Course Structure FOR
Choice Based Credit System of
B.Sc. (Physics) Program with effect from 2020-21
School of Science, UPRTOU, Prayagraj

Semester	Course Code	Title of Paper	Credits	Max. Marks
I	UGPHS -101	Vector, Mechanics and General Physics	2	100
	UGPHS -101P	Practical Work	2	100
II	UGPHS -102	Oscillation, waves and electrical circuits	2	100
	UGPHS -102P	Practical Work	2	100
III	UGPHS -103	Electromagnetism	2	100
	UGPHS -103P	Practical Work	2	100
IV	UGPHS -104	Analog and Digital Electronics	2	100
	UGPHS -104P	Practical Work	2	100
	Skill Enhancement Course			
	SBSPHS-02	Modern physics	4	100
V	**Discipline Centric Elective Course**			
	DCEPHS -105	Optics	2	100
	DCEPHS -106	Thermal Physics	2	100
	DCEPHS -107P	Practical Work	2	100
VI	**Discipline Centric Elective Course**			
	DCEPHS -108	Quantum mechanics and spectroscopy	2	100
	DCEPHS -109	Solid State Physics and Advanced Electronics	2	100
	DCEPHS -110P	Practical Work	2	100
		Total Credit/Max. Marks	**32**	**1500**

Physics syllabus for B.Sc. Course
UGPHS-101
[Vector, Mechanics and General Physics]

Block-I Vector and mechanics

Unit 01- Vector analysis

- Scalar and vector, polar and axial vectors, Concept of tensor.
- Dot and cross product of two vectors, scalar and vector triple products
- Gradient of scalar, divergence of vector, curl of vector, solenoidal and lamellar vector.
- (Line, surface, volume) integral of vectors, Gauss, Stokes and Greens theorem (only statement).
- Vector identities (only statement)

Unit 02- Dynamics of a particle

- Force, momentum, impulse.
- Work, Power, energy.
- Conservative and non-conservative forces.
- Work-energy theorem, mechanical energy.
- Conservation of momentum and conservation of mechanical energy.
- Elastic and inelastic head on collision.

Unit 03- Angular and rotational motion

- Equation of motion and fundamental definitions.
- Angular momentum, torque, rotational K.E, angular impulse.
- Conservation of angular momentum and its applications.
- Moment of inertia, radius of gyration, theorem of parallel and perpendicular axes.
- Expression for moment of inertia for ring and disc, hollow and solid spheres, hollow and solid cylinder, thin rod and plates (derivation is not required).
- Rolling without sliding and sliding without rolling motion, total kinetic energy.
- Motion of body along inclined plane in both cases.

Unit 04- Dynamics of many particles

- Centre of mass and centre of gravity of a system
- Centre of mass and laboratory frame of reference.
- Motion of centre of mass of a system.
- Linear momentum, angular momentum, torque, kinetic energy, potential energy, mechanical energy for a system of particles.
- Difference between conservation laws (linear momentum, angular momentum, mechanical energy) for a particle and system of particles.

Unit 05- Dynamics of rigid body

- Concept of rigid body and its characteristics.
- Equations of rotational motion when the directions of angular momentum coincide and do not coincide with axis of rotation.
- Relation between angular momentum, moment of inertia and angular velocity in tensor form.
- Moment and product of inertia, inertia tensor.
- Precessional motion.

Block-II General Physics

Unit 06- Gravitation

- Gravity and gravitation, inertial and gravitational mass.
- Variation of gravity with shape and rotation of earth, height and depth from surface of earth.
- Gravitational field and potential due to spherical shell and solid sphere.
- Gravitational self energy.
- Orbital motion of satellite.
- Escape velocity of body.
- Communication satellite and weightlessness condition.

Unit 07- Motion under central force

- Central force and its characteristics.
- Reduced mass. Reduction of two body central force problem to one body problem.
- Expression for transverse and radial acceleration of a body moving under central force.
- Acceleration of planet moving around sun.
- Kepler's laws of planetary motion (statement, derivation and applications).
- Expression for total energy of earth and condition to different paths.
- Newton's law of gravitation from Kepler's law.

Unit 08- Elasticity

- Kinetic model for solids (F-r and U-r graphs).
- Behavior of loaded wire (graphs and definitions).
- Poisson ratio, elastic constants and inter-relationship among them.
- Angle of twist and shear. Torsion of cylinder. Torsional rigidity.
- Bending of beam, bending moment, geometrical inertia and flexural rigidity.
- Centiliver (negligible weight and finite weight), expression for depression.
- Elastic potential energy of stressed and twisted wire.

Unit 09-Fluid mechanics and viscosity

- Ideal fluid, critical velocity, stream line and turbulent motion.
- Compressible and incompressible fluid, lamellar and nonlamellar motion, steady and variable motion.
- Equation of continuity and its significance.
- Euler's equation and its application to deduce Bernoulli's equation, Application of Bernoulli's theorem (velocity of efflux, spinning of ball).
- Newton's formula for viscous force. Kinematical and dynamical viscosity (CGS, MKS and SI units).
- Poiseuelli's law (statement, derivation, limitations), Series and parallel combinations of capillaries.
- Stoke's law for viscous force, terminal velocity.

