B. Sc. (HONS.) PHYSICS

DISTRIBUTION OF DIFFERENT COURSES AND CREDITS IN VARIOUS SEMESTERS

Offered By:

Department of Physics
Faculty of Science
Banaras Hindu University

Semester-wise Distribution of Courses and Credits

Semester	Course	Title	Credits	Remarks
I	BPT-101	Mechanics and Relativity	4	Minor Change
	BPL-101	Practical	2	
		Total	**6**	
II	BPT-201	Thermal Physics	4	
	BPL-201	Practical	2	
	Ancillary Physics I		2	Paper of 2 credits introduced
		Total	**8**	
III	BPT-301	Optics	4	Minor Change
	BPL-301	Practical	2	
		Total	**6**	
IV	BPT-401	Electronics and Modern Physics	4	Major Change
	BPL-401	Practical	2	
	Ancillary Physics - II		2	Paper of 2 credits introduced
		Total	**8**	
V	BPT-501	Mathematical Physics	3	
	BPT-502	Classical Mechanics	3	
	BPT-503	Quantum Mechanics	3	
	BPT-504	Electronic Devices and Circuits	3	
	BPT-505	Electromagnetic Theory	4	New Paper of 4 credits introduced
	BPL-501	Practical	3	
	BPL-502	Practical	3	
		Total	**22**	
VI	BPT-601	Statistical Mechanics	3	
	BPT-602	Solid State Physics	3	
	BPT-603	Elements of Nuclear Physics	3	
	BPT-604	Atomic Physics and Laser	3	
	BPE 601	Topics in Modern Physics	4	
		Or		
	BPE-602	Elementary Nano Science and Exotic Materials	4	
	BPL-601	Practical	3	
	BPL-602	Practical	3	
		Total	**22**	

Semester-wise Distribution of Courses and Credits

Semester	Course	Title	Credits
I	BPT-101	Mechanics and Relativity	4
	BPL-101	Practical	2
		Total	**6**
II	BPT-201	Thermal Physics	4
	BPL-201	Practical	2
	Ancillary Physics I		2
		Total	**8**
III	BPT-301	Optics	4
	BPL-301	Practical	2
		Total	**6**
IV	BPT-401	Electronics and Modern Physics	4
	BPL-401	Practical	2
	Ancillary Physics - II		2
		Total	**8**
V	BPT-501	Mathematical Physics	3
	BPT-502	Classical Mechanics	3
	BPT-503	Quantum Mechanics	3
	BPT-504	Electronic Devices and Circuits	3
	BPT-505	Electromagnetic Theory	4
	BPL-501	Practical	3
	BPL-502	Practical	3
		Total	**22**
VI	BPT-601	Statistical Mechanics	3
	BPT-602	Solid State Physics	3
	BPT-603	Elements of Nuclear Physics	3
	BPT-604	Atomic Physics and Laser	3
	BPE 601	Topics in Modern Physics	4
		Or	
	BPE-602	Elementary Nano Science and Exotic Materials	4
	BPL-601	Practical	3
	BPL-602	Practical	3
		Total	**22**

BPT-101: MECHANICS AND RELATIVITY Credits: 4

Mechanics:

Inertial and non-inertial frames of reference, Effect of centrifugal and Coriolis forces due to earth's rotation, Center of mass (C.M), Lab and C.M frame of reference, motion of CM of system of particles subject to external forces, elastic, and inelastic collisions in one and two dimensions, Scattering angle in the laboratory frame of reference, Conservation of linear and angular momenta.

Relativity:

Postulates of special theory of relativity, Derivation of Lorentz transformation and physical significance of Lorentz invariance, Length contraction and time dilation, Concept of simultaneity, Relativistic velocity transformation relations, mass energy relation, Concept of zero rest mass of photon, Relativistic relation between energy and momentum.

Mechanical Properties of Matter:

Modulus of rigidity, Poisson's ratio, relation connecting different elastic- constants, twisting couple of a cylinder(solid and hallow), Statical method (Barton's method), Dynamical method (Maxwell's needle) for determining the modulus of rigidity, Bending moment, Cantilever (neglecting mass), Young modulus by bending of beam, Viscosity, Poiseulle's equation of liquid flow through a narrow tube, Damped harmonic oscillations, Compound pendulum, Ballistic galvanometer.

