



SARDAR PATEL UNIVERSITY

Vallabh Vidyanagar

NAAC 'A' Grade (10-01-2023 To 09-01-2028)

NEP-2020 aligned Curriculum with effect from Academic Year 2026-27

M.Sc. (Physics) Semester – I

Course Type	Course Code	Course Title	Teaching-Learning Scheme	Total Notional Hours	Course credits
			L-P-T		
DSC	P2S01NCPHY01	Mathematical Physics and Quantum Mechanics	4-0-0	120	04

Course Learning Outcomes (CLOs)

On completion of this course, students will be able to:

CLO1: Apply complex analysis techniques to evaluate definite integrals, contour integrals, and residues and demonstrate the use of conformal mapping in physical problems.

CLO2: Apply tensor analysis including covariant differentiation using Christoffel symbols to describe curvature and coordinate transformations in physics.

CLO3: Analyze the structure of groups relevant to physics, including matrix representations, characters, classes, subgroups, and special unitary groups; construct Cayley tables and identify homomorphisms/isomorphisms.

CLO4: Apply the formal postulates of quantum mechanics in discrete and continuous bases, unitary transformations, diagonalization, degeneracy labeling by commuting observables, and the concept of parity.

CLO5: Solve problems involving angular momentum in quantum mechanics by determining eigenvalues and eigenfunctions of angular momentum operators, constructing matrix representations, addition of angular momenta, and describing spin-orbit coupling.

Unit	Course Content	Learning Pedagogies*	CLO(s)
I	Complex Analysis: Introduction, Analytic functions, Derivatives of analytic function, Contour integrals, Laurent series, The Residue theorem, Methods of finding residues, Evaluation of definite integrals by use of the residue theorem, Ramanujan's Master Theorem: statement, conditions, proof via residue theorem, Ramanujan's evaluations of definite integrals, The point at infinity; residues at infinity, Mapping	CL, SM, PBL, SDL	CLO1
II	Tensors: Types of tensors and their algebra, Contraction and inner product, Metric tensors, Quotient rule, Dual and irreducible tensors, Christoffel symbols, covariant derivative, Geodesic equation. Group Theory: Definition and examples, group multiplication table, homomorphism and isomorphism, matrix representations – reducible and irreducible, classes and character, subgroups and cosets, Harish-Chandra's contributions to representation theory of semisimple Lie groups, Dihedral group, orthogonal groups and special unitary group.	CL, SM, CBL, PBL, ICT, SDL	CLO2 CLO3



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III	Formalism of Quantum Mechanics: Quantum states; state vectors and wave functions, The Hilbert space of state vectors; Dirac notation, Dynamical variables and linear operators, Representations, Continuous basis-The Schrödinger representation Change of basis-Unitary transformations, Unitary transformations induced by change of coordinates: Translations, Unitary transformation induced by rotation of coordinate system. The algebra of rotation generators and the transformations.	CL, SM, PBL, IBL, SDL	CLO4
IV	Angular momentum: Quantum theory of angular momentum and its eigenvalue spectrum. Matrix representation of angular momentum operators, spin angular momentum, Pauli matrices and their properties, total wave function, non-relativistic Hamiltonian including spin. Addition of angular momenta, definition of Clebsch-Gordan coefficients, Phase convention, spin-wave function for a system of two spin-1/2 particles, Identical particles with spin, addition of spin and orbital angular momenta	CL, SM, PBL, IBL, SDL	CLO5

(* Learning Pedagogies/Methods

- (a) CL: Classroom Lecture
- (b) SM: Seminars (Student-led and Faculty-moderated)
- (c) CBL: Case-Based Learning
- (d) PBL: Problem-Based Learning
- (e) ICT: ICT-Enabled Learning (LMS-based Tasks, Digital Resources, Virtual Labs/Webinars)
- (f) IBL: Inquiry-Based Learning
- (g) SDL: Self-Directed Learning (Guided Readings, Concept Exploration Tasks)

• Assessment Methodologies/Tools

(A) Internal Assessment [Total: 50 Marks]

a. Internal Formative assessment [25]

- (a) Assignment, Self-learning and Terms work
- (b) Seminar/Presentation
- (c) Class regularity

b. Internal Summative Assessment [25]

- (a) Mid-term tests
- (b) Quizzes

(B) Weightage of Learning Efforts for External Assessment [Total: 50 Marks]

Unit	Aligned CLOs	Total Learning Hours	Approximate weightage (Marks) to Learning levels (BT)			Total Marks
			Remember (R)	Understanding (U)	Analyse & above (A)	
I	1	30	2	4	7	13
II	2, 3	30	2	4	6	12
III	4	30	2	4	7	13
IV	5	30	2	4	6	12
		120	08	18	26	50



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Assessment and Evaluation:

Sr. No.	Assessment/Evaluation	Component	Weightage (%)
1	Continuous Internal Evaluation	Seminars, Assignments, Quizzes, Class Regularity	50
2	End-Semester Examination	Written Exam/Practical Exam Project Evaluation (Report, Presentation, Viva)	50

CLOs – PLOs Matrix

PLO \ CLO	1	2	3	4	5	6	7	8	9	10
1	3	3	2	-	-	-	-	2	2	-
2	3	3	3	-	-	-	-	2	3	1
3	3	2	2	-	-	-	-	3	2	-
4	3	3	3	-	1	-	-	3	3	-
5	3	3	3	-	1	-	-	2	3	-

Values to CLO-PLO matrix are assigned by judging the importance of the particular CLO in relation to the PLOs.