Unit 10- Surface tension

- Adhesive and cohesive force. Shape of meniscus. Angle of contact.
- Surface tension, surface energy, unison of small drops and bubbles.
- Effect of temperature and impurity on surface tension and angle of contact.
- Excess pressure inside air bubble and soap bubble.
- Rise and fall of liquid inside capillary.
- Importance and application of capillarity.

UGPHS-102
[Oscillation, waves and electrical circuits]

Block I- Mechanical oscillations

Unit 1- Undamped oscillator

- Periodic motion and its classification.
- Electrical analogous of mechanical quantities.
- Undamped oscillations and its characteristics, kinematical and dynamical definition of SHM.
- Derivation of differential equation using energy consideration and its definition.
- Examples of SHM (mass-spring system, general pendulum compound pendulum, floating cylinder, liquid column in U-tube), effective mass of spring.

Unit 2- Damped oscillator

- Damped oscillation and its characteristics, comparison with undamped oscillation.
- Derivation of differential equation using energy consideration and its solution for heavy, critical and weak damping.
- Condition for oscillation, frequency of damped oscillation.
- Relaxation time, energy dissipation, logarithmic decrement, quality factor.

Unit 3- Forced oscillator

- Forced oscillations and its examples.
- Differential equation and steady state solution.
- Amplitude resonance and velocity resonance, mechanical impedance.
- Amplitude and velocity resonance frequency, phase difference among position velocity and force.
- Power absorption and power dissipation.
- Quality factor, band width, sharpness of resonance.

Unit 4- Coupled oscillator

- Nature and condition of Lissajuous figures (for 1:1 & 1:2 frequencies).
- Normal co-ordinate, degree of freedom, normal modes of vibrations.
- Oscillations of two coupled masses.
- Oscillation of two coupled pendulums.
- Energy of two coupled systems.

Block II- Waves

Unit 5- Wave motion

- Basic definitions, types of propagation, concept of phase.
- Expression and properties of plane progressive wave.
- Differential equation of wave motions, wave front.
- Plane progressive wave in fluid and stretched string. Displacement wave and pressure wave.
- Plane progressive wave in stretched string.
- Intensity and energy transportation in wave.

Unit 6- Waves at boundaries of two media

- Free and bounded medium.
- Specific acoustic impedance, characteristic impedance.
- Reflection and transmission coefficient of amplitude at joints of two media/strings.
- Reflection and transmission coefficient of energy at joints of two media/strings.
- Discussion of results for various conditions of impedance of both media

Unit 7- Superposition of waves

- Principles of superposition (statement, limitations, phenomenon observed).
- Reflection of sound waves at free surface and rigid surface.
- Stationary waves (formation and characteristics), SWR.
- Mode of natural oscillations of stretched string and air column.
- Fundamental frequency, harmonics and overtones.
- Difference between interference and beats in sound.

Block III- Electrical circuits

Unit 8-Transient phenomenon and galvanometer

- Transient state and steady state, Time constant.
- Transient response LR, CR, LC and LCR circuits.
- Theory of moving coil galvanometer (dead beat and ballistic), critical resistance and damping.
- Sensitivity (current, charge and voltage) of moving coil galvanometer.
- Applications to measurement of high resistance by leakage method.

Unit 9- Alternating current

- J-Operator and phasor notations, reactance, impedance, susceptance, admittance.
- Instaneous, Peak, RMS and Average value of alternating voltage and current, Form factor.
- Angle of lag and lead, wattful and wattless current, average power consumed (active, reactive and apparent), power factor.
- Phasor and vector diagram of CR, LR, LCR series, LCR parallel, LR in series with C in parallel circuits.
- Parallel and series resonance, sharpness of resonance, Quality factor, Bandwidth Resonance frequency.

Unit 10- Network analysis (For both AC and DC)

- Circuit elements and various networks circuits.
- T and π networks and their equivalence.
- Kirchoff's current and voltage laws. Mesh and nodal analysis of electrical circuits. (Matrics and determinant methods).
- Concept of constant current and constant voltage source. Thevenin and Norton's theorem.
- Maximum power transfer theorem, superposition theorem, reciprocity theorem.

UGPHS-103
[Electromagnetism]

Block-I Electrostatics

Unit 01- Electric charge, force and fields

- Concept of charge, Coulomb's law, electric field, electric flux.
- Gauss law (statement and derivation, integral and differential form).
- Application of Gauss law for charge distribution (linear, cylindrical, spherical).
- Coulomb's law from Gauss law.
- Electric field due to charged ring, charged infinite rod and charged disc from Coulomb's law.
- Laws of electrostatics.

Unit 02- Electric potential and dipole

- Electric potential and electrostatic potential energy.
- Electric fields, potential gradient and their relationship.
- Electrostatic self energy (conducting and dielectric sphere).
- Electric potential due to spherical charge distribution (hollow and solid), graphical representation.
- Electric dipole and its behavior in uniform and non uniform electric field.
- Electric field and potential due to electric dipole at a point in cartesion and polar coordinates.
- Force between two electric dipoles.

