits and Timers

Sequential Circuits: SR, D, and JK Flip-Flops. Clocked (Level and Edge Triggered) Flip-Flops. Preset and Clear operations. Race-around conditions in JK Flip-Flop. M/S JK Flip-Flop.
Shift registers: Serial-in-Serial-out, Serial-in-Parallel-out, Parallel-in-Serial-out and Parallel-in-Parallel-out Shift Registers (only up to 4 bits).
Counters (4 bits): Ring Counter. Asynchronous counters, Decade Counter. Synchronous Counter.
Timers: IC 555: block diagram and applications: Astable multivibrator and Monostable multivibrator.

Unit-IV: Computer Organization, Microprocessor and Assembly Language

Computer Organization: Input/Output Devices. Data storage (idea of RAM and ROM). Computer memory. Memory organization & addressing. Memory Interfacing. Memory Map.
Intel 8085 Microprocessor Architecture: Main features of 8085. Block diagram. Components. Pin-out diagram. Buses. Registers. ALU. Memory. Stack memory. Timing & Control circuitry. Timing states. Instruction cycle, Timing diagram of MOV and MVI.
Introduction to Assembly Language: 1 byte, 2 byte & 3 byte instructions.

Reference Books:

- Digital Principles and Applications, A.P. Malvino, D.P.Leach and Saha, 7th Ed., 2011, Tata McGraw
- Fundamentals of Digital Circuits, Anand Kumar, 2nd Edn, 2009, PHI Learning Pvt. Ltd.
- Digital Circuits and systems, Venugopal, 2011, Tata McGraw Hill.

- Digital Systems: Principles & Applications, R.J.Tocci, N.S.Widmer, 2001, PHI Learning
- Logic circuit design, Shimon P. Vingron, 2012, Springer. Digital Electronics, Subrata Ghoshal, 2012, Cengage Learning.
- Microprocessor Architecture Programming & applications with 8085, 2002, R.S. Goankar, Prentice Hall.

Syllabus for B.Sc.(Hons.) V Semester (Physics)
Physics of Devices and Instruments
Paper Code: PHB556

(Credits: Theory-04)
Theory: 48 Lectures, Tutorial: 08

Unit-I: Devices and Power supply

Devices: Characteristic and small signal equivalent circuits of UJT and JFET. Metalsemiconductor Junction. Metal oxide semiconductor (MOS) device. Ideal MOS and Flat Band voltage. SiO2-Si based MOS. MOSFET– their frequency limits. Enhancement and Depletion Mode MOSFETS, CMOS. Charge coupled devices. Tunnel diode.

Power supply and Filters: Block Diagram of a Power Supply, Qualitative idea of C and L Filters. IC Regulators, Line and load regulation, Short circuit protection,
Active and Passive Filters, Low Pass, High Pass, Band Pass and band Reject Filters.

Unit-II: Multivibrators and Phase Locked Loop

Multivibrators: Astable and Monostable Multivibrators using transistors.

Phase Locked Loop(PLL): Basic Principles, Phase detector(XOR & edge triggered), Voltage Controlled Oscillator (Basics, varactor). Loop Filter– Function, Loop Filter Circuits, transient response, lock and capture. Basic idea of PLL IC (565 or 4046).

Unit-III: Processing of Devices and Digital Data Communication Standards

Processing of Devices: Basic process flow for IC fabrication, Electronic grade silicon. Crystal plane and orientation. Defects in the lattice. Oxide layer. Oxidation Technique for Si. Metallization technique. Positive and Negative Masks. Optical lithography. Electron lithography. Feature size control and wet anisotropic etching. Lift off Technique. Diffusion and implantation.

Digital Data Communication Standards: Serial Communications: RS232, Handshaking, Implementation of RS232 on PC. Universal Serial Bus (USB): USB standards, Types and elements of USB transfers. Devices (Basic idea of UART). Parallel Communications: General Purpose Interface Bus (GPIB), GPIB signals and lines,Handshaking and interface management, Implementation of a GPIB on a PC. Basic idea ofsending data through a COM port.

