Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

Empowered Autonomous Institution

Structure and Curriculum of Two-Year Degree Programme

Postgraduate Programme of Science & Technology

M.Sc. in Physics

Board of Studies in Physics

Rajarshi Shahu Mahavidyalaya, Latur

Empowered Autonomous Institution

w.e.f. June, 2026

(In Accordance with NEP-2020)

Academic Year: 2026-27

Review Statement

The NEP Cell reviewed the Curriculum of **M.Sc. Physics** Programme to be effective from the **Academic Year 2026-27.** It was found that, the structure is as per the NEP-2020 guidelines of Govt. of Maharashtra.

Date: 11/04/2026

Place: Latur

NEP Cell
Rajarshi Shahu Mahavidyalaya, Latur
Empowered Autonomous Institution

CERTIFICATE

I hereby certify that the documents attached are the Bonafide copies of the Curriculum of **M.Sc. Physics** Programme to be effective from the **Academic Year 2026-27.**

Date: 11/04/2026

Place: Latur

Dr Abhijit Yadav
Chairperson
Board of Studies in Physics
Rajarshi Shahu Mahavidyalaya, Latur
Empowered Autonomous Institution

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

Empowered Autonomous Institution

Members of Board of Studies in the Subject Physics

Under the Faculty of Science and Technology

Department of Physics and Electronics

Sr. No.	Name	Designation	In position
1	Dr A. A. Yadav Head, Department of Physics & Electronics, Rajarshi Shahu Mahavidyalaya, Latur Empowered Autonomous Institution	Chairperson	HoD
2	Dr Vikas B Patil, School of Physical Sciences, Punyashlok Ahilyadevi Holkar Solapur University, Solapur	Member	Academic Council Nominee
3	Dr Ram Kadam, Shrikrishna Mahavidyalaya, Gunjoti, Omerga	Member	Academic Council Nominee
4	Dr Pravinkumar Ramchandra Mirkute Professor, Department of Physics, Yeshwant Mahavidyalaya, Nanded.	Member	V.C. Nominee
5	Dr Shrinivas Narsimalu Keshatti Professor of Physics, Shri Shivaji College, Parbhani- 431401	Member	V.C. Nominee
6	Shri Gundu Sabde Relyon Industries, Pune	Member	Expert from Industry
7	Dr Pramod Watekar IIT, Kharagpur	Member	Expert from Industry
8	Dr Kamalakar N. Shivalkar Head, Department of physics, Mahatma Gandhi Mahavidyalaya, Ahmedpur Dist. Latur	Member	P.G. Alumni
9	Dr Rajaram Mane School of Physical Sciences, SRTMU, Nanded	Member	Expert from outside for Special Course
10	Miss Mayuri Hawaldar	Member	Member from same Faculty
11	Miss Vishakha Patil	Member	Member from same Faculty
12	Miss Harshda Nalage	Member	Member from same Faculty
13	Mr. Harshad Dalve	Member	Member from same Faculty

From the Desk of the Chairperson…

"Look Deep into Nature, and Then You Will Understand Everything Better."

--Albert Einstein

I welcome you all. Department of Physics was established in the academic year 1971-72. The Department of Physics (Photonics) has set few outstanding academic benchmarks. The Department of Physics is known for the long-lasting academic legacy, national and international research promotion through the means of MoUs and lucidly developed research ambiance through synchronized efforts of every individual faculty. The NEP 2020 emphasizes a holistic and multidisciplinary approach to education, focusing on the overall development of students. As a consequence of this, the Department has attained the apex position in the university research index; more than 08 research scholar awarded Ph. D. At present Scopus based Statistical status reveals, we have more than 3652 citations for more than 175 papers. It's an awesome signature in the research sector of material science across the globe. The Department of Physics has bagged many prestigious honors such world's top 2% most cited scientists published by Stanford University in PLOS Biology Journal and received IASc-INSA-NASI Summer Research Fellowship 2023.

The NEP 2020 emphasizes a holistic and multidisciplinary approach to education, focusing on the overall development of students. Inclusion of emerging topics and advancements in Physics, such as Quantum mechanics, Astrophysics, Nuclear Physics etc. At PG level the department is running Photonics as specialization wherein courses related with Optics, Laser, Fiber Optics, Photonic Devices and Sensors, Thin Film and Nanotechnology, Industrial Photonics Engineering are offered.

The department organizes workshops, training programs, and seminars to update physics teachers about the revised curriculum, instructional strategies, and assessment methods. Encourage teachers to engage in professional development activities, research, and collaboration to enhance their pedagogical skills. Provide support and resources for teachers to integrate technology effectively into their teaching practices.

The assessment methods are innovative, such as project portfolios, oral presentations, demonstrations, and performance-based assessments in addition to traditional written exams. Facilitate collaborations with research institutions, industries, and organizations to provide students with real-world exposure and opportunities for internships or mentor-ship programs.

Let me take the opportunity to thank and wish you all a great success.

(Dr Abhijit Yadav)
Chairperson
Board of Studies in Physics

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

Empowered Autonomous Institution

Faculty of Science and Technology

Department of Physics and Electronics

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Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

Empowered Autonomous Institution

Faculty of Science and Technology

Department of Physics and Electronics

PG Skeleton in Accordance with NEP-2020

Illustrative Credit Distribution Structure for Two Year M.Sc. Degree

Year Level	Sem	Major 24-28 (22-26) per Sem 46-56 for two years		Lab Course	RM	OJT/FP	RP	Cum. Cr	Marks	Degree
		Mandatory	Elective							
I 6.0	I	Major I 3Cr Major II 3Cr Major III 3Cr Major IV 2 Cr	MEC I 3Cr	LC-I 1Cr LC-II 1Cr LC-III 1Cr LC-IV 1Cr	RMC 4Cr	NA	NA	22 Cr	Theory: 1Cr=25 M Lab Course: 1Cr=50 M	PG Diploma (After 03 Year B.Sc. Degree)
	II	Major V 3Cr Major VI 3Cr Major VII 3Cr Major VIII 2 Cr	MEC II 3Cr	LC-V 1Cr LC-VI 1Cr LC-VII 1Cr LC-VIII 1Cr	NA	OJT-I 4Cr /FPI 4Cr	NA	22 Cr	OJT/FP: 1Cr=25 M	
	Total	**Major 22 Cr**	**MEC 06 Cr**	**LC-8 Cr**	**RMC 04Cr**	**OJT/FP 04Cr**	**NA**	**44 Cr**		
Exit Option: PG Diploma with 40 Credits After 03 Year B.Sc. Degree										
II 6.5	III	Major IX 3Cr Major X 3Cr Major XI 3Cr	MEC III 3Cr	LC-IX 1Cr LC-X 1Cr LC-XI 1Cr LC-XII 1Cr	NA	NA	RP-I 4Cr	**20Cr**	RPI & RPII: 1Cr=25 M	PG Degree (After 03 Year UG Degree)
	IV	Major XII 3Cr Major XIII 3Cr	MEC IV 3Cr	LC-XIII 1Cr LC-XIV 1Cr	NA	NA	RP-II 6Cr	**22Cr**		

		Major XIV 3Cr		LC-XV 1Cr LC-XVI 1Cr						
	Total	**Major 18 Cr**	**MEC 06 Cr**	**LC-8 Cr**	**NA**	**NA**	**RP 10 Cr**	**42 Cr**		
Cum. Total of I & II Year		**Major 36 Cr**	**MEC 12 Cr**	**LC-16Cr**	**RMC 04 Cr**	**OJT/FP 04Cr**	**RP 10 Cr**	**44+42 =86 Cr**		**86 Credits**
	Exit Option: Two Years 04 Sem. PG Degree with 82 Credits After 03 Year UG Degree									

Abbreviations:

1. MEC : Major Elective Course
2. RMC : Research Methodology Course
3. OJT : On Job Training (Internship/Apprenticeship)
4. FP : Field Project
5. RP : Research Project
6. Cum. Cr : Cumulative Credit

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

Empowered Autonomous Institution

Faculty of Science and Technology

Department of Physics and Electronics

M.Sc. Physics Skeleton in Accordance with NEP-2020

Illustrative Credit Distribution Structure for Two Years/One Year PG (M.Sc.)

