

**Mahatma Education Society's**  
**Pillai HOC College of Arts, Science & Commerce (Autonomous)**  
**Rasayani**

**Affiliated to University of Mumbai**  
**NAAC Accredited with "A+" Grade in cycle II**  
**ISO 9001:2015 Certified**



## **SYLLABUS**

# **Master of Science (M.Sc.) in Physics**

**F.Y. M. Sc. Physics**

**As per National Education Policy 2020**

**Academic Year 2026-27**



Mahatma Education Society's

College Code: 870

**PILLAI HOC COLLEGE OF ARTS, SCIENCE & COMMERCE**

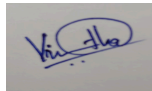


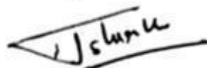
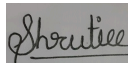

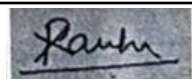

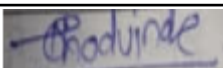
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(NAAC Accredited 'A+' Grade, CGPA - 3.26 in Cycle 2 & ISO 9001:2015 Certified)

Affiliated to the University of Mumbai, Approved by Government of Maharashtra

(AUTONOMOUS COLLEGE)

Sr.No.	Name	Designation	Signature
1	Dr. Vineetha P	Head of the Department of M.Sc. in Physics	
2	Dr. Rinkoo Shantnu	Principal	
3	Mr. Binit Kumar	Vice -Principal	
4	Ms. Juilee Shridhar Shirke	Member	
5	Ms. Shruti Hogale	Member	
9	Dr. Dinesh Navale	Vice Chancellor Nominee	
10	Ms. Komal Kamble	Subject Expert	
11	Dr. Anand K Singh	Subject Expert	Dr. Anand K Singh
12	Dr. Bapu Gawade	Industry Representative	
13	Mr. Rushikesh Ghodvinde	Alumni Representative	

## **Introduction**

The **M.Sc. Physics programme** is a two-year postgraduate degree that provides an advanced foundation in physics by seamlessly integrating theoretical concepts with practical applications. The course provides students with a strong foundation in classical and modern physics while cultivating analytical thinking, experimental skills, and research competency. Through well-structured laboratory sessions, hands-on experiments, simulations, and project work, students gain practical exposure to contemporary scientific tools and technologies. The programme aims to develop critical problem-solving abilities and prepare students for careers in research institutions, academia, industry, scientific organizations, and emerging technology sectors. It also equips learners with the essential skills required to pursue higher studies such as M.Phil. or Ph.D.

## Programme Outcomes (POs)

PO. No.	PO Title	POs in brief
PO1	Fundamental Knowledge Acquisition	Graduates will demonstrate a comprehensive and foundational knowledge of their chosen discipline along with an awareness of interdisciplinary connections.
PO2	Critical Thinking and Analytical Reasoning	Graduates will be able to analyse complex problems, synthesize data from multiple sources (qualitative and quantitative), and employ logical reasoning to formulate well-supported conclusions and arguments.
PO3	Effective Communication	Graduates will exhibit proficiency in both written and oral communication, articulating ideas clearly, persuasively, and ethically to diverse audiences
PO4	Problem Solving	Graduates will possess the ability to identify, formulate, and design solutions for real-world problems in their professional or social contexts, applying relevant theoretical knowledge and practical skills.
PO5	Information and Digital Literacy	Graduates will demonstrate the capability to locate, evaluate, and effectively use information from various sources, and utilize modern tools and Information and Communication Technology (ICT) for professional and academic tasks.
PO6	Research Skills and Scientific Temperament	Graduates will develop a sense of inquiry and research methodology, including the ability to design experiments (where applicable), collect and analyse data, and interpret results while maintaining scientific rigor and intellectual honesty.
PO7	Ethical Reasoning and Professional Integrity	Graduates will recognize ethical dilemmas, commit to professional and academic ethics, and demonstrate an understanding of moral and social responsibilities in their personal and professional conduct.
PO8	Employability and Professional Skills	Graduates will acquire the necessary job-ready skills, managerial competencies, and professional values to secure gainful employment or pursue advanced education in their respective fields.
PO9	Environmental and Sustainability Consciousness	Graduates will understand the importance of environmental conservation and sustainable development, displaying responsibility toward ecological challenges and advocating for healthy environmental practices.
PO10	Life-Long Learning	Graduates will develop the capacity for independent and self-directed learning to continuously upgrade their knowledge and skills, enabling them to adapt to rapid technological and societal changes.
PO11	Civic and Social Responsibility	Graduates will act as responsible citizens with an informed awareness of constitutional values, engaging proactively in community development and addressing social needs.
PO12	Empathy and Social Intelligence	Graduates will be able to cultivate and demonstrate affective, interpersonal, social and emotional intelligence.

## Programme Specific Outcomes (PSOs)

PSOs. No.	PSO Title	PSOs in brief
<b>PSO1</b>	Advanced Scientific Understanding and Analytical Skills	Graduates will master Acquire advanced theoretical and experimental knowledge in major areas of physics.
<b>PSO2</b>	Experimental and Laboratory Skills	Graduates will be able to Design and conduct scientific experiments, analyze experimental data, and apply mathematical and computational methods to solve complex physical problems.
<b>PSO3</b>	Application of Physics in Technology and Interdisciplinary Fields	Graduates will be able to apply principles of physics to solve real-world problems in areas such as materials science, electronics, energy, and emerging technologies.
<b>PSO4</b>	Scientific Communication and Professional Development	Graduates will be able to effectively communicate scientific ideas through research reports, presentations, and publications, and will be prepared for careers in research, academia, industry, and related fields.

