MANGALAYATAN UNIVERSITY, ALIGARH
CENTRE FOR DISTANCE AND ONLINE EDUCATION

PROGRAMME PROJECT REPORT

MASTER OF SCIENCE (PHYSICS)

M.Sc. (Physics)

2025-26

Introduction

Master of Science in Physics (M.Sc. Physics) is a postgraduate program that focuses on advanced physical concepts and theories. This program is designed to help students develop a deep understanding of various physical principles and their applications in diverse fields such as engineering, physics, computer science, and finance. The curriculum includes topics such as Classical Mechanics, Mathematical Physics, Quantum Mechanics, Electronics, Condensed Matter Physics, Classical Electrodynamics, Nuclear and Particle Physics, Statistical Mechanics in addition to discipline, electives, and computational courses. Students pursuing M.Sc. in Physics learn how to use physics to solve real-world complex problems and develop critical thinking and analytical skills. After completion of the program, students shall be well-equipped to pursue careers in academia, research, and many other fields.

M.Sc. Physics students are trained to work independently and collaboratively on research projects, helping them to develop valuable teamwork and communication skills. They are exposed to modern Physical tools and techniques, such as computer simulations and programming languages, which further enhances their problem-solving abilities. This program also encourages students to apply their knowledge in practical settings, allowing them to develop innovative solutions of complex problems and students may proceed to build their career in the research. This is a challenging and rewarding program that provides students with a strong foundation in Physics and prepares them for a wide range of exciting career opportunities.

A. Programme's Mission and Objectives

- To cater and ensure excellent theoretical and practical training through teaching, counseling, and mentoring with a view to achieve professional and academic excellence.
- To connect with industry and incorporating knowledge for research enhancement.
- To generate, disseminate and preserve knowledge for the benefit and betterment of society.

Objectives

M.Sc. in Physics programme aims to provide students with advanced classical Mechanics, Mathematical Physics, Quantum Mechanics, Electronics, Condensed Matter Physics, Classical Electrodynamics, Nuclear and Particle Physics, Statistical Mechanics in addition to discipline, electives, and computational courses. The programme also aims to provide students with the skills required to carry out independent research in Physics, including skills in literature review, mathematical modelling, data analysis, and technical writing. Furthermore, the program prepares students for further studies in Physics, including Ph.D. programmes.

B. Relevance of the Programme with HEI's Mission and Goals

The vision and mission of HEI, Mangalayatan University, Aligarh are:

Vision:

To be an institution where the most formative years of a young mind are spent in the guided pursuit of excellence while developing a spirit of inquisitive questioning, an ability to excel in the pressure of a fast-changing professional world, and a desire to grow into a personality rather than a person, in an environment that fosters strong moral and ethical values, teamwork, community service and environment consciousness.

Mission:

- To be the enablers of the confluence of academic rigor and professional practicality.
- To bring global best practices to students through widespread use of technology.
- To empower our faculty to constantly develop new skills and excel professionally.

- To provide the best campus environment to students and faculty with all facilities to nurture their interest.

M.Sc. (Physics) programme of the University strives to realize its vision and mission by rectifying student centric issues on priority and also to empower local community with the help of various social clubs running in University like NSS, KADAM and Alumni association. The University promotes multidisciplinary and allied research in various fields that supports and harnesses joyful learning environment. The goals of ODL (Open Distance Learning) program are to provide educational facilities to all qualified and willing persons who are unable to join regular courses due to personal or professional reasons. There are many potential learners who cannot afford to join regular courses due to professional responsibilities and personal commitments. For such cases M.Sc. (Physics) through ODL mode can be helpful in increasing knowledge base and skill up-gradation. The program aims to provide alternative path to wider potential learners who are in need of refresher courses to update their skills.

C. Nature of Prospective Target Group of Learners

Distance Education of Mangalayatan University (MU) shall target the working professional's executives as well as those who cannot attend a full-time program due to prior occupation or other assignments. The candidates desirous of taking admission in M.Sc. (Physics) program shall have to meet the eligibility norms as follows-

1. To obtain admission in M.Sc. (Physics) program offered through ODL mode, the learner must have completed graduation Physics as a main subject.

D. Appropriateness of Programme to be conducted in ODL mode to acquire specific skills and competence

The University has identified the following **Programme Outcomes** and **Programme Specific Outcomes** as acquisition of specific skills and competence in M.Sc. (Physics) Program.

Programme Outcomes (PO's)

After completing the M.Sc. (Physics) programme, students will be able to:

a. **PO1: Knowledge outcomes:** Acquire knowledge and ability to develop creative solutions, and better understanding of the future developments of the subject. Also, evolve analytical and logical thinking abilities.
b. **PO2: Skill Outcomes:** Learn and understand the new concepts and get prepared for placement by developing scientific skills. Further ability to communicate scientific information in a clear and concise manner.
c. **PO3: General Competence:** Be able to understand the role of science in solving real life problems and get an ability to participate in debates and discussions constructively.
d. **PO4: Scientific Aptitude and Innovation:** Know the recent developments, future possibilities and able to gather, assess, and make use of new information and applying this knowledge to find creative solutions.

Programme Specific Outcomes:

After completing the M.Sc. (Physics) programme through ODL Mode, students will be able to:

a. **PSO1:** Evaluate hypotheses, theories, methods and evidence within their proper contexts.

b. **PSO2:** Select, interpret and critically evaluate information from a range of sources that include books, scientific reports, journals, case studies and the internet.
c. **PSO3:** Develop proficiency in the analysis of complex problems and the use of mathematical techniques to solve them.
d. **PSO4:** Provide a systematic understanding of the concepts and theories of Physics and their application in the real world – to an advanced level, and enhance career prospects in a huge array of fields.

E. Instructional Design

The program is divided into four semesters and minimum credit requirement is 80 to get M.Sc. (Physics) degree in ODL mode from Mangalayatan University. Minimum time period for acquiring M.Sc. (Physics) degree will be two years and maximum time period is 4 years.

Evaluation Scheme
Semester-I

S. No.	Course Code	Course Name	Course Type	Credit	Continuous Assessment	Term End Exam	Grand Total
					MM	MM	
1	PHM-6111	Mathematical Physics	DCC	4	30	70	100
2	PHM-6112	Classical Mechanics	DCC	4	30	70	100
3	PHM-6113	Quantum Mechanics	DCC	4	30	70	100
4	PHM-6114	Classical Electrodynamics	DCC	4	30	70	100
5	PHM-6151	Physics Lab-I	DCC	4	30	70	100
			Total	**20**	**150**	**350**	**500**

Semester-II

S. No.	Course Code	Course Name	Course Type	Credit	Continuous Assessment	Term End Exam	Grand Total
					MM	MM	
1	PHM-6211	Statistical Mechanics	DCC	4	30	70	100
2	PHM-6212	Electronics	DCC	4	30	70	100
3	PHM-6213	Nuclear and Particle Physics	DCC	4	30	70	100
4	PHM-6214	Computational Physics and Programming	SE	2	30	70	100
5	PHM-6251	Physics Lab-II	DCC	4	30	70	100
6	PHM-6252	Computational Physics and Programming Lab	SE	2	30	70	100
			Total	**20**	**180**	**420**	**600**

Semester-III

S. No.	Course Code	Course Name	Course Type	Credit	Continuous Assessment	Term End Exam	Grand Total
					MM	MM	
1	PHM-7111	Advanced Mathematical Physics	DCC	4	30	70	100
2	PHM-7112	Atomic and Molecular Physics	DCC	4	30	70	100
3	PHM-7113	Condensed Matter Physics	DCC	4	30	70	100
4		Elective	Elective	4	30	70	100
5	PHM-7151	Physics Lab-III	DCC	4	30	70	100
			Total	**20**	**150**	**350**	**500**

List of elective courses

PHM-7114	Advanced Quantum Mechanics	Elective	4	30	70	100
PHM-7115	Plasma Physics	Elective	4	30	70	100
PHM-7116	Optical Fiber Communication	Elective	4	30	70	100

Semester-IV

S. No.	Course Code	Course Name	Course Type	Credit	Continuous Assessment	Term End Exam	Grand Total
					MM	MM	
1	PHM-7211	Material Science	DCC	4	30	70	100
2		Elective	Elective	4	30	70	100
3	PHM-7251	Physics Lab-IV	DCC	4	30	70	100
4	PHM-7291	Project/ Any Two Elective papers	DCC	8	30	70	100
			Total	**20**	**120**	**280**	**400**

List of elective courses

PHM-7212	Advanced Electronics	Elective	4	30	70	100
PHM-7213	Astrophysics	Elective	4	30	70	100
PHM-7214	Physics of Nanomaterials	Elective	4	30	70	100

Semester: I

Course Code: PHM-6111 **Credit: 4**

Course: Mathematical Physics-I

Course Objectives The main objective of the course is to teach the students about the theory of functions of a complex variable, Fourier transform, Laplace transform and Green function.

Course Outcomes: After completion of the course, students will be able to

CO s. No.	Course Outcomes (COs)
1.	Understand the concepts of a function of complex variable.
2.	Solve problems of Fourier and Laplace transforms.
3.	Apply Laplace transform methods to solve differential equations.
4.	Understand Green function theory and applications.

Block-I: Theory of Functions of a Complex Variable

Unit-1: Fundamentals of Complex Analysis**-** Analyticity and Cauchy-Reimann Conditions, Cauchy's integral theorem and formula

Unit-2: Advanced Topics in Complex Analysis - Taylor's series and Laurent's series expansion, Zeros and singular points, Multi valuedfunctions, Branch Points and Cuts

Unit-3: Exploring Complex Analysis- Reimann Sheets and surfaces, Residues, Cauchy's Residue theorem, Jordan's Lemma

Unit-4: Complex Integration- Evaluation of definite integrals, Principal Value, Bromwich contour integrals.

Block-II: Fourier Transform

Unit-5: Transforms- Fourier transform, Sine, Cosine and Complex transforms with examples, Definition,Properties and Representations of Dirac Delta Function

Unit-6: Analyzing Fourier Transforms- Properties of Fourier Transforms, Transforms of derivatives

Unit-7: Exploring Fourier Transforms- Parseval's Theorem, Convolution Theorem, Momentum representation, Applications to Partial differential equations,

Unit-8: Discrete Fourier Transform**-** Discrete Fourier transform, Introduction to Fast Fourier transform

Block-III: Laplace Transforms

Unit-9: Power of Laplace Transform- Laplace transform,

Unit-10: Laplace Transform- Properties and examples of Laplace Transform

Unit-11: Convolution Theorem- Convolution theorem and its applications,

Unit-12: Differential Equations with Laplace Transform Method- Laplace transform method of solving differential equations.

Block-IV: Green's Functions

Unit-13: Introduction to Green's function method, Green's function as a solution to Poisson's equation with a point source

Unit-14: symmetry of Green's function, forms of Green's functions, spherical polar coordinate expansion,

Unit-15: Quantum Mechanical Scattering- Neuman Series as well as Green's Function Solutions, Eigen function expansion,
Unit-16: One dimensional case, integral-differential equation, linear Harmonic oscillator, Green's function and Dirac delta function

Text and References Books:

1. Arfken G., Mathematical method for Physicists, Academic Press
2. Kreyszig. E., Advanced Engineering Mathematics, Wiley-India
3. Bell. W.W, Special Functions, Courier Dover Publication
4. Churchill. R.V., Functions of complex variable, McGraw-Hill Book Co.
5. Ghatak, A.K, Goyal, I.C. and Chau, S.J., Mathematical Physics, Ubs-Bangalore

Course Code: PHM-6112 **Credit: 4**
Course: Classical Mechanics

Course Objectives: The main objective of the course is to teach the students about the difference between Newtonian and Classical Mechanics. Canonical Transformations, Hamilton-Jacobi Method, Celestial mechanics, small oscillations and Relativistic Mechanics are also aimed to discuss.