Unit-IV: Communication systems

Introduction to communication systems: Block diagram of electronic communication system, Need for modulation. Amplitude modulation. Modulation Index. Analysis of Amplitude Modulated wave. Sideband frequencies in AM wave. CE Amplitude Modulator. Demodulation of AM wave using Diode Detector. basic idea of Frequency, Phase, Pulse and Digital Modulation including ASK, PSK, FSK.

Reference Books:

- Physics of Semiconductor Devices, S.M. Sze & K.K. Ng, 3rd Ed.2008, John Wiley & Sons
- Electronic devices and integrated circuits, A.K. Singh, 2011, PHI Learning Pvt. Ltd.
- Op-Amps & Linear Integrated Circuits, R.A.Gayakwad,4 Ed. 2000,PHI Learning Pvt. Ltd
- Electronic Devices and Circuits, A. Mottershead, 1998, PHI Learning Pvt. Ltd.
- Electronic Communication systems, G. Kennedy, 1999, Tata McGraw Hill.

- Introduction to Measurements & Instrumentation, A.K. Ghosh, 3rd Ed., 2009, PHI Learning Pvt. Ltd.
- PC based instrumentation; Concepts & Practice, N. Mathivanan, 2007, Prentice-Hall of India

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Syllabus for B.Sc.(Hons.) V Semester (Physics)

Nuclear and Particle Physics
Paper Code: PHB557

(Credits: Theory-04)
Theory: 48Lectures Tutorials-08

Unit I: General properties of nuclei: Constituent of nucleus and their intrinsic properties, size of the nucleus, radii, charge density. Nuclear charge: measurement of nuclear charge, Alpha scattering methods, nuclear mass, measurement of mass using Bainbridge spectrograph, mass defect, binding energy, variation of binding energy with atomic mass number. Elementary idea of nuclear fusion-fission, nuclear angular momentum, nuclear magnetic dipole moment, nuclear electric quadrupole moment: definition, units, significance of positive and negative values.
Unit 2: Radioactive decay:- Radioactive series decay, growth and decay of daughter product, ideal, transient, and secular equilibrium. Alpha decay: basic features of alpha decay, Gamow factor, Giger Nutttal law, energy spectrum of alpha particles, fine structure. Beta decay: energy kinematics of Beta decay, neutrino hypothesis, continuous nature of beta particle spectrum. Gamma decay and selection rules for Gamma decay.
Nuclear reactions:- Types of reaction, conservation laws, Q-value: negative Q-value reaction and threshold energies, energetic of α, β^+, β^- and electron capture (EC) decay.

Unit 3: Interaction of nuclear radiation with matter:- Energy loss due to ionization (Bethe block formula), range and straggling, Cerenkov radiation, interaction of Gamma radiation with matter, Photoelectric effect, Compton scattering and Pari production.
Detectors for Nuclear radiations**:-** Gas filled detectors, G.M counter, ionization chamber. Basic principle of Scintillation detectors and construction of Photo multiplier tube (PMT). Principle of Semi-Conductor (SC) detectors. Position sensitive gas filled detectors.

Unit IV: Particle Physics:- Basic interactions and their mediating quanta, types of particles and its families, Fermions and Bosons, Leptons and Hadrons, particles and antiparticles, idea of resonances, conservation rules in fundamental interactions. Determination of spins and parity of pions, spins of particles, associated production, strangeness and decay mode, charge kaons, Isospin and its conservation, Concept of Quark model: Quarks their quantum numbers.

