Chaudhary Bansi Lal University, Prem Nagar

(A State University established under Haryana Act No. 25 of 2014)

Scheme of Examination
For
Post Graduate Programme

M.Sc. PHYSICS

as per NEP 2020
Curriculum and Credit Framework for Undergraduate Programmes
(Multiple Entry-Exit, Internships and Choice Based Credit System LOCF)

With effect from the session 2025-26 (in phased manner)

DEPARTMENT OF PHYSICS

Chaudhary Bansi Lal University, Prem Nagar-127021
Bhiwani
HARYANA, INDIA

Programme Learning Outcomes(PLOs) for PG Programmes as per NEP-2020

PLOs	Master Degree in Physics
	After the completion of Master degree in Physics the student will be able to:
PLO-1: Knowledge and Understanding	Demonstrate the fundamental and advanced knowledge of the subject and understanding of recent developments and issues, including methods and techniques, related to the Physics.
PLO-2: General Skills	Acquire the general skills required for performing and accomplishing the tasks as expected to be done by a skilled professional in the fields of Physics.
PLO-3: Technical/ Professional Skills	Demonstrate the learning of advanced cognitive technical/professional skills required for completing the specialized tasks related to the profession and for conducting and analyzing the relevant research tasks indifferent domains of the Physics.
PLO-4: Communication Skills	Effectively communicate the attained skills of the Physics in well-structured and productive manner to the society at large.
PLO-5: Application of Knowledge and Skills	Apply the acquired knowledge and skills to the problems in the subject area, and to identify and analyze the issues where the attained knowledge and skills can be applied by carrying out research investigations to formulate evidence-based solutions to complex and unpredictable problems associated with the field of Physics or otherwise.
PLO-6: Critical thinking and Research Aptitude	Attain the capability of critical thinking in intra/inter-disciplinary areas of the Physics enabling to formulate, synthesize, and articulate issues for designing of research proposals, testing hypotheses, and drawing inferences based on the analysis.
PLO-7: Traditional knowledge, Values and Ethics	Demonstrate awareness of traditional astronomical tools and methodologies and compare them with modern instruments. Understand the historical, cultural, and philosophical foundations of Indian science and its global relevance.
PLO-8: Capabilities/qualities and mindset	To exercise personal responsibility for the outputs of own work as well as of group/team and for managing complex and challenging work(s)that requires new/strategic approaches.
PLO-9: Employability and job-ready skills	Attain the knowledge and skills required for increasing employment potential, adapting to the future work and responding to the rapidly changing demands of the employers/industry/society with time.

Chaudhary Bansi Lal University Bhiwani

Scheme of Examination for the Post Graduate Programmes (M.Sc. Physics)

as per NEP 2020 Curriculum and Credit Frame work for Postgraduate Programmes

(Choice Based Credit System LOCF) with effect from the session 2025-26 (in a phased manner)

2-year PG Programme

Semester I

Course Type	Course Code	Nomenclature of course	Theory (T)/ Practical (P)	Credits		Contact hours per week L: Lecture P: Practical T: Tutorial				Internal Assessment Marks	End Term Examination Marks	Total Marks	Examination hours
					Total	L	T	P	Total				
CC-1	25PN-PHY-101	Mathematical Physics	T	4	24	4	0	0	4	30	70	100	3
CC-2	25PN-PHY-102	Classical Mechanics	T	4		4	0	0	4	30	70	100	3
CC-3	25PN-PHY-103	Quantum Mechanics -I	T	4		4	0	0	4	30	70	100	3
DEC-I	25PN-PHY-105E	Electronic Devices and Circuits- I	T	4		4	0	0	4	30	70	100	3
	25PN-PHY-105M	Material Science -I											
CC-4	25PN-PHY-104	General Electronics-I	P	4		0	0	8	8	30	70	100	3
PC-1	25PN-PHY-106	Physics Lab- I	P	4		0	0	8	8	30	70	100	3

Semester II

CC-5	25PN-PHY-201	Nuclear and Particle Physics	T	4	26	4	0	0	4	30	70	100	3
CC-6	25PN-PHY-202	Solid State Physics	T	4		4	0	0	4	30	70	100	3
CC-7	25PN-PHY-203	Quantum Mechanics - II	T	4		4	0	0	4	30	70	100	3
DEC-II	25PN-PHY-205E	Electronic Devices and Circuits-II	T	4		4	0	0	4	30	70	100	3
	25PN-PHY-205M	Material Science -II											
CC-8	25PN-PHY-204	General Electronics-II	P	4		0	0	8	8	30	70	100	3
PC-2	25PN-PHY-206	Physics Lab-II	P	4		0	0	8	8	30	70	100	3
IKS	25PN-PHY-IKS201	India’s contribution to science	T	2		2	0	0	2	15	35	50	3

An internship course of 4-6 weeks duration during summer vacation after IInd semester may be allowed to be completed by student. Internship can be either for enhancing the employability or for developing the research aptitude.

Session: 2024-25			
Part A - Introduction			
Name of Programme	M.Sc. Physics		
Semester	1st		
Name of the Course	Mathematical Physics		
Course Code	25PN-PHY-101		
CourseType	CC-I		
Level of the course	500-599		
Pre-requisite for the course (ifany)	--		
CourseLearningOutcomes (CLO) After completing this course, the learner will be able to:	**CLO 101.1:** Understand basics of group theory, preparation of group multiplication tables and construction of character table of symmetry groups. **CLO 101.2:** Find the Fourier series expansion, Fourier integrals, Fourier and Laplace transforms of functions and derivatives. **CLO 101.3:** Obtain explicit expressions of Hermite, Laguerre, Bessel and Legendre polynomials and to establish their recurrence relations and other properties. **CLO 101.4**: Derive Cauchy integral theorem, Cauchy integral formula, Taylor and Laurent series expansion of functions of complex variable and to evaluate some typical definite integral using the method of contour integration.		
Credits	Theory	Practical	Total
	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Time	3 hours		

PartB-Contents of the Course

Instructions for Paper-Setter

1. The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration.
2. The compulsory question (Question No. 1) will consist of at least 4 parts covering entire syllabus.
3. The question paper is expected to contain problems to the extent of 20% of total marks.
4. The examinee will be required to attempt 5 questions; selecting one question from each unit and the compulsory question. All questions will carry equal marks.

Unit	Topics	Contact Hours
I	**Group Theory**: Fundamentals of Group theory: Definition of a group and illustrative examples, Group multiplication table, rearrangement theorem, cyclic groups, sub-groups and co-sets, permutation groups, conjugate elements and class structure, normal devisors and factor groups, isomorphism and homomorphism, class multiplication.	15

	Group representation: Reducible and irreducible representations, great orthogonality theorem (without proof) and its geometric interpretation, character of a representation, construction of character table with illustrative examples of symmetry groups of equilateral triangle, rectangle and square.Decomposition of reducible representation, the regular representation. The elements of the group of Schrodinger equation.	
II	**Fourier Series and Integral Transforms:** Fourier series, General properties, Advantages and applications, Gibbs phenomenon, Development of the Fourier integral, Inversion theorem, Fourier transform, Fourier transform of derivatives, Momentum representation, Laplace transform, Laplace transform of derivative, Properties of Laplace transforms, Faltungs theorem, Inverse Laplace transformation.	15
III	**Special Functions**: Bessel Functions: Bessel functions of the first kind $J_n(x)$, Generating function, Recurrence relations, Expansion of $J_n(x)$ when n is half an odd integer, Integral representation; Legendre Polynomials $P_n(x)$: Generating function, Recurrence relations and special properties, Rodrigues' formula, Orthogonality of $P_n(x)$; Associated Legendre polynomials, Spherical harmonics, Addition theorem for spherical harmonics, Hermite and Laguerre Polynomials: generating function & recurrence relations only.	15
IV	**Functions of a complex variable and calculus of residues:**Complex algebra, Functions of a complex variable, Cauchy's integral theorem, Cauchy's integral formula; Taylor and Laurent expansions; Singularities; Cauchy's residue theorem, Cauchy principle value, Singular points and evaluation of residues, Jordan's Lemma; Evaluation of definite integrals of the type: $\int_0^{2\pi} f(\sin\theta, \cos\theta)\, d\theta$; $\int_{-\infty}^{\infty} f(x) dx$; $\int_{-\infty}^{\infty} f(x) e^{iax} dx$ using Cauchy's residue theorem.	15
	Total Contact Hours	60

SuggestedEvaluationMethods

InternalAssessment: 30		End Term Examination: 70	
➢ **Theory**	**30**	➢ **Theory:**	**70**
• Class Participation:	5	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc.:	10		
• Mid-Term Exam:	15		

PartC-Learning Resources

Recommended Books/e-resources/LMS:

1. Group Theory and Quantum Mechanics by M. Tinkam.
2. Mathematical Methods for Physicists (4^{th} edition) by G. Arfken.
3. Mathematical Methods for Physicists (6^{th} edition) by Arfken and Weber.
4. Mathematical Physics for Physicists and Engineers by L. Pipes.
5. Introduction to Mathematical Physics by C. Harper.

