Prof. Amrendra Narayan
09204761406

Central University of Bihar

B.Sc. B.Ed. Program

Tentative Syllabus for Physics

Course Structure

Sem	Course Code	Course Title	Credits (Theory)	(Practical)
1	PHY 101	Mechanics	3	1
2	PHY 151	Elasticity, waves, Thermodynamics	3	1
3	PHY 201	Electricity and magnetism	3	1
4	PHY 251	Optics and Lasers	3	1
5	PHY 301	Electronics	3	1
5	PHY 302	Kinetic Theory &Statistical Mechanics	2	-
6	PHY 351	Quantum Mechanics	3	1
6	PHY 352	Relativity	2	-
7	PHY 401	Atomic & Molecular Physics	3	1
7	PHY 402	Electrodynamics and Plasma Physics	2	-
8	PHY 451	Solid state Physics	3	1
8	PHY 452	Nuclear Physics	2	-

PHY 101 Mechanics Credits: 3 T + 1 P

Syllabus (Theory)

Unit I : Particle Dynamics

Newton's Laws: Newton's First Law and inertial reference frames, Newton's Second Law and Force, Newton's Third law as an interaction law, Inertial and non inertial frames of reference, Everyday forces, Applications of Newton's Laws : Free body diagrams.

Momentum: Dynamics of system of particles, Centre of mass, Conservation of momentum, Linear momentum of a system of particles, Centre of mass coordinates, Impulse, Some applications of momentum principle, Flow of mass, Momentum transport.

Work and Energy: Definition of work and kinetic energy, Work-energy theorem, Application of work-energy theorem, Conservative forces and potential energy, Stability, Energy diagrams, Non-conservative forces, General energy conservation law, Mass and energy equivalence.

Collisions: Definition and types of collisions. Conservation of momentum during collisions, Collision in one and two dimensions. Collisions in laboratory frame and centre of mass frame.

Unit II : Gravitation and Central Force

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Gravitation : Newton's law of Universal Gravitation, Universal Gravitation constant 'G', Inertial and gravitational mass, Variation in acceleration due to gravity with altitude and depth, Gravitational field and potential, Gravitational potential energy, Potential energy for many particle systems, Calculations of field and potential of simple systems.

Central Force: Motion of planets and satellites, Kepler's laws of planetary motion, Inverse square law, Rutherford's problem, Derivation of Kepler's Laws from Universal law of Gravitation.

Unit III : Rotational Motion

Vector nature of angular velocity and angular acceleration, Rotation with constant angular momentum, Linear and angular variables, Conservation of angular momentum, Kinetic energy of rotation, Rotational inertia, Calculation of rotational inertia – of a rod, sphere and cylinder, Torque, Relation between torque and angular acceleration, Work – energy theorem in rotational motion.

Reference Books:

1. **Introduction to Mechanics, Daniel Kleppner and Robert J. Kolenkow. TMH.**
2. Fundamentals of Physics (6th Edition) David Halliday, Robert Resnick and Jearl Walker.
3. University Physics, Revised Edition, Harris Benson, [John Wiley and Sons, Inc.]
4. University Physics, Sears Zemansky and Young. [Pearson]
5. Concepts of Physics (Volume 1), H.C. Verma. [Bharati Bhavan]
6. Berkeley Physics Course Vol. 1. Mechanics (S.I. Edition). [TMH Publications]

Practicals **[Credit: 1]**

1. Study of range and least count in some common instruments (Vernier callipers, Screw gauge, Travelling microscope, spectrometer, etc.)
2. Plotting and interpretation of graphs in kinematics (v-t and a-t graph from x-t graph, x-t and v-t graphs from a-t graph)
3. Error analysis practice from actual experimental data.
4. Study of the rate of flow of water in a capillary tube under different pressure heads.
5. To study the relations between length, amplitude and time period of a simple pendulum.
6. Study of damping of a pendulum (large amplitude oscillation)
7. Study of energy conservation in a "two in one" pendulum.
8. Study of the motion of a freely falling body.
9. Study of stretching and oscillation in a spring-mass system on mass.
10. Experiments with a linear air track

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11. Study of conservation of momentum and energy of collision in a plane.

