DEPARTMENT OF PHYSICS

B. Sc. Physics

Goals:

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

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.

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

Employment and 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).

Programme Outcomes:

Knowledge outcome:

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

PO1: 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

PO2: 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.

Skills Outcomes

Professional Skills

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

PO3: Apply and demonstrate knowledge of concepts of physics, to analyze a variety of physical phenomena

PO4: Demonstrate the learned laboratory skills, enabling them to take measurements in a physics laboratory and analyze the measurements to draw valid conclusions

PO5: Capable of oral and written scientific communication, and will prove that they can think critically and work independently.

PO6: Communicate effectively using graphical techniques, reports and presentations within a scientific environment.

PO7: Use and apply professional software for scientific data analysis and presentation

PO8: Respond effectively to unfamiliar problems in scientific contexts

PO9: 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

PO10: Integrate and apply these skills to study different branches of physics.

Generic Competencies

PO11: 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:

PO12: 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

Program 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, and 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:

Semester I

PHY-111: Mechanics and Properties of matter

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.

PHY-112: 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 vibrational & 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.

PHY-113: Physics Laboratory- 1A

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

CO1: The students will be able to use various instruments and equipment.

CO2: The students will be able to designexperiments to test a hypothesis and/or determine the value of an unknown quantity.

CO3: The students will be able to investigate the theoretical backgroundof an experiment.

CO4: The students will be able to setup experimental equipment to implement an experimental approach.

CO5: The students will be able to analyze the data, plot appropriate graphs and reach conclusions from data analysis.

CO6: The students will be able to work in agroup to plan, implement and report on a project/experiment.

CO7: The students will be able to keep awell-maintained and instructive laboratory logbook.

Semester II

PHY-121: 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, and Carnot cycle), latent heat equation, and 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

PHY-122: Electricity andMagnetism

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 conceptualize 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.

PHY-123: Physics Laboratory-1B

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

Semester I

PHY231: 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

PHY232: Electronics

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.

PHY233: Physics Laboratory- 2A

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

CO1: The students will be able to use various instruments and equipment.

CO2: The students will be able to designexperiments to test a hypothesis and/or determine the value of an unknown quantity.

CO3: The students will be able to investigate the theoretical backgroundof an experiment.

CO4: The students will be able to setup experimental equipment to implement an experimental approach.

CO5: The students will be able to analyze the data, plot appropriate graphs and reach conclusions from data analysis.

CO6: The students will be able to work in agroup to plan, implement and report on a project/experiment.

CO7: The students will be able to keep awell-maintained and instructive laboratory logbook.

Semester II

PHY241: 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.

PHY 242: 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 polarisation state of light by interpreting polariser

PH243: Physics Laboratory-2B

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.

T.Y.B.Sc.

Semester I

PHY-351: Mathematical Methods in Physics-II

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.

PHY-352: 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.

PHY-353: 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.

PHY-354: 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.

PHY-355: Computational Physics

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-356 D: Renewable Energy Sources-I

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

CO1: **An Introduction to Energy Sources**

1. Conventional and non-conventional energy sources.
2. Solar radiations outside earth atmosphere.

CO2: **Photo thermal Applications:**

1. Photo thermal devices: Solar Insolation, Selective Coating, Glass Cover, Heat Conductor and Heat Insulation.
2. Solar water heating systems: Types, construction and working of Liquid Flat Plate Collector (FPC) and Evacuated Tube Collector (ETC)

3. Energy Balance Equation (without thermal Analysis).

4. Concentrating collectors: Flat plate collector with plane reflector, Cylindrical parabolic, Compound parabolic, Collector with fixed circular concentrators and moving receiver, paraboloid concentrator.

CO3: **Photovoltaic systems:**

1. Introduction to Photovoltaic effect and Photovoltaic Conversion.
2. Basic photovoltaic system for power generation
3. Basics of Solar Cell, PV modules, Arrays,
4. Solar Cell: I-V characteristics, Power output and conversion efficiency.
5. Factors affecting on photovoltaic efficiency. (Change in amount of input light, solar cell area, Change in angle, Change in operating Temperature etc.)
6. Types of solar cells: p-n junction solar cell, p-i-n diode solar cell, cadmium sulphide solar cell, Gallium arsenide solar cell, Indium phosphide solar cell, nano-crystalline solar cell.

