

INDIRA GANDHI UNIVERSITY

Meerpur-Rewari, Haryana (122502)

(A State University Established under Haryana Act No.29 of 2013)

(Recognized u/s 12(B) & 2(f) of UGC Act, 1956)

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CHAIRPERSON
DEPARTMENT OF PHYSICS
INDIRA GANDHI UNIVERSITY
MEERPUR REWARI-122502


SCHEME OF EXAMINATION & SYLLABI

(in accordance with National Education Policy-2020)

for

Postgraduate Programme

in

Physics

Effective from Academic Session: 2026-27

DEPARTMENT OF PHYSICS
FACULTY OF PHYSICAL SCIENCES

Indira Gandhi University,
Meerpur-Rewari (122502)
Haryana, India

DETAILS OF APPROVALS

Council/Board	Date	Remark
Staff Council	24-07-2026	
Board of Studies	14-08-2026	Through Online mode
Faculty		
Academic Council		



CHAIRPERSON
DEPARTMENT OF PHYSICS
NEERA GANDHI UNIVERSITY
MIRPUR REWARI-122502



Chairperson
(Signature with Stamp)

VISION AND MISSION OF THE UNIVERSITY

VISION

To be a globally renowned university, recognized for excellence in teaching, innovative research and welfare of the society, imbibing the spirit of “*Vasudhaiv kutumbkam*”.

MISSION

- To introduce and implement innovation in teaching and learning process matching up the global standards to strengthen academic delivery through curriculum design, teaching pedagogy and usage of ICT.
- To develop a mechanism that attracts talented, qualified and experienced faculty from across the globe for pursuing their academic and research careers at the University.
- To offer academic programmes at UG, PG, Doctoral, Post-Doctoral levels which are learner-centric, industry focused and adhere to outcome based international models.
- To create an ambiance that is conducive for undertaking sponsored research, innovation and consultancy services to a wide spectrum of societal and industrial requirements while encouraging interdisciplinary approach of learning, team work and research.
- To establish state of art centres of excellence in frontier areas of research and design innovation through industry collaboration to innovate and incubate the products and services.
- To establish smart campus and promote e-governance activities in the university for the digitally empowered society and knowledge economy.
- To provide a hygienic, modern, environment friendly and vivacious campus attuned to the urgent needs of Green Technology.
- To consider and implement norms, metrics, standards, procedures and benchmarks for assessing and improving the quality in every aspect of University system and achieve quality certifications by National and International bodies.
- To make society self-reliant by organizing various programmes including literacy, gender sensitization, health awareness and dissemination of information about livelihood generation.

VISION AND MISSION OF THE DEPARTMENT

Vision

To be a nationally and internationally recognized center of excellence in Physics education and research, fostering scientific curiosity, innovation, and critical thinking to address global challenges and contribute meaningfully to society and technology.

Mission

1. To provide high-quality education in Physics through a balanced blend of theoretical foundation, experimental training, and computational skills.
2. To promote cutting-edge research in frontier areas such as condensed matter physics, photonics, quantum physics, nuclear and particle physics, and interdisciplinary fields.
3. To nurture scientific temper, analytical thinking, and problem-solving abilities among students through student-centric, inquiry-based, and experiential learning.
4. To establish state-of-the-art laboratories, computational facilities, and smart classrooms to support teaching and research excellence.
5. To foster industry-academia collaboration through internships, workshops, conferences, and industrial/research visits.
6. To encourage and support students to qualify in national-level competitive examinations such as CSIR-NET, GATE, and JEST, and to pursue careers in academia, research, and industry.
7. To create an inclusive and ethically responsible academic environment that prepares students to be self-reliant global citizens and contributors to scientific advancement.

ABOUT THE PROGRAMME

The Master of Science (M.Sc.) in Physics is a two-year postgraduate programme spread over four semesters. The programme adopts a balanced approach that integrates classroom instruction, laboratory training, seminar presentations, computational exercises, and research-oriented project work. Teaching is delivered through lectures, interactive discussions, problem-solving sessions, and the effective use of modern pedagogical tools such as multimedia presentations, audio-visual aids, simulations, and e-learning resources.

Special emphasis is placed on hands-on laboratory experience to strengthen experimental skills and scientific temper. Students are encouraged to participate in educational visits to national laboratories, research institutions, and industrial facilities to gain exposure to contemporary developments in physics and related technologies. The curriculum also promotes research aptitude by encouraging students to undertake semester-long projects within the department or at reputed national research institutions.

The programme aims to:

1. Develop a comprehensive understanding of fundamental and advanced concepts in various branches of Physics.
2. Introduce students to modern theories, experimental techniques, and emerging developments in the discipline.
3. Provide a broad and interdisciplinary perspective of Physics and its applications.
4. Develop the ability to design, perform, analyze, and interpret scientific experiments and communicate the results effectively.
5. Strengthen analytical, mathematical, and computational skills required for solving complex physical problems.
6. Equip students with practical, intellectual, and transferable skills essential for academic, research, and industrial careers.
7. Enhance understanding of the applications of Physics in addressing real-world scientific and technological challenges.
8. Foster interdisciplinary thinking and collaborative problem-solving abilities.
9. Cultivate research aptitude, innovation, ethical practices, and lifelong learning skills.
10. Prepare highly skilled human resources with a strong foundation in theoretical and experimental Physics for careers in academia, research organizations, industry, and emerging technology sectors.

INTAKE IN THE PROGRAMME

The 2-year/4-Semester M.Sc. Physics Programme admits 60 students annually through the first semester.

MINIMUM ELIGIBILITY CRITERIA

As per Indira Gandhi University PG Ordinance.

PASSING CRITERIA

As per Indira Gandhi University PG Ordinance.

ELIGIBILITY FOR EXAMINATION

As per Indira Gandhi University PG Ordinance.

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

PEO1	To apply fundamental and advanced knowledge of Physics to analyze and solve scientific problems.
PEO2	To develop experimental, analytical, and computational skills for research, industry, and higher studies.
PEO3	To demonstrate professional ethics, effective communication, teamwork, and lifelong learning abilities.
PEO4	Contribute to scientific and technological advancements by integrating Physics knowledge with emerging interdisciplinary fields.

PROGRAMME LEARNING OBJECTIVES (PLOs)

PLO1	Capable of demonstrating comprehensive disciplinary knowledge gained during course of study.
PLO2	Capability to ask relevant/ appropriate questions for identifying, formulating and analyzing the research problems and to draw conclusion from the analysis.
PLO3	Ability to communicate effectively on general and scientific topics with the scientific community and with society at large.
PLO4	Capability of applying knowledge to solve scientific and other problems.
PLO5	Capable to learn and work effectively as an individual, and as a member or leader in diverse teams, multidisciplinary settings.
PLO6	Ability of critical thinking, analytical reasoning and research based knowledge including design of experiments, analysis and interpretation of data to provide conclusions.
PLO7	Ability to use and learn techniques, skills and modern tools for scientific practices.
PLO8	Ability to apply reasoning to assess the different issues related to society and the consequent responsibilities relevant to the professional scientific practices.
PLO9	Aptitude to apply knowledge and skills that are necessary for participating in learning activities throughout life.

PLO10	Capability to identify and apply ethical issues related to one's work, avoid unethical behavior such as fabrication of data, committing plagiarism, and unbiased truthful actions in all aspects of work.
PLO11	Ability to demonstrate knowledge and understanding of the scientific principles and apply these to manage projects.

PROGRAMME SPECIFIC OBJECTIVES (PSOs)

PSO1	The detailed functional knowledge of theoretical concepts and experimental aspects of Physics.
PSO2	To integrate the gained knowledge with various contemporary and evolving areas in Physical sciences like nanotechnology, coatings, energy & environment etc.
PSO3	To understand, analyze, plan, and implement qualitative and quantitative phenomenon-based problems in physical sciences.
PSO4	Provide opportunities to excel in academics, research, or Industry.

Scheme of Examination for Postgraduate Programme

Scheme of Examination for Postgraduate Programme	
Subject	Physics
Total number of Semesters	4
Total Marks	2700
Total Credit	108
Framework	2
Scheme	P (as per PG ordinance)

Curriculum Framework - PG - P

*L: Lecture, T: Tutorial, P: Practical, Th: Theory

Semester	Course Type	Course Code	Nomenclature of the Course	Theory (Th)/ Practical (P)	Credit	Contact hours per week (L+T+P=Total)	Internal Assessment Marks (Th+P=Total)	End Term Examination Marks (Th+P=Total)	Total Marks	Exam Hours Theory, Practical
1	CC-1	26L6.0-PHY - 101	Mathematical Physics	4T / 0P	4	4+0+0=4	30+0=30	70+0=70	100	3 Hours
	CC-2	26L6.0-PHY - 102	Classical Mechanics and Relativity	4T / 0P	4	4+0+0=4	30+0=30	70+0=70	100	3 Hours
	CC-3	26L6.0-PHY - 103	Quantum Mechanics-I	4T / 0P	4	4+0+0=4	30+0=30	70+0=70	100	3 Hours
	CC-4	26L6.0-PHY - 104	Solid State Electronics	4T / 0P	4	4+0+0=4	30+0=30	70+0=70	100	3 Hours
	PC-1	26L6.0-PHY - 105	Practical General	0T / 4P	4	0+0+8=8	0+30=30	0+70=70	100	3 Hours
	PC-2	26L6.0-PHY - 106	Practical Electronics	0T / 4P	4	0+0+8=8	0+30=30	0+70=70	100	3 Hours
	SEMINAR	26L6.0-PHY - 107	Seminar	2T / 0P	2	2+0+0=2	0	50	50	
	Total				26	34	180	470	650	
2	CC-5	26L6.0-PHY-201	Atomic and Molecular Physics	4T / 0P	4	4+0+0=4	30+0=30	70+0=70	100	3 Hours
	CC-6	26L6.0-PHY-202	Thermodynamics & Statistical Mechanics	4T / 0P	4	4+0+0=4	30+0=30	70+0=70	100	3 Hours
	CC-7	26L6.0-PHY-203	Quantum Mechanics -II	4T / 0P	4	4+0+0=4	30+0=30	70+0=70	100	3 Hours
	CC-8	26L6.0-PHY-204	Solid State Physics	4T / 0P	4	4+0+0=4	30+0=30	70+0=70	100	3 Hours
	PC-3	26L6.0-PHY-205	Practical General	0T / 4P	4	0+0+8=8	0+30=30	0+70=70	100	3 Hours
	PC-4	26L6.0-PHY-206	Practical Atomic and Molecular Physics	0T / 4P	4	0+0+8=8	0+30=30	0+70=70	100	3 Hours
	CHM	26L6.0-CHM-201	Constitutional, Human and Moral Values, and IPR	2T / 0P	2	2+0+0=2	15+0=15	35+0=35	50	2 Hours
	Internship	26L6.0-PHY-INT	*Internship		4				100	-
	Total				30	34	195	455	750	
An internship course of 4 Credits of 4-6 weeks duration during summer vacation after 2nd semester is to be completed by every student. Internship can be either for enhancing the employability or for developing the research aptitude.										

Curriculum Framework - PG - P

Semester	Course Type	Course Code	Nomenclature of the Course	Theory (Th)/ Practical (P)	Credit	Contact hours per week (L+T+P=Total)	Internal Assessment Marks (Th+P=Total)	End Term Examination Marks (Th+P=Total)	Total Marks	Exam Hours Theory, Practical
3	CC-9	26L6.5-PHY-301	Condensed Matter Physics	4T / 0P	4	4+0+0=4	30+0=30	70+0=70	100	3 Hours
	CC-10	26L6.5-PHY-302	Electrodynamics and Wave Propagation	4T / 0P	4	4+0+0=4	30+0=30	70+0=70	100	3 Hours
	DEC-1 (Choose one)	26L6.5-PHY-303	Electronics Devices	4T / 0P	4	4+0+0=4	30+0=30	70+0=70	100	3 Hours
		26L6.5-PHY-304	Computational Methods & Programming-1							
	DEC-2 (Choose one)	26L6.5-PHY-305	Green Sustainable Technology-I	4T / 0P	4	4+0+0=4	30+0=30	70+0=70	100	3 Hours
		26L6.5-PHY-306	Laser and Spectroscopy							
	PC-5 (Choose one)	26L6.5-PHY-307	Practical Electronic Devices	0T / 4P	4	0+0+8=8	0+30=30	0+70=70	100	3 Hours
		26L6.5-PHY-308	Practical Computation Methods and Programming -I							
	PC-6 (Choose one)	26L6.5-PHY-309	Practical Green Sustainable Technology-I	0T / 4P	4	0+0+8=8	0+30=30	0+70=70	100	3 Hours
		26L6.5-PHY-310	Practical Laser and Spectroscopy							
	*OEC	26L6.5-OEC-PHY-301	Sources of Energy	2T / 0P	2	2+0+0=2	15+0=15	35+0=35	50	2 Hours
	Total				26	34	195	455	650	
*For students other than those in the PG Programme Physics. Students of the PG Programme in Physics will choose from the pool of open electives offered by the university.										

Semester	Course Type	Course Code	Nomenclature of the Course	Theory (Th)/ Practical (P)	Credit	Contact hours per week (L+T+P=Total)	Internal Assessment Marks (Th+P=Total)	End Term Examination Marks (Th+P=Total)	Total Marks	Exam Hours Theory, Practical
4	CC-11	26L6.5-PHY-401	Nuclear & Particle Physics	4T / 0P	4	4+0+0=4	30+0=30	70+0=70	100	3 Hours
	CC-12	26L6.5-PHY-402	Physics of Nano- Materials	4T / 0P	4	4+0+0=4	30+0=30	70+0=70	100	3 Hours
	DEC-3 (Choose one)	26L6.5-PHY-403	Digital Electronics & Signal Processing	4T / 0P	4	4+0+0=4	30+0=30	70+0=70	100	3 Hours
		26L6.5-PHY-404	Computational Methods& Programming-II							
	DEC-4 (Choose one)	26L6.5-PHY-405	Green Sustainable Technology-II	4T / 0P	4	4+0+0=4	30+0=30	70+0=70	100	3 Hours
		26L6.5-PHY-406	Modern Optics							
	PC-7 (Choose one)	26L6.5-PHY-407	Practical Digital Electronics & Signal Processing	0T / 4P	4	0+0+8=8	0+30=30	0+70=70	100	3 Hours
		26L6.5-PHY-408	Practical Computational Methods & Programming-II							
	PC-8 (Choose one)	26L6.5-PHY-409	Practical Green Sustainable Technology-II	0T / 4P	4	0+0+8=8	0+30=30	0+70=70	100	3 Hours
		26L6.5-PHY-410	Practical Modern Optics							
	EEC	26L6.5-PHY-411	Employability Entrepreneurship Skills Course	2T / 0P	2	2+0+0=2	15+0=15	35+0=35	50	2 Hours
	Total				26	34	195	455	650	

SCHEME OF SEMESTER-4 WHEN A STUDENT OPTS FOR DISSERTATION OR PROJECT WORK

4	DEC-3 (Choose one)	26L6.5-PHY-403	Digital Electronics & Signal Processing	4T / 0P	4	4+0+0=4	30+0=30	70+0=70	100	3 Hours
		26L6.5-PHY-404	Computational Methods& Programming-II							
	DEC-4 (Choose one)	26L6.5-PHY-405	Green Sustainable Technology-II	4T / 0P	4	4+0+0=4	30+0=30	70+0=70	100	3 Hours
		26L6.5-PHY-406	Modern Optics							
	DEC-5 (Choose one)	26L6.5-PHY-412	Vacuum Science & Thin Film Technology	4T / 0P	4	4+0+0=4	30+0=30	70+0=70	100	3 Hours
		26L6.5-PHY-413	Characterization Techniques for Materials							
	PROJECT WORK/DISSE RTATION	26L6.5-PHY-414	Dissertation		12		90	210	300	
	EEC	26L6.5-EEC-RPE-400	Research Ethics	2T / 0P	2	2+0+0=2	15+0=15	35+0=35	50	2 Hours
	Total				26		195	455	650	

OR

Semester	Course Type	Course Code	Nomenclature of the Course	Theory (Th)/ Practical (P)	Credit	Contact hours per week (L+T+P=Total)	Internal Assessment Marks (Th+P=Total)	End Term Examination Marks (Th+P=Total)	Total Marks	Exam Hours Theory, Practical
4	CC-11	26L6.5-PHY-401	Nuclear & Particle Physics	4T / 0P	4	4+0+0=4	30+0=30	70+0=70	100	3 Hours
	DEC-3	26L6.5-PHY-403	Digital Electronics & Signal Processing	4T / 0P	4	4+0+0=4	30+0=30	70+0=70	100	3 Hours
	(Choose one)	26L6.5-PHY-404	Computational Methods & Programming-II							
	DEC-4	26L6.5-PHY-405	Green Sustainable Technology-II	4T / 0P	4	4+0+0=4	30+0=30	70+0=70	100	3 Hours
	(Choose one)	26L6.5-PHY-406	Modern Optics							
	PROJECT WORK/DISSE RTATION	26L6.5-PHY-414	Dissertation		12		90	210	300	
	EEC	26L6.5-EEC-RPE-400	Research Ethics	2T / 0P	2	2+0+0=2	15+0=15	35+0=35	50	2 Hours
	Total				26		195	455	650	

INDIRA GANDHI UNIVERSITY, MEERPUR**Department of Physics**

Courses offered by the department as Open Elective Courses (OEC) in the University pool for PG Programme

**Offered for the Other Departments*

Course Code	Nomenclature of the Course	Semester	Theory (Th)/ Practical (P)	Credit	Contact hours per week	Internal Marks	End Term Marks	Total Marks	Exam Hours
26L6.5-OEC-PHY-301	Sources of Energy	3rd	2T / 0P	2	2+0+0=2	15+0=15	35+0=35	50	2 Hours

Introduction				
Subject	Physics - PG			
Semester	Semester 1			
Course Composition	Theory (Theory + Tutorial)			
Nomenclature of the Course	Mathematical Physics			
Course Code	26L6.0-PHY - 101			
Course Type	CC-1			
Course Level	400-499			
Pre-requisites for the course (if any)	Basic undergraduate mathematics or mathematical physics.			
Course Learning Outcomes (CLOs) After completing this course, the learner will be able to:	26L6.0-PHY - 101.1: Apply concepts of linear algebra, group theory, and matrix methods to formulate and analyze problems in modern physics. 26L6.0-PHY - 101.2: Analyze complex functions, contour integrals, differential equations, Frobenius series solutions, Sturm-Liouville problems, and special functions to solve mathematical physics problems. 26L6.0-PHY - 101.3: Employ Fourier series, Fourier and Laplace transforms, Green's functions, and partial differential equation techniques to model and solve physical systems with appropriate boundary conditions. 26L6.0-PHY - 101.4: Apply numerical methods, probability theory, Monte Carlo methods, Markov chains, and computational techniques, including historical contributions from Indian mathematics, to investigate and solve scientific problems with error analysis.			
	Theory (Th)		Practical (P)	Total
	Lecture (L)	Tutorial (T)		
Credits	4	0	0	4
Teaching hours per week	4	0	0	4
Internal Assessment Marks (Th+P=Total)	30		0	30
End Term Exam Marks	70		0	70
Max. Marks	100		0	100
Examination Duration (in Hours)	3 Hours		NA	3 Hours

Contents of the Course			
Instructions for Examiner: Theory: The paper setter shall prepare 9 questions selecting two questions from each unit with consideration given to the Course Learning Outcomes. Among these, question number 1 will be compulsory, comprising 7 short answer type questions carrying two marks each (total 14 marks) and covering the entire syllabus. The remaining questions will be carrying 14 marks each. Examinees will be required to attempt five questions: the compulsory question no. 1 and 1 question from the each of the four units.			
Unit	Topics	CLO(s)	Contact Hours
Unit-1	Linear Vector Spaces, Linear Independence, Basis and Dimension, Scalar Product, Orthonormal Basis, Gram-Schmidt Orthogonalization, Linear Operators, Matrices, Eigenvalues and Eigenvectors, Matrix Diagonalization, Function Spaces. Groups, subgroups, Finite and continuous groups, representations of groups, characters and character tables, Lie groups and Lie algebras, SO(3), SU(2), angular momentum and spin. Brief introduction to SU(3) and applications.	1	15

Unit-2	Analytic functions, Cauchy-Riemann equations, contour integration, Cauchy's theorem and integral formula, Taylor and Laurent series, Residues and applications, Singular points, Series solution and Frobenius method, Wronskian, Sturm-Liouville theory, orthogonal functions, Legendre polynomials, Bessel functions, Hermite polynomials, Laguerre polynomials, Gamma and Beta functions, generating functions and recurrence relations.	2	14
Unit-3	Fourier series and Fourier transforms; inverse Fourier transform; convolution theorem; Discrete Fourier Transform (DFT) and Fast Fourier Transform (FFT); Laplace transform and inverse Laplace transform. Introduction and classification of partial differential equations; elliptic, parabolic and hyperbolic equations; boundary and initial conditions; Dirichlet and Neumann problems; separation of variables; characteristic curves and canonical forms. One-dimensional wave and heat equations; D'Alembert solution and separation of variables; Laplace and Poisson equations in two and three dimensions; solutions in spherical coordinates; Green's function method.	3	16
Unit-4	Historical perspectives on iterative and computational methods in Indian mathematics, Aryabhata's Methods Recursive algorithms by Bhaskara, Kerala school and infinite series. Root-finding methods, interpolation (equally and unequally spaced points), least-squares fitting and goodness of fit, numerical differentiation, finite difference methods, numerical integration (Trapezoidal, Simpson's, Gaussian quadrature), numerical solution of ODEs (Euler, RK2, RK4). Error analysis. Probability distributions, central limit theorem, random walk, Monte Carlo methods and Markov chains and their applications.	4	15

Suggested Evaluation Methods

Internal Assessment: 30	TH-30	PR-0	End Term Examination: 70	TH-70	PR-0
Class Participation	5	NA	Written Examination	70	NA
Seminar/presentation/assignment/quiz/class test etc.	10	NA	Lab record	NA	NA
Seminar/Demonstration/Viva-voce/Lab records etc.	NA	NA	Viva-Voce	NA	NA
Mid-Term Exam(s)	15	NA	Write-up and execution of the practical	NA	NA

Mapping of (CLOs) to Programme Learning Outcomes & Programme Specific Outcomes

CLO	PLO ₁	PLO ₂	PLO ₃	PLO ₄	PLO ₅	PLO ₆	PLO ₇	PLO ₈	PLO ₉	PLO ₁₀	PLO ₁₁	PSO ₁	PSO ₂	PSO ₃	PSO ₄
26L6.0-PHY-101.1	3	3	1	3	1	3	2	1	1			3	2	3	1
26L6.0-PHY-101.2	3	3	1	3	1	3	2	1	1			3	2	3	2
26L6.0-PHY-101.3	3	3	1	3	1	3	2	1	1		1	3	3	3	2
26L6.0-PHY-101.4	3	3	1	3	1	3	3	2	2		1	2	3	3	3

Learning Resources

- Mathews, J., & Walker, R. L. (1970). Mathematical Methods of Physics (2nd ed.). W. A. Benjamin.
- Boas, M. L. (2006). Mathematical Methods in the Physical Sciences (3rd ed.). John Wiley & Sons.
- Riley, K. F., Hobson, M. P., & Bence, S. J. (2006). Mathematical Methods for Physics and Engineering (3rd ed.). Cambridge University Press.
- Arfken, G. B., Weber, H. J., & Harris, F. E. (2013). Mathematical Methods for Physicists: A Comprehensive Guide (7th ed.). Elsevier Academic Press.
- Byron, F. W., & Fuller, R. W. (1992). Mathematics of Classical and Quantum Physics (Vols. 1–2). Dover Publications.
- Kreyszig, E. (2015). Advanced Engineering Mathematics (10th ed.). John Wiley & Sons.
- Potter, M. C., Goldberg, J. L., & Aboufadel, E. F. (2014). Mathematical Methods (4th ed.). Pearson Education.
- Joshi, A. W. (1995). Matrices and Tensors in Physics (3rd ed.). New Age International Publishers.
- Joshi, A. W. (1997). Elements of Group Theory for Physicists (4th ed.). New Age International Publishers.
- Balakrishnan, V. (2018). Mathematical Physics with Applications, Problems and Solutions. Ane Books.
- Hamermesh, M. (1989). Group Theory and Its Application to Physical Problems. Dover Publications.
- Jain, M. K., Iyengar, S. R. K., & Jain, R. K. (2019). Numerical Methods for Scientific and Engineering Computation (7th ed.). New Age International Publishers.
- Chapra, S. C., & Canale, R. P. (2020). Numerical Methods for Engineers (8th ed.). McGraw-Hill Education.
- Press, W. H., Teukolsky, S. A., Vetterling, W. T., & Flannery, B. P. (2007). Numerical Recipes: The Art of Scientific Computing (3rd ed.). Cambridge University Press.
- Butkov, E. (1968). Mathematical Physics. Addison-Wesley Publishing Company.
- Morse, P. M., & Feshbach, H. (1953). Methods of Theoretical Physics (Vols. 1–2). McGraw-Hill
- Plofker, K. (2009). Mathematics in India: 500 BCE–1800 CE. Princeton University Press
- Joseph, G. G. (2009). A passage to infinity: Medieval Indian mathematics from Kerala and its impact. SAGE Publications.
- Datta, B., & Singh, A. N. (1935–1938). History of Hindu mathematics: A source book (Vols. 1–2). Motilal Banarsidass.
- M. D. Srinivas et al. (eds.), Studies in the History of Indian Mathematics, Springer.
- NPTEL. Mathematical Methods and Its Applications in Physics, IIT Madras. URL: <https://nptel.ac.in/courses/115106086>

Content Mapping with NEP thrust areas

Field	Hours Devoted
Employability	18
Indian Knowledge System	2

Important Notes:

Use of scientific calculators is permitted during examinations.

Introduction				
Subject	Physics - PG			
Semester	Semester 1			
Course Composition	Theory (Theory + Tutorial)			
Nomenclature of the Course	Classical Mechanics and Relativity			
Course Code	26L6.0-PHY - 102			
Course Type	CC-2			
Course Level	400-499			
Pre-requisites for the course (if any)	Undergraduate course on mechanics/ classical mechanics			
Course Learning Outcomes (CLOs) After completing this course, the learner will be able to:	26L6.0-PHY - 102.1: Apply Lagrangian formulation and symmetry principles to analyze constrained mechanical systems. 26L6.0-PHY - 102.2: Employ Hamiltonian methods, canonical transformations and Hamilton–Jacobi theory to solve dynamical problems. 26L6.0-PHY - 102.3: Analyze central force motion, orbital dynamics and motion in non-inertial reference frames. 26L6.0-PHY - 102.4: Apply the principles of special relativity and relativistic dynamics to physical systems.			
	Theory (Th)		Practical (P)	Total
	Lecture (L)	Tutorial (T)		
Credits	4	0	0	4
Teaching hours per week	4	0	0	4
Internal Assessment Marks (Th+P=Total)	30		0	30
End Term Exam Marks	70		0	70
Max. Marks	100		0	100
Examination Duration (in Hours)	3 Hours		NA	3 Hours

Contents of the Course			
Instructions for Examiner: Theory: The paper setter shall prepare 9 questions selecting two questions from each unit with consideration given to the Course Learning Outcomes. Among these, question number 1 will be compulsory, comprising 7 short answer type questions carrying two marks each (total 14 marks) and covering the entire syllabus. The remaining questions will be carrying 14 marks each. Examinees will be required to attempt five questions: the compulsory question no. 1 and 1 question from the each of the four units.			
Unit	Topics	CLO(s)	Contact Hours
Unit-1	Review of Newtonian mechanics and systems of particles, holonomic and non-holonomic constraints, generalized coordinates, virtual work and D'Alembert's principle, Lagrange's equations of motion, generalized momentum, velocity-dependent potentials. Dissipative forces and Rayleigh dissipation function, cyclic coordinates, conservation laws and integrals of motion, symmetry principles, Noether's theorem, invariance under Galilean transformations and applications of Lagrangian mechanics.	1	15
Unit-2	Calculus of variations, Maupertuis' and Hamilton's principles, Legendre transformations, Hamilton's equations of motion, phase space, Poisson brackets and their properties, angular momentum algebra and Poisson brackets, canonical transformations and generating functions. Hamilton–Jacobi equation and its applications to the harmonic oscillator and central force problem, action-angle variables, small oscillations, normal coordinates and normal modes.	2	15

Unit-3	Central force motion, reduction to the equivalent one-body problem, effective potential, stability and closure of circular orbits, Aryabhata's model of planetary motion and earth's rotation, Kepler's laws, orbital motion and planetary trajectories, Virial theorem, scattering in a central force field, Rutherford scattering, rotating coordinate systems, inertial and non-inertial frames, Coriolis and centrifugal forces, terrestrial applications including Foucault pendulum, motion of projectiles and artificial satellites.	3	15
Unit-4	Postulates of special relativity, Lorentz transformations, Lorentz group, space-time geometry, Minkowski space, space-time interval, simultaneity, time dilation, length contraction, relativistic velocity transformation, four-vectors, four-velocity and four-momentum, relativistic energy-momentum relation, mass-energy equivalence, relativistic dynamics, covariant formulation of mechanics.	4	15

Suggested Evaluation Methods					
Internal Assessment: 30	TH-30	PR-0	End Term Examination: 70	TH-70	PR-0
Class Participation	5	NA	Written Examination	70	NA
Seminar/presentation/assignment/quiz/class test etc.	10	NA	Lab record	NA	NA
Seminar/Demonstration/Viva-voce/Lab records etc.	NA	NA	Viva-Voce	NA	NA
Mid-Term Exam(s)	15	NA	Write-up and execution of the practical	NA	NA

Mapping of (CLOs) to Programme Learning Outcomes & Programme Specific Outcomes															
CLO	PLO ₁	PLO ₂	PLO ₃	PLO ₄	PLO ₅	PLO ₆	PLO ₇	PLO ₈	PLO ₉	PLO ₁₀	PLO ₁₁	PSO ₁	PSO ₂	PSO ₃	PSO ₄
26L6.0-PHY-102.1	3	3	1	3	1	3	2	1	1		1	3	2	3	2
26L6.0-PHY-102.2	3	3	1	3	1	3	2	1	1		1	3	2	3	2
26L6.0-PHY-102.3	3	2	1	3	1	3	2	1	1		1	3	2	3	2
26L6.0-PHY-102.4	3	3	1	3	1	3	2	2	1		1	3	3	3	3

Learning Resources

- ♦ Goldstein, H., Poole, C. P., & Safko, J. L. (2011). Classical mechanics (3rd ed.). Pearson Education.
- ♦ Spiegel, M. R. (1967). Schaum's outline of theoretical mechanics. McGraw-Hill.
- ♦ Greiner, W. (2003). Classical mechanics: Systems of particles and Hamiltonian dynamics. Springer.
- ♦ Fowles, G. R., & Cassiday, G. L. (2005). Analytical mechanics (7th ed.). Thomson Brooks/Cole.
- ♦ Upadhyaya, J. C. (2014). Classical mechanics. Himalaya Publishing House.
- ♦ Rana, N. C., & Joag, P. S. (2015). Classical mechanics. Tata McGraw-Hill Education.
- ♦ Hand, L. N., & Finch, J. D. (1998). Analytical mechanics. Cambridge University Press.
- ♦ Landau, L. D., & Lifshitz, E. M. (2012). Mechanics (3rd ed.). Butterworth-Heinemann.
- ♦ Jose, J. V., & Saletan, E. J. (1998). Classical dynamics: A contemporary approach. Cambridge University Press.
- ♦ Marion, J. B., & Thornton, S. T. (2003). Classical dynamics of particles and systems (5th ed.). Brooks/Cole.
- ♦ Percival, I., & Richards, D. (1982). Introduction to dynamics. Cambridge University Press. Taylor,
- ♦ J. R. (2005). Classical mechanics. University Science Books.
- ♦ Resnick, R. (1968). *Introduction to special relativity*. John Wiley & Sons.
- ♦ Taylor, E. F., & Wheeler, J. A. (1992). *Spacetime physics: Introduction to special relativity* (2nd ed.). W. H. Freeman.
- ♦ Rindler, W. (2006). *Special relativity* (2nd ed.). Oxford University Press.

