MSc. Physics - Course Outcomes

Semester I
Paper name: CLASSICAL MECHANICS
Code: PHY1C01

Objectives

- To learn Lagrangian and Hamiltonian formulation of mechanics.
- To learn the significance of the ideas of Lagrangian, Hamiltonian, Action, Poisson brackets, canonical transformations and their application in modified form in the formulation of quantum mechanics.
- To learn and develop the analytical and mathematical skills for describing the dynamics of rigid bodies.
- To learn the theory of small oscillations which are characteristic of all bound physical systems.
- To learn the concepts in nonlinear dynamics and chaos.

Course outcome:

C.O.1: Explain the fundamental concepts in Lagrangian and Hamiltonian formulation in mechanics

C.O.2: Apply the concepts of Lagrangian, Hamiltonian, Action, Poisson brackets, canonical transformations and their subsequent development to Heisenberg's matrix mechanics and Schrodinger's wave mechanics, to carry out numerical problems.

C.O.3: Develop the analytical and mathematical skills for describing the dynamics of rigid bodies. It could be applied to practical situations. This can be applied to spectroscopic analysis of samples.

C.O.4: Explain the theory of small oscillations. Small oscillations are part and parcel of all bound physical systems.

C.O.5: Elucidate the concepts in nonlinear dynamics and chaos. These techniques can be directly applied in nonlinear physics and also to verify various experimental results.

Semester I
Paper name: MATHEMATICAL PHYSICS
Code: PHY1C02

Objectives:

Mathematics is the language of nature. Physics addresses fundamental questions in nature. Mathematical tools used for solving physical problems constitute mathematical physics. Mathematical Physics I, offered as a core course, delivers an entry level exposure to the fundamentals of this subject.

Course Outcomes:

C.O.1: Describe coordinate systems appropriate for different physical problems. Applies it to solve Laplace's equation in different coordinate systems.

C.O.2: Perform transformation operations and get the corresponding transformation matrices. Learn procedures for matrix diagonalisation.

C.O..3 : Distinguish the class of objects called tensors, their classifications and use. Understand differential equations of special nature and the ways to solve them.

C.O..4: identify differential equations of special nature and the ways to solve them.

C.O.5: Illustrate special functions as solutions to problems in atomic, molecular nuclear, and solid state physics etc. and will put them in use.

C.O..6: Distinguish Fourier series and integral transforms of different types and their properties. This will enable him/her to analyze or solve different mathematical problems in physical sciences.

Semester I
Paper name: ELECTRODYNAMICS AND PLASMA PHYSICS
Code: PHY1C03

Objective:

- To understand Maxwell's equations and general electromagnetic wave equations, their solutions in terms of potentials and fields, multipole expansion of the potentials and multipole moments of different orders.
- To understand propagation of electromagnetic waves through free space and the consequences of reflection from different types of boundaries.
- To understand the propagation of electromagnetic waves through confined media.
- To understand the propagation characteristics of electromagnetic waves through confined media of different types.
- To learn elementary plasma physics.

Course Outcomes:

C.O.1: Explain the significance of displacement current and Maxwell's equations and general electromagnetic wave equations, their solutions in terms of potentials and fields.Another basic concept of physics called gauge transformation will be understood. Multipole expansion of the potentials, fields and multipole moments of different orders will be learned.

C.O.2: Describe the propagation of electromagnetic waves through free space and the consequences of reflection from different types of boundaries. These have important consequences in wave propagation.

C.O.3: Discusses propagation of electromagnetic waves through confined media like waveguides and cavity resonators.

C.O.4: Enables to appreciate the magnificent results of the blending of relativity and electrodynamics and motivates to take up a course on quantum field theory, the study of fields, interactions and symmetries.

C.O.5: Understand the criteria for a medium to be called plasma and the various properties of it.

Semester I
Paper name: ELECTRONICS
Code: PHY1C04

Objectives:

- To learn the properties of field effect transistors and their peculiarities over bipolar transistors.
- To understand various light emitting and light sensing devices and their use for different purposes, especially microwave communication.
- To understand the fundamentals of op-amps, their characteristics and simple applications.
- To understand the basics of digital electronics by way of understanding logic gates, flip flops,registers and counters and a few elementary applications.