## Evaluation Pattern

Marking Code	Marking Scheme
<b>A</b>	50 Marks Semester End Exam, 50 Marks Continuous Assessment (distributed within 20 Marks Class Test, 25 Marks Presentation , 05 Marks Class Participation)
<b>B</b>	50 Marks Practical Examination (distributed within 30 Marks Practical, 10 Marks Journal, 10 Marks Viva)
<b>C</b>	50 External Evaluation (distributed within 20 Marks Completing Of Hours, 20 Marks Quality/Performance and 10 Marks Punctuality/Regularity, 50 Marks Internal Evaluation (distributed within 15 Marks Weekly Reporting, 20 Marks Written report and 15 Viva-Voce/ Presentation)
<b>D</b>	50 External Evaluation (distributed within 10 Marks Presentation, 25 Marks Dissertation and 15 Marks Viva, 50 Marks Internal Evaluation (distributed within 10 Marks Attendance, 25 Marks Literature Survey and 15 Marks Scheme/Outline of Project/Methodology)

## Course Structure

Semester I							
Course Code	Course Type	Course Title	Theory/ Practical	Marks	Credits	Lecture s/ Week	Evaluation Pattern
<b>HPSPH101</b>	Major	Classical Mechanics	Theory	100	4	4	A
<b>HPSPH102</b>	Major	Quantum Mechanics	Theory	100	4	4	A
<b>HPSPH103</b>	Major	Mathematical Physics	Theory	100	4	4	A
<b>HPSPH104</b>	Elective I	Fundamentals of Material Science	Theory	100	4	4	A
<b>HPSPH105</b>	Major	Research Methodology and Patent	Theory	100	4	4	A
<b>HPSPH106P</b>	Major - Practical	Practical I	Practical	50	2	4	B
Total				550	22		**

# **SEMESTER I**

<b>BOS</b>	<b>Natural and Physical Sciences</b>		
<b>Course</b>	<b>Classical Mechanics</b>		
<b>Course Code</b>	<b>HPSPH101</b>	<b>Credits</b>	<b>6.0</b>
<b>Semester</b>	<b>I</b>	<b>Level</b>	<b>6.0</b>
<b>Type</b>	<b>Major: Mandatory</b>	<b>No. of Teaching hours</b>	<b>60</b>
<b>Evaluation/ Assessment</b>	<b>Total Marks</b>	<b>Semester End</b>	<b>Continuous</b>
	<b>100</b>	<b>50</b>	<b>50</b>

<b>Learning Objectives</b>	
<b>1</b>	To master the foundations of classical mechanics
<b>2</b>	To apply Variational Principles in Mechanics
<b>3</b>	To Analyze Central Force and Oscillatory Systems
<b>4</b>	To utilize Canonical Transformations and Poisson Brackets

<b>Course Outcomes</b>	
<b>CO1</b>	Understand the principle of virtual work and the concepts of least action, the formalisms of Lagrange and Hamiltonian.
<b>CO2</b>	Describe the motion of a system in Lagrangian and Hamiltonian formalisms
<b>CO3</b>	Understand the features of motion under central force, periodic motion, small oscillations as they appear in other areas of Physics
<b>CO4</b>	Use the Poisson brackets in Hamiltonian dynamics and solve related problems.
<b>CO5</b>	Understand the linkages of the techniques of Classical Mechanics in solving problems in areas of Statistical Mechanics (Phase space), Molecular Physics.

#### Modules At Glance

<b>Module No.</b>	<b>Content</b>	<b>No. of Hours</b>	<b>Mapping with CO</b>
<b>1</b>	Unit 1	15	CO1, CO2
<b>2</b>	Unit 2	15	CO3
<b>3</b>	Unit 3	15	CO3
<b>4</b>	Unit 4	15	CO4,CO5

### Syllabus

Module No.	Content	No. of Lectures
1	Review of Newton's laws, Mechanics of a particle, Mechanics of a system of particles, Constraints, D'Alembert's principle and Lagrange's equations, Velocity-dependent potentials and the dissipation function, Simple applications of the Lagrangian formulation. Hamilton's principle, Calculus of variations, Derivation of Lagrange's equations from Hamilton's principle, Lagrange Multipliers and constraint extremization Problems, Extension of Hamilton's principle to nonholonomic systems, Advantages of a variational principle formulation (HG)	15
2	Conservation theorems and symmetry properties, Energy Function and the conservation of energy. The Two-Body Central Force Problem: Reduction to the equivalent one body problem, the equations of motion and first integrals, the equivalent one-dimensional problem and classification of orbits, the virial theorem, the differential equation for the orbit and integrable power-law potentials, The Kepler problem: Inverse square law of force, the motion in time in the Kepler problem, Scattering in a central force field, Transformation of the scattering problem to laboratory coordinates. ((HG)	15
3	Small Oscillations: Formulation of the problem, the eigenvalue equation and the principal axis transformation, Frequencies of free vibration and normal coordinates, Forced and damped oscillations, Resonance and beats. Legendre transformations and the Hamilton equations of motion, Cyclic coordinates and conservation theorems, Derivation of Hamilton's equations from a variational principle. (HG)	15
4	Canonical Transformations, Examples of canonical transformations, The symplectic approach to canonical transformations, Poisson brackets and other canonical invariants, Equations of motion infinitesimal canonical transformations and conservation theorems in the Poisson bracket formulation, The angular momentum, Poisson bracket relations. (HG)	15
<b>Case Study Scenario</b>		
M1	Based on the given situation, answer the following questions: The owner of a high-voltage transmission line wants to estimate magnetic exposure for people working or living near the line. <ul style="list-style-type: none"> <li>● Using the Biot–Savart law (or Ampère's law for a long straight conductor), calculate the magnetic flux density at a point 2.0 m away from a long straight transmission conductor carrying a current of 500 A.</li> <li>● Discuss the safety implications for nearby human exposure.</li> </ul>	
M2	Based on the given situation, answer the following questions: A research team is analyzing electric-field exposure around compact high-voltage equipment. <ul style="list-style-type: none"> <li>● A point charge of <math>q = +3.0 \mu\text{C}</math> is fixed at the origin, representing a simplified model of a highly charged component inside the device. The team wants to determine the electric-field strength experienced by a technician standing 0.50 m away from the component.</li> </ul>	