Year Level	Sem	Major 24-28(22-26) per Sem 46-56 for two years		Lab Course	RM	OJT/FP	RP	Cum. Cr	Marks	Degree
		Mandatory	Elective							
I 6.0	I	Mathematical Methods in Physics 3Cr	Electronic Devices 3Cr Or Electronic Communication Systems 3Cr	LC-I 1Cr LC-II 1Cr LC-III 1Cr LC-IV 1Cr	RMC 4Cr	NA	NA	22Cr	Theory: 1Cr=25M Lab Course: 1Cr=50M	PG Diploma (After 03 Year UG Degree)
		Classical Mechanics 3Cr								
		Advanced Quantum Mechanics 3Cr								
		NET/SET-I 2 Cr								
	II	Advanced Atomic and Molecular Physics 3Cr	Modern Optics 3Cr Or Advanced Astrophysics and Cosmology 3Cr	LC-V 1Cr LC-VI 1Cr LC-VII 1Cr LC-VIII 1Cr	NA	Field Project-I 4Cr	NA	22Cr	OJT/FP: 1Cr=25M	
		Condensed Matter Physics 3Cr								
		Thermodynamics and Statistical Mechanics 3Cr								
		NET/SET-II 2 Cr								
	Total	Major 22 Cr	MEC 06Cr	LC-8Cr	RMC 04Cr	OJT/FP 04 Cr	NA	44 Cr		
Exit Option: PG Diploma with 44 Credits After 03 Year UG Degree										
II 6.5	III	Electrodynamics and Plasma Physics 3Cr	Thin film and Nanotechnology	LC-IX 1Cr LC-X 1Cr LC-XI 1Cr	*NA*	*NA*	Research	20Cr	RP I & RP II:	PG Degree

		Nuclear and Particle Physics 3Cr **Laser Technology 3Cr**	**3Cr Or Experimental Techniques 3 Cr**	LC-XII 1Cr			**Project I 4Cr**		01 Cr. = 25 M	**(After 03 Year UG Degree)**
	IV	**Fiber Optics and its Applications 3 Cr** **Laser system and its applications 3Cr** **Industrial Photonic Engineering 3Cr**	**Photonic Devices and Sensors 3Cr Or Energy Physics 3Cr**	LC-XIII 1Cr LC-XIV 1Cr LC-XV 1Cr LC-XVI 1Cr	NA	NA	**Research Project II 6Cr**	**22Cr**		
	Total	**Major 18Cr**	**MEC 6Cr**	**LC-8Cr**	**NA**	**NA**	**RP 10Cr**	**42Cr**		
Cum. Total of I & II Yr.		**Major 40Cr**	**MEC 12Cr**	**LC-16Cr**	**RMC 04Cr**	**OJT/ FP 04Cr**	**RP 10Cr**	**44+ 42 =86 Cr**		**86 Credits**
		Exit Option: Two Years 04 Sem. PG Degree with 88 Credits After 03 Year UG Degree								

Programme Outcomes (POs) for M.Sc. Programme	
PO1	**Disciplinary Masters Knowledge:** Graduates will acquire comprehensive, in-depth relevant scientific knowledge and its execution in their specific area of study.
PO2	**Scientific Outlook:** Graduates will develop qualities such as observation, precision, analysis, logical thinking, clarity of thought and expression, and a systematic approach to working on research projects and explaining scientific phenomena.
PO3	**Problem Solving Skills:** Graduates will build analytical skills to solve complex problems, evaluate situations, and act responsibly to communicate, cooperate, and lead a team.
PO4	**Interpersonal Skills and Ethics:** Graduates will demonstrate the ability to integrate professional ethics and scientific knowledge in their life, organization, and society to fulfill the moral and material needs of mankind.
PO5	**Self-Directed Life-long Learning:** Graduates will develop the ability to independently prepare for NET, SET, GATE, and other national and international competitive examinations.
PO6	**Professional Competence:** Graduates will be able to independently apply their knowledge for continuous personal and professional development, identify business opportunities, and initiate action to achieve them.
PO7	**Research and Related Skills:** Graduates will possess technical know-how for identifying local issues and developing "lab-to-land" solutions for the benefit of society at large.
PO8	**Technological Applications and Industry Readiness:** Graduates will gain knowledge of applied physics fields-including Electronic Devices, Laser Technology, Fiber Optics, Photonic Engineering, and Nanotechnology-preparing them for careers in industry, research, and emerging technologies

Programme Specific Outcomes (PSOs) for M.Sc. Physics	
PSO No.	Upon completion of this programme, the students will be able to
PSO1	Demonstrate and explain various mathematical techniques, numerical methods, and experimental techniques to broaden independent thinking and develop a scientific temper
PSO2	Develop advanced job-oriented skills needed in the photonics industry and consultancy
PSO3	Design instrumentation using in-house laboratory setups
PSO4	Apply analytical skills and research aptitude in specific areas related to physics, including materials science, thin-film technology, solar energy, radiation dosimetry, and energy generation and storage for academic research and industrial applications
PSO5	Create a robust foundation in basic and practical aspects, enabling them to pursue careers as physics teachers and scientists
PSO6	Interpret the core physical laws to unravel a multitude of physical properties, processes, and effects involving radiation, nuclei, atoms, molecules, and bulk forms of matter.

Semester - I

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

Empowered Autonomous Institution

Faculty of Science and Technology

Department of Physics and Electronics

PG I Sem I

Course Type : MMC-I

Course Title : Mathematical Methods in Physics

Course Code : 601PHY1101

Credits : 03 Max. Marks: 75 Lectures: 45 Hrs.

Learning Objectives:

LO1. To provide students with a strong conceptual foundation in matrix theory, including eigenvalues, eigenvectors, and essential matrix operations such as addition, subtraction, and inversion using various methods.

LO2. To develop students' ability to formulate and solve partial differential equations, as well as homogeneous and non-homogeneous first-order linear equations using different techniques.

LO3. To enhance students' understanding of complex analysis concepts, including Cauchy's Residue Theorem and Cauchy's Principal Value, for evaluating definite real integrals.

LO4. To equip students with the knowledge and skills necessary to construct Fourier series for different types of functions and apply them in problem-solving.

Course Outcomes:

After completion of the course, the student will be able to

CO1. Develop an understanding of the role of computation as a tool in real-world problem-solving.

CO2. Apply numerical algorithms to solve fundamental mathematical problems, such as root-finding, linear systems of equations, and numerical integration, which frequently arise in technical fields.

CO3. Apply their knowledge of numerical techniques in their further study of advanced topics in mathematics as well as science and engineering.