Unit 03- Dielectrics

- Capicitor and its capacity, principle of capacitor, energy stored in field of capacitor.
- Capacity of partially filled parallel plate capacitor, expression for induced charge.
- Effect of dielectrics slab introduced inside plates of charged capacitor when its remains connected with battery and when it is disconnected from battery.
- Spherical plates capacitor and cylindrical plates capacitor.
- Change in electrical properties when N small charged drops coalesce to form a large drop.
- Three electric vectors (**D, E, P**), dielectric constant, dielectric strength, electrical susceptibility.
- Polarization, surface and volume charge density, Gauss law in dielectrics.
- Macroscopic and microscopic properties of dielectrics. Clausius – Mossotte formula.

Block II Magnetostatics

Unit 04- Electric current and magnetic fields

- Electric current and current density. Ohm's law and Joule's law, drift velocity.
- Magnetic field around stationary charge, moving charge and current carrying conductor.
- Biot-Savart law and its application to straight conductor, circular loop, solenoid and toriod carrying current.
- Magnetic field due to moving charge, Lorentz force

- Force between two current carrying conductor and two moving charges.
- Cyclotron (principle, construction, working, limitations and modification), Betatron.

Unit 05- Laws of magnetostatics

- Lines of forces, Gauss law in magnetostatics .
- Ampere circuital law (statement and derivation), its applications to current carrying rod (hollow and solid).
- Inconsistency of Ampere circuital law with equation of continuity.
- Modification of Ampere circuital law by Maxwell with introducing concepts of displacement currents and its importance. Comparison of displacement current and conduction current.
- Vector potential and its expression due to straight conductor and circular loop.
- Derivation of magnetic flux density using vector potential for circular loop.

Unit 06- Magnetic materials

- Magnetic properties (magnetic flux density B, magnetizing field H, intensity of magnetization Im, susceptibility, relative and absolute permeability).
- Magnetization, cycle of magnetization, hysteresis loop, retentivity, residual magnetism.
- Three magnetic vectors (B, H, Im), three magnetic currents (free, bound and total).
- Curl of intensity of magnetization.

Block III Electromagnetic Phenomenon

Unit 07- Electromagnetic induction

- Faraday's law of electromagnetic induction (statement, integral form, differential form) and analogy with Newton's laws of motion in mechanics.
- Condition for existence and depending factors of induced charge, induced voltage, induced current and induced power.
- Dynamic induced EMF and derivation of its expression,
- Self and mutual induction and inductance, static induced EMF (self and mutual).
- Reciprocity theorem and Neuman's relation.
- Relation between self and mutual inductance of two coupled coils, energy of coupled circuits.
- Transformer and its equivalent circuit, condition for ideal transformer (expression for efficiency and voltage gain), transformer losses.

BLOCK IV Electromagnetic Theory

Unit 08-Fundamental equations

- Four Maxwell's equations (statement and physical significance).
- Maxwell's equations and features of their general plane wave solution in source free space.
- Maxwell's equations and features of their general plane wave solution in simple dielectrics.

- Differential equation and velocity for electromagnetic waves in source free space and dielectric medium.
- Characteristics of electromagnetic waves, impedance, refractive index.
- Skin depth and its importance.

Unit 09- Energy and momentum of an electromagnetic wave

- Differential equation of plane electromagnetic waves in conducting media and its solution.
- Behavior and property of electromagnetic waves for good dielectric and good conductrs.
- Poynting theorem (statement and derivation).
- Expression for electromagnetic energy density.
- Momentum density vector and its importance
- Maxwell's stress tensor (statement and derivation).

Unit 10- Fresnel's equation

- Boundary conditions at discontinuity for D, E, B and H.
- Reflection and refraction at normal and oblique incidence of electric vectors perpendicular to boundary.
- Reflection and refraction at normal and oblique incidence of electric vectors parallel to boundary.
- Total internal reflection, Brewster's law, degree of polarization.
- Plane wave propagation in plasma and its properties (qualitative), metallic reflection.
- Elementary theory of dispersion.

UGPHS-104

[Analog and Digital Electronics]

Block-I Electron devices

Unit 01- Semi-conductor physics

- Band theory of solids and classification of solids on its basis. Intrinsic and extrinsic (n-type, p-type) semiconductors.
- Conductivity, mobility, drifts motion and diffusion motion of free electron and holes.
- p-n junction (formation of depletion region and potential barrier).
- Forward and reverse biasing of p-n junction, forward and reverse current.
- Diode equation and characteristics, static and dynamics resistance, knee voltage.
- Breakdown mechanism (Zener and Avalanche), transition and storage capacitance.
- Zener diode (statement, characteristics and comparison with p-n junction).
- Zener diode as voltage regulation (circuit and analysis).
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Unit 02- Power supply

- Non regulated and regulated power supply.
- Circuit and mathematical analysis of rectifier (HWR, FWR and BR).
- Ripple factor, rectification constant, voltage regulation and efficiency of rectifier.
- Filtering by RL, RC and LC circuit (only qualitative).
- Photonics device LED (principles and applications).
- Photodiode and photo transistor, photoconductivity.
- Solar cell (principle, construction, working and characteristics).