CLO – PLO correlation	Value
Strong	3
Moderate	2
Low	1
No correlation	-

• Suggested Learning Materials Books:

Sr. No.	Title	Author(s)	Edition/Year	Publisher
1	Mathematical Methods for Physicists	G. Arfken, F. Weber, B. Harris	7th Edition 2013	Elsevier
2	Mathematical Methods in Physical Sciences	M. L. Boas	Second edition, 1996	John Wiley & Sons
3	Matrices and Tensors in Physics	A. W. Joshi	3rd Edition 2005	New Age Intl. Pub
4	Elements of Group Theory for Physicists	A. W. Joshi	5 th Edition 2018	New Age Intl. Pub
5	A text book of Quantum Mechanics	P.M. Mathews and Venkatesan	2 nd Edition 2010	TMH Publication
6	Introduction to Quantum Mechanics	D J Griffiths	3 rd Edition 2018	Cambridge Uni Press
7	Quantum Mechanics: Concepts and Applications	Nouredine Zettili	3 rd Edition 2022	John Wiley & Sons Inc
8	Quantum Mechanics	G. Aruldas	2 nd Edition 2008	PHI Learning



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Online Resources (Open Source)

Sr. No.	Description of Resource(s)	Weblink
1	MIT Open Courseware for complex analysis	https://ocw.mit.edu/courses/18-04-complex-variables-with-applications-spring-2018/
2	MIT Open Courseware for Tensors	https://ocw.mit.edu/courses/8-962-general-relativity-spring-2020/
3	Group Theory for Physicists Lecture series	https://youtu.be/IEovyfCFtBs?si=RNgEbNoyUDw63egi
4	NPTEL Quantum Mechanics I & II (Prof. P Ramadevi, IIT Bombay)	https://youtu.be/AEedn_NiWN0?si=WkL8me1TX6DU0c62
5	MIT Open Courseware Quantum Physics II	https://ocw.mit.edu/courses/8-05-quantum-physics-ii-fall-2013/



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M.Sc. (Physics) Semester – I

Course Type	Course Code	Course Title	Teaching-Learning Scheme	Total Notional Hours	Course credits
			L-P-T		
DSC	P2S01NCPHY02	Classical and Statistical Mechanics	4-0-0	120	04

Course Learning Outcomes (CLOs)

On completion of this course, students will be able to:

- CLO1** Formulate and solve dynamical problems using Hamiltonian formalism, canonical transformations, and Hamilton–Jacobi theory, demonstrating analytical rigor in classical mechanics.
- CLO2** Analyze linear and nonlinear dynamical systems, including small oscillations, phase space trajectories, stability criteria, and the onset of chaos using modern dynamical systems concepts.
- CLO3** Apply the principles of classical mechanics, equilibrium classical and quantum statistical mechanics to formulate, analyse and solve problems on dynamics and thermodynamics of the physical systems.
- CLO4** Explain and model phase transitions and critical phenomena using Landau theory, symmetry considerations, and simplified models such as the Ising model.
- CLO5** Formulate and analyze stochastic processes including random walks, Brownian motion, and diffusion equations, linking microscopic dynamics to macroscopic transport behavior.

Unit	Course Content	Learning Pedagogies*	CLO(s)
I	<p>Foundational concepts (Recap) Hamiltonian Mechanics: The Hamiltonian of a System, Hamilton's Equations of Motion, Hamilton's Equations from Variational Principle. Integrals of Hamilton's Equations, Energy Integral, Integrals Associated with Cyclic Co-ordinates, Canonical Transformations, Poisson Brackets, Fundamental Poisson Brackets, Fundamental Properties of Poisson Brackets. Equations of Motion in Poisson Bracket Form, Poisson Bracket and Integrals of Motion, The Canonical Invariance of Poisson Bracket, Lagrange Brackets, D-Variation, The Principle of Least Action, Poisson Brackets and Quantum Mechanics,</p> <p>Hamilton–Jacobi Theory: Hamilton–Jacobi Equation, Hamilton's Characteristic Function, Harmonic Oscillator in The H-J Method, Separation of Variables in The H-J Equation, Central Force Problem in Plane Polar Co-ordinates, Action-Angle Variables, Harmonic Oscillator in Action-Angle Variables, Road to Quantization.</p>	ICL, SDL, PBL, SM	CLO1 CLO3