Reference Books:

1. Physics Part –1: Resanick and Halliday.

2. Mechanics : D.S.Mathur.

3. Concept in Physics Vol. I : H.C.Verma.

4. Mechanics : R.K.Shukla and Anchal Srivastava.

BPT-201: THERMAL PHYSICS Credits: 4

Kinetic Theory:

Maxwell's speed distribution, Mean free path, Elementary treatment of transport phenomena, Viscous flow and Thermal conducion in gases. Real gases, Andrew's curves, Equation of state, Virial coefficients, Van der Waals equation, Critica constants.

Thermodynamics:

Reversible and irreversible processes, Examples of thermal, mechanical and chemical irreversibility, Carnot's cycle and Carnot's theorem. Second law of thermodynamics, Thermodynamic scale of temperature.

Concept of entropy, Entropy change in reversible and irreversible processes. Entropy and disorder, Principle of increase of entropy, Entropy and unavailable energy, Entropy of ideal gases, Entropy as a thermodynamic variable, S-T diagram.

Thermodynamic functions, Internal energy, Enthalpy, Helmholtz function and Gibb's free energy, Maxwell's thermodynamical equations and their applications, TdS equations, Energy and heat capacity equations Clapeyron equations.

Application to sublimation, vaporization and freezing processes, Heat capacity of saturated vapours, Thermodynamics of liquid surfaces and paramagnetic solids. Adiabatic demagnetization, Third law of thermodynamics, Nernst heat theorem.

Criterion of equilibrium of a system, Isolated system, System in contact with constant temperature reservoir. System in contact with constant temperature and pressure reservoir, Phase transition, Coexistence of phases, Triple point.

Joule-Thomson effect, Thermodynamic analysis, Inversion temperature, Thermodynamic equations for a Van der Waals gas. Liquefaction of gases. Regenerative principle, Properties of liquid helium, Introduction to superfluidity and superconductivity.

Radiation:

The blackbody spectrum, Wien's displacement law, Rayleigh-Jean's law, Planck's quantum theory of radiation.

Reference Books:

1. Heat and Thermodynamics: K.W. Zeemansky.
2. Thermal Physics: B.K. Agarwal.
3. Heat and Thermodynamics: Brij Lal and N. Subramanyam.
4. Heat and Thermodynamics: Dayal, Verma and Pandey.
5. A Treatise on Heat: M.N. Saha and B.N. Srivastava.

BPL-101 & BPL-201: LIST OF EXPERIMENTS* Credits: 2

Group I

1. Determination of Stefan's constant.
2. PN junction diode and Zener diode characteristics.
3. Determination of Young's modulus, modulus of rigidity and Poisson's ratio of material of a wire using Searle's method.
4. Determination of absolute capacity of a condenser.
5. Determination of Young's modulus of material of a metallic bar by bending of beam method.
6. To study series and parallel resonant L. C. R. circuit.
7. Determination of acceleration due to gravity using compound pendulum.
8. Determination of focal length of combination of lenses and nodal distance using nodal slide assembly.
9. Solar cell experiment.

Group II

1. Determination of internal resistance of micro ammeter and conversion of micro ammeter into voltmeter, milliammeter and Ohmmeter.
2. Determination of modulus of rigidity using Bortron's apparatus.
3. Construction of two-input 'OR' and 'AND' gates using diode logic and preparation of their truth tables.
4. Determination of viscosity of liquid using Poiseuille's method.
5. To study variation of magnetic field along the axis of Helmholtz Galvanometer and to determine reduction factor.
6. Determination of resistance per unit length and an unknown resistance using C. F. Bridge.
7. Determination of dispersive power of material of a prism.
8. Determination of temperature coefficient of resistance of material of a given coil.
9. Determination of thermal conductivity of a card-board by Lee's disc method.

* In Semester-I, half of the students will do the experiments of Group-I and the other half will do the experiments of Group-II. In Semester II, the students will exchange their groups. Addition and deletion in the list of experiments may be made from time to time by the department.

SEMESTER -II

ANCILLARY PHYSICS COURSE - I: FOR NON-PHYSICS STUDENTS

Credits: 2

Mechanics and General Properties of Matter:
Elasticity: Strain and stress, elastic limit, Hooke's law; Moduli (Young's, Bulk, Rigidity) and Poisson's ratio, Surface tension: Surface tension and surface energy, angle of contact, capillary action,

Flow of liquids and gases: Streamline and turbulent flow, Equation of continuity, Bernoulli's theorem and its application to biological system, Torricelli's theorem; Coefficient of viscosity, Stoke's law.