Course Outcomes: At the end of the Classical Mechanics, student will be able to

COs No.	Course Outcomes (COs)
1.	Solve Lagrangian and Hamiltonian of the system.
2.	Understand and solve the problems using various canonical transformations.
3.	Explain two body central force problem.
4.	Define and Make use of tensors

Block I: Classical Mechanics Fundamentals and Principles

Unit 1: Foundations of Classical Mechanics- General idea of Newtonian physics; Mechanics of a particle, mechanics of a system ofparticles

Unit 2: Exploring Classical Mechanics- Constraints, generalized coordinates, D'Alembert's principle and Lagranges equations

Unit 3: Hamilton's Principle- Hamilton's principle, derivation of Lagrange's equations from Hamilton's principle,extension of Hamilton's principle to non-holonomic systems

Unit 4: Conservation Laws and Symmetry in Dynamics- Conservation theorems and symmetry properties, Generalized momenta, cyclic co-ordinates

Block II: Canonical Transformations and Hamilton-Jacobi Method

Unit 5: Canonical Transformations- Equation of canonical transformation, examples of canonical transformation

Unit 6: Analyzing Poisson and Lagrange Brackets- Poisson and Lagrange brackets and their invariance under canonical transformation, Jacobi'sIdentity, Poisson's Theorem

Unit 7: Infinitesimal Canonical Transformations- Equations of motion infinitesimal canonical transformation in the Poisson bracketformulation

Unit 8: Hamilton-Jacobi Method- Hamilton Jacobi Method, Generating functions.

Block III: Celestial Mechanics and Small Oscillations

Unit 9: Two-Body Central Force Problem- Two body central force problem: bound state, reduction of two-body problem to one body problem

Unit 10: Central Force Motion- Motion in a central force field, The virial theorem, the inverse square law of force

Unit 11: Central Force Motion- The motion in central force in the Kepler problem

Unit 12: Small Oscillations- Concept of small oscillations, eigen value equation, simple application (CO_2), Normalcoordinates and modes

Block IV: Tensor Analysis

Unit 13: Elementary idea of tensors- Elementary idea of tensors: co-variant, contra variant and mixed tensor, addition, subtraction, multiplication and characterization of tensors, quotient law.

Unit 14: Lorentz Transformations- Four-dimensional representation of the Lorentz transformations, covariance of the laws of nature four vectors; velocity momentum,

Unit 15: Force and Its Transformation- Force and their transformation, equation of motion of a point particle in four vector form,

Unit 16: Relativistic Dynamics in Electromagnetic Fields- Relativistic Lagrangian and Hamiltonian of a charged particle in an em field.

Text and References Books:

1. Goldstein H.; Classical Mechanics, 2nd edition, Narosa Publishing House.
2. Rana N. C. and Joag P. S.; Classical Mechanics, McGraw-Hill Education.
3. Gupta K.C.; Classical Mechanics, Wiley Publication.
4. Moller, M. C.; Theory of relativity, Oxford University.

Course Code: PHM-6113 **Credit: 4**
Course: Quantum Mechanics

Course Objectives: The primary objective of the course is to teach origin, postulates, Abstract formulation, Quantum dynamics and Angular momentum of the Quantum Mechanics.

Course Outcomes: At the end of this course, student will be able to

COs No.	Course Outcomes (COs)
1.	**Explain** the origin of quantum physics and postulates of quantum mechanics.
2.	**Outline** the Abstract Formulation of Quantum Mechanics.
3.	**Understand** the Quantum dynamics.
4.	**Explain** the quantization of angular momentum.

Block I: Introduction of Quantum Mechanics

Unit 1: Mathematical Framework and Historical Context- Mathematical tools and brief introduction to origins of quantum physics.
Unit 2: Postulates and Vector Spaces- Review of quantum postulates. Properties of linear vector space,
Unit 3: Dirac Notation and Quantum Operator Theory- Dirac notation. Operators, their Eigen values and Eigen functions, orthonormality, completeness and closure.
Unit 4: Unitary Operations and Basis Changes- Generalized Uncertainty Principle. Unitary transformations, change of basis.

Block II: Abstract Formulation

Unit 5: Matrix Representation of Quantum Operators- Matrix Representation of operators.
Unit 6: Continuous Basis in Quantum Mechanics- Continuous basis, position and momentum representation and their connection.
Unit 7: Unitary Transformations and Basis Changes -Change of basis and unitary transformation,
Unit 8: Expectation Values and Insights from the Ehrenfest Theorem- Expectation values and Ehrenfest theorem

Block III: Quantum Dynamics

Unit 9: Schrödinger and Heisenberg Pictures Schrödinger and Heisenberg Pictures Schrödinger picture, Heisenberg picture and equation of motion
Unit 10: Harmonic Oscillator via Operator Methods- Classical limit, solution of harmonic oscillator by operator method
Unit 11: Symmetries and Exploring Their Role and Significance- Symmetries in quantum mechanics, general view of symmetries,
Unit 12: Spatial and Temporal Transformations- Spatial transition, continuous and discrete, time transition, parity and time reversal

Block IV: Angular Momentum

Unit 13: Properties and Commutation Relations- Angular Momentum, commutation relations of angular momentum
Unit 14: Orbital, Spin, and Total Operators- Orbital, Spin and total angular momentum operators.
Unit 15: Pauli Spin Matrices- Pauli spin matrices, their Commutation relations.

Unit 16: Eigenvalues, Eigenfunctions, and Clebsch-Gordan Coefficients- Eigen values and Eigen functions of L2 and Lz. Clebsch-Gordon coefficients

Text and References Books:

1. Franz Schwabl: Quantum Mechanics.
2. J.J.Sakurai: ModernQuantum Mechanics.
3. N. Zettili: Quantum Mechanics.
4. P.A. M. Dirac: Principles of Quantum Mechanics.
5. Bohm: Quantum Mechanics.

Course Code: PHM-6114 **Credit: 4**
Course: Classical Electrodynamics

Course Objectives: The primary objectives of this course aim at acquiring the stimulating knowledge of dynamical inter-relationship of electric and magnetic fields and their unification in creating electromagnetic waves. To understand the concept of electromagnetic radiation in vacuum, conducting and non-conducting media, formulation of Lagrangian of Electrodynamics are also aimedto discuss.

Course Outcomes: At the end of the Classical Electrodynamics, student will be able to

COs No.	Course Outcomes (COs)
1.	**Explain** Maxwell's equation, gauge transformation and boundary conditions between different media.
2.	**Apply** Maxwell's equations to deduce wave equation, electromagnetic field energy, momentum and angular momentum density.
3.	**Determine** Lienard-Weichert potentials and fields, Larmor's and Thomson's classical radiation and scattering concepts.
4.	**Explain** Lagrangian formulation of Electrodynamics.

Block I: Review of Maxwell's Equation

Unit1: Fundamentals of Electromagnetic Theory- Review of Maxwell's equations, propagation of EM waves in conducting medium, linear, circular,elliptical polarization.

Unit 2: EM Wave Behavior in Conducting Media- Propagation of EM waves in conducting medium. Skin depth, Reflection and refraction frommetallic surface.

Unit 3: Wave Propagation- Propagation of waves between perfectly conducting planes, waves in hollow-conductors,

Unit 4: TE and TM Modes- TE and TM modes. Rectangular waveguides, resonant cavity

Block II: Particle Dynamics in EM field

Unit 5: Relativistic Dynamics of Charged Particles- Relativistic Charged particle motion in uniform statics E and B fields

Unit 6: Interplay of Electric and Magnetic Fields- Cross E & B fields

Unit 7: Particle Drifts in Non-Uniform Static Magnetic Fields- Particle drifts in (velocity and curvature) in non-uniform statics B field.

Unit 8: Adiabatic Invariance and Magnetic Mirrors- Adiabatic invariance and magnetic mirror.

Block III: Radiation

Unit 9: The Lienard-Wiechert Potential- Lienard Weichert potential, field produced by charged particle in motion,

Unit 10: Radiation from Accelerated Charged Particles- Radiation from accelerated charged particle, Larmor formula and its relativistic generalization,

Unit 11: Scattering of Electromagnetic Radiation by Free Charges- Scattering of EM radiation by free charges. Thomson scattering,

Unit 12: Scattering by Charged Systems- Scattering by a system of charges, dipole radiation.

Block IV: Lagrangian formulation of Electrodynamics

Unit 13: Lagrangian and Hamiltonian Formulations- Lagrangian and Hamiltonian formulation for a free relativistic particle, for a charged particle inEM field

Unit 14: Interaction of Charged Particles with Fields- Interacting charged particle and fields
Unit 15: Energy-Momentum Tensor and Conservation Laws- Energy-momentum tensor and related conservation laws
Unit 16: Canonical and Symmetric Stress Tensors- Canonical and Symmetric Stress Tensors, Solution of the wave equation in covariant form

Text and Reference Books:

1. Jackson J.D., Classical Electrodynamics, Wiley India.
2. Marion J.B., Classical Electromagnetic Radiation, Academic Press.
3. Griffiths D.J., Introduction to Electromagnetics, Prentice Hall.

Course Name: Physics Lab-I **Credit: 4**
Course Code: PHM-6151

Course objectives: The objective of this laboratory course is to familiarize students with optical and laser-based measurement techniques for wavelength determination, material characterization, and spectral analysis. Students will gain hands-on experience with interferometry (Michelson and Fabry-Perot), diffraction, and fiber optics, learning to measure propagation loss, bending loss, and numerical aperture. The course also explores semiconductor properties through the Hall effect and charge carrier mobility. Additionally, students will study atomic spectra, determining the Rydberg constant and investigating magneto-optical effects such as the Faraday and Zeeman effects. These experiments provide a strong foundation for research and industrial applications in optics and semiconductor physics.

Course Outcomes: After going through this lab course, student will be able to

COs No.	Course Outcomes (COs)
1.	Accurately determine the wavelength of sodium light and measure the wavelength difference between D_1 and D_2 lines using the Michelson interferometer.
2.	Utilize He-Ne lasers for precise measurement of thin wire thickness using diffraction techniques.
3.	Analyze diffraction patterns and determine the wavelength of He-Ne laser using a diffraction grating.
4.	Compute the Hall coefficient and mobility of charge carriers in a semiconductor sample, understanding their significance in material characterization.
5	Determine the numerical aperture (NA) of an optical fiber, gaining insight into its light-guiding properties.

List of Experiments:

1. To determine the wavelength of the sodium light and the wavelength difference between D1and D2 lines using Michelson interferometer.
2. To measure the thickness of thin wire using He-Ne laser.
3. To measure wavelength of He-Ne laser using diffraction grating.
4. To determine Hall coefficient and mobility of charge carriers in a given sample ofsemiconductor.
5. To measure wavelengths of the Balmer lines of hydrogen spectrum and to determine the Rydberg constant for hydrogen atom from the measurement of these lines.
6. To determine the wavelength of sodium light and D1 and D2 lines by Febry-Perotinterferometer.
7. To Study of losses in optical fiber.
   (a) Measurement of propagation loss.
   (b) Measurement of bending loss.
8. To measure Numerical Aperture of Optical Fibre.
9. Demonstrate the Faraday-Effect using Flint Glass.
10. To determine the e/m ratio using Zeeman Effect.

Semester-II

Course Code: PHM-6211 **Credit: 4**
Course: Statistical Mechanics

Course Objectives: Statistical mechanics is an indispensable tool for studying physical properties of matter "in bulk" on the basis of the dynamical behavior of its "microscopic" constituents. This course is designed to teach the phenomenological postulates and theories of the matter and their relationship with the quantum mechanics.

Course Outcomes: At the end of the **Statistical Mechanics**, student will be able to

COs No.	Course Outcomes (COs)
1.	**Explain** the laws of thermodynamics, equipartition and Liouville's theorem**.**
2.	**Determine** the ensemble theory and its applications.
3.	**Illustrate** the phenomenon of black body radiation and Bose-Einstein condensations**.**
4.	**Formulate** random walk problem and should be able to apply it to realistic systems in nature.

Block I: Classical ensemble theory

Unit 1: Quantum Statistical Mechanics of Identical Particles- Quantum statistical mechanics of identical particles, Condition for statistical equilibrium,

Unit 2: Symmetry, Probability, and Quantum Ensembles- Symmetry of wave function, Postulate of equal a prior probability, Random Walk, Ensemblein quantum statistics,

Unit 3: Grand Canonical Ensemble & Quantum Distributions- Grand Canonical Ensemble, Partition function, Quantum distribution functions (Bose-Einstein and Fermi-Dirac),

Unit 4: Derivation via Grand Partition Function- Derivation of distribution laws using grand partition function.

