GLA UNIVERSITY
MATHURA
Established vide U.P. Act 21 of 2010.

Course Structure
of
Physics Department

B.Sc (H) Physics

(w.e.f. 2020-21 as per CBCS)

UPDATED

[DEPARTMENT OF PHYSICS]

[Institute of Applied Sciences & Humanities]

Course Structure of B.Sc (H) Physics I Year

First Semester

S. NO.	CODE	SUBJECT	TEACHING SCHEME			CREDITS
			LECTURE	TUTORIALS	PRACTICALS	
1.	BPHS0011	Mechanics and Relativity	3	2	0	4
2.	BPHS1005	Ancillary Physics - I	3	2	0	4
3.	BCHC1002	General Chemistry - I	3	2	0	4
4.	BMAS0502	Algebra & Calculus	3	0	0	3
5.	BELH0007	English Language Skills-I	3	0	0	3
6.	BCSO0005	Fundamentals of Computers	2	0	0	2
7.	BPHS1805	Physics Lab-I	0	0	4	2
8.	BCHC1901	Chemistry Lab-I	0	0	4	2
9.	BCSO0074	Fundamentals of Computer Lab	0	0	2	1
		TOTAL CREDITS	**17**	**6**	**10**	**25**

Second Semester

S. NO.	CODE	SUBJECT	TEACHING SCHEME			CREDITS
			LECTURE	TUTORIALS	PRACTICALS	
1.	BPHS0012	Heat and thermodynamics	3	2	0	4
2.	BPHS1006	Ancillary Physics -II	4	0	0	4
3.	BCHC1004	General Chemistry-II	3	2	0	4
4.	BMAS0503	Applied Mathematics and Statistics	3	0	0	3
5.	BELH0008	English Language Skills-II	3	0	0	3
6.	BCSK1006	Introduction to Programming	3	0	0	3
7.	BPHS1806	Physics Lab-II	0	0	4	2
8.	BCHC1902	Chemistry Lab-II	0	0	4	2
9.	BCSO0075	Programming Lab-II	0	0	2	1
		TOTAL CREDITS	**19**	**4**	**10**	**26**

Course Structure of B.Sc (H) Physics II Year

Third Semester

S. NO.	CODE	SUBJECT	TEACHING SCHEME			CREDITS
			LECTURE	TUTORIALS	PRACTICALS	
1.	BPHS0013	Basic Electronics	3	2	0	4
2.	BPHS0014	Electricity and Magnetism	3	2	0	4
3.	BPHS0015	Modern Physics	3	2	0	4
4.	BPHS0016	Elementary Statistical Mechanics & Thermal Physics	3	2	0	4
5.	BCHS0201	Environmental Studies	2	0	0	2
6.	BPHS0807	Electronics Lab	0	0	4	2
7.	BPHS0808	Electrical Lab	0	0	4	2
8.	BPHS0050	Project - I	0	0	0	3
		TOTAL CREDITS	**14**	**8**	**8**	**25**

Fourth Semester

S. NO.	CODE	SUBJECT	TEACHING SCHEME			CREDITS
			LECTURE	TUTORIALS	PRACTICALS	
1.	BPHS0017	Elementary Solid State Physics	3	2	0	4
2.	BPHS0018	Elementary Quantum Mechanics	3	2	0	4
3.	BPHS0019	Atomic Physics	3	2	0	4
4.	BPHS0020	Elements of Nuclear Physics	3	2	0	4
5.	BPHS0809	Solid State Physics Lab	0	0	4	2
6.	BPHS0810	Optics Lab	0	0	4	2
7.	BPHS0051	Project - II	0	0	0	3
		TOTAL CREDITS	**12**	**8**	**4**	**23**

Course Structure of B.Sc (H) Physics III Year

Fifth Semester

S. NO.	CODE	SUBJECT	TEACHING SCHEME			CREDITS
			LECTURE	TUTORIALS	PRACTICALS	
1.	BPHS0021	Mathematical Physics	4	0	0	4
2.	BPHS0022	Classical Mechanics	4	0	0	4
3.	BPHS0023	Quantum Mechanics	4	0	0	4
4.	BPHS0024	Electronic Devices And Circuits	4	0	0	4
5.	BPHS0811	Modern Physics Lab - I	0	0	4	2
6.	BPHS0812	Modern Physics Lab - II	0	0	4	2
7.	BPHS0052	Project - III	0	0	0	4
		TOTAL CREDITS	**16**	**0**	**4**	**24**

Sixth Semester

S. NO.	CODE	SUBJECT	TEACHING SCHEME			CREDITS
			LECTURE	TUTORIALS	PRACTICALS	
1.	BPHS0025	Electromagnetic theory	4	0	0	4
2.	BPHS0026	Statistical Mechanics	4	0	0	4
3.	BPHS0027	Solid State Physics	4	0	0	4
4.	BPHS0028	Nuclear Physics	4	0	0	4
5.	BPHS0813	Advanced Physics lab	0	0	4	2
6.	BPHS0053	Project – IV	0	0	0	4
		TOTAL CREDITS	**16**	**0**	**2**	**22**