Unit 03-Bipolar junction transistor

- NPN and PNP transistor and their action.
- Types of configuration, region of operation, thermal runaway.
- Characteristics and parameters of CE, CB and CC configuration of transistor.
- Emitter efficiency, base transport ratio and current gain in CB configuration.
- Leakage current, hybrid parameters.
- Transistor biasing and their merits & demerits, thermal stability.
- DC and AC current gains in all three configurations of transistors and their inter-relationship of transistors.

Unit 04- Unipolar transistors

- FET (construction, classification, symbol, principle of operation).
- Internal and external biasing of FET. Fundamental definition related with FET.
- Characteristics and parameter of FET.
- Comparison of FET with BJT.
- MOSFET (enhancement and depletion mode), construction, symbol and working.
- NMOS and PMOS, CMOS as switch, BJT as switch.
- Storage and transition time (definition and importance).
- Schottky diode and Scottky transistors (statement, symbol and importance).

Block II Electronic circuits

Unit 05- Amplification

- Introduction to different gains (impedance, current, voltage and power).
- Small signal hybrid equivalent circuits of transistor in three configurations.

- Inter-relationship among hybrid parameters in CE, CB, and CC configuration of transistors.
- Importance of voltage divider biasing of transistor, operating points.
- DC and AC loadlines (statement and analysis).
- Classification of amplifiers on the basis of coupling, range of operations, uses and frequency.

Unit 06- Voltage and power amplifier

- RC coupled amplifier (single and multistage), components and their functions.
- Analysis of frequency (low, medium and high) response curve with the help of equivalent circuits.
- Push-pull amplifier (characteristics, advantages and disadvantages).
- Single and double tuned amplifier (characteristics and importance).
- Audio and radio frequency amplifier (characteristics and importance)

Unit 07- Oscillator

- Feedback amplifier (positive and negative), open and closed loop gains.
- Merits and demerits of negative feedback amplifier over positive amplifier.
- Barkhausen criterion for sustained oscillation (statement and proof).
- Component of oscillator and their functions
- Tuned collector, Hartely and Colpit oscillator (circuit and working).
- RC oscillator, phase shift oscillator and Wiens bridge oscillator.
- Crystal oscillator.

Block III Digital Electronics

Unit 08- Number system and codes

- Number system (decimal, binary octal and hexa-decimal), radix.
- Rules for interconversion of one number system into other number systems.
- 1s and 2s compliments of binary numbers. Binary arithmetics.
- Different types of codes (BCD code, Excess 3 codes, Grey code, ASCII code, EBICDIC code and error code).

Unit 09- Boolean algebra and logic gates

- Boolean algebra and its features
- Logic gates (Switching circuit, Truth table, Venn diagram, Boolean function).
- Primary gates (AND, OR, NOT) and their representation using p-n diodes & transistors.
- Universal gates (NAND, NOR) and realization of other gates using these.
- Exclusive gates (XOR, XNOR), equivalent and non-equivalent gates, characteristics and XOR-laws, XNOR-laws.
- AND-OR, OR-AND, NAND-NAND, NOR-NOR realization of Boolean expression.

Unit 10- Boolean Theorems and combinational logics

- De-Morgan's laws, commutative laws, associative laws, distributive laws, absorptive laws of Boolean algebra.
- Dual and compliment of Boolean function.
- Minterms, maxterms, SOP form, POS form of Boolean functions.
- Minterms and maxterms are conjugate to each other.
- Karnaugh's mapping and its representation (for 2, 3 and 4 variables) in terms of minterms and maxterms.
- Simplification and Boolean expression by Boolean laws and K-mapping.
- Half and full adder, half and full subtractor.

SBSPHS-02
Modern Physics

Block I: Special Theory of Relativity

Unit 1- Emergence of special relativity:

- Frame of reference (inertial and non inertial), Events (simultaneous, colocal and coincidence)
- Centripetal force, centrifugal force, and coriolis force.
- Classical relativity, Galilean variant and Galilean in-variant.
- Compatibility of electromagnetism with principle of relativity and mechanics.
- Michel Jon-Moreley experiment-significance of negative result.
- Postulates of special theory of relativity.

Unit 2. Relativistic kinematics:

- Lorentz transformations (statements and derivation).
- Relativity of simultaneity and length contraction.
- Relativity of co locality and time dilation.
- Experimental verification of length contraction and time dilation.
- Relativistic transformation of velocity, resultant of two successive Lorentz transformations.
- Relativistic velocity addition theorem (statement, derivations and applications).
- Aberration of stars (statement, derivation and comparison with classical result).
- Relativistic Doppler effect (statement, derivation and discussion of result).

Unit 3- Relativistic dynamics:

- Non-relativistic and relativistic particles.
- Einstein's mass and energy equivalence relation, relativistic kinetics energy.
- Variation of mass with velocity (only qualitative) and its importance.
- Fundamental equations of relativistic motion, longitudinal and transverse mass.
- Momentum and energy transformation equations.
- Minkowski time space diagram and its applications.

