Tribhuvan University
Institute of Science and Technology
Three year B. Sc. Physics course of study
2052

Course Title: (Mechanics I, thermodynamics, statistical physics, electricity and magnetism.) **Full Marks:** 100
Course No.: PHY 311. (Major/Minor) **Pass Marks:** 35
Nature of the Course: Theory **Year:** 1

Course Objectives:
At the end of this course the student should be able;

- to acquire sufficient basic knowledge in Physics;
- to apply this knowledge base for studying major courses in Physics.
- to solve mathematical problems in related topics.
- to deduce mathematical equations and formulas.

MECHANICS I:

Probability and Statistical Analysis of Data: Concept of Probability, Distribution function (Binomial, Normal and Poisson), Systematic and random errors, Laws of errors, Standard errors, least square fit, Chi square, F and T tests, interpolation, numerical value. **8 hrs.**

Momentum and Elastic Collisions: Principles of liner and angular momentum elastic and inelastic collision. Centre of mass of a system of particles. **3 hrs.**

Gravitational Field and Potential: Kepler's Law of planetary motion, gravitational field and potential, Gauss and Poisson equations for gravitational field, gravitational self-energy, rocket-single and multistage, reduced mass, central forces.**6 hrs.**

Rotation of Rigid Bodies: Equation of motion for a rigid body theorems of moment of inertia, M.I. of rectangular, cylindrical and circular lamina, spherical shell and solid sphere, energy of the rotation. **5 hrs.**

Oscillatory Motion: Small oscillation in a potential well, harmonic oscillation equation and general solution, examples of simple harmonic oscillation, spring and mass system, simple and compound pendulum, torsional pendulum bifilar oscillations, Heloholtz resonator, oscillation of two masses connected by a spring, normal modes, N coupled oscillators, damped and forced harmonic oscillator, power dissipation, quality factors, transient and steady states, power absorption. **10 hrs.**

Wave Motion: Particle velocity and wave velocity, equation of plane progressive wave, differential equation of wave motion, energy of progressive wave, transverse wave on string longitudinal wave in rods and gasses, energy of stationary waves. **6 hrs.**

Elastic Properties: Inter-relation between elastic constants, coefficient of rigidity of a cylinder, bending moments, shearing forces, cantilever, supported beam. **7 hrs.**

Fluid Mechanics: Kinematics of moving fluid, Equation of continuity, Euler's equation, Bernoulli's theorem, Viscous fluids, stream line and turbulent flow, Poiseulle's law, and its application, Reynold's number. **5 hrs.**

THERMODYNAMICS:

Thermodynamic Fundamental Concepts: Thermodynamic systems, thermal and thermo-dynamic-equilibrium, equation of state, thermodynamic processes, external and internal work,

internal energy, quasi-static, isothermal, adiabatic, isobaric and isochoric processes. **2 hrs.**

Laws of Thermodynamics and their Application: Zeroth law, first law of thermodynamics, second law of thermodynamics, Carnot's theorem, absolute scale of temperature, entropy changes in reversible and irreversible processes, principle of increase of entropy, entropy and second law, third law of thermodynamics and its application. **6 hrs.**

Thermodynamic Relations: First and Second latent heat equations, Triple point, Thermo-dynamic potentials, Helmholtz's function, enthalpy, Gibb's function, Maxwell's thermodynamic relation, phase transition, Clausius-Clapeyron equation. **6 hrs.**

Concept of Ideal and Real Gasses: Concept of ideal and real gases, Joule expansion, Joule's law for perfect gas, Van der-Waal's equation, critical constant of Van der-Waal's gas, Joule-Thomson expansion, porous plug experiment, constancy of enthalpy, adiabatic expansion. **6 hrs.**

Production of Low Temperature: Thermodynamics of refrigeration, refrigeration cycle, efficiency, cooling in Joule-Thomson expansion, regenerative cooling, cascade cooling, Boyle's temperature, temperature of inversion, critical temperature and its application. **6 hrs.**