Note: There is no book covering all these experiments. It is suggested to prepare a set of lab manuals for these experiments. These laboratory manuals should help the students develop their own style of scientific enquiry and train them towards developing self-reliance in their teaching.

PHY 151 Elasticity, waves, Thermodynamics Credits: 3 T + 1 P

Syllabus (Theory)

Unit I : Elasticity, Oscillation and Waves

Elasticity: Hooke's law, Modulii of elasticity, Poisson's ratio, Elastic potential Energy.

Oscillations : Physical Pendulum, Torsional pendulum. Equation for damped vibrations, Forced vibrations, Resonance. Fourier Series, Application to square wave, triangular wave.

Waves in elastic media: Transverse and Longitudinal waves, Travelling waves: Wave speed, Power and intensity in wave motion, Superposition principle, Expression for transverse waves in a stretched string, Interference of waves.

Sound Waves: Model of sound waves in air as pressure waves, Speed of longitudinal waves, Standing waves in organ pipes, Beats, Doppler effect, Sound power level and its measuring unit (decibel).

Unit II : Heat and First Law of Thermodynamics

Temperature: Thermal equilibrium, Zeroth law of thermodynamics, Ideal gas temperature scale, Absolute scale of temperature.

Heat: Heat as mode of transfer of energy, Quantity of heat and specific heat, Molar heat capacities of solids, Mechanical equivalent of heat, Heat and work.

First law of thermodynamics: First law of thermodynamics, Some special cases of the first law of thermodynamics – (i) adiabatic process, (ii) isothermal process, (iii) isochoric process, (iv) cyclic process, (v) free expansion.

Unit III : Entropy and Second Law of Thermodynamics

Carnot Engine and second law: Reversible and irreversible processes, Carnot cycle, Carnot engine, Carnot theorem, Second law of thermodynamics, Efficiency of engines, Thermodynamic temperature scale, Entropy in reversible and irreversible processes, Entropy and the second law of thermodynamics, Entropy and disorder, Second law of thermodynamics as a probabilistic statement.

Combined First and Second Law: Consequences of First and second laws of thermodynamics, TdS equations, Joule thomson effect and porous plug experiment, Liquefaction of air, Enthalpy, Helmholtz and Gibbs Free Energy, Maxwell's relations.

Reference Books:

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1. Fundamentals of Physics(6th Edition) - David Halliday, Robert Resnick and Jay Walker.
2. University Physics, Revised Edition, Harris Benson [John Wiley and Sons Inc.]
3. **Thermodynamics, Kinetic Theory and Statistical Thermodynamics – F.W. Sears and G.L. Salinger [Units II and III]**
4. **Concepts of Physics Vol. 1. H.C. Verma [Unit I]**
5. Waves (Berkeley Physics Course Vol. 3) Frank S. Crawford Jr.[TMH]
6. Introduction to Accoustics – Robert D. Finch [PHI]

Practicals **[Credit: 1]**

1. Measurement of speed of sound using speaker, microphone and CRO.
2. To determine the speed of sound in air using a resonance column.
3. To compare speed of sound in different gases (air and CO_2) with help of standing waves in a speaker driven resonance column.
4. Study of laws of transverse vibrations using sonometer.
5. Study of coupled oscillations
6. Measurement of specific heat of solids
7. Study of Heat conduction in solids (Lee's disc method).
8. Study of linear expansion of solids.
9. Study of thermoelectric emf of a thermocouple and determination of inversion temperature.
10. Study of Newton's law of cooling and estimation of latent heat.

PHY 201 Electricity and magnetism Credits: 3 T + 1 P

Syllabus (Theory)

Unit I : Electrostatics & Electric Currents

Vector Calculus : Scalar and Vector fields, Gradient of a Scalar, Divergence and Curl of a vector, Line, Surface and Volume integrals.

Electrostatics: Coulomb's law and Electric field, Continuous charge distribution, Gauss theorem, Applications of Gauss theorem, Zero curl of E and its significance, Electric Potential, Poisson and Laplace's equations, Boundary value problems in rectangular coordinates, Multipole expansion, Energy due to system of point charges.