CO4. Translate a variety of complex mathematical problems in traditional and emerging chemical engineering fields into numerical problems and how to tune numerical algorithms for effective and efficient solution.

Unit No.	Title of Unit & Contents	Hrs.
I	**Matrix Algebra and Eigen Value Problems**	**11**
	1. Matrix Multiplication – Inner Product, Direct Product, 2. Diagonal Matrices, Trace, Matrix Inversion, Example of Gauss-Jordon Inversion, Problems, 3. Eigen Values and Eigenvectors, Properties of Eigen Values and Eigenvectors, 4. Cayley Hamilton Theorem and Applications, Similar Matrices and Diagonalizable Matrices, 5. Eigen Values of Some Special Complex Matrices, Quadratics Forms, and Problems.	

Unit No.	Title of Unit & Contents	Hrs.
	Unit Outcomes: UO1. Develop an understanding of the role of computation as a tool in real-world problem-solving. UO2. Implement and compare iterative methods, such as the Bisection, Newton-Raphson, and Secant methods, to find roots of non-linear equations.	
II	**Partial Differential Equations**	**12**
	1. Introduction, Formation of Partial Differential Equations, Solutions of A Partial Differential Equation, 2. Equations Solvable by Direct Integration, Linear Equations of The First Order, 3. Non-Linear Equations of The First Order, Charpit's Method, 4. Homogeneous Linear Equations with Constant Coefficients, 5. Rules for Finding the Complementary Function, Rules for Finding the Particular Integral, 6. Working Procedure to Solve Homogeneous Linear Equations of Any Order, Non-Homogeneous Linear Equations, 7. Non-Linear Equations of The Second Order- Monge's Method.	
	Unit Outcomes: UO1. Apply analytical methods-such as separation of variables, integrating factors, or the method of undetermined coefficients-to solve first and second-order ordinary differential equations (ODEs). UO2. Implement the method of substitution and differentiation to solve equations.	
III	**Calculus of Residues**	**11**
	1. Singularities- Poles, Branch Points, 2. Calculus of Residues-Residues Theorem, 3. Cauchy Principle Value, Evaluation of Definite Integrals, 4. A Digression of Jordon's (1838-1922) Lemma, Problems, 5. Numerical Problems.	
	Unit Outcomes: UO1. Translate a variety of complex mathematical problems in traditional and emerging chemical engineering fields into numerical problems and how to tune numerical algorithms for effective and efficient solution. UO2. Identify and classify the nature of singularities (isolated, removable, poles, and essential singularities) of a complex function using Laurent series expansions.	
IV	**Fourier Series**	**11**
	1. Periodic Functions, Fourier Series, Dirichlet's Conditions, 2. Advantage of Fourier Series Useful Integrals, Determination of Fourier Series Constants (Euler's Formulae), 3. Function Defined on Two or More Sub Spaces, Even Functions, 4. Half Range Series Change of Interval, Parseval's Formula Fourier Series in Complex Form, 5. Practical Harmonic Analysis,	

Unit No.	Title of Unit & Contents	Hrs.
	6. Integral Transform, 7. Fourier Integral Theorem 8. Numerical Problems.	
	Unit Outcomes: UO1. Decompose an arbitrary periodic function into its fundamental frequency and higher-order harmonics using Fourier series. UO2. Demonstrate Fourier series to study the behavior of periodic functions and their applications.	

Learning Recourses:

1. Mathematical Methods (Second Edition) S. R. K. Iyengar, R. K. Jain, Narosa, (2006).
2. Mathematical Physics, B.S. Rajput, Pragati Prakashan (2012).
3. Advanced Engineering Mathematics, H K Dass, S Chand (2006).
4. Matrices and tensors in physics, A. W. Joshi, Wiley (1995).
5. Higher Engineering Mathematics, B. S. Grewal, Khanna Publishers (1965).
6. Mathematical Methods for Physicists, (6^{th} Edition), Arfken & Weber, Elsevier Academic Press (2005).
7. Introduction to Mathematical Physics, Charlie Harper, Prentice-Hall of India Pvt. Ltd (2009).
8. Applied Mathematics for Engineers and Physicists (Third Edition), Louis A. Pipes and Lawrence R. Harvill, Courier Corporation (2014).

Internal Examination Pattern:

CAT – I: Home Assignment

CAT – II: PPT Presentation/ Open Book Test/ Poster Presentation/ Seminar/ Online Quiz/ Descriptive Test

Mapping of POs, PSOs and COs:

COs/POs & PSOs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6
CO1	3	1	3	0	2	1	0	0	3	0	0	1	2	1
CO2	3	1	3	0	2	1	0	0	3	0	0	1	2	1
CO3	3	2	3	0	3	2	1		3	1	0	2	3	1
CO4	3	2	3	0	2	2	2	1	3	1	0	2	2	1

Scale: 3 = High, 2 = Moderate, 1 = Low, 0 = No correlation.

Faculty of Science and Technology

Department of Physics and Electronics

PG I Sem I

Course Type : MMC Lab Course-I

Course Title : MMC Lab Course-I (Based on MMC-I)

Course Code : 601PHY1105

Credit : 01 Max. Marks: 50 Lectures: 30 Hrs.

Learning Objectives:

LO1. To equip students with the fundamentals of MATLAB programming required for solving mathematical problems, performing matrix operations, and handling complex numbers.

LO2. To develop an understanding of computational techniques by implementing numerical methods, such as Euler's and the 4^{th}-order Runge-Kutta methods, to solve ordinary differential equations.

LO3. To train students in analytical logic and data visualization by writing programs for mathematical sequences (Fibonacci, factorials), Fourier series, and waveform plotting.

LO4. To foster practical skills in technical communication and data management through the use of MS Office applications (Word and Excel) for scientific documentation and report preparation.

Course Outcomes:

After completion of the laboratory course, the students will be able to-

CO1. Apply MATLAB to perform matrix operations such as addition, subtraction, multiplication, transpose, inverse, and eigenvalue computation, enhancing problem-solving skills in linear algebra.

CO2. Develop MATLAB programs to solve quadratic equations and handle complex numbers, strengthening computational proficiency in mathematical problem-solving.

CO3. Implement numerical methods like Euler's method and the 4th-order Runge-Kutta method to solve differential equations, improving understanding of computational techniques in physics and engineering.

CO4. Utilize MS Office applications, including MS Word and MS Excel, for scientific documentation, data analysis, and report preparation, enhancing technical communication and data management skills.

Practical No.	Unit
1	Addition, subtraction and multiplication of Matrices using Matlab.
2	Transpose, Inverse and eigenvalues of Matrices using Matlab.
3	Program for solution of quadratic equation in Matlab.
4	Program for complex numbers in Matlab.
5	Program for computation of forward-Euler approximation to the solution of the ODE from x = 0 to x = 10.
6	Program for computation of solution of differential equations using 4th order Runge-Kutta method.
7	Fourier series using Matlab

8	Compute the factorial of a given number using a loop or recursion in Matlab.
9	Generate the Fibonacci sequence up to a given number of terms using Matlab.
10	Finding Roots of a Polynomial – Use the roots function to compute the roots of a given polynomial using Matlab
11	Generate and visualize sine, cosine, and other waveforms using plot function using Matlab.
12	Study of Computer – Applications of MS office (MS Word and MS Excel).