Reference books:

- Kenneth S. Krane : Introductory nuclearPhysics by (Wiley India Pvt. 2008)
- Bernard L. Cohen : Concepts of nuclear physics by (Tata Mcgraw Hill 1998)
- D. Griffith : Introductory to Elementary Particles (Jhon Wiley & Sons)
- Enge, H. A. : Introductory to nuclear Physics (Addison Wesley)
- Evans, R. D. : Atomic Nucleus (Macgraw Hill)
- Kapoor, S. S. & Nuclear Radiation Detectors (New Age)
- Ramamurthy, V. S. :
- Knoll, G. F. : Radiation Detectors
- Dodd, J. E . : Ideas of Particles Physics (Cambridge Univ. Press.)
- Martin, B. R & Shaw, R. G. : Particle Physics (Jhon Wiley)
- Ghoshal, S. N. : Atomic and Nuclear Physics (S. Chand & Company, Ltd)

Syllabus for B.Sc.(Hons.) VI Semester (Physics) **OLD**

CLASSICAL MECHANICS AND ELECTROMAGNETIC THEORY

Paper Code: PHB651

(Credits: Theory-04)
Theory: 48 Lectures, Tutorial:08

Unit-I: Lagrangian Dynamics and Variational Principles

Constraints – holonomic and non-holonomic, time independent and time dependent. Generalized coordinates, Lagrange equations from D'Alembert's principle, velocity dependent potentials, velocity dependent potential for e.m. field, applications of Lagrangian formalism to simple mechanical systems. Variational Principle: Technique of the calculus of variation, Hamilton's variational principle, Lagrange equations using Hamilton's principle. Generalized momenta, Cyclic coordinates, Definition of energy function and Hamiltonian and its physical significance, conservation of energy, conservation of linear and angular momenta.

Unit-II: Humiltonian Dynamics and Two-body Central Force Problems

Hamilton's equations of motion from variational principle, Conservation laws and cyclic coordinates, Hamiltonian as a constant of the motion. Two-body Problem: Central force problem, conservation of angular momentum and Kepler's second law, the Kepler problem – inverse square law of force, Kepler's first and third laws, the Virial theorem and its simple applications. Two-body Collisions:- Scattering by a central force, Rutherford scattering formula, transformation of the scattering problem from centre of mass to laboratory coordinates.

Unit-III: Maxwell Equations

Review of Maxwell's equations. Vector and Scalar Potentials. Gauge Transformations: Lorentz and Coulomb Gauge. Electromagnetic (EM) Energy Density. Physical Concept of Electromagnetic Field, Energy Density, Momentum Density and Angular Momentum Density.
EM Wave Propagation in Unbounded Media: Propagation through conducting media, relaxation time, skin depth. Wave propagation through dilute plasma, electrical conductivity of ionized gases, plasma frequency, refractive index, skin depth, application to propagation through ionosphere.
EM Wave in Bounded Media: Boundary conditions at a plane interface between two media. Laws of Reflection & Refraction. Fresnel's Formulae for perpendicular & parallel polarization cases, Brewster's law. Reflection & Transmission coefficients. Total internal reflection, evanescent waves. Metallic reflection (normal Incidence)

Unit-IV: Wave Guides and Optical Fibres

Wave Guides: Planar optical wave guides. Planar dielectric wave guide. Condition of continuity at interface. Phase shift on total reflection. Eigenvalue equations. Phase and group velocity of guided waves. Field energy and Power transmission.
Optical Fibres:- Numerical Aperture. Step and Graded Indices (Definitions Only). Single and Multiple Mode Fibres (Concept and Definition Only).

Reference Books:

- Classical Mechanics, H. Goldstein, 2nd Ed. (Narosa)
- Classical Dynamics of Particles Systems Marion, J.B. & Thornton, S.T. (Saundeu)
- Introduction to Electrodynamics, D.J. Griffiths, 3rd Ed., 1998, Benjamin Cummings.
- Elements of Electromagnetics, M.N.O. Sadiku, 2001, Oxford University Press.
- Introduction to Electromagnetic Theory, T.L. Chow, 2006, Jones & Bartlett Learning
- Fundamentals of Electromagnetics, M.A.W. Miah, 1982, Tata McGraw Hill
- Electromagnetic field Theory, R.S. Kshetrimayun, 2012, Cengage Learning
- Electromagnetic Field Theory for Engineers & Physicists, G. Lehner, 2010, Springer