Radiation Effects on Biological Systems:
Electromagnetic spectrum, Ionizing radiations and their effect on biological systems, Effects of radiation relevant to Biology: Photosynthesis, Green House Effect, DNA Damage and Depletion of Ozone.

Reference Books:

1. University Physics: Sears and Zemansky.
2. The Feynman Lectures on Physics (Vols. 1 and 2): Feynman, Leighton and Sands.
3. Biological Physics: Nelson.

BPT-301: OPTICS Credits: 4

Interference:

Conditions for sustained interference, Theory of interference, Lloyd's mirror, Achromatic fringes. Interference in parallel and wedge shaped films, Colour of thin films. Newton's rings and Michelson interferometer and their applications. Multiple beam interference in parallel film and Fabry-Perot interferometer.

Diffraction:

Frenel's diffraction, Zone plate, diffraction due to straight edge. Fraunhoffer diffraction due to single and double slits, plane transmission grating Resolving power of grating, telescope and Microscope.

Polarization:

Polarized light and its mathematical representation, Production of polarized light by reflection, refraction and scattering. Polarization by double refraction and Huygen's theory, Nicol prism, Retardation plates, Production and analysis of circularly and elliptically polarized light. Optical activity and Fresnel's theory, Biquartz polarimeter.

Basic concepts of Laser

Reference Books:

1. Physical Optics: B. K. Mathur and T. P. Pandya.
2. A textbook of Optics: N. Subrahmanyam, Brijlal and M. N. Avadhanulu.
3. Geometrical and Physical Optics: Longhurst.
4. Introduction to Modern Optics: G. R. Fowels.
5. Optics: P. K. Srivastav.

BPT-401 ELECTRONICS AND MODERN PHYSICS Credit : 4

Properties of Materials

Dielectic constant, Polar and Non Polar dielectics, Dielectics and Gauss's Law, Dielectic Polarization, Electric Polarization vector P, Electric displacement vector D. Relation between three electric vectors, Dielectic susceptibility and permittivity, Polarizability and mechanism of Polarization, Lorentz local field, Classius Mossotti equation, Debye equation, Ferroelectric and paraelectric dielectics.

Magnetization and magnetization vector M, three magnetic vectors and their relationship, Magnetic permeability and susceptibility, Diamagnetic, paramagnetic and ferromagnetic substances. B.H. Curve, cycle of magnetization and hysteresis, Hysteresis loss.

Network Analysis:

Thevenin and Norton's theorems, concept of current and voltage sources, Transient response of LCR circuits. Differentiating and integrating circuits. High-pass, low–pass and band-pass filters. Analysis of series and parallel resonance circuits, quality factor.

Physics of Semiconductors:

Qualitative treatment of band formation in solids. Difference between metal, insulator and semiconductor. Intrinsic and extrinsic semi conductors. Concept of Fermi level. Generation and recombination of electron hole pairs in semiconductors. Mobility of electrons and holes, drift and diffusion currents.

p-n junction diode, depletion width and potential barrier, junction capacitance, I-V characteristics. Rectifiers, ripple factor, filter circuits, rectification efficiency and percentage regulation. Clipping and clamping circuits, Zener diode and voltage regulation.

Bipolar Junction Transistors:

Transistor circuits, Input and Output characteristics in CB and CE configurations, Early effect, α and β parameters; DC load line, operating point, biasing and bias-stabilization circuits; Transistor as an amplifier (CE Mode) and frequency response.

Cathode Ray Oscilloscope (CRO)

Cathode ray tube, deflection sensitivity, time-base and wave form display.

Modern Physics

Wave-particle duality, Photoelectric effect, Compton Effect, Matter waves and de-Brogle wavelength. X-ray and neutron diffraction and Bragg's Law. Electron waves and Davisson Germer experiment. Rutherford scattering and concept of nucleus, Elementary ideas of atomic and molecular spectra, Rydberg's constant and isotope effect.

