Chanda Shikshan Prasarak Mandal's

JANATA MAHAVIDYALAYA, CHANDRAPUR

DEPARTMENT OF PHYSICS

Learning outcomes for Postgraduate Programme, M.Sc. Physics

Program Specific Outcomes:

At the end of the program students will be able to-

PSO1: Understand and apply principles of physics for understanding the scientific phenomenon in classical domain. Students would be benefited with knowledge of core subjects like Mathematical Physics, Classical Mechanics, Electrodynamics, and Electronics, Solid state Physics, Quantum Mechanics, Statistical Physics, Spectroscopy and Nuclear Physics.

PSO2: Understand and apply mathematical techniques for describing and deeper understanding of physical systems.

PSO3: Understand and apply statistical methods for describing the classical and quantum particles in various physical systems and processes.

PSO4: Understand and apply inter-disciplinary concepts and computational skills for understanding and describing the natural phenomenon.

PSO5: Understand and apply principles of Quantum mechanics for understanding the physical systems in quantum realm.

PSO6: Get exposure in various specializations of Physics (Solid State Physics/Nuclear Physics/Particle Physics/Material Science etc).

PSO7: Get exposure to advanced experimental/theoretical methods for measurement, observation, and fundamental understanding of physical phenomenon/systems. Demonstrate highest standards of Actuarial ethical conduct and Professional Actuarial behavior, critical, interpersonal and communication skills as well as a commitment to life-long learning.

PSO8: Engage in research and life-long learning to adapt to changing environment and prepare s for many competitive exams like NET SET GATE. Develop into Knowledgeable, disciplined students with good values, ethics; kind hearted thus helps in nation building. Student should be aware of ethical issues and regulatory considerations while addressing society needs for growth with honesty.

M.Sc. Semester I

Core 1 paper 1 (PSCPHYT01) Mathematical Physics
Core 2 paper 2 (PSCPHYT02) Complex Analysis and Numerical Methods
Core 3 paper 3 (PSCPHYT03) Electronics
Core 4 paper 4 (PSCPHYT04) Electrodynamics I
Practical Core 1 and 2 (PSCPHYP01 & P02) Practical I (Paper 1 & 2)
Practical Core 3 and 4 (PSCPHYP03 & P04) Practical II (Paper 3 & 4)
Seminar I

M.Sc. Semester II

Core 5 paper 5 (PSCPHYT05) Quantum Mechanics I
Core 6 paper 6 (PSCPHYT06) Statistical Physics
Core 7 paper 7 (PSCPHYT07) Classical Mechanics
Core 8 paper 8 (PSCPHYT08) Electrodynamics II
Practical Core 5 and 6 (PSCPHYP05 & P06) Practical 3 (Paper 5 & 6)
Practical Core 7 and 8 (PSCPHYP07 & P08) Practical 4(Paper 7 & 8)
Seminar 2

M.Sc. Semester III

Core 9 paper 9 (PSCPHYT09) Quantum Mechanics II
Core 10 paper 10 (PSCPHYT10) Solid state Physics and Spectroscopy
Core Elective I paper 11 (PSCPHYT11) Atomic and Molecular Physics I
Foundation Course I paper 12 (PSCPHYT12) Fundamentals of Spectroscopy
Practical 5 (Based on Core 9 and 10)
Practical 6 (Based on Elective I)
Seminar 3

M.Sc. Semester IV

Core 11 Paper 13 (PSCPHYT13) Nuclear and Particle Physics
Core 12 Paper 14 (PSCPHYT14) Solid State Physics
Core Elective II Paper 15 (PSCPHYT15) Atomic and Molecular Physics II
Foundation Course II paper 16 (PSCPHYT16) Spectroscopic Applications
Practical 7 (Practical 7 Based on Core 11, 12 and elective II)
Project
Seminar 4

1. **Mathematical Physics**

   On successful completion of this course a student will be able to –

   CO1: Have knowledge about, and being able to use, advanced mathematical methods and theories on various mathematical and physical problems.

   CO2: Use mathematical formulations, analyses and models to obtain insight in specialized areas of Physics.

   CO3: Be able to apply skills of mathematical, statistical and physical modeling in applied fields and on technological problems.

   CO4: Be able to carry out, present and document a comprehensive independent work, demonstrating command of the terminology of the subject area.

   CO5: Identify different special mathematical functions.

   CO6: Apply techniques of vector analysis, such as gradient of scalar, divergence of vector, curl of vector

   CO7: To the study of special functions of mathematical physics

   CO8: To understand Cartesian (X, Y, Z), Spherical polar (r,θ,φ) and Cylindrical (ρ,φ,z) co-ordinate systems and their transformation equations.

   CO9: To understand expression for gradient, divergence, curl and Laplacian in curvilinear, spherical polar and cylindrical co-ordinate systems.