CO4: **4: Energy Storage: (06L)**

1. Importance and Needs of Energy storage in Conventional and Nonconventional Energy Systems.
2. Various forms of Energy Storage
3. Electrical Energy: Super capacitors
4. Electrochemical Energy: Battery
5. Chemical Energy: Hydrogen Production and storage

PH-3510(H): Python Programming (Skill enhancement course)

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

CO1: The students will be able to work on acomputer in Linux environment.

CO2: The students will be able to write a Ccode to solve scientific problems numerically.

CO3: The students will be able to designelectronic circuits for different purposes.

CO4: The students will be able to collect data through observation and/or experimentation and visualizing andinterpreting data.

CO5: The students will be able to understand the laboratory proceduresincluding safety and scientific methods.

CO6: The students will be able to understand the abstract concepts and theories by experiencing and visualizing them as authentic phenomena.

CO7: The students will be able to acquire the complementary skills of collaborative learning and teamwork.

PH-3511(M): Biomedical Instrumentation (Skill enhancement course)

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

CO1: Students will acquire basic knowledge of biomedical instrumentation.

CO2: Students can handle and operate different equipment's like ECG, Oxymeter, and Glucometer.

CO3: Students will be able to record the different health parameters using it.

CO4: Student will also able to analyze and interpret the recorded data.

PHY-357: Physics Laboratory-3A

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

CO1: The students will be able to use various instruments and equipment.

CO2: The students will be able to designexperiments to test a hypothesis and/or determine the value of an unknown quantity.

CO3: The students will be able to investigate the theoretical backgroundto an experiment.

CO4: The students will be able to set up experimental equipment to implementan experimental approach.

CO5: The students will be able to analyzedata, plot appropriate graphs and reach conclusions from your data analysis.

CO6: The students will be able to work in agroup to plan, implement and report on the experiments.

CO7: The students will develop a habit ofkeeping a well-maintained and instructive laboratory logbook.

PHY-358: Physics Laboratory-3B

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

CO1: The students will be able to work on acomputer in Linux environment.

CO2: The students will be able to write a Ccode to solve scientific problems numerically.

CO3: The students will be able to designelectronic circuits for different purposes.

CO4: The students will be able to collect data through observation and/or experimentation and visualizing andinterpreting data.

CO5: The students will be able to understand the laboratory proceduresincluding safety and scientific methods.

CO6: The students will be able to understand the abstract concepts and theories by experiencing and visualizing them as authentic phenomena.

CO7: The students will be able to acquire the complementary skills of collaborative learning and teamwork.

PHY-359: Project-I

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

CO1: The students will be able to understand a general definition ofresearch design.

CO2: The students will be able to designexperiments to test a hypothesis.

CO3: The students will be able to collect and analyze data to reach conclusionsrelated to the hypothesis.

CO4: The students will be able to work in agroup to plan, implement and document on the systematic study to solve a research problem.

CO5: The students will become familiarwith ethical issues and plagiarism related to research and documentation.

Semester II

PHY-361: 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.

PHY-362: 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.

PHY-363: 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.
- CO7: Derive probability distribution formula for micro canonical, canonical ensemble and calculate mean values in canonical ensemble
- CO8: Discuss applications for canonical ensemble

PHY-364: 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, and 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.

PHY-365 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.

PHY-366 (P): Medical Electronics

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

CO1: **Introduction:**

1 Terminology of medical instrumentation,
2 Physiological system of body
3 Sources of bioelectric signals,
4 Origin of bioelectric signals,
5 Analysis of ECG pattern
6 Nernst equation
7 Various types of bioelectric signals,

CO2: **Bio potential Electrodes and sensors:**

1 Electrode-electrolyte interface,
2 Polarizable and non-polarizable electrodes,
3 Electrodes for ECG, EEG, EMG,
4 Resistive sensor
5 Capacitive sensor
6 Inductive sensor
7 Piezoelectric sensor
8 Temperature sensor

CO3: **Amplifiers and Signal Processing:**

1 Introduction
2 Basic amplifier requirements
3 The Differential amplifier
4 Common mode rejection
5 Instrumentation amplifier
6 Isolation amplifier
7 Pateint safety

CO4: **Measurements of Pressure and Volume Flow of Blood:**

1 Direct measurements of blood pressure,
2 Indirect measurements of BP.
3 Heart sounds

PHY-3610 (W): Scientific data analysis using Python

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

CO1: The students will be able to understand the basics of dataprocessing.