Course Outcomes:

C.O.1:Analyze characteristics of JFET and MOSFET and their specific applications.

C.O.2: Distinguish the basic characteristics of light emitting and light sensing devices and illustrate the basic concepts behind integrating electronic and photonic devices suitably for microwave communication.

C.O.3:Classify characteristics of op-amps and their implementation in various elementary level applications.

C.O.4: Identify the basics of logic gates, flip flops and registers and the designing of counters, satisfying specific conditions. Understands RAM and D/A converter and basic features of specific microprocessors.

Semester II
Paper name: QUANTUM MECHANICS-I
Code: PHY2C05

Objectives

- To understand the importance of vector space, Dirac ket and bra notations, Hilbert space, operators,eigenvalue problems and generalized uncertainty principle in quantum mechanics. To understand the need for quantum mechanical formalism and the basic approaches.
- To understand time evolution of quantum mechanical systems and learn different time evolution approaches - Schrodinger picture and Heisenberg picture, wavefunction interpretation and application of different approaches in various fundamental problems.
- To develop an understanding of the mathematical foundations of spin and angular momentum for a system of particles and to apply spherical harmonics and to compute Clebsch - Gordon coefficients.
- To apply Schrodinger equation to central potential problems.
- To learn invariance principles based on symmetry of the system and the associated conservation
- laws and to apply quantum mechanical concepts to analyze the ground state of Helium atoms.

Course Outcomes:

C.O.1: Appreciate the importance and implication of vector spaces. Will be able to use Dirac ket and bra notations. Use operators and will be able to solve eigenvalue problems. Understand generalized uncertainty principle in quantum mechanics and the need for quantum mechanical formalism and its basic principles.

C.O.2: Explain time evolution of quantum mechanical systems and learn different time evolution approaches -Schrodinger picture and Heisenberg picture. Apply different approaches in quantum dynamics to various fundamental problems.

C.O.3:Develop a better understanding of the mathematical foundations of spin and angular momentum. Make use of spherical harmonics to compute Clebsch - Gordon coefficients.

C.O.4: Apply Schrodinger's equation to central potential problems, to solve various quantum mechanical problems.

C.O.5: Understand invariance principles based on symmetry of the system and establish the associated conservation laws. These quantum mechanical concepts will be applied to analyze the ground state of the Helium atom. Here it will be understood that all symmetry elements possess the mathematical property of groups.

Semester II
Paper name: MATHEMATICAL PHYSICS-II
Code: PHY2C06

Objectives:

- To provide the basic ideas of Complex variables, Cauchy's integral theorem, Taylor's and
  Laurent's theorems, and by the evaluation of the residues of complex functions.
- To introduce students to group theory.
- To understand the basic concepts of calculus of variation, which is widely used in different areas of physics.
- Introduce Greens function to develop expertise in solving equations showing causality relationships.

Course Outcomes:

C.O.1: In general, physical phenomena are expressed in equations involving complex quantities. Sometimes we get complex solutions to equations. Solving such problems requires special procedures. On completing this module he/she will gain the skill for solving and interpreting such problems.

C.O.2: Acquire preliminary training in group theory. All symmetry elements possess the mathematical property of groups. Concepts of group theory will help to solve problems in quantum mechanics. It is quantum mechanics that gives more stress on symmetry than classical mechanics.

C.O.3: Apply the techniques of calculus of variation to diverse problems in physics.

C.O.4: Apply the Green's function technique to solve problems showing causality relationships.

Semester II
Paper name: STATISTICAL MECHANICS
Code: PHY2C07

Objectives:

- To provide an understanding of the concepts of different ensemble theories to explain the
  behavior of systems.
- To provide an understanding of the difference between classical statistics and quantum statistics.
- To provide an understanding of the statistical behavior of Bose-Einstein and Fermi-Dirac
  systems

Course Outcomes

C.O.1: Understand macroscopic and the microscopic states, thermodynamic potentials, basic concepts of entropy, Liouville‟s theorem and its consequences. Also the students will have an understanding of the connection between statistics and thermodynamics.

C.O.2: Have a detailed understanding of different canonical ensembles.

C.O.3: Develop an understanding of the statistical behavior of Bose-Einstein and Fermi-Dirac systems.