Learning Resources:

1. MATLAB: Easy Way of Learning, by S. Swapna Kumar, S. V. B. Lenina (2016)
2. Numerical Computing with MATLAB, by Cleve B. Moler (2010)
3. MATLAB Primer, by Timothy A. Davis (2010)
4. MATLAB PROGRAMMING, By Y. KIRANI SINGH, B. B. CHAUDHURI (2007)
5. MATLAB: An Introduction with Applications, By Amos Gilat (2004)

Internal Examination Pattern:

CAT – I: Record Book Submission

CAT – II: Overall performance in the regular practical

Mapping of POs, PSOs and COs:

COs/POs & PSOs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6
CO1	2	3	3	0	2	2	2	2	3	1	0	2	2	1
CO2	2	3	3	0	2	2	2	2	3	1	0	2	2	1
CO3	2	3	3	0	2	2	2	2	3	2	0	2	2	1
CO4	1	2	2	1	2	3	3	2	1	2	0	2	3	1

Scale: 3 = High, 2 = Moderate, 1 = Low, 0 = No correlation.

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Empowered Autonomous Institution

Faculty of Science and Technology

Department of Physics and Electronics

PG I Sem I

Course Type : MMC-II

Course Title : Classical Mechanics

Course Code : 601PHY1102

Credits : 03 **Max. Marks: 75** **Lectures: 45 Hrs.**

Learning Objectives:

- LO1. To acquire basic knowledge required to solve advanced problems involving the dynamic motion of classical mechanical systems using Newton's laws of motion.
- LO2. To develop an understanding of Lagrangian and Hamiltonian formulation,
- LO3. To represent the equations of motion for complicated mechanical systems using the Lagrangian and Hamiltonian formulations,
- LO4. To use the law of conservation of energy and linear and angular momentum to solve dynamic problems.

Course Outcomes:

After completion of the course, the student will be able to

- CO1. Define basic mechanical concepts related to discrete and continuous mechanical Systems,
- CO2. Describe the vibrations of discrete and continuous mechanical systems, motion of a mechanical system using Lagrangian-Hamilton formalism,
- CO3. Demonstrate a basic knowledge of Calculus of Variations,
- CO4. Illustrate the Canonical transformations,

Unit No.	Title of Unit & Contents	Hrs.
I	**Central Force Problem**	**12**
	1. Introduction, Two Body Problem, The Equation of Motion and First Integral, 2. Equation of Orbit, Kepler's Laws, Kepler's Problem, 3. General Analysis of Orbits, Stability of Orbits, Artificial Satellites, 4. Rutherford Scattering: Differential Scattering Cross-Section, Rutherford Formulae for Scattering, 5. Numerical Problems.	
	Unit Outcomes: UO1. Formulate the two-body problem by reducing it to an equivalent one-body problem using the concept of reduced mass. UO2. Apply Newton's Law of Universal Gravitation and the laws of conservation of angular momentum to describe the motion of planets around the Sun.	
II	**Variational Principle and Hamiltonian Formulation**	**11**
	1. Hamilton's Principle, Hamiltonian, Generalized Momentum, 2. Constant of Motion, Hamilton's Canonical Equations of Motion,	

	3. Deduction of Canonical Equations from Variational Principle, 4. Applications of Hamilton's Equations of Motion, 5. Principle of Least Action, Proof of Principle of Least Action,	
	Unit Outcomes: UO1. Formulate equations of motion for particles and rigid bodies by applying Newton's Laws and D'Alembert's Principle. UO2. Find Lagrangian and Hamiltonian of different pendulums.	
III	**Canonical Transformations and Hamilton-Jacobi Theory**	**11**
	1. Introduction, Generating Functions, 2. Illustrations of Canonical Transformations, Condition for Transformation to be Canonical, Examples, 3. Poisson's Brackets, Poisson's Theorem, Properties of Poisson's Brackets, 4. Hamilton's Canonical Equations in Terms of Poisson's Brackets, 5. Hamilton-Jacobi Equation, Problems.	
	Unit Outcomes: UO1. Learn how to construct the Poisson Bracket and their applications. UO2. Identify the physical significance of the Hamilton-Jacobi equation as a specific case of canonical transformation.	
IV	**Small Oscillations & Special Theory of Relativity**	**11**
	1. Introduction, 2. Small Oscillations: Potential Energy and Equilibrium; Stable and Unstable Equilibriums, 3. Small Oscillations in A System with One Degree of Freedom, 4. Normal Coordinates; Normal Modes and Normal Frequencies of Vibration, 5. Special Theory of Relativity: Lorentz Transformations and Its Consequences, 6. Mass Energy Relation, Lagrangian Formulation of Relativistic Mechanics Integral Transform, 7. Particle Accelerating Under Constant Force, 8. Hamiltonian Formulation of Relativistic Mechanics, Particle in an EM Field.	
	Unit Outcomes: UO1. Explain the physical significance of rest mass energy and its implications in nuclear reactions (fission and fusion) and particle physics. UO2. Determine the contracted length of an object as observed from a stationary frame, identifying the direction of motion relative to the measurement.	

Learning Recourses:

1. Classical Mechanics: Gupta, Kumar, Sharma, Pragati Prakashan (2010)
2. Classical Mechanics (3rd Ed.), Herbert Goldstein, C. P. Poole, J. L. Safko, Addison Wesley (2001).

3. Classical Mechanics, J. C. Upadhyaya, Himalaya Publishing House, (2019)
4. N.C. Rana and P.S. Joag, Classical Mechanics, Tata McGraw-Hill (1991)
5. Classical Mechanics, P.V. Panat, Narosa Publishing Home, New Delhi. (2012)
6. Classical Mechanics: A Textbook, Suresh Chandra, Alpha Science International Ltd. Oxford, U.K

Internal Examination Pattern:

CAT – I: Home Assignment

CAT – II: PPT Presentation/ Open Book Test/ Poster Presentation/ Seminar/ Online Quiz/ Descriptive Test

Mapping of POs, PSOs and COs:

COs/POs & PSOs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6
CO1	3	0	3	0	2	0	0	0	3	0	0	0	2	3
CO2	3	0	3	0	2	0	0	0	3	0	0	0	2	3
CO3	3	0	3	0	2	0	0	0	3	0	0	0	2	3
CO4	3	0	3	0	2	0	0	0	3	0	0	0	2	3

Scale: 3 = High, 2 = Moderate, 1 = Low, 0 = No correlation.

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Rajarshi Shahu Mahavidyalaya, Latur

Empowered Autonomous Institution

Faculty of Science and Technology

Department of Physics and Electronics

PG I Sem I

Course Type : MMC Lab Course-II

Course Title : MMC Lab Course-II (Based on MMC-II)

Course Code : 601PHY1106

Credit : 01 **Max. Marks: 50** **Lectures: 30 Hrs.**

Learning Objectives:

LO1. To equip students with the fundamentals of Python programming to generate, manipulate, and visually plot physical signals, enabling the analysis of wave behavior and interference.

LO2. To develop an understanding of computational techniques by applying finite difference methods, including Explicit/Implicit Euler and Trapezoidal formulas, to approximate solutions for initial value problems and oscillatory systems like pendulums.

LO3. To train students in utilizing advanced Python computational libraries (such as scipy's solve_ivp) to solve complex ordinary differential equations and evaluate model accuracy through rigorous error analysis.

LO4. To foster proficiency in developing structured Python scripts that successfully translate mathematical physics models and complex number problems into executable code for simulating real-world physical phenomena.