Additional Books for Reference

- Electromagnetic Fields & Waves, P.Lorrain & D.Corson, 1970, W.H.Freeman & Co.
- Electromagnetics, J.A. Edminster, Schaum Series, 2006, Tata McGraw Hill.
- Electromagnetic field theory fundamentals, B. Guru and H. Hiziroglu, 2004, Cambridge University Press

Syllabus for B.Sc.(Hons.) VI Semester (Physics)
CLASSICAL MECHANICS AND ELECTROMAGNETIC THEORY
Paper Code: PHB-

(Credits: Theory-04)
Theory: 48 Lectures, Tutorial:08

Unit-I: Lagrangian Dynamics and Variational Principles

Constraints -- holonomic and non-holonomic, time independent and time dependent. Generalized coordinates, Lagrange equations from D'Alembert's principle, velocity dependent potentials, velocity dependent potential for e.m. field, applications of Lagrangian formalism to simple mechanical systems. Variational principle: Technique of the calculus of variation, Hamilton's variational principle, Lagrange equations using Hamilton's principle. Generalised momenta, cyclic coordinates, Definition of energy function and Hamiltonian and its physical significance, conservation of energy, conservation of linear and angular momenta.

Unit-II: Hamiltonian Dynamics and Two-body Central Force Problems

Hamilton's equation of motion from variational principle, Conservation laws and cyclic coordinates, Hamiltonian as a constant of motion, Two-body problem: Central force problem, conservation of angular momentum and Kepler's second law, the Kepler problem - inverse square law of force, Kepler's first and third laws, the Virial theorem and its simple applications. Two-body collisions - Scattering by a central force, Rutherford scattering formula, transformation of the scattering problem from centre of mass to laboratory coordinates.

Unit-III: Maxwell Equations and EM Waves

Review of Maxwell's equations: Vector and Scalar Potentials. Gauge Transformations: Lorentz and Coulomb Gauge. Electromagnetic (EM) Energy Density. Physical Concept of Electromagnetic Field, Energy Density, Momentum Density and Angular Momentum Density.

EM Wave Propagation in Unbounded Media: Propagation through conducting media, relaxation time, skin depth. Wave propagation through dilute plasma, electrical conductivity, plasma frequency, refractive index, skin depth, application to propagation through ionosphere.

EM Wave in Bounded Media: Boundary conditions at a plane interface between two media. Laws of Reflection & Refraction. Fresnel's Formulae for perpendicular & parallel polarization cases, Brewster's law. Reflection & Transmission coefficients. Total internal reflection, Metallic reflection (normal Incidence)

Unit-IV: Wave Guides and Optical Fibres

Wave Guides: Planar optical wave guides. Waves in hollow conductors. T.E. and T.M. modes. Rectangular wave guides (TE and TM cases)

Optical Fibres:- Numerical Aperture. Step and Graded Indices (Definitions Only). Single and Multiple Mode Fibres (Concept and Definition Only).

Reference Books

1. Classical Mechanics, H. Goldstein, 3rd Ed. (Paperback), 2011, Pearson Education
2. Classical Dynamics of Particles Systems Marion, S. T. Thornton, and J. B. Marion, 5th Ed., 2003, Brooks Cole
3. Introduction to Electrodynamics, D.J. Griffiths, 4th Ed., 2015, Pearson Education India Learning Private Limited
4. Classical Electromagnetic Radiation, Mark A. Heald and J. B. Marion, 3rd Ed., 1994, Saunders College Publishing
5. Fundamentals of Optics, Devraj Singh, 2nd Ed., 2015, Prentice-Hall of India Pvt. Ltd

Syllabus for B.Sc.(Hons.) VI Semester (Physics)

STATISTICAL MECHANICS
Paper Code: PHB652

(Credits: 02)
Theory: 24 Lectures, Tutorials: 04

Unit-I: Classical Statistics

Macrostate & Microstate, Elementary Concept of Ensemble, Phase Space, Entropy and Thermodynamic Probability, Maxwell-Boltzmann Distribution Law, Partition Function, Thermodynamic Functions of an Ideal Gas, Classical Entropy Expression, Gibbs Paradox, Thermodynamic Functions of a Two-Energy Levels System, Negative Temperature.