**References Books:**

1. Classical Mechanics, H. Goldstein, Poole and Safco, 3 rd Edition, Narosa Publication (2001) (HG).
2. Classical Mechanics, N. C. Rana and P. S. Joag. Tata McGraw Hill Publication.
3. Mechanics, Landau and Lifshitz, Butterworth, Heinemann.
4. Theory and Problems of Lagrangian Dynamics, Schaum Series, McGraw (1967).
5. Classical Mechanics P. V. Panat, Narosa Publication.

**Semester End Evaluation (50 Marks)**

<b>Question No</b>	<b>Questions</b>	<b>Total Marks: 50</b>
<b>Q1</b>	Attempt any three out of five (4 questions from Module1 and 1 question from Module 4) (05M)	<b>15</b>
<b>Q2</b>	Attempt any three out of five (4 questions from Module 2 and 1 question from Module 4) (05M)	<b>15</b>
<b>Q3</b>	Attempt any three out of five (4 questions from Module 3 and 1 question from Module 4) (05M)	<b>15</b>
<b>Q4</b>	Case study/Application based question-One question from module Module 4 (05M)	<b>05</b>

<b>BOS</b>	<b>Natural and Physical Sciences</b>		
<b>Course</b>	<b>Quantum Mechanics</b>		
<b>Course Code</b>	<b>HPSPH102</b>	<b>Credits</b>	<b>4</b>
<b>Semester</b>	<b>I</b>	<b>Level</b>	<b>6.0</b>
<b>Type</b>	<b>Major: Mandatory</b>	<b>No. of Teaching hours</b>	<b>60</b>
<b>Evaluation/ Assessment</b>	<b>Total Marks</b>	<b>Semester End</b>	<b>Continuous</b>
	<b>100</b>	<b>50</b>	<b>50</b>

<b>Learning Objectives</b>	
<b>1</b>	Understand the foundational principles of quantum mechanics, including wave-particle duality, uncertainty principles, quantum postulates, operator formalism, and the time-dependent Schrödinger equation.
<b>2</b>	Apply mathematical tools and quantum formalisms such as Dirac notation, Hilbert spaces, matrix mechanics, and various representations (Schrödinger, Heisenberg, and Interaction pictures) to analyze and solve quantum systems.
<b>3</b>	Solve quantum mechanical problems involving bound and unbound states, angular momentum, central potentials, and systems like the harmonic oscillator and hydrogen atom, using techniques such as ladder operators, spherical harmonics, and symmetry analysis.

<b>Course Outcomes</b>	
<b>CO1</b>	Understand the basic principles of Quantum mechanics and the need for its formalism
<b>CO2</b>	Understand the Uncertainty Principle and formulation of Schrodinger equation
<b>CO3</b>	Understand the importance of Dirac formalism, vector spaces and apply the same in solving problems of potential barrier, square well potential
<b>CO4</b>	Apply the techniques of solving differential equations using various special functions as they appear in the solution of Schrodinger equation for Hydrogen atom problem
<b>CO5</b>	Solve the various boundary value and potential problems using the techniques of quantum mechanics
<b>CO6</b>	Gain understanding of the mathematical foundations of the angular momenta of a system of particles

### Modules At Glance

<b>Module No.</b>	<b>Content</b>	<b>No. of Hours</b>	<b>Mapping with CO</b>
<b>1</b>	Unit 1	15	CO1,CO2
<b>2</b>	Unit 2	15	CO3
<b>3</b>	Unit 3	15	CO4,CO5
<b>4</b>	Unit 4	15	CO6
		60	