CO2: The students will be able to generateproper data set for analysis after cleaning and binning the big data.

CO3: The students will be able to develop amodel and test it’s validity.

CO4: The students will be able to visualizethe data for better representation.

PHY-3611(AB): Instrumentation for Agriculture

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

CO1: Able to test soil and water parameters.

CO2: Able to develop their own juice extract plant.

CO3: Able to developed their own green house

PHY-367: Physics Laboratory-4A

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

CO1: The students will be able to understand the working and use ofvarious advanced instruments and equipment's.

CO2: The students will be able to designexperiments to test a hypothesis and/or determine the value of an unknown quantity.

CO3: The students will be able to investigate the theoretical backgroundto an experiment.

CO4: The students will be able to set up experimental equipment to implementan experimental approach.

CO5: The students will be able to analyzedata, plot appropriate graphs and reach conclusions from your data analysis.

CO6: The students will be able to work in agroup to plan, implement and report on the experiments.

CO7: The students will develop a habit ofkeeping a well-maintained and instructive laboratory logbook.

PHY-368: Physics Laboratory-4B

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

CO1: The students will be able to understand the working and use ofvarious advanced instruments and equipment's.

CO2: The students will be able to designexperiments to test a hypothesis and/or determine the value of an unknown quantity.

CO3: The students will be able to investigate the theoretical backgroundto an experiment.

CO4: The students will be able to set up experimental equipment to implementan experimental approach.

CO5: The students will be able to understand the laboratory proceduresincluding safety and scientific methods.

CO6: The students will be able to understand the abstract concepts and theories by experiencing and visualizing them as authentic phenomena.

CO7: The students will be able to acquire the complementary skills of collaborative learning and teamwork.

PHY-369: Project-II

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

CO1: The students will be able to understand a general definition ofresearch design.

CO2: The students will be able to designexperiments to test a hypothesis.

CO3: The students will be able to collect and analyze data to reach conclusionsrelated to the hypothesis.

CO4: The students will be able to work in agroup to plan, implement and document on the systematic study to solve a research problem.

CO5: The students will become familiarwith ethical issues and plagiarism related to research and documentation.

M.Sc. Physics

Goals:

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

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

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

Employment and technical skills: To provide the students with technical skills necessary for successful careers in physics/Nano-technology and related or alternative careers through review of literature. These include mathematics, computers, electronics and devices, and communication skills (oral and written).

Programme Outcomes

The Master of Science in Physics programme provides the student with knowledge, general competence, and analytical skills on an advanced level, needed in academics, industry, research, or public administration.

Knowledge

Students will

PO1: get substantial knowledge in physics, basic knowledge in mathematics, and understanding of the interconnectedness of different disciplines;

PO2: get some research experience within a specific field of physics, through a project work;

PO3: get ability to apply knowledge of physics to the real world problems;

PO4: be familiar with contemporary research within various fields of physics;

PO5: use creativity, critical thinking, and analysis and research skills to solve theoretical and real-world problems

Skills

Students will

PO6: have the background and experience required to model, analyze, and solve advanced problems in physics;

PO7: use creativity, critical thinking, and analysis and research skills to solve theoretical and real-world problems

PO8: be able to employ up-to-date and relevant knowledge and skills in several disciplines.

PO9: able to enter new problem areas that require an analytic and innovative approach

General competence

The student will

PO10: be able to understand the role of physics in society and has the background to consider ethical problems.

PO11: know the historical development of physics, its possibilities and limitations, and understands the value of lifelong learning.

PO12: get an ability to participate in constructive discussions and debates.

Programme Specific Outcomes

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

PSO1: Demonstrate and understanding of principles and theories of physics. These include: Classical Mechanics, Statistical Mechanics, electrodynamics, electronics, optics, nuclear physics, quantum mechanics, Material Science;

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

PSO3: Demonstrate ability to apply knowledge learned in classroom to plan, undertake, and report on a programme of original work; including the planning and execution of experiments, the analysis and interpretation of experimental results;

PSO4: take research work at the higher degree level in the field of nanotechnology, computational physics and material science.

Course Outcomes

M. Sc. Physics Part I

Semester I

PHCT- 111: Mathematical Methods in Physics

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

CO1: Generate Legendre, Hermite, Laguerre polynomials and Bessel functions of first kind.