Session: 2024-25			
Part A - Introduction			
Name of Programme	M.Sc. Physics		
Semester	1st		
Name of the Course	Classical Mechanics		
Course Code	25PN-PHY-102		
CourseType	CC-2		
Level of the course	500-599		
Pre-requisite for the course (ifany)	--		
CourseLearningOutcomes (CLO) After completing this course, the learner will be able to:	**CLO 102.1:** Demonstrate a basic and advanced knowledge of Lagrangian and Hamiltonian Formulations and solve related problems. Identify the cyclic coordinates and understand their importance in Hamiltonian formulation. **CLO102.2:** Acquire knowledge of canonical Transformation and various generating functions for this transformation. Develop a deep understanding to tackle the problems of classical mechanics under small oscillations. **CLO 102.3:** Demonstrate the concept of motion of a particle under central force and apply advanced methods to deal with central force problems. Use Hamilton-Jacobi theory for finding the solutions of various Classical systems. **CLO 102.4:**Understand the foundations of nonlinear dynamics in general and chaotic motion and fractals, in particular. Perform stability analysis of cubic anharmonic oscillator and undamped pendulum, and find chaotic trajectories.		
Credits	Theory	Practical	Total
	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Time	3 hours		

Part B-Contents of the Course

Instructions for Paper- Setter: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist of at least 4 parts covering entire syllabus. The question paper is expected to contain problems to the extent of 20% of total marks. The examinee will be required to attempt 5 questions; selecting one question from each unitand the compulsory question. All questions will carry equal marks.

Unit	Topics	Contact Hours
I	**Lagrangian and Hamiltonian formulations:** Hamilton's principle,	15

	Derivation of Lagrange's equations from Hamilton's principle, Principle of Least Action and its applications, Canonical Transformation; The Hamiltonian Formalism: Canonical formalism, Hamiltonian equations of motion, The physical significance of the Hamiltonian, Cyclic coordinates, Rauthian procedure and equations, Derivation of Generating functions, examples, properties, Derivation of Hamiltonian equations from variational principle.	
II	**Poisson bracket and theory of small oscillations**: Poisson bracket, special cases of Poisson bracket, Poisson theorem, Poisson bracket and canonical transformation, Jacobi identity and its derivation, Lagrange bracket and its properties, the relationship between Poisson and Lagrange brackets and its derivation, the angular momenta and Poisson bracket, Liouville's theorem and its applications; Theory of small oscillations: Formulation of the problem, Eigenvalue equation and the principle axis transformation, frequencies of free vibrations and normal coordinates, free vibrations of a linear triatomic molecule.	15
III	**Two-body central force problem and H-J theory:** Two body central force problem: Reduction to the equivalent one body problem, the equation of motion and first integrals, classification of orbits, the Virial theorem, the differential equation for the orbit, integrable power law in time in the Kepler's problem, scattering in central force field; H-J Theory: H-J equation and their solutions, use of H-J method for the solution of harmonic oscillator problem, Hamilton's principle function, Hamilton's characteristic function and their properties.	15
IV	**Introductory non-linear dynamics:** Classical Chaos: Linear and nonlinear systems, periodic motion, Perturbation and KAM theorem, dynamics in phase space, phase portraits for conservative systems, attractors, classification and stability of equilibrium points, stability analysis of cubic an harmonic oscillator and un damped pendulum, chaotic trajectories and Liapunov exponent, Poincare Map, Henon-Hiels Hamiltonian, bifurcation, driven-damped harmonic oscillator, the logistic equation, Fractals and dimensionality.	15
	Total Contact Hours	60

Suggested Evaluation Methods			
InternalAssessment: 30		**End Term Examination: 70**	
➢ **Theory**	**30**	➢ **Theory:**	**70**
• Class Participation:	5	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc.:	10		
• Mid-Term Exam:	15		

Part C-Learning Resources

Recommended Books/e-resources/LMS:

1. Classical Mechanics (3rd ed., 2002) by H. Goldstein, C. Poole and J. Safko, Pearson Edition
2. Classical Mechanics by John R Taylor.
3. Chaos and Integrability in nonlinear dynamics: An introduction (1989) by Michael Tabor.
4. Nonlinear dynamics: Integrability, Chaos and patterns (2003) by M. Lakshmanan and S. Rajasekar.
5. Classical Mechanics, J.C. Upadhyaya, Himalaya Publishing House.

Session: 2024-25			
PartA–Introduction			
Name of Programme	M. Sc. Physics		
Semester	1st		
Name of the Course	Quantum Mechanics-I		
Course Code	25PN-PHY-103		
CourseType	CC-3		
Level of the course	500-599		
Pre-requisite for the course (ifany)	--		
CourseLearningOutcomes (CLOs) After completing this course, the learner will be able to:	**CLO 103.1:** Realize basic quantum-mechanical view point, learn its wave mechanical & matrix formulations, and solve the Schrödinger equation for simple potentials, including harmonic and central potentials. **CLO 103.2:** Construct matrices for observables and wave functions in different representations, apply matrix theory to linear harmonic oscillator, and describe the time-development of a quantum system in Schrödinger, Heisenberg and Interaction pictures. **CLO 103.3:** Calculate the eigenvalues and eigen functions for the orbital and general angular momenta, learn the matrix representation of angular momentum, and perform addition of two angular momenta. **CLO 103.4:** Grasp the concepts of identity & indistinguishability, understand symmetric and anti-symmetric wave functions, construct spin and total wave functions for a system of two spin ½ particles, and comprehend connection among spin, symmetry & statistics.		
Credits	Theory	Practical	Total
	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Time	3 hours		
PartB-Contentsofthe Course			
Instructions for Paper- Setter: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist of at least 4 parts covering entire syllabus. The			

question paper is expected to contain problems to the extent of 20% of total marks. The examinee will be required to attempt 5 questions; selecting one question from each unitand the compulsory question. All questions will carry equal marks.		
Unit	**Topics**	**Contact Hours**
I	**Schrodinger formulation of Quantum Mechanics:** Recapitulation of basic concepts: Two-slit experiment with *em* radiation and matter particles, Quantum-mechanical view point, The Schrödinger wave equation, Expectation values, Ehrenfest theorem; Interpretative postulates of quantum mechanics: Dynamical variables as Hermitian operators, Eigenvalues and eigenfunctions, Expansion in eigenfunctions; Illustration of postulates for energy and momentum: Orthonormality of eigenfunctions, Reality of eigenvalues, Closure property, Probability function and expectation value, Co-ordinate and momentum representations of wave function, Uncertainty principle for two arbitrary observables; Problems: A charged particle in a uniform static magnetic field (eigenfunctions and Landau levels); The Hydrogen atom (reduced mass, radial wave functions and energy eigenvalues).	15
II	**Matrix formulation of Quantum Mechanics:** Preliminaries: Hermitian and unitary matrices, Transformation and diagonalization of matrices, Matrices of infinite rank; Representation of observables and wave functions as matrices, Transformation theory, choice of basis, change of basis, unitary transformations, Hilbert space representation; Dirac's ket and bra notation; Time-development of quantum system: Schrödinger, Heisenberg and Interaction pictures, Link with classical equations of motion, Quantization of a classical system; Application to motion of a particle in an *em* field; Matrix theory of the harmonic oscillator: Spectrum of eigenvalues and eigenfunctions, Matrices for position, momentum and energy operators (energy representation).	15
III	**Quantum theory of Angular Momentum:** Orbital angular momentum operator **L**, Cartesian and spherical polar co-ordinate representation, Commutation relations, Orbital angular momentum and spatial rotations, Eigenvalues and eigenfunctions of $\mathbf{L}^2$ and L_z, Spherical harmonics; General angular momentum **J**: Eigenvalues and eigenfunctions of $\mathbf{J}^2$ and J_z, Matrix representation of angular momentum operators, Spin angular momentum, Wave function including spin (Spinor); Spin one-half: Spin eigenfunctions, Pauli spin matrices; Addition of two angular momenta, Clebsch-Gordan coefficients and their calculation for $j_1= j_2 =1/2$, $j_1=1$, $j_2 =1/2$ and $j_1= j_2 =1$; The Wigner-Eckart theorem.	15

IV	**Many-particle systems and identical particles:** Many-particle Schrödinger wave equation, Stationary-state solutions; Systems of identical particles, Physical meaning of identity, Principle of indistinguishability, Exchange and transposition operators, Totally symmetric and anti-symmetric wave functions, Time-invariance of symmetry, Construction of symmetric and anti-symmetric wave functions, Connection among spin, symmetry and statistics of identical particles, Fermions and bosons; Spin and total wave functions for a system of two spin ½ particles, Pauli exclusion principle and Slater determinant; Application to the electronic system of the helium atom (*para*- and *ortho*-helium); Limit of distinguishability of identical particles; Basic idea of quantum entanglement.	15
	Total Contact Hours	60

SuggestedEvaluationMethods

Internal Assessment: 30		**End Term Examination: 70**	
➢ **Theory**	**30**	➢ **Theory:**	**70**
• Class Participation:	5	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc.:	10		
• Mid-Term Exam:	15		

PartC-Learning Resources

Recommended Books/e-resources/LMS:

1. Quantum Mechanics (3rd edition) by L. I. Schiff
2. Quantum Mechanics (2nd edition) by B. H. Bransden and Joachain
3. Quantum Mechanics (3rd edition) by S. Gasiorowicz
4. Quantum Mechanics (3rd edition) by E. Merzbacher
5. Quantum Mechanics by John L. Powell and B. Crasemann
6. Quantum Mechanics by A. K. Ghatak and S. Loknathan
7. Introductory Quantum Mechanics (4th edition) by Richard L. Liboff
8. Quantum Mechanics: Concepts and Applications (2nd edition) by N. Zettili
9. Quantum Mechanics by Y. B. Band and Y. Avishai

Session: 2024-25			
PartA - Introduction			
Name of Programme	M.Sc. Physics		
Semester	1st		
Name of the Course	Electronic Devices and Circuits-I		
Course Code	25PN-PHY-105E		
CourseType	DEC-I		
Level of the course	500-599		
Pre-requisite for the course (if any)	--		
CourseLearningOutcomes (CLO) After completing this course, the learner will be able to:	**CLO 104.1:** Be aware of the general characteristics of important semiconductor materials. Develop a deep understanding of the basic design, operation and characteristics of a pn-junction and a BJT along with knowledge of the basic network theorems and their applications in electronic circuit analysis. **CLO 104.2:**Learn to devise and analyze various transistor amplifier models. Understand the concept of negative feedback and its importance in amplifiers. **CLO 104.3:** Perform a load-line analysis and design of various biasing schemes in amplifiers. Acquaint with the frequency response of variously coupled amplifiers and sources of noise in electronic devices. **CLO 104.4:** Gain knowledge of classification, sources of distortions and their estimation, operation and determination of efficiency of power amplifiers. Clearly understand the need of regulation, operation and circuit analysis of different voltage and current regulators.		
Credits	Theory	Practical	Total
	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Time	3 hours		

PartB-Contentsofthe Course

Instructions for Paper- Setter: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist of at least 4 parts covering entire syllabus. The question paper is expected to contain problems to the extent of 20% of total marks. The examinee will be required to attempt 5 questions; selecting one question from each unitand the compulsory question. All questions will carry equal marks.

Unit	Topics	Contact

		Hours
I	**Basics of pn-junction, BJT and Network Theorems:** Semiconductors: intrinsic and extrinsic semiconductors, charge densities in p and n type semiconductors, conduction by charge drift and diffusion, the pn-junction, energy level diagrams of pn-junction under forward and reverse bias conditions, derivation of pn-diode equation, Zener diode, Zener and avalanche breakdowns, clipping and clamping circuits; The bipolar junction transistor: basic working principle, configurations and characteristics, voltage breakdowns, Network theorems: node, mesh, superposition, Miller's, Thevenin's and Norton's theorems.	15
II	**Amplifier Models, Feedback and Biasing**: Two port network analysis: active circuit models, gain in decibels, equivalent circuit for BJT, the transconductance model for BJT, analysis of CE, CB, and CC amplifiers; An amplifier with feedback, effect of negative feedback on gain and its stability, distortions, input and output impedances of amplifiers, Location of quiescent (Q) point, biasing circuits for amplifiers: fixed bias, emitter feedback bias & voltage feedback bias, bias compensation, bias techniques for linear integrated circuits, thermal runaway and thermal stability.	15
III	**Frequency Response of Amplifiers:** The amplifier pass band, mid frequency range response of a direct coupled CE cascade, the high frequency equivalent circuit (Miller effect), the high frequency response of a direct coupled CE cascade, the frequency response of RC and transformer coupled CE amplifiers, gain-frequency plots of amplifier response (Bode plots), bandwidth of cascaded amplifiers, bandwidth criterion for the transistor, the gain-bandwidth product, composite amplifier designs, bootstrapping in amplifiers, noise in amplifiers, noise figure.	15
IV	**Power Amplifiers and Regulators:** Power amplifiers: class A large signal amplifier, second and higher order harmonic distortions, the transformer coupled power amplifier, impedance matching, efficiency, push-pull amplifiers, class-B amplifiers, complementary stages, cross over distortions, class-AB operation, heat sinks, derating curve; Electronic voltage regulators: basic operation and analysis of Zener diode voltage regulator, single BJT shunt and series regulators, feedback series BJT regulator and current regulator, overload and short circuit protection circuits.	15
	Total Contact Hours	60

SuggestedEvaluationMethods

InternalAssessment: 30		**End Term Examination: 70**	
➢ **Theory**	**30**	➢ **Theory:**	**70**
• Class Participation:	5	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc.:	10		
• Mid-Term Exam:	15		

PartC-Learning Resources

Recommended Books/e-resources/LMS:

1. Electronic fundamentals and applications (5^{th} Ed.) by J. D. Ryder.
2. Integrated Electronics by J. Millman and C. C. Halkias.
3. Circuits and Networks: Analysis and Synthesis by A.Sudhakar and S.M.S. Palli
4. Electronic devices and circuits by Y. N. Bapat.
5. Pulse, digital and switching waveforms by J. Millman and H. Taub.
6. Millman's Electronic Devices and Circuits by J. Millman, C. C. Halkias&SatyabrataJit

7. Electronic Devices and Circuit Theory by Robert L Boylestadand Louis Nashelsky.
8. Solid state Electronic Devices by B.G. Streetman and S.K. Banerjee.

Session: 2025-26 (As per scheme 2024-25)			
PartA–Introduction			
Name of Programme	M. Sc. Physics		
Semester	1st		
Name of the Course	Material Science-I		
Course Code	25PN-PHY-105M		
CourseType	DEC-I		
Level of the course	500-599		
Pre-requisite for the course (ifany)	--		
CourseLearningOutcomes (CLOs) After completing this course, the learner will be able to:	**CLO 308.1:**Understand the basic concepts and properties of Materials and describe how and why defects (point, line and planar) in materials greatly affect engineering properties and limit their use in service **CLO 308.2:**Understand strengthening and grasp the importance of various strengthening mechanisms and describe various parameters involved in elastic deformation, plastic deformation, anelastic deformation etc. **CLO 308.3:**Grasp the concept of phase diagrams and be able to predict microstructures and understand transformation mechanisms (nucleation and growth, martensitic)and comprehend Iron-Carbon system and ceramics. .**CLO 308.4:**Elucidate the kinematics of elastic collisions and have in depth understanding energetic ion beam based techniques (given in the syllabus) for analysis of materials and perform computations of depth profiles and concentration analysis using these techniques, Choose the most appropriate technique for characterization.		
Credits	Theory	Practical	Total
	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Time	3 hours		
PartB-Contentsofthe Course			

Instructions for Paper- Setter: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist of at least 4 parts covering entire syllabus. The question paper is expected to contain problems to the extent of 20% of total marks. The examinee will be required to attempt 5 questions; selecting one question from each unitand the compulsory question. All questions will carry equal marks.

Unit	Topics	Contact Hours
I	**Imperfections in Solids:** Point Defects: vacancy, substitutional, interstitial, Frenkel and Schottky defects, equilibrium concentration of Frenkel and Schottky defects**;** Line Defects: slip planes and slip directions, edge and screw dislocations, Burger's vector, cross-slip, glide and climb, jogs, dislocation energy, super & partial dislocations, dislocation multiplication, Frank Read sources; Planar Defects: grain boundaries and twin interfaces; Dislocation Theory – experimental observation of dislocation, dislocations in FCC, HCP and BCC lattice.	15
II	**Mechanical Properties:** Stress Strain Curve; Elastic Deformation: atomic mechanism of elastic deformation and anisotropy of Young's modulus, elastic deformation of an isotropic material; Anelastic and Viscous deformation; Plastic Deformation: Schmid's law, critically resolved shear stress; Strengthening Mechanisms: work hardening, recovery, recrystallization, strengthening from grain boundaries, low angle grain boundaries. Yield point. Strain aging, solid solution strengthening, two phase aggregates, strengthening from fine particles; Fracture: ideal fracture stress, brittle fracture-Griffith's theory, ductile fracture.	15
III	**Microstructure:** Solid Solutions and Intermediate Phases: phase rule, unitary & binary phase diagrams, Lever rule, Hume-Rothery rule; Free Energy and Equilibrium Phase Diagrams: complete solid miscibility, partial solid miscibility-eutectic, peritectic and eutectoid reactions, eutectaid mixture; Nucleation, Growth and Overall Transformation Kinetics; Martenstic Transformation; The Iron-Carbon System: various phases, phase diagram, phase transformations, microstructure and property changes in iron-carbon system; Ceramics: glass transition temperature, glassformers, commercial ceramics, mechanical properties, high temperature properties.	15
IV	**Materials Processing and Characterization:** Ion Implantation: introduction, ion implantation process, depth profile, radiation damage and annealing effects of trace-impurities, implantation induced alloying and structural phase transformation; Rutherford Backscattering Spectrometry (RBS): principle, kinematics of elastic collision, shape of the backscattering spectrum, depth profiles and concentration analysis, applications; Elastic Recoil Detection Analysis (ERDA): basic principle, kinematics, concentration analysis, depth profiling, depth resolution, applications; Secondary Ion Mass Spectroscopy (SIMS): basic principle, working, yield of secondary ions and applications.	15
	Total Contact Hours	60

SuggestedEvaluationMethods			
InternalAssessment: 30		**End Term Examination: 70**	
➢ **Theory**	**30**	➢ **Theory:**	**70**
• Class Participation:	5	Written Examination	

• Seminar/presentation/assignment/quiz/class test etc.:	10	
• Mid-Term Exam:	15	

PartC-Learning Resources

Recommended Books/e-resources/LMS:

1. Material Science by J. C. Anderson, K. D. Leaver, J. M. Alexander and R. D. Rawlings
2. Mechanical Metallurgy by G. E. Dieter
3. Ion Implantation by G. Dearnally
4. Fundamentals of Surface and Thin Film Analysis by L. C. Feldman and J. W. Mayer
5. Surface Analysis Methods in Material Science by D. J. O'Connor, B. A. Sexton and R. St. C. Smart (Eds), Springer Series in Surface Sciences 2023.