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M.Sc. (Physics) Semester – I

II	<p>Theory of Small Oscillations: Small Oscillation, Equilibrium and Potential Energy, Theory of Small Oscillations, Normal Modes, Two Coupled Pendula, Longitudinal Vibrations of CO₂ Molecule,</p> <p>Non-Linear Dynamics: Linear and Nonlinear Systems, Integration of Linear Equation, Quadrature Method, Integration of Nonlinear Second Order Equation, The Pendulum Equation, Phase Plane Analysis of Dynamical Systems, Phase Portrait of the Pendulum, Matching of Phase Curve with Potential V(x), Linear Stability Analysis, Fixed Point Analysis of a Damped Oscillator, Limit Cycles,</p> <p>Chaos: Bifurcation, Logistic Map, Attractors, Universality of Chaos, Lyapunov Exponent and Chaos, Fractals, Fractal Dimension, Routes to Chaos.</p>	ICL, SDL, PBL, SM	CLO2 CLO3
III	<p>Foundational concepts (Recap) Phase space and distribution functions, Microstates, macrostates, ergodic hypothesis (brief), Postulates of statistical mechanics, Microcanonical ensemble and entropy definition, Thermodynamic relations from statistical principles</p> <p>Canonical Ensemble and Fluctuations Derivation of canonical distribution, Partition function as generating function, Thermodynamic quantities (U,F,S,P) Energy fluctuations and their significance, Applications: Ideal gas, harmonic oscillator, Two-level system (Schottky anomaly)</p> <p>Grand Canonical Ensemble Open systems and chemical potential, Grand partition function Thermodynamic potential and particle number, Fluctuations in particle number, Applications: Ideal quantum gas, Density fluctuations</p>	ICL, SDL, SM	CLO2 CLO3
IV	<p>Quantum Statistics Indistinguishability and quantum state counting, Bose-Einstein statistics: Distribution function, Bose gas and Bose-Einstein condensation Fermi-Dirac statistics: Distribution function, Degenerate Fermi gas, Fermi energy and low-temperature behavior</p> <p>Phase Transitions and Critical Phenomena First-order and second-order transitions, Order parameter and symmetry breaking, Landau theory (free energy expansion and minimization), Critical phenomena: Divergence of fluctuations (qualitative), Correlation length (conceptual), Ising model: Formulation, Physical interpretation, 1D vs 2D behavior (qualitative)</p> <p>Stochastic Processes and Diffusion Random walk: 1D model, Mean displacement and variance Brownian motion: Physical basis, Einstein relation Diffusion equation: Derivation from random walk and Solution (Gaussian form, qualitative)</p>	ICL, SDL, SM	CLO4 CLO5



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M.Sc. (Physics) Semester – I

IV	<p>Quantum Statistics Indistinguishability and quantum state counting, Bose-Einstein statistics: Distribution function, Bose gas and Bose-Einstein condensation Fermi-Dirac statistics: Distribution function, Degenerate Fermi gas, Fermi energy and low-temperature behavior</p> <p>Phase Transitions and Critical Phenomena First-order and second-order transitions, Order parameter and symmetry breaking, Landau theory (free energy expansion and minimization), Critical phenomena: Divergence of fluctuations (qualitative), Correlation length (conceptual), Ising model: Formulation, Physical interpretation, 1D vs 2D behavior (qualitative)</p> <p>Stochastic Processes and Diffusion Random walk: 1D model, Mean displacement and variance Brownian motion: Physical basis, Einstein relation Diffusion equation: Derivation from random walk and Solution (Gaussian form, qualitative)</p>	ICL, SDL, SM	CLO4 CLO5
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(* Learning Pedagogies/Methods

- (h) ICL: Interactive Classroom Lecture
- (i) SM: Seminars (Student-led and Faculty-moderated)
- (j) PBL: Problem-Based Learning
- (k) ICT: ICT-Enabled Learning (LMS-based Tasks, Digital Resources, Virtual Labs/Webinars)
- (l) RP: Reflective Practices (Learning Journals, Reflective Notes, Concept Mapping)
- (m)SDL: Self-Directed Learning (Guided Readings, Concept Exploration Tasks)

Assessment Methodologies/Tools

(C) Internal Assessment [Total: 50 Marks]

a. Internal Formative assessment [25]

- (d) Assignment, Self-learning and Terms work
- (e) Seminar/Presentation
- (f) Class regularity

b. Internal Summative Assessment [25]

- (c) Mid-term tests
- (d) Quizzes



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M.Sc. (Physics) Semester – I

(D) Weightage of Learning Efforts for External Assessment [Total: 50 Marks]

Unit	Aligned COs	Total Learning Hours	Approximate weightage (Marks) to Learning levels (BT)			Total Marks
			Remember (R)	Understanding (U)	Analyse & above (A)	
I	1	30	2	3	8	13
II	2	30	2	3	7	12
III	2, 3	30	2	3	8	13
IV	4,5,6	30	2	3	7	12
		120	8	12	30	50