Transport Phenomenon: Molecular collisions, collision cross-section, molecular diameter, mean free path, transport phenomenon, transport of momentum, energy and mass, Brownian motion, Einstein's theory of Brownian motion. **5 hrs.**

Black Body Radiation: Total energy density, spectral energy density, emissive power, absorptive power, Kirchoff's Law, pressure of radiation, pressure of diffuse dadiation, Stefan-Boltzmann's law, spectrum of black body radiation, Wien's Displacement Law, Planck's Radiation law, Rayleigh-Jean's Law. **6 hrs.**

STATISTICAL PHYSICS:

Classical Statistical Physics: Phase-space, microstate and macrostate, ensemble, constraints and accessible state, thermodynamic probability, fundamental postulates of statistical mechanics, division of phase space into cells, entropy and probability, Boltzmann's Canonical Distribution law, Maxwell's Distribution law of velocities, Maxwell's-Boltzmann statistics, Law of equipartition of energy. 10 hrs.

Quantum Statistical Physics: Intorduction, Bose-Einstein Statistics, Fermi-Dirac Statistics, electron gas in metals, Fermi level and energy. **3 hrs.**

ELECTRICITY AND MAGNETISM:

Elementary Vector Analysis: Gradient, divergence and curl of a vector in Cartesian, Polar coordinates, Gauss's Stoke's and Green's theorems, Laplacian in polar coordinate system. **6 hrs.**

Electrostatic Potential and Field: Coulomb's law, the electric field, electric flux, Gauss's law and its applications, Equipotential surface, potential due to charge distributions, Poissons and Laplace's equations, Work done for a moving charge, Electrostatic energy, electrical images, potential and field due to an electric dipole and force on a charged sphere. **8 hrs.**

Electrostatic Fields in Dielectric: Polar and non-polar molecules, electric polarization, the displacement vector, Gauss's law for dielectric media, Force and energy in dielectric systems, Boundary conditions of D and E at the interface, Clausius Mossotti relation, Langevin Debye formula. **6 hrs.**

Magnetic Fields due to Currents: Sources of magnetic induction field, Biot and Savart's law and its applications, Lorentz force, Ampere's circuital law, magnetic vector and scalar potential, the magnetic dipole, surface current density. **4 hrs.**

Magnetic Properties and Fields: Magnetic dipole moment of current loop and angular momentum, magnetization, Langevin's theory of para and diamagnetism, ferromagnetism, magnetic domain theory, magnetic susceptibility and permeability, ferrites. **6 hrs.**

Interaction between Currents: Current and distribution of current, Field and interaction, of moving charges, force between parallel currents. **4 hrs.**

Electromagnetic Induction: Faraday's Law, self and mutual induction, search coil, Grassot's fluxmeter, earth inductor, energy stored in magnetic field, transformer, its use and applications. **6 hrs.**

LCR Circuit: LCR circuits with AC and DC sources, phase diagrams, impedance, resonance, the quality factor, power factor. **5 hrs.**

Maxwell's E. M. Equation: The displacement current, Maxwell's equations and their use in propagation of electromagnetic wave, derivation of Gauss's theorems,

Faraday's-Lenz bais law, Biot and Savart's law, Ampere's circuital laws, energy of a charged particle in an electromagnetic, field, general idea about reflection and transmissions of electromagnetic waves at the interface between two media. 5 hrs.

Text Books

1. Mathur, D.S., ***Mechanics***, S. Chand and Co., Ltd. New Delhi, 1993.
2. Singal, S.S., Agrawal, J.P. and Prakash S.,: ***Heat and Thermodynamics***, Pragati Prakashan, Meerut, 1990.
3. Reitz, J.R., Melford, F.J. and Christy, R.W.,: ***Fundations of Electromagnetic***, Narosa Publishing House, New Delhi.