Capacitors: Capacitance, Parallel plate capacitor, Calculation of capacitance of a spherical and cylindrical capacitor, Energy stored in a capacitor.

Polarization: Alignment of polarized molecules, Induced dipoles, Field due to polarized

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object, Field inside a dielectric, capacitor with dielectric, Gauss's law in dielectrics, Dielectric constant, Energy density of an electrostatic field (with and without dielectric), Polarisability and susceptibility, Clausius- Mossotti formula.

Unit II : Magnetostatics

Lorentz Force: Magnetic field, Lorentz force, Cyclotron motion, Current density, Continuity equation, Biot Savart Law and applications.

Ampere Law: Curl of B, Ampere's law, **B** near a long wire, Magnetic field of a solenoid and toroid, Force between two parallel conductors, Definition of ampere, Applications.

Magnetic field in matter: Diamagnetism, Paramagnetism, Ferromagnetism, Field of a magnetized object, Bound currents, Ampere Law in magnetic materials, Magnetic hysteresis.

Unit III: DC and AC networks

Kirchoff's Laws: Kirchoff's Voltage Law, Kirchoff's Current Law, Applications of KVL and KCL: Resistances, Capacitors, Inductors, Voltage and Current sources - Series and parallel connections, Node and loop methods. Potentiometer circuit, Wheatstone Bridge.

Networks with time-varying sources: Current voltage relation for sinusoidal voltages applied to resistance, capacitance and inductance, Reactance and impedance, Phasors and complex representation of voltages and currents, Power in AC circuits, RMS values, Power factor, LR and CR circuits, Series and parallel LCR circuits, Resonance, mutual inductance and transformers.

Reference Books:

1. University Physics – Sears, Zemanski and Young
2. Fundamentals of Physics (6th Edition) - David Halliday, Robert Resnick and Jearl Walker.
3. **Introduction to Electrodynamics – David J. Griffiths [Units I and II]**
4. Berkeley Physics Course Vol. II (S.I. Edition). TMH Publications.
5. Concepts of Physics (Vol. 2) – H.C. Verma.
6. **Electronics for Scientists and Engineers – T.R. Vishwanathan, G.K. Mehta and V. Rajaraman. [Unit III]**

Practicals **[Credit: 1]**

1. Plotting Electric field and equipotential curves
2. Study of dependence of capacitance of a parallel plate capacitor on various parameters.
3. Study of Network Theorems
4. Study of Biot Savart Law
5. Study of magnetic field in a solenoid

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6. EMF measurement using potentiometer
7. Study of transient response in RC circuits
8. Study of transient response in LCR circuits
9. Conversion of galvanometer into voltmeter and ammeter.
10. Study of hysteresis in a transformer
11. Study of force between Current carrying wires (Current Balance)
12. Measurement of charge (using Ballistic Galvanometer/Integrator)

PHY 251 Optics and Lasers Credits: 3 T + 1 P

Syllabus (Theory)

Unit I : Wave Nature of Light and Interference

Light: Electromagnetic spectrum, Huygen's principle, Explanation of reflection and refraction, Fermat's Principle, Phase change on reflection, Total internal reflection.

Interference: Young's experiment - coherence, intensity distribution and visibility of fringes, Fresnel's Biprism, Interference in thin films, Colours of thin films, Interference at an air wedge, Newton's rings, Michelson's interferometer.

Unit II : Diffraction and Polarization

Fraunhoffer and Fresnel Diffraction: Diffraction at a single slit, double slit, Diffraction by multiple slits, Diffraction grating, Resolving power – Rayleigh's criterion, Resolving power of a grating and telescope, Fresnel diffraction - half period zone, Zone plate, Diffraction at a circular aperture and at a straight edge (qualitative treatment only), Polarization by reflection, Brewster's law, Malus law, Double refraction, Production and detection of linearly, circularly and elliptically polarized light, Quarter and half wave plates, Polariods, Optical activity.

Unit III : Scattering of Light and Lasers

Scattering: A brief discussion on Tyndall, Rayleigh and Raman scattering of light. Blue colour of the sky and ocean. A qualitative account of fluorescence and phosphorescence, the Raman Effect experiment and its explanation, Intensity and polarisation of Raman lines, Some applications of Raman Effect.