Block II: Quantum ensemble theory

Unit 5: Phase Space, Liouville's Theorem, and Microcanonical Gas Theory- Phase space and Liouville's theorem, Micro canonical ensemble theory and its application toideal gas of monatomic particles

Unit 6: Canonical Ensemble: Thermodynamics and Ideal Gas Dynamics- Canonical ensemble and its thermodynamics, partition function, classical ideal gas in canonical ensemble theory, energy fluctuations,

Unit 7: Gibbs Paradox, Sackur-Tetrode Equation, and Quantum Ensembles- Gibbs paradox and its solution, Sackur-Tetrode equation, a system of quantum harmonic oscillators as canonical ensemble, Grand canonical ensemble,

Unit 8: Statistical Quantities and Ideal Gas in Grand Canonical Ensemble- Significance of statistical quantities, classical ideal gas in grand canonical ensemble theory.

Block III: Ideal Bose systems

Unit 9: Ideal Bose Gas and Bose-Einstein Condensation: Fundamentals and Thermodynamics- Basic concepts and thermodynamic behaviour of an ideal Bose gas, Bose-Einstein condensation,

Unit 10: Blackbody Radiation and Ideal Fermi Systems: Thermodynamic Behavior- Blackbody radiation-Planck's formula, Ideal Fermi systems: thermodynamic behavior of an idealFermi gas,
Unit 11: Heat Capacity of Free-Electron Gas at Low Temperatures: Insights and Discussion- Discussion of heat capacity of a free-electron gas at low temperatures,
Unit 12: Electron Gas in Metals: Exploring the H-Theorem- Electron gas in metals, H-theorem.

Block IV: Phase transition

Unit 13: Phase Transitions: Ising Model and Critical Fluctuations- Phase transitions, Ising model, Thermodynamic fluctuations, Critical exponents,
Unit 14: Thermodynamic Limit and Random Walk Dynamics- Thermodynamic limit and its importance Random Walk
Unit 15: Brownian Motion, Diffusion, and Fluctuation-Dissipation- Brownian motion, Diffusion equation, Fluctuation-Dissipation theorem.
Unit 16: Universality in Phase Transitions: Ising vs. Heisenberg Models- Concepts of universality of phase transitions, Ising and Heisenberg models

Text and Reference Books:

1. Landau and Lifshitz, Statistical Physics, Reed Educational & professional publication Ltd.
2. Pathria R.K., Statistical Mechanics (2ndedition), Butterworth-Heinemann, Oxford.
3. Huang K., Statistical Mechanics, Wiley Eastern, New Delhi.
4. Agarwal B.K. and Eisner M., Statistical Mechanics: Wiley Eastern, New Delhi.
5. Frederick Reif, Fundamentals of Statistical and Thermal Physics

Course Code: PHM-6212 **Credit: 4**
Course: Electronics

Course Objectives: To understand the basic concepts of Analog and Digital Electronics and apply it in experimental Physics and also for various Engineering Applications

Course Outcomes: At the end of the Electronics, student will be able to

COs No.	Course Outcomes (COs)
1.	**Analyze** and **Design** Combinational Logic Circuit
2.	**Understand** different types of Amplifiers
3.	**Summarize** Power Supplies & Digital Circuit Elements
4.	**Explain** Flip Flops, Number Systems & Counters

Block I: RC Wave Shaping: Analysis & Applications

Unit 1: Linear Wave Shaping with RC Networks: Analysis- Linear Wave Shaping: High Pass and Low Pass RC Networks: Detailed Analysis

Unit 2: Dynamic Responses to Various Input Signals -Response to Sinusoidal, Step, Pulse, Square wave, Exponential and Ramp Inputs.

Unit 3: Applications of RC Circuits: Differentiation and Integration- RC circuits applications High pass RC circuit as a differentiator, Low Pass RC circuit as an Integrator. Criterion for good differentiation and integration.

Unit 4: Laplace Transforms in Circuit Analysis - Laplace Transforms and their application to circuit elements.

Block II: Amplifiers: Difference & Broadband Techniques

Unit 5: Differential Amplifiers: Precision in Signal- Amplifiers: Difference Amplifiers.

Unit 6: Expanding Horizons: Broadband Amplification- Broadband Amplifiers, Methods for achieving broad banding

Unit 7: Emitter Follower: High-Frequency Handling- Emitter Follower at High Frequencies

Unit 8: Op Amps: The Heart of Signal Processing -Operational Amplifiers and its Applications.

Block III: Power Supplies & Digital Circuit Elements

Unit 9: Electronically Regulated Power Supplies- Power Supplies: Electronically Regulated Power Supplies, Converters and Inverters.

Unit 10: Advanced Voltage Supplies and SCR Applications- High and Low Voltage Supplies, Application of SCR as Regulator, SMPS.

Unit 11: Transistor Switching Dynamics in Digital Circuits- Elements of Digital Circuit Technology: Transistor as a Switch - Switching times: Definition and Derivation - Rise Time. Fall Time, Storage Time, Delay Time, Turn on Time, Turn Off Time Charge Control Analysis.

Unit 12: Pulse Circuits: Astable, Monostable, Bistable, and Schmitt Trigger - Multivibrators: Astable, Monostable and Bistable, Schmitt Trigger.

Block IV: Flip Flops, Number Systems & Counters

Unit 13: Flip-Flops: Types, Operation, and Features- Flip Flops: RS, RST, JK, T, D, JK M/S Flip flops, Race problem, Preset and Clear functions,

Unit 14: Foundations of Number Systems and Boolean Logic- Number Systems: Binary, Octal and Hexadecimal Number Systems. Binary Arithmetic, Arithmetic Circuits. Binary Codes: Gray, 8421, 2421, 5211. Boolean Variables and Operators, Simplification of Boolean Expressions. Karnaugh Maps.

Unit 15: Counters and Registers: Types and Operations- Counters and Registers: Binary Counters: Up, Down, Parallel. Modulus Counters:

Counter Reset Method, Logic Gating Method. Ring Counter, Shift Registers.

Unit 16: Analog-to-Digital and Digital-to-Analog Conversion- D/A converter and A/D converter. Simultaneous and Counter method of A/D converter, Successive Approximation method.

Text and Reference Books:

1. Robert L. Boylestad and Louis Nashelsky.: Electronic Devices and Circuit Theory.
2. Adel S. Sedra and Kenneth C. Smith, Microelectronic Circuits.
3. Albert Malvino and David J. Bates: Electronic Principles
4. Ned Mohan, Tore M. Undeland and William P. Robbins, Power Electronics: Converters, Applications, and Design
5. R. Jacob Baker, CMOS: Circuit Design, Layout, and Simulation.

Course Code: PHM-6213 **Credit: 4**
Course: Nuclear and Particle Physics

Course Objectives: The primary objective is to introduce the basic ideas and concepts of Nuclear Physics and impart knowledge about nuclear basic properties, nuclear decays and nuclear reactions.

Course Outcomes: At the end of the Nuclear and Particle Physics, student will be able to

COs No.	Course Outcomes (COs)
1.	**Explain** general properties of atomic nuclei and nuclear forces.
2.	**Tell** alpha, beta and gamma decay and the idea of coulomb excitation.
3.	**Explain** the idea of resonance and nuclear model
4.	**Solve** the particle flavor oscillation based on semi-quantum mechanical approach for neutrino and K-mesons.

Block I: General properties of atomic nuclei

Unit 1: Atomic Nuclei: Properties & Nuclear Forces- General properties of atomic nuclei and nuclear forces (qualitative),binding energy,
Unit 2: Nuclear Potentials & Deuteron States- Types of nuclear potential, Ground and excited states of deuteron,
Unit 3: Tensor Force & Spin Dependence in Nuclear Force- Tensor force S & D states, spin dependence ofnuclear force,
Unit 4: Low-Energy n-p and p-p Scattering -n-p scattering and p-p scattering at low energies.

Block II: Review of barrier penetration of alpha decay

Unit 5: Alpha Decay Barrier Penetration & Geiger-Nuttal Law: Review- Review of barrier penetration of alpha decay &Geiger-Nuttal law.
Unit 6: Beta Decays: Fermi Theory & Transition Types- Beta decays, Fermi theory, Allowed and forbiddentransitions,
Unit 7: Parity Violation in Beta Decay & Electron Capture- Experimental evidence for Parity-violation in beta decay, Idea of electron capture,
Unit 8: Gamma Transition Multipolarity & Selection Rules- Multipolarity of gamma transitions and selection rules, internal conversion, idea ofCoulomb excitation.

Block III: Nuclear models

Unit 9: Extreme Particle Model: Square-Well & Harmonic Oscillator- Extreme particle model with square-well & harmonic oscillator potentials
Unit 10: Spin-Orbit Coupling & Shell Model Predictions- Spin-orbit coupling, shell model predictions, magnetic moment-Schmidt lines,
Unit 11: Single-Particle Model: Total Spin Configurations - Single particle model, Total spin ‘J’ for various configurations,
Unit 12: Electric Quadrupole Moment & Nuclear Collective Modes- Electric quadrupole moment. Collective modes of motion, nuclear vibrations androtations.

Block IV: Introduction of elementary particles

Unit 13: Elementary Particles: Quantum Numbers & Conservation Laws- Introduction of elementary particles. Quantum numbers and conservation laws,

Unit 14: Charge Conjugation, Time Reversal, CPT Theorem & Particle Families -Charge conjugation, time reversal invariance, CPT theorem. The Baryon decuplet,meson octet, quark spin and color.

Unit 15: Pion-Parity, Neutrino Helicity, K-Decay & CP Violation - Pion-Parity, Neutrino Helicity, K-Decay & CP Violation- Pion-parity, helicity of neutrino, K-decay, CP violation in K-decay and itsexperimental determination, resonances,

Unit 16: Hadron Classification: SU(2) and SU(3) Symmetry- Special symmetry groups SU(2) and SU(3) classification of hadrons, quarks, Gell-Mann-Okubo mass formula.

Text and Reference Books:

1. Enge H. A, Introduction to Nuclear Physics, Addison-Wesley Pub. Co.
2. Ghoshal S. N., Nuclear Physics, S. Chand & Company Limited
3. Evans R. D., Atomic Nucleus, McGraw-Hill
4. Perkins D. H., Introduction to High Energy Physics, Cambridge University Press.

Course Name: Computational Physics and Programming **Credit: 2**
Course Code: PHM-6214

Course Objective:
The "Computational Physics with Python" course equips M.Sc. Physics students with the skills to apply Python programming to solve physics problems. In **Block I**, students learn Python basics and essential libraries like NumPy, SciPy, and Matplotlib, with a focus on mathematical tools, classical mechanics simulations, and wave propagation. **Block II** covers advanced topics, including thermodynamics, statistical mechanics, electricity, magnetism, and quantum mechanics simulations. Students explore applications like gas laws, Monte Carlo methods, and Schrödinger's equation, and delve into relativity, nonlinear dynamics, and data analysis, preparing them for research and real-world applications in computational physics.

Course Outcomes:
At the end of the course, the students would be able to:

1. Students will gain proficiency in Python programming and its application to solve complex physics problems using libraries like NumPy, SciPy, and Matplotlib.
2. Students will learn to perform vector, matrix operations, and solve algebraic and differential equations using Python's mathematical tools.
3. Students will develop the ability to simulate and visualize classical mechanics problems, including motion and projectile trajectories.
4. Students will model and simulate oscillations, wave propagation, and interference patterns in various physical systems.
5. Students will apply Python to advanced topics in thermodynamics, statistical mechanics, electricity, magnetism, quantum mechanics, and data analysis in experimental physics.