CO2: Determine Laplace transform of standard functions.

CO3: Classify methods to obtain Laplace transform and inverse Laplace transform.

CO4: Illustrate the examples of vector spaces.

CO5: Solve problems on Fourier series, Fourier transform and Fourier integral.

CO6: Solve problems on linear dependence and linear independence by using different methods.

CO7: Explain orthogonality of Legendre, Hermite, Laguerre polynomials and Bessel functions of first kind.

CO8: Define Hermitian, Orthogonal and Unitary matrices.

PHCT- 112: Classical Mechanics

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

CO1: Formulate the Lagrange's and Hamilton's equation of motion for different systems.

CO2: Choose an appropriate set of generalised coordinates to describe the system.

CO3: Classify and handle the problem related to motion in non-inertial and inertial frames.

CO4: Solve problems on poisons brackets and canonical transformations.

CO5: Apply Variational Principle to real physical problem.

CO6: Explain the concept of symmetry and Galilean Invariance.

CO7: Define generalized momenta and cyclic coordinates.

CO8: Recall Poisson's and Lagrange identities.

PHCT- 113: Electronics

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

CO1: Recall basic knowledge of electronics.

CO2: Define Astable, monostable multivibrator, Op-amp, voltage regulators, Boolean identities and expression, counter and shift register, basics of digital and binary conversions.

CO3: Discuss IC 555, types of voltage regulators, types of counters and shift registers and types of ADC and DAC.

CO4: Perform working of ICs (IC 555 in astable and monostable mode, IC78xx/IC79xx and ICLM317 of 3 pin regulators, IC 7490,IC 7495, VCO IC 566, PLL IC 565)

CO5: Apply the working of according to their applications.
CO6: Designs and performs ICs.
CO7: Assemble the ICs
CO8: Communicate, demonstrate and write effectively the needs in industrial fields.

PHOT-114 (C2T): LASERS AND APPLICATIONS (Theory)

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

CO1: Interaction of radiation with matter: Absorption, spontaneous and stimulated emission, population inversion, properties of laser, metastable state, gain, absorption coefficient, Einstein's coefficient, stimulated emission cross section, threshold condition.
CO2: (Principle, Construction, Energy level diagram and working of following lasers)
Solid state lasers: Ruby laser, Nd:YAG laser, semiconductor lasers (homo junction lasers)
Gas lasers : He-Ne laser

PHOP (C2P): LASERS AND APPLICATIONS (Practical)

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

CO 1: To determine wavelength of He-Ne laser using grating element.
CO 2: To determine wavelength of He-Ne laser using measuring scale.
CO 3: To determine divergence of laser beam.
CO 4: To determine diameter of wire using laser.
CO 5: To measure contamination in liquid sample using laser beam.
CO 6: Use of laser in optical fiber communication

PHCP 115: Physics Lab- I

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

CO 1: Diode Pump Staircase generator using UJT
CO 2. Crystal Oscillator & Digital Clock
CO 3: Voltage Control Oscillator using IC-566
CO 4: Constant current Source using OP-AMP
CO 5: DAC (Digital to Analogue Converter) using R-2R and Binary ladder
CO 6: Active filters using OP-AMP / IC- 8038(L-P, H-P. Notch type)
CO 7: Study of Multiplexer and Demultiplexer
CO 8: Precision rectifier
CO 9: Design, built and test oscillator – LC oscillator
CO 10: 8-bit ADC
CO 11: PLL application using IC565
CO 12: Voltage to Frequency / Frequency to voltage converter using OP-AMP

Semester II

PHCT- 121: Electrodynamics

After studying this course the student will be able to,

CO1: Define electric charge, charge density (λ, σ, ρ).
CO2: Apply the laws of electromagnetism and Maxwell's equations in different forms and different media
CO3: Explain the fundamental concepts of special relativity and their physical consequences, such as the Lorentz transformation, invariant quantities, the metric, and four-vectors and more general tensors, as well as their use in covariant formulations of physical laws.
CO4: Discuss origin of Maxwell's equations in magnetic and dielectric media and understand transport of energy and Poynting vector.
CO5: Calculate the magnetic forces that act on moving charges and the magnetic fields, due

to currents (Biot-Savart and Ampere laws)

CO6: Solve multipole expansions of electrostatic fields.