Content Mapping with NEP thrust areas

Field	Hours Devoted
Indian Knowledge System	1
Environmental Awareness	3
Current Issues and Social Awareness	1

Important Notes:

Use of scientific calculators is permitted during examinations.

Introduction				
Subject	Physics - PG			
Semester	Semester 1			
Course Composition	Theory (Theory + Tutorial)			
Nomenclature of the Course	Quantum Mechanics-I			
Course Code	26L6.0-PHY - 103			
Course Type	CC-3			
Course Level	400-499			
Pre-requisites for the course (if any)	Basic knowledge of Modern Physics and Mathematical Physics.			
Course Learning Outcomes (CLOs) After completing this course, the learner will be able to:	26L6.0-PHY - 103.1: Student would be able to understand the concepts of operators in Quantum mechanics 26L6.0-PHY - 103.2: Students would be able to apply Pauli spin matrices to explain angular momentum. 26L6.0-PHY - 103.3: Students would be capable to solve problems such as hydrogen atom. 26L6.0-PHY - 103.4: Students would be capable to calculate spin states of identical particles.			
	Theory (Th)		Practical (P)	Total
	Lecture (L)	Tutorial (T)		
Credits	4	0	0	4
Teaching hours per week	4	0	0	4
Internal Assessment Marks (Th+P=Total)	30		0	30
End Term Exam Marks	70		0	70
Max. Marks	100		0	100
Examination Duration (in Hours)	3 Hours		NA	3 Hours

Contents of the Course			
Instructions for Examiner: Theory: The paper setter shall prepare 9 questions selecting two questions from each unit with consideration given to the Course Learning Outcomes. Among these, question number 1 will be compulsory, comprising 7 short answer type questions carrying two marks each (total 14 marks) and covering the entire syllabus. The remaining questions will be carrying 14 marks each. Examinees will be required to attempt five questions: the compulsory question no. 1 and 1 question from the each of the four units.			
Unit	Topics	CLO(s)	Contact Hours
Unit-1	Wave-Particle Duality and Complementarity: Comparative Perspectives from IKS, States and operators; Representation of States and dynamical variables; Linear vector space; Bra Ket notation, Linear operators; Orthonormal set of vectors, Completeness relation; Hermitian operators, their eigenvalues and eigenvectors, The fundamental commutation relation; Commutation rule and the uncertainty relation; Simultaneous eigenstates of commuting operators; The unitary transformation (time and spatial), symmetries and conservation laws, relation between classical and quantum mechanical commutators, Ehrenfest theorem; Dirac delta function; Matrix representation of operators; Time dependent and time independent Schrödinger Wave equation.	1	18
Unit-2	Angular momentum operators and their representation in spherical polar coordinates; Eigenvalues and eigenvectors of L^2 , spherical harmonics; Commutation relations among L_x L_y L_z ; Rotational symmetry and conservation of angular momentum; Eigenvalues of J^2 and J_z and their matrix representation; Stern-Gerlach Experiment, spin angular momentum, general theory of spin, spin half system, Pauli spin matrices, Addition of angular momentum, C.G. coefficients.	2	15

Unit-3	Bound and Unbound states, 1-D problems (free particle, infinite and finite potential well and barrier) Solution of the linear harmonic oscillator problem by operator methods, 3-D infinite potential well and the degeneracy of the states; The three-dimensional harmonic oscillator in both cartesian and spherical polar coordinates, eigenvalues, eigenfunctions, and the degeneracy of the states; Solution of the hydrogen atom problem, the eigenvalues, eigenfunctions, and the degeneracy.	3	15
Unit-4	The principle of indistinguishability; Symmetric and antisymmetric wave functions; Spin and statistics of identical particles, spin-statistics connection, The Slater determinant; The Pauli exclusion principle & Boson condensation; Spin states of a two-electron system; States of the helium atom; Collision of identical particles.	4	12

Suggested Evaluation Methods					
Internal Assessment: 30	TH-30	PR-0	End Term Examination: 70	TH-70	PR-0
Class Participation	5	NA	Written Examination	70	NA
Seminar/presentation/assignment/quiz/class test etc.	10	NA	Lab record	NA	NA
Seminar/Demonstration/Viva-voce/Lab records etc.	NA	NA	Viva-Voce	NA	NA
Mid-Term Exam(s)	15	NA	Write-up and execution of the practical	NA	NA

Mapping of (CLOs) to Programme Learning Outcomes & Programme Specific Outcomes															
CLO	PLO ₁	PLO ₂	PLO ₃	PLO ₄	PLO ₅	PLO ₆	PLO ₇	PLO ₈	PLO ₉	PLO ₁₀	PLO ₁₁	PSO ₁	PSO ₂	PSO ₃	PSO ₄
26L6.0-PHY-103.1	3	3	2	3	1	1	1	1	1			3	2	3	2
26L6.0-PHY-103.2	3	3	2	3	1	1	1	1	1			3	2	3	2
26L6.0-PHY-103.3	3	3	2	3	2	1	1	1	1			3	2	3	3
26L6.0-PHY-103.4	3	3	2	2	1	1	1	1	1			3	2	3	3

Learning Resources

- ♦ L. D. Landau and E.M. Lifshitz, Quantum Mechanics, Butterworth Heinemann, The Netherlands, 3rd Edition, 1981.
- ♦ P. A. M. Dirac, The Principles of Quantum Mechanics, Oxford University Press, UK, 4th Edition, 1988.
- ♦ R. Shankar, Principles of Quantum Mechanics, Springer, Germany, 2nd Edition, 1994.
- ♦ N. Zettili, Quantum Mechanics: Concepts and Applications, Wiley, USA, 2nd Edition, 2009.
- ♦ J. J. Sakurai, Modern Quantum Mechanics, Pearson, India, 2nd Edition, 2013
- ♦ L. I. Schiff, Quantum Mechanics, McGraw Hill Education, USA, 4th Edition, 2017.
- ♦ D. J. Griffiths, Introduction to Quantum Mechanics, Cambridge University Press, UK, 3rd Edition, 2018.
- ♦ C. Cohen-Tannoudji, B. Diu, and F. Laloe, Quantum Mechanics, Volume 1: Basic Concepts, Tools, and Applications, Wiley, USA, 2nd Edition, 2019.
- ♦ Radhakrishnan, S. (1994). *The Principal Upanishads*. New Delhi: HarperCollins Publishers India.
- ♦ Heisenberg, W. (1958). *Physics and Philosophy: The Revolution in Modern Science*. New York: Harper & Brothers
- ♦ Capra, F. (2010). *The Tao of Physics: An Exploration of the Parallels Between Modern Physics and Eastern Mysticism* (5th ed.). Boston, MA: Shambhala Publications

Content Mapping with NEP thrust areas

Field	Hours Devoted
Employability	1
Skill Enhancement	3
Communication Development	2
Indian Knowledge System	2

Introduction				
Subject	Physics - PG			
Semester	Semester 1			
Course Composition	Theory (Theory + Tutorial)			
Nomenclature of the Course	Solid State Electronics			
Course Code	26L6.0-PHY - 104			
Course Type	CC-4			
Course Level	400-499			
Pre-requisites for the course (if any)	Basic knowledge of Semiconductor Physics			
Course Learning Outcomes (CLOs) After completing this course, the learner will be able to:	26L6.0-PHY - 104.1: To understand the fundamental concepts of semiconductor physics and electronic properties of materials. 26L6.0-PHY - 104.2: To understand the carrier transport phenomena such as drift, diffusion, recombination, and optical processes in semiconductors. 26L6.0-PHY - 104.3: To analyze the behavior and applications of p-n junctions, diodes, and related electronic devices. 26L6.0-PHY - 104.4: To understand the operation and characteristics of BJTs and FETs for electronic circuit applications.			
	Theory (Th)		Practical (P)	Total
	Lecture (L)	Tutorial (T)		
Credits	4	0	0	4
Teaching hours per week	4	0	0	4
Internal Assessment Marks (Th+P=Total)	30		0	30
End Term Exam Marks	70		0	70
Max. Marks	100		0	100
Examination Duration (in Hours)	3 Hours		NA	3 Hours

Contents of the Course			
Instructions for Examiner: Theory: The paper setter shall prepare 9 questions selecting two questions from each unit with consideration given to the Course Learning Outcomes. Among these, question number 1 will be compulsory, comprising 7 short answer type questions carrying two marks each (total 14 marks) and covering the entire syllabus. The remaining questions will be carrying 14 marks each. Examinees will be required to attempt five questions: the compulsory question no. 1 and 1 question from the each of the four units.			
Unit	Topics	CLO(s)	Contact Hours
Unit-1	Energy bands: Direct and Indirect, Metals, Semiconductors and Insulators, Variation of energy bands with alloy composition, Types of semiconductors: Intrinsic and extrinsic materials, Fermi level and its dependence on carrier concentration and temperature, Electron and hole concentration in equilibrium. Temperature dependence of carrier concentration, Compensation and charge neutrality, Conductivity and mobility: Effect of temperature, Doping and High electric field, Hall Effect, Invariance of Fermi level.	1	15
Unit-2	Optical absorption and luminescence, Direct and indirect recombination of electrons and holes, Trapping, Carrier lifetime, Steady-state carrier generation, Quasi-Fermi levels, Natural Luminescence Phenomena, Sunlight interaction with crystals, Gemstones and naturally glowing materials. Photoconductivity, carrier transport phenomena, Drift and diffusion of carriers, Diffusion and recombination, Diffusion length, Haynes-Shockley experiment.	2	15

Unit-3	P-n junction and contact potential, Space charge, Reverse and Forward bias p-n junction, Zener and Avalanche breakdown. Capacitance of p-n junction: Varactor Diodes and their applications, Silicon controlled rectifier (SCR). Diode Applications: Load-Line Analysis, Half-Wave and Full Wave Rectification: ripple factor and efficiency, Clippers, Clampers, Metal-Semiconductor contact: Rectifying contact and Ohmic contact, Piezo-electric crystals, Direct and inverse piezoelectric effects.	3	15
Unit-4	Bipolar junction Transistor (BJT) Transistor operating modes, Transistor action, Transistor biasing configurations and characteristics, BJT DC Biasing: Operating Point, Fixed-Bias Configuration, Emitter-Bias Configuration, Voltage-Divider Bias Configuration, Collector Feedback Configuration, Emitter-Follower Configuration, The Ebers-Moll model, Unijunction Transistor (UJT), Field Effect Transistors: JFET: Construction and Characteristics of JFETS, Transfer Characteristics, Metal Oxide Semiconductor Field Effect Transistor (MOSFET): Depletion-Type MOSFET, Enhancement-Type MOSFET, Transfer Characteristics, Voltage Variable Resistor	4	15

Suggested Evaluation Methods

Internal Assessment: 30	TH-30	PR-0	End Term Examination: 70	TH-70	PR-0
Class Participation	5	NA	Written Examination	70	NA
Seminar/presentation/assignment/quiz/class test etc.	10	NA	Lab record	NA	NA
Seminar/Demonstration/Viva-voce/Lab records etc.	NA	NA	Viva-Voce	NA	NA
Mid-Term Exam(s)	15	NA	Write-up and execution of the practical	NA	NA

Mapping of (CLOs) to Programme Learning Outcomes & Programme Specific Outcomes

CLO	PLO ₁	PLO ₂	PLO ₃	PLO ₄	PLO ₅	PLO ₆	PLO ₇	PLO ₈	PLO ₉	PLO ₁₀	PLO ₁₁	PSO ₁	PSO ₂	PSO ₃	PSO ₄
26L6.0-PHY-104.1	3	1		2		1	1		2			3	3	2	2
26L6.0-PHY-104.2	3	2		3		2	1	1	2			2	3	3	2
26L6.0-PHY-104.3	3	2	1	3		3	2	1	2			3	2	3	3
26L6.0-PHY-104.4	3	2	1	3		3	2	1	2		1	2	3	3	3

Learning Resources
• Sedra, A. S., & Smith, K. C. (2020). Microelectronic circuits (8th ed.). Oxford University Press. • Neamen, D. A. (2012). Semiconductor physics and devices: Basic principles (4th ed.). McGraw-Hill Education. • Streetman, B. G., & Banerjee, S. K. (2015). Solid state electronic devices (7th ed.). Pearson • Boylestad, R. L., & Nashelsky, L. (2018). Electronic devices and circuit theory (11th ed.). Pearson. • Malvino, A. P., & Bates, D. J. (2016). Electronic principles (7th ed.). McGraw-Hill Education. • Sze, S. M., & Ng, K. K. (2006). Physics of semiconductor devices (3rd ed.). Wiley. • Millman, J., & Halkias, C. (1980). Electronic devices and circuits. McGraw-Hill Education • MIT Open Course Ware 3.15.1x Electronic Materials and Devices (https://sl1nk.com/vyvs5fk) • NPTEL (National Programme on Technology Enhanced Learning). Fundamentals of semiconductor devices. https://nptel.ac.in/courses/108108122 • NPTEL (National Programme on Technology Enhanced Learning). Basic Electronics. (https://nptel.ac.in/courses/108101091) SWAYAM. • Fundamental of Electronic Engineering. https://onlinecourses.swayam2.ac.in/e-learning/preview/nou25_ec11

Content Mapping with NEP thrust areas	
Field	Hours Devoted
Employability	3
Entrepreneurship	3
Skill Enhancement	6
Indian Knowledge System	2

Introduction				
Subject	Physics - PG			
Semester	Semester 1			
Course Composition	Practical			
Nomenclature of the Course	Practical General			
Course Code	26L6.0-PHY - 105			
Course Type	PC-1			
Course Level	400-499			
Pre-requisites for the course (if any)	Basic knowledge of Physics laboratory techniques and measurements.			
Course Learning Outcomes (CLOs) After completing this course, the learner will be able to:	26L6.0-PHY - 105.1: Students would be able to determine the specific charge of an electron and understand the helical path in the electromagnetic field, solar cell principle, etc. 26L6.0-PHY - 105.2: Students will be able to understand and perform experiments related to gas discharge, ionization, dielectric materials, and optical interferometry. 26L6.0-PHY - 105.3: Students will be able to develop and implement basic programming solutions to solve mathematical and logical problems such as volume calculation, number comparison, quadratic equations, leap year detection, and numerical differentiation using appropriate control structures and algorithms, and interpret the computational results effectively. 26L6.0-PHY - 105.4: Students will be able to design and implement programs to solve mathematical and computational problems such as factorial, Armstrong number checking, GCD/LCM computation, Fibonacci series generation, and basic data visualization with curve fitting, using appropriate programming logic and numerical techniques, and interpret the results effectively			
	Theory (Th)		Practical (P)	Total
	Lecture (L)	Tutorial (T)		
Credits	0	0	4	4
Teaching hours per week	0	0	8	8
Internal Assessment Marks (Th+P=Total)	0		30	30
End Term Exam Marks	0		70	70
Max. Marks	0		100	100
Examination Duration (in Hours)	NA		3 Hours	3 Hours

Contents of the Course			
Instructions for Examiner: Practical: Write-up and execution of the practical will be conducted as per the nature of the practical by the external examiner, with consideration given to the Course Learning Outcomes. The maximum marks for the write-up and execution of the practical will be 40 .			
Unit	Topics	CLO(s)	Contact Hours
Unit-1	1. To determine the e/m for electron by helical Method. 2. To calibrate the prism spectrometer with mercury vapour lamp and hence to find the Cauchy's constant. 3. To study the characteristics of a photovoltaic cell (p-n junction solar cell)	1	30

Unit-2	4. To determine the capacitance of unknown capacitor 5. Stefan's Constant Kit to determine Stefan's constant by Black copper radiation plates (Electrical method). 6. To measure the thermal conductivity of a bad conductor (Lee's Disc Method)	2	30
Unit-3	7. To determine the dielectric constant of different solid samples. 8. To determine the velocity of sound in an air/gas column. 9. To study the B-H curve for a given sample using CRO.	3	30
Unit-4	10. Write a program to perform matrix operations (addition, subtraction, multiplication, dot product of vectors). 11. Write a program to find maximum, minimum, mean and standard deviation of a given data. 12. Write a program to plot the trajectory of a projectile. 13. Write a program to plot the eigenfunctions and probability densities of a particle in a 1D box. 14. Write a program to perform linear curve fitting on a given data set.	4	30

Suggested Evaluation Methods					
Internal Assessment: 30	TH-0	PR-30	End Term Examination: 70	TH-0	PR-70
Class Participation	NA	5	Written Examination	NA	NA
Seminar/presentation/assignment/quiz/class test etc.	NA	NA	Lab record	NA	10
Seminar/Demonstration/Viva-voce/Lab records etc.	NA	10	Viva-Voce	NA	20
Mid-Term Exam(s)	NA	15	Write-up and execution of the practical	NA	40

Mapping of (CLOs) to Programme Learning Outcomes & Programme Specific Outcomes															
CLO	PLO ₁	PLO ₂	PLO ₃	PLO ₄	PLO ₅	PLO ₆	PLO ₇	PLO ₈	PLO ₉	PLO ₁₀	PLO ₁₁	PSO ₁	PSO ₂	PSO ₃	PSO ₄
26L6.0-PHY-105.1	3	2	2	3	1							3	3	2	1
26L6.0-PHY-105.2	3	2	2	3	2							3	3	2	1
26L6.0-PHY-105.3	2	3	3	2	3					1		2	3	3	2
26L6.0-PHY-105.4	2	3	3	2	3					2		2	3	3	3

Learning Resources

- | |
|---|
| <ul style="list-style-type: none"> ♦ Flint, B. L., & Worsnop, H. T. <i>Advanced Practical Physics for Students</i>. Asia Publishing House ♦ Prakash, I., & Ramakrishna. <i>A Textbook of Practical Physics</i>. Kitab Mahal. ♦ Chauhan, S., & Singh, M. <i>Advanced Practical Physics</i>. Pragati Prakashan, Meerut. ♦ Squires, G. L. <i>Practical Physics</i> (4th ed.). Cambridge University Press, Cambridge, 2001 ♦ Jain, R. K. <i>Practical Physics</i>. S. Chand & Company, New Delhi. ♦ Balagurusamy, E. <i>Programming in ANSI C</i> (8th ed.). McGraw-Hill Education. |
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Content Mapping with NEP thrust areas
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Field	Hours Devoted
Employability	10
Entrepreneurship	3
Skill Enhancement	8
Communication Development	2
Environmental Awareness	2
Current Issues and Social Awareness	2

Important Notes:

Students should perform atleast 8-10 experiments, ensuring that the selected experiments are distributed across all units of the course.
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Introduction				
Subject	Physics - PG			
Semester	Semester 1			
Course Composition	Practical			
Nomenclature of the Course	Practical Electronics			
Course Code	26L6.0-PHY - 106			
Course Type	PC-2			
Course Level	400-499			
Pre-requisites for the course (if any)	Basic knowledge of Electronic Devices and Circuit Fundamentals.			
Course Learning Outcomes (CLOs) After completing this course, the learner will be able to:	26L6.0-PHY - 106.1: Apply semiconductor characterization techniques to determine band gap, resistivity, and carrier mobility. 26L6.0-PHY - 106.2: Analyze optical and photoconductive properties of semiconductor and piezoelectric devices. 26L6.0-PHY - 106.3: Design and evaluate rectifier, regulated power supply, and SCR-based electronic circuits. 26L6.0-PHY - 106.4: Investigate the characteristics and applications of transistor, MOSFET, and UJT devices.			
	Theory (Th)		Practical (P)	Total
	Lecture (L)	Tutorial (T)		
Credits	0	0	4	4
Teaching hours per week	0	0	8	8
Internal Assessment Marks (Th+P=Total)	0		30	30
End Term Exam Marks	0		70	70
Max. Marks	0		100	100
Examination Duration (in Hours)	NA		3 Hours	3 Hours

Contents of the Course			
Instructions for Examiner: Practical: Write-up and execution of the practical will be conducted as per the nature of the practical by the external examiner, with consideration given to the Course Learning Outcomes. The maximum marks for the write-up and execution of the practical will be 40 .			
Unit	Topics	CLO(s)	Contact Hours
Unit-1	1. To find band gap of semiconductor using Four Probe Method. 2. To determine the resistivity of a semiconductor (Ge Crystal) by four probe method, at different temp. 3. To design and construct a second order Sallen Key active low pass filter.	1	30
Unit-2	4. Planck Constant Kit to determine Plank's Constant (h) by measuring the voltage drop across light-emitting diodes of different colors. 5. To study the fluorescence behavior of a dye solution and determine the emission spectrum under UV/visible light excitation. 6. To study the Piezo electric crystal Oscillators.	2	30
Unit-3	7. Design & study of regulated power supply. 8. To construct full wave rectifier with and without capacitor filter and calculate efficiency, percentage regulation and ripple factor. 9. Characteristics and applications of Silicon Controller Rectifier.	3	30

Unit-4	10. Darlington Pair Amplifier model-C024 to measure its current gain, voltage gain, input impedance, and frequency response. 11. Experiments on MOSFET characterization and application as an amplifier. 12. Experiment on Uni-junction Transistor and its application.	4	30
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Suggested Evaluation Methods					
Internal Assessment: 30	TH-0	PR-30	End Term Examination: 70	TH-0	PR-70
Class Participation	NA	5	Written Examination	NA	NA
Seminar/presentation/assignment/quiz/class test etc.	NA	NA	Lab record	NA	10
Seminar/Demonstration/Viva-voce/Lab records etc.	NA	10	Viva-Voce	NA	20
Mid-Term Exam(s)	NA	15	Write-up and execution of the practical	NA	40

Mapping of (CLOs) to Programme Learning Outcomes & Programme Specific Outcomes															
CLO	PLO ₁	PLO ₂	PLO ₃	PLO ₄	PLO ₅	PLO ₆	PLO ₇	PLO ₈	PLO ₉	PLO ₁₀	PLO ₁₁	PSO ₁	PSO ₂	PSO ₃	PSO ₄
26L6.0-PHY-106.1	3	2	1	3		3	3	1	2			3	3	3	2
26L6.0-PHY-106.2	3	3	1	3		3	2	1	2			3	3	3	2
26L6.0-PHY-106.3	3	3	2	3	1	2	3	1	2		2	3	3	3	3
26L6.0-PHY-106.4	3	2	1	3		2	3	1	2		1	3	3	3	3

Learning Resources
Neamen, D. A. (2012). Semiconductor physics and devices: Basic principles (4th ed.). McGraw-Hill Education. • Kittel, C. (2005). Introduction to solid state physics (8th ed.). John Wiley & Sons. • Streetman, B. G., & Banerjee, S. K. (2015). Solid state electronic devices (7th ed.). Pearson. • Beiser, A. (2003). Concepts of modern physics (6th ed.). McGraw-Hill. • Serway, R. A., Moses, C. J., & Moyer, C. A. (2005). Modern physics (3rd ed.). Thomson Brooks/Cole. • Lakowicz, J. R. (2006). Principles of fluorescence spectroscopy (3rd ed.). Springer. • McHale, J. L. (2017). Molecular spectroscopy (2nd ed.). CRC Press - Boylestad, R. L., & Nashelsky, L. (2019). Electronic devices and circuit theory (12th ed.). Pearson. • Malvino, A. P., & Bates, D. J. (2016). Electronic principles (8th ed.). McGraw-Hill Education. • Sedra, A. S., & Smith, K. C. (2020). Microelectronic circuits (8th ed.). Oxford University Press. - Millman, J., & Halkias, C. C. (1972). Integrated electronics: Analog and digital circuits and systems. McGraw-Hill. • Bimbhra, P. S. (2012). <i>Power electronics</i> (5th ed.). Khanna Publishers. • Rashid, M. H. (2014). <i>Power electronics: Circuits, devices, and applications</i> (4th ed.). Pearson. • IIT Kharagpur Virtual Lab – https://vlab.amrita.edu?utm_source=chatgpt.com. • Virtual Labs – Semiconductor Characterization, https://vlab.co.in?utm_source=chatgpt.com.

Content Mapping with NEP thrust areas	
Field	Hours Devoted
Employability	6
Entrepreneurship	6
Skill Enhancement	12

Important Notes:
Students should perform at least 8–10 experiments, ensuring that the selected experiments are distributed across all units of the course.

Introduction				
Subject	Physics - PG			
Semester	Semester 2			
Course Composition	Theory (Theory + Tutorial)			
Nomenclature of the Course	Atomic and Molecular Physics			
Course Code	26L6.0-PHY-201			
Course Type	CC-5			
Course Level	400-499			
Pre-requisites for the course (if any)	Basic knowledge of Quantum Mechanics and Modern Physics.			
Course Learning Outcomes (CLOs) After completing this course, the learner will be able to:	26L6.0-PHY-201.1: Will be able to know about the Vector-atom model and its application. 26L6.0-PHY-201.2: Will be able to relate theoretical results of the Zeeman effect, the Paschen-Back effect, Stark effect with experimental results 26L6.0-PHY-201.3: Will be able to describe rotational spectra, energy levels and intensity of rigid and non-rigid rotator, and PQR branches 26L6.0-PHY-201.4: Will be able to know about Raman effect & electronic energy levels, and their application			
	Theory (Th)		Practical (P)	Total
	Lecture (L)	Tutorial (T)		
Credits	4	0	0	4
Teaching hours per week	4	0	0	4
Internal Assessment Marks (Th+P=Total)	30		0	30
End Term Exam Marks	70		0	70
Max. Marks	100		0	100
Examination Duration (in Hours)	3 Hours		NA	3 Hours

Contents of the Course			
Instructions for Examiner: Theory: The paper setter shall prepare 9 questions selecting two questions from each unit with consideration given to the Course Learning Outcomes. Among these, question number 1 will be compulsory, comprising 7 short answer type questions carrying two marks each (total 14 marks) and covering the entire syllabus. The remaining questions will be carrying 14 marks each. Examinees will be required to attempt five questions: the compulsory question no. 1 and 1 question from the each of the four units.			
Unit	Topics	CLO(s)	Contact Hours
Unit-1	Quantum states of one-electron atoms, atomic orbitals, Hydrogen spectrum, Relativistic corrections for energy levels of hydrogen atom, spectra of alkali elements, spin-orbit interaction, and fine structure in alkali spectra. Spectra of two-electron systems, interaction energy in LS and j-j coupling, Lande interval rule, Laporte rule, Calculation of spectroscopic terms arising from-equivalent electrons, non-equivalent electrons and two equivalent and third non-equivalent electron, ground state of spectroscopic terms (in half-filled, more half-filled and less half-filled electronic configuration), Breit Scheme, total degeneracy of energy levels.	1	15
Unit-2	Normal and anomalous Zeeman effect, selection rules, Paschen-Back effect, Stark effect Hyperfine structure (magnetic and electric), Isotopic shift, determination of nuclear spin from hyperfine structure, Stern-Gerlach experiment: splitting (no. of traces/points) and distance from centre line in inhomogeneous field, broadening of spectral lines and its causes, Spontaneous and stimulated emission & absorption, Einstein coefficients. The laser idea, properties of laser beams, Rate equations, methods of obtaining population inversions, laser resonator; modes of resonator and coherence length.	2	15

Unit-3	Types of molecules, Diatomic linear symmetric top, asymmetric top and spherical top molecules, Rotational spectra of diatomic molecules as a rigid rotator, energy levels and spectra of non-rigid rotor, intensity of rotational lines, Vibrational energy of diatomic molecule, Diatomic molecules as a simple harmonic oscillator, Energy levels and spectrum, Morse potential energy curve, Molecules as vibrating rotator, vibration spectrum of diatomic molecules, PQR Branches.	3	15
Unit-4	Raman effect - quantum theory - molecular polarizability pure rotational Raman spectra of diatomic molecules - vibration rotation Raman Spectrum of diatomic molecules. Intensity alternation in Raman spectra of diatomic molecules, Experimental set up for Raman spectroscopy - application of Raman spectroscopy in the structure determination of simple molecules, Electronic spectra of diatomic molecules, Born Oppenheimer approximation - vibrational coarse structure of electronic bands - progression and sequences, intensity of electronic bands - Frank Condon principle, Dissociation and pre-dissociation energy.	4	15

Suggested Evaluation Methods					
Internal Assessment: 30	TH-30	PR-0	End Term Examination: 70	TH-70	PR-0
Class Participation	5	NA	Written Examination	70	NA
Seminar/presentation/assignment/quiz/class test etc.	10	NA	Lab record	NA	NA
Seminar/Demonstration/Viva-voce/Lab records etc.	NA	NA	Viva-Voce	NA	NA
Mid-Term Exam(s)	15	NA	Write-up and execution of the practical	NA	NA

Mapping of (CLOs) to Programme Learning Outcomes & Programme Specific Outcomes															
CLO	PLO ₁	PLO ₂	PLO ₃	PLO ₄	PLO ₅	PLO ₆	PLO ₇	PLO ₈	PLO ₉	PLO ₁₀	PLO ₁₁	PSO ₁	PSO ₂	PSO ₃	PSO ₄
26L6.0-PHY-201.1	3	3	2	3	1	2	1		1			3	2	3	2
26L6.0-PHY-201.2	3	3	2	3	1	2	2	1	1			3	3	3	3
26L6.0-PHY-201.3	3	3	2	3	1	2	2		1			3	3	3	3
26L6.0-PHY-201.4	3	3	2	3	1	2	3	1	1		1	3	3	3	3