Course Outcomes:

After completion of course, the student will be able to-

CO1. Implement Python scripts to generate, manipulate, and visualize physical signals (such as sine waves) to analyze wave interference and behavior.

CO2. Apply finite difference methods, including Explicit Euler, Implicit Euler, and Trapezoidal formulas, to approximate solutions for first-order initial value problems and oscillatory systems (like the simple pendulum).

CO3. Utilize advanced computational libraries (such as scipy.integrate.solve_ivp) to solve complex differential equations and evaluate model accuracy by performing error analysis against analytical solutions.

CO4. Develop structured Python programs to solve complex number problems and simulate physical phenomena, demonstrating proficiency in translating mathematical physics models into executable code.

Practical No.	Unit
1	Basic programming in Python
2	Write and execute a program in Python to plot Sine Wave
3	Using python generate two sine waves with time between 0 and 1 seconds. Both waves have frequency 5 Hz and sampled at 100 Hz, but the phase at 0 and 10, respectively. Also, the amplitudes of the two waves are 5 and 10. Plot the two waves and see the difference.

4	Using python approximate the solution to this initial value problem between 0 and 1 in increments of 0.1 using the Explicity Euler Formula. Plot the difference between the approximated solution and the exact solution.
5	With python use the Euler Explicit, Euler Implicit, and Trapezoidal Formulas to solve the pendulum equation over the time interval [0,5] in increments of 0.1 and for an initial solution of $S_0 = \binom{1}{0}$ For the model parameters using $\sqrt{(g/l)}$ =4. Plot the approximate solution on a single graph Programme
6	Using python Consider the ODE $$\frac{dS(t)}{dt} = \cos(t)$$ for an initial value S_0=0 . The exact solution to this problem is S(t)=sin(t) . Use **solve_ivp** to approximate the solution to this initial value problem over the interval [0, π] . Plot the approximate solution versus the exact solution and the relative error over time.
7	Using python Consider the ODE $$\frac{dS(t)}{dt} = -S(t)$$ for an initial value S_0=1 . The exact solution to this problem is $S(t)=e^{-t}$. Use **solve_ivp** to approximate the solution to this initial value problem over the interval [0,1] . Plot the approximate solution versus the exact solution and the relative error over time.

Learning Resources:

1. A Guide to MATLAB: For Beginners and Experienced Users, By Brian R. Hunt, Ronald L. Lipsman, Jonathan M. Rosenberg, Kevin R. Coombes, John E. Osborn, Garrett J. Stuck (2006).
2. Programming in Python 3: A Complete Introduction to the Python Language, By Mark Summerfield (2010).
3. The Power of Python, By Rachel Keranen (2017)
4. The Python Book, By Rob Mastrodomenico (2022)
5. Learn Python With 200 Programs Practical Guide for CBSE XI, XII & Beginners by Vaishali B Bhagat (2020)
6. A Python Book: Beginning Python, Advanced Python, and Python Exercises, by Dave Kuhlman (2011)

Internal Examination Pattern:

CAT – I: Record Book Submission

CAT – II: Overall performance in the regular practical

Mapping of POs, PSOs and COs:

COs/POs & PSOs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6
CO1	2	3	3	0	2	2	2	2	3	2	0	2	2	1
CO2	2	3	3	0	2	2	2	2	3	1	0	2	2	1
CO3	2	3	3	0	2	2	3	2	3	2	0	3	2	1
CO4	2	3	3	0	2	2	2	2	3	2	0	2	2	1

Scale: 3 = High, 2 = Moderate, 1 = Low, 0 = No correlation.

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

Empowered Autonomous Institution

Faculty of Science and Technology

Department of Physics and Electronics

PG I Sem I

Course Type : MMC-III

Course Title : Quantum Mechanics

Course Code : 601PHY1103

Credits : 03 Max. Marks: 75 Lectures: 45 Hrs.

Learning Objectives:

LO1. To provide students with a strong conceptual foundation in the mathematical frameworks of quantum mechanics.

LO2. To develop students' ability to solve the Schrödinger equation for physically important one-dimensional potentials and formulate quantum mechanics using Dirac's matrix and bra-ket notation.

LO3. To enhance students' understanding of the quantum mechanical theory of angular momentum, including commutation relations, ladder operators, eigenvalues, and the conservation of angular momentum through rotational symmetry.

LO4. To equip students with the knowledge and skills necessary to apply approximation methods, specifically time-independent perturbation theory, to solve complex quantum systems like the perturbed linear harmonic oscillator.

Course Outcomes:

After completion of the course, the student will be able to

CO1. Formulate and manipulate quantum mechanical states and represent square-integrable wave functions using advanced mathematical tools such as Hilbert spaces, Dirac notation, and Hermitian or unitary operators.

CO2. Solve one-dimensional potential problems to obtain and estimate wave functions, and apply matrix formulations to analyze quantum states and bound potentials.

CO3. Analyze orbital and spin angular momentum states, solve eigenvalue equations, and mathematically evaluate commutation relations and ladder operators in quantum mechanical systems.

CO4. Apply approximation techniques, such as first and second-order time-independent perturbation theory, to evaluate atomic structure and systems where exact solutions are not feasible.

Unit No.	Title of Unit & Contents	Hrs.
I	**Mathematical Tools of Quantum Mechanics**	11
	1. Introduction, The Hilbert Space and Wave Functions, 2. The Linear Vector Space, The Hilbert Space, Dimension and Basis of a Vector Space, 3. Square-Integrable Functions: Wave Functions, 4. Dirac Notation, 5. Operators: General Definitions, Hermitian Adjoint, Projection Operators, Commutator Algebra, 6. Uncertainty Relation between Two Operators, Functions of Operators,	

	7. Inverse and Unitary Operators, Eigenvalues and Eigenvectors of an Operator 8. Basic Postulates of Quantum Mechanics,	
	Unit Outcomes: UO1. Formulate and manipulate quantum mechanical states using the mathematical frameworks of Linear Vector Spaces and Hilbert Spaces, specifically applying Dirac notation to represent and analyze square-integrable wave functions. UO2. Apply mathematical operators-including Hermitian, projection, unitary, and inverse operators	
II	**One-Dimensional Potential Problems**	**12**
	1. Finite Square Well Potential; 2. Infinite Square Well Potential; 3. Potential Step; 4. Rectangular Potential Barrier, 5. Bound States: Delta Function Potential, 6. Parity Operation, 7. Matrix Formulation of Quantum Mechanics: Dirac's Bra and Ket Notation, 8. Properties of Dirac's Bra and Ket, Linear Operators.	
	Unit Outcomes: UO1. Solve the Schrodinger equation to obtain the wave function for some basic, physically important potential. UO2. Estimate the shape of the wave function based on the shape of potential.	
III	**Theory of Angular Momentum**	**11**
	1. Introduction, Orbital Angular Momentum; 2. Commutation Relations for Orbital Angular Momentum (Lx, Ly, Lz), 3. Commutation Relations for Ladder Operators (L+, L-), Orbital Angular Momentum (Lx, Ly, Lz), 4. Total Angular Momentum (L^2), Spin Angular Momentum (S^2 And Sz), 5. Eigenvalues of L^2, Lz, J^2, Jz; 6. Angular Momentum and Rotations, 7. Rotational Symmetry and Conservation of Angular Momentum, 8. Rotational Invariance of Lz, Problems.	
	Unit Outcomes: UO1. Analyze angular momentum states quantum mechanically, defined angular momentum. UO2. Solve angular momentum eigenvalue equations.	
IV	**Approximation Methods**	**11**
	1. Introduction, 2. Time Independent Perturbation Theory: Introduction, Non-Degenerate Case: 3. First Order Perturbation 4. Second Order Perturbation, 5. Perturbation to The Linear Harmonic Oscillator Problem, 6. Linear Harmonic Oscillator of Charge Q Perturbed by An Electric Field,	

	Unit Outcomes: UO1. Apply the technique of separation of variables to solve problems in more than one dimension and the role of degeneracy in the occurrence of electron shell structure in atoms. UO2. Develop a knowledge and understanding of perturbation theory.	