Block – I: Computational Physics with Python
Unit 1: Foundations of Python Programming for Physicists
- Introduction to Computational Physics and Python's Role
- Installing Python and Libraries for Physics (NumPy, SciPy, Matplotlib, SymPy)
- Python Basics: Syntax, Data Types, Control Structures
- Writing and Executing Python Scripts
- Debugging and Error Handling

Unit 2: Mathematical Tools in Python for Physics
- Vectors, Scalars, and Matrix Operations Using NumPy
- Solving Algebraic and Differential Equations Using SciPy
- Numerical Integration and Differentiation Techniques
- Visualization of Mathematical Functions with Matplotlib

Unit 3: Classical Mechanics and Motion Simulation
- Python Implementation of Newtonian Mechanics
- Simulating Linear and Projectile Motion
- Numerical Solutions to Equations of Motion (Euler and Runge-Kutta Methods)
- Visualizing Kinematics and Dynamics of Systems

Unit 4: Oscillations, Waves, and Acoustics
- Modeling and Simulation of Simple Harmonic Motion

- Wave Propagation in 1D and 2D: Standing and Traveling Waves
- Superposition of Waves and Interference Patterns
- Applications in Acoustics and Vibrations

Block – II: Advanced Computational Applications in Physics
Unit 5: Thermodynamics and Statistical Mechanics

- Computational Modeling of Thermodynamic Processes
- Python Simulation of Gas Laws and Thermodynamic Cycles
- Basics of Statistical Physics: Monte Carlo Simulations
- Modeling Heat Transfer and Thermal Equilibrium

Unit 6: Electricity, Magnetism, and Circuit Simulation

- Numerical Modeling of Electric Fields and Potentials
- Python Tools for Analyzing DC and AC Circuits
- Simulation of Magnetic Fields and Forces
- Applications to Electromagnetic Wave Propagation

Unit 7: Quantum Mechanics with Python

- Discretization of Schrödinger's Equation
- Visualization of Quantum Wave functions (Particle in a Box, Tunneling)
- Python Applications in Quantum Superposition and Entanglement
- Introduction to Quantum Computing with Python Libraries

Unit 8: Advanced Topics and Research Applications

- Introduction to Relativity and Space-Time Simulations
- Nonlinear Dynamics and Chaos Theory with Python
- Data Analysis and Visualization in Experimental Physics

Books Recommended/Suggested Reading:

1. Python: The Complete Reference Paperback – 20 March 2018 by Martin C. Brown (Author), TMH Publication

2. Python Programming, A modular approach, First Edition, By Pearson Publication by Taneja Sheetal and Kumar Naveen, 26 September 2017.

Course Name: Physics Lab-II **Credit: 4**
Course Code: PHM-6251

Course Objectives:
The objective of this laboratory course is to provide hands-on experience with operational amplifier (Op-Amp) circuits and their applications in signal processing. Students will design and analyze inverting and non-inverting amplifiers, differentiators, and integrators, gaining insight into fundamental Op-Amp operations. The course covers oscillator circuits (Wein-bridge), waveform generators (square and triangular wave), and nonlinear applications such as Schmitt triggers and zero-crossing detectors. Additionally, students will explore frequency response characteristics of filters (low-pass, high-pass, band-pass, and band-stop) and design a voltage regulator using Op-Amps. The lab also includes the study of SCR V-I characteristics, providing a foundation in analog electronics and signal conditioning for real-world applications.

Course Outcomes: After going through this lab course, student will be able to

COs No.	Course Outcomes (COs)
1.	Design and analyze basic Op-Amp circuits, including inverting and non-inverting amplifiers, differentiators, and integrators.
2.	Construct and test oscillator circuits, such as the Wein-bridge oscillator, and evaluate their frequency response.
3.	Implement and study filter circuits (low-pass, high-pass, band-pass, and band-stop) and understand their role in signal processing.
4.	Develop waveform generators and non-linear applications, including Schmitt triggers, square wave, and triangular wave generators.
5	Study and interpret the V-I characteristics of SCR, understanding its switching behavior and practical applications in power electronics.

List of Experiments:
1. To Study of Basic Op-Amp circuits and perform the Inverting & Non-Inverting Amplifier Using OP-Amp.
2. To perform the Differentiator& Integrator Using OP-Amp.
3. To calculate the Frequency of Wein-bridge Oscillator Using Op Amp.
4. To perform the Schmitt trigger Using OP-Amp.
5. Draw the frequency Response curve of Low pass filter & High pass filter Using OPAmp.
6. Draw the frequency Response curve of Band pass filter &Band stop filter Using OPAmp.
7. To perform the Square Wave generator and Triangular Wave generator Using OPAmp.
8. Voltage Regulator using Op-Amp.
9. To perform the zero-crossing detector (sine wave to square wave convertor) using Op-Amp.
10. Study of V- I Characteristics of SCR.

Course Name: Computational Physics and Programming Laboratory
Course Code: PHM-6252 **Credit: 2**

Course Objective:

The objective of the "Computational Physics and Programming Laboratory using Python" course is to equip students with the essential skills to apply Python programming in solving complex physics problems. The course emphasizes hands-on experience with scientific computing, covering topics such as numerical methods, data analysis, and simulations of physical systems. Students will learn to use Python libraries like NumPy, SciPy, and Matplotlib for tasks ranging from basic calculations to advanced simulations in areas such as mechanics, thermodynamics, electromagnetism, and quantum physics. This course aims to foster computational problem-solving abilities, preparing students for research and real-world applications in physics.

Course Outcomes:

At the end of the course, the students would be able to:

1. Students will gain proficiency in Python programming and its application to solve complex physics problems using libraries such as NumPy, SciPy, and Matplotlib.
2. Students will learn to simulate and visualize various physical phenomena, including mechanics, thermodynamics, and electromagnetism.
3. Students will develop the skills to implement numerical methods and algorithms for solving differential equations and analyzing physical systems.
4. Students will apply Python to model and analyze data, enhancing their understanding of physical principles and experimental results.
5. Students will acquire practical experience in using Python for computational physics research, preparing them for real-world applications and further studies in physics.

List of Experiments:

1. Write a Python program to compute the kinetic energy of a particle given its mass and velocity.
2. Create a program to plot the trajectory of a freely falling object using Matplotlib.
3. Perform basic matrix operations (addition, subtraction, multiplication) for two given matrices representing transformations.
4. Solve a system of linear equations representing currents in a simple circuit using NumPy.
5. Compute the work done by a force using numerical integration over a given path. Implement the Euler method to solve the equations of motion for a pendulum.
6. Simulate and plot the kinetic and potential energy of a mass-spring system to demonstrate energy conservation.
7. Simulate and visualize the motion of a simple harmonic oscillator for given initial conditions.
8. Model and plot a 1D traveling wave using Python, showing amplitude vs. time and space.
9. Write a program to simulate and visualize the interference of two waves with different frequencies and amplitudes.
10. Simulate the behavior of an ideal gas and plot its Pressure-Volume graph.
11. Model the temperature distribution in a rod over time using finite difference methods.
12. Simulate the random walk of a gas particle in 2D and visualize its trajectory.
13. Write a program to calculate and visualize the electric potential of a system of point charges.
14. Simulate a simple RC circuit and plot the voltage across the capacitor over time.
15. Visualize the magnetic field lines around a current-carrying wire.
16. Solve and visualize the wavefunctions and energy levels of a particle in a one-dimensional box.
17. Simulate and plot the probability of a particle tunneling through a potential barrier.

Semester-III

Course Name: Mathematical physics -II **Credit: 4**
Code: PHM-7111

Course Objectives: To familiarize students with basic of concepts of partial differential equations, Lagrange's linear equation and wave equations in various coordinate systems, Define binary operations, groups, semi-groups, and Abelian groups, along with exploring multiplication tables and equivalence classes.

Course Outcomes: After the completion of the course, student shall be able to:

COs No.	Course Outcomes (COs)
1.	**Explain** Solve Laplace, Poisson, diffusion, and wave equations in various coordinate systems
2.	**Classify** Explore Fourier integrals, various forms, and transforms, such as Fourier sine, cosine, and complex transforms.
3.	**Understand** the properties and applications of Beta and Gamma functions in various fields
4.	**Describe** concepts such as conjugate elements, invariant subgroups, permutation groups, cyclic groups, and cosets.

Block I: Mathematical Methods & Physical Applications: PDEs, Coordinates, and Solutions

Unit 1: Lagrange's Linear Equation with Multipliers-Lagrange's linear equation, Method of multipliers.
Unit 2: Fundamental Equations in Cartesian Coordinates- Solutions of Laplace, Poisson, Diffusion and wave equations in Cartesian.
Unit 3: PDEs in Spherical and Cylindrical Coordinates- Partial differential equations in spherical and cylindrical co-ordinates.
Unit 4: Practical Applications of Advanced PDE Solutions- Physical applications of the above topics.

Block II: Advanced Mathematical Techniques & Physical Applications

Unit 5: Inhomogeneous Equations and Fourier Series Analysis- Inhomogeneous equations, Green's function for a free particle, Fourier series, Dirichlet's conditions, Even and odd functions, Parseval's identity for Fourier series.
Unit 6: Comprehensive Study of Fourier Integrals and Special Functions-Fourier integral, different forms of Fourier integrals, Fourier sine, cosine and complex transform, Parseval's identity for Fourier integrals. Beta and Gamma functions,
Unit 7: Beta and Gamma Functions and Their Interrelations -Different forms of Beta and Gamma functions and relation between them
Unit 8: Applications of Beta and Gamma Functions -Physical applications of the above topics

Block III: Foundations of Group Theory & Operations

Unit 9: Introduction to Groups and Binary Operations- Binary operation, Definitions of Group, Semi-Group and Abelian group, Multiplication table
Unit 10: ECCEC- Equivalence class, Conjugate elements and classes.

Unit 11: IPCC- Invariant subgroups, Permutation group, Cyclic group, Cosets of a subgroup
Unit 12: FIGP**-** Finite and infinite group, Period of the group

Block IV: Group Representations & Symmetry Applications

Unit 13: STReC- Similarity transformations, Representation Character of Trace of the group.
Unit 14: SLOT- Schur's Lemma and the Orthgonality theorem.
Unit 15: CRS **-**Examples of C2v, Regular representation, Symmetrised basis functions for irreducible representation
Unit 16: DPR-SVP**-** Direct product of representation. Applications to simple vibrational problems.

Books Recommended/Suggested Reading:

1. Partial Differential Equations for Scientists and Engineers" by Stanley J. Farlow.
2. Partial Differential Equations: An Introduction" by Walter A. Strauss.
3. Partial Differential Equations in Physics" by Arnold Sommerfeld. Fourier Analysis and Its Applications" by Gerald B. Folland
4. Abstract Algebra" by David S. Dummit and Richard M. Foote.

Course Code: PHM-7112 **Credit: 4**
Course: Atomic and Molecular Physics

Course Objectives: To impart the knowledge about the fundamentals of atomic and molecular Physics of the systems, and to describe the structure of atoms and molecules on the basis of quantum mechanics.

Course Outcomes: At the end of the Atomic and Molecular Physics, student will be able to

COs No.	Course Outcomes (COs)
1.	**Explain** quantum mechanical treatment of an atom, wave function, electric dipoles and quadrupole.
2.	**Classify** the molecules, molecular energy states, electronic states and spectra.
3.	**Understand** different spectroscopy and resonance
4.	**Describe** the working of various spectrometers.

Block I: Atomic structure

Unit-1: Quantum Treatment of Hydrogen Atom- Quantum Mechanical Treatment of one-electron Atom, Spin-Orbit interaction and fine structure of hydrogen atom,
Unit 2: Alkali Element Spectra & Helium States- Spectra of alkali elements. Singlet and triplet States of Helium, Central fieldapproximation, Thomas-Fermi field,
Unit 3: Atomic Wavefunctions & Approximations- Atomic wavefunction, Hartree and Hartree–Fock approximations, Spectroscopic Terms: LS and J J coupling schemes for many electron atoms,
Unit 4: Wavefunctions & Multiplet Energies- Wavefunctions and energies of multiplets, Electric dipole and Electric Quadrupole.

Block II: Molecular structure

Unit 5: Born-Oppenheimer & H2 Theory -Born - Oppenheimer approximation, Heitler-London theory of H_2
Unit 6: Diatomic Molecule Structure -Rotation, vibration and electronic structure of diatomic molecules
Unit 7: Molecular Orbit & Valence Bond in H2- Molecular orbit and valance bond methods for H_2^+ and H_2
Unit 8: Heteronuclear Correlation Diagrams - Correlation diagram for hetero nuclear molecules

Block III: Molecular spectra

Unit 9: Diatomic Molecule Spectra- Rotation, vibration and electronic spectra of diatomic molecules
Unit 10: Franck-Condon & Electron Spin Principles - The Franck-Condon principle, electron spin and Hund's cases

Unit 11: Symmetry in Molecules: Diatomic & Polyatomic- Idea of symmetry elements and point groups and diatomic and poly atomic molecules

Unit 12: Spectroscopic Techniques: IR, Raman, Photoelectron- Infrared Spectroscopy and Raman spectroscopy, Photoelectron Spectroscopy

Block IV: Spectroscopy

Unit 13: NMR & ESR Principles: Introduction- Nuclear Magnetic Resonance, Chemical Shift, and Electron Spin Resonance(Introduction and their principles only).