Learning Resources
• H. E. White, Introduction to Atomic Spectra, McGraw Hill, New York, 1st Edition, 1934 • H. G. Kuhn, Introduction to Atomic Spectra, Green and Co., Harlow, 2nd Edition, 1969 • K. Thyagarajan and A.K. Ghatak, Lasers - Theory and Applications, Plenum Press, New York, 1st Edition, 1981. • B. H. Bransden and C. J Joachain, Physics of Atoms and Molecules, Pearson, UK, 2nd Edition, 2003. • Raj Kumar, Atomic & Molecular Spectra, Kedar Nath Ram Nath Publication. • C. N. Banwell, Fundamentals of Molecular Spectroscopy, McGraw Hill, New York, 4th Edition, 2017 • Arthur Beiser, Perspectives of Modern Physics, McGraw Hill, New York, 6th Edition, 2006 • Spectroscopy Vol I and II by Walker and Straughen • Spectroscopy Vol I and II by Walker and Straughen • Introduction to Atomic and Molecular Spectroscopy by V.K.Jain • Introduction to Atomic and Molecular Spectroscopy by V.K.Jain • J M Holkas, Modern Spectroscopy, 4 ed., John Wiley & Sons Inc

Content Mapping with NEP thrust areas	
Field	Hours Devoted
Employability	2
Skill Enhancement	3
Communication Development	2
Environmental Awareness	1
Current Issues and Social Awareness	1

Introduction				
Subject	Physics - PG			
Semester	Semester 2			
Course Composition	Theory (Theory + Tutorial)			
Nomenclature of the Course	Thermodynamics & Statistical Mechanics			
Course Code	26L6.0-PHY-202			
Course Type	CC-6			
Course Level	400-499			
Pre-requisites for the course (if any)	Undergraduate course on thermodynamics			
Course Learning Outcomes (CLOs) After completing this course, the learner will be able to:	26L6.0-PHY-202.1: Apply ensemble theory and statistical principles to describe equilibrium thermodynamic systems. 26L6.0-PHY-202.2: Analyze classical many-particle systems, thermodynamic fluctuations, and stochastic processes using statistical methods. 26L6.0-PHY-202.3: Apply quantum statistical mechanics to describe bosonic and fermionic systems and their physical properties. 26L6.0-PHY-202.4: Analyze phase transitions, critical phenomena, and non-equilibrium processes using modern statistical mechanics approaches.			
	Theory (Th)		Practical (P)	Total
	Lecture (L)	Tutorial (T)		
Credits	4	0	0	4
Teaching hours per week	4	0	0	4
Internal Assessment Marks (Th+P=Total)	30		0	30
End Term Exam Marks	70		0	70
Max. Marks	100		0	100
Examination Duration (in Hours)	3 Hours		NA	3 Hours

Contents of the Course			
Instructions for Examiner: Theory: The paper setter shall prepare 9 questions selecting two questions from each unit with consideration given to the Course Learning Outcomes. Among these, question number 1 will be compulsory, comprising 7 short answer type questions carrying two marks each (total 14 marks) and covering the entire syllabus. The remaining questions will be carrying 14 marks each. Examinees will be required to attempt five questions: the compulsory question no. 1 and 1 question from the each of the four units.			
Unit	Topics	CLO(s)	Contact Hours
Unit-1	Macrostates and microstates, phase space, Liouville theorem and Liouville equation, equal a priori probability postulate, statistical equilibrium, ergodic hypothesis, quantization of phase space, Gibbs paradox and indistinguishability, microcanonical, canonical and grand canonical ensembles, partition functions and their physical significance, thermodynamic quantities from partition functions, fluctuations and ensemble equivalence. Introduction to Shannon entropy.	1	15
Unit-2	Classical ideal gas, Maxwell-Boltzmann distribution, equipartition theorem and its applications, entropy and the Sackur-Tetrode equation, ideal gas in canonical and grand canonical ensembles, interacting systems and virial expansion, qualitative introduction to cluster expansion, van der Waals equation of state, thermodynamic potentials and Legendre transformations, fluctuations in thermodynamic systems. Stochastic processes: Brownian motion, random walks, Langevin and Fokker-Planck equations, fluctuation-dissipation concepts.	2	15

Unit-3	Quantum states and occupation number representation, density operator (density matrix) and statistical ensembles, pure and mixed states, Bose-Einstein, Fermi-Dirac and Maxwell-Boltzmann statistics, grand partition function, ideal Bose gas and Bose-Einstein condensation, black-body radiation and Planck distribution, phonons and specific heat of solids, ideal Fermi gas, degenerate electron gas, Fermi energy and Fermi temperature, electrons in metals, Pauli paramagnetism, Landau diamagnetism, liquid helium and superfluidity (qualitative).	3	15
Unit-4	First-order and continuous phase transitions, order parameters, and spontaneous symmetry breaking. Landau theory of phase transitions. Mean-field theory and the Bragg-Williams approximation. Ising model in 1D (exact solution) and 2D (mean-field and qualitative exact results). Critical phenomena: critical exponents, scaling laws, universality classes, and correlation length. Introduction to Renormalization Group (RG) ideas. Non-equilibrium mechanics: Master equation, Jarzynski equality, and introduction to Monte Carlo (Metropolis) methods.	4	15

Suggested Evaluation Methods					
Internal Assessment: 30	TH-30	PR-0	End Term Examination: 70	TH-70	PR-0
Class Participation	5	NA	Written Examination	70	NA
Seminar/presentation/assignment/quiz/class test etc.	10	NA	Lab record	NA	NA
Seminar/Demonstration/Viva-voce/Lab records etc.	NA	NA	Viva-Voce	NA	NA
Mid-Term Exam(s)	15	NA	Write-up and execution of the practical	NA	NA

Mapping of (CLOs) to Programme Learning Outcomes & Programme Specific Outcomes															
CLO	PLO ₁	PLO ₂	PLO ₃	PLO ₄	PLO ₅	PLO ₆	PLO ₇	PLO ₈	PLO ₉	PLO ₁₀	PLO ₁₁	PSO ₁	PSO ₂	PSO ₃	PSO ₄
26L6.0-PHY-202.1	3	3	1	3	1	3	1	1	2		1	3	2	3	1
26L6.0-PHY-202.2	3	3	1	3	1	3	2	2	2		1	3	3	3	2
26L6.0-PHY-202.3	3	3	1	3	1	3	2	1	2		1	3	3	3	2
26L6.0-PHY-202.4	3	3	1	3	1	3	3	2	2		1	3	3	3	3

Learning Resources

- ♦ Pathria, R. K., & Beale, P. D. (2011). Statistical mechanics (3rd ed.). Academic Press.
- ♦ Huang, K. (2011). Statistical mechanics (2nd ed.). Wiley India.
- ♦ Landau, L. D., & Lifshitz, E. M. (1980). Statistical physics (3rd ed., Vol. 5). Butterworth-Heinemann.
- ♦ Schroeder, D. V. (2000). An introduction to thermal physics. Addison-Wesley.
- ♦ Reif, F. (1965). Fundamentals of statistical and thermal physics. McGraw-Hill.
- ♦ Kardar, M. (2007). Statistical physics of particles. Cambridge University Press.
- ♦ Sethna, J. P. (2006). Statistical mechanics: Entropy, order parameters and complexity. Oxford University Press.
- ♦ Aggarwal, B. K., & Eisner, M. (2012). Statistical mechanics (4th ed.). New Age International.
- ♦ Gould, H., & Tobochnik, J. (2010). Statistical and thermal physics: With computer applications. Princeton University Press.
- ♦ Kittel, C., & Kroemer, H. (1980). Thermal physics (2nd ed.). W. H. Freeman.
- ♦ Bhattacharjee, J. K. (2011). Statistical physics: Equilibrium and non-equilibrium aspects. Allied Publishers.
- ♦ Mohanty, P. K. (2022). Nonequilibrium statistical mechanics. Cambridge University Press.
- ♦ David Tong. (n.d.). *Statistical Physics Lecture Notes*. Department of Applied Mathematics and Theoretical Physics, University of Cambridge. Available at: <https://www.damtp.cam.ac.uk/user/tong/statphys.html>

Content Mapping with NEP thrust areas

Field	Hours Devoted
Employability	2
Skill Enhancement	1
Environmental Awareness	2

Introduction				
Subject	Physics - PG			
Semester	Semester 2			
Course Composition	Theory (Theory + Tutorial)			
Nomenclature of the Course	Quantum Mechanics -II			
Course Code	26L6.0-PHY-203			
Course Type	CC-7			
Course Level	400-499			
Pre-requisites for the course (if any)	Basic knowledge of Quantum Mechanics and Mathematical Physics.			
Course Learning Outcomes (CLOs) After completing this course, the learner will be able to:	26L6.0-PHY-203.1: Students can determine energies and wave functions of first and second order, the ground state of the He atom. 26L6.0-PHY-203.2: Students will be enabled to analyze various transitions and their selection rules. 26L6.0-PHY-203.3: Students would be capable of understanding 3D collisions and scattering. 26L6.0-PHY-203.4: Students will know about antiparticles and different perspectives/interpretations of realities			
	Theory (Th)		Practical (P)	Total
	Lecture (L)	Tutorial (T)		
Credits	4	0	0	4
Teaching hours per week	4	0	0	4
Internal Assessment Marks (Th+P=Total)	30		0	30
End Term Exam Marks	70		0	70
Max. Marks	100		0	100
Examination Duration (in Hours)	3 Hours		NA	3 Hours

Contents of the Course			
Instructions for Examiner: Theory: The paper setter shall prepare 9 questions selecting two questions from each unit with consideration given to the Course Learning Outcomes. Among these, question number 1 will be compulsory, comprising 7 short answer type questions carrying two marks each (total 14 marks) and covering the entire syllabus. The remaining questions will be carrying 14 marks each. Examinees will be required to attempt five questions: the compulsory question no. 1 and 1 question from the each of the four units.			
Unit	Topics	CLO(s)	Contact Hours
Unit-1	Time independent perturbation theory; Nondegenerate case, the energies and wave functions in first order, the energy in second order; Anharmonic perturbations of the form x^3 and x^4 ; Degenerate perturbation theory; Stark effect of the first excited state of hydrogen. Ground state of Helium by both variational and perturbation methods; WKB approximation (bound state for a potential well with no rigid wall).	1	15
Unit-2	Time-dependent perturbation theory; The Schrodinger Picture, Heisenberg picture and Interaction picture, Constant perturbation; Harmonic perturbation; Fermi golden rule; Adiabatic and sudden approximation, Applications in radiative transition of an atom. Transition probability for absorption and induced emission; Electric dipole transition and selection rules; Magnetic dipole transitions; Forbidden transitions; Higher order transitions; Einstein's coefficients	2	15

Unit-3	Laboratory and C.M. reference frames; scattering amplitude; Differential scattering cross section and total scattering cross section; The optical theorem; Scattering by spherically symmetric potentials; Partial waves and phase shifts; Ramsauer–Townsend Effect, scattering by a perfectly rigid sphere and by a square well potential; Complex potential and absorption; The Born approximation and its validity condition, Yukawa potential; scattering of identical particles.	3	15
Unit-4	Relativistic wave mechanics: Klein-Gordon equation, Dirac equation: relativistic electron, spin, antiparticles, EPR paradox, Bell theorem, Bell inequality, Experimental tests of Bell inequalities, Quantum Entanglement, Anekāntavāda and Bohr's complementarity, Concepts of reality in Advaita Vedānta and interpretations of quantum mechanics concept of sunya/void.	4	15

Suggested Evaluation Methods					
Internal Assessment: 30	TH-30	PR-0	End Term Examination: 70	TH-70	PR-0
Class Participation	5	NA	Written Examination	70	NA
Seminar/presentation/assignment/quiz/class test etc.	10	NA	Lab record	NA	NA
Seminar/Demonstration/Viva-voce/Lab records etc.	NA	NA	Viva-Voce	NA	NA
Mid-Term Exam(s)	15	NA	Write-up and execution of the practical	NA	NA

Mapping of (CLOs) to Programme Learning Outcomes & Programme Specific Outcomes															
CLO	PLO ₁	PLO ₂	PLO ₃	PLO ₄	PLO ₅	PLO ₆	PLO ₇	PLO ₈	PLO ₉	PLO ₁₀	PLO ₁₁	PSO ₁	PSO ₂	PSO ₃	PSO ₄
26L6.0-PHY-203.1	3	3	2	3	1	2	1	1	1			3	2	3	3
26L6.0-PHY-203.2	3	3	2	3	1	2	1	1	1			3	3	3	3
26L6.0-PHY-203.3	3	3	2	3	2	2	1	1	1			3	3	3	3
26L6.0-PHY-203.4	3	3	2	2	1	2	1	1	2			3	3	2	3

Learning Resources

- L. D. Landau and E.M. Lifshitz, Quantum Mechanics, Butterworth Heinemann, The Netherlands, 3rd Edition, 1981
- P. A. M. Dirac, The Principles of Quantum Mechanics, Oxford University Press, UK, 4th Edition, 1988
- R. Shankar, Principles of Quantum Mechanics, Springer, Germany, 2nd Edition, 1994
- N. Zettili, Quantum Mechanics: Concepts and Applications, Wiley, USA, 2nd Edition, 2009
- J. J. Sakurai, Modern Quantum Mechanics, Pearson, India, 2nd Edition, 2013
- L. I. Schiff, Quantum Mechanics, McGraw Hill Education, USA, 4th Edition, 2017
- D. J. Griffiths, Introduction to Quantum Mechanics, Cambridge University Press, UK, 3rd Edition, 2018
- C. Cohen-Tannoudji, B. Diu, and F. Laloe, Quantum Mechanics, Volume 1: Basic Concepts, Tools, and Applications, Wiley, USA, 2nd Edition, 2019
- Bell, J. S. (2004). *Speakable and Unspeakable in Quantum Mechanics: Collected Papers on Quantum Philosophy* (2nd ed.). Cambridge University Press. ISBN: 978-0521523387
- Greenstein, G., & Zajonc, A. (2006). *The Quantum Challenge: Modern Research on the Foundations of Quantum Mechanics* (2nd ed.). Jones & Bartlett Learning. ISBN: 978-0763724702
- Schrödinger, E. (1964). *My view of the world*. Cambridge University Press
- Radhakrishnan, S. (1994). *The principal Upanishads*. HarperCollins India
- Capra, F. (2010). *The Tao of Physics*. Shambhala Publications
- Nāgārjuna. (1995). *The fundamental wisdom of the middle way: Nāgārjuna's Mūlamadhyamakakārikā* (J. L. Garfield, Trans.). Oxford University Press.

Content Mapping with NEP thrust areas

Field	Hours Devoted
Employability	1
Skill Enhancement	2
Communication Development	2
Indian Knowledge System	2

Introduction				
Subject	Physics - PG			
Semester	Semester 2			
Course Composition	Theory (Theory + Tutorial)			
Nomenclature of the Course	Solid State Physics			
Course Code	26L6.0-PHY-204			
Course Type	CC-8			
Course Level	400-499			
Pre-requisites for the course (if any)	Basic knowledge of Quantum Mechanics and Crystal Structure.			
Course Learning Outcomes (CLOs) After completing this course, the learner will be able to:	26L6.0-PHY-204.1: Apply crystallographic and X-ray diffraction principles to analyze crystal structures, symmetry, reciprocal lattices, and diffraction patterns of crystalline materials 26L6.0-PHY-204.2: To understand the interatomic bonding, lattice dynamics, and phonon behavior in solids, and apply Einstein and Debye models 26L6.0-PHY-204.3: To Analyze dielectric properties of solids, including polarization mechanisms, polarizability, ferroelectricity, piezoelectricity 26L6.0-PHY-204.4: Evaluate the electronic, thermal, magnetic, optical, and corrosion-related properties of metals using classical and quantum free-electron theories			
	Theory (Th)		Practical (P)	Total
	Lecture (L)	Tutorial (T)		
Credits	4	0	0	4
Teaching hours per week	4	0	0	4
Internal Assessment Marks (Th+P=Total)	30		0	30
End Term Exam Marks	70		0	70
Max. Marks	100		0	100
Examination Duration (in Hours)	3 Hours		NA	3 Hours

Contents of the Course			
Instructions for Examiner: Theory: The paper setter shall prepare 9 questions selecting two questions from each unit with consideration given to the Course Learning Outcomes. Among these, question number 1 will be compulsory, comprising 7 short answer type questions carrying two marks each (total 14 marks) and covering the entire syllabus. The remaining questions will be carrying 14 marks each. Examinees will be required to attempt five questions: the compulsory question no. 1 and 1 question from the each of the four units.			
Unit	Topics	CLO(s)	Contact Hours
Unit-1	Crystal Structure and X-ray Diffraction : Basis and the Crystal Structure, crystal directions, planes and Miller indices, Bravais lattices, symmetry operations, Symmetry elements and stereographic projections, Point groups and their stereograms, interaction of X-rays with matter, reciprocal lattice and its construction, reciprocal lattice application to diffraction techniques, Ewald construction, Bragg diffraction, Laue, powder and rotating crystal methods, atomic form factor, crystal structure factor, structure factors of BCC and FCC crystals, effect of temperature and impurities on X-ray diffraction patterns, Ancient Indian Knowledge of Gems and Crystals.	1	15
Unit-2	Interatomic Forces and Lattice Dynamics : Interatomic forces and bonding in solids, ionic, covalent, metallic, van der Waals and hydrogen bonding, cohesive energy and lattice constant, lattice vibrations in one-dimensional monoatomic and diatomic chains, acoustic and optical modes, phonon concept and phonon momentum, density of normal modes in one and three dimensions, quantization of lattice vibrations, Inelastic Scattering by Phonons, Einstein and Debye theories of specific heat, anharmonic effects in crystals, thermal expansion of solids and introduction to thermal properties of solids, Materials Used in Temple Architecture and Stone Acoustics, Temple bell alloys and acoustic properties of metals.	2	15

Unit-3	Dielectric Properties of Solids : Electric dipole moment and polarization, electric field of a dipole, local electric field at an atom, dielectric constant and its measurement, electronic, ionic and dipolar polarizability, frequency dependence of dielectric constant, dielectric loss and dielectric relaxation, Clausius–Mossotti relation, piezoelectricity, pyroelectricity, ferroelectricity and ferroelectric domains, antiferroelectricity, and applications of dielectric and ferroelectric materials.	3	15
Unit-4	Electron Dynamics and Physical Properties of Metals: Classical free electron theory of metals: Drude model, Sommerfeld free-electron theory (quantum theory), Thermal properties of free electron gas: Fermi–Dirac distribution, density of states, Fermi energy and elementary concepts of Fermi surface, electronic heat capacity, electrical conductivity and resistivity of metals, thermal conductivity, Wiedemann–Franz law and Lorenz number, Hall effect and magnetoresistance, optical properties of metals, attenuation coefficient, skin depth, plasma frequency, metal reflection, Iron Pillar of Delhi: Corrosion Resistance and Material Properties.	4	15

Suggested Evaluation Methods					
Internal Assessment: 30	TH-30	PR-0	End Term Examination: 70	TH-70	PR-0
Class Participation	5	NA	Written Examination	70	NA
Seminar/presentation/assignment/quiz/class test etc.	10	NA	Lab record	NA	NA
Seminar/Demonstration/Viva-voce/Lab records etc.	NA	NA	Viva-Voce	NA	NA
Mid-Term Exam(s)	15	NA	Write-up and execution of the practical	NA	NA

Mapping of (CLOs) to Programme Learning Outcomes & Programme Specific Outcomes															
CLO	PLO ₁	PLO ₂	PLO ₃	PLO ₄	PLO ₅	PLO ₆	PLO ₇	PLO ₈	PLO ₉	PLO ₁₀	PLO ₁₁	PSO ₁	PSO ₂	PSO ₃	PSO ₄
26L6.0-PHY-204.1	3	2	1	3		3	2		1			3	2	3	1
26L6.0-PHY-204.2	3	2		3		2	1		1			3	2	3	1
26L6.0-PHY-204.3	3	2	1	3		2	2	1	1			3	3	2	1
26L6.0-PHY-204.4	3	2	1	3		2	2	1	1		1	3	3	3	2

Learning Resources

- Kittel, C. (2005). *Introduction to solid state physics* (8th ed.). Wiley
- Ashcroft, N. W., & Mermin, N. D. (1976).
- Omar, M. A. (2015). *Elementary solid state physics: Principles and applications* (2nd ed.). Pearson
- Pillai, S. O. (2024). *Solid state physics* (9th ed.). New Age International
- Cullity, B. D., & Stock, S. R. (2014). *Elements of X-ray diffraction* (3rd ed.). Pearson
- Warren, B. E. (1990). *X-ray diffraction*. Dover Publications
- Squires, G. L. (2012). *Introduction to the theory of thermal neutron scattering*. Cambridge University Press
- Srivastava, G. P. (1990). *The physics of phonons*. CRC Press
- Hummel, R. E. (2011). *Electronic properties of materials* (4th ed.). Springer
- Kasap, S. O. (2018). *Principles of electronic materials and devices* (4th ed.). McGraw-Hill Education
- Ibach, H., & Lüth, H. (2009). *Solid-state physics: An introduction to principles of materials science* (4th ed.). Springer.
- Hook, J. R., & Hall, H. E. (2010). *Solid state physics* (2nd ed.). Wiley
- Massachusetts Institute of Technology. (n.d.). MIT OpenCourseWare: Physics for Solid-State Applications, <https://ocw.mit.edu/courses/6-730-physics-for-solid-state-applications-spring-2003/>
- National Programme on Technology Enhanced Learning. (n.d.). NPTEL online courses: Solid State Physics, https://onlinecourses.nptel.ac.in/e-learning/preview/noc21_ph21

Content Mapping with NEP thrust areas

Field	Hours Devoted
Employability	3
Entrepreneurship	2
Skill Enhancement	2
Indian Knowledge System	3

Introduction				
Subject	Physics - PG			
Semester	Semester 2			
Course Composition	Practical			
Nomenclature of the Course	Practical General			
Course Code	26L6.0-PHY-205			
Course Type	PC-3			
Course Level	400-499			
Pre-requisites for the course (if any)	Basic knowledge of Physics laboratory techniques and measurements.			
Course Learning Outcomes (CLOs) After completing this course, the learner will be able to:	26L6.0-PHY-205.1: Demonstrate the use of experimental methods to investigate thermal and radiation phenomena and evaluate fundamental physical constants and material properties through measurement and data analysis 26L6.0-PHY-205.2: Demonstrate proficiency in measuring and analyzing the magnetic, dielectric, and optical characteristics of materials using standard experimental methods and instrumentation. 26L6.0-PHY-205.3: Demonstrate experimental competence in evaluating electrical, semiconductor, and molecular properties of materials using standard measurement techniques and data interpretation 26L6.0-PHY-205.4: Demonstrate the ability to use numerical and computational techniques to model, simulate, and solve mathematical problems arising in physical systems.			
	Theory (Th)		Practical (P)	Total
	Lecture (L)	Tutorial (T)		
Credits	0	0	4	4
Teaching hours per week	0	0	8	8
Internal Assessment Marks (Th+P=Total)	0		30	30
End Term Exam Marks	0		70	70
Max. Marks	0		100	100
Examination Duration (in Hours)	NA		3 Hours	3 Hours

Contents of the Course			
Instructions for Examiner: Practical: Write-up and execution of the practical will be conducted as per the nature of the practical by the external examiner, with consideration given to the Course Learning Outcomes. The maximum marks for the write-up and execution of the practical will be 40 .			
Unit	Topics	CLO(s)	Contact Hours
Unit-1	1. Heat Capacity Kit to determine the heat capacity of Solids. 2. To determine the reflective index of water and oil using mirror and lenses. 3. To determine Boltzmann Constant (k) make use of the Black Body radiation & using Wien's displacement & Stefan's law	1	30

Unit-2	4. To determine the dielectric constant of benzene and calculate the dipole moment of acetone using dielectric polarization measurements. 5. To determine the magnetic susceptibility of $\text{NiSO}_4/\text{FeSO}_4/\text{CoSO}_4$ by Gouy's method. 6. Fourier Analysis Kit to verify the existence of different harmonics and measure their relative amplitude using Fourier Analysis Kit.	2	30
Unit-3	7. To determine the Hall coefficient, carrier concentration, and nature (type) of charge carriers in a semiconductor using the Hall effect setup. 8. To determine the thermal conductivity of good conductor using Searle's Bar Method. 9. Measurement of the lattice parameters and indexing of powder photographs. 10. To calculate the velocity of sound in solid metal rod and deduce the adiabatic Young's Modulus (Y) of rod.	3	30
Unit-4	11. Simulation of random walk. 12. Root finding of a polynomial equation using numerical methods 13. Numerical integration 14. Numerically Solving first and second-order differential equation	4	30

Suggested Evaluation Methods					
Internal Assessment: 30	TH-0	PR-30	End Term Examination: 70	TH-0	PR-70
Class Participation	NA	5	Written Examination	NA	NA
Seminar/presentation/assignment/quiz/class test etc.	NA	NA	Lab record	NA	10
Seminar/Demonstration/Viva-voce/Lab records etc.	NA	10	Viva-Voce	NA	20
Mid-Term Exam(s)	NA	15	Write-up and execution of the practical	NA	40

Mapping of (CLOs) to Programme Learning Outcomes & Programme Specific Outcomes															
CLO	PLO ₁	PLO ₂	PLO ₃	PLO ₄	PLO ₅	PLO ₆	PLO ₇	PLO ₈	PLO ₉	PLO ₁₀	PLO ₁₁	PSO ₁	PSO ₂	PSO ₃	PSO ₄
26L6.0-PHY-205.1	3	2	1	2	1							3	2	1	
26L6.0-PHY-205.2	3	2	2	2	1							3	3	1	
26L6.0-PHY-205.3	3	2	2	2	2							3	3	2	
26L6.0-PHY-205.4	2	3	3	2	3					1		2	3	3	1

Learning Resources

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| <ul style="list-style-type: none"> ♦ Flint, B. L., & Worsnop, H. T. <i>Advanced Practical Physics for Students</i>. Asia Publishing House ♦ Chapra, S. C., & Canale, R. P. <i>Numerical Methods for Engineers</i>. McGraw-Hill Education ♦ Chauhan, S., & Singh, M. <i>Advanced Practical Physics</i>. Pragati Prakashan, Meerut. ♦ Jain, R. K. <i>Practical Physics</i>. S. Chand & Company, New Delhi Balagurusamy, E. ♦ <i>Programming in ANSI C</i> (8th ed.). McGraw-Hill Education. |
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Content Mapping with NEP thrust areas
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Field	Hours Devoted
Employability	6
Entrepreneurship	2
Skill Enhancement	8
Communication Development	3
Environmental Awareness	2
Current Issues and Social Awareness	3

Important Notes:

Students should perform atleast 8-10 experiments, ensuring that the selected experiments are distributed across all units of the course.
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Introduction				
Subject	Physics - PG			
Semester	Semester 2			
Course Composition	Practical			
Nomenclature of the Course	Practical Atomic and Molecular Physics			
Course Code	26L6.0-PHY-206			
Course Type	PC-4			
Course Level	400-499			
Pre-requisites for the course (if any)	Basic knowledge of Atomic and Molecular Physics and laboratory techniques.			
Course Learning Outcomes (CLOs) After completing this course, the learner will be able to:	26L6.0-PHY-206.1: Apply the fundamental principles of optics, including dispersion, diffraction, and interference, to perform precision measurements using optical instruments and analyze experimental data to determine physical parameters such as refractive index, wire thickness, and laser wavelength. 26L6.0-PHY-206.2: Apply advanced optical interference and spectroscopy techniques using the Michelson Interferometer and Fabry–Perot Etalon to determine refractive index, spectral line separation, and the charge-to-mass ratio (e/m) of the electron through experimental analysis and interpretation of interference patterns. 26L6.0-PHY-206.3: Apply the principles of atomic spectroscopy and magnetic interactions to analyze spectral line structures, determine the Landé g-factor and Rydberg constant, and identify elemental compositions through emission spectrum analysis. 26L6.0-PHY-206.4: Apply the principles of laser optics and optical fiber communication to characterize fiber parameters, including numerical aperture, acceptance angle, attenuation, and laser beam propagation characteristics through experimental measurements and data analysis.			
	Theory (Th)		Practical (P)	Total
	Lecture (L)	Tutorial (T)		
Credits	0	0	4	4
Teaching hours per week	0	0	8	8
Internal Assessment Marks (Th+P=Total)	0		30	30
End Term Exam Marks	0		70	70
Max. Marks	0		100	100
Examination Duration (in Hours)	NA		3 Hours	3 Hours

Contents of the Course			
Instructions for Examiner: Practical: Write-up and execution of the practical will be conducted as per the nature of the practical by the external examiner, with consideration given to the Course Learning Outcomes. The maximum marks for the write-up and execution of the practical will be 40 .			
Unit	Topics	CLO(s)	Contact Hours
Unit-1	1. Verification of Hartmann's Dispersion Formula using a Prism Spectrometer. 2. Measurement of Thickness of a Thin Wire using Laser Diffraction. 3. Determination of Wavelength of Laser Radiation using Michelson Interferometer.	1	30
Unit-2	4. Measurement of Refractive Index of Transparent Plate using Michelson Interferometer. 5. Study of Fabry–Perot Interference Fringes and Determination of Wavelength Separation of Spectral Lines. 6. Determination of e/m of Electron using Normal Zeeman Effect and Fabry–Perot Etalon.	2	30

Unit-3	7. Study of Zeeman Splitting and Determination of Lande g-Factor. 8. Analysis of Hydrogen Spectrum and Determination of Rydberg Constant. 9. Analysis of Atomic Emission Spectrum of Fe and Cu Samples.	3	30
Unit-4	10. Determination of Numerical Aperture (NA) of Optical Fibre using Semiconductor LASER. 11. Determination of Acceptance Angle and Attenuation Characteristics of Optical Fibre. 12. Study of Laser Beam Divergence and Gaussian Beam Parameters.	4	30

Suggested Evaluation Methods					
Internal Assessment: 30	TH-0	PR-30	End Term Examination: 70	TH-0	PR-70
Class Participation	NA	5	Written Examination	NA	NA
Seminar/presentation/assignment/quiz/class test etc.	NA	NA	Lab record	NA	10
Seminar/Demonstration/Viva-voce/Lab records etc.	NA	10	Viva-Voce	NA	20
Mid-Term Exam(s)	NA	15	Write-up and execution of the practical	NA	40

Mapping of (CLOs) to Programme Learning Outcomes & Programme Specific Outcomes															
CLO	PLO ₁	PLO ₂	PLO ₃	PLO ₄	PLO ₅	PLO ₆	PLO ₇	PLO ₈	PLO ₉	PLO ₁₀	PLO ₁₁	PSO ₁	PSO ₂	PSO ₃	PSO ₄
26L6.0-PHY-206.1	3	3	1	3	3							3	2	1	
26L6.0-PHY-206.2	3	3	2	3	3							3	3	2	
26L6.0-PHY-206.3	3	3	1	3	2							3	3	2	
26L6.0-PHY-206.4	3	3	2	3	3							3	3	3	1

Learning Resources

- ♦ Halliday, D., Resnick, R., & Walker, J. (2018). *Fundamentals of physics* (11th ed.). Wiley.
- ♦ Kittel, C. (2005). *Introduction to solid state physics* (8th ed.). Wiley
- ♦ Squires, G. L. (2001). *Practical physics* (4th ed.). Cambridge University Press.
- ♦ Streetman, B. G., & Banerjee, S. (2015). *Solid state electronic devices* (7th ed.). Pearson.
- ♦ Cullity, B. D., & Graham, C. D. (2011). *Introduction to magnetic materials* (2nd ed.). Wiley-IEEE Press
- ♦ Gupta, S. L., & Kumar, V. (2019). *Practical physics* (25th ed.). Pragati Prakashan
- ♦ Bleaney, B. I., & Bleaney, B. (2013). *Electricity and magnetism* (3rd ed.). Oxford University Press.
- ♦ Millikan, R. A. (1913). On the elementary electrical charge and the Avogadro constant. *Physical Review*, 2(2), 109–143.
<https://doi.org/10.1103/PhysRev.2.109>
- ♦ Maryott, A. A. (1953). Table of dielectric constants and electric dipole moments of substances in the gaseous state (NBS Circular No. 537). National Bureau of Standards. <https://doi.org/10.6028/NBS.CIRC.537>
- ♦ Lancashire, R. J. (2025). Magnetic susceptibility measurements: The Gouy method. In *Chemistry LibreTexts*.
<https://chem.libretexts.org/>
- ♦ Cochran, J. F., & Heinrich, B. (2025). B–H curves. In *Applications of Maxwell's Equations*. *Physics LibreTexts*.
<https://phys.libretexts.org/>

Content Mapping with NEP thrust areas

Field	Hours Devoted
Employability	6
Entrepreneurship	6
Skill Enhancement	36
Environmental Awareness	3
Current Issues and Social Awareness	4

Important Notes:

Students should perform 8-10 experiments, ensuring that the selected experiments are distributed across all units of the course.