DETAILED SYLLABUS

BPHS0011: MECHANICS AND RELATIVITY

Credits: 04 **Semester I** **L–T–P : 3–2–0**

Module No.	Content	Teaching Hours (Approx.)
I	**Mechanics:** Conservation of momentum and Energy. Moment of inertia of rigid-bodies: solid sphere, solid cylinder, solid rod, hollow cylinder, parallel axis theorem and perpendicular axis theorem, radius of gyration, 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. **Mechanical Properties of Matter - I:** Modulus of rigidity, Poisson's ratio, relation connecting different elastic- constants, elastic behavior of solids, different types of elasticity, twisting couple of a cylinder (solid and hallow),	24
II	**Mechanical Properties of Matter – II:** Statistical 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. **Relativistic Mechanics:** 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, mass- energy relation, Concept of zero rest mass of photon, Relativistic relation between energy and momentum, massless particles, relativistic momentum and force.	24

Reference Books/ Text Books :

* Physics Part –1: Resanick and Halliday.
* Mechanics : D.S.Mathur.
* Concept in Physics Vol. I : H.C.Verma.
* Mechanics : R.K.Shukla and Anchal Srivastava
*Classical Mechanics: J.C Upadhyay

BPHS1005: ANCILLARY PHYSICS - I

WAVES AND OSCILLATIONS

Credits: 03 **Semester I** **L–T–P : 3–0–0**

Module No.	Content	Teaching Hours (Approx.)
I	**Wave motion:** Type of mechanical wave, wave length, frequency and wave number, progressive harmonic wave, differential equation of wave motion, energy density of plane progressive wave, superposition of wave, beats, propagation of longitudinal and transverse vibration along string, modes of vibration, Fourier's theorem, La'place correction of Newton's formula, group velocity and phase velocity **Simple Harmonic Motion - I:** Periodic and harmonic motion, simple harmonic motion, energy of harmonic oscillator, average value of kinetic and potential energy of H.O. mass spring system.	24
II	**Simple Harmonic Motion - II:** Two body harmonic oscillator, oscillation of diatomic molecule, time period of pendulum of large amplitude. Kapler's laws and its applications, equation of orbit, anharmonic motion. **Damped and forced Harmonic Motion:** Frictional effects-(damping), damped harmonic oscillator, power dissipation, quality factor (Q), example of damped H.O, driving (forced) harmonic oscillator, sharpness of resonance, phase of driving Oscillator, Velocity resonance, half width of resonance curve, power absorption. **S**uperposition principle driving L-C-R circuit, parallel resonance circuit, example and application.	24

Reference Books/ Text Books

* Physics Part –1: Resanick and Halliday.
* Mechanics : D.S.Mathur.
* Concept in Physics Vol. I : H.C.Verma.
* Mechanics : R.K.Shukla and Anchal Srivastava
*Classical Mechanics: J.C Upadhyay

BPHS1805

PHYSICS LAB – 1

(B.SC. (H) PHYSICS – I YEAR)

Credits: 01 **Semester I** **L–T–P : 0–0–1**

1. Determination of modulus of rigidity and Poisson's ratio of material of a wire using Searle's method.
2. Determination of Young's modulus of material of a metallic bar by bending of beam method.
3. Determination of modulus of rigidity using Borton's apparatus.
4. Determination of viscosity of liquid using Poiseuille's method.
5. Determination of acceleration due to gravity using compound pendulum.
6. Determination of internal resistance of micro ammeter and conversion of micro ammeter into voltmeter, milliammeter and ohmmeter.
7. Determination of resistance per unit length and an unknown resistance using C.F.Bridge.
8. To determine specific resistance of wire by Carey Foster bridge.
9. Determination of absolute capacity of a condenser.
10. To study variation of magnetic field along the axis of Helmholtz Galvanometer and to determine reduction factor.
11. Determination of Energy band gap in a semiconductor diode.
12. To study series and parallel resonant L.C.R circuit.
13. Calibrations of Ammeter by using potentiometer.
14. Calibrations of Voltmeter by using potentiometer.

BPHS0012: Heat and Thermodynamics

Credits: 4 **Semester II** **L-T-P: 3-2-0**

Module No.	Content	Teaching Hours (Approx.)
I	**(Thermal radiation) :** Maxwell's speed distribution, Mean free path, Elementary treatment of transport phenomena, Viscous flow and Thermal conduction in gases. Real gases, Andrew's curves, Equation of state, Virial coefficients, Van der Waals equation, Critical constants, The blackbody spectrum, Wien's displacement law, Rayleigh-Jean's law, Planck's quantum theory of radiation. **(Thermodynamics-I) :** Zeroth and First law of thermodynamics, Carnot's cycle and Carnot's theorem. Second law of thermodynamics. Concept of entropy, Entropy change in reversible and irreversible processes. Entropy and disorder.	24
II	**(Thermodynamics-II) :** Principle of increase of entropy, 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. 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. Liquification of gases, Properties of liquid helium, Introduction to super-fluidity and superconductivity.	24

Reference Books/ Text Books

*Heat and Thermodynamics: K.W. Zeemansky.
*Thermal Physics: B.K. Agarwal.
*Heat and Thermodynamics: Brij Lal and N. Subramanyam.
*A Treatise on Heat: M.N. Saha and B.N. Srivastava.