PartA- Introduction			
Name of the Programme	M.Sc. Physics		
Semester	1st		
Name of the Course	General Electronics-I		
Course Code	25PN-PHY-104		
CourseType	CC-4		
Level of the course	500-599		
Pre-requisite for the course (ifany)	--		
CourseLearningOutcomes (CLO) After completing this course, the learner will be able to:	**CLO 105.1:** Draw and understand the frequency response of different Filter circuits and a RC-coupled amplifier in its three configurations. Also measure important parameters of rectifier, filter, voltage regulator and pn-junction circuits. **CLO 105.2**: Design and draw load characteristics of a push-pull amplifier **CLO 105.3:** Design and understand the operations of clipping, clamping circuits, differentiating and integrating circuits. **CLO 105.4:** Measure the sensitivities of X and Y plates of a CRO and determine frequency and phase-difference using a CRO.		
Credits	Theory	Practical	Total
	0	4	4
Teaching Hours per week	0	8	8
Internal Assessment Marks	0	30	30
End Term Exam Marks	0	70	70
Max. Marks	0	100	100
Examination Time	0	4 hours	

PartB-Contentsofthe Course	
Practicals	**Contact Hours**
Note: Student will perform at least eight experiments. The examiner will allot one practical at the time of end term examination. 1. To determine various parameters of a pn-junction diode. 2. To study the frequency response of low-pass, high-pass and band-pass filters. 3. To study the rectifier circuits and to measure the ripple factors of C, L and π-section filters. Also study the stabilization characteristics of a voltage regulator consisting of IC-741. 4. To study the load characteristics of a Class-B push-pull amplifier. 5. To draw frequency response characteristics of a RC-coupled single stage BJT amplifier in all the three configurations. 6. To measure (a) phase difference, (b) deflection sensitivities and (c) frequency of an unknown ac signal using CRO. 7. To study the clipping and the clamping circuits. 8. To study the differentiating and integrating circuits. 9. To simplify a complex circuit into a simpler equivalent circuit consisting of a voltage source in series with a resistance or by Thevenin's circuit. 10. To simplify a complex circuit into a single current source in	120

	parallel with a resistance or by Norton's circuit. 11. To analyze circuits with multiple independent voltage or current sources by considering the effect of each source individually or by Superposition circuit. 12. To study the characteristics of CB and CE Transistor configuration.	

SuggestedEvaluationMethods			
InternalAssessment: 30		**End Term Examination: 70**	
➢ **Practicum**	**30**	➢ **Practicum**	**70**
• Class Participation:	5	Lab record, Viva-Voce, write-up and execution of the practical	
• Seminar/Demonstration/Viva-voce/Lab records etc.:	25		

PartC-Learning Resources

Recommended Books/e-resources/LMS:

1. Integrated Electronics by J. Millman and C. C. Halkias
2. Pulse, digital and switching waveforms by J. Millman and H. Taub
3. Electronic devices and circuits by Y. N. Bapat
4. Microwave devices and circuits by Samuel Y. Liao
5. Physics of semiconductor Devices by S. M. Sze
6. Electronic instrumentation and measurement techniques by W. D. Cooper and A. D. Helfrick
7. OPAMPs and linear IC circuits by Ramakant A. Gayakwad
8. Electronics for Scientists and Engineers: Devices, Circuits and Systems by TV Viswanathan, GK Mehta and V Rajaraman

<table>
<tr><td colspan="4">Session: 2024-25</td></tr>
<tr><td colspan="4">PartA - Introduction</td></tr>
<tr><td>Name of the Programme</td><td colspan="3">M.Sc. Physics</td></tr>
<tr><td>Semester</td><td colspan="3">1st</td></tr>
<tr><td>Name of the Course</td><td colspan="3">Physics Lab-I</td></tr>
<tr><td>Course Code</td><td colspan="3">25PN-PHY-106</td></tr>
<tr><td>CourseType</td><td colspan="3">PC-2</td></tr>
<tr><td>Level of the course</td><td colspan="3">500-599</td></tr>
<tr><td>Pre-requisite for the course (ifany)</td><td colspan="3">--</td></tr>
<tr><td>CourseLearningOutcomes (CLO)
After completing this course, the learner will be able to:</td><td colspan="3">CLO 106.1:Determine the ionization potential of mercury. Measure the width of a narrow slit using diffraction phenomenon. Calculate the Planck's constant using a suitable light source.
CLO 106.2: Set Fabry-Parot interferometers for various practical measurements. Verify the energy quantization using the Frank-Hertz Experiment.
CLO 106.3:Demonstrate different harmonics present in complex signals using Fourier Analysis.Verify the inverse square law of radiation flux.
CLO 106.4:Measure the band gap of a semiconductor material. Understand the underlying dynamics mimicked by the Chua' and Feigenbaum circuits.</td></tr>
<tr><td rowspan="2">Credits</td><td>Theory</td><td>Practical</td><td>Total</td></tr>
<tr><td>0</td><td>4</td><td>4</td></tr>
<tr><td>Teaching Hours per week</td><td>0</td><td>8</td><td>8</td></tr>
<tr><td>Internal Assessment Marks</td><td>0</td><td>30</td><td>30</td></tr>
<tr><td>End Term Exam Marks</td><td>0</td><td>70</td><td>70</td></tr>
<tr><td>Max. Marks</td><td>0</td><td>100</td><td>100</td></tr>
<tr><td>Examination Time</td><td>0</td><td colspan="2">4 hours</td></tr>
<tr><td colspan="4">PartB-Contentsofthe Course</td></tr>
<tr><td colspan="3">Practicals</td><td>Contact Hours</td></tr>
<tr><td colspan="3">Note: Student will perform at least eight experiments. The examiner will allot one practical at the time of end term examination.
1. To determine the ionization potential of mercury.
2. To measure the width of a narrow slit using the diffraction phenomenon.
3. To determine the value of Planck's constant using photocell/LED.
4. Fabry-Parot interferometer experiment.
5. Demonstration of energy quantization using the Frank-Hertz Experiment.
6. Fourier analysis of complex signals
7. To determine band-gap of a semiconductor material.
8. To verify the inverse square law of radiation flux.
9. To study nonlinear dynamics using Chua' circuit.
10. To study nonlinear dynamics using Feigenbaum circuit.
11. To study B-H curve of a given ferrite sample and find energy loss in case</td><td>120</td></tr>
</table>

	of ferrite Core. 12. To determine the capacitance of a parallel plate Capacitor using Capacitance and permittivity kit. 13. To determine the value of e/m i.e. specific charge for an electron by Helical Method. 14. To determine the wavelength of an given source using the double-slit experiment	

SuggestedEvaluationMethods			
InternalAssessment: 30		**End Term Examination: 70**	
➢ **Practicum**	**30**	➢ **Practicum**	**70**
• Class Participation:	5	Lab record, Viva-Voce, write-up and execution of the practical	
• Seminar/Demonstration/Viva-voce/Lab records etc.:	25		

PartC-Learning Resources

Recommended Books/e-resources/LMS:

1. Integrated Electronics by J. Millman and C. C. Halkias
2. Nonlinear dynamics: Integrability, Chaos and patterns (2003) by M. Lakshmanan and S. Rajasekar
3. Introduction to Solid State Physics (7^{th} edition) by Charles Kittel
4. Modern Physics by Arthur Beiser
5. Elements of Nuclear Physics by W. E. Meyerhof.
6. Nuclear Radiation Detectors by S. S. Kapoor and V. S. Ramamurthy.