References:

1. Smith C.J.,: ***General Properties of Matter***, Radha Publishing House, Calcutta, Indian Edition 1985
2. Sears F.W. and Zemansky. : ***Thermodynamics, Kinetic theory and Statistical Thermodynamics***, Norosa Publishing House, New Delhi (Reprint 1993).
3. Smith, C.J.,: ***Electricity and Magnetism***, Radha CBS Publisher, New Delhi.
4. Reif, F.,: ***Fundamentals of Statistical and Thermal Physics***, McGraw Hill Publishing.
5. Huang, K.,: ***Statistical Physics***, Wiley Eastern.
6. Khandelwal, D.P., and Panide, A.K.,: ***Thermodynamics and Statistical Physics***, Himalayan Publishing House, Bombay.
7. Brinlal and N. Subrahmanyam,: ***Heat and Thermodynamics***, S. Chand and Company Ltd., New Delhi.
8. Kittle and Kommer: ***Thermal Physics***, CBS Publishers, New Delhi.

Course Title: Physics Laboratory I **Full Marks:** 50
Course No.: PHY 312 (Major/Minor) **Pass Marks:** 20
Nature of the Course: Practical **Year:** I

Course Objectives:
At the end of this practical course the student should be able:

- to relate theoretical concepts to practical skills
- to perform laboratory work
- to perform major laboratory courses
- to set experiments related to physics
- to design laboratory experiments
- to draw conclusions from laboratory work
- to develop proper laboratory skills
- to interpret laboratory work results

EXPERIMENTS: **(150 hrs.)**

Mechanics Experiments: Determination of moment of inertia of flywheel., Determination of 'g' using bar pendulum/Kater's pendulum.., Determination of 'Y' by bending beam method.. Determination of surface tension of liquid by capillary rise method/Jaeger method, Determination of modulus of rigidity of wire by torsional pendulum/Maxwell's vibration needle., Determination of coefficient of viscosity by Poiseulli's method.

Thermodynamic Experiment Constant: Determination of Stefan's constant., Determination of the ratio of C_p and C_v by Clement and Desorme's method.

Electricity and Magnetism Experiments: Measurement of the sensitivity and constant of Ballistic galvanometer., Measurement of high resistance by the method of leakage., Measurement of low resistance by Carey Foster bridge., Determination of power factor of coil., Determination of magnetic field using search coil, Determination of dip using

earth inductor.. Estimation of efficiency of transformer, Measurement of impedance of inductor/capacitor circuit, Measurement of impedance of LCR series circuit, Measurement of capacitance by Ballistic galvanometer.

Text Books

1. Arora, C.L., ***B.Sc. Pratical***, S. Chand and Co.

Course Title: Physics (Optics, Atomic and Nuclear Physics, Electronics) **Full Marks:** 100
Course No.: PHY 321 (Major/Minor) **Pass Marks:** 35
Nature of the Course: Theory **Year:** I

Course Objectives:
At the end of this course the student should be able:

- to acquire sufficient basic knowledge on such topics in physics as optics Atomic and Nuclear Physics and electronics
- to apply their knowledge to learn major courses
- to solve mathematical problems related to the topics
- to deduce mathematical relations and formulas.

OPTICS:

Wave Nature of Light: Nature of light, Huygen's wave theory and its application for propagation of waves. **2 hrs.**

Aberrations at Spherical Surfaces: Refraction through spherical surfaces from Huygen's wave theroy, chromatic aberrations; astigmatism, Coma, Curvature distortion and their elimination. Ramsden's and Huygen's eyepieces. **7 hrs.**

Interference: Condition for obtaining interference, spatial and temporal coherence, interferences by division of wave front. Fresnel's biprism, Lloyd's mirror. Division of amplitude; thin and wedge films, Newton's rings, Michelson interferometer, Fabry Perot interferometer, Intensity distribution, Antireflection gratings. **11 hrs.**

Diffraction: Huygen's principle, Fresnel and Fraunhoffer diffraction. Fresnel's diffraction: Zone plate, Circular aperture, straight edge, straight wire, disc. Fraunhoffer's diffraction; Diffraction through a single and double slit, Circular aperture

and disc. Dispersive and resolving power of grating, microscope and telescope. **12 hrs.**

Polarization: Unpolarized, plane, circular and elliptically polarized light, Double refraction, Crystal polarizer, Malus law, Brewster's law, polarization by reflection and scattering, Double refraction and Huygen's explanation, Production and analysis of polarized light optical activity Laurent's half shade polarimeter and its applications. **8 hrs.**