Assessment and Evaluation:

Sr. No.	Assessment/Evaluation	Component	Weightage (%)
1	Continuous Internal Evaluation	Seminars, Assignments, Quizzes, Class Regularity	50
2	End-Semester Examination	Written Exam/Practical Exam Project Evaluation (Report, Presentation, Viva)	50

CLOs – PLOs Matrix

PLO \ CLO	1	2	3	4	5	6	7	8	9	10
1	3	3	2	-	-	-	-	1	2	-
2	3	2	3	-	1	-	-	2	2	-
3	3	3	3	-	2	-	-	2	2	-
4	3	2	2	-	2	1	-	1	1	-
5	3	2	2	-	2	1	-	1	3	-

Values to CLO-PLO matrix are assigned by judging the importance of the particular CLO in relation to the PLOs.

CLO – PLO correlation	Value
Strong	3
Moderate	2
Low	1
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M.Sc. (Physics) Semester – I

Suggested Learning Materials Books:

Sr.No.	Title	Author(s)	Edition/Year	Publisher
1.	Introduction to Classical Mechanics	R. G. Takwale, P. S. Puranik	55th Ed., 2016	Tata McGraw-Hill
2.	Classical Mechanics,	H. Goldstein, C. P. Poole, J. L. Safko,	3rd Ed., 2011	Pearson
3.	Classical Mechanics Classical Mechanics: With Introduction to Nonlinear Oscillations and Chaos	V. B. Bhatia	2001	Narosa Pub. House
4.	Classical Mechanics	J. C. Upadhyay	2019	Himalaya Publishing 5.House
5.	Classical Mechanics	G. Aruldas	8 th Ed., 2017	PHI Learning Private Limited
6.	Classical Mechanics	N.C. Rana, P.S. Joag,	34 th reprint, 2013	Tata McGraw-Hill
7.	Statistical Mechanics for Beginners – A Textbook for Undergraduates	L. G. Benguigui	Second Edition 2026	World Scientific
8.	Introduction to Statistical Physics	Kersan Huang	Second Edition 2009	CRC Press Taylor & Francis

Online Resources (Open Source)

Sr. No.	Description of Resource(s)	Weblink
1	classical mechanics lectures	https://www.youtube.com/watch?v=GOkZs2RZMQY&list=PLoRUNeJAicqYt-iU3qK77tXcu1YpT9htz&index=10
2	Linear Dynamical systems	https://www.youtube.com/watch?v=ucG_Ft36XOo&list=PL5E4E56893588CBA8&index=4
3	Introduction to Statistical Mechanics, Peter Eastman. Online Book.	https://web.stanford.edu/~peastman/statmech/
4	Lectures on Statistical Physics, David Tong. Online Resources	https://www.damtp.cam.ac.uk/user/tong/statphys.html
5	Statistical Physics. Online Course Content	http://crossgroup.caltech.edu/Ph127/index.html
6	Various Online Books on Statistical Mechanics	https://phys.libretexts.org/Bookshelves/Thermodynamics_and_Statistical_Mechanics



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M.Sc. (Physics) Semester – I

Course Type	Course Code	Course Title	Teaching-Learning Scheme	Total Notional Hours	Course credits
			L-P-T		
DSC	P2S01NCPHY03	Solid State Physics and Solid State Electronics	4-0-0	120	04

Course Learning Outcomes (CLOs)

On completion of this course, students will be able to:

- CLO1 Critically analyze the structural properties of crystalline and amorphous solids by constructing and interpreting Bravais lattices, reciprocal lattices and X-ray diffraction including structure factor analysis.
- CLO2 Evaluate lattice dynamics and thermal properties of solids using Einstein and Debye models, and analyze the role of phonons and dispersion relations in governing specific heat and vibrational behavior.
- CLO3 Examine advanced solid-state phenomena, including superconductivity and superfluidity, and assess the influence of crystal defects, phase transitions, and different phases of matter (such as liquid crystals and quasicrystals) on material properties, symmetry, and physical behavior.
- CLO4 Students will learn basics of semiconductor physics and devices, understand the applications of different devices.
- CLO5 Learn diligence of various devices ranging from conversion from light to electricity, applications of UJT, SCR, etc. devices.
- CLO6 Learns basics of digital electronics and its relevance in various applications.