Introduction to Lasers: Spontaneous and stimulated emission, density of states, Einstein's A and B coefficients. Ratio of stimulated to spontaneous transitions in a system in thermal equilibrium, Condition for amplification, Population inversion, Methods of optical pumping, Energy level schemes of Ruby laser and He-Ne laser. Properties and uses of Lasers, Basic concepts of holography, Construction of hologram, Discussion on the use of holograms in daily life, Recording and reproduction of holograms.

Reference Books:

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1. Optics - A K Ghatak.
2. Fundamentals of Optics - Jenkins and White.
3. Optics – Eugene Hecht and A.R. Ganesan. Pearson

Practicals **[Credit: 1]**

1. Locating Image position for a Lens using parallax and verifying relations such as [1/v+1/u=1/f], [m1m2 = 1]. (Understanding the concept of parallax)
2. Determination of refractive index of material of prism
3. Measurement of resolving power of a plane diffraction grating
4. Determination of wavelength of Sodium light using a plane diffraction grating
5. Newton's Rings experiment
6. Young's Double slit experiment
7. Fresnel's Biprism
8. Diffraction at a single slit/circular hole using He-Ne Laser light
9. Verification of Malus Law
10. Study of optical activity using polarimeter
11. Determination of speed of Light in air

PHY 301 Electronics Credits: 3 T + 1 P

Syllabus (Theory)

Unit I : Semiconductor Characteristics and Applications

Semiconductors:

Intrinsic and extrinsic semiconductors, Energy bands in semiconductors, Fermi level, P-N junction diode, Circuit models for a junction diode, Half wave and full wave rectifiers, Power output and efficiency, Ripple factors. Clipping and clamping circuits, Amplitude demodulation, Breakdown in diodes – Avalanche and Zener breakdown, Zener diode characteristics and application in voltage regulation. LEDs, photo diodes.

Unit II : Transistors and Applications

Bipolar junction transistor, PNP and NPN transistors, Characteristics and different configurations, Current components in CE configuration, Large signal and small signal dc current gains, Transistor biasing – self bias circuit, Load line and operating point.

Transistor as an amplifier : Transistor as a two port device, Small signal h-parameters, analysis of CE amplifier, Stabilization of voltage gain in CE amplifiers, Two stage amplifiers, RC coupling, Frequency response of CE amplifier. Comparison of transistor configurations.

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Emitter follower circuit and its use, Transistor as Power amplifier.

JFET construction and its characteristics – MOSFET characteristics.

Feedback in amplifiers, Properties of negative feedback. Requirements for oscillation, Barkhausen criterion, Hartley and Colpitts oscillators.

Unit III : Digital Electronics

Number systems: Positional number systems, Binary representation, 2's complement notation, Binary addition and subtraction, Octal number system, Hexadecimal system, Binary codes - BCD and ASCII codes.

Boolean Algebra: Switching circuits, AND, OR and NOT operations, Truth table, Boolean functions, Postulates and theorems of Boolean Algebra, Duality principle, Venn diagram, Canonical forms of boolean functions, Simplification of boolean functions, K-maps, Incompletely specified functions.

Combinatorial and sequential circuits: Logic gates, NAND and NOR as universal gates, Realization of logical functions using SOP and POS techniques, XOR gate, Half and Full adder, Multiplexer and demultiplexer, Use of multiplexer for realization of a logical function, Basic model of a sequential circuit, RS flip flop, Asynchronous and synchronous circuits, JK and Master-slave JK flip flops.

Reference Books:

1. Electronic Principles, Malvino.
2. Principles of Electronics – V.K. Mehta
3. **Electronics for Scientists and Engineers – T.R. Vishwanathan, G.K. Mehta and V. Rajaraman.**
4. Digital Principles and Applications, Malvino and Leech.
5. Principles of Communication Systems, Taub and Schilling.
6. Handbook of Electronics – Gupta and Kumar

Practicals [Credit: 1]

1. Familiarity with Bread-board, tools and components,DMM, CRO, Function generator, Power Supply.
2. Obtaining characteristics of junction diode/LED and obtaining bandgap,forward and reverse characteristics of Zener diode.
3. Obtaining characteristics of a PNP/NPN junction transistor and measuring β.
4. Obtaining characteristics of a JFET.
5. Construction and study of power supply using Diodes and capacitor filter.
6. Study of Common Emitter Amplifier
7. Hartley Oscillator

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8. Experiments on OP-AMP – Inverting amplifier, Adder, Differentiator, Integrator.
9. Construction of Logic gates using diodes, resistors and transistor.
10. Study of truth tables of Logic gates
11. Study of amplitude modulation and demodulation.