   CO10: Solve partial differential equations with appropriate initial or boundary conditions with Green function techniques

   CO11: Have confidence in solving mathematical problems arising in physics by a variety of mathematical techniques

   CO12: To understand special relativity theory and to solve Lorent'z transformation equations, Length contraction, time dilation.

2. **Numerical Methods and Complex Analysis**

   After completion of this course students will be able to-

   CO1: To understand Complex number (Addition, Subtraction, Multiplication, Division, Complex conjugate) and Exponential form of complex number.

   CO2: To solve problems using Euler's formula,

   CO3: To state de-Moivere's theorem and to Trigonometrical functions Application of exponential form for power and roots of complex numbers.

   CO4: Be able to solve relevant theoretical problems.

   CO5: To solve partial differentiation.

   CO6: To understand Vector Algebra including Scalar and Vector product Scalar triple product and its geometrical interpretation, Vector triple product

   CO7: To apply vector algebra to interpret physical quantities such as angular displacement, angular velocity and angular acceleration.

   CO8: Application of vector analysis such as vector operator, Gradient, Divergence, Curl of a vector to solve the problems of Physics.

3. **Electronics-I**

CO1: To distinguish between P-N diode, Zener diode, LED and Photodiode.

CO2: To understand Half wave, full wave and bridge rectifiers and filters: capacitance filter, inductor filter and π filter.

CO3: To demonstrate voltage regulation using Zener diode.

CO4: To understand basic construction and operation of bipolar transistors (NPN and PNP),

CO5: To distinguish between transistor circuit configurations (CB, CE, CC), current gains (α, and β) and their interrelationship.

CO6: To solve problems of electronics using decimal and hexadecimal number system.

CO7: To learn logic gates and to design R-S, clocked R-S, D , JK and T flip flops using logic gates.

CO8: To state De Morgan's theorems and understand symbols, Boolean expression and truth tables for gates.

4. **Electrodynamics I**

After completion of this course students will be able to-

CO1: To state Gauss law and its application to obtain electric field for different cases.

CO2: Describe and explain the relationship between the electric field and the electrostatic potential.

CO3: Understand the relation between Electric displacement vector D, Susceptibility, Permittivity, Dielectric constant.

CO4: To understand Lorentz force on a point charge moving in a magnetic field.

CO5: To state Biot and Savart's law and Ampere's circuital law to Describe and explain the generation of magnetic fields by electrical currents;

CO6: Be able to solve relevant theoretical problem and use their conceptual understanding of the electromagnetic laws in order to qualitatively describe the behavior of the solution to the problem

CO7: Understand origin of Maxwell's equations in magnetic and dielectric media

CO8: Write down Maxwell's equations in linear, isotropic, homogeneous media

CO9: To derive continuity conditions on electromagnetic fields at boundaries

CO10: To derive electromagnetic wave solutions and propagation in dielectric and other media and understand transport of energy and Poynting vector.

CO11: To Show laws of geometric optics originate with Maxwell's equations at dielectric boundaries calculate reflection and transmission coefficients for waves at dielectric boundaries.

5. **Practical I (Paper 1 & 2)**

At the end of the course, the student will be able to

CO1: Write a program to find the largest or smallest of a given set of numbers and execute

CO2: Write a program for Bubble sort and execute.

CO3: Write a program for Matrix multiplication and execute

CO4: Write a program for Lagrange Interpolation method.

CO5: Write a program for Newton-Raphson Method.

6. **Practical 2 (Paper 2 &3)**

At the end of the course, the student will be able to

CO1: Design a regulated power supply
CO2: Design Basic, TTL, NAND and NOR gates.
CO3: Design and study Combinational logic gates
CO4: Design and study Flip-Flops.
CO5: Design and study Astable, Monostable and Bistable multivibrator.

7. **Quantum Mechanics I**

After completion of this course students will be able to-

CO1: To develop a knowledge and understanding of the concept that quantum states live in a vector space.

CO2: To solve quantum mechanics problems.

CO3: Formulation of Schrödinger equation-time dependent and time independent forms.

CO4: To derive energy Eigen value and eigen functions particle in a box and 1-D harmonic oscillator.

CO5: To formulate the Schrödinger wave equation in terms of spherical polar coordinates for its application to solve Hydrogen atom problem.

CO6: To understand Postulate of quantum mechanics, operators and use of commutation and commutative algebra of operators to solve quantum mechanics problem.

8. **Statistical Mechanics Physics**

After completion of this course students will be able to-

CO1: To understand basic concepts of probability and probability distribution.

CO2: To solve Random walk problem in one dimension and Gaussian probability distribution.

CO3: To understand specification of the state of the system (Classical & Quantum).