Dispersion and Scattering: Normal and anomalus dispersion, scattering of light. **2 hrs.**

Leasers: Spontaneous and induced emission, condition for laser action, population inversion, optical pumping, Ruby and He-Ne lasers and application. **4 hrs.**

Holography: Basic technique of holography, theory of holography, applications. **4 hrs.**

ATOMIC AND NUCLEAR PHYSICS I:

Nuclear Structure: General background of structure of atom and nucleus. Rutherford scattering, its conclusions, limitations of Rutherford model of atom, need for quantum idea. **4 hrs.**

Bohr's Atomic Theory: Bohr's hydrogen atom, energy level diagram and spectra of hydrogen atom, Franck-Hertz, experiment and limitation of Bohr's model. **4 hrs.**

Sommerfield's Atomic Model: Sommerfield non-relativistic atom, space quantisation, vector atom model, spectral terms arising from LS coupling and s,p,d,f notation, Stern-Gerlach experiment, Pauli's exclusion principle. **5 hrs.**

Fine Structure Spectrum: Fine structure of Hydrogen lines, doublet structure of alkali spectrum, single and triple series of alkaline earth atoms. **4 hrs.**

Zeeman Effect: Normal and anomalous Zeeman effect for one electron system. **4 hrs.**

Characteristic X-ray Spectrum: Characteristic X-ray, X-ray Spectrometer, Fine structure of X-ray transitions, Mosley's law and its application. **4 hrs.**

Constituents of the Nucleus: Proton-electron hypothesis and its failure Proton-neutron hypothesis, Qualitative-facts about, mass, charge, density, magnetic and electric properties of the nucleus, packing fraction, mass defect, binding energy, and its main feature. **6 hrs.**

Radioactivity: Basis of the theory of radioactive disintegration, half-life, mean life, successive radioactive transformations equilibrium, natural radioactive series, units of radioactivity, Qualitative discussion of alpha, beta and gamma ray spectra, absorption of α particles, range, straggling and stopping power, theory of α decay, Neutrino hypothesis of β - decay, qualitative discussion of the theory of β decay. **7 hrs.**

Interaction of Nuclear Radiation with Matter: Interaction of γ rays with matter, absorption, photoelectric effect, compton scattering, pair production, measurement of γ -ray energies internal conversion. **6 hrs.**

Nuclear Detectors: Ionization chamber, G.M. Counter, scintillation counter, nuclear emulsion, Bubble chamber.

Accelerators: Cyclotron, synchrotron, synchrocyclotron, Betatron, Linear accelerator. **3 hrs.**

ELECTRONICS:

Circuit Analysis: Superposition theorem, Thevenin's and Norton's theorem and their applications, maximum power transfer theorem. **5 hrs.**

Characteristics of Diodes: Semiconductor, Different types of diodes, energy band in semiconductors, band gap, Diode characteristics, application of junction diode as half and full wave rectifier, bridge rectifier, filter (R-C filter). Zener diode as voltage regulator. **7 hrs.**

Bipolar Junction Transistor: PNP and NPN transistors, transistor characteristics in different modes, α and β of transistor, input and output characteristics of CB, CE and CC amplifiers, transistor biasing, Amplifier gain calculation, AC-input impedance of different configuration Q-point, Optimum Q-point, bias stabilization, Stability factor. **12 hrs.**

FET and UJT: Field effect transistor, characteristics of FET, Unijuction transistor and its characteristics, FET as an amplifying device with infinite input impedance, UJT as a relaxation oscillator. **5 hrs.**

Amplifiers: R-C amplifier, frequency response, power amplifier, overall voltage gain. **5 hrs.**

Operational Amplifiers: Principle of differential amplifiers and operational amplifiers, transfer characteristics, inverting and non-inverting mode, common mode rejection ratio (CMRR). **4 hrs.**

Oscillators: Introduction of feedback and their types, negative feedback, positive feedback and Oscillators, Barkhausen criterion, working principle of Hartley, Colpitts and phase shift Oscillators, multivibrators. **6 hrs.**