CO7: Analyze propagation, reflection and transmission of plane waves

CO8: Evaluate radiation energy losses by passage through the matter.

PHCT-122: Atomic and molecular physics

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

CO1: Recite atomic structure, quantum number Calculate the ground state, apply Hund's rule. Diagram the fine and hyperfine structure

CO2: Explain Zeeman effect Solve problems on Zeeman effect for different materials in Zeeman effect

CO3: Identify different regions of spectra & Summarize types of spectra with regions CO4: Classify different molecular spectra &analyse band structure

CO5: Determine dissociation energy and dissociation product for explanation of ESR & NMR

CO6: Predict the band head position in rotational fine structure to solve problems on ESR &NMR.

CO7: Define X-ray diffraction, Explain SC, FCC, BCC HCP structure and calculate atomic structure factor of SC, FCC, BCC, HCP and diamond structure.

CO8: Explain different modes of vibration. Simplify atomic scattering factor. Relate Acoustic & optical modes of vibration

CO8: Show how the London equations and Maxwell's equations lead to the prediction of the Meissner effect.

PHCT- 123: Quantum Mechanics

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

CO1: Recall the main aspects of the historical development of quantum mechanics by replacing the classical mechanics and able to discuss wave properties of matter.

CO2: Understand Schrodinger's equation, uncertainty principle, representation of states, relation between quantum mechanics and linear algebra.

CO3: Solve Schrodinger's equation in one to three dimensions, Eigen function of operator, uncertainties as well as their physical interpretations.

CO4: Solve problems by applying Dirac notations.

CO5: Simplify angular momentum and spin, their rules for quantization and additions, Clebsch-Gorden coefficients in simple cases.

CO6: Explain Zeeman Effect, spin- orbit coupling.

CO7: Solve Schrodinger equation using various approximation methods.

CO8: Develop an understanding of both analytic and numerical methods and solution are important in quantum mechanics.

PHOT-124 (D2T): Physics of Semiconductor Devices

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

CO 1: Properties of Semiconductor and p-n Junctions

Basics of semiconductors and p-n junctions, carrier concentration at thermal equilibrium for intrinsic and doped semiconductor and calculation of Fermi level, Donor and acceptor impurities, Density of available states, Carrier diffusion, Generation and Recombination processes, p-n diode, p-i-n diode, schottky diode, zener diode, and their characteristic, Depletion region and depletion capacitance, Current- Voltage Characteristics (Shockley Equation), Diffusion Capacitance, Junction Breakdown- Thermal instability, Tunneling effect, Avalanche Multiplication.

CO 2: Junction Transistor and Metal Insulator Semiconductor devices

Static characteristics of transistor, Current gain- injection efficiency, base transport factor, Depletion layer and surface recombination, Junction formation and operating characteristics of UJT, JFET and MOSFET, General Energy band diagram, Current transport processes – Thermionic emission theory, Diffusion theory, thermionic emission –diffusion theory, expression for barrier height, metal semiconductor IMPATT Diode, ideal MIS diode surface space-charge region.

PHOP (D2) Physics of Semiconductor Devices

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

CO 1: Study of optoelectronic properties of semiconductor devices (Solar cell)

CO 2: Studies on the characterization of JFET (Output & transfer characteristic)

CO 3: Determination of band gap of semiconductor from temperature dependence of resistivity using four probe method

CO 4: Study of Hall voltage as a function of probe current and magnetic field and determination of Hall coefficient and carrier concentration.

CO 5: Opamp as a differential and substraction application

CO 6: Studies on the diode charactristics such as zener breakdown p-n junction diode etc

PHCP- 125: Physics Lab- II

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

CO 1: Steafan's Constant- Black Body Radiation

CO 2: Michelson's Interferometer: To determine the wavelength of He-Ne LASER by using Michelson's Interferometer apparatus.

CO 3: Specific Heat of Solids: To determine the specific heat of copper, lead and glass at three different temperatures.