BPHS1006: ANCILLARY PHYSICS -II

Optics

Credits: 4 **Semester II** **L-T-P: 4-0-0**

Module No.	Content	Teaching Hours (Approx.)
I	**Interference:** Young's experiment, Coherent source, theory of interference fringes, Fresnel biprism, determination of wavelength, Newton's ring, Conditions for sustained interference, Theory of interference, Lloyd's mirror, Interference in parallel and wedge shaped films, Colours of thin film, Newton's rings , Multiple beam interference in parallel film, Fabry-Perot interferometer. **Diffraction I:** Frenel's and Fraunhoffer diffraction, Zone plate, diffraction due to straight edge. Fraunhoffer diffraction due to single..	24
II	**Diffraction II:** N-slits(grating), maximum number of order with plane transmission grating, angular half width of principal maxima, Resolving and dispersive 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 concept of Laser, Eisenstein's coefficients.	24

Reference Books/ Text 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

BPHS0805

PHYSICS LAB – 2

(B.SC. (H) PHYSICS – I YEAR)

Credits: 01 **Semester II** **L–T–P : 0–0–1**

1. Determination of Stefan's constant.
2. Determination of temperature coefficient of resistance of material of a given coil.
3. Determination of thermal conductivity of a card-board by Lee's disc method.
4. PN junction diode and Zener diode characteristics.
5. To draw the input and output characteristics of a p-n-p transistor.
6. Construction of two-input 'OR' and 'AND' gates using diode logic and preparation of their truth tables.
7. Determination of self inductance of a coil by Anderson's bridge.
8. Determination of focal length of combination of lenses and nodal distance using nodal slide assembly.
9. Determination specific rotation of cane sugar by polarimeter.
10. Determination of wave length of sodium yellow line by Fresnal's biprism.
11. Determination of wavelength of mercury lines by diffraction grating.
12. Determination of wavelength of sodium yellow line by Newton's rings.
13. To determine diameter/thickness of a thin wire by diffraction method.
14. To determine the plank's constant by Wein's radiation formula using an LDR or (photo cell)

BPHS0013: BASIC ELECTRONICS

Credits: 04 **Semester III** **L–T–P : 3–2–0**

Module No.	Content	Teaching Hours (Approx.)
I	**Semiconductors:** Intrinsic, Extrinsic, P and N type semiconductors. Concept of Energy Levels (in different solids), Fermi Level and Impurity Level. Mobility, Concept of Drift velocity, Conductivity (Temperature Dependence). **Diode**: PN Junction, Potential Barrier Formation, Derivation for Barrier Potential, Barrier Width and Current, Diode Equation, Current Flow Mechanism in Forward and Reverse Biased Diode. Breakdown (Zener and Avalanche). **Diode Applications:** Rectifier Diode, Half-wave Rectifiers. Centre-tapped and Bridge Full-wave Rectifiers, Ripple Factor and Efficiency, Zener Diode and Voltage Regulation. Other important diodes (1) LED, (2) Photo diode and (3) Solar Cell). **Transistors:** BJT and its type: n-p-n and p-n-p, I-V characteristics of CB and CE Configurations. Active, Cutoff and Saturation Regions. Current gains α and β. AC and DC Analysis of Transistor: DC Load line and Q-point. Physical Mechanism of Current Flow. Transistor as an Amplifier. Transistor Biasing and Stabilization Circuits. Fixed Bias and Voltage Divider Bias.	24
II	**Amplifiers:** Need of Transistor Biasing and Stabilization Circuits. Fixed Bias and Voltage Divider Bias. RC-coupled amplifier and its frequency response. Direct coupled (DC amplifier), Concept of Feedback in Amplifiers, Positive and Negative Feedback. Effect of negative feedback on Input Impedance, Output Impedance, Gain, Stability, Distortion and Noise. **Filters:** L, T and Pi networks. Concept of Low pass, High Pass, Band Pass, Band Stop filters, Filter characteristics. **Integrated Circuits:** Introduction to integrated circuits, hybrid & monolithic IC, Classifications of IC (SSI, MSI, LSI, VLSI etc) **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.	24

Reference Books/ Text Books

1. Introductory Circuit Analysis, Robert L. Boylestad, Twelfth edition, Pearson, 2012.
2. A Handbook of Electronics, Gupta & Kumar, Pragati Prakashan, Meerut.
3. Electronic Devices and Circuit Theory Introductory Circuit Analysis, Robert L. Boylestad and Louis Nashelsky, Pearson, Tenth Edition, 2007.