PHY 302 Kinetic Theory &Statistical Mechanics Credits: 2 T

Syllabus (Theory)

Unit I :Kinetic Theory of Gases

Introduction, Postulates of Kinetic theory of gases, Kinetic theory as particle model, Ideal gas: macroscopic and microscopic descriptions, Kinetic calculation of pressure, Kinetic interpretation of temperature, Ideal gas scale, Intermolecular forces, Specific heat of an ideal gas, Law of equipartition of energy.

Mean free path, Maxwell' distribution law, Distribution of molecular speeds, Van der Waal's equations of State, Critical constants, Application to liquefaction of gases. Liquid State: Surface Tension and Viscosity.

Unit II: Statistical Thermodynamics

Energy states and energy levels, Macrostates and microstates, Thermodynamic probability, Bose Einstein Statistics, Fermi Dirac statistics, Maxwell Boltzmann statistics, Statistical interpretation of entropy, BE distribution function, FD distribution function Classical distribution function, Comparison of distribution functions for indistinguishable particles, MB distribution function, Partition function, Thermodynamic properties of a system.

Reference Books:

1. Statistical Mechanics - K Huang.
2. **Thermodynamics, Kinetic Theory and Statistical Thermodynamics – F.W. Sears and G.L. Salinger**
3. Thermal Physics – F. Rief
4. Modern Physics – R. Murugeshan, Kiruthiga Sivaprasath. [S. Chand & Co.]

PHY 351 Quantum Mechanics Credits: 3 T + 1 P

Syllabus (Theory)

Unit I: Origin of Quantum Theory

Particle properties of radiation, Polarization with weak light source, Wave properties of material particles, Davisson and Germer experiment, Young's double slit experiment with electrons, Wave function, Delta function and plane wave functions, Wave packets, Eigenvalues and eigenfunctions, Expansion of a wavefunction in terms of position and momentum

eigenfunctions, Wave function as a vector.

Unit II: Uncertainty principle and operator formalism

Position and momentum uncertainty, Heisenberg uncertainty principle, Gaussian wave packet, Operator formalism, Position, momentum and energy operators, Operator algebra, Commutator, Hermitian operators, Hermitian adjoint, Eigenvalues of hermitian operators, Orthogonality of eigenfunctions, Degenerate eigenvalues, Simultaneous eigenfunctions of commuting operators, Basis vectors, Projection operator, Parity operator, Expectation value.

Unit III: Schrodinger equation and solutions

Schrodinger equation, Free particle solution, Motion of wave packet, Spreading of gaussian wave packets, Stationary states, Operators commuting with H, Ehrenfest's theorem and relation between classical and quantum mechanics, Energy-time uncertainty, Time evolution, Width of spectral lines, Probability current density. Applications of Schrodinger equation in one dimension – Infinite square well potential, Particle in a box, Finite square well, Attractive delta function potential, Harmonic oscillator, Potential step, Potential barrier.

Reference Books:

1. Concepts of Modern Physics - Arthur Beiser. [TMH]
2. Modern Physics – Anderson.
3. Quantum Physics (Berkeley Physics Course V. 4) – Eyvind H. Wichman [TMH]
4. **Quantum Physics – H.C. Verma. [Surya Publications]**
5. Modern Physics – R. Murugeshan, Kiruthiga Sivaprasath. [S. Chand & Co.]

Practicals **[Credit: 1]**

1. Millikan's oil drop experiment.
2. Michelson Interferometer
3. Measurement of Planck's constant using LED.
4. Rutherford scattering experiment.
5. Study of wave motion using ripple tank.
6. Measurement of moment of inertia of a flywheel.
7. Study of a bar pendulum.
8. Mechanical Transmission Line.
9. Measurement of surface tension using pull-out method.
10. Viscosity measurement using falling sphere.
11. Study of elastic deformation of a wire.