Reference Books:

1. Electronic devices : T.L. Floyd
2. Modern Physics : A.P. Arya
3. Device and Circuits : J. Millman and C. Halkias.
4. Concepts of Modern Physics : A. Beiser
5. Electronic Fundamental and Applications: D. Chatopadhyay and P.C. Rakshit.
6. Electricity and Magnetism : K.K. Tiwari.

BPL-301 & BPL-401: LIST OF EXPERIMENTS* Credits: 2

Group-I

1. Determination of wavelength of sodium yellow line by Fresnal's Biprism.
2. Determination of specific rotation of cane sugar by polarimeter.
3. Determination of wavelength of mercury lines by diffraction grating.
4. Determination of minimum resolution power of a telescope to distinguish two close objects at a large distance.
5. Determination of self inductance of a coil by Anderson's bridge.
6. To draw characteristic curves of a triode valve.

Group-II

1. Determination of wavelength of sodium yellow line by Newton's rings.
2. To determine the Planck's constants by Wein's radiation formula using an LDR.
3. To determine diameter/thickness of a thin wire by diffraction method.
4. Measurement of energy band gap of Si using a p-n junction diode.
5. Determination of mutual inductance of a pair of coils.
6. Phase shift between the current and the applied voltage in (a) C.R., (b) L.R. (c) L.C.R. circuits using a CRO and an oscillator.
7. To draw the input and output characteristics of a p-n-p transistor.

* In Semester-III, half of the students will do the experiments of Group-I and the other half will do the experiments of Group-II. In Semester IV, the students will exchange their groups. Addition and deletion in the list of experiments may be made from time to time by the department.

SEMESTER -IV

Ancillary Physics Course - II: FOR NON- PHYSICS STUDENTS Credits: 2

Thermal Physics:

Thermodynamics: Laws of thermodynamics and interpretation, Relevance to biological systems, Entropy and disorder, free-energy and chemical potential. Elementary ideas of Brownian motion, equipartition energy, Phenomenon of Diffusion, Mean free path and drift speed.

Optics:

Light: Fermat's principle of least time, reflection and refraction.

Geometrical optics: Focal length of a spherical surface, Concave and convex mirror and lenses, magnification, compound lenses, telescope and microscope, Resolving power

(i) Interference: Young's double-slit experiment its application (ii) Diffraction: Fraunh offer and Fresnel diffraction; Grating and its resolving power (iii) Refractive index, dispersion and absorption (iv) Polarization and Polarisers, Birefringence Optical activity and its relevance to biological systems.

Reference Books:

1. University Physics: Sears and Zemansky.
2. The Feynman Lectures on Physics (Vols. 1 and 2): Feynman, Leighton and Sands.
3. Fundamentals of Optics: Jenkins and White.
4. Biological Physics: Nelson.

BPT-501: MATHEMATICAL PHYSICS Credits: 3

Curvilinear Coordinates:

Orthogonal curvilinear coordinates; differential operators, concept of a metric, spherical and cylindrical coordinates and their unit vectors.

Tensor Analysis:

Introduction to tensors, Cartesian, covariant and contravariant tensors; contractions and direct products, Examples: pseudo, dual, isotropic, symmetric and anti-symmetric tensors.

Matrices:

Hermitian, orthogonal and unitary matrices, inverse of a matrix, similarity transformations, Eigenvalue problems and diagonalization of matrices (Examples: non-degenerate and degenerate cases).

Differential Equations:

Second order homogeneous differential equations and their series solution (example: Bessel equation), linear independence of two solutions (Wronskian), Integral and power series methods for second solution.

Special Functions:

Bessel, Legendre (spherical harmonics), Hermite and Laguerre: generating functions and recurrence relations, orthonormality conditions, Dirac delta function.

Fourier Analysis:

Fourier theorem, Fourier analysis of square wave, saw-tooth wave, plucked strings, half wave/full wave rectifier wave forms

Reference Books:

1. Mathematical Methods for Physicists: Arfken and Weber.
2. Mathematical Physics: P. K. Chattopadhyay.
3. Mathematical Methods in Physical Sciences: Boas.
4. Mathematics for Physicists and Engineers: Pipes.

BPT-502: CLASSICAL MECHANICS Credits: 3

System of particles, Constraints, Generalized coordinates, D'Alemberts principle and Lagrange's equation, Velocity dependent potential of electro-magnetic field.