Logic gates and Digital Electronic: Decimal and binary numbers and their interconversion, arithmetic and binary numbers. Boolean algebra, and de-Morgan's theorem, AND, OR, NAND, NOR, NOT, X-OR and XNOR gates. Synthesis of gates to realise a Boolean equation. NAND gate as basic building block. RS, JK, D flip – flops. Half adders and full adders. **6 hrs.**

Text Books:

1. Subrahmanyamn, N. and Brij, L: ***Test book of Optics***, S. Chand and Co. Ltd. 1994.
2. Wahr, Richard and Adir: ***Physics of raw Atom***, Addison Wesley.
3. Malvino, A.P.: ***Electronic Principles***, Tata Mc Graw Hill publishing Co. Ltd., India.
4. Murugesan R: ***Modern Physics***, S. Chand & Co. Ltd., New Delhi.

References:

1. Jenkins and White: ***Fundamental of Optits***, McGrawHill Hook Co. Ltd. Ny., 1957.
2. Theraja, B.L.: ***Basic Electronics***, S. Chand & Co. Ltd., New Delhi.

Course Title: Physics Laboratory II **Full Marks:** 50
Course No.: PHY 322 (Major/Minor) **Pass Marks:** 20
Nature of the Course: Practical **Year:** II

Course Objectives:
At the end of this practical course the student will be able:

- to relate theoretical concepts to practical skills.
- to perform prescribed practical works.
- to perform the major laboratory course.
- to set experiments related to the course.
- to design laboratory experiments.
- to draw conclusions from laboratory work.
- to develop proper laboratory skills.
- to interpret data from laboratory work.

EXPERIMENTS: **150 hrs.**

Optics Experiments: Wave length determination by Newton's Rings method, Estimation of wavelength using Fresnal biprism., Wavelength determination using Michelson interferometer., Wavelength determination from diffraction due to sharp edge., Determination of width of a slit by diffraction method., Wavelength determination using plane diffraction grating,. Estimation of resolving power of prism., Determination of resolving power of plane transmission grating., Deter of refractive index of prism for light of different wavelengths., Determination of specific rotation of sugar solution using Laurentz Half-shade Polarimeter.

Electronics Experiments: Verification of network theorems of Maximum power transfer/Thevin'/Norton., Study of characteristics of junction and Zener diode., Study of characteristics of Bipolar transistors., Calibration of CRO for the measurement of voltage and frequency., Study of rectification characteristics of DC power supply.

Electricity and Magnetism Experiments: Series and parallel resonant circuits., Time constants of RL, CR and LCR circuits., Measurement of capacitance by AC Bridge (de-Sauty Method)., Measurement of inductance by Maxwell's inductance capacitance Bridge.

Text Books

1. Arora, C.L., ***B.Sc. Practical***, S. Chand and Co.

References:

Course Title: (Solid State Physics, Nuclear Physics, Mechanics.) **Full Marks:** 100
Course No.: PHY 331 (Major) **Pass Marks:** 35
Nature of the Course: Theory **Year:** II

Course Objectives:
At the end of this course the student will be able:

- to acquire comprehensive and indepth knowledge on major topics of physics.
- to solve mathematical problems related.
- to the course topics to deduce mathematical equations and formulas to pursue higher courses in physics.

SOLID STATE PHYSICS:

Types and Structure of Crystals: The crystalline types of solid, amorphous and glassy, liquid states, lattice and lattice transitional vector, the basis and crystal, structure, primitive lattice cells, fundamental lattices, two and three dimensional lattices, Miller indices, simple crystal structure. **8 hrs.**

Crystal Structure from Different: Elecron, neutron and X-ray diffraction techniques for studying crystal structure, Laue method, Brillouin Zone, reciprocal lattice and conversion to different lattices. **4 hrs.**

Bonding in Crystals: Equilibrium lattice constant, different types of bonding and lattice energy. **5 hrs.**

Defects in Crystal: Lattice vacancies, colour-centres, alloy, slip, types of dislocation, Burger's vector, dislocation and crystal growth. **5 hrs.**