Block II: Atomic Physics

Unit 4-Atomic models:

- Bohr's theory of hydrogen likes atoms, Bohr radius, Sommerfeld fine structure constant, Rydberg & Rydberg Constant , Binding energy.
- Spectral series of hydrogen atom, H_α, H_β, H_γ, H_δ Balmer lines
- Reduced mass, effect of nuclear motion, isotopic shift,
- Ground, Excited and ionized state, emission and absorption spectra
- Excitation, resonance and ionization potential, ionization energy of atom
- Bohr's correspondence principle (statement, proof and importance)
- Qualitative discussion of sommerfeld atom model.

Unit -5: X-Ray spectra

- Production of X-rays (qualitative discussion of Roentgen tube and Coolidge tube)
- Properties and application of X-rays
- Continuous and characteristic X-rays, Bremstrahlung radiation
- Continuous and line X-ray spectra (K-series, L-series, M-series)
- Duane-Hunt's law, cutoff frequency and cutoff wavelength,
- Moseleys law (statement, derivation and applications), absorption edge

- Comparison of optical and X-rays spectra

Unit 6- Atomic structure:

- Vector atom model (need, statement and importance)
- Space quantization, concept of electron spin and quantum numbers
- Stern-Gerlach experiment (principle theory and importance of results)
- Magnetic moment of atom, Bohr magneton, Gyro magnetic ratio,Larmor precession and frequency
- Intensity rules, selection rules, spectral terms, sodium D_1 and D_2 lines, Fine structure of Hα lines,
- Coupling scheme (L-S and j-j), spectra of alkali and alkaline earth elements.

Unit 7- Dualism nature:

- Planck's quantum theory and Einstein modifications, Photon and its characteristics
- Photoelectric effect (statements laws and mathematical explanation), quantum efficiency
- Compton effect (statement and explanation, expression for compton shift and recoil energy),
- Dualism in nature, de-Broglie hypothesis, matter waves and its importance.
- Comparison of matter waves with electromagnetic waves and mechanical waves
- Davisson-Germer experiment (principle, working and importance of result)
- Wave packet, phase velocity and group velocity, wave and particle velocity, relation among them
- Uncertainty principle (statement, significance and application)

Block III- Nuclear physics

Unit 8-Radioactivity:

- Natural and artificial radioactivity, emission of alpha particle, electron, positron and gamma particles
- Size of nucleus, classification of nuclei (isotopes, isobars, isotons, isomers and isodiapheres).
- Radioactive series, successive radioactive decay, radioactive equilibrium
- Earth dating and carbon dating, artificial nuclear transmutation
- Discovery of neutrons and radioisotope in every day life
- Nuclear force and its Yukawa (Meson) theory.

Unit 9-Nuclear energy:

- Mass defect, packing fraction, binding energy, specific binding energy,
- Binding energy curve, explanation of nuclear fission, nuclear fusion and release of nuclear energy,
- Kinematics of nuclear reaction, Q-value of reactions
- Bohr's-Wheeler model, activation and excitation energy, normal and enriched Uranium,
- Liquid drop model, semi-empirical mass formula,
- Shell model, magic number, collective model

Unit 10-Elementary particles

- Classification of elementary particles on the basis of mass, spin and interaction,
- Particles and anti particles.
- Process of annihilation and process of production of matters,
- Quantum number (Lepton number, Bayron number, iso-spin number, hyper charge number, strange number)
- Conservation laws and concept of Quarks.

DCEPHS-105
OPTICS

Block I: Geometrical and Quantum optics

Unit 1- Co-axial system of lenses

- Cardinal points (focal points, principal points and nodal points).
- Analytical methods for analysis of cardinal points.
- Matrix methods for analysis of cardinal points.
- Equivalent lens, problems on combination of thin lenses.
- Eye pieces (Ramsdon and Huygens), Ray diagram and characteristics, merits and demerits.
- Aplanatic points and its importance

Unit 2. Laser and holography:

- Coherence (Temporal and Spatial)
- Stimulated and spontaneous emission, Einstein co-efficients and their inter-relationship
- Basic idea about laser and its components , pumping and population inversion
- Comparison of laser light and ordinary light
- Ruby laser, Helium-Neon laser, semi conductor laser and their applications
- Holography and hologram, comparison of hologram with photography.
- Recording and reconstruction of hologram and its applications

Unit 3- Fiber optics

- Constructions and materials used in optical fibers,
- Principle of fiber optics and propagation of light in optical fiber,
- Advantages and disadvantages of optical fiber communication
- Numerical aperture, acceptance angle, V-parameters, meridional and skew rays analysis
- Types of fibers (SIF,GIF, Single mode and multimode), fiber profile.
- Phase index and group index in optical fiber, slowest and fastest mode of propagation in optical fibers,
- Attenuation and dispersion in optical fibers parameter (attenuation loss, dispersion)
- Qualitative discussion of coupler, splices and connecter.

Block II:

Unit 4- Nature of light:

- Statement, merits and demerits of Newton's corpuscular theory, Huygens longitudinal wave's theory and Fresnel transverse wave theory.
- Huygens principle and its explanation, laws of reflection and refraction.
- Electromagnetic wave theory (statement, consequences and limitations)
- Fermats principles (statement and applications).
- Perception of light (human vision, color vision and color receptor)
- Scattering of light and its importance

Unit-5: Concept of polarization:

- Cause and concept of polarization, plane of vibration and plane of polarization
- Un-polarized light and types of polarized light (linear, circular and elliptical).
- Plane polarized light by reflection and refraction, Brewsters law, piles of plates
- Plane polarized light by selective absorption (dichroism) and double reflection (E & O rays), birefringence.