Calculus of Variation, Hamilton's principle, Lagrange's equation, Lagrangian for simple systems, Cyclic coordinates, symmetries and conservation laws. Advantages of Lagrangian: electro-mechanical analogies, Lagrange's undetermined multipliers, Lagrange's equation for nonholonomic systems, Virial theorem, Principle of mechanical similarity.

Legendre transformations and Hamilton's equations of motion, Hamiltonian for a charge particle in Electro-magnetic field, Cyclic coordinates and conservation laws, Poisson Brackets, Jacobi Identity, Canonical transformation.

Hamilton-Jacobi theory, Action-Angle variables, related problems.

Two body central force problem, reduction to the equivalent one body problem, Differential equation for the orbit and integrable power law potentials, Condition for stable circular orbit, Kepler problems.

Reference Books:

1. Classical Mechanics: H. Goldstein.
2. Mechanics: L . D. Landau and E. M. Lifshitz
3. Introduction to Classical Mechanics: R. G. Takwale and Puranik.
4. Classical Mechanics of Particles and Rigid Bodies: K. C. Gupta.
5. Introduction to Classical Mechanics: N. C. Rana and P. Joag.

BPT-503: QUANTUM MECHANICS Credits: 3

Limits of Classical Physics:

Black body radiation (without derivation), Photoelectric effect, Compton effect.

Wave Packets and Uncertainty Relation:

de Broglie hypothesis, Wave-particle duality, Davisson-Germer experiment, Wave packets, Group velocity and phase velocity, Uncertainty principle, Complimentarity.

Wave Mechanics:

Schrödinger equation, Physical interpretation of wave function, Probability current density and conservation of probability, Free particle wave function, Schroedinger equation in the presence of a potential, Linear operators, Hermitian operators, Observables, Eigenvalues and Eigenfunctions, Expectation values, Ehrenfest's theorem, Stationary states, Superposition principle, Commutation relations, Commuting observables and compatibility.

Application of Schrödinger Wave Equation:

Particle in one dimensional Box, Square well, Rectangular potential barrier and tunnelling, Linear harmonic oscillator, Spherically symmetric potential, Angular momentum operators and their eigen functions, Concept of spin, Hydrogen atom.

Reference Books:

1. Quantum Physics: S. Gasiorowicz.
2. Quantum Mechanics: B. H. Bransden and C. J. Joachain.
3. Quantum Physics of Atoms, Molecules, Nuclei and Solids: R. M. Eisberg and R. Resnick.
4. Quantum Mechanics: V. Devanathan.
5. Quantum Mechanics: C. S. Chaddha.

BPT-504: ELECTRONIC DEVICES AND CIRCUITS Credits: 3

Electronic Devices:

Field effect transistors, I-V Characteristics of JFET and MOSFET, FET biasing, FET as an amplifier. Silicon controlled rectifier, I-V Characteristics, phase controlled rectifier. Unijunction transistor, I-V Characteristics , relaxation oscillator. Operational amplifier (block diagram),characteristics parameters, inverting and noninverting amplifier. Cathode ray oscilloscope. Photo diode, Light emitting diode and solar cell.

Analog Circuits:

Hybrid parameter model of transistor, analysis of transistor amplifier (with and without RS and RL) using h-parameters, simplified hybrid model, brief idea about hybrid model. Single stage amplifier in CE,CB and CC modes. RC coupled CE amplifier and its frequency response, tuned voltage amplifier. Power amplifier classification, distortion and efficiency, push pull amplifier, Feedback in amplifiers, positive and negative feedback, effect of negative feedback on the characteristics of different types of amplifiers, voltage and current series feedback circuits.
Barkhausen criterion of oscillations, tuned collector oscillator, Hartley / Colpitt oscillator, phase shift oscillator and multiuvibrators.
Need and types of modulation, amplitude modulation, analysis of A.M. wave, modulator and demodulator circuits.

Digital Circuits:

Boolean algebra, logic gates, NAND and NOR gates as universal gates. Simplification of Boolean expressions using K- maps. Half and full adders and subtractors.

Reference Books:

1. Electronics Fundamental and Application: Chattopadhyay and Rakshit.
2. Principle of Digital Electronics: Malvino and Leach.
3. A Text Book of Electronics: Kakani and Bhandari.
4. Electronic Devices: T.L. Floyd.
5. Integrated Electronics: Millman and Halkias.