Unit 14: Infrared Spectrophotometer Basics- General description and working of infra-red Spectrophotometer,

Unit 15: Photoelectron & Raman Spectrometers- Photoelectron Spectrometer, Simple Raman Spectrometer,

Unit 16: NMR & ESR Spectrometers- NMR Spectrometer and ESR Spectrometer.

Text and Reference Books:

1. White H. E.: Introduction to atomic spectra, McGraw-Hill book company.
2. Weissbluth M.: Atoms and molecules, Academic Press Inc.
3. Barrow G.M.: Introduction to molecular spectroscopy, McGraw-Hill book company.

Course Code: PHM-7113 **Credit: 4**
Course: Condensed Matter Physics

Course Objectives: The objective of this course is to provide a fundamental understanding of the structural, electronic, and magnetic properties of condensed matter systems. Students will explore key concepts such as crystal structures, band theory, transport properties of electron motion along with their real-world applications. The course also emphasizes the role of quantum mechanics and statistical physics in explaining material behavior, preparing students for advanced research and technological applications in condensed matter physics.

Course Outcomes: At the end of the Condensed Matter Physics, student will be able to

Cos No.	Course Outcomes (COs)
1.	**Tell** the basic symmetry operations performed in crystals and various types of defects that exist in crystals**.**
2.	**Explain** the band theory and different types of band structures.
3.	**Demonstrate** the transport properties in bands.
4.	**Illustrate** lattice and its thermal properties.

Block I: Bonding in crystals

Unit 1: Crystal Bonding Types & Madelung Constant- Bonding in crystals: covalent, ionic, metallic, hydrogen bond, vander Waal's bond and the Madelung constant.

Unit 2: Crystalline Solids & Lattice Structures- Crystalline solids, unit cell, primitive cell, Bravais lattices, Miller indices, closed packed structures. Atomic radius, lattice constant and density.

Unit 3: Orbital Symmetry in Crystal Structures- Connection between orbital symmetry and crystal structure. Scattering from periodic structures, reciprocal lattice, Brillouin Zones.

Unit 4: Electron Behavior in Solids & Fermi Statistics - Free electrons in solids, density of states, Fermi surface, Fermi gas at T=0K, Fermi statistics, specific heat capacity of electrons in metals, thermionic emission of electrons from metals.

Block II: Electronic band structure in solids

Unit 5: Electronic Band Structure in Solids- Electronic band structure in solids, Electrons in periodic potentials,

Unit 6: Solid State Physics Models- Bloch’s Theorem, Kronig-Penney model, nearly free electron model,

Unit 7: Tight-Binding Model & Band Structures- Tight-binding model: density of states, examples of band structures.

Unit 8: Fermi Surfaces in Metals & Semiconductors- Fermi surfaces of metals and semiconductors.

Block III: Transport properties

Unit 9: Electron Motion in Bands & Effective Mass -Transport properties: Motion of electrons in bands and the effective mass,

Unit 10: Band Currents & Electron Scattering- Currents in bands and holes, scattering of electrons in bands,

Unit 11: Electron Journeys: Boltzmann's Equation & Conductivity- Boltzmann equation and relaxation time, electrical conductivity of metals,

Unit 12: Electron Flow and Heat Harmony: Wiedemann-Franz Law- Thermo electric effects, the Wiedemann-Franz Law.

Block IV: Lattice dynamics of atoms in crystals

Unit 13: Linear Chain Vibrations: Monoatomic & Diatomic- Vibrations of mono atomic and diatomic linear chains,

Unit 14: Phonon Modes & Thermal Properties- Acoustic and optical phonon modes, density of states, thermal properties of crystal lattices,

Unit 15: Harmonic Oscillator Thermal Energy & Specific Heat -Thermal energy of the harmonic oscillator, specific heat capacity of the lattice,

Unit 16: Debye Theory of Specific Heats -Debye theory of specific heats.

Text and Reference Books:

1. Hook and Hall: Solid State Physics (Manchester Physics Series).
2. Kittel: Introduction to Solid State Physics (John-Wiley).
3. Iba chand Luth: Solid State Physics (Springer-Verlag Berlin).
4. H.M. Rosenberg: Introduction to the Theory of Solids (Prentice Hall).
5. Blakemore: Solid State Physics (Pergamon).
6. J.P. Srivastava: Element of Solid-State Physics (Prentice Hall).

Course Code: PHM-7114 **Credit: 4**
Course Advanced Quantum Mechanics

Course Objectives:
Students will earn the basic ideas of angular momentum and symmetry. Relativistic Quantum Mechanics will provide an exposure to how special relativity in quantum theory leads to intrinsic spin angular momentum as well as antiparticles approximations methods along with scattering theory shall presumably equip the student with sufficient knowledge to solve related problems.

Course Outcomes: At the end of the Advanced Quantum Mechanics, student will be able to

COs No.	Course Outcomes (COs)
1.	**Tell** approximation methods for stationary systems.
2.	**Illustrate** approximation methods for non-stationary systems.
3.	**Explain** scattering theory.
4.	**Know** relativistic quantum mechanics.

Block I: Approximation methods for stationary systems

Unit 1: Perturbation Theory: Non-Degenerate States- Time independent perturbation theory. Perturbation of non-degenerate states: first and secondorder perturbation.

Unit 2: Perturbation: Harmonic Oscillator & Degeneracy Removal- Perturbation of a harmonic oscillator. Perturbation of degenerate states, removal of degeneracy.

Unit 3: Zeeman, Isotopic, and Stark Effects- Zeeman effect, isotopic shift and Stark effects.

Unit 4: Variational & WKB Methods- Variational and WKB methods.

Block II: Approximation methods for time dependent problems

Unit 5: Interaction Picture & Time-Dependent Perturbations- Interaction picture and Time dependent perturbation theory

Unit 6: Dynamics: Constant & Harmonic Perturbations- Equations of Motion. Constant and harmonic perturbation.

Unit 7: Transition Probabilities: Discrete and Continuous Cases- Discrete and continuous case, transition probability. Fermi golden rule.

Unit 8: Adiabatic and sudden- Adiabatic and sudden approximations.

Block III: Scattering Theory

Unit 9: Scattering of Wave Packets: Theory- Scattering Theory Scattering of a wave packet.

Unit 10: Cross Sections and Born Approximation -The differential and total Cross section. The Born approximation.

Unit 11: Partial Waves, Lippman-Schwinger Equation, S-Matrix Properties- Partial waves and phase shifts, The Lippman Schwinger equation.

Unit 12: S-Matrix & T-Matrix: Properties and Optical Theorem -Definition and properties of S-matrix, T matrix. Optical theorem.

Block IV: Relativistic Quantum Mechanics

Unit 13: Klein-Gordon & Dirac Equations: Properties of Matrices- Klein-Gordon and Dirac equations, properties of Dirac matrices.

Unit 14: Dirac Equation: Plane Wave Solution & Electron Spin- Plane wave solution of Dirac equation. Spin and magnetic moment of the electron

Unit 15: Non-Relativistic Dirac Equation: Central Forces & Hydrogen Atom -Non-relativistic reduction of the Dirac equation. Central forces and the hydrogen atom.

Unit 16: Hydrogen Atom in Dirac Theory & Dirac Electron in Magnetic Field- Hydrogen atom in Dirac's theory, Dirac electron in constant magneticfield,

Text and Reference Books:

1. Franz Schwabl: Quantum Mechanics.
2. Eugen Merzbacher: Quantum Mechanics.
3. N. Zettili: Quantum Mechanics.
4. P.M. Mathews and K. Venkatesan: Quantum Mechanics.
5. P.A. M. Dirac: Priciples of Quantum Mechanics.

Course Code: PHM-7115 **Credit: 4**
Course: Plasma Physics

Course Objectives

Plasma physics is an important subject for a large number of research areas, including space. Plasma physics, solar physics, astrophysics, controlled fusion research, high-power laser. Physics, plasma processing, and many areas of experimental physics. The primary objectives for this course is for the students to learn the basic principles and main equations of plasma physics, at an introductory level, with emphasis on topics of broad applicability.

Course Outcomes: At the end of the course, students will be able to

COs No.	Course Outcomes (COs)
1.	**Tell** using fundamental plasma parameters, under what conditions an ionized gas consisting of charged particles**.**
2.	**Distinguish** the single particle approach, fluid approach and kinetic statistical approach.
3.	**Demonstrate** the basic transport phenomena such as plasma resistivity, diffusion
4.	**Discuss** MHD equation for plasma,

Block I: Plasma Fundamentals and Applications

Unit 1: Plasma: Properties and Laboratory Production- Definition and properties of plasma, Plasma production in laboratory and diagnostics.
Unit 2: Charged Particle Dynamics in Fields: Microscopic View- Microscopic description, Motion of a charged particle in electric and magnetic fields-curvature, gradient and external force drifts.
Unit 3: Magnetically Confined Fusion Systems- Controlled thermonuclear devices, magnetically confined open and closed systems (linear pinch, mirror machine and
Tokamak).
Unit 4: Inertial Confinement Fusion with Laser-Plasmas- Laser-plasmas: inertially confined system.

Block II: Statistical Plasma Dynamics: Equations and Transport Coefficients

Unit 5: Plasma Dynamics Unraveled: BBGKY & Boltzmann-Vlasov- Statistical description of plasmas, B.B.G.K.Y. hierarchy of equations, Boltzmann-Vlasov equation,
Unit 6: Particle Orbits and Vlasov's Vision: Equivalence Explored- Equivalence of particle orbit theory and the Vlasov equation, Boltzmann and landau collision integral H-theorem,
Unit 7: BGK Model: Simplifying Transport Phenomena- B.G.K. model, Fokker-Planck term, Solution of Boltzmann equation (brief outline),
Unit 8: Conductive Currents: Exploring Electrical Conductivity- Transport coefficient-electrical conductivity, diffusion.

Block III: Plasma Oscillations and Stability Analysis: Theory and Applications

Unit 9: Plasma Oscillations and Landau Damping- Small amplitude plasma oscillations. Oscillations in warm field free plasma. Landau damping.
Unit 10: Stability Analysis in Plasma Physics- Nyquist method-Penrose criterion of stability. Two stream stability (linear and quasi linear theory).
Unit 11: Magnetized Plasma Theory and Instabilities- Vlasov theory of magnetized plasma. Loss cone instability. Quasilinear theory of gently bump instability.

Unit 12: Nonlinear Electrostatic Waves: BCK Waves- Non-linear electrostatic waves, BCK waves.

Block IV: Plasma Fluid Dynamics and Magnetohydrodynamics: Theory and Applications

Unit 13: Fluid Dynamics in Plasmas: Moment Equations- Fluid description of plasmas, Moment equations.

Unit 14: Magneto hydrodynamic Equations and Ohm's Law- MHD equations. Generalized Ohm's law,

Unit 15: Field Decay and Flux Conservation- Flux conservation, Decay of fields.

Unit 16: Pressure-Balanced and Force-Free Fields- Pressure balanced and force free fields.

Text and Reference Books:

1. Introduction to Plasma Physics, F. F. Chen (Plenum Press, 1984)
2. Principles of Plasma Physics, N. A. Krall and Trivelpiece (San Fransisco Press, 1986)
3. Physics of High temperature Plasmas, G. Schimdt (2ndEd., Academic Press, 1979)
4. The framework of Plasma Physics, R.D. Hazeltine & F.L. Waelbroeck (Perseus.Books, 1998)
5. Introduction to Plasma Physics, R.J. Goldston and P.H. Rutherford (IOP, 1995)

Course Code: PHM-7116 **Credit: 4**
Course: Optical Fiber Communication

Course Objectives: This course provides a broad framework for studying optical fibers and related technologies, covering both theoretical concepts and practical applications.

