DEPARTMENT OF PHYSICS

B. Sc. Physics

Goals:

The Department has formulated three broad educational goals for the undergraduate degree programs:

Technical skills: To provide the students with technical skills necessary for successful careers in physics/Nano-technology and related or alternative careers for which a physics foundation can be very useful. These include mathematics, computers, electronics and devices, and communication skills (oral and written).

Problem solving skills: To provide students with the tools needed to analyse problems, apply mathematical formalism and experimentation, and synthesize ideas.

Physics knowledge: To provide students with the basic foundation in physics and Nano technology, the interplay of theory and experiment, and to motivate scientific enthusiasm and curiosity and the joy of learning.

Programme Outcomes :

Skills Outcomes

Professional Skills

After completing B.Sc. Physics Programme students will be able to:

PO1: Apply and demonstrate knowledge of concepts of physics, to analyze a variety of physical phenomena

PO2: Demonstrate the learned laboratory skills, enabling them to take measurements in a physics laboratory and analyze the measurements to draw valid conclusions

PO3: Capable of oral and written scientific communication, and will prove that they can think critically and work independently.

PO4: Communicate effectively using graphical techniques, reports and presentations within a scientific environment.

PO5: Respond effectively to unfamiliar problems in scientific contexts

PO6: Plan, execute and report the results of a complex extended experiment or investigation, using appropriate methods to analyze data and to evaluate the level of its uncertainty

PO7: Integrate and apply these skills to study different branches of physics.

Knowledge outcome:

After completing B.Sc. Physics Programme students will be able to:

PO8: Transfer and apply the acquired fundamental knowledge of physics, including basic concepts and principles of 1) classical mechanics, electrodynamics, quantum mechanics, Statistical Mechanics and thermodynamics; (2) mathematical (analytic and numerical) methods and experimental methods for physics to study different branches of physics

PO9: Demonstrate the ability to translate a physical description to a mathematical equation, and conversely, explain the physical meaning of the mathematics, represent key aspects of physics through graphs and diagrams, and use geometric arguments in problem-solving.

Generic Competencies

PO10: Work comfortably with numbers and analyzing an issue quantitatively, acquire knowledge effectively by self-study and work independently, present information in a clear, concise and logical manner and apply appropriate analytical and approximation methods.

Attitude/Value Outcomes

After completing B.Sc. Physics Programme students should have developed some positive attitudes and will have:

PO11: Willingness to take up responsibility in study and work

Confidence in his/her capabilities

Capacity to work effectively in a team

Motivation for learning and experimentation

Programme Specific Outcomes :

After completing B. Sc. Physics, students will be able to

PSO1: Demonstrate and understanding of principles and theories of physics. These include: Newtonian Mechanics, thermodynamics, atomic and Molecular physics, electrodynamics, electronics, optics, nuclear physics, quantum mechanics;

PSO2: Apply vector algebra, differential and integral calculus as well as graphical methods to solve physics problems;

PSO3: Demonstrate ability to apply knowledge learned in classroom to set and perform simple laboratory experiments;

PSO4: solve physics problems using the appropriate methods in mathematical, theoretical and computational physics

Course Outcomes :

F.Y.B.Sc. Physics

Course: Mechanics

After successfully completing this course, the student will be able to:

CO1: Demonstrate an intermediate knowledge of Newton's Laws and the equations of motion

CO2: Analyze the forces on the object and apply them in calculations of the motion of simple systems using the free body diagrams

CO3:Determine whether using conservation of energy or conservation of momentum would be more appropriate for solving a dynamics problem

CO4: Apply the concepts of elasticity to real world problems.

CO5: List fundamental forces in nature, applications and factors affecting surface tension.

CO6: Define and conceptualize different laws of fluid mechanics and related quantities like steady, turbulent flow and concept of Reynolds number

CO7: Demonstrate different applications of Bernoulli's theorem, laws of elasticity, surface tension.

Course: Physics principles & applications.