BPT-505: ELECTROMAGNETIC THEORY **Credits: 4**

Vector Calculus:

Concept of gradient, divergence and curl operators; Gauss divergence theorem, Stokes theorem and related problems.

Boundary Value Problems

Laplace & Poisson's equation, boundary condition, solution through method of images.

Electromagnetism:

Laws of Electromagnetism (Gauss law of electricity, Gauss law of magnetism, Faraday' law of electromagnetic induction, Ampere's circuital law); Concept of different charge and current densities (free charges, bound charges); Displacement current and generalized Ampere's law; Equation of continuity, Maxwell's equations in differential form; Electric and magnetic polarization vectors and their mutual relationship; Vector and scalar potentials, Poynting theorem and energy conservation (qualitative idea of momentum conservation).

EM wave propagation:

EM wave equation and their solutions; Polarization of EM wave; Propagation of plane EM waves in different media: free space, dielectrics and conductors; Laws of reflection, transmission at normal and oblique incidence in linear media and conducting media (Fresnel's equations), total internal reflection and Brewster angle, Problems.

Guided E.M. Wave Propagation:

Propagation of e.m. wave through transmission line, reflection coefficient, standing wave, characteristic impedance, propagation constant. Rectangular waveguides. Expressions for field components, TE, TM & TEM modes. Propagation properties, cutoff frequency, group & phase velocity, Problems.

Reference Books:

1. Introduction to Electrodynamics (3^{rd} Edition): David J. Griffiths.
2. EM Waves and Fields: P. Lorrain and O. Corson.

BPT-601: STATISTICAL MECHANICS — Credits: 3

Random Walk Problem:

Probability distribution, calculation of mean and dispersion (as a measure of fluctuation), and simple numerical problems.

Basics of Statistical Mechanics:

State of a system (Microscopic and Macroscopic); Phase space, density of states and Liouville's theorem; Postulates of statistical mechanics; Relation between statistical and thermodynamic parameters.

Classical Statistical Mechanics:

Ensemble theory (Micro-canonical, Canonical and Grand-canonical), applications to classical ideal gas and simple numerical problems; Gibbs paradox; Statistical equivalence of three ensembles.

Quantum Statistical Mechanics:

Introduction to Bose-Einstein and Fermi-Dirac statistics; Maxwell-Boltzmann statistics as a classical limit; Comparison of the three statistics; Qualitative features of degenerate Fermi and Bose gases.

Reference Books:

1. Fundamentals of Statistical and Thermal Physics: Frederick Reif.
2. Statistical Mechanics (2nd Edition): R.K. Pathria.
3. Equilibrium Statistical Physics: Michael Plischke and Birger Bergersen.
4. Statistical Mechanics: (Wiley): Kerson Huang.

BPT-602: SOLID STATE PHYSICS Credits: 3

Structure and Symmetry:

Elements of external symmetry of crystals, space lattice, Bravais lattices, Miller indices for direction and planes, Common crystal structures: NaCl, CsCl, ZnS and Diamond, Close packed structures, elementary idea of quasicrystals and amorphous materials.

Diffraction of x-rays, Laue equations and Braggs law, reciprocal lattice, Brillouin Zones and Ewald construction, atomic scattering and structure factors.

Elementary idea of bonding in solids, Lennard Jones potential.

Lattice Vibrations:

Vibrational modes of continuous medium, Density of states, Einstein’s and Debye's theory of specific heat, Vibrations of one dimensional monoatomic and diatomic chain, Phonons.

Electronic Properties:

Theory of free electron gas, Fermi surface, Electrons in periodic potential, Kronig-Penny model, Bloch theorem, energy bands, metals, insulators and semiconductors, Motion of electron in electric and magnetic fields, Hall Effect.

Magnetic Properties:

Origin of magnetism, Langevin's theory, Quantum theory of paramagnetism, Curie-Brilloun law, Weiss Molecular theory, ordering of spins, Heisenberg model, spin waves, dispersion relation of magnons, ferromagnetic domains.