Introduction				
Subject	Physics - PG			
Semester	Semester 3			
Course Composition	Theory (Theory + Tutorial)			
Nomenclature of the Course	Condensed Matter Physics			
Course Code	26L6.5-PHY-301			
Course Type	CC-9			
Course Level	500-599			
Pre-requisites for the course (if any)	Basic knowledge of Solid State Physics and Quantum Mechanics.			
Course Learning Outcomes (CLOs) After completing this course, the learner will be able to:	26L6.5-PHY-301.1: Analyze the electronic structure of crystalline solids using band theory and explain charge carrier dynamics, semiconductor properties, and Fermi surface concepts. 26L6.5-PHY-301.2: Evaluate electron–phonon interactions, lattice thermal transport, and optical phenomena in solids, including excitations and photon–matter interactions. 26L6.5-PHY-301.3: Understand the origin of magnetism and magnetic ordering in solids using classical, quantum, and exchange-interaction-based theories. 26L6.5-PHY-301.4: Interpret superconducting phenomena using BCS and Ginzburg–Landau theories and examine their applications in modern technology.			
	Theory (Th)		Practical (P)	Total
	Lecture (L)	Tutorial (T)		
Credits	4	0	0	4
Teaching hours per week	4	0	0	4
Internal Assessment Marks (Th+P=Total)	30		0	30
End Term Exam Marks	70		0	70
Max. Marks	100		0	100
Examination Duration (in Hours)	3 Hours		NA	3 Hours

Contents of the Course			
Instructions for Examiner: Theory: The paper setter shall prepare 9 questions selecting two questions from each unit with consideration given to the Course Learning Outcomes. Among these, question number 1 will be compulsory, comprising 7 short answer type questions carrying two marks each (total 14 marks) and covering the entire syllabus. The remaining questions will be carrying 14 marks each. Examinees will be required to attempt five questions: the compulsory question no. 1 and 1 question from the each of the four units.			
Unit	Topics	CLO(s)	Contact Hours
Unit-1	Electronic Structure and Semiconductor Physics: Nearly Free Electron Model, Origin of the Energy Gap, Bloch Functions, Electron motion in a periodic potential: Kronig-Penney Model, Reduced and extended and periodic zone schemes, Effective mass concept, Classification of solids into conductors, Semiconductors and insulators, Intrinsic and extrinsic semiconductors, donor and acceptor impurity states, Direct and indirect band-gap semiconductors, Effective mass and its physical significance, electron and hole dynamics, carrier concentration and carrier statistics, Fermi surfaces and their construction, tight-binding approximation and its applications to simple cubic, BCC and FCC crystals, de Haas–van Alphen effect.	1	15
Unit-2	Electron–Phonon and Optical Properties: Interaction of electrons with phonons and its role in electrical and thermal transport, anharmonicity of lattice vibrations, Grüneisen parameter, thermal resistivity of phonons, Umklapp processes, and thermal conductivity of non-metallic solids. Interaction of electrons and phonons with electromagnetic radiation, optical absorption in solids, one-phonon absorption processes, optical properties of semiconductors and insulators, excitons, polarons and polaritons. Measurement of phonon dispersion relations by inelastic neutron scattering and their significance in understanding lattice dynamics and optical phenomena. Indigenous Materials for Thermal Management and Insulation, Indigenous thermal insulation materials (mud, lime, natural composites).	2	15

Unit-3	Magnetism in Solids: Magnetic response of materials, classification of magnetic materials, origin of permanent magnetic moments, Langevin theories of diamagnetism and paramagnetism, quantum theory of paramagnetism, Pauli paramagnetism of free electrons, Landau diamagnetism, ferromagnetism, Weiss molecular field theory, physical origin of exchange interaction, temperature dependence of spontaneous magnetization, Curie–Weiss law, ferromagnetic domains and domain theory, Heisenberg model of ferromagnetism, spin waves and magnons, antiferromagnetism, ferrimagnetism (ferrites), ferro-, ferri- and antiferromagnetic ordering and magnetic anisotropy, Traditional Magnetic Materials and Lodestone in India.	3	15
Unit-4	Superconductivity and Advanced Quantum Phenomena: Occurrence of superconductivity, Meissner effect, Type-I and Type-II superconductors, persistent currents, thermodynamic properties and heat capacity of superconductors, superconducting energy gap, isotope effect, London equations, penetration depth and coherence length, Cooper pairing due to electron–phonon interaction, postulates of BCS theory, BCS ground state, Ginzburg–Landau theory, flux quantization, Josephson effects (DC and AC), macroscopic quantum interference, SQUID devices, high-temperature superconductors, and applications of superconducting materials. Traditional understanding of zero-resistance / perfect conductivity concepts in ideal materials (linked to superconducting energy gap and persistent currents).	4	15

Suggested Evaluation Methods

Internal Assessment: 30	TH-30	PR-0	End Term Examination: 70	TH-70	PR-0
Class Participation	5	NA	Written Examination	70	NA
Seminar/presentation/assignment/quiz/class test etc.	10	NA	Lab record	NA	NA
Seminar/Demonstration/Viva-voce/Lab records etc.	NA	NA	Viva-Voce	NA	NA
Mid-Term Exam(s)	15	NA	Write-up and execution of the practical	NA	NA

Mapping of (CLOs) to Programme Learning Outcomes & Programme Specific Outcomes

CLO	PLO ₁	PLO ₂	PLO ₃	PLO ₄	PLO ₅	PLO ₆	PLO ₇	PLO ₈	PLO ₉	PLO ₁₀	PLO ₁₁	PSO ₁	PSO ₂	PSO ₃	PSO ₄
26L6.5-PHY-301.1	3	2	1	3		3	2	1	2			3	3	3	2
26L6.5-PHY-301.2	3	2	1	3		3	2	1	2			3	3	3	2
26L6.5-PHY-301.3	3	2	1	3		2	1	1	1			3	2	3	2
26L6.5-PHY-301.4	3	3	1	2		2	1	3	2		1	3	3	2	3

Learning Resources
• Kittel, C. (2005). <i>Introduction to solid state physics</i> (8th ed.). Wiley • Kasap, S. O. (2018). <i>Principles of electronic materials and devices</i> (4th ed.). McGraw-Hill Education. • Hummel, R. E. (2011). <i>Electronic properties of materials</i> (4th ed.). Springer. • Srivastava, G. P. (1990). <i>The physics of phonons</i>. CRC Press • Fox, M. (2010). <i>Optical properties of solids</i> (2nd ed.). Oxford University Press. • Bhattacharya, P. (2017). <i>Semiconductor optoelectronic devices</i> (2nd ed.). Pearson • Cullity, B. D., & Graham, C. D. (2011). <i>Introduction to magnetic materials</i> (2nd ed.). Wiley-IEEE Press • Blundell, S. (2001). <i>Magnetism in condensed matter</i>. Oxford University Press • Tinkham, M. (2004). <i>Introduction to superconductivity</i> (2nd ed.). Dover Publications • Annett, J. F. (2004). <i>Superconductivity, superfluids and condensates</i>. Oxford University Press. • Hook, J. R., & Hall, H. E. (2010). <i>Solid state physics</i> (2nd ed.). Wiley. • Ibach, H., & Lüth, H. (2009). <i>Solid-state physics: An introduction to principles of materials science</i> (4th ed.). Springer. • MIT OpenCourseWare: Strongly Correlated Systems in Condensed Matter Physics, https://ocw.mit.edu/courses/8-514-strongly-correlated-systems-in-condensed-matter-physics-fall-2003/ • National Programme on Technology Enhanced Learning. (n.d.). NPTEL online courses: Advanced Condensed Matter Physics, https://onlinecourses.nptel.ac.in/e-learning/preview/noc22_ph09

Content Mapping with NEP thrust areas	
Field	Hours Devoted
Employability	2
Entrepreneurship	2
Indian Knowledge System	5

Introduction				
Subject	Physics - PG			
Semester	Semester 3			
Course Composition	Theory (Theory + Tutorial)			
Nomenclature of the Course	Electrodynamics and Wave Propagation			
Course Code	26L6.5-PHY-302			
Course Type	CC-10			
Course Level	500-599			
Pre-requisites for the course (if any)	Basic knowledge of Electromagnetism and Vector Calculus.			
Course Learning Outcomes (CLOs) After completing this course, the learner will be able to:	26L6.5-PHY-302.1: visualize the concept of space and time in four-dimensional space 26L6.5-PHY-302.2: explain the fields due to moving and accelerated charges within and on the surface 26L6.5-PHY-302.3: understand the transformations and covariance relations in a lucid way 26L6.5-PHY-302.4: realize various applications with proper understanding of waveguides and transmission lines			
	Theory (Th)		Practical (P)	Total
	Lecture (L)	Tutorial (T)		
Credits	4	0	0	4
Teaching hours per week	4	0	0	4
Internal Assessment Marks (Th+P=Total)	30		0	30
End Term Exam Marks	70		0	70
Max. Marks	100		0	100
Examination Duration (in Hours)	3 Hours		NA	3 Hours

Contents of the Course			
Instructions for Examiner: Theory: The paper setter shall prepare 9 questions selecting two questions from each unit with consideration given to the Course Learning Outcomes. Among these, question number 1 will be compulsory, comprising 7 short answer type questions carrying two marks each (total 14 marks) and covering the entire syllabus. The remaining questions will be carrying 14 marks each. Examinees will be required to attempt five questions: the compulsory question no. 1 and 1 question from the each of the four units.			
Unit	Topics	CLO(s)	Contact Hours
Unit-1	Maxwell's equation in differential and integral form, electromagnetic wave in free space, EM wave propagation in homogenous medium, waves in conducting medium, Lossless medium & Good dielectrics approximation, energy stored in electric and magnetic field, Poynting theorem, Power density, Review of four-vector and Lorentz transformation in four dimensional space; Conservation of charge and four current density in covariant form; Electromagnetic field tensor formulation, Maxwell's equations in covariant form, dual electromagnetic field tensors, Lorentz invariants of electromagnetic fields; Transformation of electric and magnetic field vectors under Lorentz transformation; Covariance of Lorentz force equation in relativistic form.	1	18
Unit-2	Motion of charged particles in uniform E and B fields; Time varying fields. Field and radiation of a localized time-dependent source; Oscillating electric dipole; Centre-fed linear antenna; Lienard-Wiechert potential; Electric and magnetic fields due to a uniformly moving charge and accelerated charge; Bremsstrahlung synchrotron radiation, Cherenkov radiation, Linear and circular acceleration and angular distribution of power radiated.	2	15
Unit-3	Radiative reaction force; Scattering and absorption of radiation; Thompson scattering and Rayleigh scattering; Normal and anomalous dispersion; Ionosphere; Propagation of electromagnetic wave through ionosphere; Reflection of electromagnetic waves by ionosphere	3	12
Unit-4	Fields at the surface of and within a conductor; Wave guides; Modes in a rectangular waveguide; Attenuation in waveguides; Dielectric waveguides; Circuit representation of parallel plate transmission lines; Transmission line equations and their solutions; Characteristic impedance and propagation coefficient; Low loss radio frequency and UHF transmission lines.	4	15

Suggested Evaluation Methods					
Internal Assessment: 30	TH-30	PR-0	End Term Examination: 70	TH-70	PR-0
Class Participation	5	NA	Written Examination	70	NA
Seminar/presentation/assignment/quiz/class test etc.	10	NA	Lab record	NA	NA
Seminar/Demonstration/Viva-voce/Lab records etc.	NA	NA	Viva-Voce	NA	NA
Mid-Term Exam(s)	15	NA	Write-up and execution of the practical	NA	NA

Mapping of (CLOs) to Programme Learning Outcomes & Programme Specific Outcomes															
CLO	PLO ₁	PLO ₂	PLO ₃	PLO ₄	PLO ₅	PLO ₆	PLO ₇	PLO ₈	PLO ₉	PLO ₁₀	PLO ₁₁	PSO ₁	PSO ₂	PSO ₃	PSO ₄
26L6.5-PHY-302.1	3	3	2	3	1	2	1	1	1			3	2	3	2
26L6.5-PHY-302.2	3	3	2	3	1	2	2	1	1			3	3	3	3
26L6.5-PHY-302.3	3	3	2	3	1	2	2	1	1			3	3	3	3
26L6.5-PHY-302.4	3	3	3	3	2	2	3	2	1		1	3	3	3	3

Learning Resources
• L.D. Landau and E.M. Lifshitz, Classical Theory of Electrodynamics, Butterworth-Heinemann. Germany, 4th Edition, 1987. • S.P. Puri, Classical Electrodynamics, Narosa Publishing House, 2011. • Melvin Schwartz, Principles of Electrodynamics, Dover Publications, UK, 1st Edition, 1987. • Walter Greiner, Classical Electrodynamics, Springer, Germany, 1st Edition, 1998. • J. Schwinger, L.L. Deraad Jr, K.A. Milton, W-Y. Tsai and J. Norton, Classical Electrodynamics, Westview Press, UK, 1998. • David J. Griffiths, Introduction to Electrodynamics, Benjamin Cummings, USA, 3rd Edition, 1999. • J.D. Jackson, Classical Electrodynamics, John Wiley & Sons, United States, 2nd Edition, 2003. • Charles A. Brau, Modern Problems in Classical Electrodynamics, Oxford University Press, 1st Edition, 2003. • L. D. Landau and E. M. Lifshitz & L. P. Pitaevskii, Electrodynamics of Continuous Media Oxford, 1st Edition, 2005. • Wolfgang K. H. Panofsky and Melba Phillips, Classical Electricity and Magnetism, Dover Publications, UK, 2nd Edition, 2012. • Joseph Edminister, Schaum's outline of electromagnetics, New Delhi, 2nd Edition.

Content Mapping with NEP thrust areas	
Field	Hours Devoted
Employability	2
Skill Enhancement	3
Communication Development	2
Current Issues and Social Awareness	1

Introduction				
Subject	Physics - PG			
Semester	Semester 3			
Course Composition	Theory (Theory + Tutorial)			
Nomenclature of the Course	Electronics Devices			
Course Code	26L6.5-PHY-303			
Course Type	DEC-1			
Course Level	500-599			
Pre-requisites for the course (if any)	Basic knowledge of Semiconductor Physics and Electronic Circuits.			
Course Learning Outcomes (CLOs) After completing this course, the learner will be able to:	26L6.5-PHY-303.1: To understand the principles of photoelectric effect and working of optoelectronic devices. 26L6.5-PHY-303.2: To understand multivibrators, IC fabrication process, and basics of microprocessors and microcontrollers. 26L6.5-PHY-303.3: Analyze operational amplifier characteristics and apply OP-AMPs in linear applications such as amplification, mathematical operations, and signal conditioning. 26L6.5-PHY-303.4: Understand the principles and applications of microwave devices.			
	Theory (Th)		Practical (P)	Total
	Lecture (L)	Tutorial (T)		
Credits	4	0	0	4
Teaching hours per week	4	0	0	4
Internal Assessment Marks (Th+P=Total)	30		0	30
End Term Exam Marks	70		0	70
Max. Marks	100		0	100
Examination Duration (in Hours)	3 Hours		NA	3 Hours

Contents of the Course			
Instructions for Examiner: Theory: The paper setter shall prepare 9 questions selecting two questions from each unit with consideration given to the Course Learning Outcomes. Among these, question number 1 will be compulsory, comprising 7 short answer type questions carrying two marks each (total 14 marks) and covering the entire syllabus. The remaining questions will be carrying 14 marks each. Examinees will be required to attempt five questions: the compulsory question no. 1 and 1 question from the each of the four units.			
Unit	Topics	CLO(s)	Contact Hours
Unit-1	External photoelectric effect detector: Vacuum photodiode, photo-multipliers, microchannels, Internal photoelectric effect detectors: p-n junction photodiode, PIN and avalanche photodiodes, Phototransistor, Solar cell (open circuit voltage, short circuit current, fill factor), Light emitting diode, Light dependent resistor (LDR) and their applications.	1	15
Unit-2	Switching Circuits: Monostable, Bistable and Astable multivibrators, their working principles, circuit operations, timing characteristics and applications in digital and pulse circuits, Microprocessors & micro controller basics. Introduction to Integrated Circuits (ICs), Classification and types of integrated circuits, Fabrication process of monolithic integrated circuits, Fabrication of Monolithic passive components such as integrated resistors and capacitors and active components including diodes, bipolar junction transistors (BJTs), Clean room & their classification.	2	15
Unit-3	Basic Operational Amplifier (OP-Amp), Block diagram of Operational amplifier, Differential Amplifier, Emitter coupled differential amplifier, Emitter coupled supplied with constant current, Transfer characteristics, Common mode rejection ratio (CMRR), Offset error voltage and current, Slew rate, OP-Amp as inverting and non-inverting amplifier, Basic applications: Summing, Scaling, Current to voltage and Voltage to current signal conversion, Differential dc amplifier, Voltage follower, Bridge amplifier, AC-coupled amplifier, Integrator, Differentiator, Logarithmic amplifier, Antilogarithmic amplifier.	3	15

Unit-4	Op-Amp applications: Digital to analog conversion –ladder and weighted resistor types, Analog to digital conversion-Counter type, comparators, Regenerative comparator (Schmitt trigger), Square wave generator, Pulse generator, Triangle wave generator. Resonant Cavity: Concept and characteristics of resonant cavities. Klystrons: Velocity modulation, Basic principles of two-cavity klystron and reflex klystron, Magnetron: Principle of operation and applications, Microwave Devices: Hot electrons, transferred electron devices and Gunn effect: Principle and modes of operation, Avalanche Transit-Time Devices: Read diode, IMPATT diode and TRAPATT diode, their working principles and applications.	4	15
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Suggested Evaluation Methods					
Internal Assessment: 30	TH-30	PR-0	End Term Examination: 70	TH-70	PR-0
Class Participation	5	NA	Written Examination	70	NA
Seminar/presentation/assignment/quiz/class test etc.	10	NA	Lab record	NA	NA
Seminar/Demonstration/Viva-voce/Lab records etc.	NA	NA	Viva-Voce	NA	NA
Mid-Term Exam(s)	15	NA	Write-up and execution of the practical	NA	NA

Mapping of (CLOs) to Programme Learning Outcomes & Programme Specific Outcomes															
CLO	PLO ₁	PLO ₂	PLO ₃	PLO ₄	PLO ₅	PLO ₆	PLO ₇	PLO ₈	PLO ₉	PLO ₁₀	PLO ₁₁	PSO ₁	PSO ₂	PSO ₃	PSO ₄
26L6.5-PHY-303.1	3	2	1	2		1	1	2	2			3	3	2	2
26L6.5-PHY-303.2	3	3	2	3	1	2	3	1	2		2	3	3	3	3
26L6.5-PHY-303.3	3	3	2	3		2	3	1	2		1	3	3	3	3
26L6.5-PHY-303.4	3	2	1	2		1	1	2	2		1	3	3	2	3

Learning Resources

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| <ul style="list-style-type: none"> • Boylestad, R. L., & Nashelsky, L. (2019). Electronic devices and circuit theory (11th ed.). Pearson Education. • Malvino, A. P., & Bates, D. J. (2015). Electronic principles (8th ed.). McGraw-Hill Education. • Sedra, A. S., & Smith, K. C. (2020). Microelectronic circuits (8th ed.). Oxford University Press. • Floyd, T. L. (2015). Electronic devices (10th ed.). Pearson Education. • Millman, J., & Halkias, C. C. (2017). Integrated electronics: Analog and digital circuits and systems. McGraw-Hill Education. • Rashid, M. H. (2016). Microelectronic circuits: Analysis and design (3rd ed.). Cengage Learning. • Franco, S. (2014). Design with operational amplifiers and analog integrated circuits (4th ed.). McGraw-Hill Education. • Gaonkar, R. S. (2019). Microprocessor architecture, programming, and applications with the 8085 (6th ed.). Penram International Publishing. • Streetman, B. G., & Banerjee, S. K. (2016). Solid state electronic devices (7th ed.). Pearson. • Liu, G. K., & Jin, S. (2017). Microwave devices and circuits (3rd ed.). Wiley. • MIT Open Course Ware: Integrated Microelectronic Devices (https://sl1nk.com/piyd61j) • MIT Open Course Ware: Microelectronic Devices and Circuits (https://l1nq.com/j9ouwqm) • NPTEL (National Programme on Technology Enhanced Learning) Integrated Circuits, Mosfets, OP-Amps and their Applications. (https://www.youtube.com/watch?v=xdEsQbdQbKo) |
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Content Mapping with NEP thrust areas	
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Field	Hours Devoted
Employability	3
Entrepreneurship	3
Skill Enhancement	5
Environmental Awareness	3

Introduction				
Subject	Physics - PG			
Semester	Semester 3			
Course Composition	Theory (Theory + Tutorial)			
Nomenclature of the Course	Computational Methods & Programming-1			
Course Code	26L6.5-PHY-304			
Course Type	DEC-1			
Course Level	500-599			
Pre-requisites for the course (if any)	Completion of Mathematical Physics or similar course.			
Course Learning Outcomes (CLOs) After completing this course, the learner will be able to:	26L6.5-PHY-304.1: Apply fundamental computing concepts, programming structures, and algorithmic thinking to develop simple scientific computing solutions. 26L6.5-PHY-304.2: Analyze numerical errors and implement root-finding, differentiation, and curve-fitting techniques for physical problems. 26L6.5-PHY-304.3: Solve interpolation, matrix, and eigenvalue problems using direct and iterative numerical methods. 26L6.5-PHY-304.4: Apply numerical integration and ordinary differential equation techniques to model and solve physics-based systems.			
	Theory (Th)		Practical (P)	Total
	Lecture (L)	Tutorial (T)		
Credits	4	0	0	4
Teaching hours per week	4	0	0	4
Internal Assessment Marks (Th+P=Total)	30		0	30
End Term Exam Marks	70		0	70
Max. Marks	100		0	100
Examination Duration (in Hours)	3 Hours		NA	3 Hours

Contents of the Course			
Instructions for Examiner: Theory: The paper setter shall prepare 9 questions selecting two questions from each unit with consideration given to the Course Learning Outcomes. Among these, question number 1 will be compulsory, comprising 7 short answer type questions carrying two marks each (total 14 marks) and covering the entire syllabus. The remaining questions will be carrying 14 marks each. Examinees will be required to attempt five questions: the compulsory question no. 1 and 1 question from the each of the four units.			
Unit	Topics	CLO(s)	Contact Hours
Unit-1	Computer Fundamentals: Basics of digital computing. Overview of modern operating systems and file systems. Introduction to compilers, interpreters, and scripting languages. Models of computing: Von-Neumann architecture. Boolean algebra. Binary and hexadecimal number representation. Programming Concepts: Flowchart, algorithm and pseudocode. Data types: integer, floating point, double precision, complex numbers. Input/output operations, control and looping constructs. Arrays, user-defined functions, and subroutines. Structured Programming, Modular programming, functions and subroutines. Error handling, code readability, and documentation. Language Exposure: Brief introduction to C/C++ and Python syntax. Historical perspectives on numerical computation: Aryabhata's iterative methods, Bhaskara's root-finding techniques and Kerala School approximations.	1	15

Unit-2	Machine representation: Precision and errors. Propagation of errors, truncation and round-off errors. Error propagation and numerical stability. Root finding methods: Bisection, Newton-Raphson and Secant method. Convergence of solutions. Numerical differentiation: Taylor series and finite difference approximations (forward, backward and central). Curve Fitting: Principle of least squares; linear, polynomial, and exponential regression (via linearization transformation). Least-square parameter estimation and quantitative goodness-of-fit.	2	15
Unit-3	Interpolation: Finite differences operators; Gregory-Newton forward and backward interpolation formulas for equally spaced points. Divided differences and Newton's divided difference formula; Lagrangian interpolation for unequally spaced data points. Simultaneous Linear Equations: Gaussian elimination with and without partial pivoting; Gauss-Jordan elimination. Matrix inversion. LU decomposition. Iterative Methods & Eigenvalues: Jacobi and Gauss-Seidel iterative methods with convergence conditions. Eigenvalue problems: Power method for dominant eigenvalues and Jacobi diagonalization for symmetric matrices.	3	15
Unit-4	Numerical Integration: Newton-Cotes quadrature formulas: Derivation and error estimates of the Trapezoidal rule and Simpson's 1/3 rule. Richardson's deferred limit approach. Gauss-Legendre quadrature method (2-point and 3-point formulas). Ordinary Differential Equations (ODEs): Numerical solution of first-order initial value problems (IVPs). Taylor series method, Euler's method, and Modified Euler's method. Runge-Kutta methods: derivation of RK2 and algorithm for RK4. Predictor-Corrector methods (Milne's or Adams-Bashforth-Moulton method). Concept of numerical stability and stiffness in ODEs.	4	15

Suggested Evaluation Methods					
Internal Assessment: 30	TH-30	PR-0	End Term Examination: 70	TH-70	PR-0
Class Participation	5	NA	Written Examination	70	NA
Seminar/presentation/assignment/quiz/class test etc.	10	NA	Lab record	NA	NA
Seminar/Demonstration/Viva-voce/Lab records etc.	NA	NA	Viva-Voce	NA	NA
Mid-Term Exam(s)	15	NA	Write-up and execution of the practical	NA	NA

Mapping of (CLOs) to Programme Learning Outcomes & Programme Specific Outcomes															
CLO	PLO ₁	PLO ₂	PLO ₃	PLO ₄	PLO ₅	PLO ₆	PLO ₇	PLO ₈	PLO ₉	PLO ₁₀	PLO ₁₁	PSO ₁	PSO ₂	PSO ₃	PSO ₄
26L6.5-PHY-304.1	2	2	1	3	1	2	3	1	1		1	2	1	3	2
26L6.5-PHY-304.2	3	2	1	3	1	3	3	1	2		1	2	2	3	3
26L6.5-PHY-304.3	3	2	1	3	1	3	3	1	2		1	2	2	3	3
26L6.5-PHY-304.4	3	3	1	3	1	2	3	1	1		1	2	2	3	3

Learning Resources

- ♦ Sastry, S. S. (2012). *Introductory methods of numerical analysis* (5th ed.). PHI Learning Private Limited.
- ♦ Rajaraman, V. (2015). *Computer oriented numerical methods* (4th ed.). PHI Learning Private Limited.
- ♦ Jain, M. K., Iyengar, S. R. K., & Jain, R. K. (2012). *Numerical methods for scientific and engineering computation* (6th ed.). New Age International Publishers.
- ♦ McCalla, T. R. (2010). *Introduction to numerical methods and FORTRAN programming*. John Wiley & Sons.
- ♦ Ram Kumar. (1989). *Programming with FORTRAN 77*. McGraw-Hill Education.
- ♦ Desai, R. C. (1994). *FORTRAN programming and numerical methods*. Tata McGraw-Hill.
- ♦ Verma, P. S., Ahluwalia, P. K., & Sharma, K. K. (2005). *Computational physics: An introduction*. New Age International Publishers.
- ♦ Gould, H., Tobochnik, J., & Christian, W. (2007). *An introduction to computer simulation methods: Applications to physical systems* (3rd ed.). Addison-Wesley.
- ♦ Chapra, S. C., & Canale, R. P. (2020). *Numerical methods for engineers* (8th ed.). McGraw-Hill Education.
- ♦ Pang, T. (2006). *An introduction to computational physics* (2nd ed.). Cambridge University Press.
- ♦ Giordano, N. J., & Nakanishi, H. (2006). *Computational physics* (2nd ed.). Pearson Prentice Hall.
- ♦ Atkinson, K. E. (1989). *An introduction to numerical analysis* (2nd ed.). John Wiley & Sons.
- ♦ Plofker, K. (2009). *Mathematics in India: 500 BCE–1800 CE*. Princeton University Press.
- ♦ Joseph, G. G. (2009). *A passage to infinity: Medieval Indian mathematics from Kerala and its impact*. SAGE Publications.
- ♦ Datta, B., & Singh, A. N. (1935–1938). *History of Hindu mathematics: A source book* (Vols. 1–2). Motilal Banarsidass.
- ♦ M. D. Srinivas et al. (eds.), *Studies in the History of Indian Mathematics*, Springer.
- ♦ Python documentation: <https://www.python.org/>
- ♦ Numpy documentation: <https://numpy.org/>

Content Mapping with NEP thrust areas

Field	Hours Devoted
Employability	20
Skill Enhancement	10
Indian Knowledge System	2

Important Notes:

Use of scientific calculator is permitted during examination.