Semester II
Paper name: COMPUTATIONAL PHYSICS
Code: PHY2C08

Objectives:

- To learn the basic concepts of computer programming using Python language.
- To learn the use of necessary modules in python language for doing advanced mathematical calculations and visualizations.
- Learn the use of numerical techniques and implement them for solving mathematical problems like interpolation, curve fitting, integration etc.
- Learn the techniques for solving mathematical problems like solving differential equations, finding Fourier transforms etc. numerically, using computers.
- Learn the basic concepts of solving diverse problems in physics by computer simulation using python language.

Course Outcomes:

C.O.1: Write computer programs using core python.

C.O.2: Use advanced mathematical modules like Numpy and Pylab in python program for solving mathematical and physical problems and also to present the result visually using graphs and charts.

C.O.3: Solve numerically mathematical problems like interpolation, curve fitting, integration etc. and to write python programs for these.

C.O.4: Solve numerically mathematical problems like differential equations, Fourier transforms etc. and also to write python programs for these.

C.O.5: Analyze by simulating simple physical problems in physics like one-dimensional and two-dimensional motion, harmonic oscillator, radioactive disintegration, chaos, solution of Schrodinger equation etc., using python programs by applying the knowledge acquired for the course.

Semester III
Paper name: QUANTUM MECHANICS –II
Code: PHY3C09

Objectives:

- To understand time independent perturbation theory and apply it to different quantum mechanical systems.
- To apply methods like Ritz variational technique and WKB approximation to quantum mechanical systems.
- To understand the time dependent perturbation theory and apply to different quantum mechanical systems.
- To understand the theory of scattering and the partial wave analysis.
- To understand the need for relativistic quantum mechanics and the derivation of various relativistic wave equations and their interpretations.

Course Outcomes:

C.O.1: Understand time independent perturbation theory and to apply it to harmonic and anharmonic oscillators, and learn the fine structure and hyperfine splitting of Hydrogen atoms in the presence of external magnetic and electric fields.

C.O.2: Apply methods like Ritz variational technique and WKB approximation to quantum mechanical systems.

C.O.3: Interpret time dependent perturbation theory and apply it to describe radiative transitions in atoms. Understand Fermi's Golden rule and learn Born approximation.

C.O.4: Explain the theory of scattering and apply the method of partial waves to scattering by central potential and square well potential.

C.O..5: Identify the principles of relativistic quantum mechanics and apply to Dirac particles, Klein-Gordon equation. Also understand the concept of spinors and the non-relativistic limit and Hole theory.

Semester III
Paper name: NUCLEAR AND PARTICLE PHYSICS
Code: PHY3C10

Objectives

- To understand the basic properties of a nucleus, fundamentals of nucleon scattering and derive the information regarding deuteron structure.
- To understand different decay modes of unstable nuclei and to estimate the related parameters.
- Understand various nuclear models and nuclear processes like fission and fusion.
- Understand the working of radiation detectors and the associated nuclear electronics.

Course Outcome:

C.O.1: Interpret the properties of nucleus, binding energy, angular momentum, two nucleon scattering, spin dependence, tensor force, partial wave concept and the theory of deuteron structure.

C.O.2: Elucidate the theory of various types of nuclear decay, selection rules of transition, concept of parity and multipole moments.

C.O.3: Compare various nuclear models and nuclear processes like fission and fusion. Will be able to apply it to various nuclear systems in the chart of nuclides.

C.O.4: Demonstrate the working of one or two nuclear radiation detectors of different types and the signal processing and analyzing units.

C.O.5: Compare basic interactions and classify the elementary particles. Interactions are linked with the concept of symmetry and conservation laws. Understand Sakata model, Gellmann-Okubo mass formula, Quark mode and their significance.

Semester III
Paper name: SOLID STATE PHYSICS
Code: PHY3C11

Objectives:

- To understand the reciprocal lattice, Brillouine zone, crystal structures and various bondings incrystals.
- To understand different excitations in crystals and their after effects.
- To understand the free electron model and the explanation for the properties of metals. To have a deeper understanding of band gaps in different situations.
- To understand the thermal, electrical and magnetic properties of matter.
- To understand electron pairing and superconductivity.