BPHS0014: ELECTRICITY AND MAGNETISM

Credits: 04 **Semester III** **L–T–P : 3–2–0**

Module No.	Content	Teaching Hours (Approx.)
I	**Electric Field and Potential:** Electric Field, Superposition Principal, E. Field due to Charge Distribution: Wire, Ring, Disk. Electric Flux, Gauss's Theorem and its Application. Electric Potential. Electrostatic Energy and Force on Charged Conductor. Electric Dipole: Electric Field and Potential, Force and Torque on Dipole in External Field. Method of Images and its application to: (1) Plane Infinite Sheet and (2) Sphere. Capacitance, Energy Stored in Capacitor, Parallel-Plate, Cylindrical and Spherical Capacitor. Dielectric Materials, Capacitor filled with dielectrics. **Dielectric Properties of Matter:** Electric Field in Matter, Polarization (**P**). Electrical Susceptibility and Dielectric Constant. Displacement Vector **D**. Relations between **E, P** and **D**. Gauss's Law in dielectrics.	24
II	**Magnetic Field:** Magnetic Field, Magnetic Force, Charge Particle in M. Field, Hall Effect. Biot-Savart's Law and its Applications. Current Loop as a Magnetic Dipole and its Dipole Moment (Analogy with Electric Dipole). Force and Torque on a Current Loop. Ampere Law and its Applications. **Magnetic Properties of Materials**: Magnetization Vector (**M).** Magnetic Intensity (**H),** Magnetic Susceptibility. Relation between **B, H** and **M**. Diamagnetism, Paramagnetism and Ferromagnetism. BH curve and Hysteresis. **Electromagnetic Induction:** Faraday's Law. Lenz's Law. Self Inductance and Mutual Inductance. Reciprocity Theorem. Energy Density of Magnetic Fields. Introduction to Maxwell's Equations. Concept of Displacement current.	24

Reference Books/ Text Books

1. Electricity and Magnetism: Edward M. Purcell
2. Electricity, Magnetism & Electromagnetic Theory: Mahajan & Choudhury
3. Electricity and Magnetism: Chattopadhyay and Rakshit
4. Electricity and Magnetism: R. Murugeshan

BPHS0015: MORDERN PHYSICS

Credits: 04 **Semester III** **L–T–P : 3–2–0**

Module No.	Content	Teaching Hours (Approx.)
I	**Radiation and its nature:** **Particle properties of waves:** Black body Radiation, Photoelectric effect, Compton effect. **Wave properties of particles:** de Broglie Hypothesis, phase velocity and group velocity, Wave packets, Heisenberg Uncertainty Principle. **Quantum Mechanics** Wave equation, Time independent and time dependent Schrodinger wave equation, Particle in 1D box, Harmonic Oscillator, Linearity and Superposition, Expectation Values, Operators.	24
II	**Nucleus and its interaction:** **Nuclear Structure:** Nuclear composition, Nuclear Physics Size and structure of atomic nucleus, Its relation with atomic weight, Nature of nuclear force, Binding energy, Liquid drop model, Shell model and magic numbers **Radioactivity:** Law of radioactive decay and half-life, Alpha decay, Beta decay- energy released, Gamma ray emission, Fission and fusion, Classification of Elementary Particles	24

Reference Books/ Text Books

1. Concepts of Modern Physics --- Arthur Beiser, McGraw-Hill.
2. Modern Physics --- Murugesan and Sivaprasad (S. Chand Higher Academics)

BPHS0016: ELEMENTARY STATISTICAL MECHANICS AND THERMAL PHYSICS

Credits: 04 **Semester III** **L–T–P : 3–2–0**

Module No.	Content	Teaching Hours (Approx.)
I	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 van der Waals gas, Liquidification of gases, Properties of liquid helium, Introduction to super-fluidity and superconductivity.	24
II	Probability, Some probability considerations (Tossing of coins), Combination possessing maximum and minimum probability, Distribution of n molecules in two halves of a box, Basic idea of phase-space, Idea of Macro states and Microstates, Constraints, Accessible and inaccessible states, Probability distribution and its narrowing with increase in number of particles, Thermodynamic probability, Principle of equal a priori probability, Distribution of particles with a given total energy into a discrete set of energy states.	24

Reference Books/ Text Books

1. Thermodynamics and Statistical Physics: J.P. Agrawal and Satya Prakash.
2. Heat Thermodynamics and Statistical Physics: Brij Lan, N. Subrahmanyam and P.S. Hemne.
3. Introduction to Statistical Mechanics: B B Laud.
4. Statistical Physics: F Reif.
5. Statistical Physics: K Haung.

BPHS0017: ELEMENTARY SOLID STATE PHYSICS

Credits: 04 **Semester IV** **L–T–P : 3–2–0**

Module No.	Content	Teaching Hours (Approx.)
I	Crystal Structure: Introduction, Solids: Amorphous and Crystalline Materials, Crystal lattice and translation vectors, unit cell, Basis, Symmetry operations, Lattice directions and planes, Bravais lattices, Miller indices for direction and planes, Simple crystal structures, Close packed structures. Bonding of Solids: Introduction, Concept of inter-atomic forces, Cohesive energy and types of bonding, Primary bonds (ionic bonds, Covalent bond and metallic bond), secondary bonds (Vander waals bond and hydrogen bonds), Lennard Jones potential. Structure and Symmetry: Diffraction of X-rays by crystals, Laue equations and Braggs law.	24
II	Band Theory of Solids, Insulators, Conductors, Semiconductor (P and N type). Conductivity of Semiconductor, mobility, Hall Effect & Hall coefficient. Superconductivity: Critical Temperature. Critical magnetic field. Meissner effect. Type I and type II Superconductors, London"s Equation and Penetration Depth. Magnetic Properties of Matter: Dia-, Para-, and Ferromagnetic Materials. Langevin Theory of diamagnetism, Ferromagnetism and Discussion of B-H Curve. Hysteresis and Energy Loss. Dielectric Properties of Materials: Polarization. Types of Polarization. Relation between electric field, polarization and D.	24

Reference Books/ Text Books

1. 1.Solid State Physics --- S.O Pillai.
2. 2. Solid State Physics ----- Gupta Kumar
3. Fundamental of Solid-State Physics ---- Sexena, Gupta, Sexena
4. Solid state Physics ----- Deccar
5. Solid State Physics ----- R.K. puri, V.K. Babbar; Modern Physics by R.Murugesham
6. Introduction to Solid State Physics--- Charles Kittel, 8th Ed.