Lattice Dynamics: Lattice vibration lattice specific heat, phonon spectrum, Dulong and Petits relation, Einsteins theroy, Debye's theory. **5 hrs.**

Free Electron Theory: Free electron theory of metals, density of states, Fermi energy, electron specific heat, relaxation time, mean free path, mobility, thermal conductivity, electrical conductivity, Wiedaman-Franz law Hall effect. **5 hrs.**

Band Structure of Crystals: Concept of energy band in solids, valence and conduction band, distinction between conductor, insulator and semiconductors on the basis of band theory. **6 hrs.**

Properties of Semiconductors: Types of semiconductor (Extrinsic and intrinsic) and carrier concentration, mobility life time product, photo voltaic cell and its applications. **6 hrs.**

Super Conductors: Introduction to super conducting behaviour of materials, zero resistivity, critical temperature, Meissner effect. **4 hrs.**

Magnetism: Classical theories of magnetism, Approach to quantum theory of magnetism. **2 hrs.**

NUCLEAR PHYSICS II:

Nuclear Forces: Nuclear binding energy and saturation of nuclear, forces, nuclear stability, charge independence of nuclear forces, Two nucleon system deuteron problem. **8 hrs.**

Nuclear Reactions: Nuclear transmutation and discovery of neutrons, characterisation and Types of nuclear reactions, conservation theorems, Q-value, threshold energy cross-section of nuclear reactions. **8 hrs.**

Nuclear Reactors: Fission, multiplication factor, critical size, power of a nuclear reactor, classification of nuclear fusion reactors, Research and power reactors, Proton-Proton, chain, carbon-nitrogen cycle, controlled thermo nuclear reactions.**10 hrs.**

Nuclear Models: Assumption of liquid drop model of nucleus, semi-empirical mass formulas and significance of various terms, condition of nuclear stability, experimental evidence for nuclear magic numbers, elementary accounts of nuclear shell model, energy level scheme and explanations of magic numbers, Prediction of shell model. **12 hrs.**

Cosmic Ray and Elementary Particles: Discovery and properties of cosmic rays, elementary particles, Meson theory of Nuclear forces, classification of particles, types of interaction, conservation symmetry, strangeness, hypercharge, Introduction to quarks and qualitative description of quark model, Interaction of quarks and leptons. **12 hrs.**

MECHANICS II:

Motion in Central Field: Motion in Central force field, motion in arbitrary potential field, equation of orbits, Kepler's Laws of planetary motion. **8 hrs.**

Elastic and Inelastic Collision: Collision of particles, collision in laboratory and centre of mass systems, cross section, collision Rutherford scattering. **8 hrs.**

Lagrangian Formulation and Application: Lagrangian formulation, constraints, generalized co-ordinates, D' Alembert's principles, Lagrange's equations, Kinetic energy, Laws of conservation of energy, cyclic co-ordinates **8 hrs.**

Inertial Frames: Moving co-ordinate system, translating of energy, cyclic co-ordinates. **8 hrs.**

Motion of Rigid Bodies: Motion of rigid body, Euler's theorem, angular momentum and kinetic energy, the inertitensor, Euler's equation of motion, torque free motion, Eulerian angle, symmetrical top. **10 hrs.**

Relativity: Gallilean invariance, inertial frames of reference, Gallilean Transformations non-inertial frames and, fictitious forces Michelson-Morley experiment, Lorentz transformation, length contraction, time dilation, transformation and addition of velocities, variation of mass with velocity, mass energy relation, relation between momentum and energy, transformation of energy and momentum. **10 hrs.**

Text Books:

1. Goldstein, H. : ***Classical Mechanics***, Narosa Pub. House, (Reprint), New Delhi, 1993.
2. Kittel : ***Introduction to Solid State Physics***, John Wiley
3. Kaplan I. : ***Nuclear Physics***
4. Mathur, D. S., ***Mechanics***, S. Chand and Co.
5. Kittel C. : ***Solid State Physics***, Wiley eastern
6. Srivastava B. N. : ***Basic Nuclear Physics***, Pragati Prakash Merrut, India.
7. Murugesan R.: ***Modem Physics***, S. Chand & Co. Ltd., New Delhi.