Unit-II: Classical and Quantum Theory of Radiation

Classical Theory of Radiation: Properties of Thermal Radiation. Blackbody Radiation.
Pure temperature dependence. Review of Kirchhoff's law, Stefan-Boltzmann law, Radiation Pressure, Wien's Displacement law, Wien's Distribution Law, Saha's Ionization Formula and Rayleigh-Jean's Law. Ultraviolet Catastrophe.

Quantum Theory of Radiation: Spectral Distribution of Black Body Radiation. Planck's Quantum Postulates. Planck's Law of Blackbody Radiation. Deduction of (1) Wien's Distribution Law, (2) Rayleigh-Jeans Law, (3)Stefan-Boltzmann Law, (4) Wien's Displacement law from Planck's law.

Unit-III:Bose-Einstein Statistics

B-E distribution law, Thermodynamic functions of a strongly Degenerate Bose Gas, Bose Einstein condensation(qualitative description), properties of liquid He (qualitative description), Radiation as a photon gas and Thermodynamic functions of photon gas.

Unit-IV: Fermi-Dirac Statistics

Fermi-Dirac Distribution Law, Thermodynamic functions of a Completely and strongly Degenerate Fermi Gas, Fermi Energy, White Dwarf Stars, Chandrasekhar MassLimit.

Reference Books:

- Statistical Mechanics, R.K. Pathria, Butterworth Heinemann: 2nd Ed., 1996, Oxford University Press.
- Statistical Physics, Berkeley Physics Course, F. Reif, 2008, Tata McGraw-Hill
- Statistical and Thermal Physics, S. Lokanathan and R.S. Gambhir. 1991, Prentice Hall
- Thermodynamics, Kinetic Theory and Statistical Thermodynamics, Francis W. Sears and Gerhard L. Salinger, 1986, Narosa.
- Modern Thermodynamics with Statistical Mechanics, Carl S. Helrich, 2009, Springer
- An Introduction to Statistical Mechanics & Thermodynamics, R.H. Swendsen, 2012, Oxford Univ. Press
- Statistical Physics, L. D. Landau and E. M. Lifshitz, 3rd Ed, Elsevier

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Syllabus for B.Sc.(Hons.) VI Semester (Physics)

BASIC INSTRUMENTATION SKILLS

Paper Code: PHB653

(Credits: 02)

Theory: 24 Lectures, Tutorial: 04

This course is to get exposure with various aspects of instruments and their usage through hands-on mode. Experiments listed below are to be done in continuation of the topics.

Unit-I: Instruments for Electrical Measurement

Basic of Measurement: Instruments accuracy, precision, sensitivity, resolution range etc. Errors in measurements and loading effects.

Multimeter: Principles of measurement of dc voltage and dc current, ac voltage, ac current and resistance. Specifications of a multimeter and their significance.

Electronic Voltmeter: Advantage over conventional multimeter for voltage measurement with respect to input impedance and sensitivity. Principles of voltage, measurement (block diagram only). Specifications of an electronic Voltmeter/ Multimeter and their significance.

AC millivoltmeter: Type of AC millivoltmeters: Amplifier- rectifier, and rectifier- amplifier. Block diagram ac millivoltmeter**,** specifications and their significance.

Unit-II: Cathode Ray Oscilloscope

Block diagram of basic CRO. Construction of CRT, Electron gun, electrostatic focusing and acceleration (Explanation only– no mathematical treatment), brief discussion on screen phosphor, visual persistence & chemical composition. Time base operation, synchronization. Front panel controls. Specifications of a CRO and their significance.

Use of CRO for the measurement of voltage (dc and ac frequency, time period. Special features of dual trace, introduction to digital oscilloscope, probes. Digital storage Oscilloscope: Block diagram and principle of working.