Course Outcomes: At the end of the course, students will be able to

Cos No.	Course Outcomes (COs)
1.	**Tell** the fundamental principles of light propagation in optical fibers,
2.	**Explain** Identify different types of optical fibers.
3.	**Demonstrate** Gain knowledge of optical fiber communication systems.
4.	**Illustrate** techniques for splicing optical fibers.

Block I: Overview of optical fiber communication

Unit 1: Optical Fiber Communication: Past, Present, and Future- Introduction, Historical development, general system, advantages, disadvantages, and applications of optical fiber communication,

Unit 2: Understanding Optical Fiber Waveguides-optical fiber waveguides, Ray theory, cylindrical fiber (no derivations in article 2.4.4),

Unit 3: Single-Mode Fiber Essentials- single mode fiber, cutoff wave length, mode filed diameter.

Unit 4: Fiber Optics: Materials and Specialty Cables- Optical Fibers: fiber materials, photonic crystal, fiber optic cables specialty fibers.

Block II: Fundamentals of Optical Components and Devices

Unit 5: Optical Fiber Losses- Introduction, Attenuation, absorption, scattering losses, bending loss,

Unit 6: Dispersion in Optical Fibers: Types and Effects- dispersion, Intra modal dispersion, Inter modal dispersion.

Unit 7: Essentials of Optical Devices and Photodetection- Introduction, LED's, LASER diodes, Photo detectors, Photo detector noise, Response time,

Unit 8: Double Heterostructure and Photodiode Comparison- double hetero junction structure, Photo diodes, comparison of photo detectors.

Block III: Optical Fiber Connectivity and Receiver Operation

Unit 9: Optical Fiber Joints: Alignment and Loss Considerations- Introduction, fiber alignment and joint loss, single mode fiber joints,

Unit 10: Essentials of Fiber Splicing, Connectors, and Couplers - Fiber splices, fiber connectors and fiber couplers. Introduction,

Unit 11: Optical Receiver Essentials: Sensitivity and Performance- Optical Receiver Operation, receiver sensitivity, quantum limit, eye diagrams,

Unit 12: Advanced Optical Receiver Technologies- Coherent detection, burst mode receiver operation, Analog receivers.

Block IV: Analog and digital links

Unit 13: Analog Links and Multichannel Transmission Overview- Introduction, overview of analog links, CNR, multichannel transmission techniques,

Unit 14: RF Over Fiber and Microwave Photonics- RF over fiber, key link parameters, Radio over fiber links, microwave photonics.

Unit 15: Point-to-Point Optical Links- Introduction, point–to–point links, System considerations, link power budget, resistive budget

Unit 16: Single Mode Fiber Transmission Dynamics- short wave length band, transmission distance for single mode fibers, Power penalties, nodal noise and chirping.

Text and Reference Books:

1. Optical Fiber Communication – Gerd Keiser, 4th Ed., MGH, 2008.
2. Optical Fiber Communications– – John M. Senior, Pearson Education. 3 rd Impression, 2007.
3. Fiber optic communication – Joseph C Palais: 4th Edition, Pearson Education.

Course Name: Physics Lab-III **Credit: 4**
Course Code: PHM-7151

Course Objectives:
This laboratory course aims to provide hands-on experience with semiconductor materials, electronic devices, and digital logic circuits. Students will determine the energy band gap of semiconductors using different experimental methods and analyze the characteristics of transistors (BJT, FET, MOSFET, SCR, UJT). The course also focuses on the amplification and voltage control properties of FETs. Additionally, students will explore digital logic gates (AND, OR, NAND, NOR, NOT, XOR) using TTL ICs, verifying their truth tables and universal gate properties. These experiments build a strong foundation in analog and digital electronics, essential for further studies and practical applications.

Course Outcomes: After going through this lab course, student will be able to

COs No.	Course Outcomes (COs)
1.	Determine the energy band gap of semiconductors using reverse saturation current and four-probe methods, understanding its significance in material properties.
2.	Analyze the electrical characteristics of transistors (BJT, FET, MOSFET, SCR, UJT) and their applications in amplification and switching.
3.	Design and implement FET-based amplifiers and study its role as a variable voltage resistor (VVR) and voltage-controlled amplifier (VCA).
4.	Verify the functionality of basic logic gates (AND, OR, NOT, XOR) and demonstrate the use of NAND and NOR as universal gates using TTL ICs.
5	Apply semiconductor and digital logic concepts to real-world applications in electronics, communication, and embedded systems.

List of Experiments
1. Energy band gap of semiconductor by reverse saturation current method
2. Energy band gap of semiconductor by four probe method
3. Hybrid parameters of transistor
4. Characteristics of FET, MOSFET, SCR, UJT
5. FET Conventional Amplifier
6. FET as VVR and VCA
7. Study and Verification of AND gate using TTL IC 7408
8. Study and Verification of OR gate using TTL IC 7432
9. Study and Verification of NAND gate and use as Universal gate using TTL IC 7400
10. Study and Verification of NOR gate and use as Universal gate using TTL IC 7402
11. Study and Verification of NOT gate using TTL IC 7404
12. Study and Verification of Ex-OR gate using TTL IC 7486

Course Code: PHM-7211 **Credit: 4**
Course: Material Sciences

Course Objectives This elective course is designed to give a comprehensive knowledge about the materials observed around us. Apart from their nature, and various properties, we will discuss the synthesis methods adopted in preparation of various materials. It is important to study the properties of materials, since that is the main determining factor governing their applications.

Course Outcomes: At the end of the Electronics, student will be able to

COs No.	Course Outcomes (COs)
1.	**Explain** Nature and Morphology of material
2.	**Understand** the synthesis techniques
3.	**Discuss crystallization**, diffusion and phase rules
4.	**Explain** Microprocessors: Architecture, Memory, and Programming

Block I: Nature of Material Structure and Morphology:

Unit 1: Material Composition & Crystallinity- Crystalline and amorphous nature of materials, Composition of materials;

Unit 2: Material Morphology & Structure-Property Correlations- Morphology of materials, structure –property correlations.

Unit 3: Characterization Methods for Materials -Methods of characterizing crystalline and amorphous materials (X-ray diffraction, electron microscopy, etc.).

Unit 4: Crystallinity Influence & Industrial Applications- Properties influenced by crystallinity (mechanical, electrical, optical, etc.), Applications and significance in various industries (semiconductors, polymers, ceramics, etc.).

Block II: Materials Processing

Unit 5: Powder Technology: Processing Techniques- Powder technology for metallic, non-metallic, ceramics: Compaction, sintering, calcinations, annealing, vitrification reactions, quenching, Chemical (soft) synthesis techniques, Equilibrium and non-equilibrium process,

Unit 6: Thin Film Synthesis Techniques- Synthesis of thin films and surface layers of solids: Ion beam induced phenomena, laser assisted materials synthesis, physical and chemical vapour deposition techniques

Unit 7: Solid Imperfections: Defect Types- Imperfections in Solids: Types of Defects: Point defects, impurities in solids, linear defects, dislocations, interfacial defects, volumetric defects,

Unit 8: Defect Causes & Material Properties- Causes of defects, Correlation of defects with properties (magnetic, optical and electrical) of materials

Block III: Phase Transformation and Rate Processes in Solids:

Unit 9: Crystallization & Solid Solutions- Crystallization: Nucleation, growth rates, single crystal growth, zone refining, Solid solutions: Precipitation and dispersion strengthening,

Unit 10: Diffusion & Phase Transitions in Solids- Diffusion Processes: Mechanism of diffusion in solids, steady & non-steady state diffusion, Fick’s law, Phase Transitions: Order parameter, liquid-solid transitions, glass transition,

Unit 11: Solid Solutions, Intermetallics & Phase Equilibrium- Solid solutions and intermetallics, Phase Equilibrium Diagrams (with examples): Phase rules and equilibrium, Cooling curves,

Unit 12: Solid Solution Equilibrium & Eutectic Systems- Solid solution equilibrium diagram, Eutectic systems, Gibbs phase rule, Martensitic transformation

Block IV: Properties of Materials:

Unit 13: Mechanical & Electrical Properties Overview **-** Mechanical properties, Electrical properties

Unit 14: Material Conductivity Overview -Conductivity of materials (metals, semiconductors [elemental and compound], superconductors),

Unit 15: Conductive Materials Diversity- Conducting polymers, ionic and fast ionic conductivity,

Unit 16: Overview: Molecular Electronics, Optical & Magnetic Properties- Introduction to molecular electronics, Optical properties, Magnetic materials and their properties, Chemical properties

Text and Reference Books:

1. Materials Science and Engineering: An Introduction" by William D. Callister Jr. David G. Rethwisch.
2. Principles of Materials Science and Engineering" by William F. Smith Javad Hashemi.
3. Phase Transformations in Metals Alloys" by David A. Porter, Kenneth E. Easterling, and Mohamed Sherif.

Course Code: PHM-7212 **Credit: 4**
Course: Advanced Electronics

Course Objectives: To understand Gain foundational knowledge of amplitude and frequency modulation techniques, including their principles, limitations, and comparison. Understand the concepts and operations of television systems, digital communication, and microprocessors, including their architectures, programming models, and instruction sets.

Course Outcomes: At the end of the Electronics, student will be able to

COs No.	Course Outcomes (COs)
1.	**Exploring** Modulation Techniques
2.	**Understand** the working of Television
3.	**Summarize** Digital Communication Fundamentals and Techniques
4.	**Explain** Microprocessors: Architecture, Memory, and Programming

Block I: Exploring Modulation Techniques: AM, FM, and Beyond

Unit 1: Comprehensive Guide to Amplitude and Frequency Modulation Techniques- Amplitude and Frequency Modulation: Introduction, Amplitude Modulation, Spectrum of the modulated signal, Square law Modulator, Balanced Modulator, DSBSC, SSB and vestigial sideband modulation

Unit 2: Exploring AM Limitations and FM Signal Processing-Limitations of Amplitude Modulation, Analysis and frequency Spectrum, Generation and Detection of FM

Unit 3: AM vs. FM: Enhancements and Modulation Techniques- Comparison of AM and FM, Pre-emphasis and De-emphasis, Reactance Modulator. Capture Effect. Varactor Modulator.

Unit 4: FM Receivers and Detection Methods -FM Receiver, Foster Seely Discriminator. Ratio Detector

Block II: Television

Unit 5: Advancements in Electronic Image Capture and Scanning Techniques-Electronic image capture, Conventional Camera tubes & Modern Devices, Interlaced Scanning, Synchronization, Resolution.

Unit 6: Composite Video Signal and Vestigial Sideband Modulation Composite Video Signal. Vestigial Sideband Modulation.

Unit 7: Transmitter/Receiver Systems in B/W and Color TV: Components and Circuits -Transmitter/Receiver- B/W TV & Colour TV, Receiver Block Diagram. Sync. Separator. Vertical and Horizontal deflection circuits

Unit 8: Modern Display Technologies: Flat Panels and Smart Windows- Modern Display Technology: Flat Panel Displays (LCD, Plasmas etc.) and their addressing techniques. Smart Windows.

Block III: Digital Communication Fundamentals and Techniques

Unit 9: Digital Communication: Fundamentals and Benefits- Digital Communication: Basics of Digital Communications, Advantages of Digital Communication, Typical communication system.

Unit 10: Mathematical Foundations of Digital Communication-Mathematical Theory of Digital Communication: Classification of signals, unit impulse function, Sampling property of the unit impulse function, unit step function, Analysis and transmission of signals, expression of an aperiodic signal as a continuous sum of exponential functions, unit gate function, Fourier spectrum of the gate pulse, The 'mathematics' of modulation, Impulse train and its Fourier response, ideal and practical filters, Sampling Theorem, Nyquist rate and Nyquist interval.

Unit 11: Signal Reconstruction and Pulse Code Modulation (PCM)- Signal reconstruction: The Interpolation Formula, The Interpolation Function, Practical difficulties in signal reconstruction, Aliasing, Pulse Code Modulation, Basic stages of Generation and Reception of PCM, Quantizing, Compandor, Encoder.