References:

1. Wagman, Y.R.,: ***Classical Mechanics***, Prentice Hall of India Pvt. Ltd., New Delhi, 1990.
2. G. Tak wale and, P.S. Puranik: ***Introduction of Classical Mechanics***.
3. C. Rana and P.S. JOag: ***Classical Mechanics***.

4. Greecwood, ***Classical Dynamics***.
5. Resnick ***Special Theory of Relativity***.
6. D.S. Mann & Mukhejke, ***Relativity Mechanics and Statistical Physics***.
7. Kompanyets A.S.: ***Theoretical Physics***.
8. R.L Singhal : ***Solid State Physics***, Pub, Kear Nath Ram Nath Co. Meerut.
9. Kachhava: ***Solid State Physics***, Tata, McGraw Hill Publishing Company Ltd.
10. Keer: ***Principle of the solid state***, Wiley Eastern Ltd.
11. Saxena Gupta & Saxena: ***Fundamental of Solid State Physics***, Pragati Prakashan.
12. H.E. Hall: ***Solid State Physics***, E.L.B.S.

Course Title: Physics (Quantum Mechanics, Mathematical Physics). **Full Marks:** 100
Course No.: PHY 333 (Major) **Pass Marks:** 35
Nature of the Course: Theory **Year:** II

Course Objectives:
At the end of this course the student should be able:

- to acquire sufficient indepth knowledge needed for major Physics
- to solve mathematical problems related to the course.
- to deduct mathematical equations and formulas.

QUANTUM MECHANICS:

Introductory Wave Mechanics: Inadequacy of classical mechanics, Davisson-Germer experiment, de Broglie waves, group and phase velocity, uncertainty principle and its applications. **10 hrs.**

Quantum Mechanical Wave Propagation: Equation of wave propagation, time dependent and time independent Schrodinger equation, normalization of wave function, expectation values of dynamical quantities, Ehrenfest theorem. **13 hrs.**

Operator, Formalism in Quantum Mechanics: Operator, eigenvalues and non-commuting operators, Hermitian Operators, orthogonal functions, and orthoganality momentum operator, expansion in eigen functions, parity operator equation of motion, box normalization, angular momentum operator.**15 hrs.**

Barrier Penetration: Free particle, particle in a box, potential step and particle wave function, finite and infinite potential barrier, reflection and transmission coefficients, tunnelling effect. **12 hrs.**

Harmonic Oscillator and Applications: Linear harmonic oscillator, Hermite polynomials, oscillator wave function, even and old parity states, energy of harmonic oscillator, zero point energy, rigid rotator. **10 hrs.**

Quantum Mechanical Solutions: Schrodinger equation for spherically symmetric potential, spherical harmonics, degeneracy, angular momentum Laguerre polynomials solution of Schordinger equation for hydrogen atom, probable densities of electrons and shapes or orbital, transition probabilities and selection rules. **15 hrs.**

MATHEMATICAL PHYSICS:

Vector Analysis: Review of vector algebra, unit vector, basis vector, components, vector field, dot, cross and triple product, reciprocal set of vectors, vector differentiation, gradient, divergence and curl.

Vector integration, Gauss, Stoke's and Green Theorems unit vectors in curvilinear system, arc length and volume element in curvilinear system, gradient, divergence, curl and Laplacian in curvilinear system, orthogonal curvilinear system with examples of cylindrical and spherical systems. **12 hrs.**

Tensor Analysis: Tensors in physics, moment of inertia and stress tensors, General co-ordinate transformation, contravariant and covariant vectors, contravariant, covariant and mixed tensors, Kroneckar delta, addition, multiplication and contraction. **6 hrs.**

Operators in Linear Vector Space: Definition, linear independence, dimension, basis, inner porduct orthogonal basis, orthogonalization transformation, matrix algebra, Hermitian, unitary and orthogonal matrices, inverse co-

transformation, similarity transformation, eigenvalue and eigenvector, diagonalization. **11 hrs.**