Reference Books:

1. Crystalloraphy for Solid State Physics: A. R. Verma and O.N. Srivastava.
2. Introduction to Solids: Azaroff.
3. Solids State Physics: C. Kittel.
4. Solids State Physics: Ashcroft and Mermin.
5. Solids State Physics: Decker.
6. Solid State Physics ---An Introduction to principles of Materials Science: H. Ibach & H. Luth (Springer)

BPT-603: ELEMENTS OF NUCLEAR PHYSICS Credits: 3

Properties of Nuclei and Models:

Introduction to the nucleus, Fermi gas model, Binding energy, Bethe-Weizsaecker mass formula and its application to explain most stable isobars and nuclear fission, Inferences of nuclear size from elastic electron-nucleus experiments (no derivation).

Nuclear Force and Two-nucleon System:

Properties of nucleon-nucleon interaction, General forms of N-N potential, Description of low energy neutron-proton scattering to show the spin dependence of nuclear force, Ground state properties of deuteron, Simple consideration of deuteron using central potential (square well).

Nuclear Stability:

Nucleon emission, separation energy, Alpha decay and its energy spectrum, Q-value, Gamow's theory of alpha decay (no derivation), Beta decay and its energy spectrum (for example, $_{137}$Cs), Need for neutrinos, Q-value for beta decay, Gamma decay, Selection rules for gamma transitions (no derivation).

Accelerators and Detectors:

Van de Graaff and Linear accelerators, Synchrotrons, Geiger-Mueller detector, Scintillation detector.

Elementary Particles:

Classification of particles and their interactions, Quantum numbers, Quarks as the building blocks of hadrons, colour degree of freedom.

Reference Books:

1. Introductory Nuclear Physics: S. S. M. Wong.
2. Nuclear Physics: V. Devanathan.
3. Concepts of Nuclear Physics: B. L. Cohen.
4. Fundamentals of Nuclear Physics: B. B. Srivastava.
5. Introduction to Nuclear Physics: H. A. Enge.

BPT-604: ATOMIC PHYSICS AND LASERS Credits: 3

Atomic Physics:

Brief review of Bohr and Sommerfeld model of atom. Effect of finite nuclear mass in relation to Rydberg constant. Idea of discrete energy levels and electron spin: Fanck – Hertz and Stern – Gerlach experiments Significance of four quantum numbers and concept of atomic orbitals.

One valence electron atom:

Orbital magnetic dipole moment, Orbital, spin and total angular momenta, Larmor precession, Vector model of atom, Electronic configuration and atomic states, Spin-orbit interaction and fine structure, Intensity of spectral lines, General selection rules. Normal Zeeman Effect. Two valence electron atoms: LS and JJ coupling schemes and resulting spectra. Idea of normal and inverted doublet. Basics of stark effect.

Lasers and Non-Linear Optics:

Einstein coefficients, Threshold condition for LASER action, Rate equation for three level laser system, Characteristics of laser radiation. He-Ne and Nd-YAG Laser. Significance of non-linear polarization of lasers and some applications: Second harmonic generation using non-linear optical methods.

Reference Books:

1. Quantum Physics of Atoms, Molecules, Solids, Nuclei, and Particles: Robert Eisberg and Robert Resnick.
2. Introduction to Atomic Spectra: H.E. White.
3. Principles of Lasers: Orazio Svelto.
4. Atom, Laser & Spectroscopy : S.N.Thakur and D.K.Rai

BPE – 601: TOPICS IN MODERN PHYSICS Credits: 4

Theory of Relativity:

Gravitational red-shift, Doppler effect in relativity, Four dimensional space and concept of fourvector, Transformation properties of four-momentum and four-force, Vector and scalar potentials and Gauge transformation, Four-potential and four-current, Transformation relations for E and B, Invariance of Maxwell's equations.

Astrophysics and Cosmology:

Introduction to the Universe, Expansion of the Universe, The Hertzprung-Russell Diagram, The cosmic microwave background radiation, The Big Bang Hypothesis, Nucleosynthesis: formation of nuclei and atoms, Formations of Galaxies and Stars, Thermal Nuclear Reaction, Astrophysical processes : H and He burning, the r-process, the rp-process, Chandrashekhar-limit, White Dwarf, Neutron star and Black Hole, Dark Matter and Dark Energy.

Atoms, Nuclei and Solids:

Rutherford scattering (detailed derivation), Compton scattering and comparison with Raman scattering, Mössbauer effect, Solid state detectors, Mass spectrometer (illustrated by Bainbridge and Aston spectrometer), Charge particles in magnetic field, Landau levels.