Introduction				
Subject	Physics - PG			
Semester	Semester 3			
Course Composition	Theory (Theory + Tutorial)			
Nomenclature of the Course	Green Sustainable Technology-I			
Course Code	26L6.5-PHY-305			
Course Type	DEC-2			
Course Level	500-599			
Pre-requisites for the course (if any)	Basic knowledge of Environmental Science and Physics.			
Course Learning Outcomes (CLOs) After completing this course, the learner will be able to:	26L6.5-PHY-305.1: Explain and interpret Vedic ecological concepts, environmental ethics, principles of balanced resource use (Isha Upanishad), Indian environmental knowledge systems, and environmental laws, etc. 26L6.5-PHY-305.2: Analyze local and global environmental issues such as solid waste management, resource degradation, air pollution, climate change, etc. 26L6.5-PHY-305.3: Apply principles of sustainable agriculture and traditional Indian technologies, including organic farming, permaculture, aquaponics, rainwater harvesting, passive cooling systems, smokeless stoves, etc. 26L6.5-PHY-305.4: Evaluate solar energy technologies, including silicon, perovskite, organic, thin film, dye-sensitized, tandem solar cells, solar concentrators, and Fresnel lens applications.			
	Theory (Th)		Practical (P)	Total
	Lecture (L)	Tutorial (T)		
Credits	4	0	0	4
Teaching hours per week	4	0	0	4
Internal Assessment Marks (Th+P=Total)	30		0	30
End Term Exam Marks	70		0	70
Max. Marks	100		0	100
Examination Duration (in Hours)	3 Hours		NA	3 Hours

Contents of the Course			
Instructions for Examiner: Theory: The paper setter shall prepare 9 questions selecting two questions from each unit with consideration given to the Course Learning Outcomes. Among these, question number 1 will be compulsory, comprising 7 short answer type questions carrying two marks each (total 14 marks) and covering the entire syllabus. The remaining questions will be carrying 14 marks each. Examinees will be required to attempt five questions: the compulsory question no. 1 and 1 question from the each of the four units.			
Unit	Topics	CLO(s)	Contact Hours
Unit-1	Vedic concept of nature, principle of balanced use (Isha Upnishad), Interdependence of life (Vedic ecology), circular resource use, water and forest conservation ethics in ancient India, Green habit (limited use of resources), limited earth, limited resources, limited consumption), Environmental ethics and education, multilateral environmental agreements and protocols, enforcement of environmental laws in India – The Water Act, The Air Act, The Environment Act in India	1	15
Unit-2	Local Environmental Issues- Solid waste, impact of solid waste on natural resources, zero waste concept and three R concept, Global Environmental Issues- Resource degradation: deterioration of water resources, land degradation, air pollution (PM 2.5, PM 10, adverse effect), food adulteration in India, climate change and global warming, ozone layer depletion, carbon footprint, carbon trading, Energy security needs for viksit Bharat, Importance of Green Technology: Environmental Protection, Economic Benefits and Social Impacts.	2	15

Unit-3	Agri-based sensors: NPK, soil moisture, electrical conductivity, pH and humidity of soil sensors (Principle and working), Grain storage thermodynamics and preservation techniques in ancient India (gas diffusion kinetics, and passive microclimate engineering, and thermal mass of earth, phase-equilibrium of moisture, and hermetic bio-gas mechanics), Natural textile system and dyeing techniques, Wind and passive cooling architecture (Aerodynamics, thermodynamics and evaporation cooling technologies), carbon-negative techniques (Smokeless stove and Biogas plant)	3	15
Unit-4	Solar spectrum, Air mass index, Solar energy and technology: Silicon solar cell, Perovskite solar cell, organic solar cell, thin film photovoltaic, dye-sensitized solar cell, tandem solar cell, Hydrogen solar cell, light trapping in solar cell, solar concentrators, solar cooker, Use of Fresnel lens in solar energy technology (relation among the spot size, achievable temperature using Fresnel lens).	4	15

Suggested Evaluation Methods					
Internal Assessment: 30	TH-30	PR-0	End Term Examination: 70	TH-70	PR-0
Class Participation	5	NA	Written Examination	70	NA
Seminar/presentation/assignment/quiz/class test etc.	10	NA	Lab record	NA	NA
Seminar/Demonstration/Viva-voce/Lab records etc.	NA	NA	Viva-Voce	NA	NA
Mid-Term Exam(s)	15	NA	Write-up and execution of the practical	NA	NA

Mapping of (CLOs) to Programme Learning Outcomes & Programme Specific Outcomes															
CLO	PLO ₁	PLO ₂	PLO ₃	PLO ₄	PLO ₅	PLO ₆	PLO ₇	PLO ₈	PLO ₉	PLO ₁₀	PLO ₁₁	PSO ₁	PSO ₂	PSO ₃	PSO ₄
26L6.5-PHY-305.1	2	2	1	1	1	3	3	3	1		1	2	1	2	1
26L6.5-PHY-305.2	3	3	2	2	1	3	3	2	1		1	2	2	3	1
26L6.5-PHY-305.3	3	3	3	2	2	2	3	1	1		1	3	2	3	2
26L6.5-PHY-305.4	3	3	3	2	3	2	3	1	1		2	3	3	3	2

Learning Resources
• Sharma, C. N. (2007). <i>Environmental thought in ancient India</i>. New Delhi: Classical Publishing Company. • Radhakrishnan, S. (Trans.). (2008). <i>The principal Upanishads</i>. HarperCollins India • Dwivedi, O. P. (2001). <i>Hinduism and ecology: The intersection of earth, sky, and water</i>. Harvard University Press • Divan, S., & Rosencranz, A. (2022). <i>Environmental law and policy in India: Cases, materials and statutes</i> (3rd ed.). Oxford University Press • Miller, G. T., & Spoolman, S. E. (2022). <i>Environmental science</i> (17th ed.). Cengage Learning • Palaniappan, S. P., & Annadurai, K. (2018). <i>Organic farming: Theory and practice</i>. Scientific Publishers. • Mollison, B. (1988). <i>Permaculture: A designer's manual</i>. Tagari Publications • Resh, H. M. (2022). <i>Hydroponic food production</i> (8th ed.). CRC Press. • Agarwal, A., & Narain, S. (1997). <i>Dying wisdom: Rise, fall and potential of India's traditional water harvesting systems</i>. Centre for Science and Environment • Givoni, B. (1998). <i>Climate considerations in building and urban design</i>. John Wiley & Sons. • Sukhatme, S. P., Nayak, J. K., & Baredar, P. (2021). <i>Solar energy: Principles of thermal collection and storage</i> (5th ed.). McGraw Hill Education • Nelson, J. (2020). <i>The physics of solar cells</i> (2nd ed.). Imperial College Press • Green, M. A. (2022). <i>Third generation photovoltaics: Advanced solar energy conversion</i> (2nd ed.). Springer

Content Mapping with NEP thrust areas	
Field	Hours Devoted
Employability	2
Entrepreneurship	2
Skill Enhancement	3
Communication Development	2
Indian Knowledge System	3
Environmental Awareness	4
Current Issues and Social Awareness	2

Introduction				
Subject	Physics - PG			
Semester	Semester 3			
Course Composition	Theory (Theory + Tutorial)			
Nomenclature of the Course	Laser and Spectroscopy			
Course Code	26L6.5-PHY-306			
Course Type	DEC-2			
Course Level	500-599			
Pre-requisites for the course (if any)	Basic knowledge of Optics, Atomic Physics, and Wave Theory.			
Course Learning Outcomes (CLOs) After completing this course, the learner will be able to:	26L6.5-PHY-306.1: Will be able to know the operation and working of different types of lasers			
	26L6.5-PHY-306.2: Will be able to know the NMR and Mossbauer spectroscopy			
	26L6.5-PHY-306.3: Will be able to know the ESR spectroscopy and its application			
	26L6.5-PHY-306.4: Will be able to know the XPS, ICP:AEP and other spectroscopy			
	Theory (Th)		Practical (P)	Total
	Lecture (L)	Tutorial (T)		
Credits	4	0	0	4
Teaching hours per week	4	0	0	4
Internal Assessment Marks (Th+P=Total)	30		0	30
End Term Exam Marks	70		0	70
Max. Marks	100		0	100
Examination Duration (in Hours)	3 Hours		NA	3 Hours

Contents of the Course			
Instructions for Examiner:			
Theory:			
The paper setter shall prepare 9 questions selecting two questions from each unit with consideration given to the Course Learning Outcomes. Among these, question number 1 will be compulsory, comprising 7 short answer type questions carrying two marks each (total 14 marks) and covering the entire syllabus. The remaining questions will be carrying 14 marks each. Examinees will be required to attempt five questions: the compulsory question no. 1 and 1 question from the each of the four units.			
Unit	Topics	CLO(s)	Contact Hours
Unit-1	Nd: YAG Laser, CO2 laser, Nitrogen laser, Dye laser, Laser Applications: Holography, material processing, fusion reaction, laser isotope separation, Luminescence: Fluorescence & phosphorescence spectra and applications, Molecular electronic states, symmetry properties of electronic eigenfunctions, and selection rules for electronic transition in molecules	1	15
Unit-2	NMR, principle of NMR, NMR spectrometer, Types of NMR, Types of nuclei viewed from the stand point of NMR, High Resolution and Broad line NMR, Relaxation mechanisms, chemical shift; spin-spin coupling. Applications of NMR spectroscopy. Mossbauer Spectrometer, Isomer nuclear transition, Resonance fluorescence, Mossbauer effect, Mossbauer nuclei, Isomer shift, quadrupole splitting, Magnetic hyperfine structure. Applications of Mossbauer spectroscopy.	2	15
Unit-3	ESR spectrometer, substances which can be studied by ESR, and resonance conditions. Description of ESR by Precession, Relaxation mechanisms, Features of ESR spectra, the g factor, Fine structure, hyperfine structure, ligand hyperfine structure, Applications of ESR	3	15

Unit-4	Atomizers (Flame, electrochemical, special) Inductively coupled plasma: Atomic Emission Spectroscopy (ICP:AES), Direct Current plasma: Atomic Emission Spectroscopy (DCP:AES), Microwave induced plasma (MIP), Photoelectron and Auger Spectroscopy (Photoelectron Spectroscopy (XPS), and ultraviolet photoelectron spectroscopy (UPS) for surface and electronic structure characterization), Multi-photon absorption (MPA), Two-Photon Spectroscopy, and Laser-Induced Breakdown Spectroscopy (LIBS)	4	15
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Suggested Evaluation Methods					
Internal Assessment: 30	TH-30	PR-0	End Term Examination: 70	TH-70	PR-0
Class Participation	5	NA	Written Examination	70	NA
Seminar/presentation/assignment/quiz/class test etc.	10	NA	Lab record	NA	NA
Seminar/Demonstration/Viva-voce/Lab records etc.	NA	NA	Viva-Voce	NA	NA
Mid-Term Exam(s)	15	NA	Write-up and execution of the practical	NA	NA

Mapping of (CLOs) to Programme Learning Outcomes & Programme Specific Outcomes															
CLO	PLO ₁	PLO ₂	PLO ₃	PLO ₄	PLO ₅	PLO ₆	PLO ₇	PLO ₈	PLO ₉	PLO ₁₀	PLO ₁₁	PSO ₁	PSO ₂	PSO ₃	PSO ₄
26L6.5-PHY-306.1	3	3	2	3	1	2	2	1	1	2		3	3	2	3
26L6.5-PHY-306.2	3	3	2	3	1	2	3	1	1	2		3	3	3	3
26L6.5-PHY-306.3	3	3	2	3	1	2	3	1	1	2		3	3	3	3
26L6.5-PHY-306.4	3	3	2	3	2	2	3	2	1	2	1	3	3	3	3

Learning Resources
• K. P. Huber, G. Herzberg, Molecular spectra and Molecular structure II and III Springer, 1979. • Marc Levenson, Introduction to non-linear laser spectroscopy, Springer, 1988. • V.K. Jain, Introduction to Atomic and Molecular Spectroscopy, Narosa Publishing House, 2009 • Amnon Yariv, Quantum Electronics, 3rd Edition, John Wiley & Sons Inc • Skoog, D. A., Holler, F. J., & Crouch, S. R. (2018). <i>Principles of Instrumental Analysis</i> (7th ed.). Cengage Learning • Briggs, D., & Grant, J. T. (Eds.). (2003). <i>Surface Analysis by Auger and X-ray Photoelectron Spectroscopy</i>. IM Publications. • Hüfner, S. (2003). <i>Photoelectron Spectroscopy: Principles and Applications</i> (3rd ed.). Springer. • Demtröder, W. (2015). <i>Laser Spectroscopy: Basic Concepts and Instrumentation</i> (5th ed.). Springer. • Miziolek, A. W., Palleschi, V., & Schechter, I. (Eds.). (2006). <i>Laser-Induced Breakdown Spectroscopy (LIBS): Fundamentals and Applications</i>. Cambridge University Press

Content Mapping with NEP thrust areas	
Field	Hours Devoted
Employability	2
Skill Enhancement	2
Communication Development	2

Introduction				
Subject	Physics - PG			
Semester	Semester 3			
Course Composition	Practical			
Nomenclature of the Course	Practical Electronic Devices			
Course Code	26L6.5-PHY-307			
Course Type	PC-5			
Course Level	500-599			
Pre-requisites for the course (if any)	Basic knowledge of Electronic Devices and Circuits.			
Course Learning Outcomes (CLOs) After completing this course, the learner will be able to:	26L6.5-PHY-307.1: Analyze the photoconductive and photovoltaic characteristics of semiconductor devices by studying CdS photoresistors, solar cells, and the variation of conductivity with illumination. 26L6.5-PHY-307.2: Design and evaluate electronic and digital systems using 555 timer-based multivibrators, 8085/8086 microprocessor arithmetic operations, and BJT characteristic analysis. 26L6.5-PHY-307.3: Apply operational amplifier principles to implement and analyze amplifier, integrator, differentiator, differential amplifier, and summing amplifier circuits. 26L6.5-PHY-307.4: Design and investigate data conversion and signal-processing circuits including ADC–DAC systems, analog comparators, and sawtooth wave generators using operational amplifiers.			
	Theory (Th)		Practical (P)	Total
	Lecture (L)	Tutorial (T)		
Credits	0	0	4	4
Teaching hours per week	0	0	8	8
Internal Assessment Marks (Th+P=Total)	0		30	30
End Term Exam Marks	0		70	70
Max. Marks	0		100	100
Examination Duration (in Hours)	NA		3 Hours	3 Hours

Contents of the Course			
Instructions for Examiner: Practical: Write-up and execution of the practical will be conducted as per the nature of the practical by the external examiner, with consideration given to the Course Learning Outcomes. The maximum marks for the write-up and execution of the practical will be 40 .			
Unit	Topics	CLO(s)	Contact Hours
Unit-1	1. To study the photoconductivity of CdS Photoresistor (i) for applied voltage vs photocurrent (IPH) at constant irradiance (Φ) and (ii) Photocurrent (IPH) vs irradiance (Φ) at a constant applied voltage (V). 2. To study Solar cell characteristics. 3. To study variation of conductivity with illumination.	1	30
Unit-2	4. To design and study the operation of multivibrators using the 555 Timer IC. 5. Addition, Subtraction, Multiplication & Division using 8085/8086. 6. To plot input and output characteristics of BJT using monolithic IC (CA3086, CA3046, or LM3045).	2	30
Unit-3	7. To study OP-AMP as inverting and non-inverting amplifier. 8. To study OP-AMP application as integrator and differentiator. 9. To study differential amplifier and summing amplifier using OP-AMP.	3	30

Unit-4	10. To study digital-to-analog and analog-to-digital conversion (DAC to ADC) circuits. 11. To design and study the operation of an analog comparator circuit using an operational amplifier and observe its switching behavior for different input voltages. 12. Generation of Sawtooth wave using OP-AMP.	4	30
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Suggested Evaluation Methods					
Internal Assessment: 30	TH-0	PR-30	End Term Examination: 70	TH-0	PR-70
Class Participation	NA	5	Written Examination	NA	NA
Seminar/presentation/assignment/quiz/class test etc.	NA	NA	Lab record	NA	10
Seminar/Demonstration/Viva-voce/Lab records etc.	NA	10	Viva-Voce	NA	20
Mid-Term Exam(s)	NA	15	Write-up and execution of the practical	NA	40

Mapping of (CLOs) to Programme Learning Outcomes & Programme Specific Outcomes															
CLO	PLO ₁	PLO ₂	PLO ₃	PLO ₄	PLO ₅	PLO ₆	PLO ₇	PLO ₈	PLO ₉	PLO ₁₀	PLO ₁₁	PSO ₁	PSO ₂	PSO ₃	PSO ₄
26L6.5-PHY-307.1	3	2	1	3		3	3	2	2			3	3	2	2
26L6.5-PHY-307.2	3	3	1	3	1	2	3	1	2		2	3	3	3	3
26L6.5-PHY-307.3	3	3	2	3		2	3	1	2		1	3	3	3	2
26L6.5-PHY-307.4	3	3	2	3	1	3	3	1	2		1	3	3	3	3

Learning Resources
- Boylestad, R. L., & Nashelsky, L. (2013). Electronic devices and circuit theory (11th ed.). Pearson Education. - Malvino, A. P., & Bates, D. J. (2016). Electronic principles (8th ed.). McGraw-Hill Education. - Sedra, A. S., & Smith, K. C. (2014). Microelectronic circuits (7th ed.). Oxford University Press. - Sze, S. M., & Ng, K. K. (2006). Physics of semiconductor devices (3rd ed.). Wiley. - Kumar, A., & Gupta, S. (2019). Electronic devices and circuits laboratory manual. (Common university lab manual reference). - Ramakant A. Gayakwad. (2000). Op-amps and linear integrated circuits (4th ed.). Prentice Hall. - Tokheim, R. (2002). Digital electronics: Principles and applications. McGraw-Hill. - Gaonkar, R. S. (2013). Microprocessor architecture, programming, and applications with the 8085. Penram International Publishing. - Morris Mano, M., & Ciletti, M. D. (2017). Digital design (5th ed.). Pearson. - NPTEL (IIT Bombay/IIT Madras). (n.d.). Basic electronics, analog circuits, and microprocessors. https://nptel.ac.in - Texas Instruments. (n.d.). Operational amplifier application notes. https://www.ti.com - Intel Corporation. (n.d.). Microprocessor architecture documentation. https://www.intel.com

Content Mapping with NEP thrust areas	
Field	Hours Devoted
Employability	12
Entrepreneurship	12
Skill Enhancement	16

Important Notes:
Students should perform at least 8–10 experiments, ensuring that the selected experiments are distributed across all units of the course

Introduction				
Subject	Physics - PG			
Semester	Semester 3			
Course Composition	Practical			
Nomenclature of the Course	Practical Computation Methods and Programming -I			
Course Code	26L6.5-PHY-308			
Course Type	PC-5			
Course Level	500-599			
Pre-requisites for the course (if any)	Basic knowledge of Mathematical physics			
Course Learning Outcomes (CLOs) After completing this course, the learner will be able to:	26L6.5-PHY-308.1: Develop scientific programs to analyze numerical precision, floating-point errors, and multidimensional data structures relevant to computational physics. 26L6.5-PHY-308.2: Implement numerical methods for root-finding, differentiation, and function approximation and evaluate their accuracy and convergence. 26L6.5-PHY-308.3: Apply interpolation, curve fitting, and matrix-based numerical techniques to solve physical and mathematical problems. 26L6.5-PHY-308.4: Implement numerical integration and differential equation solvers to model and analyze dynamical physical systems.			
	Theory (Th)		Practical (P)	Total
	Lecture (L)	Tutorial (T)		
Credits	0	0	4	4
Teaching hours per week	0	0	8	8
Internal Assessment Marks (Th+P=Total)	0		30	30
End Term Exam Marks	0		70	70
Max. Marks	0		100	100
Examination Duration (in Hours)	NA		3 Hours	3 Hours

Contents of the Course			
Instructions for Examiner: Practical: Write-up and execution of the practical will be conducted as per the nature of the practical by the external examiner, with consideration given to the Course Learning Outcomes. The maximum marks for the write-up and execution of the practical will be 40 .			
Unit	Topics	CLO(s)	Contact Hours
Unit-1	Write a program to numerically determine the machine epsilon for single and double data types. Extend this to calculate the infinite sum $\sum 1/n$ up to a large N, comparing the obtained by summing forward vs. backward to demonstrate floating-point round-off error. Generate a 2D array. Program the code to compute properties like matrix transpose, trace, and element-wise products using native complex data types. Save the final multi-dimensional array systematically to an external .data.txt file with customized tabular formatting.	1	30

Unit-2	3. Implement Madhava-Bhaskara's sine approximation formula or the Kerala School's infinite series for π. Graphically track and calculate how the truncation error changes as a function of the number of terms kept in the expansion. 4. Solve the transcendental bound-state equations for a particle trapped in a finite 1D quantum square well using bisection and Newton-Raphson method. Compare their rates of convergence. 5. Given an analytical function, write a program to calculate its first derivative using forward, backward, and central finite difference approximations. Compute and plot the absolute error against decreasing grid step size.	2	30
Unit-3	6. Use principle of least square to fit the experimental data from an experiment and calculate goodness of fit. 7. Implement Newton's forward and backward difference formula and Lagrange's interpolation formula. 8. Implement Gauss elimination and LU decomposition. 9. Set up the characteristic matrix equation for a system of three coupled mass-spring harmonic oscillators. Use the Power Method to extract the dominant natural frequency (highest eigenvalue) and corresponding normal mode eigenvector.	3	30
Unit-4	10. Program the Trapezoidal and Simpson's 1/3 integration rules to evaluate a definite integral with a known analytical solution. 11. Write a program to implement the 2-point and 3-point Gauss-Legendre Quadrature methods. 12. Solve the system of ordinary differential equations modeling a projectile experiencing quadratic air drag. Solve this initial value problem using both the Standard Euler and Modified Euler (RK2) methods, mapping the resulting trajectories to see how stability breaks down over long times in the lower-order method. 13. Implement the standard RK4 algorithm to solve the planetary motion equations under Newton's gravitational law (Keplerian problem). Track total energy and angular momentum over multiple complete orbits. 14. Solve a non-linear chemical reaction rate or population dynamics equation using an explicit Predictor-Corrector method	4	30

Suggested Evaluation Methods					
Internal Assessment: 30	TH-0	PR-30	End Term Examination: 70	TH-0	PR-70
Class Participation	NA	5	Written Examination	NA	NA
Seminar/presentation/assignment/quiz/class test etc.	NA	NA	Lab record	NA	10
Seminar/Demonstration/Viva-voce/Lab records etc.	NA	10	Viva-Voce	NA	20
Mid-Term Exam(s)	NA	15	Write-up and execution of the practical	NA	40

Mapping of (CLOs) to Programme Learning Outcomes & Programme Specific Outcomes															
CLO	PLO ₁	PLO ₂	PLO ₃	PLO ₄	PLO ₅	PLO ₆	PLO ₇	PLO ₈	PLO ₉	PLO ₁₀	PLO ₁₁	PSO ₁	PSO ₂	PSO ₃	PSO ₄
26L6.5-PHY-308.1	2	2	3	3	2	2	3	1	1	1	2	2	1	3	3

26L6.5 -PHY- 308.2	3	3	3	3	2	3	3	1	1	1	2	2	1	2	3
26L6.5 -PHY- 308.3	3	3	3	3	2	3	3	1	1	1	2	2	2	3	3
26L6.5 -PHY- 308.4	3	3	3	3	2	3	3	1	1	1	2	2	3	3	3

Learning Resources

- Sastry, S. S. (2012). *Introductory methods of numerical analysis* (5th ed.). PHI Learning Private Limited.
 - Rajaraman, V. (2015). *Computer oriented numerical methods* (4th ed.). PHI Learning Private Limited.
 - Jain, M. K., Iyengar, S. R. K., & Jain, R. K. (2012). *Numerical methods for scientific and engineering computation* (6th ed.). New Age International Publishers.
 - McCalla, T. R. (2010). *Introduction to numerical methods and FORTRAN programming*. John Wiley & Sons.
 - Verma, P. S., Ahluwalia, P. K., & Sharma, K. K. (2005). *Computational physics: An introduction*. New Age International Publishers.
 - Gould, H., Tobochnik, J., & Christian, W. (2007). *An introduction to computer simulation methods: Applications to physical systems* (3rd ed.). Addison-Wesley.
 - Chapra, S. C., & Canale, R. P. (2020). *Numerical methods for engineers* (8th ed.). McGraw-Hill Education.
 - Pang, T. (2006). *An introduction to computational physics* (2nd ed.). Cambridge University Press.
 - Landau, R. H., Páez, M. J., & Bordeianu, C. C. (2015). *Computational physics: Problem solving with Python* (3rd ed.). Wiley-VCH.
 - Atkinson, K. E. (1989). *An introduction to numerical analysis* (2nd ed.). John Wiley & Sons.
 - Giordano, N. J., & Nakanishi, H. (2006). *Computational physics* (2nd ed.). Pearson Prentice Hall.
 - Plofker, K. (2009). *Mathematics in India: 500 BCE–1800 CE*. Princeton University Press.
 - Joseph, G. G. (2009). *A passage to infinity: Medieval Indian mathematics from Kerala and its impact*. SAGE Publications.
 - Datta, B., & Singh, A. N. (1935–1938). *History of Hindu mathematics: A source book* (Vols. 1–2). Motilal Banarsidass.
 - M. D. Srinivas et al. (eds.), *Studies in the History of Indian Mathematics*, Springer.
- Python documentation: <https://www.python.org/>
- Numpy documentation: <https://numpy.org/>

Content Mapping with NEP thrust areas

Field	Hours Devoted
Employability	15
Skill Enhancement	30
Indian Knowledge System	2

Important Notes:

Students should perform 8-10 experiments, ensuring that the selected experiments are distributed across all units of the course.