BPHS0018: ELEMENTARY QUANTUM MECHANICS

Credits: 04 **Semester IV** **L–T–P : 3–2–0**

Module No.	Content	Teaching Hours (Approx.)
I	**Origins of Quantum Mechanics:** In adequacy of classical mechanics, development of old quantum theory, particle aspects of radiations, black body radiation, quantum photoelectric effect, dual nature of light and matter, dbrogli's hypothesis, phase velocity and group velocity, wave packets, heisen berg's uncertainty principles and its application.	24
II	**Equation of motion of matter waves:** Schrodinger equation of a free particle, time independent and time dependent Schrodinger equation, physical interpretation of wave function, normalized and orthogonal wave function, exception values of dynamical quantities, probability current density, solution of Schrodinger equation, physical application of Schrodinger equation to one dimensional problems, particle in a box.	24

Reference Books/ Text Books

1. Quantum Mechanics – Satya Prakash
2. Introduction to Quantum Mechanics by David J. Griffiths
   Quantum Mechanics by Ajoy Ghatak and S. Lognathan

BPHS0019: ATOMIC PHYSICS

Credits: 04 **Semester IV** **L–T–P : 3–2–0**

Module No.	Content	Teaching Hours (Approx.)
I	**Atomic Physics:** J.J. Thomson atomic model, Rutherford scattering: Rutherford atomic model, Bohr's atomic model and its limitations, Somerfield relativistic atomic model, effect of finite nuclear mass in relation to Redburg's constant, Idea of discrete energy levels and electron spin: Frans and Hertz and Strarm – Geolack experiments, Quantum numbers and thus significance, paul's exclusion principle, concept of atomic orbiters, Hunde rule. **One and two volume electron atom:** Orbital magnetic moment, orbital, spin and total angular momenta, Larimore procession, vector atomic model, electronic configuration and atomic states, Spin orbit interaction, fine structure, selection rules, intensity of spectral line, LS and JJ coupling scheme in two volume electron atoms, normal and inverted doublet spectra of Helium, Sodium and Mercury, Linde 'g' factor, Zeeman effect (normal), Stark effect.	24
II	**X-Ray Spectroscopy:** Production of X-Rays and their properties, continuous X-Ray spectrum and its dependence on voltage, dune and hunt's law, characteristic X-Rays, Moseley's law, doublet structure and scrumming parameter in X-Ray Spectra, X-Ray absorption spectra. **Laser:** Spontaneous and stimulated expression, Einstein A and B Loeffiements and relatron between them, Metastable state, population inversion, pumping and its types, three and four state lasers: Ruby Laser, He-Ne Laser, He-Ne Laser.	24

Reference Books/ Text Books

1. Atomic Physics by J.B. Rajam, S.Chand & Company Limited.
2. Quantum Physics of Atoms, Molecules, Solves, Nuclie and particles: Robert Eisburg and Robert Resnick.
3. Physics of atoms and molecules, Bransden and Joshin Pearson.
4. Atom, Laser and Spectroscopy, S.N. Thakur and D.K. Rai, Prentice Hall of India.
5. Nuclear Physics by D C Tayal, Himalyan Publications.

BPHS0020: ELEMENTS OF NUCLEAR PHYSICS

Credits: 04 **Semester IV** **L–T–P : 3–2–0**

Module No.	Content	Teaching Hours (Approx.)
I	**General Properties of Nucleus and Nuclear Models :** Introduction to the nucleus and a brief survey of general Properties of the Nucleus (size, internal structure, charges, Spin and Magnetic moment, Binding energy, Nucleon emission, separation energy, Properties of nucleon-nucleon interaction). Fermi gas model, Liquid drop model and bethe Weiszacher mass formula, Single particle shell model (only the level scheme in the context of reproduction of magic numbers). **Nuclear Forces:** Nature, Range, Saturation phenomena and Exchange forces, Deutron ground state properties (No derivation). **Nuclear Reactions:** Nuclear reactions and their conservation laws, Theory of fission (Qualitative), Nuclear reactors and Nuclear fusion	24
II	**Natural Radioactivity:** Fundamental laws of radioactivity, Soddy-Fajan 's displacement law and law of radioactive disintegration, Basic ideas about decay, Alpha decay and its energy spectrum, Q-value, Gamow's theory of alpha decay (no derivation), Beta decay , Need for neutrinos, Q-value for beta decay, Gamma decay. **Accelerators and detectors:** Vande Graff, Cyclotron and Synchrotron, Interaction of charged particles and gamma rays with matter (qualitative), GM counter, Scintillation counter and neutron detectors. **Elementary Particles:** Basic classification based on rest mass, Spin and half life, particle interactions (gravitational, Electromagnetic, week and strong Interactions), Quantum numbers.	24

Reference Books/ Text Books

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

BPHS0021: MATHEMATICAL PHYSICS

OBJECTIVE: This course is used as mathematical tool to explain the various topics in all the branches of physics in terms of various mathematical applications.