### Syllabus

Module No.	Content	No. of Lectures
1	<p><b>Theory:</b> Blackbody Radiation, Waves Versus Particles, de Broglie hypothesis, Heisenberg's uncertainty principle; probability waves. Postulates of QM: Observables and operators; measurements; the state function and expectation values; the time-dependent Schrodinger equation; time development of state functions; solution to the initial value problem, Superposition and Commutation: The superposition principle; commutator relations; their connection to the uncertainty principle; degeneracy; complete sets of commuting observables. (RL)</p>	15
2	<p><b>Formalism:</b> Dirac notation; Hilbert space; Hermitian operators and their properties. Matrix mechanics: Basis and representations; matrix properties; unitary and similarity transformations; the energy representation. Schrodinger, Heisenberg and Interaction pictures. (RL)</p>	15
3	<p><b>Schrodinger equation solutions</b> Time development of state functions and expectation values; conservation of energy, linear momentum and angular momentum; parity. General properties of one-dimensional Schrodinger equation. Particle in a box. The Bohr Correspondence Principle, Harmonic oscillator. Unbound states; one-dimensional barrier problems. Finite potential well. Two beads on the wire and a particle in a Two-dimensional box, Two-dimensional harmonic Oscillator. (RL)</p>	15
4	<p><b>Angular Momentum:1</b> Orbital angular momentum operators in cartesian and spherical polar coordinates, commutation and uncertainty relations, spherical harmonics. Two-particle problem - coordinates relative to the centre of mass; radial equation for a spherically symmetric central potential. Hydrogen atom, eigenvalues and radial eigenfunctions, degeneracy, probability distribution. Ladder operators, eigenvalues and eigenfunctions of <math>L^2</math> and <math>L_z</math> using spherical harmonics, angular momentum and rotations. (RL)</p>	15
<b>Case Study Scenario</b>		
M1	<p>Based on the given situation, answer the following questions: The owner of a high-voltage transmission line wants to estimate magnetic exposure for people working or living near the line.</p> <ul style="list-style-type: none"> <li>● Using the Biot–Savart law (or Ampère's law for a long straight conductor), calculate the magnetic flux density at a point <b>2.0 m</b> away from a long straight transmission conductor carrying a current of <b>500 A</b>.</li> <li>● Discuss the safety implications for nearby human exposure.</li> </ul>	
M2	<p>Based on the given situation, answer the following questions: A research team is analyzing electric-field exposure around compact high-voltage equipment.</p> <ul style="list-style-type: none"> <li>● A point charge of <b><math>q = +3.0 \mu\text{C}</math></b> is fixed at the origin, representing a simplified model of a highly charged component inside the device. The team wants to determine the electric-field strength experienced by a technician standing <b>0.50 m</b> away from the component.</li> </ul>	

**Reference:**

1. Richard Liboff, Introductory Quantum Mechanics, 4th ed., 2003. (RL)
2. D J Griffiths, Introduction to Quantum Mechanics, 1995. (DG)
3. A Ghatak & S Lokanathan, Quantum Mechanics: Theory & Applications. 5th ed., 2004. (GL)
4. R Shankar, Principles of Quantum Mechanics, 2nd ed., 1994.
5. Quantum Mechanics, (Third Edition) L. I. Schiff, Tata McGraw – Hill Edition 2010

**Semester End Evaluation (50 Marks)**

<b>Question No.</b>	<b>Questions</b>	<b>Total Marks: 50</b>
Q1	Attempt any three out of five ( 4 questions from module I and 1 question from module IV )(05M)	15
Q2	Attempt any three out of five ( 4 questions from module II and 1 question from module IV )(05M)	15
Q3	Attempt any three out of five ( 4 questions from module III and 1 question from module IV )(05M)	15
Q4	Case study/Application based question-One question from module IV (05M)	05

<b>BOS</b>	<b>Natural and Physical Sciences</b>		
<b>Course</b>	<b>Mathematical Physics</b>		
<b>Course Code</b>	<b>HPSPH103</b>	<b>Credits</b>	<b>4</b>
<b>Semester</b>	<b>I</b>	<b>Level</b>	<b>6.0</b>
<b>Type</b>	<b>Major: Mandatory</b>	<b>No. of Teaching hours</b>	<b>60</b>
<b>Evaluation/ Assessment</b>	<b>Total Marks</b>	<b>Semester End</b>	<b>continuous</b>
	<b>100</b>	<b>50</b>	<b>50</b>

<b>Learning Objectives</b>	
<b>1</b>	Master complex analysis and contour integration techniques, including analytic functions, Cauchy-Riemann equations, Taylor and Laurent series, and residue calculus, to evaluate integrals and solve related problems.
<b>2</b>	Develop proficiency in linear algebra and tensor analysis, focusing on matrix operations, eigenvalue problems, tensor manipulation, and their applications to physical systems.
<b>3</b>	Solve advanced differential equations using analytical methods, including power series and special functions (Legendre, Hermite, Laguerre, Bessel), and apply Fourier and Laplace transforms to partial differential equations and initial value problems.

<b>Course Outcomes</b>	
<b>CO1</b>	Solve eigenvalue problems using matrices as they appear in Classical and Quantum Mechanics.
<b>CO2</b>	Apply tensor analysis to understand the formulation of relativistic electrodynamics and other areas of Physics
<b>CO3</b>	Apply residue theorem of complex variables to solve real and definite integrals
<b>CO4</b>	Understand the emergence of special functions as solutions of differential equations and to solve problems in physics
<b>CO5</b>	Solve partial differential equations using integral transforms in boundary value problems

### Modules At Glance

<b>Module No.</b>	<b>Content</b>	<b>No. of Hours</b>	<b>Mapping with CO</b>
<b>1</b>	Unit 1	15	CO3
<b>2</b>	Unit 2	15	CO1,CO2
<b>3</b>	Unit 3	15	CO4
<b>4</b>	Unit 4	15	CO5
		60	CO5