Learning Recourses: -

1. Quantum Mechanics: Concepts and Applications, Zettili Nouredine, John Wiley & Sons Ltd., Second Ed
2. Quantum mechanics - Ghatak and Loknathan
3. Quantum mechanics - L. I. Schiff (McGraw Hill)
4. Modern quantum mechanics - J. J. Sakurai (Addison Wesely)
5. A Text book of Quantum Mechanics- P.M. Mathews and Venkaresan K. (McGraw Hill, 2007)
6. Quantum Mechanics-B.K. Agrwal and Hari Prakash (Prentice-Hall of India, New Delhi, 2004)

Internal Examination Pattern:

CAT – I: Home Assignment

CAT – II: PPT Presentation/ Open Book Test/ Poster Presentation/ Seminar/ Online Quiz/ Descriptive Test

Mapping of POs, PSOs and COs:

COs/POs & PSOs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6
CO1	3	1	3	0	3	0	0	0	3	0	0	1	2	3
CO2	3	1	3	0	3	0	0	0	3	0	0	1	2	3
CO3	3	1	3	0	3	0	0	0	3	0	0	1	2	3
CO4	3	1	3	0	3	0	0	0	3	0	0	1	2	3

Scale: 3 = High, 2 = Moderate, 1 = Low, 0 = No correlation.

PG I Sem I

Course Type : MMC Lab Course-III

Course Title : MMC Lab Course-III (Based on MMC-III)

Course Code : 601PHY1107

Credit : 01 Max. Marks: 50 Lectures: 30 Hrs.

Learning Objectives:

LO1. To equip students with the practical skills required to analyze the fundamental characteristics, biasing, and amplifier applications of diverse semiconductor devices such as transistors, FETs, MOSFETs, and UJTs.

LO2. To develop a comprehensive understanding of Operational Amplifiers (OP-AMPs) by facilitating hands-on implementation of mathematical operation circuits (adders, differentiators, integrators) and active filters.

LO3. To train students in evaluating the operational parameters of specialized devices like SCRs and in utilizing instruments like the CRO to analyze frequencies and pulse widths in multivibrator circuits.

LO4. To foster a scientific attitude and practical problem-solving skills by engaging students in the design, assembly, and testing of functional electronic systems, bridging theoretical physics concepts with real-world applications like regulated power supplies.

Course Outcomes:

After completion of the course, the students will be able to-

CO1. Analyze the characteristics, biasing, and applications of transistors, FETs, MOSFETs, and UJTs in amplifier circuits.

CO2. Evaluate the voltage-current characteristics of semiconductor devices like SCR and their operational parameters.

CO3. Demonstrate the functionality of OP-AMP circuits as inverting and non-inverting amplifiers, adders, differentiators, and integrators.

CO4. Design and implement active filters (low-pass, high-pass, and band-pass) and a regulated power supply.

Practical No.	Unit
1	Transistor characteristics, biasing and its application as amplifier.
2	FET characteristics, biasing and its application as amplifier.
3	MOSFET characteristics, biasing and its application as amplifier.
4	Uni-junction transistor (UJT): study of the characteristics of Unijunction transistor (UJT) and calculation of the Intrinsic Stand- off Ratio (η).
5	Silicon Controlled Rectifier (SCR): Study of the voltage-current characteristics.

6	Astable Multivibrator to determine the pulse width, space width and frequency with the help of CRO.
7	OP-AMP as inverting and non-inverting amplifiers.
8	OP-AMP as adder, differentiator and integrator.
9	Active filters (Low Pass, High Pass and Band Pass).
10	Design of a Regulated Power Supply.

Learning Resources:

1. Semiconductor devices: Physics and Technology 2nd Edition, S. M. Sze
2. Op-Amps and Linear Integrated Circuits, Ramakant A. Gayakwad
3. Modern Digital Electronics by R.P. Jain Fourth Edition, (2010) Tata McGraw Hill Education Pvt. Ltd.
4. Semiconductor Optoelectronic devices-Pallab Bhattacharya, PHI, (1995)
5. Digital Principles and Circuits- Dr. C. B. Agarwal, Himalaya Publishing House.
6. Microprocessor Architecture, Programming, and Applications with the 8085 by Ramesh S. Gaonkar (2002)
7. A Textbook of Applied Electronics – R. S. Sedha

Internal Examination Pattern:

CAT – I: Record Book Submission

CAT – II: Overall performance in the regular practical

Mapping of POs, PSOs and COs:

COs/POs & PSOs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6
CO1	2	3	2	1	1	2	1	3	2	3	3	2	2	1
CO2	2	3	3	1	1	2	2	3	2	2	3	2	2	1
CO3	2	3	3	1	1	2	1	3	2	2	3	2	2	1
CO4	2	3	3	1	1	2	2	3	2	3	3	2	2	1

Scale: 3 = High, 2 = Moderate, 1 = Low, 0 = No correlation.

Shiv Chhatrapati Shikshan Sanstha's

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Faculty of Science and Technology

Department of Physics and Electronics

PG I Sem I

Course Type : MMC-IV

Course Title : Preparation of NET/SET Examination-I

Course Code : 601PHY1104

Credits : 02 **Max. Marks: 50** **Lectures: 30 Hrs.**

Learning Objectives:

Learning Resources:

Internal Examination Pattern:

CAT – I: Home Assignment

CAT – II: PPT Presentation/ Open Book Test/ Poster Presentation/ Seminar/ Online Quiz/ Descriptive Test

Mapping of POs, PSOs and COs:

COs/POs & PSOs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6
CO1														
CO2														
CO3														
CO4														

Scale: 3 = High, 2 = Moderate, 1 = Low, 0 = No correlation.

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

Empowered Autonomous Institution

Faculty of Science and Technology

Department of Physics and Electronics

PG I Sem I

Course Type : MEC-I (A)

Course Title : Electronic Devices

Course Code : 601PHY1201A

Credits : 03 **Max. Marks: 75** **Lectures: 45 Hrs.**

Learning Objectives:

LO1. To explain how transistor can be used to amplify a signal,

LO2. To illustrate the concept about the basic characteristics, construction, open loop and close loop operations of Operational-Amplifiers,

LO3. To enable students to analyze and design linear and non-linear circuits using Op-amp,

LO4. To familiarize students about the conversion of data from Analog to Digital and Digital to Analog.

Course Outcomes:

After completion of the course, the student will be able to-

CO1. Appreciate the role of semiconductor devices in various applications,

CO2. Analyze parameters of Op-amp and its applications,

CO3. Design and explain analog to digital conversion operations and vice versa.

CO4. Use Op-amp as analog to digital and digital to analog converter.