Credits: 04 **Semester V** **L–T–P : 4–0–0**

Module No.	Content	Teaching Hours (Approx.)
I	**Vector Calculus and Orthogonal Curvilinear Coordinates Vector Differentiation**: 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).	24
II	**Fourier Series:** Dirichlet Conditions (Statement only). Expansion of periodic functions in a series of sine and cosine functions and determination of Fourier coefficients. Expansion of functions with arbitrary period. First Order Differential equations (variable separable, homogeneous, nonhomogeneous), exact and inexact differential equations and Integrating Factor. Second Order Differential equations: Homogeneous Equations with constant coefficients. Wronskian and general solution. Particular Integral with operator method, method of undetermined coefficients and variation method of parameters. Application of Differential equations in Physics Newton's law of cooling, Growth of population, radioactive decay, SHM, Horizontal and vertical strings, electrical circuits.	24

Reference Books/ Text Books

1. Applied Mathematics for Engineers and Physicists –Lious A Pipes and Lawrance R. Rarvill.
2. Mathematical Physics –AK Ghatak, IC Goyal and SL Chua-Macmillan India Ltd.
3. Vector and Tensor Analysis –Scham Series.
4. Mathematical Physics –H K Dass and Rama Verma, S. Chand Publishing
5. Ordinary And Partial Differential Equations-Dr. M. D. Raisinghania, S Chand Publishing

BPHS0022: CLASSICAL MECHANICS

OBJECTIVES: To develop mathematical concepts and skills among the students regarding the Lagrangian and Hamiltonian formulations of mechanical systems

Credits: 04 **Semester V** **L–T–P : 4–0–0**

Module No.	Content	Teaching Hours (Approx.)
I	Lagrangian dynamics and variational principle Constraints - holonomic and non-holonomic, generalized coordinates, principle of virtual work, D'Alembert's principle, Lagrange equations from D'Alembert's principle, velocity dependent potentials, velocity dependent potential for electromagnetic field, applications of Lagrangian formalism, Significance and advantages of Lagrange approach, variational principle: technique of the calculus of variation, Hamilton's variational principle, Lagrange equations using Hamilton's principle, generalised momenta, cyclic coordinates, conservation of energy, linear and angular momenta.	24
II	Hamiltonian dynamics and two-body central force problems Hamiltonian and its physical significance, Hamiltonian as a constant of motion, Hamilton's equations of motion and their applications, 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, transformation of the scattering problem from centre of mass to laboratory coordinates.	24

Reference Books/ Text 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 Edition
3. Mechanics: L. D. Landau and E. M. Lifshitz
4. Introduction to Classical Mechanics: R. G. Takwale and Puranik
5. Classical Mechanics of Particles and Rigid Bodies: K. C. Gupta
6. Introduction to Classical Mechanics: N. C. Rana and P. Joag

BPHS0023: QUANTUM MECHANICS

OBJECTIVES: This course is design in such a manner to explain the drawbacks in classical mechanics and modified the shortcomings in term of quantum physics.

Credits: 04 **Semester V** **L–T–P : 4–0–0**

Module No.	Content	Teaching Hours (Approx.)
I	Inadequacy in Classical mechanics, origin of quantum mechanic, postulates of quantum mechanics, wave function, development of weve equations: Schrodinger equation-time dependent and time independent form, expectation values, Schrodinger equation-steady state form, eigen values & eigen functions, orthonormality and completeness, Expectation values, Separation of variables in Time-Dependent Schrodinger Equation, Density of states, One dimensional Potential step problems. One – dimensional Harmonic Oscillator, Zero-point energy.	24
II	Angular Momentum at commutation rule, operator forms of physical observables, parity operator. Spherically symmetric potentials, Complete solution of the Hydrogen – Atom Problem, Hydrogen Spectrum. Time-independent, non-degenerate, first – order Perturbation Theory, Ground and excited states of Helium atom and exchange degeneracy. Identical Particles, Symmetric and Antisymmetric wave functions.	24

Reference Books/ Text Books

7. Concepts of Modern Physics 6th Edition-By Arthur Beiser
8. Quantum Mechanics By Satya Prakash
9. Introduction to Quantum Mechanics, D.J. Griffith