- Polarizer and analyzer, Nicol prism, law of Malus
- Huygens theory of double reflection by uniaxial crystal, negative and positive crystal, optic axis
- Superposition of two plane polarized lights along mutually perpendicular directions.

Unit-6: Detection of polarized light:

- Retardation plates (quarter and half wave plates), features and applications.
- Production and detection of elliptically and circularly polarized light
- Analysis of different polarized light.
- Babinet compensator (principle, theory, application).
- Optical rotation and specific rotation, optical activity
- Fresnal theory of optical rotation.
- Polarimeters (Half Shade and Biquartz), their merits and demerits.

Block III- Interference and diffraction

Unit -7: Concept of interference

- Statement and essential conditions for observation of interference
- Constructive and destructive interference , shape of fringes, visibility of fringes
- Youngs double slit experiment, shift in fringes pattern due to thin sheet of transparent material.
- Fresnel, biprism, Frenel bimirror, non localized fringes.
- Lloyds single mirrors, achromatic fringes.
- Formation of coherent sources due to division of wave front in above devices and comparison of their fringe pattern.
- Fringes pattern with white light.

Unit 8- Interference by division of amplitudes

- Stokes analysis of phase change on reflection
- Color in thin films (parallel and Wedge shaped) due to white light.
- Newton's rings (principle, theory and applications)
- Haidenger fringes, localized fringes.
- Michelson interferometer (principle and working), conditions for different shape of fringes, comparison with Newton's ring fringes
- Febry-Perot interferometer, intensity distribution, coefficient of finesse, visibility of fringes, sharpness of fringes, superiority over Michelson interferometer fringes,
- L-G plates

Unit 9- Fresnel diffraction

- Difference between interference and diffraction.
- Classification of diffraction and their conditions.
- Fresnel construction of half periods zones, rectilinear propagation of light.
- Diffraction at straight edge and circular aperture.
- Zone plate and its comparison with convex lens
- Cornu's spiral (theory, applications and merit)

Unit 10- Fraunhoffer diffraction:

- Single slit fraunhoffer diffraction (theory and graph for maxima and minima)
- Double slit fraunhoffer diffraction (theory and importance), missing spectra.
- Plane diffraction grating (principle and analysis), condition for absent spectra
- Grating spectra and prism spectra.
- Concave diffraction grating (theory and types), superiority over plane grating.
- Rayleigh criterion of resolution, limits of resolution of eye.
- Resolving power of Grating, Prism ,Telescope, and Microscope.

DCEPHS -106

[Thermal Physics]

Block-I Thermodynamics

Unit 01- Fundamental of thermodynamics

- Thermodynamic systems, thermodynamic variables.
- Thermodynamic equilibrium (thermal, mechanical and chemical).
- Equation of state, equation of constraints.
- Zeroth law of thermodynamics, concept of temperature.
- Macroscopic and microscopic variables, extensive and intensive variables.
- Quasi-static and non quasi-static processes. reversible and irreversible processes.
- Conditions for reversibility.

Unit 02- First law of thermodynamics

- Expression for thermal work done. Types of work done.
- Point function and path function.
- Internal energy and enthalpy both as point function.
- First law of thermodynamics (statement, derivation, limitations and applications).
- Degrees of freedom, atomic heat ratio, Mayer's relation.
- Processes (cyclic, isobaric, isochoric, isothermal and adiabatic).
- P-V indicator diagram and its importance.

Unit 03- Second law of thermodynamics

- Need of second law.
- Carnot cycle (P-V and T-S diagram).
- Carnot heat engine and Refrigerator.
- Thermal efficiency and coefficient of performance.
- Carnot theorems (statement, proof and significance).
- Clausius & Kelvin statement of Second law and their equivalence.
- Absolute scale of temperature and its comparison with perfect gas scale of temperature.

Unit 04- Entropy

- Entropy (need, statement and characteristics).
- Clausius theorem and Clausius inequality of entropy.
- Change of entropy (in mixing, for change of state and for perfect gas).
- Available and non available energy, ordered and disordered state.
- The principle of increase of entropy and degradation of energy.
- Consistency of Clausius & Kelvin statement with definition of second law in terms of entropy.

Block II Thermodynamic relations

Unit 05- Maxwell's relations

- Reciprocal theorem and reciprocity theorem in thermodynamics
- Maxwell's relations (statement, significance and derivation from laws of thermodynamics).
- Thermodynamic potentials (statement, significance and applications).
- TdS equations (statement, proof and applications).
- Heat capacity equations in different forms.
- Atomic heat ratio.

Unit 06- Phase Transition

- First order phase transitions and its characteristics. Clausius Clapeyron equations.
- Second order phase transition and its characteristics. Ehrenfest equations.
- First and Second latent heat equations from Maxwell's relation, effect of pressure on melting point of solids and boiling point of liquids.
- Joule's expansion, Joule's coefficient, Energy equation.
- Free expansion and conservation of internal energy in it.
- Change of entropy in isothermal irreversible process.