After successfully completing this course, the student will be able to:

CO1: Define absorption, spontaneous emission and stimulated emission process and describe Laser action describe different atomic models in order to understand atomic structure

CO2: Classify different types of bonding & their properties.

CO3: Draw electromagnetic spectrum showing different regions and analyze vibration & rotational spectra of diatomic molecule.

CO4: Study the properties of Laser and its applications.

- CO5: Quote essential principles of operation of radar system and develop the radar for any given frequency.
- CO6: Describe principle and construction of solar cell & to calculate efficiency and fill factor of solar cell.

Course: Heat and Thermodynamics

After successfully completing this course, the student will be able to:

- CO1: Define laws of thermodynamics, entropy, thermodynamic processes etc.
- CO2: Describe Andrew's experiment, Amagat's experiment, Carnot engine, concept of entropy.
- CO3: Derive expression for efficiency of heat engine (Otto cycle, Diesel cycle, Carnot cycle), latent heat equation, adiabatic relations for perfect gas, work done during isothermal and adiabatic change.
- CO4: Determine critical constants using Vander Waal's gas equation, Reduced equation of state
- CO5: Compare reversible and irreversible processes, adiabatic and isothermal process,
- CO6: Illustrate that work is a path dependent function using PV diagram and to solve entropy for reversible and irreversible process.
- CO7: Apply first law of thermodynamics to solve problems.
- CO8: Categorize thermometers and state its applications

Course: Electromagnetics

After successfully completing this course, the student will be able to:

- CO1: Define the basic terms such as electric field, electric potential, magnetic intensity, magnetic induction, magnetic susceptibility and electric and magnetic flux.
- CO2: State and conceptualise basic laws in electromagnetic.
- CO3: Explain the superposition principle, gauss's law in dielectrics and relation between three electric vectors.
- CO4: Solve numerical problems using Coulombs Law ,Gauss's law, Biot-Savart's law ,Ampere circuital law and principle of superposition
- CO5: Determine the electric field and potential due to an electric dipole and different types of charge distribution.
- CO6: Determine magnetic induction due to various current distributions
- CO7: Derive the relation between three magnetic vectors and compare different types of magnetic material.
- CO8: Describe soft and hard magnets on the basis of hysteresis loop.

Course: Physics Practical

After successfully completing this course, the student will be able to:

- CO1: Demonstrate an ability to collect data through observation and/or
- CO2: Acquire technical and manipulative skills in using laboratory equipment, tools and materials
- CO3: Experimentation and interpreting data.
- CO4: Demonstrate an understanding of laboratory procedures including safety, and scientific methods.
- CO5: Demonstrate a deeper understanding of abstract concepts and theories gained by experiencing and visualizing them as authentic phenomena.
- CO6: Acquire the complementary skills of collaborative learning and teamwork in laboratory settings.

S.Y.B.Sc

PH211 Mathematical Methods in Physics I

After successful completion of the course the student will be able to:

CO1: Define the basic operations in complex numbers
CO2: explain graphical representation of complex numbers and calculate roots of complex numbers;
CO3: solve partial differential equations in Physics;
CO4: discuss vector algebra required in Physics;
CO5: define and calculate the gradient, divergence and curl of a field;
CO6: define order, degree and homogeneity of ordinary differential equation;
CO7: explain singular points of ordinary differential equation;
CO8: develop problem-solving skills of identifying strategies to solve unfamiliar problem

PH212 Electronics I

After successful completion of the course the student will be able to:

CO1: define various laws, theorems and basic terms in electronics;
CO2: calculate power, voltage or current across or through the particular component of a given circuit using circuit theorems; and able to design a circuit for transistor biasing, rectifier;
CO3: describe construction and working of transistor and its applications in current and voltage amplification using different configurations;
CO4: describe DC load line and bias point. List, explain, and design and analyze the different biasing circuits;
CO5: explain real and ideal characteristics of operational amplifier and calculate gain in different modes;
CO6: describe different applications of operational amplifier;
CO7: design rectifier circuits, unregulated and regulated power supply;
CO8: illustrate data from one number system to another and apply Boolean algebra to design logic circuits.