Session: 2024-25			
PartA - Introduction			
Name of Programme	M. Sc. Physics		
Semester	2^{nd}		
Name of the Course	Nuclear and Particle Physics		
Course Code	25PN-PHY-201		
CourseType	CC-5		
Level of the course	500-599		
Pre-requisite for the course (ifany)	--		
CourseLearningOutcomes (CLOs) After completing this course, the learner will be able to:	**CLO 402.1:** Understand the energy loss processes of different energetic particles in a medium and mechanisms of interaction of gamma photon with matter and Learn about the basic properties and characteristics of Nuclear forces, and their mediating particle. **CLO 402.2:** Know and learn about various type of detectors used in nuclear physics experiments, unique properties of different detectors and their applications in the field of nuclear physics andDifferentiate between different type of nuclear reactions, relevant aspects associated with nuclear reactions and kinematics of such reactions. **CLO 402.3:** Describe certain properties associated with nuclei, models governing different aspects of nuclear behaviour and detailed understanding of deuteron problem and understand the phenomenon of radioactive decays of alpha and beta particles, their detailed formalism. **CLO 402.4:** Know about different elementary particles, their quark content and quark model and Learn about decay of some elementary particles and laws governing such decays.		
Credits	Theory	Practical	Total
	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Time	3 hours		

PartB-Contentsofthe Course		
Instructions for Paper- Setter: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist of at least 4 parts covering entire syllabus. The question paper is expected to contain problems to the extent of 20% of total marks. The examinee will be required to attempt 5 questions; selecting one question from each unitand the compulsory question. All questions will carry equal marks.		
Unit	**Topics**	**Contact Hours**
I	**Radiation Interaction and Nuclear Forces:** Interaction of Charged Particles with Matter: qualitative description of various energy loss mechanisms, their relative contribution in case of heavy ions and electrons, classical stopping power equation for electronic energy-loss (no derivation) with significance of various terms involved, behavior of electronic energy-loss curve as a function of ion velocity, concept of energy straggling and range straggling and their correlation; Interaction of Gamma Radiation with Matter: features of photoelectric, Compton and pair production processes, Nuclear Forces: experimental evidence of charge symmetry and charge independence of nuclear forces, concept of isospin, Meson theory of nuclear forces, relationship between the range of the force and mass of the mediating particle.	15
II	**Radiation Detectors and Nuclear Reactions:** Gamma Ray Spectrometer: basic principle and working of NaI (Tl) scintillation detector, mechanism of pulse formation, basic idea of pulse processing unit, concept of energy resolution and efficiency of detector and its applications; Semiconductor Detectors: basic principle, construction and working and applications of Si surface barrier detector, high purity germanium detector. Nuclear Reactions: types of nuclear reactions, Q-value of a nuclear reaction and its determination, definition of cross section and its significance, elementary idea of compound nuclear reactions and direct reactions. Concept of neutron detection, Coulomb excitation, nuclear kinematics.	15
III	**Nuclear Properties and Radioactive Decays:** Basic nuclear properties: size, shape and charge distribution, spin and parity. Binding energy, semi-empirical mass formula, liquid drop model, Deuteron problem; Ground state of deuteron, Magnetic moment and its importance in the determination of exact ground state of deuteron. Radioactive Decays: energetics of alpha decay, tunnel theory of alpha decay, energetics of beta decay, Fermi theory of allowed beta decay, importance of Fermi-Kurie plot, parity non-conserving property of neutrino;	15
IV	**Particle Physics:** Units in high energy physics; Classification of particles- fermions and bosons, particles and antiparticles; Strange particles, Basic idea of different fundamental types of interactions with suitable examples; Quark flavors and their quantum numbers, Quarks as constituents of Hadrons, Qualitative idea of Quark confinement and asymptotic freedom, necessity of introducing the Color quantum no., Quark model, decay of pion and muon, Gell-Mann Nishijima formula,	15

	conservation laws.	
	Total Contact Hours	60

SuggestedEvaluationMethods			
InternalAssessment: 30		**End Term Examination: 70**	
➢ **Theory**	**30**	➢ **Theory:**	**70**
• Class Participation:	5	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc.:	10		
• Mid-Term Exam:	15		

PartC-Learning Resources

Recommended Books/e-resources/LMS:

1. Introduction to Experimental Nuclear Physics by R. M. Singru.
2. Elements of Nuclear Physics by W. E. Meyerhof.
3. Nuclear Radiation Detectors by S. S. Kapoor and V. S. Ramamurthy
4. Introduction to High Energy Physics (2nd edition) by D. H. Perkins.
5. Radiation Detection and Measurement by G. F. Knoll.
6. Nuclear Physics Theory and Experiment, by R. R. Roy and B. P. Nigam.

Session: 2024-25			
PartA– Introduction			
Name of Programme	M. Sc. Physics		
Semester	2^{nd}		
Name of the Course	Solid State Physics		
Course Code	25PN-PHY-202		
CourseType	CC-6		
Level of the course	500-599		
Pre-requisite for the course (ifany)	--		
CourseLearningOutcomes (CLOs) After completing this course, the learner will be able to:	**CLO 202.1:** Analyze the structure of a crystalline solid in terms of lattice, basis and unit cell, and of a non-crystalline solid on the basis of pair-distribution function and deduce the structure of a crystalline solid from the XRD pattern. **CLO 202.2:** Calculate the dispersion of lattice waves for crystals with mono- and diatomic basis, and acquire an understanding of phonon and use it to determine the lattice heat capacity in the Einstein and Debye models. **CLO 202.3:** Learn the Bloch's theorem, solve the KP model & one-electron Schrödinger equation for a periodic potential, classify materials into conductors, semiconductors and insulators, and apply the tight binding & Wigner-Seitz methods for calculation of energy bands. **CLO 202.4:** Grasp main characteristics of superconductors, along with qualitative aspects of the BCS theory, explain flux quantization in a superconducting ring, and the DC& AC Josephson effects.		
Credits	Theory	Practical	Total
	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Time	3 hours		
PartB-Contentsofthe Course			
Instructions for Paper- Setter: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist of at least 4 parts covering entire syllabus. The question paper is expected to contain problems to the extent of 20% of total marks. The examinee will be required to attempt 5 questions; selecting one question from each unitand the compulsory			

question. All questions will carry equal marks.		
Unit	**Topics**	**Contact Hours**
I	**Crystal Structure:** Recapitulation of basic concepts: Bravais lattice and Primitive vectors; Primitive, Conventional and Wigner-Seitz unit cells; Crystal structures of Diamond, Cubic *ZnS* and *NaCl*; Packing Fraction, Packing fraction of *sc, bcc, fcc, hcp* and Diamond structure; Symmetry operations and fundamental types of lattices; Index system for crystal planes. Determination of crystal structure by X-ray diffraction: Reciprocal lattice and Brillouin zones (examples of *sc*, *bcc* and *fcc* lattices); Bragg and Laue formulations of X-ray diffraction by a crystal and their equivalence; Laue equations; Ewald construction; Brillouin interpretation; Crystal and atomic structure factors; Structure factor of the *bcc* and *fcc* lattices, Examples of *NaCl* and diamond; Experimental methods of structure analysis: Types of probe beam.	15
II	**Lattice dynamics and thermal properties:** Cohesive energy in solids; Qualitative idea of Ionic bonds, Covalent bonds, Hydrogen bonds, Intermolecular bonds, Dispersion bonds, dipole-dipole bonds and Metallic binding. Classical theory of lattice vibration (in harmonic approximation): Vibrations of crystals with monatomic basis- Dispersion relation, First Brillouin zone, Group velocity; Two atoms per primitive basis- dispersion of acoustical and optical modes. Quantization of lattice waves: Phonons, Phonon momentum, Inelastic scattering of neutrons by phonons. Thermal properties: Lattice (phonon) heat capacity; Normal modes; Density of states in one and three dimensions; Models of Debye and Einstein, Debye T^3 law; Basic idea about point imperfection in crystals.	15
III	**Electronic properties of solids:** Sommerfeld's free electron gas model, Density of states, Fermi sphere, Fermi and ground-state energy; Heat capacity of electronic gas, experimental heat capacity of metals, Thermal Effective Mass, Electrical Conductivity and Ohm's law, Motion in a Magnetic field and Hall effect, Difficulties with the free electron gas model; Band theory of solids; Periodic potential and Bloch's theorem; Kronig-Penney model; Wave equation of electron in a periodic potential, Effective Mass in Crystal and its Physical Significance, Central equation, Crystal momentum of electron, Solution of the central equation, Approximate solution at and near a zone boundary; Periodic, extended and reduced zone schemes of energy band representation; Number of orbital's in a band; Classification into metals, semiconductors and insulators. Calculation of energy bands: Tight binding method and its application to *sc, bcc* and *bcc* structures; Wigner-Seitz method, Cohesive energy; Pseudo-potential methods (qualitative idea).	15
IV	**Superconductivity:** Experimental survey: Superconductivity and its occurrence, Destruction of superconductivity by magnetic fields, Meissner effect, Type I and type II superconductors, Entropy, Free energy, Heat capacity, Energy gap, Microwave and infrared properties, Isotope effect; Theoretical survey: Thermodynamics of the	15

<table>
<tr><td></td><td colspan="3">superconducting transition, London equation, London penetration depth, Coherence length; Microscopic theory: Qualitative features of the BCS theory, BCS ground state wave function; Quantitative predictions of the BCS theory, critical temperature, energy gap, critical field, specific heat; Flux quantization in a superconducting ring, duration of persistent currents; Dc and Ac Josephson effects; Macroscopic long-range quantum interference; High T_c superconductors (introduction only).</td><td></td></tr>
<tr><td colspan="4" align="right">Total Contact Hours</td><td>60</td></tr>
<tr><td colspan="5" align="center">SuggestedEvaluationMethods</td></tr>
<tr><td colspan="2" align="center">InternalAssessment: 30</td><td colspan="3" align="center">End Term Examination: 70</td></tr>
<tr><td>➢ Theory</td><td>30</td><td colspan="2">➢ Theory:</td><td>70</td></tr>
<tr><td>• Class Participation:</td><td>5</td><td colspan="3" rowspan="3" align="center">Written Examination</td></tr>
<tr><td>• Seminar/presentation/assignment/quiz/class test etc.:</td><td>10</td></tr>
<tr><td>• Mid-Term Exam:</td><td>15</td></tr>
<tr><td colspan="5" align="center">PartC-Learning Resources</td></tr>
<tr><td colspan="5">Recommended Books/e-resources/LMS:
1. Introduction to Solid State Physics (7th edition) by Charles Kittel
2. Solid State Physics by Neil W. Ashcroft and N. David Mermin
3. Solid State Physics: An Introduction to Theory and Experiment by H. Ibach and H. Luth
4. Principles of the Theory of Solids (2nd edition) by J. M. Ziman
5. Condensed Matter Physics by Michael P. Marder
6. Applied Solid State Physics by Rajnikant</td></tr>
</table>