Unit	Course Content	Learning Pedagogies*	CLO(s)
I	<p>Crystal Structure, lattice dynamics, specific heat Introduction: Reciprocal Lattice, Concept and mathematical formulation, Reciprocal lattice vectors, Relation between direct and reciprocal lattices, Diffraction and Structure Factor, Bragg's Law and diffraction condition, Structure factor and intensity of diffracted beams, X-ray diffraction techniques.</p> <p>Introduction to Bonding in Solids, Elastic Properties in a solid, Lattice Vibrations and Phonons, Classical theory of lattice vibrations, Phonons and quantization of lattice vibrations, Dispersion, Lattice Specific Heat, Einstein model and Debye Model of Specific heat, Hall Effect and Thermoelectric Phenomena, Response and Relaxation Phenomena ,Electrical relaxation, Dielectric response</p>	ICL, SM, ICT, PBL	CLO1 CLO2
II	<p>Superconductivity and Phases of matter Superconductivity Properties of superconductors, Meissner Effect, Type I and Type II Superconductors, Thermodynamics of superconducting transition and London equation, Coherence length, BCS theory of superconductivity Josephson Junction</p>	ICL, SM, ICT, PBL	CLO3



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M.Sc. (Physics) Semester – I

	and Josephson effects, Superfluidity, Concept and properties of superfluid, Superfluid helium. Defects and Phases of Matter, Crystal Defects: vacancies, interstitials, dislocations, Ordered phases: translational and orientational order, Liquid crystals and liquid crystalline phases, Quasicrystals.		
III	Semiconductor Junction Based Devices: Carrier Statistics in PN Junction-Barrier Potential, width and capacitance. Linearly graded and Abrupt PN junctions. I-V Characteristics, Applications of P-N junctions- Diode as a switch, Diode as Clipper, Diode as a Clamper circuit, Reverse Recovery Time of diode. Optoelectronic devices- Light Emitting Diode, Photodiode and Phototransistor. Solar Cells, Uni-Junction Transistor, Silicon Control Rectifier, DIAC and TRIAC.	ICL, SM, ICT, PBL	CLO4 CLO5
IV	BCD Codes and Digital Circuits: Review of Binary Coded Decimal Codes, Boolean functions, Min-terms and Max-terms. Karnaugh Mapping, Tri-state logic, Positive and Negative logic, Signed binary numbers. Arithmetic Logic Circuits: Flip-Flops, Adders- Half adder and Full adder, Subtractors, comparators. Combinational and Sequential Circuits Decoders, De-multiplexers, Encoders, Multiplexers, Registers and Counters.	ICL, SM, ICT, PBL	CLO4 CLO6

(* Learning Pedagogies/Methods

- (n) ICL: Interactive Classroom Lecture
- (o) SM: Seminars (Student-led and Faculty-moderated)
- (p) PBL: Problem-Based Learning
- (q) ICT: ICT-Enabled Learning (LMS-based Tasks, Digital Resources, Virtual Labs/Webinars)
- (r) RP: Reflective Practices (Learning Journals, Reflective Notes, Concept Mapping)
- (s) SDL: Self-Directed Learning (Guided Readings, Concept Exploration Tasks)

• Assessment Methodologies/Tools

(E) Internal Assessment [Total: 50 Marks]

a. Internal Formative assessment [25]

- (g) Assignment, Self-learning and Terms work
- (h) Seminar/Presentation
- (i) Class regularity

b. Internal Summative Assessment [25]

- (e) Mid-term tests
- (f) Quizzes



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M.Sc. (Physics) Semester – I

(F) Weightage of Learning Efforts for External Assessment [Total: 50 Marks]

Unit	Aligned CLOs	Total Learning Hours	Approximate weightage (Marks) to Learning levels (BT)			Total Marks
			Remember (R)	Understanding (U)	Analyse & above (A)	
I	1,2	15	2	4	7	13
II	3	15	2	4	6	12
III	4,5	15	2	4	7	13
IV	4,6	15	2	4	6	12
		60	8	16	26	50

Assessment and Evaluation

Sr. No.	Assessment/Evaluation	Component	Weightage (%)
1	Continuous Internal Evaluation	Seminars, Assignments, Quizzes, Class Regularity	50
2	End-Semester Examination	Written Exam/Practical Exam Project Evaluation (Report, Presentation, Viva)	50

CLOs – PLOs Matrix

PLO \ CLO	1	2	3	4	5	6	7	8	9	10
1	3	2	3	–	2	2	1	1	–	–
2	3	3	3	–	2	2	–	1	–	–
3	3	2	3	–	2	3	2	1	1	1
4	3	--	3	3	--	--	2	1	--	--
5	3	--	3	3	--	--	2	1	--	--
6	3	--	3	3	--	--	2	1	--	--

Values to CLO-PLO matrix are assigned by judging the importance of the particular CLO in relation to the PLOs.