CO4: To state Basic postulate of equal a priori probability,

CO5: To understand Statistical Ensembles and Calculation of microstates of an ideal monatomic gas.

CO6: To understand Distribution of energy between systems in equilibrium.

CO7: To state Boltzmann relation for entropy and to perform Statistical calculations of thermodynamic quantities.

CO8: To state Equipartition theorem and its application to mean K.E. of a molecule in a gas and to Harmonic oscillator.

CO9: To derive Maxwell's equations from thermodynamic potentials

CO10: To state TdS and energy equation.

9. **Classical Mechanics**

On successful completion of this course a student will be able to –

CO1: Apply the basic laws of physics in the areas of classical mechanics, Newtonian gravitation, Types of forces: Forces of Gravitation, Lorentz force, Hooks Force, Frictional Force, and Fundamental Forces of Nature.

CO2: Recognize how observation, experiment and theory work together to continue to expand the frontiers of knowledge of the physical universe.

CO3: Apply basic mathematical tools commonly used in physics, including elementary probability theory, differential and integral calculus, vector calculus, ordinary differential equations, partial differential equations, and linear algebra.

CO4: To solve Lagrange's equation, Properties and simple application of Lagrange's equation (simple pendulum, harmonic oscillator, compound pendulum, atwoods machine),

CO5: To solve Hamiltonian, Hamilton's canonical equation of motion, and to understand Physical significance Advantages and Applications of Hamilton's equations of motion (simple pendulum, compound pendulum, Linear harmonic oscillator).

CO6: To understand Central force, Reduction of two body problem into equivalent one body problem, Motion in inverse square law force field and to state Kepler's laws.

CO7: To apply Rotating coordinates system and to Derive the Corioli's force from Lagrangian formulation

10. Electrodynamics II

On successful completion of this course a student will be able to –

CO1: Understand Scalar waves, Vector waves and their properties.

CO2: Understand Symmetries of Maxwell equations and Lorentz transformations and application of Lagrangian for EM field.

CO3: Understand Motion of a charge in EM fields.

CO4: Understand Wave guides and their types, Bremsstarhlung and its application in synchrotron

11. Practical 3

At the end of the course, the student will be able to

CO1: Determination of e/m by Thomson method
CO2: Determination of Plank's constant.
CO3: Determination of Stephan's constant
CO4: Construction and determination of dielectric constant.
CO5: Study of B-H Curve.

12. Practical 4

At the end of the course, the student will be able to

CO1: Thickness of thin wire with lasers
CO2: Measurement of wavelength of He-ne laser light using ruler..
CO3: Ultrasonic velocity of liquid mixtures- Interferometer
CO4: Determination of wavelength of monochromatic source using MICHELSON

Interferometer.

CO5: Study of Hall Effect in semiconductors.

13. **Quantum mechanics II**

CO1: Understand time independent perturbation theory in Quantum mechanics and it's applications.

CO2: understand Time dependent perturbation theory and WKB approximation.

CO3: Understand identical particles and Born Oppenheimer Approximation.

CO4: Understand the interaction picture, S-matrix, and Wick's Theorem.

CO5: Understand Scattering theory and its importance

CO6: Understand Relativistic wave equations, Klein Gorden equations and Dirac's relativistic equations.

14. **Solid State Physics and Spectroscopy**

Students should gain basic knowledge of solid state physics. This implies that the student will:

CO1: Be able to account for interatomic forces and bonds

CO2: Have a basic knowledge of crystal systems and spatial symmetries

CO3: Be able to account for how crystalline materials are studied using diffraction, including concepts like the Edwald's sphere, form factor, structure factor, and scattering amplitude.

CO4: Be able to perform structure determination of simple structures

CO5: Understand the concept of reciprocal space and be able to use it as a tool to know the significance of Brillouin zones

CO6: Know what phonons are, and be able to perform estimates of their dispersive and thermal properties

CO7: Be able to calculate thermal and electrical properties in the free-electron model and know Bloch's theorem and energy band and distinction between metals, semiconductors and insulators

CO8: Be able to estimate the charge carrier mobility and density.

CO9: Be able to account for what the Fermi surface is and how it can be measured.

CO10: To understand Lattice heat capacity and to compare Classical theory, Einstein's theory, Debye's theory of specific heat of solids.

CO11: To apply techniques of X-Ray Diffraction and UV Spectroscopy to study crystals.

15. **Atomic and Molecular Physics I**

Upon successful completion of this course it is intended that a student will be able to:

CO1: State and explain the key properties of vector atom model and the importance of the Pauli Exclusion Principle.

CO2: To explain the observed dependence of atomic spectral lines on externally applied electric and magnetic fields.

CO3: To state and justify the selection rules for various optical spectroscopies in terms of the symmetries of molecular vibrations.