Fourier Analysis and Applications: Review of functions of real variables, limit continuity, differentiation, integration, infinite series and convergence, Fourier series, Direchlet conditions, even and odd functions, square, triangular and saw tooth waves, output of a full wave rectifier. Summing of Fourier series, Gibbs phenomenon, applications. **11 hrs.**

Integral Transforms: Fourier transforms of functions and their derivations, convolution theorem, Parseval's relation, Laplace transforms of elementary functions, derivatives, integrals, unit step function and periodic functions Laplace inverse transform, solution of initial value problems. **11 hrs.**

Differential Equations with Special Functions: Reviews of methods of solving second order differential equations, linear independence and Worknsian, second order equations with variable coefficients, power series method, Hermite, Legendre, Laguerre and Bassel equations and solutions. **12 hrs.**

Partial Differential Equations: Stretched string and d' Alembert's solution, wave and heat conduction equations in one, two and three dimensions, Laplace equation in Cartesian, cylindrical and spherical coordinate systems and solutions.**12 hrs.**

Text Books:

1. Powell and Crase Mann B.: ***Quantum Machanics***, Narosa, New Delhi, 1994.
2. Charlie Harper: ***Introduction to Mathematical Physics***, Prentice Hall of India Pvt. Ltd., 1990.

References:

1. Mathews, P.H. & Venkatesan S.: ***A Text Books of Quantum Mechanics***, Tata McGraw Hill Publishing Co., New Delhi.
2. Gupta, S.D.: ***Mathematical Physics***, Vikas Pub. House Pvt. Ltd., New Delhi, 1994 (Reprint).
3. Rajput, B.S.: ***Elementary Mathematical Physics***, Pragati Prakashan, Meerut, 1994.
4. Mathew and Walker: ***Methods of Mathematical Physics.***
5. Arfken: ***Mathematical Methods for Physics***, Academic Press.
6. Margenau and Murphy, G.M.: ***Mathematical for Physicist and Chemist***, Van Norstand.
7. Pipes L.A.: ***Mathematics for Scientists and Engineers***.
8. A. Hinchey: ***Vectors and Tensors***, Wiley Eastern.
9. W. Joshi,: ***Matrices and Tensors in Physics***, Wiley Eastern.

Course Title: Physics Laboratory III **Full Marks:** 100
Course No.: PHY 333 (Major) **Pass Marks:** 35
Nature of the Course: Practical **Year:** II

Course Objectives:
At the end of this course the student should be able:

- to perform Laboratory works related to the course.
- to set experiments related to the course.
- to design laboratory experiment.
- to draw conclusions from the laboratory experiments.
- to develop laboratory skills.
- to interpret the result of Laboratory work.
- to conduct mini projects.
- to interpret the findings of the project work.

experiments: 100 hrs.
Atomic and Nuclear Experiments: Estimation of charge of electron by Millikan's method., Esitmation of e/m of an electron., Estimation of Planck's constant using photo-electric effect., Study the characteristics of Geiger counter and find its, dead time., Determination of linear absorption coefficient of β/γ rays through matter.

Solid State Physics Experiment: To find the resistivity of semiconductor using four probe method., Estimation of band of semiconductor using leakage current method., Study Hall effect.

Electronics Experiments: Study the characteristics of regulated power supply using Zener diode, transistor and integrated circuit., Study the characteristics of phase-shift oscillator., Experiments with multivibrator., Study logic gates (OR, AND, NAND, NOR, XOR)., Experiments to study

characteristics of FET and UJT., Experiment involving characteristics of operational amplifiers.

EXPERIMENTAL PROJECT:

Project may involve fabrication, characterisation of application electronics, solid state physics, Nuclear physics, etc.

Or,

Computer programming, may involve least squares fitting of a straight line, statistical analysis of data, curve fitting of Poisson or other distributions, Estimation of probability, Chi-square value, Fitting of Histogram to data etc.

Or,

Additional regular experiments can be given in place of minor project computer programming if facilities are not available for the latter.

Text Books

1. Worsnop and Flint, ***Physics Practicals***.