CLO – PLO correlation	Value
Strong	3
Moderate	2
Low	1
No correlation	-



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M.Sc. (Physics) Semester – I

Suggested Learning Materials Books:

Sr.No.	Title	Author(s)	Edition/Year	Publisher
1	Introduction to Solid State Physics	Charles Kittel	Eight edition/2015	Wiley
2	Elements of Solid State Physics	J. P. Srivastava	2009	Prentice Hall of India
3	Solid State Physics: Structure and Properties of Materials	M. A. Wahab	Second edition/2008	Narosa Publishers
4	Elementary Solid State Physics: Principles and Applications	M. A. Omar	1975	Addison-Wesley
5	Elements of X-ray diffraction	B. D. Cullity and S. R. Stock	Third edition/2014	Pearson
6	Solid State Pulse Circuits	David A. Bell	1991	Prentice Hall of India
7	Digital Principles and Applications	Donald P. Leach, Albert Paul Malvino and Gautam Saha	8 th / 2015	Tata McGraw Hill Education Pvt. Ltd.
8	Microelectronics: Digital and Analog	K. R. Botkar	1991	Khanna Publishers
9	Electronic Devices & Components	J. Seymour	1989	Longman
10	Integrated Circuits	K. R. Botkar	1987	Khanna Publishers

• Online Resources (Open Source)

Sr. No.	Description of Resource(s)	Weblink
1	NPTEL – Solid State Physics (Crystal structure, lattice dynamics, phonons, superconductivity)	https://nptel.ac.in
2	HyperPhysics – Concise notes on XRD, Hall effect, superconductivity	http://hyperphysics.phy-astr.gsu.edu/
3	LibreTexts – Solid state physics, diffraction, thermoelectric effects, dielectric response	https://phys.libretexts.org/
4	SWAYAM – Courses on Solid State Physics, Materials Science, Crystal Structure, Superconductivity (offered by IITs, IISc)	https://swayam.gov.in
5	Electronics & Communication	www.freebookcentre.net
6	Virtual Labs	https://he-coep.vlabs.ac.in › exp › theory



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M.Sc. (Physics) Semester – I

Course Type	Course Code	Course Title	Teaching-Learning Scheme	Total Notional Hours	Course credits
			L-P-T		
DSC	P2S01NCPHY04	Practical I	0-8-0	120	04

Course Learning Outcomes (CLOs)

After completing the lab, students will be able to:

CLO1 Evaluate characteristics of electronic components and study applications of ICs

CLO2 Perform simulations and interpret physical phenomena (X-ray diffraction, optical band gap).

CLO3 Setup experiments and evaluate transport properties of semiconductors.

CLO4 Apply numerical methods for solving physics problems and Interpret experimental data to present results effectively.

CLO5 Use modern tools/software for simulation, data analysis, and visualization.

Sr. No.	List of Practicals	CLO(s)
1	UJT: Characteristics & Relaxation Oscillator	CLO1
2	X-ray Simulation	CLO2, CLO5
3	Wave Shaping Circuits	CLO1
4	Optical Band Gap	CLO3
5	Transport Properties of Semiconductor at RT	CLO2, CLO3
6	Adder / Subtractor	CLO1
7	Numerical Analysis – Root Finding Method	CLO4

• Assessment Methodologies/Tools

(G) Internal Assessment [Total: 50 Marks]

a. Internal Formative assessment [25]

- (j) Preparation of Journal
- (k) Viva Voce
- (l) Laboratory Regularity

b. Internal Summative Assessment [25]

- (g) Mid-term tests
- (h) Laboratory Performance

(H) Weightage of Learning Efforts for External Assessment [Total: 50 Marks]

Practical	Aligned CLOs	Total Learning Hours	Approximate weightage (Marks) to Learning levels (BT)			Total Marks
			Remember (R)	Understanding (U)	Analyse & above (A)	
1	1	17	1	1	5	7
2	2, 5	17	1	1	5	7
3	1	17	1	1	5	7
4	3	17	1	1	5	7
5	2, 3	17	1	1	5	7
6	1	17	1	1	5	7
7	4	18	1	1	6	8
		120	07	07	36	50



SARDAR PATEL UNIVERSITY

Vallabh Vidyanagar

NAAC 'A' Grade (10-01-2023 To 09-01-2028)

NEP-2020 aligned Curriculum with effect from Academic Year 2026-27

M.Sc. (Physics) Semester – I

Assessment and Evaluation:

Sr. No.	Assessment/Evaluation	Component	Weightage (%)
1	Continuous Internal Evaluation	Internal Practical Exam	50
2	End-Semester Examination	External Practical Exam	50

CLOs – PLOs Matrix

PLO \ CLO	1	2	3	4	5	6	7	8	9	10
1	2	1	2	3	2	2	2	1	1	1
2	3	2	3	2	3	3	3	3	2	2
3	3	1	3	3	3	3	2	2	2	2
4	2	3	3	2	3	2	2	3	1	1
5	2	2	3	2	3	2	3	3	1	2

Values to CLO-PLO matrix are assigned by judging the importance of the particular CLO in relation to the PLOs.