### Syllabus

Module No.	Content	No. of Lectures
1	Complex Variables, Limits, Continuity, Derivatives, Cauchy-Riemann Equations, Analytic functions, Harmonic functions, Elementary functions: Exponential and Trigonometric, Taylor and Laurent series, Residues, Residue theorem, Principal part of the functions, Residues at poles, zeroes and poles of order $m$ , Contour Integrals, Evaluation of improper real integrals, improper integral involving Sines and Cosines, Definite integrals involving sine and cosine functions. (No proof of the theorems required, various types of problems have to be solved) (GA)	15
2	Matrices, Eigenvalues and Eigen vectors, orthogonal, unitary and hermitian matrices, Diagonalization of Matrices, Cayley – Hamilton’s theorem, Application to Physics problems. Introduction to Cartesian Tensor Analysis, Addition and Subtraction of Tensors, summation convention, Contraction, Direct Product, Levi-Civita Symbol (Note: Various types of problems have to be solved) (GA)	15
3	General treatment of second order linear differential equations with non-constant coefficients, Power series solutions, Frobenius method, Legendre, Hermite and Laguerre polynomials, Bessel equations. Nonhomogeneous equation – Green’s function, Sturm-Liouville theory. (AKG)	15
4	Fourier Transform, Integral transforms: three dimensional Fourier transforms and its applications to PDEs (Green function of Poisson’s PDE), convolution theorem, Parseval’s relation, Laplace transforms, Laplace transform of derivatives, Inverse Laplace transform and Convolution theorem, use of Laplace’s transform in solving differential equations. (GA)	15
<b>Case Study Scenario</b>		
<b>M1</b>	Based on the given situation, answer the following questions: The owner of a high-voltage transmission line wants to estimate magnetic exposure for people working or living near the line. <ul style="list-style-type: none"> <li>● Using the Biot–Savart law (or Ampère’s law for a long straight conductor), calculate the magnetic flux density at a point 2.0 m away from a long straight transmission conductor carrying a current of 500 A.</li> <li>● Discuss the safety implications for nearby human exposure.</li> </ul>	
<b>M2</b>	Based on the given situation, answer the following questions: A research team is analyzing electric-field exposure around compact high-voltage equipment. <ul style="list-style-type: none"> <li>● A point charge of <math>q = +3.0 \mu\text{C}</math> is fixed at the origin, representing a simplified model of a highly charged component inside the device. The team wants to determine the electric-field strength experienced by a technician standing 0.50 m away from the component.</li> </ul>	

#### Reference:

1. G. Arfken and H. J. Weber: Mathematical Methods for Physicists, Academic Press 2005
2. A. K. Ghatak, I. C. Goyal and S. J. Chua, Mathematical Physics, McMillan
3. M. L. Boas, Mathematical methods in the Physical Sciences, Wiley India 2006
4. S. D. Joglekar, Mathematical Physics: The Basics, Universities Press 2005
5. S. D. Joglekar, Mathematical Physics: Advanced Topics, CRC Press 2007

**Semester End Evaluation (50 Marks)**

<b>Question No</b>	<b>Questions</b>	<b>Total Marks: 50</b>
<b>Q1</b>	Attempt any three out of five (4 questions from module I and 1 question from module IV) (05M)	<b>15</b>
<b>Q2</b>	Attempt any three out of five (4 questions from module II and 1 question from module IV) (05M)	<b>15</b>
<b>Q3</b>	Attempt any three out of five (4 questions from module III and 1 question from module IV) (05M)	<b>15</b>
<b>Q4</b>	Case study/Application based question-One question from module IV (05M)	<b>05</b>

<b>BOS</b>	<b>Natural and Physical Sciences</b>		
<b>Course</b>	<b>Fundamental of Material Science</b>		
<b>Course Code</b>	<b>HPSPH104</b>	<b>Credits</b>	<b>4</b>
<b>Semester</b>	<b>I</b>	<b>Level</b>	<b>6.0</b>
<b>Type</b>	<b>Elective I</b>	<b>No. of Teaching hours</b>	<b>60</b>
<b>Evaluation/ Assessment</b>	<b>Total Marks</b>	<b>Semester End</b>	<b>continuous</b>
	<b>100</b>	<b>50</b>	<b>50</b>

<b>Learning Objectives</b>	
<b>1</b>	Understand the fundamental structure and bonding of materials, including atomic arrangements, crystal structures, crystallographic directions and planes, and their influence on material properties.
<b>2</b>	Analyze the physical and mechanical behavior of materials, such as solidification, diffusion, deformation, fracture, and mechanical testing, with emphasis on the processing and performance of metals and alloys.
<b>3</b>	Interpret and apply phase diagrams to understand phase transformations, solidification behavior, and the design of alloys, including binary and ternary systems and invariant reactions..

<b>Course Outcomes</b>	
<b>CO1</b>	To understand the atomic structure, types of bonding, and crystal geometry of materials, and relate these features to their physical and mechanical properties.
<b>CO2</b>	To understand and evaluate material imperfections and diffusion mechanisms, including their temperature dependence and applications in material processing.
<b>CO3</b>	Interpret mechanical properties and deformation behavior of metals through stress-strain relationships, hardness testing, and phenomena such as creep, fatigue, and fracture.
<b>CO4</b>	Apply phase diagram concepts (binary, eutectic, peritectic, monotectic, and ternary systems) and the Gibbs phase rule to predict microstructural changes during alloy solidification and heat treatment processes.

### Modules at Glance

<b>Module No.</b>	<b>Content</b>	<b>No. of Hours</b>	<b>Mapping with CO</b>
<b>1</b>	Unit 1	15	CO1
<b>2</b>	Unit 2	15	CO2
<b>3</b>	Unit 3	15	CO3
<b>4</b>	Unit 4	15	CO4
		60	