Session: 2024-25			
PartA - Introduction			
Name of Programme	M. Sc. Physics		
Semester	2nd		
Name of the Course	Quantum Mechanics-II		
Course Code	25PN-PHY-203		
CourseType	CC-7		
Level of the course	500-599		
Pre-requisite for the course (ifany)	--		
CourseLearningOutcomes (CLOs) After completing this course, the learner will be able to:	**CLO 203.1:** Formulate perturbation, variational & WKB methods for obtaining approximate solutions of the Schrödinger equation, and comprehend simple physical effects: Zeeman & Stark effects&alpha decay. **CLO 203.2:** Apply the time-dependent perturbation theory to deal with atom-em radiation interaction and calculate explicitly the transition probability for induced absorption and emission. **CLO 203.3:** Explicate electronic structure of many-electron atoms in central-field approximation, estimate the central potential using the Thomas-Fermi &Hartree methods, and have an understanding of molecular energy levels. **CLO 203.4:** Grasp the basics of quantum scattering theory, learn the partial waves and Green's function methods for deriving scattering cross-sections, and calculate these for finite square well, hard sphere & screened Coulomb potentials.		
Credits	Theory	Practical	Total
	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Time	3 hours		
PartB-Contentsofthe Course			

Instructions for Paper- Setter: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist of at least 4 parts covering entire syllabus. The question paper is expected to contain problems to the extent of 20% of total marks. The examinee will be required to attempt 5 questions; selecting one question from each unitand the compulsory question. All questions will carry equal marks.

Unit	Topics	Contact Hours
I	**Approximate methods for bound states-I:** Stationary perturbation theory: Non-degenerate case- First-order and second-order corrections to energy eigenvalues and eigenfunctions, Perturbation of an oscillator (harmonic and anharmonic ($ax^3 + bx^4$) perturbations), Ground state of Helium atom; Degenerate case- Removal of degeneracy in first and second order, Zeeman effect without electron spin, First-order Stark effect in n=2 state of Hydrogen, Fine structure of hydrogen atom (Relativistic and spin-orbit coupling corrections); Rayleigh-Ritz variational method: Ground and excited states, Application to ground state of Helium, Van der Waals interaction using perturbation and variational methods.	15
II	**Approximate methods for bound states-II:**The WKB approximation: Classical limit, Approximate solutions, Asymptotic nature of the solutions, Solution near a turning point, Linear turning point, Connection at the turning point, Asymptotic connection formulae, Application to energy levels of a quantum well, tunneling through a potential barrier and alpha decay; First-order time-dependent perturbation theory, Transition probability for constant and harmonic perturbations, Transition to a group of final states- The Fermi golden rule, Applications: Ionization of a hydrogen atom, Ionization probability, Interaction of an atom with *em* radiation (semi-classical treatment), Transition probability for induced absorption and emission, perturbation theory in scattering problems.	15
III	**Selected applications of Quantum Mechanics:** Atomic structure of many-electron atoms: Central-field approximation, Periodic system of elements, Thomas-Fermi statistical model, Evaluation of the potential, Hartree's self-consistent fields and connection with the variational method, Corrections to the central-field approximation, L-S and j-j couplings; Molecular structure: Classification of energy levels, Wave equation; The Hydrogen molecule: Potential energy function, The Morse potential, Rotation and vibration of diatomic molecules, Energy levels.	15
IV	**Quantum theory of scattering:** Scattering experiments and cross-sections, The laboratory and center-of-mass systems, Scattering amplitude and cross-section; The method of partial waves: Phase shift, Differential and total cross-sections, Relation between phase shift and scattering potential, Convergence of the partial-wave series, Scattering by a finite square well, Resonances- Breit-Wigner formula, Scattering by a hard-sphere potential; Green's function method: Lippmann-Schwinger equation, The Born series, The first Born approximation, Scattering of an electron by a screened Coulomb potential in Born approximation and validity criterion; Scattering of two identical spinless bosons, and spin-1/2 fermions.	15
	Total Contact Hours	60
	Suggested Evaluation Methods	

InternalAssessment: 30		**End Term Examination: 70**	
➢ **Theory**	**30**	➢ **Theory:**	**70**
• Class Participation:	5	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc.:	10		
• Mid-Term Exam:	15		

PartC-Learning Resources

Recommended Books/e-resources/LMS:

1. Quantum Mechanics (3rd edition) by L. I. Schiff
2. Quantum Mechanics (2nd edition) by B. H. Bransden and Joachain
3. Introduction to Quantum Mechanics (2nd edition) by David J. Griffiths
4. Quantum Mechanics by A. K. Ghatak and S. Loknathan
5. A Textbook of Quantum Mechanics by P. M. Mathews and K. Venkatesan
6. Quantum Mechanics by John L. Powell and B. Crasemann
7. Quantum Mechanics: Concepts and Applications (2nd edition) by N. Zettili

Session: 2024-25			
PartA - Introduction			
Name of Programme	M.Sc. Physics		
Semester	2nd		
Name of the Course	Electronic Devices and Circuits-II		
Course Code	25PN-PHY-204E		
Course Type	CC-8		
Level of the course	500-599		
Pre-requisite for the course (ifany)	--		
CourseLearningOutcomes (CLO) After completing this course, the learner will be able to:	**CLO 204.1:** Well acquainted with the basic structures, operations, characteristics and biasing schemes of various field effect transistors. Understand the operations of different multivibrator circuits. **CLO 204.2:** Develop a clear understanding of the basics of OPAMPS, its operating modes, internal structure and its vital design parameters. Become familiar with the basic structure, operation, characteristics and important applications of negative resistance devices. **CLO 204.3:** Design and describe the operations of various families of logic gates. Simplify involved Boolean expressions with the help of Boolean algebra and K-map. **CLO 204.4:** Explain the construction, operation, characteristics and important technological applications of various photonic devices. Explain the construction, operation, characteristics and important technological applications of different temperature sensitive devices.		
Credits	Theory	Practical	Total
	4	0	4
Teaching Hours per week	4	0	4
Internal Assessment Marks	30	0	30
End Term Exam Marks	70	0	70
Max. Marks	100	0	100
Examination Time	3 hours		
PartB-Contentsofthe Course			

Instructions for Paper- Setter: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist of at least 4 parts covering entire syllabus. The question paper is expected to contain problems to the extent of 20% of total marks. The examinee will be required to attempt 5 questions; selecting one question from each unitand the compulsory

question. All questions will carry equal marks.		
Unit	**Topics**	**Contact Hours**
I	**Field Effect Transistors and Multivibrators:** Basic structure and operation of JFET, calculation of pinch off voltage, V-I characteristics of JFET, the FET small signal model, metal oxide semiconductor field effect transistor (MOSFET), physical structure, operation and characteristics, enhancement and depleted modes of operation, metal semiconductor field effect transistor (MESFET), low frequency common source and common drain FET amplifiers, FET biasing, FET as a voltage variable resistor (VVR); Multivibrators: a fixed biased transistor, a self-biased transistor and a direct connected bistablemultivibrator circuits, Schmitt trigger circuit, triggering techniques for bistablemultivibrators, collector-coupled and emitter-coupled monostable and astablemultivibrators.	15
II	**OPAMPs and Negative Resistance Devices**: The basic OPAMP, inverting and non-inverting mode of operation of OPAMP, effect of negative feedback on input and output resistances of OPAMPs, the differential amplifier, common mode rejection ratio (CMRR), the emitter coupled differential amplifier, the transfer characteristics of a differential amplifier, an IC OPAMP (MC-1530 Motorola) and its dc analysis, offset voltages and currents, universal balancing techniques, measurement of OPAMP parameters; basic working principles, characteristics and applications of uni-junction transistor (UJT), four layer diode (pnpn-diode), tunnel diode and silicon controlled rectifier.	15
III	**Digital Circuits:** Digital (binary) operation of a system, logic systems, the OR gate, the AND gate, the NOT gate, the exclusive OR gate, De Morgan’s laws, Boolean algebra, the NAND and NOR diode-transistor gates, Modified DTL gates, fan-in and fan-out, wired logics, high threshold logic (HTL) gates, transistor- transistor logic (TTL) gates, output stages for TTL gates, resistance-transistor logic (RTL) gates, direct coupled transistor logic (DCTL) gates, emitter coupled logic (ECL) gates, digital MOSFET circuits, complementary MOS (CMOS) logic gates, comparison of logic families, Karnaugh- map (K-map) up to four variable and its applications.	15
IV	**Optoelectronic and Temperature Sensing Devices:**Radiative and nonradiative transitions, basic construction, operation, characteristics and applications of solar cells, light dependent resistance (LDR), photodiodes, p-i-n diodes, metal semiconductor photodiodes, avalanche photodiodes, light emitting diodes (LEDs), semiconductor diode lasers, photo transistors, resistance thermometers, thermocouples and thermistors.	15
	Total Contact Hours	60