CLO – PLO correlation	Value
Strong	3
Moderate	2
Low	1
No correlation	-

Suggested Learning Materials Books:

Sr. No.	Title	Author(s)	Edition/Year	Publisher
1	Practical Physics	A. Srivastava, R. K. Shukla	2018	New age publisher
2	B.Sc. Practical Physics	C. L Arora	2016	S Chand
3	Electronic: Vol I & II	K. A. Navas	5th Edition 2015	PHI Learning Pvt. Ltd.
4	Digital Electronics: A Comprehensive Lab Manual	Cherry Bhargava	2019	BSP Books
5	Numerical Methods	Balagurusamy	1999	McGrew Hill
6	Computational Physics: An Introduction	R C Verma, P K Ahluwalia, K C Sharma	2014	New Age International
7	Electronics Practical	A K Sawhney	19th Edition 2015	Dhanpat Rai & Co. (Pvt.) Ltd.



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M.Sc. (Physics) Semester – I

Course Type	Course Code	Course Title	Teaching-Learning Scheme	Total Notional Hours	Course credits
			L-P-T		
DSC	P2S01NCPHY05	Practical II	0-8-0	120	04

Course Learning Outcomes (CLOs)

After completing the lab, students will be able to:

CLO1 Perform experiments to illustrate the principle of nuclear physics and apply it to analyse radioactive sources.

CLO2 Apply concepts of mathematical and computational physics and classical mechanics to study nonlinear dynamics including chaos.

CLO3 Perform experiments to determine thermal, electrical and vibrational properties of materials.

CLO4 Determine solar cell characteristics of semiconducting materials.

CLO5 Practice standard numerical data analysis in experimental results including standard deviation, error propagation computation etc.

Sr. No.	List of Practicals	CLO(s)
1	Thermal Properties of Semiconductor	CLO3, CLO5
2	Lattice Dynamics	CLO3, CLO5
3	Damped Harmonic Oscillator	CLO2, CLO5
4	Dielectric Constant of Solid	CLO3
5	G. M. Counter I	CLO1, CLO5
6	Solar Cell	CLO4
7	Numerical Analysis: Chaos	CLO2, CLO5

Assessment Methodologies/Tools

(I) Internal Assessment [Total: 50 Marks]

a. Internal Formative assessment [25]

(m) Preparation of Journal

(n) Viva Voce

(o) Laboratory Regularity

b. Internal Summative Assessment [25]

(i) Mid-term tests

(j) Laboratory Performance

(J) Weightage of Learning Efforts for External Assessment [Total: 50 Marks]

Practical	Aligned CLOs	Total Learning Hours	Approximate weightage (Marks) to Learning levels (BT)			Total Marks
			Remember (R)	Understanding (U)	Analyse & above (A)	
1	3, 5	17	1	1	5	7
2	3, 5	17	1	1	5	7
3	2, 5	17	1	1	5	7
4	3	17	1	1	5	7
5	1, 5	17	1	1	5	7
6	4	17	1	1	5	7
7	2, 5	18	1	1	6	8
		120	07	07	36	50



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M.Sc. (Physics) Semester – I

Assessment and Evaluation:

Sr. No.	Assessment/Evaluation	Component	Weightage (%)
1	Continuous Internal Evaluation	Internal Practical Exam	50
2	End-Semester Examination	External Practical Exam	50

CLOs – PLOs Matrix

PLO \ CLO	1	2	3	4	5	6	7	8	9	10
1	3	1	3	3	2	1	1	1	2	1
2	3	3	3	1	2	1	2	3	1	1
3	3	2	3	3	3	3	2	2	2	2
4	3	1	3	3	3	3	3	2	1	3
5	2	2	3	2	3	2	1	3	1	2

Values to CLO-PLO matrix are assigned by judging the importance of the particular CLO in relation to the PLOs.

CLO – PLO correlation	Value
Strong	3
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4	Digital Electronics: A Comprehensive Lab Manual	Cherry Bhargava	2019	BSP Books
5	Numerical Methods	Balagurusamy	1999	McGraw Hill
6	Computational Physics: An Introduction	R C Verma, P K Ahluwalia, K C Sharma	2014	New Age International
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M.Sc. (Physics) Semester – I

Course Type	Course Code	Course Title	Teaching-Learning Scheme	Total Notional Hours	Course credits
			L-P-T		
DSC	P2S01NCPHY06	Computational techniques for physics: Problem based skills	1-2-0	60	02

Course Learning Outcomes (CLOs)

On completion of this course, students will be able to:

CLO1: Apply Maxwell's equations in matter to analyze charge conservation, energy flow, and momentum transfer, along with electromagnetic wave propagation in vacuum including polarization and energy–momentum relations.

CLO2: Evaluate electromagnetic wave behavior in material media using boundary conditions, reflection and refraction, and transmission at interfaces through Fresnel equations.

CLO3: Apply scalar and vector potentials, gauge conditions, and retarded formulations to determine electromagnetic fields of time-varying sources

CLO4: Analyze radiation from accelerated charges and localized sources using Larmor formula and its relativistic generalization, including dipole radiation, radiation patterns, and mechanisms such as synchrotron and bremsstrahlung radiation.