Introduction				
Subject	Physics - PG			
Semester	Semester 3			
Course Composition	Practical			
Nomenclature of the Course	Practical Green Sustainable Technology-I			
Course Code	26L6.5-PHY-309			
Course Type	PC-6			
Course Level	500-599			
Pre-requisites for the course (if any)	Basic knowledge of Green Sustainable Technology concepts.			
Course Learning Outcomes (CLOs) After completing this course, the learner will be able to:	26L6.5-PHY-309.1: Students would be able to design smokeless stove and dye-sensitized solar cell			
	26L6.5-PHY-309.2: Students would be able to know the synthesis of natural pesticide and fertilizer.			
	26L6.5-PHY-309.3: Students would be able to design the natural cooler/Ac system, and solar cooker			
	26L6.5-PHY-309.4: Students would be able to detect food adulteration			
	Theory (Th)		Practical (P)	Total
	Lecture (L)	Tutorial (T)		
Credits	0	0	4	4
Teaching hours per week	0	0	8	8
Internal Assessment Marks (Th+P=Total)	0		30	30
End Term Exam Marks	0		70	70
Max. Marks	0		100	100
Examination Duration (in Hours)	NA		3 Hours	3 Hours

Contents of the Course			
Instructions for Examiner:			
Practical:			
Write-up and execution of the practical will be conducted as per the nature of the practical by the external examiner, with consideration given to the Course Learning Outcomes. The maximum marks for the write-up and execution of the practical will be 40 .			
Unit	Topics	CLO(s)	Contact Hours
Unit-1	1. To design and study the temperature distribution of a smokeless stove. 2. To fabricate and study the dye-sensitized solar cell.	1	30
Unit-2	3. To manufacture a natural pesticide for the crop using natural components. 4. To manufacture the natural fertilizer using natural components.	2	30
Unit-3	5. To design and study the natural cooler/AC using wind and passive cooling architecture. 6. To design and study the solar cooker.	3	30
Unit-4	7. To study the relationship among the spot size, solar energy density, and the temperature of the spot using a Fresnel lens of a given size. 8. To check the food adulteration using electrochemical techniques.	4	30

Suggested Evaluation Methods					
Internal Assessment: 30	TH-0	PR-30	End Term Examination: 70	TH-0	PR-70
Class Participation	NA	5	Written Examination	NA	NA
Seminar/presentation/assignment/quiz/class test etc.	NA	NA	Lab record	NA	10
Seminar/Demonstration/Viva-voce/Lab records etc.	NA	10	Viva-Voce	NA	20
Mid-Term Exam(s)	NA	15	Write-up and execution of the practical	NA	40

Mapping of (CLOs) to Programme Learning Outcomes & Programme Specific Outcomes															
CLO	PLO ₁	PLO ₂	PLO ₃	PLO ₄	PLO ₅	PLO ₆	PLO ₇	PLO ₈	PLO ₉	PLO ₁₀	PLO ₁₁	PSO ₁	PSO ₂	PSO ₃	PSO ₄
26L6.5-PHY-309.1	3	3	2	2	2	2	3	1	1	1	1	3	2	2	2
26L6.5-PHY-309.2	2	3	2	2	2	3	3	1	1	1	1	2	3	2	3
26L6.5-PHY-309.3	3	3	2	3	2	3	3	1	1	1	1	3	3	3	3
26L6.5-PHY-309.4	3	3	3	3	3	2	3	1	1	1	1	3	3	3	3

Learning Resources	
- Sukhatme, S. P., & Nayak, J. K. <i>Solar Energy: Principles of Thermal Collection and Storage</i>. McGraw Hill Education. - Duffie, J. A., & Beckman, W. A. (2013). <i>Solar engineering of thermal processes</i> (4th ed.). Wiley, Hoboken, NJ - Givoni, B. (1994). <i>Passive cooling of buildings</i>. Wiley, New York - Bard, A. J., & Faulkner, L. R. (2001). <i>Electrochemical methods: Fundamentals and applications</i> (2nd ed.). Wiley, New York - Jadhav, R. R. (2018). <i>Energy-efficient buildings in India</i>. TERI Press, New Delhi - Kalyanasundaram, K. (2010). <i>Photoelectrochemical solar cells</i>. Elsevier, Amsterdam - Dhaliwal, G. S. (2010). <i>Organic farming and sustainable agriculture</i>. Kalyani Publishers, Ludhiana - Anastas, P. T., & Warner, J. C. (1998). <i>Green chemistry: Theory and practice</i>. Oxford University Press, Oxford	

Content Mapping with NEP thrust areas	
Field	Hours Devoted
Employability	4
Entrepreneurship	6
Skill Enhancement	10
Communication Development	2
Indian Knowledge System	2
Environmental Awareness	3
Current Issues and Social Awareness	1

Introduction				
Subject	Physics - PG			
Semester	Semester 3			
Course Composition	Practical			
Nomenclature of the Course	Practical Laser and Spectroscopy			
Course Code	26L6.5-PHY-310			
Course Type	PC-6			
Course Level	500-599			
Pre-requisites for the course (if any)	Prior knowledge of Atomic and Molecular Physics			
Course Learning Outcomes (CLOs) After completing this course, the learner will be able to:	26L6.5-PHY-310.1: Perform atomic spectroscopy experiments including Frank-Hertz and atomic emission spectroscopy to investigate atomic excitation processes, discrete energy levels and spectral characteristics. 26L6.5-PHY-310.2: Characterize optical and electronic properties of materials using UV-Visible absorption, reflectance and fluorescence spectroscopic techniques. 26L6.5-PHY-310.3: Analyze ESR spectra of paramagnetic systems and determine physical parameters such as g-factor and spin concentration. 26L6.5-PHY-310.4: Interpret advanced spectroscopic data and employ computational tools for the analysis of molecular and solid-state systems using ESR, NMR and Mössbauer techniques.			
	Theory (Th)		Practical (P)	Total
	Lecture (L)	Tutorial (T)		
Credits	0	0	4	4
Teaching hours per week	0	0	8	8
Internal Assessment Marks (Th+P=Total)	0		30	30
End Term Exam Marks	0		70	70
Max. Marks	0		100	100
Examination Duration (in Hours)	NA		3 Hours	3 Hours

Contents of the Course			
Instructions for Examiner: Practical: Write-up and execution of the practical will be conducted as per the nature of the practical by the external examiner, with consideration given to the Course Learning Outcomes. The maximum marks for the write-up and execution of the practical will be 40 .			
Unit	Topics	CLO(s)	Contact Hours
Unit-1	1. Frank-Hertz Experiment and Determination of Excitation Potential of Mercury. 2. Study of Reflectance Spectrum of a Given Sample. 3. Study of Fluorescence Spectrum of a Given Sample.	1	30
Unit-2	4. Determination of Optical Band Gap of Semiconductor Sample using UV-VIS Spectroscopy. 5. Determination of Concentration of Unknown Solution using UV-VIS Absorption Spectroscopy. 6. Analysis of ESR Spectra of Transition Metal Ions.	2	30
Unit-3	7. Determination of Lande's g-Factor of DPPH using ESR Spectrometer. 8. Determination of Spin Concentration in Paramagnetic Sample using ESR. 9. Determination of Stokes Shift from Absorption and Fluorescence Spectra.	3	30
Unit-4	10. Study of Vibronic Structure of Molecular Electronic Spectra. 11. Computer-Based Simulation and Analysis of NMR Spectra of Simple Molecules. 12. Computer-Based Simulation of Mössbauer Spectra and Hyperfine Splitting.	4	30

Suggested Evaluation Methods					
Internal Assessment: 30	TH-0	PR-30	End Term Examination: 70	TH-0	PR-70
Class Participation	NA	5	Written Examination	NA	NA
Seminar/presentation/assignment/quiz/class test etc.	NA	NA	Lab record	NA	10
Seminar/Demonstration/Viva-voce/Lab records etc.	NA	10	Viva-Voce	NA	20
Mid-Term Exam(s)	NA	15	Write-up and execution of the practical	NA	40

Mapping of (CLOs) to Programme learning Outcomes & Programme Specific Outcomes															
CLO	PLO ₁	PLO ₂	PLO ₃	PLO ₄	PLO ₅	PLO ₆	PLO ₇	PLO ₈	PLO ₉	PLO ₁₀	PLO ₁₁	PSO ₁	PSO ₂	PSO ₃	PSO ₄
26L6.5-PHY-310.1	3	2	3	3	3	3	2	1	1	1	2	3	2	3	2
26L6.5-PHY-310.2	3	2	3	3	3	3	3	1	1	1	2	3	3	3	2
26L6.5-PHY-310.3	3	3	3	3	3	3	3	1	1	1	2	3	3	3	3
26L6.5-PHY-310.4	3	3	3	3	3	3	3	1	1	1	2	3	3	3	3

Learning Resources	
- Jain, V. K. (2017). <i>Introduction to Atomic and Molecular Spectroscopy</i> (2nd ed.). Narosa Publishing House. - Banwell, C. N., & McCash, E. M. (1994). <i>Fundamentals of Molecular Spectroscopy</i> (4th ed.). McGraw-Hill Education. - Skoog, D. A., Holler, F. J., & Crouch, S. R. (2018). <i>Principles of Instrumental Analysis</i> (7th ed.). Cengage Learning. - Poole, C. P. (1996). <i>Electron Spin Resonance: A Comprehensive Treatise on Experimental Techniques</i> (2nd ed.). Dover Publications. - Demtröder, W. (2015). <i>Laser Spectroscopy: Basic Concepts and Instrumentation</i> (5th ed.). Springer. - Thyagarajan, K., & Ghatak, A. K. (2010). <i>Lasers: Fundamentals and Applications</i> (2nd ed.). Springer India. - Gupta, S. L., Kumar, V., & Sharma, R. C. <i>Elements of Spectroscopy</i>. Pragati Prakashan.	

Important Notes:
Students should perform 8-10 experiments , ensuring that the selected experiments are distributed across all units of the course.

Introduction				
Subject	Physics - PG			
Semester	Semester 4, 4B			
Course Composition	Theory (Theory + Tutorial)			
Nomenclature of the Course	Nuclear & Particle Physics			
Course Code	26L6.5-PHY-401			
Course Type	CC-11			
Course Level	500-599			
Pre-requisites for the course (if any)	Basic knowledge of Modern Physics and Quantum Mechanics.			
Course Learning Outcomes (CLOs) After completing this course, the learner will be able to:	26L6.5-PHY-401.1: Students would be able to realize the nature of nuclear force 26L6.5-PHY-401.2: Students would be able to understand the structure of nucleus and would be able to find out spin, parity, magnetic moments etc. of different nuclei 26L6.5-PHY-401.3: Students would be able to understand different nuclear decays and reactions 26L6.5-PHY-401.4: Students would gain a basic knowledge about Elementary Particle and interactions.			
	Theory (Th)		Practical (P)	Total
	Lecture (L)	Tutorial (T)		
Credits	4	0	0	4
Teaching hours per week	4	0	0	4
Internal Assessment Marks (Th+P=Total)	30		0	30
End Term Exam Marks	70		0	70
Max. Marks	100		0	100
Examination Duration (in Hours)	3 Hours		NA	3 Hours

Contents of the Course			
Instructions for Examiner: Theory: The paper setter shall prepare 9 questions selecting two questions from each unit with consideration given to the Course Learning Outcomes. Among these, question number 1 will be compulsory, comprising 7 short answer type questions carrying two marks each (total 14 marks) and covering the entire syllabus. The remaining questions will be carrying 14 marks each. Examinees will be required to attempt five questions: the compulsory question no. 1 and 1 question from the each of the four units.			
Unit	Topics	CLO(s)	Contact Hours
Unit-1	Nuclear properties: size, shape, charge distribution, spin & parity, The deuteron: binding energy, dipole moment quadrupole moment and the evidence of non-central (Tensor) force, spin dependence of nuclear force. Nucleon-nucleon scattering; s-wave effective range theory, charge independence and charge symmetry of nuclear forces, iso-spin formalism, Atomistic ideas in Indian philosophy.	1	15
Unit-2	Magnetic moment and Schmidt lines, angular momentum & spin parity of Nuclear ground state, spin orbit coupling, Liquid drop model, stability of nuclei, fission; evidence of shell structure, the shell model spin parity and magnetic moment in extreme single particle model, evidence of collective excitations, collective vibration of a spherical liquid drop.	2	15
Unit-3	Alpha, Beta and Gamma decays, Selections rules, Fermi's theory of beta decay, selection rules, comparative half lines, Kurie plot Fermi and Gamow -Teller Transitions; parity non-conservation in beta decay. Reaction cross section, compound nuclear reactions and direct reactions, the optical model, Breit-Wigner resonance formula for $l=0$, disintegration constant of radio-active decay half life time, shape of Beta spectrum, internal conversion nuclear isomerism, interaction of charged particle with matter	3	15

Unit-4	Basic interactions in nature: Gravitational, Electromagnetic, weak and strong, Grand Unification and Philosophical Concepts of Cosmic Unity (IKS Perspective), Cosmological inquiry in ancient Indian thought: (Nāsadiya Sūkta and its critical comparison), classification of elementary particles, Leptons, Hadrons, Mesons, Baryons. Conservation Laws for Elementary Particles. Baryon, Lepton and Muon number, Strangeness and Hypercharge, Gellman - Nishijima formula. Quark model, SU (2) and SU (3) Symmetries, Gellmann-Okubo formula for octet and decuplet hadrons, Parities of subatomic particles, charge conjugation, Time reversal, CP & CPT invariance.	4	15
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Suggested Evaluation Methods					
Internal Assessment: 30	TH-30	PR-0	End Term Examination: 70	TH-70	PR-0
Class Participation	5	NA	Written Examination	70	NA
Seminar/presentation/assignment/quiz/class test etc.	10	NA	Lab record	NA	NA
Seminar/Demonstration/Viva-voce/Lab records etc.	NA	NA	Viva-Voce	NA	NA
Mid-Term Exam(s)	15	NA	Write-up and execution of the practical	NA	NA

Mapping of (CLOs) to Programme Learning Outcomes & Programme Specific Outcomes															
CLO	PLO ₁	PLO ₂	PLO ₃	PLO ₄	PLO ₅	PLO ₆	PLO ₇	PLO ₈	PLO ₉	PLO ₁₀	PLO ₁₁	PSO ₁	PSO ₂	PSO ₃	PSO ₄
26L6.5-PHY-401.1	3	3	2	3	1	2	2	1	1			3	3	2	3
26L6.5-PHY-401.2	3	3	2	3	1	2	3	1	1			3	3	3	3
26L6.5-PHY-401.3	3	3	2	3	1	2	3	1	1			3	3	3	3
26L6.5-PHY-401.4	3	3	2	3	2	2	3	2	1		1	3	3	3	3

Learning Resources

- ♦ Kenneth S. Kiane, Introductory Nuclear Physics, Wiley, New York, 1988.
- ♦ Structure of the Nucleus by M. A. Preston and R.K. Bhaduri, CRC Press, 2019
- ♦ Singuru R. M., Introduction to experimental nuclear physics, Wiley Eastern Publications, 1987
- ♦ Muraleedhara V. Nuclear radiation Detection, measurement, and Analysis, Narosa Publishing House, 2009.
- ♦ Roy & Nigam, Nuclear Physics, John Wiley & Sons, USA, 1st Edition, 1967.
- ♦ H. Enge, Introduction to Nuclear Physics, Addison Wesley, USA, 1st Edition 1969.
- ♦ J.M. Blatt and V.F. Weisskopf, Theoretical Nuclear Physics, Springer, Germany, 1st Edition, 1969
- ♦ M. Leon, Particle Physics: An Introduction, Elsevier, Netherlands, 1st Edition, 1973.
- ♦ S. N. Ghoshal, Nuclear Physics, S. Chand, India, 1st Edition, 1994
- ♦ F.I. Stancu, Group Theory in Subnuclear Physics, Clarendon Press, UK, 1st Edition, 1997
- ♦ J.D. Walecka, Theoretical Nuclear and Subnuclear Physics, World Scientific, Singapore, 2nd Edition, 2004.
- ♦ B. R. Martin and G. Shaw, Particle Physics, John Wiley & Sons, USA, 3rd Edition, 2008.
- ♦ Pal, Babaloo. "Atomism in Vaisheshik Philosophy: An Analysis of the Fundamental Building Blocks of the Universe." *The Creative Launcher* 8, no. 3 (2023): 74-83
- ♦ N Sai Prashanthi, The scientific and philosophical analysis of nasadiya sukta on origin of universe, International Journal of Sanskrit Research 2025; 11(3): 25-27
- ♦ <https://siesce.edu.in/docs/resources/IKS.pdf>

Content Mapping with NEP thrust areas

Field	Hours Devoted
Employability	2
Skill Enhancement	3
Communication Development	2
Indian Knowledge System	2
Environmental Awareness	1

Introduction				
Subject	Physics - PG			
Semester	Semester 4			
Course Composition	Theory (Theory + Tutorial)			
Nomenclature of the Course	Physics of Nano- Materials			
Course Code	26L6.5-PHY-402			
Course Type	CC-12			
Course Level	500-599			
Pre-requisites for the course (if any)	Basic knowledge of Solid State Physics and Quantum Mechanics.			
Course Learning Outcomes (CLOs) After completing this course, the learner will be able to:	26L6.5-PHY-402.1: Explain the effects of quantum confinement on the electronic structure and corresponding physical and chemical properties of materials at the nanoscale 26L6.5-PHY-402.2: Choose the appropriate synthesis technique to synthesize quantum nanostructures of desired size, shape, and surface properties 26L6.5-PHY-402.3: Correlate properties of nanostructures with their size, shape, and surface characteristics 26L6.5-PHY-402.4: Explains the microscopy, particle size, band gap of the nano-materials			
	Theory (Th)		Practical (P)	Total
	Lecture (L)	Tutorial (T)		
Credits	4	0	0	4
Teaching hours per week	4	0	0	4
Internal Assessment Marks (Th+P=Total)	30		0	30
End Term Exam Marks	70		0	70
Max. Marks	100		0	100
Examination Duration (in Hours)	3 Hours		NA	3 Hours

Contents of the Course			
Instructions for Examiner: Theory: The paper setter shall prepare 9 questions selecting two questions from each unit with consideration given to the Course Learning Outcomes. Among these, question number 1 will be compulsory, comprising 7 short answer type questions carrying two marks each (total 14 marks) and covering the entire syllabus. The remaining questions will be carrying 14 marks each. Examinees will be required to attempt five questions: the compulsory question no. 1 and 1 question from the each of the four units.			
Unit	Topics	CLO(s)	Contact Hours
Unit-1	Nanoscience & Nanotechnology, Traces of nanomaterials in ancient Indian history, size dependence of properties, Chemical reactivity, Mechanical properties at the nanoscale, Moor's law, Surface energy, and Melting point (quasi melting) of nanoparticles, de-Broglie wavelength, Bohr radius, Excitons, confinement regimes, Density of states, Variation of the density of states with energy and size of the crystal. Population of conduction and valance band for 0D, 1D, 2D & 3D material. Application of Nanotechnology in different areas	1	15
Unit-2	Quantum confinement and its consequences, quantum wells, quantum wires, quantum dots and artificial atoms. Electronic structure from bulk to quantum dot. Electron states in direct and indirect gap semiconductors nanocrystals. Confinement in disordered and amorphous systems.	2	15
Unit-3	Key issues in the synthesis of Nanomaterials, Different methods of preparation of nanomaterials, Top-down and Bottom-up approaches, Thermal and e-beam evaporation, Gas phase synthesis of nanopowders, chemical and colloidal methods, sol-gel method, functionalization of nanoparticles, Ball Milling, Specific materials like graphene and carbon nanotubes (CNTs).	3	15

Unit-4	Determination of particle size, increase in width of XRD peaks of nanoparticles, Electron Microscopy: Scanning Electron Microscopy (SEM), Transmission Electron Microscopy (TEM), Scanning Probe Microscopy (SPM), Atomic Force Microscopy (AFM), Raman Spectroscopy and XPS, Shift in photoluminescence peaks, UV-Visible spectroscopy-estimation of band gap, Thermogravimetric analysis	4	15
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Suggested Evaluation Methods					
Internal Assessment: 30	TH-30	PR-0	End Term Examination: 70	TH-70	PR-0
Class Participation	5	NA	Written Examination	70	NA
Seminar/presentation/assignment/quiz/class test etc.	10	NA	Lab record	NA	NA
Seminar/Demonstration/Viva-voce/Lab records etc.	NA	NA	Viva-Voce	NA	NA
Mid-Term Exam(s)	15	NA	Write-up and execution of the practical	NA	NA

Mapping of (CLOs) to Programme Learning Outcomes & Programme Specific Outcomes															
CLO	PLO ₁	PLO ₂	PLO ₃	PLO ₄	PLO ₅	PLO ₆	PLO ₇	PLO ₈	PLO ₉	PLO ₁₀	PLO ₁₁	PSO ₁	PSO ₂	PSO ₃	PSO ₄
26L6.5-PHY-402.1	3	3	2	1	1	1	2	1	1		1	3	2	2	1
26L6.5-PHY-402.2	3	3	2	2	1	1	1	1	1		1	3	3	2	1
26L6.5-PHY-402.3	2	3	3	2	2	1	2	1	1		1	2	3	3	2
26L6.5-PHY-402.4	2	3	2	3	3	1	1	1	1		1	2	3	3	2

Learning Resources
- Gan-Moog Chow, Kenneth E. Gonsalves, Nanotechnology Molecularly designed materials, American Chemical Society D. Bimerg, M. Grundmann and N.N. Ledenstov, Quantum dot heterostructures, John Wiley & Sons, 1988 - B.C. Crandall, Nanotechnology: molecular speculations on global abundance, MIT Press 1996. - John H. Davies, Physics of low dimensional semiconductors, Cambridge Univ. Press 1997 - K.P. Jain, Physics of Semiconductors nanostructures, Narosa Publishing House, 1997 - Harvey C. Hoch, Harold G. Craighead and Lynn Jelinskii, Nanofabrication, and biosystem: Integrating materials science engineering science and biology, Cambridge Univ. Press 1996 - J.H. Fendler, Nanoparticles and nanostructured films; Preparation characterization and applications, John Wiley & Sons 1998 - Verhoeven, J. D., Pendray, A. H., & Dauksch, W. E. (1998). The key role of impurities in ancient Damascus steel blades. <i>JOM</i>, 50(9), 58–64. - Gargade, V.A. (2019). Nanotechnology in Ancient India. In History of Nanotechnology, M. Sharon (Ed.). https://doi.org/10.1002/9781119460534.ch3.

Content Mapping with NEP thrust areas	
Field	Hours Devoted
Employability	2
Skill Enhancement	2
Communication Development	2
Indian Knowledge System	2
Environmental Awareness	2
Current Issues and Social Awareness	2

Introduction				
Subject	Physics - PG			
Semester	Semester 4, 4A, 4B			
Course Composition	Theory (Theory + Tutorial)			
Nomenclature of the Course	Digital Electronics & Signal Processing			
Course Code	26L6.5-PHY-403			
Course Type	DEC-3			
Course Level	500-599			
Pre-requisites for the course (if any)	Basic knowledge of Electronic Circuits and Signals.			
Course Learning Outcomes (CLOs) After completing this course, the learner will be able to:	26L6.5-PHY-403.1: To understand number system conversions and digital arithmetic operations using binary codes and complements. 26L6.5-PHY-403.2: To analyze and simplify digital logic circuits using Boolean algebra and logic gates. 26L6.5-PHY-403.3: Design combinational and sequential circuits using flip-flops, counters, and MOSFET/CMOS technologies. 26L6.5-PHY-403.4: Explain and analyze analog and pulse modulation techniques used in communication systems.			
	Theory (Th)		Practical (P)	Total
	Lecture (L)	Tutorial (T)		
Credits	4	0	0	4
Teaching hours per week	4	0	0	4
Internal Assessment Marks (Th+P=Total)	30		0	30
End Term Exam Marks	70		0	70
Max. Marks	100		0	100
Examination Duration (in Hours)	3 Hours		NA	3 Hours

Contents of the Course			
Instructions for Examiner: Theory: The paper setter shall prepare 9 questions selecting two questions from each unit with consideration given to the Course Learning Outcomes. Among these, question number 1 will be compulsory, comprising 7 short answer type questions carrying two marks each (total 14 marks) and covering the entire syllabus. The remaining questions will be carrying 14 marks each. Examinees will be required to attempt five questions: the compulsory question no. 1 and 1 question from the each of the four units.			
Unit	Topics	CLO(s)	Contact Hours
Unit-1	Number Systems and Codes: Binary numbers, Octal numbers, Hexadecimal numbers, Inter-conversions of numbers. Binary addition, subtraction, multiplication, signed numbers, 1's complement, 2's complement, 2's complement subtraction, Hexadecimal addition, subtraction, BCD code, Gray code, conversion from binary to Gray code, and Gray code to binary code.	1	15
Unit-2	Logic Gates and Boolean Algebra: Basic Concepts of dc positive and negative logic systems, OR gate, AND gate, NOT gate, NAND gate, EXOR gate, NOR gate & their applications, TTL (transistor-transistor logic), Boolean identities associated with gates, Boolean algebra-DeMorgans Laws, Sum of products (SOP) and product of sums (POS) expressions, Minterm, Maxterm, deriving SOP and POS expressions from truth tables, Simplifying logic circuits: algebraic method, Karnaugh map, Parity method.	2	15

Unit-3	Combinational and Sequential Circuits & MOSFET Technology: Combinational Circuits: Half Adder, Full Adder, Decoder, Encoder, Multiplexer, Demultiplexer and their applications. Sequential Circuits: Flip flops; SR, JK, T and D, Shift Register, Counters: Synchronous and Asynchronous. Metal oxide semiconductor field effect transistors, enhancement mode transistor, depletion mode transistor, p-channel and n-channel devices, MOS invertors- static inverter, dynamic inverter, two phase inverter, MOS NAND gates, NOR gates, complementary MOSFET technology, CMOS inverter, CMOS NOR gates and NAND gates.	3	15
Unit-4	Analog and Pulse Modulation Techniques: Fundamentals of modulation, Frequency spectra in AM modulation, power in AM modulated class C amplifier, Efficiency modulation, linear demodulation of AM waves, frequency conversion, SSB system, Balanced modulation, filtering the signal for SSB, phase shift method, product detector, Pulse modulation: PAM, PTM, PWM, PPM, PCM (in brief)	4	15

Suggested Evaluation Methods					
Internal Assessment: 30	TH-30	PR-0	End Term Examination: 70	TH-70	PR-0
Class Participation	5	NA	Written Examination	70	NA
Seminar/presentation/assignment/quiz/class test etc.	10	NA	Lab record	NA	NA
Seminar/Demonstration/Viva-voce/Lab records etc.	NA	NA	Viva-Voce	NA	NA
Mid-Term Exam(s)	15	NA	Write-up and execution of the practical	NA	NA

Mapping of (CLOs) to Programme learning Outcomes & Programme Specific Outcomes															
CLO	PLO ₁	PLO ₂	PLO ₃	PLO ₄	PLO ₅	PLO ₆	PLO ₇	PLO ₈	PLO ₉	PLO ₁₀	PLO ₁₁	PSO ₁	PSO ₂	PSO ₃	PSO ₄
26L6.5-PHY-403.1	3	2	1	3		1	2	1	2			3	2	2	2
26L6.5-PHY-403.2	3	3	1	3		2	2	1	2			3	3	3	2
26L6.5-PHY-403.3	3	3	2	3	1	3	3	1	2		2	3	3	3	3
26L6.5-PHY-403.4	3	3	2	3		2	2	2	2		1	3	3	2	2

Learning Resources

- Mano, M. M., & Ciletti, M. D. (2017). Digital design (6th ed.). Pearson Education. Morris
- Mano, M. (2013). Digital logic and computer design. Pearson Education.
- Tocci, R. J., Widmer, N. S., & Moss, G. L. (2017). Digital systems: Principles and applications (12th ed.). Pearson Education.
- Floyd, T. L. (2015). Digital fundamentals (11th ed.). Pearson Education.
- Malvino, A. P., & Leach, D. P. (2016). Digital principles and applications. McGraw-Hill Education.
- Taub, H., & Schilling, D. L. (2014). Principles of communication systems (4th ed.). McGraw-Hill Education.
- Haykin, S. (2013). Communication systems (5th ed.). Wiley.
- Carlson, A. B. (2010). Communication systems (5th ed.). McGraw-Hill Education.
- NPTEL (National Programme on Technology Enhanced Learning) Digital Circuits (https://onlinecourses.nptel.ac.in/e-learning/preview/noc20_ee70)
- NPTEL (National Programme on Technology Enhanced Learning) Digital Electronic Circuits (https://onlinecourses.nptel.ac.in/e-learning/preview/noc23_ee50)
- NPTEL (National Programme on Technology Enhanced Learning) Switching Circuits and Logic Design (https://onlinecourses.nptel.ac.in/e-learning/preview/noc25_cs67)
- SWAYAM Analog communication (<https://11nq.com/ugvycag>)
- MIT Open Course Ware: Signals and Systems (<https://sl1nk.com/piwn9x4>)
- MIT Open Course Ware : Communication Systems Engineering (<https://11nq.com/bx06onh>)

Content Mapping with NEP thrust areas

Field	Hours Devoted
Employability	4
Entrepreneurship	4
Skill Enhancement	6

Introduction				
Subject	Physics - PG			
Semester	Semester 4			
Course Composition	Theory (Theory + Tutorial)			
Nomenclature of the Course	Computational Methods& Programming-II			
Course Code	26L6.5-PHY-404			
Course Type	DEC-3			
Course Level	500-599			
Pre-requisites for the course (if any)	Successful completion of Computational Methods and Programming-I or equivalent course.			
Course Learning Outcomes (CLOs) After completing this course, the learner will be able to:	26L6.5-PHY-404.1: Apply object-oriented programming, parallel computing, and HPC concepts to develop efficient computational solutions for physics problems.			
	26L6.5-PHY-404.2: Implement numerical methods for differential equations, spectral analysis, and quantum mechanical systems.			
	26L6.5-PHY-404.3: Apply Monte Carlo, stochastic, and Markov-process-based techniques to model and analyze complex physical phenomena.			
	26L6.5-PHY-404.4: Formulate and solve optimization and machine learning problems relevant to scientific data analysis and computational physics.			
	Theory (Th)		Practical (P)	Total
	Lecture (L)	Tutorial (T)		
Credits	4	0	0	4
Teaching hours per week	4	0	0	4
Internal Assessment Marks (Th+P=Total)	30		0	30
End Term Exam Marks	70		0	70
Max. Marks	100		0	100
Examination Duration (in Hours)	3 Hours		NA	3 Hours

Contents of the Course			
Instructions for Examiner:			
Theory:			
The paper setter shall prepare 9 questions selecting two questions from each unit with consideration given to the Course Learning Outcomes. Among these, question number 1 will be compulsory, comprising 7 short answer type questions carrying two marks each (total 14 marks) and covering the entire syllabus. The remaining questions will be carrying 14 marks each. Examinees will be required to attempt five questions: the compulsory question no. 1 and 1 question from the each of the four units.			
Unit	Topics	CLO(s)	Contact Hours
Unit-1	Object oriented concepts; classes, objects, incapsulation and inheritance, reuse and extension of classes, polymorphism. Object-Oriented Programming (OOP) applied to physical entities (e.g., modeling particles, fields, or lattices as classes). Efficient memory management and dynamic allocation. Parallel & Accelerated Computing: Introduction to parallel architectures. Basic concepts of Shared Memory (OpenMP) and Distributed Memory (MPI) paradigms. HPC Applications: Introduction to GPU computing. Applications of high-performance computing clusters. Introcution to Version control and reproducible scientific computing.	1	15

Unit-2	Numerical Solutions of Second Order Differential Equations: Initial and boundary value problems: shooting method, finite difference method. PDEs: Elementary ideas of solutions of partial differential eqns. Finite difference solution of heat equation, wave equation and laplace equation. Numerical solution of Schrodinger equation in 1D (infinite square well, harmonic oscillator), numerical tight binding models, introduction to sparse matrices. Fourier and Spectral Methods: DFT and FFT , Signal processing, Power spectra , Correlation functions.	2	15
Unit-3	Monte Carlo Methods: Random number generation , Pseudo-random and quasi-random sequences, Monte Carlo integration (estimation of one and multidimensional integration) , Importance sampling, Rejection sampling, Metropolis algorithm, Ising model, Random walk problems , Diffusion and Brownian motion. Markov processes, discrete-time Markov chains, transition probability matrices. Applications in population dynamics, epidemic spreading models, transport phenomena. Introduction to cellular automata (Wolfram's 1D rules and Conway's Game of Life).	3	15
Unit-4	Linear Programming & Classical Optimization: Mathematical formulation of optimization problems; structural constraints and objective functions. Linear Programming: Graphical solution method for two-variable problems and physical resource allocation applications; Simplex method and algorithmic steps. Concepts of constrained vs. unconstrained optimization; Lagrange multipliers. Machine Learning Foundations: Core concepts; training, validation, and testing phases. Linear Regression: Cost function formulation (Mean Squared Error), analytical solution via normal equations, optimization via Gradient Descent. Classification: Binary classification basics, Logistic regression, and cross-entropy loss. Managing models: Overfitting, underfitting, and the role of regularization. Unsupervised Learning: K-means clustering algorithm. Introduction to neural networks (qualitative).	4	15

Suggested Evaluation Methods					
Internal Assessment: 30	TH-30	PR-0	End Term Examination: 70	TH-70	PR-0
Class Participation	5	NA	Written Examination	70	NA
Seminar/presentation/assignment/quiz/class test etc.	10	NA	Lab record	NA	NA
Seminar/Demonstration/Viva-voce/Lab records etc.	NA	NA	Viva-Voce	NA	NA
Mid-Term Exam(s)	15	NA	Write-up and execution of the practical	NA	NA

Mapping of (CLOs) to Programme learning Outcomes & Programme Specific Outcomes															
CLO	PLO ₁	PLO ₂	PLO ₃	PLO ₄	PLO ₅	PLO ₆	PLO ₇	PLO ₈	PLO ₉	PLO ₁₀	PLO ₁₁	PSO ₁	PSO ₂	PSO ₃	PSO ₄
26L6.5-PHY-404.1	2	2	1	3	1	2	3	1	2		2	2	2	3	2
26L6.5-PHY-404.2	3	3	1	3	1	3	3	1	1		1	2	2	3	3
26L6.5-PHY-404.3	3	3	1	3	1	3	3	1	1		1	2	3	3	3
26L6.5-PHY-404.4	2	3	1	3	1	2	3	1	1		2	1	3	3	3

Learning Resources

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| <ul style="list-style-type: none"> ♦ Giordano, N. J., & Nakanishi, H. (2006). <i>Computational physics</i> (2nd ed.). Pearson Prentice Hall. ♦ Gould, H., Tobochnik, J., & Christian, W. (2007). <i>An introduction to computer simulation methods: Applications to physical systems</i> (3rd ed.). Addison-Wesley. ♦ Landau, D. P., & Binder, K. (2021). <i>A guide to Monte Carlo simulations in statistical physics</i> (5th ed.). Cambridge University Press. ♦ Landau, R. H., Páez, M. J., & Bordeianu, C. C. (2015). <i>Computational physics: Problem solving with Python</i> (3rd ed.). Wiley-VCH. ♦ Pacheco, P. S. (2011). <i>An introduction to parallel programming</i>. Morgan Kaufmann. ♦ Pang, T. (2006). <i>An introduction to computational physics</i> (2nd ed.). Cambridge University Press. ♦ Nocedal, J., & Wright, S. J. (2006). <i>Numerical optimization</i> (2nd ed.). Springer. ♦ Bishop, C. M. (2006). <i>Pattern recognition and machine learning</i>. Springer. ♦ Van Kampen, N. G. (2007). <i>Stochastic processes in physics and chemistry</i> (3rd ed.). Elsevier. |
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Content Mapping with NEP thrust areas

Field	Hours Devoted
Employability	30
Skill Enhancement	20

Important Notes:

Use of scientific calculator is permitted during examination.