PHY 352 Relativity Credits: 2 T

Syllabus (Theory)

Unit 1: Relativistic Kinematics

Speed of Light c as a fundamental constant, Measurement of c.

Principle of equivalence, Postulates of special relativity, Gallilean and Lorentz Transformations, Length contraction, Time dilation.

Unit II: Relativistic dynamics

Relativistic Momentum and energy, Doppler effect, Minkowski space and four vectors, Energy momentum four vector, Equivalence of mass and energy.

Magnetic field as a relativistic phenomenon.

Equivalence of gravitational and inertial mass, Gravitational mass of photons.

Reference Books:

1. Concepts of Modern Physics - Arthur Beiser.
2. Modern Physics – Anderson.
3. Mechanics (Berkeley Physics Course V. 1) – Charles Kittel, Walter D. Knight, Malvin A. Ruderman.
4. Introduction to Electrodynamics – David J. Griffiths

PHY 401 Atomic & Molecular Physics Credits: 3 T + 1 P

Syllabus (Theory)

Bohr Model: Rutherford scattering experiment and scattering formula, Failure of planetary model, Atomic spectra and Bohr theory, Energy levels and spectra, Correspondence principle, Effect of nuclear mass on spectrum, Atomic excitation.

Quantum theory of Hydrogen atom: Schrodinger equation for the hydrogen atom, Separation of variables, Quantum numbers, Principal quantum number, Azimuthal quantum number, Magnetic quantum number, Electron probability density, Radiative transitions, Selection rules, Zeeman effect for one electron system, Paschen Bach effect for one electron system.

Many electron atoms: Electron spin, Pauli's exclusion principle, Symmetric and antisymmetric wave functions, Atomic structure and periodic table, Spin-orbit coupling, Total angular momentum, Atomic spectra, Characteristic X-ray spectra.

Molecular spectra: Molecular bonds, H_2^+ molecular ion, Hydrogen molecule, Complex molecules, Molecular bonds, Hybrid orbitals, Rotational energy levels, Vibrational energy levels, Vibrational and rotational spectra.

Reference Books:

1. Introduction to Modern Physics - Mani and Mehta.

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2. Concepts of Modern Physics – Arthur Beiser.
3. Physics of the Atom -M. Russel Wehr, James A. Richards Jr. and Thomas W. Adair
4. Atomic and Molecular Spectra – Raj Kumar
5. Elements of Spectroscopy – Gupta, Kumar, Sharma
6. Atomc Spectra – Harvey E. White
7. Modern Physics – R. Murugeshan, Kiruthiga Sivaprasath. [S. Chand & Co.]

Practicals **[Credit: 1]**

1. Single slit and double slit diffraction using microwaves
2. Bragg's Law using microwaves
3. Measurement of e/m of electron using Thomson's method
4. Study of Zeeman effect
5. Absorption spectrum of Iodine vapour
6. Study of Hydrogen spectrum (Balmer series)
7. Photoconductivity
8. Project on construction of Low Cost Apparatus (equivalent to 3 experiments)

PHY 402 Electrodynamics and Plasma Physics Credits: 2 T

Syllabus (Theory)

Unit I

Faraday's Law:

Electromotive Force, Motional emf ($E \propto -d\Phi/dt$), Proof in static magnetic field, Faraday's law in integral and differential forms, Applications of Faraday's Law, Lenz's law, Inductance - self and mutual, Transformers, LR circuit, energy in a magnetic field, Magnetic energy density.

Maxwell's Equations:

Maxwell's modification of Ampere's Law, Maxwell's equations in free space, Maxwell's equations in matter, Boundary conditions at surface, Poynting's theorem, Poynting Vector.

Wave equation:

Wave equation, Polarization of electromagnetic waves, Boundary Conditions, Reflection and Transmission at normal and oblique incidence, Snell's Law.

Unit II

Plasma Physics:

Definition of Plasma, Debye Shielding, Plasma parameter and criterion for plasma, Motion of charged particle in uniform electric and magnetic field, Larmour radius, Non-uniform B field: $\nabla B \,//\, B$, Magnetic mirror, Loss cone.