BPHS0024: ELECTRONIC DEVICES & CIRCUITS

Credits: 04 **Semester V** **L–T–P : 3–2–0**

Module No.	Content	Teaching Hours (Approx.)
I	**Resonance & Analysis:** Reactance and Impedance, RC, LC, Circuits, Series and parallal LCR Circuit: (1) Resonance, (2) Power Dissipation and (3) Quality Factor, and (4) Band Width. **Network Analysis:** Review of Kirchhoff's Current Law & Kirchhoff's Voltage Law. Ideal constant-voltage and constant-current Sources. Mesh & Node Analysis. Thevenin theorem, Norton theorem, Maximum Power Transfer theorem. Applications to dc circuits. **Devices:** Field effect transistors, I-V Characteristics of JFET and MOSFET, FET biasing, FET as an amplifier. Silicon controlled rectifier and I-V Characteristics, phase controlled rectifier. Uni-junction transistor and I-V Characteristics, relaxation oscillator. Opto-electronic devices & characteristics: Photo diode, Phototransistor, Light emitting diode, LASER (Ruby and semiconductor) and solar cell.	24
II	**Amplifiers:** Transistor as 2-port Network- Hybrid parameter/ h-parameter equivalent Circuit. Analysis of a single-stage CE amplifier using Hybrid-Pi Model- Input and Output Impedance. Current, Voltage and Power Gains. Classification of Class A, B & C Amplifiers. Coupled Amplifier: RC-coupled amplifier and its frequency response. **Feedback in Amplifiers:** Effects of Positive and Negative Feedback on Input Impedance, Output Impedance, Gain, Stability, Distortion and Noise. **Oscillator:** Barkhaussen criterion of oscillations, tuned collector oscillator, Hartley / Colpitt oscillator, phase shift oscillator, Wien's Bridge oscillator. **Operational Amplifiers**: Characteristics of Ideal Operational Amplifier, Block diagram of an IC -741 operational Amplifier, Analysis of inverting amplifier, Non-inverting amplifier. Applications-Inverting, Non Inverting, Voltage follower, Integrator, differentiator and difference amplifier, summer, log and Antilog.	24

Reference Books/ Text Books

10. Introductory Circuit Analysis, Robert L. Boylestad, Twelfth edition, Pearson, 2012.
11. Introduction to Electric Circuits, Richard C. Dorf and James A. Svoboda, Wiley India Private Limited, Sixth Edition, 2007.

Electronic Devices and Circuit Theory Introductory Circuit Analysis, Robert L. Boylestad and Louis Nashelsky, Pearson, Tenth Edition, 2007.

BPHS0025: ELECTROMAGNETIC THEORY

OBJECTIVES: To develop mathematical concepts and skills among the students regarding E.M. theory and its applications

Credits: 04 **Semester VI** **L–T–P : 4–0–0**

Module No.	Content	Teaching Hours (Approx.)
I	**Boundary Value Problems:** Laplace & Poisson's equation, boundary condition, solution through method of images. **Electromagnetism:** Laws of electromagnetism, Concept of different charge and current densities, 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.	24
II	**EM wave propagation:** Propagation of plane EM waves in different media: free space, dielectrics and conductors; Laws of reflection, transmission at normal incidence in linear media and conducting media (Fresnel's equations), total internal reflection and Brewster angle. **Guided E.M. Wave Propagation:** Propagation of EM wave through transmission line: reflection coefficient, standing wave, characteristic impedance, propagation constant, Propagation of EM wave in rectangular waveguides: expressions for field components in TE, TM & TEM modes, Propagation properties, cut off frequency, group & phase velocity.	24

Reference Books/ Text Books

1. Introduction to Electrodynamics (3rd Edition): David J. Griffiths.
2. EM Waves and Fields: P. Lorrain and O. Corson.
3. Classical Electromagnetic Radiation, Mark A. Heald and J. B. Marion, 3rd Edition,1994, Saunders College Publishing

BPHS0026: STATISTICAL MECHANICS

OBJECTIVES: This course provides the ability to interpret and to find the differences between macroscopic and microscopic systems, statistical mechanics and thermodynamics, classical statistics and quantum statistics and then apply the theory to different thermodynamical and statistical system of interest

Credits: 04 **Semester VI** **L–T–P : 4–0–0**

Module No.	Content	Teaching Hours (Approx.)
I	**1. Basics of Statistical Mechanics:** The macroscopic and microscopic states, Phase space, Trajectories and density of states, Liouville's theorem (qualitative), Postulates of Statistical Mechanics, Relation between statistical and thermodynamic parameters, Classical ideal gas. **2. Classical Statistical Mechanics:** Ensemble theory (Micro-canonical, Canonical and Grand canonical ensemble), Calculation of statistical quantities, Gibb's paradox, Statistical equivalence of three ensembles, Energy fluctuation in canonical ensemble and Particle fluctuation in Grand canonical ensembles.	24
II	**1. Quantum Statistical Mechanics:** Statistics of indistinguishable particles, Maxwell-Boltzman distribution (classical limit), Need for quantum statistics, Postulates of quantum statistics. 2. **Bose-Einstein and Fermi-Dirac Statistics:** Introduction to Bose-Einstein and Fermi-Dirac statistics, Comparison of the three statistics, Qualitative features of degenerate Fermi and Bose gases, Bose-Einstein's condensation (qualitative) and white dwarf stars (qualitative).	24

Text Books

12. Reif, F; Fundamentals of Statistical and Thermal Physics, Tata McGraw-Hill, Ed.2008
13. Pathria,R.K.; Statistical Mechanics, Oxford University Press,2nd Ed., 1996

Reference Books :

1. S, Prakash ; Statistical Mechanics, Kedar Nath Ram Nath Publication,Ed. 2014.
2. J P, Agrawal; Prakash S, Thermodynamics and Statistical Physics, 29th Ed,2018

BPHS0027: SOLID STATE PHYSICS

OBJECTIVES: This syllabus gives an introduction to the basic phenomena in Solid State Physics. This aims to provide a general introduction to theoretical and experimental topics in solid state physics. On successful completion of the course students should be able to understand the main features of crystal lattices and phonons, understand the elementary lattice dynamics and its influence on the properties of materials, describe the main features of the physics of electrons in solids; understand and explain the dielectric, ferroelectric and magnetic properties of solids.