Unit-III: Signal Generators and Analysis Instruments

Signal Generators and Analysis Instruments: Block diagram, explanation and specifications of low frequency signal generators. pulse generator, and function generator. Brief idea for testing, specifications. Distortion factor meter, wave analysis.

Impedance Bridges & Q-Meters: Block diagram of bridge. working principles of basic (balancing type) RLC bridge. Specifications of RLC bridge. Block diagram & working principles of a Q- Meter. Digital LCR bridges.

Unit-IV: Digital Instruments

Principle and working of digital meters. Comparison of analog & digital instruments. Characteristics of a digital meter. Working principles of digital voltmeter.

Digital Multimeter: Block diagram and working of a digital multimeter. Working principle of time interval, frequency and period measurement using universal counter/ frequency counter, time- base stability, accuracy and resolution.

The test of lab skills will be of the following test items:

1. Use of an oscilloscope.
2. CRO as a versatile measuring device.
3. Circuit tracing of Laboratory electronic equipment,
4. Use of Digital multimeter/VTVM for measuring voltages
5. Circuit tracing of Laboratory electronic equipment,
6. Winding a coil / transformer.
7. Study the layout of receiver circuit.
8. Trouble shooting a circuit
9. Balancing of bridges

Laboratory Exercises:

1. To observe the loading effect of a multimeter while measuring voltage across a low resistance and high resistance.
2. To observe the limitations of a multimeter for measuring high frequency voltage and currents.
3. To measure Q of a coil and its dependence on frequency, using a Q- meter.
4. Measurement of voltage, frequency, time period and phase angle using CRO.
5. Measurement of time period, frequency, average period using universal counter/ frequency counter.
6. Measurement of rise, fall and delay times using a CRO.
7. Measurement of distortion of a RF signal generator using distortion factor meter.
8. Measurement of R, L and C using a LCR bridge/ universal bridge.

Open Ended Experiments:

1. Using a Dual Trace Oscilloscope
2. Converting the range of a given measuring instrument (voltmeter, ammeter)

Reference Books:

- A text book in Electrical Technology - B L Theraja - S Chand and Co.
- Performance and design of AC machines - M G Say ELBS Edn.
- Digital Circuits and systems, Venugopal, 2011, Tata McGraw Hill.
- Logic circuit design, Shimon P. Vingron, 2012, Springer.
- Digital Electronics, Subrata Ghoshal, 2012, Cengage Learning.

- Electronic Devices and circuits, S. Salivahanan & N. S.Kumar, 3rd Ed., 2012, Tata Mc-Graw Hill
- Electronic circuits: Handbook of design and applications, U.Tietze, Ch.Schenk, 2008, Springer
- Electronic Devices, 7/e Thomas L. Floyd, 2008, Pearson India 65

Syllabus for B.Sc.(Hons.) VI Semester (Physics)
ATOMIC, MOLECULAR AND LASER PHYSICS
Paper Code: PHB654

Credit: 04
Lectures: 40, Tutorials: 08

Unit-I: Atomic Physics

One valence electron atom: Electronic configuration and atomic states, spin-orbit interaction, fine structure, intensity rules for structure doublets, selection rule for electrical dipole transitions. Two valence electron atoms: LS and jj coupling scheme, vector model of atom, terms and levels for non-equivalent electron system (sp,pd and spd configuration) and equivalent electrons (p^2,d^2 configurations). Hund's rules. Normal and anomalous Zeeman effect. Hyperfine structure.

Unit-II: Molecular Physics

Rotational Spectra: Diatomic molecule as rigid and non-rigid rotator, effect of isotopic substitution, rotational spectrum.

Vibrational Spectra: The vibrating diatomic molecule, harmonic and anharmonic oscillator models, vibrating-rotator and its spectrum. Infrared spectrum of diatomic molecules. Fundamental modes of H2O and CO_2.