PHY221 Oscillations, Waves and Sound

After successful completion of the course the student will be able to:

CO1: define periodic and oscillatory motion;
CO2: setup and solve differential equations of motion for simple harmonic, damped, and forced oscillators;
CO3: describe oscillatory motion with graphs and equations, and use these descriptions to solve problems of oscillatory motion;
CO4: discuss phenomenon of resonance and apply in different applications;
CO5: set and solve differential equation for wave motion for longitudinal and transverse waves;
CO6: calculate the phase velocity, energy and intensity of simple harmonic waves;
CO7: discuss the Doppler effect, and predict in qualitative terms the frequency change that will occur for relative motion between source and observer or listener;
CO8: Explain in qualitative terms how frequency, amplitude, and wave shape affect the pitch, intensity, and quality of tones produced by musical instruments.

Course: PHY 222 Optics

After successful completion of the course the student will be able to:

CO1: Describe the geometrical formation of images by thin lenses, lens equation and lens makers formula using fundamental laws of geometrical optics.
CO2: Use mathematical analysis to calculate properties of image, formed by combination

of lenses and applies theory of optics to calculate the cardinal points of an optical system and design optical devices

CO3: Describe optical aberrations produced in image by lenses and methods of their removal.

CO4: Describe the construction and operation of optical devices, including, eyepieces, compound microscope, grating, polarisers etc.

CO5: Use mathematical analysis to find bright and dark fringes in an interference pattern of thin and wedge shaped film and find a wavelength of light using newton’s rings

CO6: Interpret a diffraction pattern to determine resolution of an optical system and grating

CO7:Demonstrate an ability to solve problems using ‘paraxial’ optics-based formulae, numerical calculations and graphical drawings.

CO8:Geometrical determination of polarization of light and concept and determine a polarization state of light by interpreting polariser

PH223: PRACTICAL COURSE

After completing this practical course student will be able to

CO1:Use various instruments and equipment.

CO2: design experiments to test a hypothesis and/or determine the value of an unknown quantity.

CO3: Describe the methodology of science and the relationship between observation and theory.

CO4: Set up experimental equipment to implement an experimental approach.

CO5: Analyze data, plot appropriate graphs and reach conclusions from your data analysis.

CO6: Work in a group to plan, implement and report on a project/experiment.

CO7: Keep a well-maintained and instructive laboratory logbook.

CO8: Express their knowledge and ideas through oral and written language.

T.Y. B.Sc. .

PH-331: Mathematical methods of physics

After successful completion of the course the student will be able to:

CO 1: Define and generate a general equation for gradient ,divergence ,curl &laplacian in an orthogonal curvilinear coordinate system & their applications in physics.

CO 2: Interpret relative motion, Galilean & Lorentz transformation equations.

CO 3: Define proper time , minkowskis space ,Time dilation , length contraction

CO 4: Describe Michelson Morley experiment & its negative result.

CO 5: Convert commonly occurring partial differential equations in physics into ODE’s

CO 6: Illustrate the problems on Frobenius method of series solution and to differentiate point of expansion of given differential equations.

CO 7: Evaluate &plot Legendre polynomials, Hermite polynomials ,Bessel function of first kind.

CO 8: List the most important special functions in physics and to solve different properties related to special functions.

PH-332: Solid state physics.

After successful completion of the course the student will be able to:

CO1: Define crystal structure to develop it in 2D as well as 3D and to determine Indices for ‘Directions’ and ‘Planes’ in a crystal structure.

CO2: Give original examples of crystal structures and to analyze them with packing fraction, coordination number, number of atoms per unit cell etc.

CO3: Derive Bragg Diffraction condition in direct lattice and to relate it in reciprocal lattice using Ewald construction.

CO4: Classify the crystal structure by XRD diffraction and to simplify formula for inter-planer distance.

CO5: Illustrate various experimental techniques for characterisation of material.