Credits: 04 **Semester VI** **L–T–P : 4–0–0**

Module No.	Content	Teaching Hours (Approx.)
I	**Crystal Structure:** Solids: Amorphous and Crystalline Materials, Lattice Translation Vectors, Lattice with a Basis, Symmetry Elements , Unit Cell, Miller Indices, Reciprocal Lattice, Lattices Types, Brillouin Zones and Ewald construction, Bonding in solids, Diffraction of X-rays by Crystals, Braggs Law and Laue Condition of diffraction of X rays. **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, T^3 law. **Electrical properties of Materials:** Electrons in metals- Drude Model, Wiedemann Franz law, Fermi energy and Density of states , Elementary band theory of solids, Effective mass of electron, Semiconductors. Direct and Indirect Band Gap. Conductivity in Semiconductors. Hall Effect in metals and semiconductors (Qualitative)	24
II	**Magnetic Properties of Matter:** Dia-, Para-, Ferri- , Ferromagnetic and antiferromagnetic Materials, Classical Langevin Theory of dia– and Paramagnetic Domains (Qualitative), Weiss Theory of Paramagnetism, Curie‟s law, Weiss Theory of Ferro magnetism, Ferromagnetic Domains, Curie-weiss law, B-H Curve, Soft and hard material, Antiferromagnetic materials and Neel temperature. **Dielectric Properties of Materials**: Dielectrics, Dielectric constant, Electric flux density , Polarization, Types of polarization, Classical Langevin Theory of Polarization in polar dielectrics, Local Electric Field at an Atom, Electric Susceptibility, Polarizability, Clausius Mosotti Equation, Lorentz-Lorentz equation, Complex Dielectric Constant. **Ferroelectric Properties of Materials:** Piezoelectric effect, Pyroelectric effect, Ferroelectric effect, Electrostrictive effect, Ferroelectric domains, PE hysteresis loop.	24

Reference Books :

1. Introduction to Solid State Physics, Charles Kittel, 8th Edn., 2004, Wiley India Pvt. Ltd.
2. Elements of Solid State Physics, J.P. Srivastava, 2nd Edn., 2006, Prentice-Hall of India.
3. Introduction to Solids, Leonid V. Azaroff, 2004, Tata Mc-Graw Hill.
4. Solid-state Physics, H.Ibach and H. Luth, 2009, Springer.
5. Solid State Physics, Rita John, 2014, McGraw Hill
6. Solid State Physics, M.A. Wahab, 2011, Narosa Publications

BPHS0028: NUCLEAR PHYSICS

OBJECTIVES: To impart knowledge about the Nuclear structure and its various application nuclear theory.

Credits: 04 **Semester VI** **L–T–P : 4–0–0**

Module No.	Content	Teaching Hours (Approx.)
I	**Nuclear and Particle Physics:** Basic nuclear properties; size, shape and charge distribution, spin and parity. Binding energy, semi empirical mass formula, liquid drop model. Nature of nuclear force, form of nuclean-nuclean potential, charge-independence and charge-symmetry of nuclear forces, deuteron problem. Evidence of shell structure, single-particle shell model, its validity and limitation. Rotational spectra. **Nuclear Decay:** Fermi theory of beta-decay, Curie plots, Comparative half-life, Allowed and forbidden transitions, Detection and properties of neutrino, Electromagnetic interactions in nuclei, Multipole transitions in nuclei, Parity and angular momentum selection rules, Internal conversion.	24
II	**Nuclear Reactions:** Direct and Compound nuclear reaction mechanisms, expressions for scattering and reaction cross sections in terms of partial wave amplitudes, Resonances, Discussions and Applications of Breit-Wigner single level formula, compound nucleus theory. **Detectors and Accelerators:** Outline of interaction of charged particles and of Gamma-rays with matter. Detectors: Gas Filled counters (ionization Chamber), Scintillation counter, Spark Chambers, Cerenkov detectors, Nuclear Emulsion Detector, High Purity Ge (HPGe) detector. Accelerators: Ion Sources, Synchrotron, Introduction of Modern Colliders (LHC and RHIC), Storage Ring.	24

Reference Books/Text Book:

1. Atomic and Nuclear Physics Vol. II: Ghoshal.
2. Nuclear Structure: Preston and Bhaduri.
3. Nuclear Physics (Problem oriented approach) : PHI(2016), Hari M.Agrawal
4. Introductory Nuclear Physics: Wong.
5. Nuclear Theory: Elton.
6. Nuclear Interactions: de Benedetti.
7. Radiation detection and measurement: G. F. Knoll