Unit 07- Third law of thermodynamics

- Joule's Thomson expansion, conservation of enthalpy.
- Enthalpy equation, Joule-Kelvin coefficient, inversion curve.
- Different methods of coolings, liquefaction of gas, adiabatic demagnetization.
- Comparison of Joule-Thomson expansion with Joule expansion and adiabatic expansion.
- Throttling process, change of entropy in an irreversible adiabatic process.
- Third law of thermodynamics and its consequences.

Block III Heat

Unit 08 Kinetic Theory of Gases

- Perfect gas equation and conditions for its validity to real gas.
- Comparison of ideal gas and real gas. Vander waal equation of state, Vander waal constants.
- Andrews experiment on CO_2 , critical state, gas and vapours.
- Critical constants (statement and inter-relationship).
- Mean free path (qualitative) and its applications.
- Transport phenomenon in gases (viscosity, thermal conductivity and self diffusion, derivation of expressions for each and their inter-relationship).
- Brownian's motions and its features.

Unit 09 Conduction and convection

- Modes of transfer of heat.
- Steady and variable states.Thermal conductivity, Thermal diffusivity.
- Temperature gradient, heat flow through combination of slabs, thermal resistance.
- Formation of ice layer and its consequences.
- Fourier equation of heat. Discussion of results for exposed and covered rods, Ingen-Hause experiment.
- Periodic flow of heat (qualitative) and its applications.
- Natural and forced convection (qualitative).

Unit 10 Radiation

- Radiant energy, black body radiation, white radiation. Reflectivity, absorptivity and transmitivity.
- Kirchoff's law for radiation, (statement, derivation, significance and applications).
- Stefen-Boltzman law (statement and derivation), Stefan's constant, Newton's law of cooling.
- Average energy of quantum oscillator and classical oscillator. Number of modes per unit volume in frequency range.
- Planck's law for radiations (need, statement and derivation), ultraviolet catastrophe.
- Derivation of classical laws (Stefan's, Wien's displacement, Wien's fifth power, Rayleigh-Jean) from Planck's law.
- Spectrum of black body radiations at different temperatures.

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Quantum Mechanics and Spectroscopy

Block I: Wave mechanics

Unit 1- Basic concept:

- Need of quantum theory and quantum mechanics
- Fundamental equation of wave mechanics and its representation in various forms
- Wave function and its interpretation by Max-Born and Schroedinger
- Separation of variables , stationary states
- Probability density and probability current density
- Equation of continuity

Unit 2. Condition of wave function:

- Normalizable and unnormalizable wave function
- Condition for normalized, orthogonal, ortho normal and complete wave function
- Expectation values of thermo dynamical variables
- Dirac-Delta function and Kronecker delta function
- Non-degenerate states and degenerate state
- Ehenfest theorem (statement, derivation and significance).

Unit 3- Operator algebra

- Concept of operator, null operator, inverse operator, operator algebra
- Operator in quantum mechanics (position, momentum, energy velocity, kinetic energy and angular momentum)
- Physical operators (Linear, hermitian, parity and their properties)
- Commutator and non-commutator operators, simultaneous wave function and uncertainty relation
- Eigen function, Eigen values and Eigen values equations
- Commutator rules among components of orbitral angular momentum, momentum, position , L^2.
- Ladder operates ($L+$ and L^-), commutator rules amongst L+,L-, Lz and L^2.

Block II: Applications of Schroedinger's equation

Unit 4- One and three dimensional problems

- Free particles, particle in box.
- Potential steps, potential barrier(tunneling),
- Potential well of infinite depth and finite depth.
- Harmonic oscillator (classical and quantum), series solution.
- Eigen values and Eigen function of harmonic oscillator,Hermite polynomial
- Zero point energy and parity of oscillator.

Unit-5: Spherically symmetric systems:

- Spherically symmetric potential, components of angular momentum in polar coordinate
- Spherical harmonics and their orthogonality legendre Polynomial,
- Schrödinger equations for rotator with free axis and its series solutions

- Schrödinger quatim for hydrogen atom, solution of r-equation, θ-equation, ∅ equation, Eigen function and Eigen values of hydrogen atom , Bhoris radius
- Degeneracy and quantum number of hydrogen atoms
- Comparison of Schrödinger atomic model with Bohr's atomic models.

Block III- Identical particles and perturbation

Unit-6: Identical particles

- Distinguishable and indistinguishable particles.
- Symmetric and anti symmetric wave functions
- Concept of spin and spin angular momentum
- Pauli spin matrices (definition, commutation, anti-commutation), spin wave function
- Exchange operator, exchange degeneracy
- Equation of motion, condition for constant motion.
- Pauli exclusion principle (statement and importance)

Unit -7: Approximation methods:

- Born-approximation (statement and application)
- Variation methods (statement and application)
- Perturbation method (time independent and time dependent)
- Time independent perturbation (non-degenerate and degenerate, first order and second order correction)
- Application of perturbation theory to helium atom, ortho and para helium.
- Application of perturbation theory to anhormonic oscillator, comparison of harmonic and anhormonic oscillator