Course Outcome:

C.O.1: Analyze the structure of materials based on X-ray diffraction and interpret it on the basis of the theory understood.

C.O.2: Distinguish different excitations in crystals. Properties of quasiparticles could be explained. Arrive at proper explanation of specific heat.

C.O.3: Explain free electron model and interpret the properties of metals. Gain a deeper understanding of the energy bands based on the properties of carriers.

C.O.4: Interpret properly the thermal, electrical and magnetic properties of materials. Will enable the student to understand the current research going on in the related areas.

C.O.5: Illustrate using phase diagrams, phase transitions in materials leading to superconductivity and different types of superconductors.

Semester IV
Paper name: ATOMIC AND MOLECULAR SPECTROSCOPY
Code: PHY4C12

Objectives:

- To provide an understanding of the interaction of electromagnetic waves with matter.
- To understand different spectroscopic techniques and the corresponding instrumentations.
- To realize the role and practical application of spectroscopy in research and development.

Course Outcome:

C.O.1: Understand the behavior of atoms and molecules and their interactions with electromagnetic waves.

C.O.2: Apply the behavior of nonrigid rotor and understand the microwave spectroscopy

C.O.3: Distinguish between Raman and IR spectroscopy and elucidate on the features of Raman spectrum.

C.O.4: Explain electronic spectroscopy and applications.

C.O.5: Identify the structure of the sample from spin resonance and Mossbauer spectra

ELECTIVE COURSES

Semester III
Paper name: EXPERIMENTAL TECHNIQUES
Code: PHY3E05

Objectives :

- To impart knowledge on vacuum techniques, pumps and measuring gauges.
- To learn the different thin film fabrication techniques, thickness measurement and application.
- Knowledge on different types of particle accelerators and their uses
- Learn the methods of different materials analysis by nuclear techniques
- Understand different X-Ray techniques to characterize materials.

Course Outcome:

C.O.1: Explain vacuum, Gauges to measure vacuum, types of pumps and their utility, cryogenics etc.

C.O.2:Explain and demonstrate different thin film fabrication techniques, thickness measurement and application of thin films

C.O.3: Explain different types of particle accelerators, their working and specific applications

C.O.4: Explain methods of materials analysis by different nuclear techniques. C.O.5: Be trained on defining X-ray techniques to characterize materials.

Semester IV
Paper name: COMMUNICATION ELECTRONICS
Code: PHY4E15

Objectives

- To understand the different modulation techniques and their merits and benefits based on the circuit elements and signal to noise ratio.
- To understand the basics of pulse modulated communication and digital ways to transmit these signals.
- To understand basics of AM and FM transmitters and receivers, working microwave systems
- To understand basics of continuous and discrete time signals, A/D and D/A conversions techniques for digital signal communication
- To understand the basics of radiation from an oscillating dipole, different types of antennas

Course Outcome:

C.O.1: Compare signal to noise ratios of Amplitude, Frequency and Angle modulation techniques based on circuit elements and signal to noise ratio.

C.O.2: Compare amplitude and time modulations techniques in pulse modulated systems, able to quantify the errors in digital communication and suggest methods to correct it.

C.O.3: Differentiate between the circuit elements of AM and FM transmitters and receivers, explain the working of microwave systems.

C.O.4: Classify signals based on time and frequency, differentiate the working of D/A and A/D convertors

C.O.5: Classify signals based on time and frequency, differentiate the working of D/A and A/D convertors, explain different techniques for terrestrial and extraterrestrial signal communications

Semester IV
Paper name: MICROPROCESSORS AND APPLICATIONS
Code: PHY4E23

Objectives:

- To impart basic knowledge on the internal architecture of typical microprocessors and the idea of Assembly language programming.
- Introduce basic concepts of microprocessor timings and memory/IO device interfacing.
- Provide adequate understanding about the general purpose interfacing chips required for microcomputer design.
- Familiarize the internals of typical AVR microcontrollers and idea of Assembly language programming.
- Introduce essential knowledge on Assembly and C language programming of AVR microcontrollers leading to design of simple embedded systems.

Course Outcome:

C.O.1: to be equipped with essential knowledge on design and programming of simple microprocessor based systems.

C.O.2: develop basic skills in design of simple AVR microcontroller based embedded systems