Raman Spectra: Classical and quantum theory of Raman effect, polarizibility, rotational Raman spectra of diatomic molecules. Vibrational Raman spectra.

Electronic spectra of diatomic molecules: Born-Oppenheimer approximation, Vibrational coarse structure (progressions and sequences), intensity of vibrational-electronic spectra: Franck-Condon principle (qualitative). Electronic structure of diatomic molecules: molecular orbitals, electronic configuration, electronic angular momentum in diatomic molecules: classification of states, molecular orbitals energy level diagram for simple diatomic molecules.

Unit-III: Laser Physics

Spontaneous and stimulated emissions, population inversion, Resonator: modes of resonator, number of modes per unit volume, open resonator, quality factor, Laser pumping, ammonia maser, principal and working of Argon ion, CO_2 laser, and N_2 lasers. Characteristics of laser beam.

Holography: Recording of hologram, reconstruction of image, characteristics of holographs.

Unit-IV: Experimental Spectroscopy

Spectrum, Absorption and Emission Spectra, Subdivisions of Spectroscopy, Spectroscope, Spectrograph, Spectrometer, gratings. Detrmination of wavelength of a spectral line using the transmission grating. Grating mountings. Rayleigh criterion of resolution. Dispersive and resolving power. Resolving power of prism and grating. Prism and grating spectrographs. Prism and grating spectra. Constant deviation spectrometer. Light sources and detectors.

Reference Books:

- Introduction to Atomic Spectra, White, H.E. (McGraw-Hill)
- Atomic and Quantum Physics, Haken, H. & Wolf, H.C.,
- Haken, H. & Wolf, H.C., Atomic and Quantum Physics (Springer-Verlag)
- Banwell, C.A., Fundamentals of Molecular Spectroscopy (Tata McGraw-Hill)
- Hollas,J.M., Basic Atomic and Molecular Spectroscopy(RS.C)
- Laud, B.B. Lasers and Non-Linear Optics (Wiley Eastern)
- Wolfgang Demtröder, Atoms,Molecules and Photons
- Sawyer, R.A., Experimental Spectroscopy (Dover)
- Thorne, A., Litzen, U, Johansson, S, Spectrophysics (Springer)

Syllabus for B.Sc.(Hons.) VI Semester (Physics)

NANO-MATERIALS AND APPLICATIONS

Paper Code: PHB655

(Credits: Theory-04)
Theory: 48 Lectures, Tutorials-08

Unit-I: NANOSCALE SYSTEMS
Length scales in physics, Nanostructures: 1D, 2D and 3D nanostructures (nanodots, thin films, nanowires, nanorods)**,** Band structure and density of states of materials at nanoscale, Size Effects in nano systems, Quantum confinement: Applications of Schrodinger equation- Infinite potential well, potential step, potential box, quantum confinement of carriers in 3D, 2D, 1D nanostructures and its consequences.

Unit-II: SYNTHESIS AND CHARACTERIZATION OF NANOSTRUCTURE MATERIALS
SYNTHESIS: Top down and Bottom up approach, Photolithography. Ball milling. Gas phase condensation. Vacuum deposition. Physical vapor deposition (PVD): Thermal evaporation, E-beam evaporation, Pulsed Laser deposition. Chemical vapor deposition (CVD). Sol-Gel. Electro deposition. MBE growth of quantum dots.

CHARACTERIZATION: X-Ray Diffraction. Optical Microscopy. Scanning Electron Microscopy. Transmission Electron Microscopy. Atomic Force Microscopy. Scanning Tunneling Microscopy.

Unit-III: OPTICAL PROPERTIES AND ELECTRON TRANSPORT
OPTICAL PROPERTIES: Coulomb interaction in nanostructures. Concept of dielectric constant for nanostructures and charging of nanostructure. Quasi-particles and excitons. Excitons in direct and indirect band gap semiconductor nanocrystals. charging effects. Radiative processes: General formalization-absorption, emission and luminescence. Optical properties of heterostrctures and nanostructures.