SuggestedEvaluationMethods			
InternalAssessment: 30		**End Term Examination: 70**	
➢ **Theory**	**30**	➢ **Theory:**	**70**
• Class Participation:	5	Written Examination	

• Seminar/presentation/assignment/quiz/class test etc.:	10	
• Mid-Term Exam:	15	

PartC-Learning Resources

Recommended Books/e-resources/LMS:

1. Integrated Electronics by J. Millman and C. C. Halkias
2. Pulse, digital and switching waveforms by J. Millman and H. Taub
3. Electronic devices and circuits by Y. N. Bapat
4. Microwave devices and circuits by Samuel Y. Liao
5. Physics of semiconductor Devices by S. M. Sze
6. Electronic instrumentation and measurement techniques by W. D. Cooper and A. D. Helfrick
7. OPAMPs and linear IC circuits by Ramakant A. Gayakwad
8. Electronics for Scientists and Engineers: Devices, Circuits and Systems by TV Viswanathan, GK Mehta and V Rajaraman

<table>
<tr><td colspan="4">Session: 2025-26 (As per scheme 2024-25)</td></tr>
<tr><td colspan="4" align="center">PartA–Introduction</td></tr>
<tr><td>Name of Programme</td><td colspan="3">M. Sc. Physics</td></tr>
<tr><td>Semester</td><td colspan="3">2nd</td></tr>
<tr><td>Name of the Course</td><td colspan="3">Material Science-II</td></tr>
<tr><td>Course Code</td><td colspan="3">25PPN-PHY-204M</td></tr>
<tr><td>CourseType</td><td colspan="3">DEC-4</td></tr>
<tr><td>Level of the course</td><td colspan="3">500-599</td></tr>
<tr><td>Pre-requisite for the course (ifany)</td><td colspan="3">---</td></tr>
<tr><td>CourseLearningOutcomes (CLOs)
After completing this course, the learner will to:</td><td colspan="3">CLO 204.1: Comprehend various tests (Tension test, hardness tests, Impact test, fatigue test, creep test) used for measuring the mechanical properties of materials and Realize the difference between strength and hardness of materials. Compute various strength and ductility measures from engineering stress-strain curve and true stress-strain curves.
CLO 204.2: Understand magnetic processes, Diamagnetism, Paramagnetism, density of states curves for a metal; and Grasp the concepts of Ferromagnetism, exchange interactions, domain structure; Antiferromagnetism, Ferrimagnetism and Ferrites
CLO 204.3: Elucidate the physics describing dielectrics and ferroelectric materials, with focus on the functionality and Describe the optical properties of insulators
CLO 204.4: Understanding of the surface and concepts of salvage depth and Grasp the concept, working and applications of different electron and photon based surface analysis techniques.</td></tr>
<tr><td rowspan="2">Credits</td><td>Theory</td><td>Practical</td><td>Total</td></tr>
<tr><td>4</td><td>0</td><td>4</td></tr>
<tr><td>Teaching Hours per week</td><td>4</td><td>0</td><td>4</td></tr>
<tr><td>Internal Assessment Marks</td><td>30</td><td>0</td><td>30</td></tr>
<tr><td>End Term Exam Marks</td><td>70</td><td>0</td><td>70</td></tr>
<tr><td>Max. Marks</td><td>100</td><td>0</td><td>100</td></tr>
<tr><td>Examination Time</td><td>3 hours</td><td></td><td></td></tr>
<tr><td colspan="4" align="center">PartB-Contentsofthe Course</td></tr>
<tr><td colspan="4"><u>Instructions for Paper- Setter:</u> The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The</td></tr>
</table>

compulsory question (Question No. 1) will consist of at least 4 parts covering entire syllabus. The question paper is expected to contain problems to the extent of 20% of total marks. The examinee will be required to attempt 5 questions; selecting one question from each unitand the compulsory question. All questions will carry equal marks.

Unit	Topics	Contact Hours
I	**Material Testing:** The Tension Test: engineering stress-strain curve, true stress-strain curve, instability in tension, Considere's construction, ductility measurement, effect of strain rate on flow properties, strain rate sensitivity; notch tensile test; The Hardness Test: Brinell hardness, Meyer hardness, Vicker's hardness number and test, Rockwell hardness test, Knoop hardness number and test; The Impact Test: brittle fracture problem, notched bar impact tests-Carpy and Izod Impact tests; The Fatigue Test: fatigue failures, stress cycles, the S-N curve, fatigue limit; The Creep Test: creep curve, primary, secondary and tertiary creep, effect of temperature and stress on the creep curve.	15
II	**Magnetic Materials:**Magnetic Processes: Larmor frequency; Diamagnetism, magnetic susceptibility, Langevin's diamagnetism equation; Paramagnetism, Curie constant, density of states curves for a metal; Ferromagnetism, Curie temperature, Curie-Weiss law, exchange interactions, domain structure; Antiferromagnetism and magnetic susceptibility of an antiferromagnetic material; Ferrimagnetism and Ferrites; Paramagnetic, ferromagnetic and cyclotron-resonance.	15
III	**Dielectric, Optical and Ferroelectric Materials:** Introduction, Energy bands, dielectric constant, complex permittivity, dielectric loss factor, polarization, mechanism of polarization, classification of dielectrics-frequency dependence of dielectric constant; Optical Phenomena in Insulators Colour of crystals - Excitons - weakly bound and tightly bound excitons. Colour centers – F-centers and other electronic centers in alkali halides. Ferroelectrics: General characteristics - piezoelectric, pyroelectric and ferroelectric materials. Classification of ferroelectrics and representative materials. Ferroelectric domains. Polarization catastrophe, Landau theory of first and second-order phase transitions, antiferroelectric materials .	15
IV	**Solid Surfaces and Analysis:** Surface and its importance, selvedge depths of surface; Methods of Surface Analysis: Auger Electron spectroscopy (AES)- basic principle, methodology, composition analysis and depth profiling; X-ray photoelectron spectroscopy (XPS) or ESCA: principle, methodology and quantitative analysis; Glancing angle X-ray Diffraction (GXRD), basic concept, methodology and structural analysis; Scanning Electron Microscopy (SEM) and Transmission Electron Microscopy (TEM): Principle, methodology and Applications in surface analysis; Atomic Force Microscopy (AFM): Basic principle, Methodology, applications in structural analysis.	15
	Total Contact Hours	60

SuggestedEvaluationMethods	
InternalAssessment: 30	**End Term Examination: 70**

➢ **Theory**	**30**	➢ **Theory:**	**70**
• Class Participation:	5	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc.:	10		
• Mid-Term Exam:	15		

PartC-Learning Resources

Recommended Books/e-resources/LMS:

1. Material Science, J.C. Anderson, K.D. Leaver, J. M. Alexander and R. D. Rawlings
2. Mechanical Metallurgy, G.E. Dieter.
3. Electronic Processes in Materials, L. V. Azaroff and J. J. Brophy
4. Fundamentals of Surface and Thin Film Analysis, L.C. Feldman and J. W. Mayer
5. Surface Analysis Methods in Material Science, D. J. O'Connor, B. A. Sexton and R. St. CSmart (Eds), Springer Series in Surface Sciences 23
6. Solid State Physics – A J Dekker (McMillan, 1971)
7. Materials Science and Engineering by William D. Callister

Session: 2024-25			
PartA - Introduction			
Name of the Programme	M.Sc. Physics		
Semester	2^{nd}		
Name of the Course	General Electronics-II		
Course Code	25PN-PHY-205		
Course Type	PC-3		
Level of the course	500-599		
Pre-requisite for the course (ifany)	--		
CourseLearningOutcomes (CLO) After completing this course, the learner will be able to:	**CLO 205.1:** Draw V-I characteristics of an UJT and also able to design and able to determine the frequency ofsaw-tooth waves using UJT. **CLO 205.2:** Design and draw load characteristics of a push-pullamplifier and design and verify truthtables of the basic logic gates. **CLO 205.3:** Design and understand the operations of astablemultivibrator. Also draw the characteristics of various opto-electronic devices. **CLO 205.4:** Explain the FET as VVR, the V-I characteristics of an emitter coupled differential amplifier, pnpn-diode and thermistor.		
Credits	Theory	Practical	Total
	0	4	4
Teaching Hours per week	0	8	8
Internal Assessment Marks	0	30	30
End Term Exam Marks	0	70	70
Max. Marks	0	100	100
Examination Time	0	4 hours	

PartB-Contentsofthe Course

Practicals	Contact Hours
Note: Student will perform at least six experiments. The examiner will allot one practical at the time of end term examination. 1. To draw the V-I characteristics of a Uni-Junction Transistor. 2. To generate saw-tooth waves using UJT and find its frequency. 3. To design circuits for OR, AND, NOT, NAND and NOR logic gates and verify their truth tables. 4. To study the astablemultivibrator. 5. To draw characteristics of opto-electronic devices. 6. To study a FET as voltage variable resistance (VVR). 7. To draw transfer characteristics of an emitter-coupled BJT differential amplifier. 8. To draw characteristics of a negative resistance thermistor	120

	9. To draw the V-I characteristics of a pnpn-diode. 10. To generate square waves using a Schmitt's trigger circuit. 11. Designing of an integrator using operational amplifier for a given specification & study of its frequency response. 12. Designing of a differentiator using operational amplifier for a given specification & study its frequency response. 13. Designing a first order Low-pass filter by using operational amplifier. 14. Designing a first order High-pass filter using operational amplifier.	