CO4: List different types of atomic and molecular spectra and related instrumentation.

CO5: Describe theories explaining the structure of atoms and the origin of the observed spectra

CO6: Identify atomic effect such as space quantization and Zeeman Effect.

CO7: To understand the Origin and nature of x-ray, Characteristic x-ray spectra,

CO8: To state Moseley's law and its importance, regular and irregular doublets and their laws.

16. Fundamentals of Spectroscopy

CO1: Understand hydrogen atom and three quantum numbers, Zeeman effect, Paschen-Back effect and Stark effect.

CO2: Understand Molecular spectra and IR spectra

CO3: Understand Raman Spectroscopy and determine structure using Raman and IR spectra.

CO4: Understand electronic spectra of diatomic molecules.

CO5: Understand Franck-Condon Principle and dissociation energy

CO6: Understand rotational fine structure of electronic-vibrational transition.

17. Practical 5

At the end of the course, the student will be able to

CO1: Measure wavelength in the emission spectra of iron (Iron arc).
CO2: Determine Rydberg‟s constant.
CO3: Determine Planck's constant
CO4: Understand and design crystal structure.
CO5: Measure wavelength and different properties of LASER

18. Practical 6

At the end of the course, the student will be able to

CO1: Analyze the fluorescence spectrum of a sample.
CO2: Determine E/m of electron..
CO3: To measure the ultrasonic velocity in unknown liquid
CO4: Understand and design experiments with He-Ne Laser
CO5: Measure and study the polarization of LASER Light

19. Nuclear and Particle Physics

After completion of this course students will be able to-

CO1: To understand nuclear compositions and Elementary particles, charge symmetry and independence, spin dependence of nuclear force.

CO2: To state Law of radioactive decay and its application.

CO3: To distinguish between Types of nuclear models: Single particle shell model and Liquid drop model.

CO4: To understand nuclear reactions and conservation laws.

CO5: To understand nuclear fission on the basis of liquid drop model and nuclear fusion.

CO6: To understand basic principles and classification of Nuclear Reactor.

CO7: To learn types of detectors and classification of accelerators.

20. Solid State Physics

CO1: Understand Band theory and it's applications

CO2: Understand magnetic properties of materials and quantum theory of paramagnetism.

CO3: Understand Lattice dynamics, Theories of lattice specific heat, Dulong and Petit‟s law, and Einstein and Debye models for specific heat

CO4: Understand Free electron theory of metals and Seebeck effect, thermoelectric power of metals

CO5: Understand Superconductivity and Landau's theory of superconductivity.

21. Atomic and Molecular Physics II

CO1: Understand Time dependence in quantum mechanics and importance of time dependent perturbation theory.

CO2: Understand Saturation spectroscopy, Experimental methods of saturation spectroscopy in laser and its application in condensed matter physics

CO3: Understand Roseneweig and Greshow theory and it application in spectroscopy

CO4: Understand Stimulated Raman scattering and its Quantum mechanical treatment, Fluorescence spectroscopy, Phase sensitive detectors.

CO5: Understand Matrix isolation spectroscopy and Fourier transforms spectroscopy,

CO6: Understand Group theory, Normal coordinates, normal modes, Application of group theory to molecular vibrations.

22. Spectroscopic Applications

CO1: Understand the Principle of spectroscopic instruments- UV-VIS instruments and its working

CO2: Understand the analysis of representative spectra of metal complexes with various functional groups at the coordination sites through Raman and IR spectroscopy

CO3: Understand NMR phenomenon and its applications

CO4: Understand the Electronic spectroscopy its basic principle & electronic transitions in organic, inorganic and organometalic molecules and application to structure elucidation.

CO5: Understand the Electron paramagnetic resonance (EPR) spectroscopy of inorganic and organic compounds

CO6: Understand the Mossebauer spectroscopy, Mass spectroscopy and their applications

23. Practical 7

At the end of the course, the student will be able to

CO1: Measure resistivity of a semiconductor by four probe method at different temperatures and determine band gap energy.

CO2: Measure Hall coefficient of given semiconductor: identify type of semiconductor and estimate charge carrier concentration.

CO3: Determine Dielectric constant

CO4: Understand and measure the Random decay of nuclear disintegration using dice

24. Project

CO1: Explain the significance and value of problem in physics, both scientifically and in the wider community.

CO2: Design and carry out scientific experiments as well as accurately record the results of experiments.

CO3: Critically analyze and evaluate experimental strategies, and decide which is most appropriate for answering specific questions.

CO4: Research and communicate scientific knowledge in the context of a topic related to material science/Electronics/Solid state Physics, in oral, written and electronic formats to both scientists and the public at large.

CO5: Explore new areas of research in physics and allied fields of science and technology