Unit No.	Title of Unit & Contents	Hrs.
I	**Transistors and Microwave Devices**	**11**
	1. Bipolar Junction Transistor (BJT), 2. Frequency Response and Switching Of BJT, 3. Field Effect Transistor (JFET), 4. MOSFET And Related Devices, 5. MESFET Device Structure and Its Operation, 6. Tunnel Diode, 7. Transferred Electron Devices and Gunn Diode, 8. Avalanche Transit Time Diode and IMPATT Diode.	
	Unit Outcomes: UO1. Analyze characteristics of semiconductor junctions. UO2. Perform microwave measurements.	
II	**Operational Amplifiers**	**12**
	1. Introduction to Op-Amp, 2. Schematic Symbol, 3. Characteristics of An Ideal Op-Amp, 4. Types of Op-Amps (Inverting and Non-Inverting),	

	5. Op-Amp Parameters, Gain Expression of Inverting and Non-Inverting Op-Amps, 6. Applications of Op-Amp Such as Adder, Subtractor, Integrator and Differentiator, 7. Numerical Problems.	
	Unit Outcomes: UO1. Analyze parameters of Op-Amp and its applications. UO2. Identify the internal stages of an operational amplifier, including the differential amplifier, gain stage, and output buffer.	
III	**D/A and A/D Converters**	**11**
	1. Introduction Digital-to-Analog(D/A) Converter, 2. Characteristic Specification of D/A Converter 3. Weighted-Resistor D/A Converter (Voltage Output), 4. Weighted-Resistor D/A Converter (Current Output), 5. R-2R Ladder D/A Converter, 6. Analog-to-Digital (A/D) Converter, 7. Counter Controlled A/D Converter, 8. Successive- Approximation A/D Converter, 9. Flash-A/D Converter, 10. Numerical Problems.	
	Unit Outcomes: UO1. Design and explain analog to digital conversion operations and vice versa. UO2. Use Op-Amp as analog to digital and digital to analog converter.	
IV	**Microprocessors**	**11**
	1 Architecture of 8085, 2. Signals and Timing Diagram of 8085, 3. Demultiplexing Address and Data Bus, 4. Instruction Set, Addressing Modes, 5. Assembly Language Programming of 8085 (Sum of An Array) 6. Minimum and Maximum of an Array, 7. Multiplication and Division of four- and Eight-Bit Numbers.	
	Unit Outcomes: UO1. Describe the Architecture and organization of 8085 Microprocessor UO2. Categorize the 8085-instruction set into its five functional groups: Data Transfer, Arithmetic, Logical, Branching, and Machine Control instructions.	

Learning Resources:

1. Semiconductor devices: Physics and Technology 2nd Edition, S. M. Sze
2. Op-Amps and Linear Integrated Circuits, Ramakant A. Gayakwad
3. Modern Digital Electronics by R.P. Jain Fourth Edition, (2010) Tata McGraw Hill Education Pvt. Ltd.
4. Semiconductor Optoelectronic devices-Pallab Bhattacharya, PHI, (1995)

5. Digital Principles and Circuits- Dr. C. B. Agarwal, Himalaya Publishing House.
6. Microprocessor Architecture, Programming, and Applications with the 8085 by Ramesh S. Gaonkar (2002)
7. A Textbook of Applied Electronics – R. S. Sedha

Internal Examination Pattern:

CAT – I: Home Assignment

CAT – II: PPT Presentation/ Open Book Test/ Poster Presentation/ Seminar/ Online Quiz/ Descriptive Test

Mapping of POs, PSOs and COs:

COs/POs & PSOs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6
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CO2	2	2	3	0	2	1	1	3	2	3	2	2	2	1
CO3	2	2	3	0	2	2	1	3	2	3	3	2	2	1
CO4	2	2	3	0	2	2	1	3	2	3	3	2	2	1

Scale: 3 = High, 2 = Moderate, 1 = Low, 0 = No correlation.

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

Empowered Autonomous Institution

Faculty of Science and Technology

Department of Physics and Electronics

PG I Sem I

Course Type : MEC-I(B)

Course Title : Electronics Communication Systems

Course Code : 601PHY1201B

Credits : 03 **Max. Marks: 75** **Lectures: 45 Hrs.**

Learning Objectives:

LO1. The course focuses on understanding fundamental concepts, analyzing communication systems, and applying knowledge to design and troubleshoot real-world applications

LO2. To introduce students to electronic communications, Basic electronic system, types of communication system, modulation and demodulation and its need,

LO3. To acquaint students about generation and detection of AM and FM, Power relations for AM and FM,

LO4. To equip students with latest developments in AM radio receivers, TRF and super heterodyne receiver, characteristics of AM receiver (selectivity, sensitivity and fidelity), Modern communication techniques such as satellite, cellular and FAX communication, Modem, FSK modem,

Course Outcomes:

After completion of the course, the students will be able to-

CO1. Analyze the fundamentals of electronic communication systems, apply the principles of modulation and demodulation, and evaluate the characteristics of Amplitude Modulation.

CO2. Examine the functions and types of AM radio receivers, assess key performance parameters such as sensitivity, selectivity, and fidelity.

CO3. Interpret the principles of frequency and phase modulation.

CO4. Explore modern communication technologies, including satellite communication systems, cellular radio systems, and modems.

Unit No.	Title of Unit & Contents	Hrs.
I	**Introduction to Communication Systems and Amplitude Modulation**	**11**
	1. Introduction, 2. Basic Communication System, Classification of Electronic Communication Systems, 3. Modulation and Need for Modulation, 4. Types of Modulation, 5. Demodulation or Detection, Concept of Bandwidth 6. Amplitude Modulation: Mathematical Representation of AM Wave, Modulation Index, Frequency Spectrum of the AM Wave, Representation of AM Wave, 7. Concept of Over Modulation, Modulation Index Calculation Using AM Wave, 8. Power Relations in AM Wave, Generation of AM: High Level Collector Modulator Circuit (Class C),	

	9. AM Demodulation: Simple Diode Detector for AM, Problems.	
	Unit Outcomes: UO1. Analyze characteristics Basic Communication System and its classification. UO2. Perform Demodulation or Detection of any modulation.	
II	**AM Radio Receivers**	**12**
	1. Introduction to Functions of Receiver, 2. Receiver Types, 3. Tuned Radio Frequency (TRF) Receiver, 4. Super Heterodyne Receivers, 5. Characteristics of The Receivers, Sensitivity, Selectivity, Fidelity, 6. Image Frequency and its Rejection, 7. Double Spotting, Problems.	
	Unit Outcomes: UO1. Analyze parameters of different types of AM radio receiver and its applications. UO2. Determine the specific frequency range where image interference is most likely to occur based on the receiver's tuning characteristics.	
III	**Frequency Modulation**	**11**
	1. Introduction to Theory of FM and PM, 2. Frequency Modulation, 3. Phase Modulation, 4. Mathematical Representation of FM, Frequency Spectrum of FM Wave, 5. Practical Bandwidth, 6. Phase Modulation: Generation of FM, Transistor Reactance Modulator and Varactor Diode Modulators, 7. FM Receivers, Block Diagram of FM Receiver, 8. FM Detectors: Balanced Slope Detector For FM, 9. Numerical Problems.	
	Unit Outcomes: UO1. Design and explain frequency and phase modulation. UO2. Explain the role of the Local Oscillator (LO) and Mixer in down-converting high-frequency FM signals to a standard Intermediate Frequency (IF), typically 10.7 MHz.	
IV	**Modern Communication Applications**	**11**
	1 Satellite Communications Systems, 2. Modems: FSK Modem, Block Diagram of FSK Modem, 3. Introduction to Networks, 4. Facsimile Machine, Scanning Mechanism in FAX Machine, 5. Block Diagram of FAX Transceiver, 6. Cellular Radio System, 7. Multiplication & Division of 4- & 8-bit numbers, 8. Basic Concepts of Cellular Radio System and General Block Diagram of Cellular System.	
	Unit Outcomes: UO1. Describe the Architecture and organization Satellite Communications Systems.	