CO6: Apply free electron theory to restate thermal and electrical properties

CO7: Explain superconductivity and Meissner effect

CO8: Define magnetic properties of material and to derive susceptibility formula for different magnetic materials using Lange vein theory.

PH-333: Classical Mechanics:

After successfully completing this course, the student will be able to:

CO1: Solve advanced problems involving the dynamic motion of classical mechanical systems with an intermediate knowledge of Newton's laws of motion

CO2: Apply the concept of centre of mass and mechanics of system of particles and conservation of energy, linear and angular momentum to solve dynamics problems

CO3: Demonstrate an intermediate knowledge of central-force motion and the concept of converting two body problems to single body problem and apply advanced methods to complex central-force motion problems.

CO4: Demonstrate an intermediate knowledge of concept of laboratory frame and centre of mass frame and their use to calculate results of scattering experiments.

CO5: Apply the concept scattering to get important information regarding the nature of interaction between atomic and subatomic particles through experiments

CO6: Derive Lagrange and Hamilton's equations, and represent the equations of motion for simple mechanical systems such as: the Atwood's machine, Simple pendulum using these formulations of classical mechanics.

CO7: Acquire working knowledge of the methods of Hamiltonian Dynamics and compute the Hamilton equations of motion for mechanical systems

CO8: Use calculus of variations to find the Euler-Lagrange equations and canonical transformations to find the constants of motion according to the Hamilton Jacobi theory.

CO9: Use Poisson brackets to find derivatives in phase space.

PH-334: Atomic and Molecular Physics

After successful completion of the course the student will be able to:

CO1: Derive the formulae for total energy of an atom so that energy level diagram can be drawn and also able to obtain the expression for spin orbit interaction energy.

CO2: State laws, postulates in atomic and molecular Physics and able to compare various models of atomic structure.

CO3: Calculate quantum state of electrons in an atom, spectral notation and electronic configuration of atom.

CO4: Obtain formulae for Zeeman shift, wavelength of emitted X-ray s, Raman shift , rotational and vibrational energy for diatomic molecule and apply it.

CO5: Explain origin of line spectra and able to compare continuous spectra, characteristic spectra and can differentiate between rotational, vibrational and electronic spectra.

CO6: Explain application of Duane and Hunt's rule, Moseley's law and its importance, applications of X-rays, Raman effect and Auger effect.

CO7: Draw and explain X-ray spectra, spectrum with and without magnetic field (Zeeman effect),Raman spectra and molecular spectra using quantum treatment

CO8: Explain experimental arrangement to produce X-ray,, to observe Raman effect and Zeeman effect.

PH-335: C programming

After successful completion of the course the student will be able to:

- CO1: define types of programming languages and their uses;
- CO2: gain basic competency with a widely used C-language for both general and scientific programming;
- CO3: define operators and expression in C-programming and navigate commands;
- CO4: explain control statements and loops as well as capable of writing C-program to solve problems;
- CO5: describe arrays and pointers and apply them in C program;
- CO6: critically present different numerical methods to solve different types of physical and technical problems;
- CO7: implement numerical algorithms into C-program and visualize the results of the computations
- CO8: demonstrate the ability to estimate the errors in the use of numerical methods

PH-336 B: Elements of Material science

After successful completion of the course the student will be able to:

- CO1: Define and outline the rules of solubility, deformation in metals, basic concepts in phase diagram, molecular phases and the concept of smart materials.
- CO2: Explain the imperfections in solids, mechanism of plastic deformation by slip, properties of ceramic materials, the importance and objective of phase diagram.
- CO3: Calculate and solve problems on stress and strain of materials, CRSS of single phase metals, weight in percentage of compositions using lever rule.
- CO4: List the defects in solids, diffusion mechanisms and types of phase diagram.
- CO5: Classify between elastic deformation and plastic deformation, linear polymers and cross linked polymers.
- CO6: Derive the CRSS of metals and the lever rule for phase diagrams.
- CO7: Discuss the types of smart materials, properties of smart materials and their applications.
- CO8: Summarize the concept of polymers and the process of polymerization.