### Syllabus

Modul No.	Content	No. of Lectures
1	Introduction to Materials Science and Engineering, Types of Materials, Competition among Materials, Future trends In Materials Usage, Atomic Structure and Bonding, Types of Atomic and Molecular Bonds, Ionic Bonding, Covalent Bonding, Metallic Bonding, Secondary Bonding, Mixed Bonding, Crystal Structures and Crystal Geometry, The Space Lattice and Unit Cells, Crystal Systems and Bravais Lattices, Principal Metallic Crystal Structures, Atom Positions in Cubic Unit Cells, Directions in Cubic Unit Cells, Miller Indices For Crystallographic Planes In Cubic Unit Cells, Crystallographic Planes and Directions In Hexagonal Unit Cells, Comparison of FCC, HCP, and BCC Crystal Structures, Volume, Planar, and Linear Density Unit Cell Calculations, Polymorphism or Allotropy, Crystal Structure Analysis	15
2	Solidification, Crystalline Imperfections, and Diffusion in Solids, Solidification of Metals, Solidification of Single Crystals, Metallic Solid Solutions, Crystalline Imperfections, Rate Processes in Solids, Atomic Diffusion in Solids, Industrial Applications of Diffusion Processes, Effect of Temperature on Diffusion in Solids.	15
3	Mechanical Properties of Metals, The Processing of Metals and Alloys, Stress and Strain in Metals, The Tensile Test and The Engineering Stress-Strain Diagram, Hardness and Hardness Testing, Plastic Deformation of Metal Single Crystals, Plastic Deformation of Polycrystalline Metals, Solid-Solution Strengthening of Metals, Recovery and Recrystallization of Plastically Deformed. Metals, Fracture of Metals, Fatigue of Metals, Creep and Stress Rupture of Metals.	15
4	Phase Diagrams, Phase Diagrams of Pure Substances, Gibbs Phase Rule, Binary Isomorphous Alloy Systems, The Lever Rule, Nonequilibrium Solidification of Alloys, Binary Eutectic Alloy Systems, Binary Peritectic Alloy Systems, Binary Monotectic Systems, Invariant Reactions, Phase Diagrams with Intermediate Phases and Compounds, Ternary Phase Diagrams.	15
<b>Case Study Scenario</b>		
<b>M1</b>	Based on the given situation, answer the following questions: The owner of a high-voltage transmission line wants to estimate magnetic exposure for people working or living near the line. <ul style="list-style-type: none"> <li>● Using the Biot–Savart law (or Ampère’s law for a long straight conductor), calculate the magnetic flux density at a point <b>2.0 m</b> away from a long straight transmission conductor carrying a current of <b>500 A</b>.</li> <li>● Discuss the safety implications for nearby human exposure.</li> </ul>	
<b>M2</b>	Based on the given situation, answer the following questions: A research team is analyzing electric-field exposure around compact high-voltage equipment. <ul style="list-style-type: none"> <li>● A point charge of <b>q = +3.0 μC</b> is fixed at the origin, representing a simplified model of a highly charged component inside the device. The team wants to determine the electric-field strength experienced by a technician standing <b>0.50 m</b> away from the component.</li> </ul>	

**Reference:**

1. William F Smith, JavadHashemi, Ravi Prakash, Materials Science and Engineering, Tata-McGraw Hill, 4th Edition.
2. William D. Callister, Materials Science and EngineeringAn Introduction, John Wiley & Sons, Inc., 7th Edition.
3. Charles Kittel “Introduction to Solid State Physics”, 7th edition John Wiley & sons.
4. J.Richard Christman “Fundamentals of Solid State Physics” John Wiley & sons
5. M.A.Wahab “Solid State Physics –Structure and properties of Materials” Narosa Publications 1999.

**Semester End Evaluation (50 Marks)**

<b>Question No</b>	<b>Questions</b>	<b>Total Marks: 50</b>
<b>Q1</b>	Attempt any three out of five (4 questions from module I and 1 question from module IV) (05M)	<b>15</b>
<b>Q2</b>	Attempt any three out of five (4 questions from module II and 1 question from module IV) (05M)	<b>15</b>
<b>Q3</b>	Attempt any three out of five (4 questions from module III and 1 question from module IV) (05M)	<b>15</b>
<b>Q4</b>	Case study/Application based question-One question from module IV (05M)	<b>05</b>

<b>BOS</b>	<b>Natural and Physical Sciences</b>		
<b>Course</b>	<b>Research Methodology and Patent</b>		
<b>Course Code</b>	<b>HPSPH105</b>	<b>Credits</b>	<b>4</b>
<b>Semester</b>	<b>I</b>	<b>Level</b>	<b>6.0</b>
<b>Type</b>	<b>Major: Mandatory</b>	<b>No. of Teaching hours</b>	<b>60</b>
<b>Evaluation/ Assessment</b>	<b>Total Marks</b>	<b>Semester End</b>	<b>Continuous</b>
	<b>100</b>	<b>50</b>	<b>50</b>

<b>Learning Objectives</b>	
<b>1</b>	Learners will be able to explain the fundamental concepts of research methodology, including types of research, research process, and criteria for good research, and will be able to define and formulate a clear research problem
<b>2</b>	Develop Effective Research Communication Skills: Learners will be able to interpret research findings, write structured research reports using appropriate tools (e.g., LaTeX, MS Office, Zotero, Mendeley), and demonstrate awareness of ethical practices such as plagiarism detection and proper citation
<b>3</b>	Understand the fundamentals of Intellectual Property Rights (IPR) and their global and national significance. Integrate IP awareness into their research planning and execution.

<b>Course Outcomes</b>	
<b>CO1</b>	Students are expected to learn the meaning of research, objectives and motivation of research, methodology of research etc.
<b>CO2</b>	Students are expected to learn Interpretation of data, report writing, and techniques of analysis.
<b>CO3</b>	Students will be able to explain the concept of Intellectual Property and identify different types of IP with their relevance in academic and industrial research
<b>CO4</b>	Students will develop the ability to conduct patent searches, understand the procedures for patent filing, and evaluate the commercial and legal value of their innovations.