SuggestedEvaluationMethods			
InternalAssessment: 30		**End Term Examination: 70**	
➢ **Practicum**	**30**	➢ **Practicum**	**70**
• Class Participation:	5	Lab record, Viva-Voce, write-up and execution of the practical	
• Seminar/Demonstration/Viva-voce/Lab records etc.:	25		

PartC-Learning Resources

Recommended Books/e-resources/LMS:

1. Integrated Electronics by J. Millman and C. C. Halkias
2. Pulse, digital and switching waveforms by J. Millman and H. Taub
3. Electronic devices and circuits by Y. N. Bapat
4. Microwave devices and circuits by Samuel Y. Liao
5. Physics of semiconductor Devices by S. M. Sze
6. Electronic instrumentation and measurement techniques by W. D. Cooper and A. D. Helfrick
7. OPAMPs and linear IC circuits by Ramakant A. Gayakwad
8. Electronics for Scientists and Engineers: Devices, Circuits and Systems by TV Viswanathan, GK Mehta and V Rajaraman

<table>
<tr><td colspan="4">Session: 2024-25</td></tr>
<tr><td colspan="4">PartA - Introduction</td></tr>
<tr><td>Name of the Programme</td><td colspan="3">M.Sc. Physics</td></tr>
<tr><td>Semester</td><td colspan="3">2nd</td></tr>
<tr><td>Name of the Course</td><td colspan="3">Physics Lab-II</td></tr>
<tr><td>Course Code</td><td colspan="3">25PN-PHY-206</td></tr>
<tr><td>Course Type</td><td colspan="3">PC-4</td></tr>
<tr><td>Level of the course</td><td colspan="3">500-599</td></tr>
<tr><td>Pre-requisite for the course (ifany)</td><td colspan="3">--</td></tr>
<tr><td>CourseLearningOutcomes (CLO)
After completing this course, the learner will be able to:</td><td colspan="3">CLO 206.1:Calculate the Planck's constant using a suitable light source and half life of Indium.
CLO 206.2: Measure the mass absorption coefficient of β-rays in Aluminum and the band gap of a semiconductor. Set Michelson interferometer for various practical measurements
CLO 206.3: Determine the strength of α-source and verify nuclear statistics using SSNTD.
CLO 206.4: Determine the specific heat of a given solid specimen and the thermoelectric voltage as a function of the temperature differential. Study of Dia-, para- and ferromagnetic materials in an inhomogeneous magnetic field.</td></tr>
<tr><td rowspan="2">Credits</td><td>Theory</td><td>Practical</td><td>Total</td></tr>
<tr><td>0</td><td>4</td><td>4</td></tr>
<tr><td>Teaching Hours per week</td><td>0</td><td>8</td><td>8</td></tr>
<tr><td>Internal Assessment Marks</td><td>0</td><td>30</td><td>30</td></tr>
<tr><td>End Term Exam Marks</td><td>0</td><td>70</td><td>70</td></tr>
<tr><td>Max. Marks</td><td>0</td><td>100</td><td>100</td></tr>
<tr><td>Examination Time</td><td>0</td><td colspan="2">4 hours</td></tr>
<tr><td colspan="4">PartB-Contentsofthe Course</td></tr>
<tr><td colspan="3">Practicals</td><td>Contact Hours</td></tr>
<tr><td colspan="3">Note: Student will perform at least six experiments. The examiner will allot one practical at the time of end term examination.
1. To study absorption of β-rays in Aluminum.
2. Michelson interferometer experiment.
3. To determine the half-life of Indium.
4. To determine the strength of an α-source using SSNTD.
5. To study nuclear statistics using SSNTD.
6. To determine band-gap of a semiconductor material.
7. To determine the specific heat of a given solid specimen.
8. Seeback effect: Determining the thermoelectric voltage as a function of the temperature differential.</td><td>120</td></tr>
</table>

	9. Study Dia-, para- and ferromagnetic materials in an inhomogeneous magnetic field. 10. To find the velocity and compressibility of solid/ liquid sample using Ultrasonic Interferometer 11. Lattice dynamic kit a) Study of the Dispersion relation for the "Monoatomic Lattice" and Comparison with theory. b) Determination of the Cut-off frequency of the Monoatomic Lattice. c) Study of the Dispersion relation for the Di-atomic Lattice, Acoustical mode and Energy gap and Comparison with theory. 12. . To determine the Dielectric constant of polar and non-polar liquids	

SuggestedEvaluationMethods

Internal Assessment: 30		**End Term Examination: 70**	
➢ **Practicum**	**30**	➢ **Practicum**	**70**
• Class Participation:	5	Lab record, Viva-Voce, write-up and execution of the practical	
• Seminar/Demonstration/Viva-voce/Lab records etc.:	25		

PartC-Learning Resources

Recommended Books/e-resources/LMS:

1. Introduction to Experimental Nuclear Physics by R. M. Singru.
2. Elements of Nuclear Physics by W. E. Meyerhof.
3. Nuclear Radiation Detectors by S. S. Kapoor and V. S. Ramamurthy
4. Introduction to High Energy Physics (2nd edition) by D. H. Perkins.
5. Radiation Detection and Measurement by G. F. Knoll.
6. Nuclear Physics Theory and Experiment, by R. R. Roy and B. P. Nigam.
7. Introduction to Solid State Physics (7th edition) by Charles Kittel
8. Solid State Physics by Neil W. Ashcroft and N. David Mermin.

Session: 2025-26			
PartA - Introduction			
Name of the Programme	Common to all PG Programmes		
Semester	2^{nd}		
Name of the Course	India’s contribution to Science		
Course Code	25PN-PHY-IKS201		
CourseType	IKS		
Level of the course	200-299		
Pre-requisite for the course (ifany)	---		
CourseLearningOutcomes (CLO) After completing this course, the learner will be able to:	**CLO 207.1:** Understand the development of astro the Indus, Vedic, and Post-Vedic periods. **CLO 207.2:** Explain the Indian Yuga system, Moon star and planet movements, and Indian systems. **CLO 207.3:** Identify traditional Indian astronomical instruments and their functions. **CLO 207.4:** Analyze the contribution of observatories to astronomy. **CLO 207.5:** Appreciate the lives and works of Indian scientists and their scientific impact **CLO 207.6:** Evaluate the role of Indian scientific ins like CSIR, ISRO, and DAE in development.		
Credits	Theory	Practical	Total
	2	0	2
Teaching Hours per week	2	0	2
Internal Assessment Marks	15	0	15
End Term Exam Marks	35	0	35
Max. Marks	50	0	50
Examination Time	3 hours		

PartB-Contentsofthe Course

Instructions for Paper- Setter: The examiner will set 9 questions asking two questions from each unit and one compulsory question by taking course learning outcomes (CLOs) into consideration. The compulsory question (Question No. 1) will consist of at least 4 parts covering entire syllabus. The examinee will be required to attempt 5 questions, selecting one question from each unitand the compulsory question. All questions will carry equal marks.

Unit	Topics	Contact Hours
I	Astronomy: Astronomy in Indus and Vedic period, Post Vedic Astronomy: Planetary Kinematics, the early traditions of siddhanta,	8
II	Brief Idea of Yuga system of India and phases of Moon, rising and setting of stars & Planets Indian Calendar : Pancanga, nakstra, festival dates in the Indian calendar	8
III	Astronomical Instruments: Samrat Yantra, Disha Yantra, Cakra Yantra,	8

	Jai Prakash Yantra, Phalaka-Yantra, Kapala-Yantra, Nalaka-Yantra, Dhanuryantra, Chatl-Yantra, Gola-Yantra, Karttari-Yantra, Pitha-Yantra And Chatra-Yantr, Development of Astronomical Laboratories: Delhi Observatory and Jaipur Observatory	
IV	Life and work of Indian Scientists: Sir Jagadish Chandra Bose, P.C. Ray, Srinivasa Ramanujan, Sir C.V. Raman, Meghnad Saha, Satyendra Nath Bose, S.S. Bhatnagar, Homi Jehangir Bhabha andVikram Sarabhai Role and development of CSIR, ISRO and DAE.	6
	Note: Scope of the syllabus shall be restricted to generic and introductory level of mentioned topics.	
	Total Contact Hours	30

Suggested Evaluation Methods

Internal Assessment: 15		End Term Examination: 35	
➢ **Theory**	**15**	➢ **Theory**	**35**
• Class Participation:	4	Written Examination	
• Seminar/presentation/assignment/quiz/class test etc.:	4		
• Mid-Term Exam:	7		

PartC-Learning Resources

Recommended Books/e-resources/LMS:

1. History Of Astronomy In India by S.N. Sen,K.S. Shukla.
2. Indian Mathematics and Astronomy: Some Landmark