Unit 8- Atomic spectra:

- Lande-g factor (statement and derivation)
- Shift in energy of atom when placed in magnetic field
- Zeeman effect (statement and classification)
- Classical and quantum theory of normal and anomalous Zeeman effect, Paschen Back effect
- Zeeman pattern for sodium lines and other various transitions
- Stark effect and its characteristics

Block IV- Molecular spectroscopy

Unit 9- Types of spectroscopy:

- Electronic ,Rotational, Vibrational and Rotational-vibrational spectroscopy
- Selection rules, energy and frequency of vibrational spectra
- Selection rules, energy and frequency of Rotational spectra
- Raman effect, stokes and anti stokes lines (quantum and classical explanation)
- Infrared spectroscopy
- Fluorescence and phosphorescence spectroscopy

Unit 10- Techniques of spectroscopy:

- Electronic spectra,
- Electronic transitions
- Frank-Condon principle
- Singlet and triplet states
- Fine structure and hyper fine structure
- NMR (principle and importance)
- ESR (principle and importance)

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[Solid State Physics and Advanced Electronics]

Block I Basic concepts of solids

Unit 1- Crystal and its structure

- Crystalline and amorphous state of solids, liquid crystal and its characteristics (qualitataive).
- Simple crystal structure (SC, FCC, BCC).
- Unit cell and Bravais lattice.
- Classification of lattices and types of crystals on the basis of Bravais lattice.
- Direct and reciprocal lattice, Miller indices and planes.
- X-ray diffraction, Bragg's law.
- Generalized Hooke's law for Anisotropic body, elastic constants of cubic crystals

Unit 2- Band theory of solids

- Need of free electron quantum theory
- Summerfeld Fermi model band theory.
- One dimensional motion of electron in periodic potential (Bloch theorem).\
- Kronning-Penny model (features and its importance).
- Fermi surface, effective mass of charge carriers (electron and holes).
- Concentration in semiconductors.
- Hall effect (qualitative).

Unit 3 Lattice vibrations

- Interatomic force and classification of solids.
- Lattice energy of ionic crystals.
- Vibration of monoatomic and diatomic linear chain, acoustic and optical modes, phonon.
- Thermal capacity of solids, classical theory of specific heats (Dulong and Petit's law).
- Experimental results and need of quantum theory of specific heat of solids.
- Einstein's theory of specific heats (need, statement, assumptions, derivations and limitations).
- Debye theory of specific heats (need, statement, assumptions, derivations and limitations).
- Concept of Einstein's temperature and Debye temperature.

Unit 04 Magnetism and superconductivity

- Comparison of fatures of diamagnetic and paramagnetic materials with examples. Curie law and Curie Wiess law.
- Classical and quantum theory of diamagnetism and paramagnetism.
- Qualitative discussion of ferromagnetism, anti-ferromagetism and ferrimagnetism.
- Superconductivity and its characteristics, magnetic behavior of superconductor.
- Meisener's effect, BCS theory (qualitative).
- Types of superconductors (examples, properties and applications).
- Josephson effect, quantum Hall effect.

Block II Advanced analog electronics

Unit 5 Different modes of operations.

- Eber's moll model for PNP and NPN transistors.
- Expressions for various currents and voltage.
- Saturation parameters and its importance.

- Conditions for cut off mode, saturation mode, inverse mode and active mode.
- Comparison among all modes of operatons.

Unit 6 Transmission and reception

- Basic elements of radio communication systems.
- Requirements of transmitter, medium and receiver.
- Modulation (need, types and statements).
- Analysis of AM, FM and PM, modulation index.
- Frequency spectrum and power in modulations.
- Circuit of modulator.
- Demodulation (need and statements).
- Circuit for demodulator.

Unit 7 Operational amplifier

- OP-amplifier (symbol, number code, power supply and characteristics).
- Input-output relationship, input-offset and output offset voltage.
- Differential input and output resistance.
- Common mode rejection ratio, output current, power consumption, slew rate gain-band width product.
- Characteristics of OP- amplifier, comperator and detector.
- Inverting and non inverting amplifier.
- Differentiator and basic integrator.

Block III Advance digital electronics

Unit 8 Logic families

- Introduction and classification of logic families.
- Input and output characteristics.
- Fan-in and fan-out.
- Noise margin and noise immunity.
- Rise and fall time.
- RTL (circuit, analysis and applications).
- DTL (circuit, analysis and applications).
- TTL (circuit, analysis and applications), totem-pol.
- Comparison of RTL, DTL and TTL.

Unit 9 Sequential circuits

- Difference from combinational circuit.
- Flip-flops (RS, D, JK) master slave.
- Register (function and types).
- Counter (function and types).
- Memory (function and types).
- Convertors (A/D and D/A).

Unit 10 Integrated circuits and devices

- Introduction of integrated circuit and its comparison with discrete circuits.
- Classification of IC on the basis of construction and operation.
- Monolithic IC (basics structure and fabrication).
- Cathode ray oscilloscope (principle, construction, block diagram, working and application).
- Multimeter (principle, types, construction and function).
- Ultrasonics (production, detection, velocity measurements and applications), Hypersonics and ultrasonics.