Introduction				
Subject	Physics - PG			
Semester	Semester 4, 4A, 4B			
Course Composition	Theory (Theory + Tutorial)			
Nomenclature of the Course	Green Sustainable Technology-II			
Course Code	26L6.5-PHY-405			
Course Type	DEC-4			
Course Level	500-599			
Pre-requisites for the course (if any)	Basic knowledge of renewable energy, environmental science, and sustainability concepts.			
Course Learning Outcomes (CLOs) After completing this course, the learner will be able to:	26L6.5-PHY-405.1: Students would be able to realize RO principle, the natural cleaning of water, and the management of plastic waste 26L6.5-PHY-405.2: Students would be able to understand the different types of micro fuel cells and their applications 26L6.5-PHY-405.3: Students would be able to understand the hydrogen economy and generation techniques 26L6.5-PHY-405.4: Students would gain a basic knowledge about e-bricks, green building, harmful effects of paints			
	Theory (Th)		Practical (P)	Total
	Lecture (L)	Tutorial (T)		
Credits	4	0	0	4
Teaching hours per week	4	0	0	4
Internal Assessment Marks (Th+P=Total)	30		0	30
End Term Exam Marks	70		0	70
Max. Marks	100		0	100
Examination Duration (in Hours)	3 Hours		NA	3 Hours

Contents of the Course			
Instructions for Examiner: Theory: The paper setter shall prepare 9 questions selecting two questions from each unit with consideration given to the Course Learning Outcomes. Among these, question number 1 will be compulsory, comprising 7 short answer type questions carrying two marks each (total 14 marks) and covering the entire syllabus. The remaining questions will be carrying 14 marks each. Examinees will be required to attempt five questions: the compulsory question no. 1 and 1 question from the each of the four units.			
Unit	Topics	CLO(s)	Contact Hours
Unit-1	Water Purification: Technologies that provide clean drinking water and treat wastewater, such as reverse osmosis and UV filtration; Waste to wealth (toffee wrapper, disposable and other eco-friendly materials from agri-waste); Plastic and microplastics, plastic waste to energy technology; thermo-chemical conversion, biochemical conversion	1	15
Unit-2	Thermoelectric materials and devices (principle, construction and commercialized devices), Fuel cell materials, Bio-fuel cells (Enzymatic fuel cell), micro-fuel cell (MFC), bio-batteries, bio-capacitors, Magnetic refrigeration (principle, construction and challenges), waste to energy technology based on Bio-Fuel cells.	2	15
Unit-3	Hydrogen economy: Need, characteristics of hydrogen, components of H economy and applications & Challenges (Technical, environmental and economic), Proton exchange membrane (construction, working principle, application and challenges), Hydrogen production technologies (Principles, working mechanisms, advantages, limitations, and applications of electrochemical, photocatalytic, and photoelectrochemical hydrogen production),	3	15

Unit-4	Concept of green building, green building materials (e-bricks, agri-waste/cow dung bricks), green building certification and rating: green rating for integrated habitat assessment (GRIHA), leadership in energy and environmental design (LEED) rating, energy efficient buildings, sustainable cities, sustainable transport, sustainable pavements, case studies in sustainability engineering: Green building, sustainable city, sustainable transport system), harmful effects of paints, safe levels of Pb in paints (In Indian market).	4	15
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Suggested Evaluation Methods					
Internal Assessment: 30	TH-30	PR-0	End Term Examination: 70	TH-70	PR-0
Class Participation	5	NA	Written Examination	70	NA
Seminar/presentation/assignment/quiz/class test etc.	10	NA	Lab record	NA	NA
Seminar/Demonstration/Viva-voce/Lab records etc.	NA	NA	Viva-Voce	NA	NA
Mid-Term Exam(s)	15	NA	Write-up and execution of the practical	NA	NA

Mapping of (CLOs) to Programme learning Outcomes & Programme Specific Outcomes															
CLO	PLO ₁	PLO ₂	PLO ₃	PLO ₄	PLO ₅	PLO ₆	PLO ₇	PLO ₈	PLO ₉	PLO ₁₀	PLO ₁₁	PSO ₁	PSO ₂	PSO ₃	PSO ₄
26L6.5-PHY-405.1	3	3	2	2	2	3	3	1	1		2	3	2	2	1
26L6.5-PHY-405.2	3	3	3	2	2	2	3	1	1		2	3	3	2	1
26L6.5-PHY-405.3	3	3	3	2	2	2	3	1	1		2	3	3	3	1
26L6.5-PHY-405.4	2	3	2	2	2	3	3	2	1		2	2	2	3	2

Learning Resources

- Davis, M. L. (2010). *Water and wastewater engineering: Design principles and practice*. McGraw-Hill Education
- Baker, R. W., & Lokhandwala, K. (2020). *Membrane technology and applications* (4th ed.). John Wiley & Sons
- Singh, J., & Gupta, V. K. (Eds.). (2020). *Agricultural waste and residues: Generation, utilization and management*. Springer
- Brown, R. C. (2019). *Thermochemical processing of biomass: Conversion into fuels, chemicals and power* (2nd ed.). Wiley-Blackwell
- Kumar, S., & Sharma, V. (Eds.). (2024). *Microbial degradation of synthetic plastics*. Springer. Plastics to Energy
- Enzymatic Fuel Cells. Minter, S. D., & Atanasov, P. (Eds.). (2014). *Enzymatic Fuel Cells: From Fundamentals to Applications*. Wiley
- Microbial Fuel Cells. Logan, B. E. (2008). *Microbial Fuel Cells*. Wiley.
- Merino-Jimenez, Irene et al. (2017). "Bioelectrochemical capacitors for energy storage and generation." *Trends in Biotechnology*, 35(7), 598–611.
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- Hydrogen Economy — Rifkin, J. (2002). *The Hydrogen Economy: The Creation of the Worldwide Energy Web and the Redistribution of Power on Earth*. Tarcher/Putnam
- Fuel Cell Fundamentals. O'Hayre, R., Cha, S., Colella, W., & Prinz, F. B. (2016). *Fuel Cell Fundamentals* (3rd Edition). Wiley
- PEM Fuel Cells. Barbir, F. (2013). *PEM Fuel Cells: Theory and Practice* (2nd Edition). Academic Press.
- Sankir, M., & Sankir, N. D. (Eds.). (2017). *Hydrogen production technologies*. John Wiley & Sons.
- D. T. Allen and D. R. Shonnard. *Sustainability Engineering: Concepts, Design and Case Studies*, 1st Edition, Prentice Hall, 2011
- How safe is your paint? Compliance of Lead in Paint regulations in India 2020, report by Toxics links
- O'Connor, David, Deyi Hou, Jing Ye, Yunhui Zhang, Yong Sik Ok, Yinan Song, Frederic Coulon, Tianyue Peng, and Li Tian. "Lead-based paint remains a major public health concern: A critical review of global production, trade, use, exposure, health risk, and implications." *Environment international* 121 (2018): 85-101.
- Kumar, Abhay, and Perry Gottesfeld. "Lead content in household paints in India." *Science of the Total Environment* 407, no. 1 (2008): 333-337

Content Mapping with NEP thrust areas

Field	Hours Devoted
Employability	3
Entrepreneurship	3
Skill Enhancement	3
Communication Development	2
Indian Knowledge System	2
Environmental Awareness	4
Current Issues and Social Awareness	3

Introduction				
Subject	Physics - PG			
Semester	Semester 4			
Course Composition	Theory (Theory + Tutorial)			
Nomenclature of the Course	Modern Optics			
Course Code	26L6.5-PHY-406			
Course Type	DEC-4			
Course Level	500-599			
Pre-requisites for the course (if any)	Basic knowledge of Electromagnetic Theory, Quantum Mechanics, and Optics.			
Course Learning Outcomes (CLOs) After completing this course, the learner will be able to:	26L6.5-PHY-406.1: Analyze photonic materials, light-matter interactions, and integrated photonic devices for optical signal processing and sensing applications. 26L6.5-PHY-406.2: Explain and apply nonlinear optical phenomena and ultrafast photonic processes in modern photonic systems. 26L6.5-PHY-406.3: Evaluate the optical properties of photonic crystals and metamaterials using concepts of band structure and electromagnetic wave propagation. 26L6.5-PHY-406.4: Analyze quantum, topological, and non-Hermitian photonic systems and their applications in next-generation optical technologies.			
	Theory (Th)		Practical (P)	Total
	Lecture (L)	Tutorial (T)		
Credits	4	0	0	4
Teaching hours per week	4	0	0	4
Internal Assessment Marks (Th+P=Total)	30		0	30
End Term Exam Marks	70		0	70
Max. Marks	100		0	100
Examination Duration (in Hours)	3 Hours		NA	3 Hours

Contents of the Course			
Instructions for Examiner: Theory: The paper setter shall prepare 9 questions selecting two questions from each unit with consideration given to the Course Learning Outcomes. Among these, question number 1 will be compulsory, comprising 7 short answer type questions carrying two marks each (total 14 marks) and covering the entire syllabus. The remaining questions will be carrying 14 marks each. Examinees will be required to attempt five questions: the compulsory question no. 1 and 1 question from the each of the four units.			
Unit	Topics	CLO(s)	Contact Hours
Unit-1	Photonic Materials and Platforms: Dielectric, semiconductor and plasmonic materials, Optical confinement and light localization, Photonic integrated circuits, Silicon photonics, Ring resonators and microcavities. Light-Matter Interaction: Optical modes and resonances, Quality factor (Q-factor), Purcell effect, Strong and weak coupling regimes, Optical sensing principles. Integrated Photonic Devices: Modulators, Optical switches, Photonic sensors	1	15
Unit-2	Nonlinear Optical Response: Nonlinear polarization, Second- and third-order susceptibilities, Symmetry considerations, Nonlinear Optical Processes, Second harmonic generation, Sum- and difference-frequency generation, Optical parametric processes, Four-wave mixing. Ultrafast Photonics: Optical Kerr effect, Self-phase modulation Cross-phase modulation, Optical solitons,, Frequency Comb Generation	2	15

Unit-3	Photonic Crystals: Periodic dielectric structures, Bloch theorem, Photonic band structures, Photonic band gaps, Defect modes, Waveguiding and cavity modes in photonic crystals. Metamaterials: Effective medium theory, Negative refractive index, Split-ring resonators, Plasmonic metamaterials, Superlenses.	3	15
Unit-4	Quantum Photonics: Single-photon sources, Photon statistics. Entangled photon generation, Quantum communication, Quantum photonic circuits Topological and Non-Hermitian Photonics: Berry phase and topological protection, Topological edge states, Valley photonics, PT symmetry, Exceptional points	4	15

Suggested Evaluation Methods					
Internal Assessment: 30	TH-30	PR-0	End Term Examination: 70	TH-70	PR-0
Class Participation	5	NA	Written Examination	70	NA
Seminar/presentation/assignment/quiz/class test etc.	10	NA	Lab record	NA	NA
Seminar/Demonstration/Viva-voce/Lab records etc.	NA	NA	Viva-Voce	NA	NA
Mid-Term Exam(s)	15	NA	Write-up and execution of the practical	NA	NA

Mapping of (CLOs) to Programme learning Outcomes & Programme Specific Outcomes															
CLO	PLO ₁	PLO ₂	PLO ₃	PLO ₄	PLO ₅	PLO ₆	PLO ₇	PLO ₈	PLO ₉	PLO ₁₀	PLO ₁₁	PSO ₁	PSO ₂	PSO ₃	PSO ₄
26L6.5-PHY-406.1	3	3	1	3	1	2	2	1	1		1	3	2	2	2
26L6.5-PHY-406.2	3	3	1	3	1	3	2	1	1		1	3	2	2	2
26L6.5-PHY-406.3	3	3	1	3	1	3	2	1	2		1	3	3	2	3
26L6.5-PHY-406.4	3	3	1	3	1	3	2	1	2		1	3	3	2	3

Learning Resources

- | |
|---|
| <ul style="list-style-type: none"> ♦ Boyd, R. W. (2020). Nonlinear optics (4th ed.). Academic Press. ♦ Joannopoulos, J. D., Johnson, S. G., Winn, J. N., & Meade, R. D. (2011). Photonic crystals: Molding the flow of light (2nd ed.). Princeton University Press. ♦ Agrawal, G. P. (2019). Nonlinear fiber optics (6th ed.). Academic Press. ♦ Chrostowski, L., & Hochberg, M. (2015). Silicon photonics design: From devices to systems. Cambridge University Press. ♦ Novotny, L., & Hecht, B. (2012). Principles of nano-optics (2nd ed.). Cambridge University Press. ♦ Saleh, B. E. A., & Teich, M. C. (2019). Fundamentals of photonics (3rd ed.). Wiley. ♦ Scully, M. O., & Zubairy, M. S. (1997). Quantum optics. Cambridge University Press. ♦ Yariv, A., & Yeh, P. (2007). Photonics: Optical electronics in modern communications (6th ed.). Oxford University Press. ♦ Sakoda, K. (2005). Optical properties of photonic crystals (2nd ed.). Springer. ♦ Weiner, A. M. (2022). Ultrafast optics (2nd ed.). Wiley. |
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Content Mapping with NEP thrust areas	
Field	Hours Devoted
Employability	5
Skill Enhancement	5

Field	Hours Devoted
Employability	5
Skill Enhancement	5

Introduction				
Subject	Physics - PG			
Semester	Semester 4			
Course Composition	Practical			
Nomenclature of the Course	Practical Digital Electronics & Signal Processing			
Course Code	26L6.5-PHY-407			
Course Type	PC-7			
Course Level	500-599			
Pre-requisites for the course (if any)	Basic knowledge of digital electronics, logic circuits, and signal processing fundamentals.			
Course Learning Outcomes (CLOs) After completing this course, the learner will be able to:	26L6.5-PHY-407.1: Understand basic digital logic concepts including gates and flip-flops. 26L6.5-PHY-407.2: To get the idea of designing combinational circuits such as adders, subtractors, comparators and decoders. 26L6.5-PHY-407.3: To implement sequential and programmable digital circuits using counters, shift registers, and multiplexers. 26L6.5-PHY-407.4: Understand and demonstrate analog communication techniques including pulsed amplitude modulation and frequency modulation/demodulation.			
	Theory (Th)		Practical (P)	Total
	Lecture (L)	Tutorial (T)		
Credits	0	0	4	4
Teaching hours per week	0	0	8	8
Internal Assessment Marks (Th+P=Total)	0		30	30
End Term Exam Marks	0		70	70
Max. Marks	0		100	100
Examination Duration (in Hours)	NA		3 Hours	3 Hours

Contents of the Course			
Instructions for Examiner: Practical: Write-up and execution of the practical will be conducted as per the nature of the practical by the external examiner, with consideration given to the Course Learning Outcomes. The maximum marks for the write-up and execution of the practical will be 40 .			
Unit	Topics	CLO(s)	Contact Hours
Unit-1	1. To study the conversion of BCD inputs into decimal digits using a seven-segment display. 2. Study the basic logic Gates, NAND and NOR 3. Study the SR, JK, T and D flip flop. 4. Half & Full Adder Model-A084. 5. Half & Full Subtractor Model – A094.	1	30
Unit-2	6. To study the Digital Comparator, 3-to-8-line decoder, and tri-state digital O/P circuits. 7. Study of Module-N Counter using Programmable Counter IC 74190 with input Logics with LED display model D526. 8. Analysis and Synthesis of Multi-bit Sequential Circuits using Shift Registers.	2	30
Unit-3	9. To study frequency multiplication using a Phase Locked Loop (PLL) and verify the relationship between input and output frequencies using PLL Trainer Kit Model – A011. 10. Study of pulse Amplitude Modulations & Demodulation model-C019. 11. Implementation of Boolean function using Multiplexer.	3	30

Unit-4	12. Study of Frequency Modulation and Demodulation. 13. To generate a Pulse Amplitude Modulated (PAM) signal and recover the original message signal using a PAM demodulator. 14. To generate a Pulse Width Modulated (PWM) signal and recover the original message signal using a PWM demodulator 15. Generation and spectral analysis of SSB (USB/LSB) and determination of its bandwidth.	4	30
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Suggested Evaluation Methods					
Internal Assessment: 30	TH-0	PR-30	End Term Examination: 70	TH-0	PR-70
Class Participation	NA	5	Written Examination	NA	NA
Seminar/presentation/assignment/quiz/class test etc.	NA	NA	Lab record	NA	10
Seminar/Demonstration/Viva-voce/Lab records etc.	NA	10	Viva-Voce	NA	20
Mid-Term Exam(s)	NA	15	Write-up and execution of the practical	NA	40

Mapping of (CLOs) to Programme Learning Outcomes & Programme Specific Outcomes															
CLO	PLO ₁	PLO ₂	PLO ₃	PLO ₄	PLO ₅	PLO ₆	PLO ₇	PLO ₈	PLO ₉	PLO ₁₀	PLO ₁₁	PSO ₁	PSO ₂	PSO ₃	PSO ₄
26L6.5-PHY-407.1	3	2	1	2		1	2	1	2			3	2	2	2
26L6.5-PHY-407.2	3	3	1	3		2	2	1	2		1	3	3	3	2
26L6.5-PHY-407.3	3	3	2	3	1	3	3	1	2		2	3	3	3	3
26L6.5-PHY-407.4	3	3	2	3		2	2	2	2		1	3	3	2	3

Learning Resources

- Boylestad, R. L., & Nashelsky, L. (2013). Electronic devices and circuit theory (11th ed.). Pearson Education.
- Malvino, A. P., & Bates, D. J. (2016). Electronic principles (8th ed.). McGraw-Hill Education.
- Sedra, A. S., & Smith, K. C. (2014). Microelectronic circuits (7th ed.). Oxford University Press.
- Ramakant A. Gayakwad. (2000). Op-amps and linear integrated circuits (4th ed.). Prentice Hall of India.
- Morris Mano, M., & Ciletti, M. D. (2017). Digital design (5th ed.). Pearson.
- Tokheim, R. (2002). Digital electronics: principles and applications. McGraw-Hill Education.
- Gaonkar, R. S. (2013). Microprocessor architecture, programming, and applications with the 8085. Penram International Publishing.
- Wakerly, J. F. (2017). Digital design: Principles and practices (5th ed.). Pearson.
- Millman, J., & Grabel, A. (1987). Microelectronics (2nd ed.). McGraw-Hill Education.
- Horowitz, P., & Hill, W. (2015). The art of electronics (3rd ed.). Cambridge University Press.
- NPTEL (IIT Bombay & IIT Madras). (n.d.). *Basic electronics and digital circuits laboratory courses*. <https://nptel.ac.in>
- Texas Instruments. (n.d.). *Operational amplifiers application notes*. <https://www.ti.com>
- Intel Corporation. (n.d.). *8085/8086 microprocessor manuals and architecture guide*. <https://www.intel.com>
- MIT OpenCourseWare. (n.d.). *Semiconductor electronics and digital systems*. <https://ocw.mit.edu>

Content Mapping with NEP thrust areas

Field	Hours Devoted
Employability	8
Entrepreneurship	8
Skill Enhancement	12

Important Notes:

Students should perform at least 8–10 experiments, ensuring that the selected experiments are distributed across all units of the course.

Introduction				
Subject	Physics - PG			
Semester	Semester 4			
Course Composition	Practical			
Nomenclature of the Course	Practical Computational Methods & Programming-II			
Course Code	26L6.5-PHY-408			
Course Type	PC-7			
Course Level	500-599			
Pre-requisites for the course (if any)	Successful completion of Computational Methods and Programming-I theory and practical, or equivalent background.			
Course Learning Outcomes (CLOs) After completing this course, the learner will be able to:	26L6.5-PHY-408.1: Develop and implement object-oriented and parallel computing programs for modelling and simulation of physical systems. 26L6.5-PHY-408.2: Apply numerical methods to solve differential equations and quantum mechanical problems and analyze their stability and accuracy. 26L6.5-PHY-408.3: Implement Monte Carlo, stochastic, and statistical simulation techniques to investigate complex physical phenomena. 26L6.5-PHY-408.4: Develop computational solutions for optimization and machine learning problems and interpret the resulting physical or data-driven models.			
	Theory (Th)		Practical (P)	Total
	Lecture (L)	Tutorial (T)		
Credits	0	0	4	4
Teaching hours per week	0	0	8	8
Internal Assessment Marks (Th+P=Total)	0		30	30
End Term Exam Marks	0		70	70
Max. Marks	0		100	100
Examination Duration (in Hours)	NA		3 Hours	3 Hours

Contents of the Course			
Instructions for Examiner: Practical: Write-up and execution of the practical will be conducted as per the nature of the practical by the external examiner, with consideration given to the Course Learning Outcomes. The maximum marks for the write-up and execution of the practical will be 40 .			
Unit	Topics	CLO(s)	Contact Hours
Unit-1	1. Create a structured program using Object-Oriented Programming (OOP) paradigms. Define a Particle class with attributes (mass, position vector, velocity vector) and encapsulated methods to calculate kinetic energy and update position. Instantiate an array of objects to model a collection of particles inside a boundary container. 2. Write a program that calculates a computationally expensive operations loop (e.g., computing all pairwise gravitational forces for an N-body system). Implement parallelization. Measure and plot execution time and speedup factor as a function of the number of CPU thcores used.	1	20

Unit-2	3. Implement an explicit finite-difference time-domain (FDTD) scheme to solve the hyperbolic wave equation for a vibrating string with fixed boundary conditions. Plot the time evolution of the wave profile and numerically show how violating the CFL condition leads to severe numerical instability. 4. Set up and solve the parabolic 1D heat conduction equation in a metal rod. Use the Crank-Nicolson implicit method, transforming the system into a tridiagonal matrix equation at each time step. Solve the tridiagonal system efficiently using the Thomas algorithm and compare its stability against the explicit FTCS approach. 5. Implement the Shooting Method combined with an RK4 integrator to find the ground state and first excited state energy eigenvalues of a quantum particle trapped in a 1D harmonic oscillator potential. Numerically verify that the wavefunctions satisfy the required boundary conditions at infinity. 6. Perform FFT on time domain data. Calculate momentum space wavefunction of a quantum free particle.	2	30
Unit-3	7. Evaluate a multi-dimensional phase-space integral using Monte Carlo mean-value integration. Implement Importance Sampling by picking a non-uniform weight distribution function that matches the integrand, and show how it drastically reduces the statistical variance compared to simple uniform hit-or-miss sampling. 8. Simulate a 2D ferromagnetic square lattice using the Metropolis algorithm. Track the system over thousands of Monte Carlo steps per spin at various temperatures. Compute and plot total energy, magnetization, and magnetic susceptibility against temperature to visually pinpoint the ferromagnetic-to-paramagnetic phase transition. 9. Simulate an ensemble of independent random walkers on a 2D discrete grid. Compute the mean squared displacement as a function of time step. Numerically verify the Einstein diffusion relation and extract the effective diffusion coefficient. 10. Implement a discrete-time Markov chain simulation modeling a population under an epidemic threat using SIR (Susceptible-Infectious-Recovered) dynamics. Track how the fraction of population in each category shifts over time, and determine the critical transmission rate threshold required to cause a major outbreak. 11. Implement 2D Ising model and perform metropolis algorithm for various temperatures (Use parallel computing).	3	30
Unit-4	12. Formulate an objective resource or cost allocation problem containing multiple linear inequality bounds. Program the Simplex Method algorithm to traverse the convex polytope vertices to extract the mathematically optimized coordinates and maximum profit/minimum cost value. 13. Implement gradient descent algorithm for a multi-dimensional fitting. 14. Implement K-means algorithm.	4	40

Suggested Evaluation Methods					
Internal Assessment: 30	TH-0	PR-30	End Term Examination: 70	TH-0	PR-70
Class Participation	NA	5	Written Examination	NA	NA
Seminar/presentation/assignment/quiz/class test etc.	NA	NA	Lab record	NA	10
Seminar/Demonstration/Viva-voce/Lab records etc.	NA	10	Viva-Voce	NA	20
Mid-Term Exam(s)	NA	15	Write-up and execution of the practical	NA	40

Mapping of (CLOs) to Programme Learning Outcomes & Programme Specific Outcomes															
CLO	PLO ₁	PLO ₂	PLO ₃	PLO ₄	PLO ₅	PLO ₆	PLO ₇	PLO ₈	PLO ₉	PLO ₁₀	PLO ₁₁	PSO ₁	PSO ₂	PSO ₃	PSO ₄
26L6.5-PHY-408.1	2	2	3	3	3	3	3	1	2		2	2	1	3	2
26L6.5-PHY-408.2	3	3	3	3	3	3	3	1	2		2	2	2	3	3
26L6.5-PHY-408.3	3	3	3	3	3	3	3	1	2		2	2	3	3	3
26L6.5-PHY-408.4	2	3	3	3	3	3	3	1	2		2	1	3	3	3

Learning Resources
- Newman, M. E. J. (2013). <i>Computational Physics</i> (2nd ed.). CreateSpace Independent Publishing Platform. - Landau, R. H., Páez, M. J., & Bordeianu, C. C. (2015). <i>Computational Physics: Problem Solving with Python</i> (3rd ed.). Wiley-VCH. - Giordano, N. J., & Nakanishi, H. (2006). <i>Computational Physics</i> (2nd ed.). Pearson Education. - Gould, H., Tobochnik, J., & Christian, W. (2007). <i>An Introduction to Computer Simulation Methods: Applications to Physical Systems</i> (3rd ed.). Addison-Wesley. - Press, W. H., Teukolsky, S. A., Vetterling, W. T., & Flannery, B. P. (2007). <i>Numerical Recipes: The Art of Scientific Computing</i> (3rd ed.). Cambridge University Press. - Thijssen, J. M. (2007). <i>Computational Physics</i> (2nd ed.). Cambridge University Press. - McKinney, W. (2022). <i>Python for Data Analysis</i> (3rd ed.). O'Reilly Media. - Grama, A., Gupta, A., Karypis, G., & Kumar, V. (2003). <i>Introduction to Parallel Computing</i> (2nd ed.). Addison-Wesley. - Allen, M. P., & Tildesley, D. J. (2017). <i>Computer Simulation of Liquids</i> (2nd ed.). Oxford University Press. - Python documentation: www.python.org

Content Mapping with NEP thrust areas	
Field	Hours Devoted
Employability	90
Indian Knowledge System	10

Important Notes:
Students should perform 8-10 experiments , ensuring that the selected experiments are distributed across all units of the course.

Introduction				
Subject	Physics - PG			
Semester	Semester 4			
Course Composition	Practical			
Nomenclature of the Course	Practical Green Sustainable Technology-II			
Course Code	26L6.5-PHY-409			
Course Type	PC-8			
Course Level	500-599			
Pre-requisites for the course (if any)	Basic knowledge of renewable energy technologies, sustainability principles, and laboratory practices.			
Course Learning Outcomes (CLOs) After completing this course, the learner will be able to:	26L6.5-PHY-409.1: Students would be able to design a natural water purifier, disposables using agri-waste and leaves			
	26L6.5-PHY-409.2: Students would be able to design bio fuel cell, capacitor, battery etc.			
	26L6.5-PHY-409.3: Students would be able to know about hydrogen splitting.			
	26L6.5-PHY-409.4: Students would be able to design e-bricks using agri/bio based waste.			
	Theory (Th)		Practical (P)	Total
	Lecture (L)	Tutorial (T)		
Credits	0	0	4	4
Teaching hours per week	0	0	8	8
Internal Assessment Marks (Th+P=Total)	0		30	30
End Term Exam Marks	0		70	70
Max. Marks	0		100	100
Examination Duration (in Hours)	NA		3 Hours	3 Hours

Contents of the Course			
Instructions for Examiner:			
Practical:			
Write-up and execution of the practical will be conducted as per the nature of the practical by the external examiner, with consideration given to the Course Learning Outcomes. The maximum marks for the write-up and execution of the practical will be 40 .			
Unit	Topics	CLO(s)	Contact Hours
Unit-1	1. To understand the principle of TDS meter and study the TDS of the drinking water taken from different locations. 2. To design, fabricate and study the natural water purifier system using natural components. 3. To make and study the water holding capacity of disposables using agri-waste and leaves.	1	40
Unit-2	4. To fabricate and study a soil/compost-based micro-fuel cell. 5. To fabricate and study a soil/compost-based Enzymatic fuel cell. 6. To fabricate and study a soil/compost-based bio-capacitor. 7. To fabricate and study a hybrid bio-battery	2	50
Unit-3	8. To study water electrolysis and produce hydrogen gas. 9. To determine the rate of hydrogen production during electrolysis of water and study its dependence on applied current.	3	15

	10. To investigate how electrolyte concentration affects the hydrogen production rate and electrical efficiency of an electrolytic cell. 11. To determine the V-I and power characteristics of a hydrogen fuel cell.		
Unit-4	12. To develop and study the different parameters (compressive strength, water absorption, hardness, etc.) of the e-bricks from bio/agri-waste.	4	15

Suggested Evaluation Methods					
Internal Assessment: 30	TH-0	PR-30	End Term Examination: 70	TH-0	PR-70
Class Participation	NA	5	Written Examination	NA	NA
Seminar/presentation/assignment/quiz/class test etc.	NA	NA	Lab record	NA	10
Seminar/Demonstration/Viva-voce/Lab records etc.	NA	10	Viva-Voce	NA	20
Mid-Term Exam(s)	NA	15	Write-up and execution of the practical	NA	40

Mapping of (CLOs) to Programme learning Outcomes & Programme Specific Outcomes															
CLO	PLO ₁	PLO ₂	PLO ₃	PLO ₄	PLO ₅	PLO ₆	PLO ₇	PLO ₈	PLO ₉	PLO ₁₀	PLO ₁₁	PSO ₁	PSO ₂	PSO ₃	PSO ₄
26L6.5-PHY-409.1	3	3	2	3	2	3	1	1	1	1	1	3	3	3	3
26L6.5-PHY-409.2	3	3	3	3	3	3	1	1	1	1	1	3	3	3	3
26L6.5-PHY-409.3	3	3	3	3	3	3	1	1	1	1	1	3	3	3	3
26L6.5-PHY-409.4	3	3	3	3	2	3	1	1	1	1	1	3	3	3	3

Learning Resources

- Bureau of Indian Standards. *IS 10500: Drinking Water — Specification*. New Delhi: BIS.
- Water Quality Assessments. Chapman, D. (Ed.). *Water Quality Assessments: A Guide to the Use of Biota, Sediments and Water in Environmental Monitoring*. UNESCO/WHO/UNEP
- Biosand Filter Research. Elliott, M. A., Stauber, C. E., Koksai, F., DiGiano, F. A., & Sobsey, M. D. (2008). "Reductions of E. coli, echovirus type 12 and bacteriophages in an intermittently operated household-scale slow sand filter."
- United Nations Children's Fund (UNICEF) publications on household water treatment and safe storage
- Water Supply Engineering. Garg, S. K. *Environmental Engineering, Volume I: Water Supply Engineering*. Khanna Publishers.
- UNICEF resources on low-cost water purification systems
- Food and Agriculture Organization publications on agricultural waste utilization
- Rabaey, Korneel, & Verstraete, W. (2005). Microbial fuel cells: Novel biotechnology for energy generation. *Trends in Biotechnology*, 23(6), 291–298
- Minteer, Shelley D.. (2010). *Enzymatic Biofuel Cells: From Fundamentals to Applications*. Wiley-VCH
- Rahimnejad, Mostafa, Adhami, A., Darvari, S., Zirepour, A., & Oh, S.-E. (2015). Microbial fuel cell as new technology for bioelectricity generation: A review. *Alexandria Engineering Journal*, 54(3), 745–756
- Hydrogen and Fuel Cells. Stolten, D., & Emonts, B. (Eds.). (2016). *Hydrogen Science and Engineering: Materials, Processes, Systems and Technology*. Wiley-VCH.
- Binici, Hanifi. (2007). Engineering properties of bricks produced with agricultural and industrial wastes. *Construction and Building Materials*, 21(8), 1777–1784
- Sustainable Construction Materials. Ramakrishna, G., & Sundararajan, T. (Eds.). *Sustainable Building Materials and Technologies*
- Bureau of Indian Standards. *IS 1077: Common Burnt Clay Building Bricks—Specification*. New Delhi: BIS.