#### **Modules At Glance**

<b>Module No.</b>	<b>Content</b>	<b>No. of Hours</b>	<b>Mapping with CO</b>
<b>1</b>	Unit-1: Introduction to Research Methodology	15	CO1
<b>2</b>	Unit -2: Interpretation, Report Writing & Techniques	15	CO2
<b>3</b>	Unit 3: Introduction to Intellectual Property Rights (IPR)	15	CO3
<b>4</b>	Unit 4: Patents and Patent Filing Process	15	CO4
		60	

## Syllabus

Module No.	Content	No. of Lecture
1	<p><b>Introduction to Research Methodology:</b>  Meaning of Research, Objectives of Research, Motivation in Research, Types of Research, Research Approaches, Significance of Research, Research Methods versus Methodology, Research and Scientific Method, Importance of Knowing How Research is Done, Research Process, Criteria of Good Research, Problems Encountered by Researchers in India Defining the Research Problem: What is a Research Problem? , Selecting the Problem, Necessity of Defining the Problem, Technique Involved in Defining a Problem, An Illustration. (CRK).</p>	15
2	<p><b>Interpretation, Report Writing &amp; Techniques:</b>  Meaning of Interpretation, Why Interpretation? Technique of Interpretation: Precaution in Interpretation, Significance of Report Writing, Different Steps in Writing Report, Layout of the Research Report, Types of Reports, Oral Presentation, use of tools/techniques for Research: methods to search required information effectively, Reference Management Software like Zotero/Mendeley, Software for paper formatting like LaTeX/MS Office, and Software for detection of Plagiarism. (CRK)</p>	15
3	<p><b>Introduction to Intellectual Property Rights (IPR)</b>  Concept and Importance of Intellectual Property (IP). Types of Intellectual Property: Patents, Copyrights, Trademarks, Trade Secrets, Geographical Indications, Industrial Designs, Need for IPR in Research and Innovation, International Treaties and Agreements: TRIPS (Trade-Related Aspects of Intellectual Property Rights), WIPO (World Intellectual Property Organization), Indian IPR Regime: Overview and Legal Framework, Role of IPR in Academic and Industrial Research, Ethical Issues in IPR and Research.</p>	15
4	<p><b>Patents and Patent Filing Process:</b>  What is a Patent?, Definition and Examples, Criteria: Novelty, Inventive Step, Industrial Applicability, Types of Patents, Utility Patents, Design Patents, Process vs Product Patents, Patent Search and Patent Databases (Google Patents, E space net, etc.), Steps in Patent Filing: Provisional and Complete Specification, Filing in India: Procedure and Forms, PCT (Patent Cooperation Treaty) Filing, Role of Patent Agents and Patent Attorneys, Patent Infringement and Remedies, Case Studies: Patents in Academia and Industry</p>	15
<b>Case Study Scenario</b>		
M1	<p>Based on the given situation, answer the following questions: The owner of a high-voltage transmission line wants to estimate magnetic exposure for people working or living near the line.</p> <ul style="list-style-type: none"> <li>● Using the Biot–Savart law (or Ampère’s law for a long straight conductor), calculate the magnetic flux density at a point <b>2.0 m</b> away from a long straight transmission conductor carrying a current of <b>500 A</b>.</li> <li>● Discuss the safety implications for nearby human exposure.</li> </ul>	
M2	<p>Based on the given situation, answer the following questions: A research team is analyzing electric-field exposure around compact high-voltage equipment.</p> <ul style="list-style-type: none"> <li>● A point charge of <b>q = +3.0 μC</b> is fixed at the origin, representing a simplified model of a highly charged component inside the device. The team wants to determine the electric-field strength experienced by a technician standing <b>0.50 m</b> away from the component.</li> </ul>	

**References:**

1. Research Methodology – C. R. Kothari
2. Best, J. W. and Khan, J. Research in Education. (7th Ed.) New Delhi: Prentice-Hall India Ltd. 1997.
3. Borg, B. L. Qualitative Research Methods. Boston: Pearson. 2004. 23
4. Bogdan, R. C. and Biklen, S. K. Qualitative Research For Education: An Introduction to Theory and Methods. Boston, MA: Allyn and Bacon.1998.
5. Bryman, A. Quantity and Quality in Social Science Research. London: Routledge.1988.

**Semester End Evaluation (50 Marks)**

<b>Question No</b>	<b>Questions</b>	<b>Total Marks: 50</b>
<b>Q1</b>	Attempt any three out of five (4 questions from module I and 1 question from module IV) (05M)	<b>15</b>
<b>Q2</b>	Attempt any three out of five (4 questions from module II and 1 question from module IV) (05M)	<b>15</b>
<b>Q3</b>	Attempt any three out of five (4 questions from module III and 1 question from module IV) (05M)	<b>15</b>
<b>Q4</b>	Case study/Application based question-One question from module IV (05M)	<b>05</b>

<b>BOS</b>	<b>Natural and Physical Sciences</b>		
<b>Course</b>	<b>Practical I</b>		
<b>Course Code</b>	<b>HPSPH106P</b>	<b>Credits</b>	<b>4</b>
<b>Semester</b>	<b>I</b>	<b>Level</b>	<b>6</b>
<b>Type</b>	<b>Practical: Mandatory</b>	<b>No. of Teaching hours</b>	<b>60</b>
<b>Evaluation/ Assessment</b>	<b>End Semester evaluation of 50 Marks</b>		

<b>Learning Objectives</b>	
<b>1</b>	To develop hands-on skills in conducting advanced physics experiments involving optics, lasers, atomic spectra, and semiconductor devices..
<b>2</b>	To understand and analyze the operational principles of electronic circuits including oscillators, power supplies, filters, and control circuits using discrete components and integrated circuits.
<b>3</b>	To familiarize students with the use of modern instruments and measurement techniques for precise data acquisition and analysis in physics and electronics.
<b>4</b>	To cultivate experimental design, problem-solving, and analytical skills through systematic investigation and interpretation of experimental results.