PH-341: Classical Electrodynamics.

After successful completion of the course the student will be able to:

- CO1: Define the Biot-savart law, Amperes law, Coulombs law, Electric field, Electric susceptibility, Magnetic field &Faradays law.
- CO2: Explain method of electrical images, equation of continuity, Magnetic vector potential, B.H curve, Maxwell's equation &wave equations.
- CO3: Solve numerical problem on coulombs force, magnetic induction, magnetic permeability and induced voltage, magnitude of electric &magnetic vectors.
- CO4: Determine work done by charges, total charge, force on the wire in different symmetry.
- CO5: Summarize pointing vector, polarization, reflection &refraction.
- CO6: Apply Biot Savart law in different symmetry problem.
- CO7: List the applications of Amperes law, Biot Savart law, Poynting theorem.
- CO8: Elaborate magnetic properties of the material.

PH-342: Quantum Mechanics

After successful completion of the course the student will be able to:

- CO1: outline the historical aspects of development of quantum mechanics;
- CO2: explain the differences between classical and quantum mechanics;
- CO3: describe matter waves, wave function and uncertainty principle;

- CO4: describe Schrodinger's equation and its steady state form;
- CO5: solve Schrodinger's steady state equation for simple potentials to obtain eigen functions and eigen values
- CO6: apply Schrodinger's steady state equation for spherically symmetric potentials obtain eigen functions and eigen values;
- CO7: interpret quantum numbers in atomic system;
- CO8: discuss operator algebra in quantum mechanics.

PH-343: Thermodynamics and Statistical Physics

After successful completion of the course the student will be able to:

- CO1: Describe transport phenomena and compute coefficient of thermal conductivity, viscosity and diffusion in terms of mean free path
- CO2: Define and discuss the concepts and roles of thermodynamic functions from the view point of statistical mechanics
- CO3: Derive Binomial distribution and Gaussian probability distribution using random walk problem and calculate mean values for a statistical system
- CO4: Discuss the concepts of microstate and macro state, basic postulates and behaviour of density of states for model system and calculate the number of microstates for different statistical systems
- CO5: Differentiate thermal, mechanical and general interaction between statistical system
- CO6: Derive and compare Maxwell Boltzmann, Bose-Einstein and Fermi-Dirac distributions; state where they are applicable and explain the connection between classical
- CO7: Derive probability distribution formula for micro canonical, canonical ensemble and calculate mean values in canonical ensemble
- CO8: Discuss applications for canonical ensemble

PH-344: Nuclear Physics

After successful completion of the course the student will be able to:

- CO1: Define threshold voltage, dead time and recovery time in GM counter, threshold energy, nuclear fission, nuclear fusion, critical size, critical mass.
- CO2: Determine the basic properties of nucleus.
- CO3: Classify nuclear radiations, elementary particles and nuclear states, nuclear detectors.
- CO4: Compose baryons and mesons with Quark model.
- CO5: Derive expression for energy of ions and frequency of RF signal in cyclotron, Q-value equation, threshold energy, decay constant.
- CO6: Estimate binding energy from fission
- CO7: Justify nuclear reactions using conservation laws
- CO8: Explain the different processes by which energetic particles interact with matter, kinematics of various reactors and decay processes.

PH-345 Electronics II

After successful completion of the course the student will be able to:

- CO1: Define and state the meaning of terms such as amplification, voltage gain, line and load regulation, flip-flop, counters, register, distortion, multiplexer, de-multiplexer, etc.
- CO2: Draw and explain characteristics of various types of FET's and various types of diode and construct a circuit using these components according to application.
- CO3: Draw and explain block diagram of IC 723, IC555, OPAMP.

CO4: Compare various types of semiconductor diode (LED, photodiode, etc.) types of multivibrator, types of power amplifier and types of three pin regulators (78XX,79XX, etc.) on the basis of working principle and application.