Content Mapping with NEP thrust areas

Field	Hours Devoted
Employability	4
Entrepreneurship	5
Skill Enhancement	10
Communication Development	2
Indian Knowledge System	2
Environmental Awareness	4
Current Issues and Social Awareness	1

Important Notes:

Students should perform atleast 8-10 experiments, ensuring that the selected experiments are distributed across all units of the course.

Introduction				
Subject	Physics - PG			
Semester	Semester 4			
Course Composition	Practical			
Nomenclature of the Course	Practical Modern Optics			
Course Code	26L6.5-PHY-410			
Course Type	PC-8			
Course Level	500-599			
Pre-requisites for the course (if any)	Knowledge of basic optics and programming.			
Course Learning Outcomes (CLOs) After completing this course, the learner will be able to:	26L6.5-PHY-410.1: Characterize optical resonators, optical fibres and photonic sensing systems through experimental and computational techniques, and evaluate parameters such as attenuation, resonance characteristics and quality factor. 26L6.5-PHY-410.2: Analyze nonlinear optical phenomena through numerical simulations of second harmonic generation, optical solitons and related ultrafast photonic processes. 26L6.5-PHY-410.3: Investigate photonic crystal and metamaterial systems by computing band structures, defect modes, reflectance characteristics and effective optical parameters. 26L6.5-PHY-410.4: Model and interpret quantum and topological photonic phenomena including photon statistics and topological edge states using modern computational tools.			
	Theory (Th)		Practical (P)	Total
	Lecture (L)	Tutorial (T)		
Credits	0	0	4	4
Teaching hours per week	0	0	8	8
Internal Assessment Marks (Th+P=Total)	0		30	30
End Term Exam Marks	0		70	70
Max. Marks	0		100	100
Examination Duration (in Hours)	NA		3 Hours	3 Hours

Contents of the Course			
Instructions for Examiner: Practical: Write-up and execution of the practical will be conducted as per the nature of the practical by the external examiner, with consideration given to the Course Learning Outcomes. The maximum marks for the write-up and execution of the practical will be 40 .			
Unit	Topics	CLO(s)	Contact Hours
Unit-1	1. Determination of Q-factor of an optical resonator using Fabry-Perot talon. 2. Study of optical ring resonator characteristics using simulation. 3. Determination of optical attenuation of optical fibres.	1	30
Unit-2	4. Characterisation of optical sensors using intensity modulation. 5. Numerical simulation of second harmonic generation 6. Numerical simulation of optical soliton propagation in fibres.	2	30
Unit-3	7. Computation of photonic band structure of 1D photonic crystal using transfer matrix method. 8. Design and study of distributed Bragg reflector. 9. Simulation of defect modes in 1D photonic crystal.	3	30

Unit-4	10. Numerical study of effective refractive index of metamaterials. 11. Simulation of topological edge states in SSH model 12. Simulation of photon statistics.	4	30
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Suggested Evaluation Methods					
Internal Assessment: 30	TH-0	PR-30	End Term Examination: 70	TH-0	PR-70
Class Participation	NA	5	Written Examination	NA	NA
Seminar/presentation/assignment/quiz/class test etc.	NA	NA	Lab record	NA	10
Seminar/Demonstration/Viva-voce/Lab records etc.	NA	10	Viva-Voce	NA	20
Mid-Term Exam(s)	NA	15	Write-up and execution of the practical	NA	40

Mapping of (CLOs) to Programme learning Outcomes & Programme Specific Outcomes															
CLO	PLO ₁	PLO ₂	PLO ₃	PLO ₄	PLO ₅	PLO ₆	PLO ₇	PLO ₈	PLO ₉	PLO ₁₀	PLO ₁₁	PSO ₁	PSO ₂	PSO ₃	PSO ₄
26L6.5-PHY-410.1	3	3	3	3	3	3	3	1	2		2	3	2	3	2
26L6.5-PHY-410.2	3	3	3	3	3	3	3	1	2		2	3	2	3	2
26L6.5-PHY-410.3	3	3	3	3	3	3	3	1	2		2	3	3	3	3
26L6.5-PHY-410.4	3	3	3	3	3	3	3	1	2		2	3	3	3	3

Learning Resources
- Saleh, B. E. A., & Teich, M. C. (2019). <i>Fundamentals of Photonics</i> (3rd ed.). Wiley. - Yariv, A., & Yeh, P. (2007). <i>Photonics: Optical Electronics in Modern Communications</i> (6th ed.). Oxford University Press. - Boyd, R. W. (2020). <i>Nonlinear Optics</i> (4th ed.). Academic Press. - Joannopoulos, J. D., Johnson, S. G., Winn, J. N., & Meade, R. D. (2011). <i>Photonic Crystals: Molding the Flow of Light</i> (2nd ed.). Princeton University Press. - Thyagarajan, K., & Ghatak, A. (2010). <i>Lasers: Fundamentals and Applications</i> (2nd ed.). Springer India. - Ghatak, A., & Thyagarajan, K. (1998). <i>Introduction to Fiber Optics</i>. Cambridge University Press.

Content Mapping with NEP thrust areas	
Field	Hours Devoted
Employability	30
Skill Enhancement	30

Important Notes:
Students should perform 8-10 experiments, ensuring that the selected experiments are distributed across all units of the course.

Introduction				
Subject	Physics - PG			
Semester	Semester 4			
Course Composition	Theory (Theory + Tutorial)			
Nomenclature of the Course	Employability Entrepreneurship Skills Course			
Course Code	26L6.5-PHY-411			
Course Type	EEC			
Course Level	500-599			
Pre-requisites for the course (if any)	Basic communication and problem-solving skills.			
Course Learning Outcomes (CLOs) After completing this course, the learner will be able to:	26L6.5-PHY-411.1: To understand the importance of the Indian knowledge system, and the threats to the environment and solutions to protect our environment 26L6.5-PHY-411.2: To get familiar with computer programming, data science and entrepreneurship			
	Theory (Th)		Practical (P)	Total
	Lecture (L)	Tutorial (T)		
Credits	2	0	0	2
Teaching hours per week	2	0	0	2
Internal Assessment Marks (Th+P=Total)	15		0	15
End Term Exam Marks	35		0	35
Max. Marks	50		0	50
Examination Duration (in Hours)	2 Hours		NA	2 Hours

Contents of the Course			
Instructions for Examiner: Theory: The paper setter shall prepare 5 questions selecting two questions from each unit with consideration given to the Course Learning Outcomes. Among these, question number 1 will be compulsory . Examinees will be required to attempt three questions : the compulsory question no. 1 and 1 question from each of the two units.			
Unit	Topics	CLO(s)	Contact Hours
Unit-1	Indian perspectives on wealth creation: Agriculture, trade, and enterprise; Entrepreneurship and economic thought in ancient India; Leadership and management principles from Indian traditions; Business ethics and professional values; Innovation through traditional knowledge systems; Sustainable livelihoods and green entrepreneurship in renewable energy, Business model for plastic waste management, market analysis for renewable energy resources, Entrepreneurial response to the environmental degradation and energy crisis.	1	15
Unit-2	Basics of computer programming. Introduction to machine learning and data science. Supervised: linear and polynomial regression, Decision trees, Unsupervised learning: k-means, clustering. Introduction to the concept of neural networks and Artificial Intelligence (AI). Introduction to use of AI tools, Basic idea of Entrepreneurship, and start-up, turning an idea/skill into a start-up, writing project proposals to funding agencies (governmental, non-governmental), tech-hub, incubation center, the necessity of the interface of industry and institution.	2	15

Suggested Evaluation Methods					
Internal Assessment: 15	TH-15	PR-0	End Term Examination: 35	TH-35	PR-0
Class Participation	5	NA	Written Examination	35	NA
Seminar/presentation/assignment/quiz/class test etc.	5	NA	Lab record	NA	NA
Seminar/Demonstration/Viva-voce/Lab records etc.	NA	NA	Viva-Voce	NA	NA
Mid-Term Exam(s)	5	NA	Write-up and execution of the practical	NA	NA

Mapping of (CLOs) to Programme learning Outcomes & Programme Specific Outcomes															
CLO	PLO ₁	PLO ₂	PLO ₃	PLO ₄	PLO ₅	PLO ₆	PLO ₇	PLO ₈	PLO ₉	PLO ₁₀	PLO ₁₁	PSO ₁	PSO ₂	PSO ₃	PSO ₄
26L6.5-PHY-411.1	3	2	1	2	1	1	1	3	2	3	1	2	3	2	3
26L6.5-PHY-411.2	3	2	3	3	3	3	3	2	3	2	3	3	3	3	3

Learning Resources
- Bhaduri, A. (2005). <i>Development with dignity: A case for full employment</i>. National Book Trust. - Agarwal, A., & Narain, S. (1997). <i>Dying wisdom: Rise, fall and potential of India's traditional water harvesting systems</i>. Centre for Science and Environment. - Fawcett, T., & Provost, F. (2013). <i>Data science for business: What you need to know about data mining and data-analytic thinking</i>. O'Reilly Media. - Géron, A. (2022). <i>Hands-on machine learning with Scikit-Learn, Keras, and TensorFlow: Concepts, tools, and techniques to build intelligent systems</i> (3rd ed.). O'Reilly Media. - Thiel, P., & Masters, B. (2014). <i>Zero to one: Notes on startups, or how to build the future</i>. Crown Business. - Ries, E. (2011). <i>The lean startup: How today's entrepreneurs use continuous innovation to create radically successful businesses</i>. Crown Business.

Content Mapping with NEP thrust areas	
Field	Hours Devoted
Employability	3
Entrepreneurship	3
Skill Enhancement	4
Communication Development	3
Indian Knowledge System	4
Environmental Awareness	4
Current Issues and Social Awareness	3

Introduction				
Subject	Physics - PG			
Semester	Semester 4A			
Course Composition	Theory (Theory + Tutorial)			
Nomenclature of the Course	Vacuum Science & Thin Film Technology			
Course Code	26L6.5-PHY-412			
Course Type	DEC-5			
Course Level	500-599			
Pre-requisites for the course (if any)	Basic knowledge of Modern Physics and Materials Science.			
Course Learning Outcomes (CLOs) After completing this course, the learner will be able to:	26L6.5-PHY-412.1: Understand the fundamental concepts of gas kinetics, molecular motion, and vacuum physics, including Maxwell–Boltzmann distribution, mean free path, transport properties, and Knudsen equation. 26L6.5-PHY-412.2: Analyze the principles of evaporation and deposition processes, including thermodynamics of evaporation, evaporation rate, and behavior of alloys and compounds in thin film formation. 26L6.5-PHY-412.3: Understand the physical concepts of lithography and the solid-state electronics devices design patterns. 26L6.5-PHY-412.4: Apply the knowledge of thin film deposition and monitoring techniques to understand real-time film growth control and evaluate material behavior during deposition processes.			
	Theory (Th)		Practical (P)	Total
	Lecture (L)	Tutorial (T)		
Credits	4	0	0	4
Teaching hours per week	4	0	0	4
Internal Assessment Marks (Th+P=Total)	30		0	30
End Term Exam Marks	70		0	70
Max. Marks	100		0	100
Examination Duration (in Hours)	3 Hours		NA	3 Hours

Contents of the Course			
Instructions for Examiner: Theory: The paper setter shall prepare 9 questions selecting two questions from each unit with consideration given to the Course Learning Outcomes. Among these, question number 1 will be compulsory, comprising 7 short answer type questions carrying two marks each (total 14 marks) and covering the entire syllabus. The remaining questions will be carrying 14 marks each. Examinees will be required to attempt five questions: the compulsory question no. 1 and 1 question from the each of the four units.			
Unit	Topics	CLO(s)	Contact Hours
Unit-1	The physics of gases and vacuum systems: Gas kinetics, mean free path, Maxwell–Boltzmann distribution, transport properties, molecular impingement flux, Knudsen equation, thermodynamics of evaporation, evaporation rate, evaporation: alloys, compounds, sources, deposition monitoring techniques, adsorption, surface diffusion, nucleation, structure development, interfaces, stress, adhesion.	1	15
Unit-2	Vacuum Science and deposition techniques: Basics of vacuum science, creation of vacuum using different pumps, vacuum gauges, vacuum leak detection, helium leak detector, residual gas analyzer. Thermal evaporation and electron beam evaporation system, idea of DC and R.F. sputtering system, Methods of producing thin films using Physical vapour deposition, Chemicals Vapour Deposition and spray pyrolysis methods, Molecular Beam Epitaxy and laser Ablation methods for thin film deposition.	2	15

Unit-3	Lithography and micro-nano fabrication: Importance of lithography, Basic steps of lithography, Substrate preparation methods, Positive photoresist, Negative photoresist, photoresist Processing, photoresist coating methods, Resist Exposure (single, bi-layer and multi- level photoresist exposure) and Resist Development, soft backing and hard baking, Etching, Types of lithography, Photolithography, Idea of electron beam lithography, Idea of an X-ray lithography, Interference Lithography, Step Growth, Nano imprint, Self-Assembly, Nano templates.	3	16
Unit-4	Thin Film Analysis and Applications: Film structure, thickness, topography, inhomogeneity, crystallography, bonding, point defects, composition, optical properties, electrical properties, mechanical properties, optical windows, integrated circuits, micro-electro-opto-mechanical systems, photovoltaics.	4	14

Suggested Evaluation Methods					
Internal Assessment: 30	TH-30	PR-0	End Term Examination: 70	TH-70	PR-0
Class Participation	5	NA	Written Examination	70	NA
Seminar/presentation/assignment/quiz/class test etc.	10	NA	Lab record	NA	NA
Seminar/Demonstration/Viva-voce/Lab records etc.	NA	NA	Viva-Voce	NA	NA
Mid-Term Exam(s)	15	NA	Write-up and execution of the practical	NA	NA

Mapping of (CLOs) to Programme learning Outcomes & Programme Specific Outcomes															
CLO	PLO ₁	PLO ₂	PLO ₃	PLO ₄	PLO ₅	PLO ₆	PLO ₇	PLO ₈	PLO ₉	PLO ₁₀	PLO ₁₁	PSO ₁	PSO ₂	PSO ₃	PSO ₄
26L6.5-PHY-412.1	3	2	1	2		2	1	1	2			3	2	2	2
26L6.5-PHY-412.2	3	2	1	3		3	2	1	2			3	3	3	2
26L6.5-PHY-412.3	3	2	2	3		2	3	1	2		1	3	3	3	3
26L6.5-PHY-412.4	3	3	2	3	1	3	3	2	2		2	3	3	3	3

Learning Resources

- Chopra, K.L., Thin Film Phenomena, Robert E. Krieger publishing, 1969.
- Smith, D.L., Thin-Film Deposition: Principles and Practice, McGraw-Hill, 1995.
- Hummel, R. E. and Guenther, K.H., Handbook of Optical Properties: Thin Films for Optical Coatings, Volume 1, CRC Press, 1995.
- Ohring, M., The Materials Science of Thin Films, 2nd Edition, Academic press, 2002.
- Soriaga, M.P., Stickney, J., Bottomley, L.A., and Kim Y.G, Thin Films: Preparation, Characterization,
- Mahan, J. E. (2000). *Physical vapor deposition of thin films*. Wiley-VCH.
- Venables, J. A. (2010). Introduction to surface and thin film processes. Cambridge University Press.
- Frey, H., & Khan, H. R. (Eds.). (2015). Handbook of thin film technology. Springer.
- Goswami, A. (1996). Thin film fundamentals. New Age International.
- Sze, S. M., & Ng, K. K. (2006). Physics of semiconductor devices (3rd ed.). Wiley-Interscience. (Useful for photodetectors, solar cells, and device applications)
- Streetman, B. G., & Banerjee, S. (2015). Solid state electronic devices (7th ed.). Pearson. (Useful for photodiodes, LEDs, semiconductor devices)
- Ray, S. K. (n.d.). Thin film technology, SWAYAM–NPTEL, Indian Institute of Technology Kharagpur. https://onlinecourses.nptel.ac.in/noc24_ge56/preview
- Selvaraja, S., & Avasthi, S. (n.d.). Fundamentals of micro and nanofabrication. SWAYAM–NPTEL, Indian Institute of Science Bangalore. https://onlinecourses.nptel.ac.in/noc21_bt38/preview
- Indian Institute of Science (IISc) Bangalore. (n.d.). Micro and nanofabrication technology courses [MOOC catalog]. SWAYAM. <https://swayam.gov.in>

Content Mapping with NEP thrust areas

Field	Hours Devoted
Employability	3
Entrepreneurship	3
Skill Enhancement	8

Introduction				
Subject	Physics - PG			
Semester	Semester 4A			
Course Composition	Theory (Theory + Tutorial)			
Nomenclature of the Course	Characterization Techniques for Materials			
Course Code	26L6.5-PHY-413			
Course Type	DEC-5			
Course Level	500-599			
Pre-requisites for the course (if any)	Basic knowledge of Materials Science and Solid State Physics.			
Course Learning Outcomes (CLOs) After completing this course, the learner will be able to:	26L6.5-PHY-413.1: Understand the fundamental concepts of X-ray diffraction techniques and TGA for analyzing material structure and thermal properties. 26L6.5-PHY-413.2: Apply electron microscopy techniques such as SEM, TEM, and HRTEM to examine surface morphology, microstructure, and crystallographic features of materials. 26L6.5-PHY-413.3: Analyze surface and nanoscale properties of materials using scanning probe techniques like AFM and STM for topography and mechanical characterization. 26L6.5-PHY-413.4: Evaluate material composition, bonding, and properties using spectroscopic techniques such as EDX, XPS, UV-Vis, FTIR, and Raman spectroscopy, and correlate them with structure-property relationships.			
	Theory (Th)		Practical (P)	Total
	Lecture (L)	Tutorial (T)		
Credits	4	0	0	4
Teaching hours per week	4	0	0	4
Internal Assessment Marks (Th+P=Total)	30		0	30
End Term Exam Marks	70		0	70
Max. Marks	100		0	100
Examination Duration (in Hours)	3 Hours		NA	3 Hours

Contents of the Course			
Instructions for Examiner: Theory: The paper setter shall prepare 9 questions selecting two questions from each unit with consideration given to the Course Learning Outcomes. Among these, question number 1 will be compulsory, comprising 7 short answer type questions carrying two marks each (total 14 marks) and covering the entire syllabus. The remaining questions will be carrying 14 marks each. Examinees will be required to attempt five questions: the compulsory question no. 1 and 1 question from the each of the four units.			
Unit	Topics	CLO(s)	Contact Hours
Unit-1	Crystal Structure and Thermal analysis Techniques: X-ray diffraction (XRD) fundamentals, Bragg's law, diffraction conditions, powder XRD technique, single crystal XRD basics, structure determination using XRD, crystallite size and strain analysis using Scherrer equation, stress and texture analysis in crystalline materials. Differential thermal analysis (DTA), Differential Scanning Calorimetry (DSC), Thermo-gravimetric analysis (TGA).	1	15
Unit-2	Electron Microscopy Techniques: Introduction to electron microscopy, interaction of electrons with matter, scanning electron microscopy (SEM) principle, image formation and surface morphology analysis, resolution and depth of field, transmission electron microscopy (TEM) principle, electron diffraction in TEM, selected area electron diffraction (SAED), high-resolution TEM (HRTEM) for lattice imaging, sample preparation techniques for SEM and TEM, applications of electron microscopy in material characterization.	2	15

Unit-3	Scanning Probe and Surface Analysis Techniques: Introduction to scanning probe microscopy, atomic force microscopy (AFM) principle, modes of operation (contact, non-contact, tapping), surface topography and roughness measurement, scanning tunneling microscopy (STM) basics, surface atomic imaging, resolution limits, nano-scale surface characterization, mechanical properties measurement at nanoscale, applications of SPM techniques in thin films and nanomaterials.	3	15
Unit-4	Spectroscopic and Compositional Analysis Techniques: Principles of spectroscopic techniques, energy dispersive X-ray spectroscopy (EDX/EDS) for elemental analysis, X-ray photoelectron spectroscopy (XPS) for surface chemical composition and bonding states, UV-Visible spectroscopy for optical properties, Fourier transform infrared spectroscopy (FTIR) basics, Raman spectroscopy fundamentals, quantitative and qualitative analysis of materials, correlation of structure with optical, electrical, and chemical properties of materials.	4	15

Suggested Evaluation Methods					
Internal Assessment: 30	TH-30	PR-0	End Term Examination: 70	TH-70	PR-0
Class Participation	5	NA	Written Examination	70	NA
Seminar/presentation/assignment/quiz/class test etc.	10	NA	Lab record	NA	NA
Seminar/Demonstration/Viva-voce/Lab records etc.	NA	NA	Viva-Voce	NA	NA
Mid-Term Exam(s)	15	NA	Write-up and execution of the practical	NA	NA

Mapping of (CLOs) to Programme learning Outcomes & Programme Specific Outcomes															
CLO	PLO ₁	PLO ₂	PLO ₃	PLO ₄	PLO ₅	PLO ₆	PLO ₇	PLO ₈	PLO ₉	PLO ₁₀	PLO ₁₁	PSO ₁	PSO ₂	PSO ₃	PSO ₄
26L6.5-PHY-413.1	3	2		2		2	3		1			3	2	2	2
26L6.5-PHY-413.2	2	3		2	1	3	3		1			2	3	3	3
26L6.5-PHY-413.3	2	3		2		3	3		2			2	3	3	2
26L6.5-PHY-413.4	3	3		3		3	3	1	2		1	3	3	3	3

Learning Resources
♦ Wendlandt, W.W., Thermal Analysis, John Wiley & Sons, 1986. ♦ Wachtman, J.B., Kalman, Z.H., Characterization of Materials, Butterworth Heinemann, 1993. ♦ Murphy, Douglas B, Fundamentals of Light Microscopy and Electronic Imaging, Wiley-Liss, Inc. USA, 2000 ♦ Cullity, B.D., and Stock, R.S., "Elements of X-Ray Diffraction", Prentice-Hall, 2001. ♦ B. Raj, T. Jayakumar, M. Thavasimuthu, Practical Non-Destructive Testing, 2nd ed., Narosa Publishing House, 2002 ♦ D. A. Skoog, F.J. Holler, S. R. Crouch, Instrumental Analysis, Cengage Learning, 2007. ♦ Li Lin, Ashok Kumar, Materials Characterization Techniques Sam Zhang; CRC Press, 2008. ♦ Y. Leng, Materials Characterisation: Introduction to Microscopic and Spectroscopic Methods, John Wiley & Sons (Asia), 2008. ♦ J. C. Vickerman, I. Gilmore, Surface Analysis: The Principal Techniques, 2 nd ed., John Wiley & Sons, Inc.2009.

Content Mapping with NEP thrust areas	
Field	Hours Devoted
Employability	3
Entrepreneurship	3
Skill Enhancement	6
Environmental Awareness	3
Current Issues and Social Awareness	2

Introduction				
Department Name	Physics - PG			
Semester	3rd			
Course Composition	Theory (Theory + Tutorial)			
Nomenclature of the Course	Sources of Energy			
Course Code	26L6.5-OEC-PHY-301			
Course Type	OEC			
Course Level	500-599			
Pre-requisites for the course (if any)	Basic knowledge of Energy Resources, Environmental Science, and Physics.			
Course Learning Outcomes (CLOs) After completing this course, the learner will be able to:	26L6.5-PHY-311.1: Understand the fundamental concepts of renewable energy systems, including limitations of conventional energy sources, solar radiation principles, photovoltaic systems, and solar thermal energy technologies. 26L6.5-PHY-311.2: Analyze the working principles, performance, and applications of geothermal energy, wind energy systems, and fuel cells, including their thermodynamic and conversion processes.			
	Theory (Th)		Practical (P)	Total
	Lecture (L)	Tutorial (T)		
Credits	2	0	0	2
Teaching hours per week	2	0	0	2
Internal Assessment Marks (Th+P=Total)	15		0	15
End Term Exam Marks	35		0	35
Max. Marks	50		0	50
Examination Duration (in Hours)	2 Hours		NA	2 Hours

Contents of the Course			
Instructions for Examiner: Theory: The paper setter shall prepare 5 questions selecting two questions from each unit with consideration given to the Course Learning Outcomes. Among these, question number 1 will be compulsory . Examinees will be required to attempt three questions : the compulsory question no. 1 and 1 question from each of the two units.			
Unit	Topics	CLO(s)	Contact Hours
Unit-1	Solar Energy and Solar Thermal Systems : Energy Overview: Limitations of conventional energy sources, need and growth of alternative energy sources, basic schemes and applications of direct energy conversion. Solar Photovoltaic Systems: Theory of solar cells, solar cell materials, solar cell arrays, performance parameters. Solar Thermal Energy Systems: Solar radiations, flat plate collectors and materials, performance and applications, focusing collectors and materials, solar thermal power plants, thermal energy storage for heating and cooling, limitations of solar energy systems.	1	15

Unit-2	Geothermal Energy, Wind Energy and Fuel Cells: Geothermal Energy: Resources of geothermal energy, thermodynamics of geothermal energy conversion (electrical and non-electrical), environmental considerations, geothermal power plants and applications. Wind Energy: Wind power sources, principles of wind energy conversion systems, momentum theory, wind characteristics, performance and limitations, site selection criteria. Fuel Cells: Principle of fuel cells, working of different types of fuel cells, performance characteristics, applications and limitations.	2	15
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Suggested Evaluation Methods					
Internal Assessment: 15	TH-15	PR-0	End Term Examination: 35	TH-35	PR-0
Class Participation	5	NA	Written Examination	35	NA
Seminar/presentation/assignment/quiz/class test etc.	5	NA	Lab record	NA	NA
Seminar/Demonstration/Viva-voce/Lab records etc.	NA	NA	Viva-Voce	NA	NA
Mid-Term Exam(s)	5	NA	Write-up and execution of the practical	NA	NA

Mapping of (CLOs) to Programme Learning Outcomes & Programme Specific Outcomes															
CLO	PLO ₁	PLO ₂	PLO ₃	PLO ₄	PLO ₅	PLO ₆	PLO ₇	PLO ₈	PLO ₉	PLO ₁₀	PLO ₁₁	PSO ₁	PSO ₂	PSO ₃	PSO ₄
26L6.5-PHY-311.1	3	1	1	2			1	2	2		1	3	3	2	1
26L6.5-PHY-311.2	3	2	1	2		2	2	2	2		1	2	3	3	2

* Note: This is a University Pool course with independent mapping.

Learning Resources
- Duffie, J. A., & Beckman, W. A. (2013). Solar engineering of thermal processes (4th ed.). Wiley - Rai, G. D. (2011). Non-conventional energy sources (5th ed.). Khanna Publishers - Twidell, J., & Weir, T. (2015). Renewable energy resources (3rd ed.). Routledge. - Kalogirou, S. A. (2014). Solar energy engineering: Processes and systems (2nd ed.). Academic Press - Boyle, G. (Ed.). (2012). Renewable energy: Power for a sustainable future (3rd ed.). Oxford University Press. - Goswami, D. Y., Kreith, F., & Kreider, J. F. (2007). Principles of solar engineering (2nd ed.). Taylor & Francis - Patel, M. R. (2006). Wind and solar power systems: Design, analysis, and operation (2nd ed.). CRC Press - Bent Sørensen. (2017). Renewable energy: Physics, engineering, environmental impacts (4th ed.). Academic Press - Auer, P. (Ed.). (n.d.). Advances in energy systems and technology (Vols. I–II). Academic Press - Chauhan, D. S. (n.d.). Non-conventional energy resources. New Age International - Fahrenbruch, A. L., & Bube, R. H. (1983). Fundamentals of solar cells: Photovoltaic solar energy conversion. Academic Press - Koteswara Rao, M. V. R. (2006). Energy resources: Conventional & non-conventional. BSP Publications. - Raja, A. K. (n.d.). Introduction to non-conventional energy resources. Scitech Publications - Solanki, C. S. (2011). Renewable energy technologies: A practical guide for beginners. PHI Learning

Content Mapping with NEP thrust areas	
Field	Hours Devoted
Employability	3
Entrepreneurship	2
Skill Enhancement	3
Environmental Awareness	3
Current Issues and Social Awareness	2