ELECTRON TRANSPORT: Carrier transport in nanostrcutures. Coulomb blockade effect, thermionic emission, tunneling and hoping conductivity. Defects and impurities:Deep level and surface defects.

Unit-IV: APPLICATIONS
Applications of nanoparticles, quantum dots, nanowires and thin films for photonic devices (LED, solar cells). Single electron devices (no derivation). CNT based transistors. Nanomaterial Devices: Quantum dots heterostructure lasers, optical switching and optical data storage. Micro Electromechanical Systems (MEMS), Nano Electromechanical Systems (NEMS).

Reference books:

- C.P. Poole, Jr. Frank J. Owens, Introduction to Nanotechnology (Wiley India Pvt. Ltd.).
- S.K. Kulkarni, Nanotechnology: Principles & Practices (Capital Publishing Company)
- K.K. Chattopadhyay and A. N. Banerjee, Introduction to Nanoscience and Technology (PHI Learning Private Limited).
- Richard Booker, Earl Boysen, Nanotechnology (John Wiley and Sons).
- M. Hosokawa, K. Nogi, M. Naita, T. Yokoyama, Nanoparticle Technology Handbook (Elsevier, 2007).
- Bharat Bhushan, Springer Handbook of Nanotechnology (Springer-Verlag, Berlin, 2004).

Syllabus for B.Sc.(Hons.) VI Semester (Physics)
CLASSICAL DYNAMICS
Paper Code: PHB656

(Credits: Theory-04)
Theory: 48 Lectures, Tutorial:08

The emphasis of the course is on applications in solving problems of interest to physicists. Students are to be examined on the basis of problems, seen and unseen.

Unit-I:

Generalised coordinates and velocities.Hamilton's Principle, Lagrangian and Euler-Lagrange equations. Applications to simplesystems such as coupled oscillators.

Canonical momenta & Hamiltonian. Hamilton's equations of motion. Applications: Hamiltonian for a harmonic oscillator, particle in a central force field. Poisson brackets. Canonical transformations.

Unit-II: Special Theory of Relativity I

Postulates of Special Theory of Relativity. Lorentz Transformations. Minkowski space. The invariant interval, light cone and world lines. Space-time diagrams. Time-dilation, length contraction & twin paradox.

Four-vectors:space-like, time-like & light-like. Four-velocity and acceleration. Metric and alternating tensors. Four-momentum and energy-momentum relation. Doppler effect from a four vector perspective. Concept of four-force. Conservation of four-momentum. Relativistic kinematics. Application to two-body decay of an unstable particle.

Unit-III: Special Theory of Relativity II

The Electromagnetic field tensor and its transformation under Lorentz transformations: relation to known transformation properties of **E** and **B**. Electric and magnetic fields due to a uniformly moving charge. Equation of motion of charged particle & Maxwell's equations in tensor form. Motion of charged particles in external electric and magnetic fields.

Unit-IV: Electromagnetic Radiation and Wave Guides

Electromagnetic Radiation: Review of retarded potentials. Potentials due to a moving charge: Lienard Wiechert potentials. Electric & Magnetic fields due to a moving charge: Power radiated, Larmor’s formula and its relativistic generalisation.

Wave Guides: Planar optical wave guides. Planar dielectric wave guide. Condition of continuity at interface. Phase shift on total reflection. Eigenvalue equations. Phase and group velocity of guided waves. Field energy and Power transmission.

Reference Books:

- Classical Mechanics, H.Goldstein, C.P. Poole, J.L. Safko, 3rd Edn. 2002,Pearson Education.
- Mechanics, L. D. Landau and E. M. Lifshitz, 1976, Pergamon.
- Classical Electrodynamics, J.D. Jackson, 3rd Edn., 1998, Wiley.

- The Classical Theory of Fields, L.D Landau, E.M Lifshitz, 4th Edn., 2003, Elsevier.
- Introduction to Electrodynamics, D.J. Griffiths, 2012, Pearson Education.
- Classical Mechanics: An introduction, Dieter Strauch, 2009, Springer.