CO 4: Electron Spin Resonance: To study the Electron Spin Resonance and to determine Lande's g-factor

CO 5: Frank-Hertz experiment: To study the discrete energy levels using Frank-Hertz experiment

CO 6: G.M. counter: Counting statistics, Characteristics of GM tube and determination of end point energy of β-ray source

CO 7: G.M. counter: Determination of dead time of GM tube by Double source method

CO 8: Skin depth : Skin depth in Al using electromagnetic radiation

CO 9: Gouy's Method: Measurement of magnetic susceptibility of $MnSO_4$

CO 10: Thermionic emission: To determine work function of Tungsten filament

CO 11: Hall effect: To determine charge concentration, conductivity of Ge-semiconductor

CO 12: Four Probe method: Temperature variation and Band gap of Ge-semiconductor

M.Sc. Physics Part II

Semester III

PHCT-231: Statistical Mechanics

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

CO1: This course in statistical mechanics provides the basic idea of probability to the students. There are ways of calculating probability for various statistical system of particles.

CO2: Students will study basic ideology of phase space, microstate, macrostate.

CO3: The objective is to apply the principles of probability in distribution of particles in various systems and to calculate thermodynamic probability.

CO4: The course gives the insight of postulates of statistical physics. 5. Students will learn the different types of statistics distribution and particles. They will learn which particles follow which statistics and why?

PHCT-232: Solid State Physics

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

CO1: Can explain crystal systems, Diffraction and Reciprocal space.

CO2: Can explain bonding types in crystals.

CO3: Can explain Phonons and Thermal properties of phonons.

CO4: Can explain free electron gas model and band models.

CO5: Can explain Properties of semiconductors.

PHCT-233: Experimental techniques in Physics I

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

CO1: Define signals, vacuum, vacuum measurement units, gas transport phenomenon.

CO2: Classify signals and systems as discrete/continuous, linear/non-linear, causal/non-Causal, time-variant/invariant, etc., errors in signals and pipe flows, vacuum pumps.

CO3: Interpret signals with correlation function of random processes.

CO4: Explain need of vacuum and gas transport properties.

CO5: Solve problems based on kinetic theory of gases and the application of the momentum and energy equations as well as various parameters of fluid mechanics

C06: Convert vacuum measurement units from one unit to another unit.

CO7: Describe different vacuum gauges and vacuum pumps with their working principle, range of measurement, advantages and drawbacks.

CO8: Apply vacuum principles in preparation of thin and thick film.

PHOT234J2: Biomedical Instrumentation-I (Theory)

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

CO 1: Fundamentals to Biomedical Instrumentation and Patient Safety

Basic medical instrumentation system System configuration, Basic characteristics of measuring system Problems faced when measuring a human body, Essentials of biomedical instrumentation Electric shock hazards-Gross shock-Micro current shock

CO 2: Electrodes and Physiological Transducers:

Electrode theory, and Biopotential electrodes. Electrodes for ECG, EEG, EMG. Introduction to physiological transducers. Classification of Transducer. Performance characteristic of transducer. Displacement, position, motion, and pressure transducers. Transducer for Body temperature measurement. Biosensors

PHOP234J2: Biomedical Instrumentation-I (Practical)

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

CO1: Active filters for Bio-signals- Design and Filtering (Low pass and High pass filter)

CO2: Design and build a Notch filter (To reduce noise of 50 Hz).

CO3: ECG preamplifier-Instrumentation amplifier and testing.

CO4: Use of sphygmomanometers for measurement of blood pressure.

CO5: Concept of ECG, system and placement of electrodes ECG signal recording with surface electrodes.

CO6: Design and build a Wide/ Narrow band pass filters for measurement for Bio-signals

7. To study LVDT Characteristic.

PHCP- 235: Physics Laboratory -III

After successfully completing this course, the student will be able to: CO1:

Recall the theory of all the programmes to be performed.

CO2: Draw the algorithm and flowchart chart of the concepts discussed.

CO3: Design the flow chart using the theory and the derivation of the concepts.

CO4: Estimate the required value by running the programme on turbo C.
CO5: Interpret the value obtained on turbo C and manually.
CO6: Illustrate the motion of pendulum, oscillations and miller indices on turbo C CO7: Determine kinetic, potential energy, binding energy etc. by designing programs. CO8: Diagram the results of program using graphics in C

Semester IV

PHCT- 241: Nuclear Physics

After studying this course the student will be able to,

CO1: Classify elementary particles and nuclear states in terms of their quantum numbers.
CO2: Describe the role of S-O coupling in the shell structure of atomic nuclei and predict the properties of nuclear ground and excited states based on the shell model.
CO3: Describe the properties of strong and weak interactions.
CO4: Explain the different processes by which ionising radiation interacts with matter and the construction and applications of detectors for radioactivity.
CO5: Determine the basic properties of nucleus.
CO6: Calculate the kinematics of various reactions and decay processes.
CO7: Analyse production and decay reactions for fundamental particles by applying conservation principles.
CO8: Evaluating: Evaluate radiation energy losses by passage through the matter.