Unit 12: Advanced Digital Data Transmission Techniques-Differential Pulse Code Modulation, Delta Modulation, Principles of Digital data transmission: Amplitude Shift Keying, Frequency Shift Keying. Phase Shift Keying. Differential Phase Shift Keying. Digital Multiplexing.

Block IV: Microprocessors: Architecture, Memory, and Programming

Unit 13: Microprocessor Memories and Addressing Techniques- Microprocessors-Architecture and Programming: Volatile and non-volatile memories, magnetic memories, DRO, NDRO system Semiconductor memories RAM, ROM, EPROM Addressing of memories: MAR, MAD & NDR hexadecimal addressing,

Unit 14: Digital Circuitry Essentials and Arithmetic Units-Buffer register, Shift register, Ring Counter shift counter, Controlled shift registers, Tristage switches Tristate register Reduction of Connecting wires, Bus organization Arithmatic unit, Binary addition Half and Full subtractor.

Unit 15: Intel Microprocessors: Evolution and Programming Essentials- Intel Microprocessors: Historical Perspective. Organization of Microprocessor based system. 8085: Programming model. Registers, Accumulator, Flags, Program Counter, Stack Pointer. 8085 Instruction Set: Data Transfer Operation, Arithmetic Operations, Logic Operations, Branching Operations, One, Two- and Three-Byte Instructions, Opcode Format.

Unit 16: Understanding the Intel 8086: Organization and Instructions- Microprocessor 8086, its organization & instructions.

Text and Reference Books:

1. John G. Proakis and Masoud Salehi.: Communication Systems Engineering.
2. K. Blair Benson, Television Engineering Handbook.
3. John G. Proakis: Digital Communications.
4. Ramesh S. Gaonkar: Microprocessor Architecture, Programming, and Applications with the 8085

Course Code: PHM-7213 **Credit: 4**
Course: Astrophysics

Course Objectives: To understand Tools of Astronomy and celestial mechanics, to introduce basic astronomical principles in the study of the planets, stars and galaxies.
Course Outcomes: At the end of the course, students will be able to

COs No.	Course Outcomes (COs)
1.	Exploring the expanse of the universe and the nature of the planets, stars and galaxies
2.	Understand how the astronomical observations are done for these celestial objects
3.	Apply mathematical tools and physics laws to understand the nature of planets, stars and galaxies
4.	Explain the results of this analyses and interpret the nature of the Solar system, variety of stars and galaxies.

Block I: Tools and Techniques of Modern Astronomy

Unit 1: Exploring the Solar System: Sun, Planets, and Formation-The Sun: Characteristics, Structure, and Dynamics, Physical Processes in the Solar System; Terrestrial Planets: Formation, Composition, and Features; Giant Planets: Characteristics, Moons, and Rings, Formation of Planetary Systems

Unit 2: Stellar Characteristics & Extrasolar Planets- Brightness of Stars: Magnitudes and Flux; Color-Magnitude Diagrams (HR Diagrams): Interpretation and Significance; Luminosities of Stars: Measurement and Comparison, Angular Radii of Stars and Their Determination; Effective Temperatures of Stars: Calculation and Application, Masses and Radii of Stars: Binary Systems and Their Analysis, Search for Extrasolar Planets and Their Detection Methods

Unit 3: Astronomical Observational Techniques- Tools of Astronomy - Observational Techniques: Telescopes: Basic Optics and Principles; Optical Telescopes: Types, Designs, and Applications; Radio Telescopes: Functionality and Usage in Astronomy; Infrared, Ultraviolet, X-ray, and Gamma-Ray Astronomy: Detectors and Observatories; Overview of Different Detection Methods and Instruments for Each Wavelength Region

Unit 4: Advanced Detection Techniques in Astronomy- Advanced Detection Techniques in Astronomy- Gravitational Wave Detectors: Principles and Operation; Neutrino Detectors: Detection Mechanisms and Applications in Astrophysics; All-Sky Surveys: Purpose, Methodologies, and Impact on Astronomical Research; Virtual Observatories: Utilization and Benefits for Astronomical Studies

Block II: The Solar System and Basic Stellar Parameters

Unit 5: Our Galaxy: Structure & Size- Our Galaxy: Structure and Dynamics- The Shape and Size of Our Galaxy Interstellar Extinction and Reddening, Galactic Coordinates and Coordinate Systems, Galactic Rotation and Dynamics, Stellar Population in the Milky Way,

Unit: 6 Interstellar Medium & Galactic Environment- Interstellar Medium: Composition and Properties, Galactic Magnetic Field and Cosmic Rays,

Unit 7: Extragalactic Astronomy Overview- Extragalactic Astronomy- Normal Galaxies: Morphological Classification and Kinematics; Expansion of the Universe: Hubble's Law and Cosmological Redshift;

Unit 8: Active Galaxies, Galaxy Clusters & Large-Scale Structure- Active Galaxies: AGNs, Quasars, and Seyfert Galaxies; Clusters of Galaxies: Structures and Dynamics; Large-Scale; Distribution of Galaxies: Galaxy Filaments and Voids; Gamma-Ray Bursts: Origins and Phenomenology

Block III: Unveiling Stellar Mysteries: Spectral Classification and Dynamic Phenomena

Unit 9: Stellar Spectra & Classification- Stellar Spectra and Classification- Spectral Classification of Stars; Understanding Stellar Spectra;

Unit 10: Population II Stars & Peculiar Spectra - Population II Stars: Characteristics and Significance; Stars with Peculiar Spectra

Unit 11: Stellar Dynamics & Phenomena- Stellar Dynamics and Phenomena- Stellar Rotation and Its Effects; Stellar Magnetic; Fields: Formation and Influence; Pulsating Stars: Mechanisms and Types;

Unit 12: Explosive Stars & Interstellar Absorption- Explosive Stars: Supernovae and Their Impact; Interstellar Absorption: Causes and Effects

Block IV: Journey Through the Cosmos: Exploring Our Galaxy and Beyond

Unit 13: Our Galaxy and Interstellar Matter- Our Galaxy and Interstellar Matter- The Shape and Size of Our Galaxy; Interstellar Extinction and Reddening; Galactic Coordinates and Coordinate Systems;

Unit 14: Galactic Dynamics & Stellar Population- Galactic Rotation and Dynamics; Stellar Population in the Milky Way; Interstellar Medium: Composition and Properties; The Galactic Magnetic Field and Cosmic Rays

Unit 15: Extragalactic Astronomy- Extragalactic Astronomy- Normal Galaxies: Morphological Classification and Kinematics; Expansion of the Universe: Hubble's Law and Cosmological Redshift;

Unit 16: Active Galaxies, Clusters, & Large-Scale Structure- Active Galaxies: AGNs, Quasars, and Seyfert Galaxies; Clusters of Galaxies: Structures and Dynamics; Large-Scale Distribution of Galaxies: Galaxy Filaments and Voids; Gamma-Ray Bursts: Origins and Phenomenology

Text and Reference Books:

1. Introduction to Stellar Astrophysics, Volume 1, Basic stellar observations and data, ByErika
2. Bohm-Vitense, Cambridge University Press
3. An Introduction to Modern Astrophysics, Second Edition, By Carroll B.W., Ostlie D.A., Pearson Addison Wesley.
4. "Astrophysics for Physicists" by Arnab Rai Choudhuri, Cambridge University Press,2010
5. Galactic Astronomy: Structure and Kinematics by Mihalas & Binney, W.H.Freeman &Co Ltd; 2nd Revised edition 1981.

Course Code: PHM-7214 **Credit: 4**
Course: Physics of Nanomaterials

Course Objectives: To comprehend the fundamental theory and influence of dimensionality on the properties of nanomaterials with their prospects in advanced devices. This course will also familiarize the student not only with existing techniques and underlying principles/concepts involved in the fabrication of nanomaterials but also to make them well versed in various characterization techniques.

Course Outcomes: At the end of the course, students will be able to

COs No.	Course Outcomes (COs)
1.	**Tell** familiarize about the principles and background to nanotechnology**.**
2.	**Explain** optimize suitable process to synthesize nanostructures of desired size, shape and surface properties.
3.	**Demonstrate** Perceive the basic theories, properties, characterization techniques.
4.	**Tell** applications of nanomaterials.

Block I: Introduction to Nanomaterials and properties

Unit 1: Nanomaterials: A Historical Overview- Brief history and overview of nanomaterials;

Unit 2: Nanomaterial Synthesis: Top-down vs. Bottom-up Approaches Synthesis techniques: Top down and Bottom-up approaches (High energy ball milling, Sol-gel process, Chemical bath deposition,

Unit 3: Advanced Nanomaterial Fabrication Techniques-Plasma Arc discharge, Chemical vapor deposition, Sputtering, Pulsed Laser deposition, Molecular beam epitaxy).

Unit 4: Multifaceted Properties of Nanomaterials- Mechanical, Thermal, Electrical, Magnetic and Optical properties.

Block II: Characterization tools and Carbon-based Nanomaterials

Unit 5: Exploring SPM and Electron Microscopy -Scanning Probe Microscopy (SPM) and Electron Microscopy

Unit 6: Carbon Bonding and Fullerene Structures -Nature of carbon bond, Carbon structures, small carbon clusters; Fullerenes:

Unit 7: Exploring Fullerene Materials, Graphene, and Carbon Nanotubes- Synthesis and Properties, various forms of fullerene materials; Graphene: Synthesis and Applications; Carbon nanotubes: classification,

Unit 8: Diving into Nano Diamond: Synthesis, Properties, and Applications -synthesis, properties (Electrical, Vibrational & Mechanical) and applications, Nano diamond.

Block III: Quantum Nanostructures and Nanostructured Ferromagnetism

Unit 9: Exploring Quantum Nanostructures: Fabrication and Properties- Quantum wells, wires and dots, Fabrication of Quantum Nanostructures, Size effect, Conduction electron and dimensionality,

Unit 10: Fermi Gas Dynamics and Partial Confinement -Fermi gas and density of states. Partial confinement,

Unit 11: Single Electron Devices: Theory and Fabrication- Single electron transistor (SET), Single electron capacitor, Quantum effects on SET, Fabrication of SET,

Unit 12: Bulk Nanostructuring and Magnetic Dynamics- Bulk Nano structuring and Magnetic properties, Dynamics of Nanomagnets, Nanopore containment ofmagnetic particles.

Block IV: Applications

Unit 13: Exploring Micromechanical Systems and Robotic Innovations -Micromechanical systems - Robots - Ageless materials

Unit 14: Nano-Electronics and Optoelectronics: Advancements- Nanomechanics - Nano electronics - Optoelectronic devices

Unit 15: Illuminating LED Applications and Colorants - LED - Applications - Colourants and pigments -

Unit 16: Nano-Biotechnology: DNA Chips and Drug Delivery- Nano biotechnology - DNA chips - DNA array devices - Drag delivery systems.

Text and Reference Books:

1. Poole Jr., C.P. & Owens, F.J. Introduction to Nanotechnology (Wiley IEdnteerscience)
2. lstein A.S., and Cammarata, R.C. Nanomaterials: Synthesis, Properties and Applications Edn. (Institute ofPhysics Fujita, F.E. Physics of New Materials, Second Edn. (Springer-Verlag)
3. Zhen Guo, Li Tan Fundamentals and Applications of nanomaterials
4. Gaber L. H. Harry F. Tibbals, Joydeep Dutta and John J. Moore Introduction to Nanoscience andNanotechnology (CRC Press)
5. K.K. Chattopadhyay & A.N. Banerjee Introduction to Nanoscience & Nanotechnology (PHI Learning Pvt.Michael F. Ashby, Paulo J. Ferreira & Daniel L. Schodek
6. John Smith, Nanotechnology: Applications and Advances, Wiley.
7. Sulabha K. Kulkarni, Nanotechnology: Principles and Practices.

Course Name: Physics Lab-IV **Credit: 4**
Course Code: PHM-7251

Course Objectives:
The objective of this laboratory course is to provide practical exposure to 8085 and 8086 microprocessor programming and interfacing. Students will develop assembly language programming (ALP) skills for performing arithmetic operations, data manipulation, and logical operations. The course includes memory handling techniques, such as data transfer and block shifting, along with hardware interfacing of peripheral devices (8255 PPI, ADC, and DAC). Through hands-on experiments, students will learn how microprocessors interact with external components, enabling them to apply these concepts in embedded systems and digital computing applications.