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Dielectric constant of plasma, plasma oscillations, Electromagnetic waves with $B_0 = 0$, Experimental application to measure plasma density, Communication blackout during re-entry of space vehicles, Cutoffs and resonances in plasma.

Reference Books:

1. **Introduction to Electrodynamics – David J. Griffiths [Units I and II]**
2. Berkeley Physics Course Vol. II (S.I. Edition). TMH Publications.
3. Foundations of Electromagnetic Theory – Reitz and Milford
4. **Introduction to Plasma Physics – Francis F. Chen**

PHY 451 Solid state Physics Credits: 3 T + 1 P

Unit I: Crystal Structure

Lattice and basis, Periodicity, Translation vectors, Unit cell, Primitive cell, Allowed rotations, Lattice types, Lattice planes, Common crystal structures.

Bragg's Law, Laue theory of X-Ray diffraction, Laue equations, Powder diffraction.

Bonding: Potential between pair of atoms, Lennard Jones potential, Cohesive energy, Covalent, Van der Waals, Ionic and Metallic crystals.

Unit II: Magnetic and Thermal properties

Magnetism: Atomic magnetic moment, magnetic susceptibility, Diamagnetism, Paramagnetism, Ferromagnetism, Ferromagnetic domains, Hysteresis.

Thermal properties: Lattice vibrations, Simple harmonic oscillator, Second order expansion of Lennard Jones potential about the minimum, Vibration of one dimensional monoatomic chain under harmonic and nearest neighbour interaction approximations, Concept of phonons, Density of modes (1-dimensional), Debye model, Lattice specific heat, Low temperature limit, Extension (conceptual) to 3-d.

Unit III: Metals and semiconductors

Band structure: Electron in periodic potential, Nearly free electron model (qualitative), Energy bands, Band gap, Metals, insulators and semiconductors.

Motion of electrons: Free electrons, Conduction electrons, Electron collisions, Mean free path, Conductivity and ohm's law, Density of states, Fermi energy, Fermi velocity.

Intrinsic semiconductors, Electrons and holes, Fermi level, Temperature dependence of electron and hole concentrations, Doping, Impurity states, n and p type semiconductors, Conductivity, Mobility, Hall effect, Hall coefficient.

Reference Books:

1. Solid State Physics - A J Dekker.
2. Introduction to Solid State Physics – C. Kittel.
3. Solid State Physics – R.L. Singhal
4. Modern Physics – R. Murugeshan, Kiruthiga Sivaprasath. [S. Chand & Co.]

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1. Spark detector
2. Geiger Muller Counter
3. Study of Compton effect
4. Frank Hertz experiment
5. Four Probe resistivity measurement
6. Investigation of Dia- Para and Ferromagnetism
7. Study of Hall Effect

8. Project on construction of Low Cost Apparatus (equivalent to 3 experiments)

PHY 452 Nuclear Physics Credits: 2 T -

Unit I: The nucleus

Nuclear structure:

Composition and Properties of the Nucleus, Stable nuclei, Binding energy, Liquid drop model, Shell model, Meson theory of nuclear forces.

Nuclear Transformations:

Radioactive decay, Half life, Radioactive series, Alpha decay – Gamow theory, Beta decay – Neutrino theory, Gamma decay, Cross section, Nuclear reaction, Fusion reactors.

Unit II: Nuclear measurements and Elementary Particles

Interactions of charged particles and neutrons with matter, Working of nuclear detectors: G.M. Counter, Proportional counter, Scintillation counters, Cloud chamber, Spark chamber, Emulsions.

Interactions of charged particles, Leptons, Hadrons, Elementary particle quantum numbers, Quarks, Fundamental interactions, Beginning of the Universe.

Reference Books:

1. Concepts of Modern Physics – Arthur Beiser.
2. Introduction to Modern Physics - Mani and Mehta.
3. Concepts of Nuclear Physics – Bernald L. Cohen.
4. Nuclear Physics Principles and Applications – John Lilley.
5. Nuclear Physics – B.N. Srivastava.
6. Modern Physics – R. Murugeshan, Kiruthiga Sivaprasath.

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