<b>Course Outcomes</b>	
<b>CO1</b>	Students will be able to perform advanced experiments in optics, lasers, and semiconductor physics to determine key physical parameters with accuracy.
<b>CO2</b>	Students will design, build, and analyze various electronic circuits such as regulated power supplies, oscillators, phase controllers, and filters using ICs and discrete components.
<b>CO3</b>	Students will demonstrate proficiency in using laboratory instruments such as interferometers, spectrometers, laser diffraction setups, and oscilloscopes for data measurement and validation.
<b>CO4</b>	Students will develop the ability to critically analyze experimental data, prepare detailed reports, and present findings with clarity and scientific rigor.

**Practical Syllabus**

<b>Group A</b>				<b>No. Of Lectures</b>
<b>Sr. No</b>	<b>Experiments</b>	<b>Mapping to CO</b>	<b>References</b>	
1	Michealson Interferometer	CO 1, CO2, CO3 and O4	1. Advanced Practical Physics -Worsnop and Flint	<b>30</b>
2	Analysis of sodium spectrum		1. Atomic spectra - H.E. White 2. Experiments in modern physics –Mellissinos	
3	h/e by vacuum photocell		1. Advanced Practical Physics -Worsnop and Flint 2. Experiments in modern physics- Mellissinos	
4	Study of He-Ne laser measurement of wavelength using reflection grating		1. A course of experiments with Laser – Siroh 2. Elementary experiments with LaserG. White	
5	Coupled Oscillations		1. Coupled Oscillations HBCSE Selection camp 2007 Manual	
6	Carrier lifetime by pulsed reverse method		1. Semiconductor electronics by Gibson	
7	Temperature dependence of avalanche and Zener breakdown diodes		1. Solid state devices – W.D. Cooper 2. Electronic text lab manual – PB Zbar 3. Electronic devices & circuits – Millman and Halkias	
8	Determination of particle size of lycopodium particles by laser diffraction method		1. A course of experiments with Laser – Siroh 2. Elementary experiments with Laser- G. White	
9	Microwave oscillator characteristics		1. Physics of Semiconductor Devices by S.M.Sze	

Group B				
Sr. No	Experiments	Mapping to CO	References	No. of Lectures
1	Diac - Triac phase control circuit	CO1, CO2, CO3,CO4	1. Solid state devices- W.D. Cooper	30
			2. Electronic text lab manual - P.B. Zbar	
2	Delayed linear sweep using IC 555		1. Electronic Principles - A. P. Malvino	
3	Regulated power supply using IC LM 317 voltage regulator IC		1. Amplifiers and linear Integrated circuits – Coughlin & Driscoll	
			2. Practical analysis of electronic circuits through experimentation – L.MacDonald	
4	Regulated dual power supply using IC LM317 and IC LM 337 voltage regulator Ics		1. Operational amplifiers and linear Integrated circuits – Coughlin & Driscoll	
			2. Practical analysis of electronic circuits through experimentation – L.MacDonald	
5	Constant current source using IC 741 and LM 317		1. Integrated Circuits- K. R. Botkar	
6	Active filter circuits (second order)		1. Op-amps and linear integrated circuit technology- R. Gayakwad	
			2. Operational amplifiers and linear integrated circuits – Coughlin & Driscoll	
7	Study of 4 digit multiplex display system	1. Digital Electronics - Roger Tokheim		
8	Temperature on-off controller using IC	1. Op-amps and linear integrated circuit technology by Gayakwad		
9	Waveform generating using IC	1. circuits- — Coughlin & Driscoll		
		2. Op-amps and linear integrated circuit technology: R. Gayakwad		
		3. Operational amplifiers: experimental manual C.B. Clayton		
10	Instrumentation amplifier and its application	1. Operational amplifiers and linear integrated		

			circuits- — Coughlin & Driscoll
			2 Integrated Circuits – K. R. Botka
11	Study of 8-bit DAC		1. Op-amps and linear integrated circuit technology: R. Gayakwad
			2. Digital principles and applications by Malvino and Leach
12	16 channel digital multiplexer		1.. Digital principles and applications by Malvino and Leach
			2. Digital circuit practice by RP Jain
13	Study of elementary digital voltmeter		1. Digital Electronics by Roger Tokheim (5 <sup>th</sup> Ed, page 371)

### End Sem practical examination (50 marks)

Sr. No.	Assessment/ Evaluation	Marks
1	Any one experiment	30
2	Journal	10
3	Viva	10

#### Note:

1. Minimum number of experiments to be performed and reported in the journal = 06 with minimum 3 experiments from each Group. i.e. Group A: 03 and Group B: 03
2. Evaluation in viva voce will be based on regular experiments.
3. After completing the required number of experiments in the semester and recording them in a journal, students will have to get their journal certified and produce the certified journal at the time of practical examination to be eligible to appear in the Semester End Practical Examination.

#### General Instructions:

For practical examinations, the learner will be examined in One experiment from the list of experiments.

Evaluation in viva voce will be based on regular experiments. A learner will be allowed to appear for the semester end practical examination only if he/she submits a certified journal of Physics with a certificate that the learners has completed the practical course of Physics Semester-III as per the minimum requirements.

#### Note:

1. The questions on slips for the same should be framed in such a way that the candidate will be able to complete the task within the specified time.
2. While evaluating practical, weightage should be given to circuit / ray diagram, observations, tabular representation, experimental skills, procedure, graph, calculation and result.
3. The skill of doing the experiment and understanding physics concepts should be more important than the accuracy of the final result.