Reference Books:

1. Elementary Modern Physics: A.P. Arya.
2. Introduction to Special Relativity : Robert Resnick.
3. Modern Physics: K.S. Krane.
4. Modern Physics: J. Bernstein, P.M. Fisshbane, Stephen Gasiorowicz.
5. Solid State Physics: N.W. Ashcroft and N.D. Mermin.
6. Cauldrons in the Cosmos: Nuclear Astrophysics: Clous E Rolf and William S. Rodney.

BPE-602: ELEMENTS OF NANOSCIENCE AND EXOTIC MATERIALS Credits: 4

Background Physics for Nano and Exotic Materials :

Electron Band Structure and Its Modification due to change in dimensionality. Phonon absorption in Nanomaterials.

Nano Materials:

Physical, Chemical and Bio-routes for Synthesis of Nanomaterials, Experimental Techniques for Characterization of Nanomaterials, Metal Nanoparticles, Carbon Nanostructures, Electronic Properties of Nanomaterials, Some applications of Nano Materials.

Exotic Materials:

High Temperature Superconductors and Colossal Magnetoresistance Materials. Meissner Effect, Discovery of HTSC Materials, Structure and Properties of HTSC Materials, Elements of Proposed Mechanisms of high temperature superconductivity, Elementary Concepts of CMR Materials, Double Exchange Mechanism , Some Application of CMR material based devices.

Quasicrystals:

Basic definition of quasicrystal, Fibonaci Sequence, Penose Tiling and its Relevance to Structure of Quasicrystals.

Reference Books:

1. Introduction to Solid State Physics (VI Edition): Charles Kittel.
2. Introduction to Nanotechnology: C.P. Poole and F.J. Owens.
3. Nanobiotechnology : Concepts, Applications and Perspectives (Eds. C.M. Niemeyer and C.A. Mikin).

LIST OF EXPERIMENTS*

Group – I

BPL-501 **Credits: 3**

1. To determine the ionic magnetic moment of Ni-ion in $NiSO_4$ solution (Magnetic susceptibility)
2. To determine the wavelength and speed of ultrasonic wave by method of Acoustic grating.
3. To draw the dispersion curve for the constant deviation prism spectrograph using the spectral lines of iron as standard and to determine the wave length of Copper lines.
4. To determine the Cauchy's constant for the material of a given prism using the spectrometer.
5. (a) To determine the angle of a given wedge using given laser beam.
   (b) To determine the refractive index of water using hollow prism.
6. To study the Hall Effect and to calculate the different parameter like Hall Coefficient, carrier density & mobility.

BPL-502 **Credits: 3**

1. Experiment on logic gates- Verification of laws of Boolean algebra.
2. Transient response of LCR circuit and determination of quality factor.
3. Experiment of negative feedback amplifier.
4. Power supply and filter characteristics.
5. Design of Zener regulated power supply.
6. Characteristics of SCR and its application as phase control rectifier

Group –II

BPL-601 **Credits: 3**

1. To determine Planck's constant 'h' using a photoelectric cell and a direct reading potentiometer.
2. (a) To draw the operating characteristic of Geiger Muller counter.
   (b) To determine the dead time of the counter by the two source Method.
3. To draw the Hysteresis loop of the given specimen and to determine the Energy loss per unit volume per cycle of magnetization with Universal B-H curve Tracer.
4. To determine the wavelength of yellow line of sodium and the wavelength Difference between the two components of this line using Michelson Interferometer.
5. To draw the dispersion curve for the grating spectrograph using the Spectral lines of iron as standard and to determine the wavelength of the Bands of ALO and to compare them with the standard value given in the Chart.
6. To calibrate the given constant deviation spectrometer (CDS) with the help of mercury lines and to calculate the Rydberg constant and series limit of Balmer series using hydrogen lamp.
7. To calculate the Numerical aperture and the bending loss using the fiber optics kit.

BPL-602 **Credits: 3**

1. Positive feedback- Hartley and phase shift oscillator.
2. Amplitude modulation and demodulation characteristics.
3. Characteristics of FET and MOSFET and their application as amplifier.
4. Wave shaping circuits.
5. Characteristics of UJT and its application as relaxation oscillator.

* In Semester-V, half of the students will do the experiments of Group-I and the next half will do the experiments of Group-II. In Semester- VI the students will exchange their groups. Addition and deletion in the list of experiments may be made from time to time by the department.