Course Outcomes: After going through this lab course, student will be able to

COs No.	Course Outcomes (COs)
1.	Develop and execute assembly language programs (ALP) for arithmetic and logical operations using the 8085 and 8086 microprocessors.
2.	Implement data transfer and manipulation techniques, including block movement and bitwise operations.
3.	Interface peripheral devices such as the 8255 PPI, ADC, and DAC with microprocessors for real-time applications.
4.	Generate and analyze waveforms using DAC and observe their behavior on a CRO.
5	Apply microprocessor programming concepts to solve real-world computing and control problems in embedded systems and automation.

List of Experiments:

1. To study of 8085 and 8086 Microprocessor training kit.
2. To perform addition of two 8-bit numbers; sum 8 and 16bit.
3. To perform addition and subtraction of two 8-bit numbers; sum16 bit.
4. To perform the decimal addition of two8 bit number, sum 16-bit.
5. To find the largest number from a given number of strings.
6. To perform multiplication of 8-bit data; product should be 16bit.
7. To move a block of data from one memory location to another memory location.
8. To write an assembly language program to shift 8-bit no. (left shift).
9. To interface 8255 P Pi to microprocessor and set port A as input port inMode0.
10. To interface ADC card to microprocessor& generate the digital output.
11. To interface DAC card to microprocessor& generate a square wave on CRO.

F. Faculty and Support Staff

The University has identified the requisite faculty and support staff as mandated by UGC and formally they shall be allocated the required positions from amongst the existing faculty exclusively for ODL mode or fresh appointments as required so, shall be initiated for which Letter of Intent have been issued to the prospective faculty and staff. The course material prepared by thisuniversity will be on par with any open university/Distance education centre in the country.

List of Faculty associated with MSc- Physics program is as follows: -

S.No.	Name of Faculty	Designation	Nature of Appointment	Qualification	Subject
1	Dr. Yatendra Pal Singh	Professor	Full Time	Ph.D	Physics
2	Dr. Pooja Mishra	Assistant Professor	Full Time	Ph.D	Physics

G. Delivery Mechanism

The ODL of MU follows a modern ICT (Information & Communication Technology) enabled approach for instruction. The methodology of instruction in ODL of MU is different from that of the conventional/regular programs. Our ODL system is more learner-oriented and the learner is an active participant in the teaching-learning process. ODL of MU academic delivery system comprises:

a) Print Material

The printed material of the programme supplied to the students will be unit wise for every course.

b) Counselling Sessions

Normally, counselling sessions are held as per a schedule drawn beforehand by the Subject Coordinator. There will be 6 counselling/ contact classes for 4 credit courses will be held on the campus on Saturday and on Sunday of 2-hour duration for each course in face-to-face mode (In case of 2 credit course contact hours are required 6 hours and in case of 6 credit course contact hours required 18 hours). Contact classes will be held in the campus on Saturdays and on Sundays.

c) Medium of Instruction

Medium of Course Instruction: English
Medium of Examination: English

H. Student Support Systems

Universities Study Centres or Learner Support Centre shall be headed by a coordinator, not below the rank of Assistant professor and shall be augmented with academic and non-academic staff depending on the learner.

The university has made appropriate arrangements for various support services including counselling schedule and resource-oriented services evaluation methods and dates both online and offline modes for easy and smooth services to the students of distance mode.

At present the university have only one study centre on the campus. The institution is not promoting any study centres outside the campus. All student support services will be provided to the student through a single window method/mode onsite and online.

I. Procedure for Admissions, Curriculum, Transaction and Evaluation

Admission to the M.Sc. (Physics) Programme will be done on the basis of screening of candidate's eligibility on first come first serve basis. The University will follow the reservation policy as per norms of the Government. Admission shall not be a right to the students and MU, CDOE shall retain the right to cancel any admission at any point of time if any irregularity is found in theadmission process, eligibility etc.

Maximum Duration

a) The maximum duration of the M.Sc. (Physics) Programme is four years. Thereafter, studentsseeking completion of the left-over course(s) will be required to seek fresh admission.

b) The student can complete his programme within a period of 4 years failing which he/she shall seekfresh admission to complete the programme.

Eligibility

Graduate from a recognised University with Physics as a main subject is eligible for admission into M.Sc.(Physics) programme.

Fee Structure

Name of the Program	Degree	Duration	Year	Tuition Fee/Year	Exam Fee/Year	Total (in Rs.)
Master of Science (Physics)	PG	2 to 4 Years	1	15000	2000	17000
			2	13500	2000	15500
					Total	32500

Activity Schedule

S. No.	Name of the Activity	Tentative months schedule (specify months) during year			
		From	To	From	To
1	Admission	Jul	Sep	Jan	Mar
2	Assignment submission (if any)	Sep	Oct	Mar	Apr
3	Evaluation of Assignment	Oct	Nov	Apr	May
4	Examination	Dec		Jun	
5	Declaration of Result	Jan		Jul	
6	Re-registration	Jul		Jan	
7	Distribution of SLM	Jul	Sep	Jan	Mar
8	Contact Programmes (counseling, Practicals.etc.)	Sep	Nov	Mar	May

J. Credit System

MU, CDOE proposes to follow the 'Credit System' for most of its programs. Each credit amounts to 30 hours of study comprising all learning activities. Thus, an 8-credit course requires 240 hours,

6 credit course requires 180 hours, 4 credit course requires 120 hours and 2 credit course requires 60 hours of study. This helps the student to understand the academic effort to complete a course. Completion of an academic programme requires successful clearing of both, the assignments and the term-end examination of each course in a programme.

Duration of Programme	Credits	Name of Programme	Level of Programme
2 Years.	80	M.Sc. (Physics)	Master's Degree

K. Assignments

Distance Education learners have to depend much on self study. In order to ascertain the writing skill and level of comprehension of the learner, assignment work is compulsory for all learners. Each assignment shall consist of a number of questions, case studies and practical related tasks. The Assignment Question Papers will be uploaded to the website within a scheduled time and the learners shall be required to respond them within a specified period of time. The response of the learner is examined by a faculty member.

Evaluation**:** The evaluation system of the programme is based on two components:

a) Continuous Evaluation in the form of assignments (weightage 30%): This Component carries a weightage of 30%. There will be at least one graded assignment and test per course. These assignments are to be submitted to the Co-Ordinator of the CDOE/Study Centre to which the student is assigned or attached with.

b) Term-end examination (weightage 70%): This will be held twice every year in the months of June and December. The students are at liberty to appear in any of the examinations conducted by the University during the year. A student will be allowed to appear in the Term-End Examination only after she/he has registered for that course and submitted the assignment. For appearing in the Examination, every student has to submit an Examination form through online (www.mangalayatan.in)/ or offline before the due dates as given in the schedule of operations. If a student misses any term-end examination of a course for any reason, s/he may appear for any of them or all the courses subject to the maximum of 8 courses in the subsequent term-end examinations. This facility will be available until a student secures the minimum pass grade in the courses but up to a maximum period of four semesters, since the date of registration of the course is valid for four semesters. Beyond this period s/he may continue for another four semesters by getting Re-registration by paying fee again. In that case, the score of qualified assignments and/or term-end examination will be retained and the student will be required to complete the left out requirements of such re-registered courses. Minimum requirement for passing a course will be 40% marks.

c) Laboratory Support and Library Resources

The library of Mangalayatan University aims to empower the teaching mission and intellectual culture of the community through availability through an organized collection of information as well as instruction in its access, relevance and evaluation.

The University Library enriches advance learning and discovery by providing access to a broad array of resources for education, research and creative work to ensure the rich interchange of ideas in the pursuit of knowledge.

The Directorate of Distance Education of Mangalayatan University has initiated the process of setting up a dedicated Library for ODL program and acquiring printed books and e-books for this purpose. The required International and National subject journals are also provided. We have a full functioning community radio service onboard (90.4 FM). We already have annual journal subscriptions and the capacity can be enlarged at later stages as the University lines up with more online journals.

The collection of the library is rich and diverse especially in terms of the breadth and depth of coverage. Collection encompasses subjects in Management, Commerce, Information Technology, Computer Applications, and other allied areas. This collection further includes Books, Research Journals, Project Reports/Dissertations and online Journals.

The University has well equipped Computer Laboratories, Lecture Capturing Systems, Audio Video facilities, ICT enabled class rooms, Wi-Fi facilities etc.

L. Cost estimate of the programme and the provisions

Initial expenses have been done by the University in terms of provision of infrastructure, manpower, printing of Self Study Material etc. The University intends to allocate expenses out of the total fee collection as per following details:

a) SLM Development and Distribution	:	20%
b) Postal and ICT Expenses	:	10%
c) Salary and other Administrative expenses	:	60%
d) Future Research development reserve	:	10%

Once programmes are operational, the programme budget from fee receipts will be planned as per the guidelines of University Grants Commission.

M. Quality Assurance

The University has established the Centre for Internal Quality Assurance (CIQA) in the University campus. The CIQA will monitor and maintain the quality of the ODL programmes. It has the following objectives in making the compliances of quality implementations.

Objectives

The objective of Centre for Internal Quality Assurance is to develop and put in place a comprehensive and dynamic internal quality assurance system to ensure that programmes of higher education in the Open and Distance Learning mode and Online mode being implemented by the Higher Educational Institution are of acceptable quality and further improved on continuous basis.

Functions of CIQA

The functions of Centre for Internal Quality Assurance would be following:

1) To maintain quality in the services provided to the learners.
2) To undertake self-evaluative and reflective exercises for continual quality improvement in all the systems and processes of the Higher Educational Institution.
3) To contribute in the identification of the key areas in which Higher Educational Institution should maintain quality.
4) To devise mechanism to ensure that the quality of Open and Distance Learning programmes and Online programmes matches with the quality of relevant programmes in conventional mode.
5) To devise mechanisms for interaction with and obtaining feedback from all stake holders namely, learners, teachers, staff, parents, society, employers, and Government for quality improvement.
6) To suggest measures to the authorities of Higher Educational Institution for qualitative improvement.
7) To facilitate the implementation of its recommendations through periodic reviews.
8) To organize workshops/seminars/symposium on quality related themes, ensure participation of all stakeholders, and disseminate the reports of such activities among all the stakeholders in Higher Educational Institution.
9) To develop and collate best practices in all areas leading to quality enhancement in services to the learners and disseminate the same all concerned in Higher Educational Institution.

10) To collect, collate and disseminate accurate, complete and reliable statistics about the quality of the programme(s).
11) To ensure that Programme Project Report for each programme is according to the norms and guidelines prescribed by the Commission and wherever necessary by the appropriate regulatory authority having control over the programme;
12) To put in place a mechanism to ensure the proper implementation of Programme Project Reports.
13) To maintain a record of Annual Plans and Annual Reports of Higher Educational Institution, review them periodically and generate actionable reports.
14) To provide inputs to the Higher Educational Institution for restructuring of programmes in order to make them relevant to the job market.
15) To facilitate system-based research on ways of creating learner centric environment and to bring about qualitative change in the entire system.
16) To act as a nodal coordinating unit for seeking assessment and accreditation from a designated body for accreditation such as NAAC etc.
17) To adopt measures to ensure internalization and institutionalization of quality enhancement practices through periodic accreditation and audit.
18) To coordinate between Higher Educational Institution and the Commission for various qualities related initiatives or guidelines.
19) To obtain information from other Higher Educational Institutions on various quality benchmarks or parameters and best practices.
20) To record activities undertaken on quality assurance in the form of an annual report of Centre for Internal Quality Assurance.
21) It will be mandatory for Centre for Internal Quality Assurance to submit Annual Reports to the Statutory Authorities or Bodies of the Higher Educational Institution about its activities at the end of each academic session. A copy of report in the format as specified by the Commission duly approved by the statutory authorities of the Higher Educational Institution shall be submitted annually to the Commission.

After enrolling in M.Sc. (Physics) programme of Mangalayatan University in ODL mode, student will exhibit knowledge, skill and general competence with scientific aptitude and innovation. After completion of M.Sc. (Physics) programme, student will pursue further studies in physics for roles in academia, research, industry, finance, technology and government.