PHCT- 242: Experimental techniques in Physics- II

After studying this course the student will be able to,

CO1: List of required characterization techniques for fundamental research in material science and nanotechnology.
CO2: Identify the crystal structure, crystalline nature of any material by using X-ray diffraction technique.
CO3: Provide phase transition, absorption, chemical changes as temperature changes by using thermal analysis methods.
CO4: Make use of spectroscopic analysis for identification of materials i.e. which type of material is present by analysing their UV-Vis, IR, FTIR, DRS spectroscopies.
CO5: Study morphology, topography of any material by using SEM, TEM, and FESEM.
CO6: Find various applications like industrial, biomedical etc. by using magnetic characterization.
CO7: Apply the knowledge of characterization techniques for research.
CO8: Compile the information of characterization together to confirm the proposal in research work.

PHOTB2T: Physics of nano-materials (Theory)

After studying this course the student will be able to,

CO1: List of required characterization techniques for fundamental research in material science and nanotechnology.
CO2: Identify the crystal structure, crystalline nature of any material by using X-ray diffraction technique.
CO3: Provide phase transition, absorption, chemical changes as temperature changes by using thermal analysis methods.
CO4: Make use of spectroscopic analysis for identification of materials i.e. which type of material is present by analysing their UV-Vis, IR, FTIR, DRS spectroscopies.
CO5: Study morphology, topography of any material by using SEM, TEM, and FESEM.
CO6: Find various applications like industrial, biomedical etc. by using magnetic

characterization.

CO7: Apply the knowledge of characterization techniques for research.

CO8: Compile the information of characterization together to confirm the proposal in research work.

PHOPB2P: Physics of nano-materials (Practical)

After studying this course the student will be able to,

CO1: Synthesis of nonmaterial by sol gel method

CO2: Synthesis of nonmaterial by hydrothermal method

CO3: Synthesis of nonmaterial by chemical bath deposition

CO4: Synthesis of nonmaterial by biological method

CO5: Determination of average crystallite size of nanoparticles from X-ray diffraction technique

CO6: Study of optical absorption (Ultraviolet) of nanoparticles

CO7: Microwave assisted synthesis of nanomaterials

PHOT244J2: Biomedical Instrumentation-II (Theory)

After studying this course the student will be able to

CO 1: The Computer in Biomedical Instrumentation

The digital computer-computer hardware-Computer Software. Microprocessors –Types of Microprocessors Microprocessors in Biomedical instrumentation Microcontrollers in Biomedical instrumentation Examples of Microcontroller Based system (data acquisition) Interfacing the computer with medical instrumentation and other equipment. Biomedical computer applications.

CO 2: Biomedical Recorders

Introduction to nervous system, Neuromuscular transmission, muscle potentials, receptors, Neurotransmitters Electroencephalograph (EEG), Block diagram, Computerized Analysis of EEG Electromyography (EMG) Pulse Oximetry

PHOP244J2: Biomedical Instrumentation-II (Practical)

After studying this course the student will be able to

CO 1: Recording of pulse signal using pulse oximetry/Pulse recording system.

CO2: Glucometer as a sensors/strain gauge, measurement of BMR, BMI and fats using fat monitor

CO3: Design and built data acquisition system using microprocessor/Microcontroller

CO4: Skin temperature using thermo sensor

CO5: Operation and function of all the controls of hospital X-ray machine/ C. T. Scan / Ultrasound scanner (Visit at Hospital)

CO6: To study Lead I , II and III of standard bipolar Lead configuration

CO7: To study AVR, AVF and AVL lead of standard unipolar leads configuration

PHCP- 245: Project

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

CO1: Design hypothesis for their work to be carried out.

CO2: Describe the underlying theory of experiments in the project work.

CO3: Perform derivations of theoretical models of relevance for the experiments in the project.

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

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

CO6: Interpret relationships in graphed data and develop an intuition for alternative plotting methods and communicate results from project work, 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.

X X X X