CO5: Design and construct a circuit for amplifier, a-stable, mono-stable and bi stable multivibrator using IC555, low voltage and high voltage regulator using IC723, various types of flip-flop and counters.

CO6: Use OPAMP (IC723) as an adder, subs tractor, differentiator, integrator and comparator.

CO7: Represent POS and SOP expression on K-map and design of half adder, full adder, half subs tractor, full subs tractor using K-map.

CO8: Explain applications of LED, photodiode, veractor, power amplifiers, FET, UJT, counters, registers and solve the problems such as write the output for given circuit, design the circuit from given data.

PH-346 H: Physics of Nanomaterials

After successful completion of the course the student will be able to:

CO1: Explain the brief history of nanomaterials and structures, Significance of nano-size, propertiesand classification of nanostructured materials

CO2: Explain the Bottom-up and Top-down approaches Illustrate the Physical methods: High energy ball milling, Physical vapour deposition, Ionized cluster beam deposition, sputter deposition, Ultrasonic spray pyrolysis etc. Chemical methods: colloidal method, co-precipitation and sol-gel method Hybrid method: Electrochemical and chemical vapour deposition.

CO3: Explain the Characterization techniques UV- visible spectroscopy, X-ray diffraction, Scanning electron microscopy, Transmission electron microscopy.

CO4: Explain the Properties of nanomaterials: Mechanical, Electrical, Thermal, Optical, solubility, melting point and Magnetic properties

CO5: Special nanomaterials:Carbon nanotubes, quantum dots, NanocrystallineZnO and TiO_2.

CO6: Describe the applications of Nanoelectronics, Medical, Biological, Automobiles, Space, Defense, Sports, Cosmetics, Cloth industry etc

Physics Practical-I

After successful completion of the course the student will be able to:

CO1: Describe the underlying theory of experiments in the course.

CO2: Perform derivations of theoretical models of relevance for the experiments in the course.

CO3: Follow instructions to perform laboratory experiments in Optics, Thermodynamics, Mechanics, Modern Physics, Electronics and Electromagnetics.

CO4: Document their results, using correct procedures and protocols.

CO5: Perform a quantitative analysis of experimental data including the use of computational and statistical methods where relevant.

CO6: Interpret relationships in graphed data and develop an intuition for alternative plotting methods and communicate results from laboratory experiments, orally or in a written laboratory report.

CO7: Calculate permissible standard error in any physics experiment

CO8: Derive conclusions from the analysis of own data.

CO9: Assess the language used to describe physics experiments and how it can alter perceptions of the method and results

Physics Practical-II

After successful completion of the course the student will be able to:

- CO1: Describe the underlying theory of experiments in the course.
- CO2: Perform derivations of theoretical models of relevance for the experiments in the course.
- CO3: Follow instructions to perform laboratory experiments in Optics, Thermodynamics, Mechanics, Modern Physics, Electronics and Electromagnetics.
- CO4: Document their results, using correct procedures and protocols.
- CO5: Perform a quantitative analysis of experimental data including the use of computational and statistical methods where relevant.
- CO6: Interpret relationships in graphed data and develop an intuition for alternative plotting methods and communicate results from laboratory experiments, orally or in a written laboratory report.
- CO7: Calculate permissible standard error in any physics experiment
- CO8: Derive conclusions from the analysis of own data.
- CO9: Assess the language used to describe physics experiments and how it can alter perceptions of the method and results

Physics Practical-III : Project

After successful completion of the course the student will be able to

- CO1: design and test hypothesis
- CO2: Describe the underlying theory of experiments in the course.
- CO3: Perform derivations of theoretical models of relevance for the experiments in the course.
- CO4: Document their results, using correct procedures and protocols.
- CO5: Perform a quantitative analysis of experimental data including the use of computational and statistical methods where relevant.
- CO6: Interpret relationships in graphed data and develop an intuition for alternative plotting methods and communicate results from laboratory experiments, orally or in a written laboratory report.
- CO7: write a project report with literature review.
- CO8: defend the outcome of project work in scientific manner.