Unit	Course Content	Learning Pedagogies*	CLO(s)
I	<p>Python for Scientific and Physical Computation: Python as a scientific computing tool: variables, data types, control structures, functions, and programming in the context of physical problems. Numerical data handling: arrays, vectorized operations, and efficient computation of physical quantities. Visualization of physical systems: plotting scalar and vector fields, time-dependent behavior, and parametric representations. Introduction to computational thinking: algorithm design, validation, and physical interpretation of numerical results Problem-based implementation: simple physical models such as motion under constant acceleration, oscillatory systems, and basic field distributions. Introduction to numerical implementation: basic coding of simple algorithms such as root finding, integration, differentiation.</p>	ICL, PBL	CLO1 CLO2
II	<p>Numerical and Integral Transform Methods with Physical Applications Error analysis and numerical accuracy: floating-point representation, truncation and round-off errors, and their impact on physical computations. Numerical methods for physical systems: root finding, numerical integration, numerical differentiation, and solution of ordinary differential equations.</p>	ICL, PBL, ICT, IBL, CBL, SDL, CDV, ACA	CLO3 CLO4



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	<p>Integral transforms and spectral methods: Fourier transforms and Laplace transforms and their numerical implementation, physical interpretation of frequency-domain representations, and applications to linear systems.</p> <p>Convolution and system response: basics and numerical implementation of convolution, impulse response, and their applications in physical systems.</p> <p>Basic signal analysis: time-domain and frequency-domain representation of signals, sampling concepts, and interpretation of spectra.</p>		
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(* Learning Pedagogies/Methods

- (t) ICL: Interactive Classroom Lecture
- (u) CBL: Case-Based Learning
- (v) PBL: Problem-Based Learning
- (w) ICT: ICT-Enabled Learning (LMS-based Tasks, Digital Resources, Virtual Labs/Webinars)
- (x) IBL: Inquiry-Based Learning
- (y) SDL: Self-Directed Learning (Guided Readings, Concept Exploration Tasks)
- (z) CDV: Computational Demonstration and Visualization
- (aa) ACA: Analytical-Computational Approach

• Assessment Methodologies/Tools

(K) Internal Assessment [Total: 25 Marks]

a. Internal Formative assessment [10]

- (p) Assignment, Self-learning and Terms work
- (q) Seminar/Presentation
- (r) Class Regularity

b. Internal Summative Assessment [15]

- (k) Mid-term tests
- (l) Laboratory performance
- (m) Quizzes



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M.Sc. (Physics) Semester – I

(B) Weightage of Learning Efforts for External Assessment [Total: 25 Marks]

Unit	Aligned CLOs	Total Learning Hours	Approximate weightage (Marks) to Learning levels (BT)			Total Marks
			Remember (R)	Understanding (U)	Analyse & above (A)	
I	1, 2	30	2	3	7	12
II	3, 4	30	2	3	8	13
		60	4	6	15	25

Assessment and Evaluation

Sr. No.	Assessment/Evaluation	Component	Weightage (%)
1	Practical Internal Evaluation	Assignments, Quizzes, Lab Regularity, Practical.	50
2	End-Semester Examination	Written Exam/Practical Exam & viva	50

CLOs – PLOs Matrix

PLO \ CLO	1	2	3	4	5	6	7	8	9	10
1	3	3	3	-	2	-	-	2	3	-
2	3	2	3	-	2	1	1	2	3	-
3	3	3	3	-	2	-	-	3	3	-
4	3	3	3	-	2	-	-	3	3	-

Values to CLO-PLO matrix are assigned by **judging the importance of the particular CLO** in relation to the PLOs.

CLO – PLO correlation	Value
Strong	3
Moderate	2
Low	1
No correlation	-



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M.Sc. (Physics) Semester – I

Suggested Learning Materials Books:

Sr. No.	Title	Author(s)	Edition/Year	Publisher
1	Introduction to Electrodynamics	David J Griffiths,	3 rd , 2002	Prentice Hall, India
2	Modern Electrodynamics	Andrew Zangwill	2013	Cambridge University Press
3	Electrodynamics Tutorials with Python Simulations	Taejoon Kouh Minjoon Kouh	2024	CRC press
4	LASERS Theory and Applications.	K. Thyagarajan and A. K. Ghatak	2008	Macmillan India Ltd.,
5	Lasers and Non-linear Optics	B. B. Laud	2 nd , 1996	New Age International

Online Resources (Open Source)

Sr. No.	Description of Resource(s)	Weblink
1	Scientific Computing with Python (freeCodeCamp)	https://www.freecodecamp.org/learn/scientific-computing-with-python
2	Python for Scientific Computing (Aalto University)	https://aaltoscicomp.github.io/python-for-scicomp/
3	Introduction to Python for Physics (YouTube Lecture)	https://www.youtube.com/watch?v=LIb14A1ULmI
4	Computational Physics Using Python (YouTube Series)	https://youtu.be/mLZTDcewtfg?si=uowB-pSapGiVLNYj