	UO2. Compare the noise immunity of FSK modems against Amplitude Shift Keying (ASK) systems in industrial environments.	

Learning Resources:

1. Communication Engineering- J. S. Katre Tech. Max. Publications, Pune 2nd Revised Edition (Unit I, II, III)
2. Electronic Communication Systems 4th Edition, George Kennedy, Bernard Davis, Tata McGraw Publishing Company Ltd New Delhi (Unit I To IV)
3. Communication Electronics- 2nd Edition Louis E. Frenzel, McGraw Hill International Editions.
4. Electronic Communications 4th Edition- Dennis Roddy, John Coolen, Printice-Hall of India Pvt. Ltd New Delhi.

Internal Examination Pattern:

CAT – I: Home Assignment

CAT – II: PPT Presentation/ Open Book Test/ Poster Presentation/ Seminar/ Online Quiz/ Descriptive Test

Mapping of POs, PSOs and COs:

COs/POs & PSOs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6
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CO2	2	2	3	0	2	2	1	3	2	3	2	2	2	1
CO3	2	1	3	0	2	1	1	3	1	2	1	1	2	1
CO4	2	1	2	0	2	2	1	3	1	3	1	2	2	1

Scale: 3 = High, 2 = Moderate, 1 = Low, 0 = No correlation.

Faculty of Science and Technology
Department of Physics and Electronics
PG I Sem I

Course Type : MEC Lab Course-I
Course Title : MEC Lab Course-I (Based on MEC-I)
Course Code : 601PHY1202
Credit : 01 **Max. Marks: 50** **Lectures: 30 Hrs.**

Learning Objectives:

LO1. To equip students with the practical skills required to verify fundamental logic gates and realize complex logic functions using universal gates such as NAND and NOR.

LO2. To develop a comprehensive understanding of sequential logic operations through the hands-on construction and analysis of latches, flip-flops (J-K, D, T), and versatile shift registers.

LO3. To train students in the design, implementation, and evaluation of core combinational circuits, specifically focusing on parallel adders/subtractors, multiplexers, and demultiplexers.

LO4. To foster practical proficiency in microprocessor architecture and assembly language programming by guiding students to write and execute code for the 8085 microprocessors to operate decimal counters and digital displays.

Course Outcomes:

After completion of the course, the students will be able to-

CO1. Verify and interpret the truth tables of basic logic gates and implement logic functions using universal gates (NAND and NOR).

CO2. Construct and analyze sequential circuits such as latches, flip-flops, and shift registers for various operations.

CO3. Design and implement combinational circuits, including multiplexers, demultiplexers, and parallel adders/subtractors.

CO4. Develop and execute assembly language programs for decimal counters and flashing displays using the 8085 microprocessors.

Practical No.	Unit
1	Verification and interpretation of truth tables for AND, OR, NOT and NAND gates
2	Realization of logic functions with the help of universal gates-NAND Gate.
3	Realization of logic functions with the help of universal gates-NOR Gate.
4	Construction of a NOR gate latch and verification of its operation.
5	Implementation and verification of truth table for J-K flip-flop, D flip-flop and T flipflop using logic gates.
6	Design and implementation of shift register to function as i) SISO, ii) SIPO, iii) PISO, iv) PIPO, v) shift left and vi) shift right operation.

7	Parallel adder / subtractor using IC 7483.
8	Design and set up a 4:1 Multiplexer and 1:4 demultiplexer.
9	Program for two-digit decimal counters by using 8085 microprocessors.
10	Program for flashing display by using 8085 microprocessors.

Learning Resources:

1. Semiconductor devices: Physics and Technology 2nd Edition, S. M. Sze
2. Op-Amps and Linear Integrated Circuits, Ramakant A. Gayakwad
3. Modern Digital Electronics by R.P. Jain Fourth Edition, (2010) Tata McGraw Hill Education Pvt. Ltd.
4. Semiconductor Optoelectronic devices-Pallab Bhattacharya, PHI, (1995)
5. Digital Principles and Circuits- Dr. C. B. Agarwal, Himalaya Publishing House.
7. Microprocessor Architecture, Programming, and Applications with the 8085 by Ramesh S. Gaonkar (2002)
8. A Textbook of Applied Electronics – R. S. Sedha

Internal Examination Pattern:

CAT – I: Record Book Submission

CAT – II: Overall performance in the regular practical

Mapping of POs, PSOs and COs:

COs/POs & PSOs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6
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CO3	2	3	3	1	1	2	2	3	2	3	3	2	2	1
CO4	2	3	3	1	1	2	2	3	2	3	3	2	2	1

Scale: 3 = High, 2 = Moderate, 1 = Low, 0 = No correlation

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Faculty of Science and Technology

Department of Physics and Electronics

PG I Sem I

Course Type : RMC
Course Title : Research Methodology
Course Code : 601PHY1301
Credits : 04 **Max. Marks: 100** **Lectures: 60 Hrs.**

Learning Objectives:

- LO1. To enable to student to understand and work methods and concepts related Research.
- LO2. To enable the student to develop research proposal and to work with research problem.
- LO3. To develop broad comprehension of research area.

Course Outcomes:

After completion of the course, the student will be able to-

- CO1. Examine the basic aspects of Research methods
- CO2. Apply and integrate the basic concepts Collection and analysis of data.
- CO3. Identify and implement the essential components of a formal report, including the abstract, table of contents, methodology, results, and bibliography.
- CO4. Examine the plagiarism by using various apps.

Unit No.	Title of Unit & Contents	Hrs.
I	**Introduction and Methods of Research**	15
	1. Meaning of Research, Objectives of Research, Types of Research, 2. Research Approaches, Significance of Research, Research Methods Versus Methodology, Research and Scientific Methods, 3. Research Processes, Criteria for Good Research 4. Research Problem, Selecting the Problem, Necessity of Defining the Problem, Techniques Involved in Defining a Problem	
	Unit Outcome: UO1. Examine the basic aspects of Research methods	
II	**Research Design and Sampling**	15
	1. Meaning and Need for Research Design, Features of A Good Design. 2. Important Concepts Relating to Research Design: Dependent and Independent Variables, Extraneous Variables, Control, Research Hypothesis, Experimental and Non-Experimental Hypothesis –Testing Research, Experimental and Control Group 3. Different Research Designs: Research Design in Case of Exploratory Research Studies, Research Design in Case of Hypothesis- Testing Research Studies, Basic Principles of Experimental Designs, Important Experimental Designs 4. Sampling Design, Steps in Sample Design, Criteria of Selecting a Sampling Procedure, Characteristics of A Good Sample Design, Different Types of Sample Design	
	Unit Outcome:	

	UO1. Apply and integrate the basic concepts Collection and analysis of data.	
III	**Data Collection and Data Processing**	**15**
	1. Measurements in Research, Measurement Scales, Sources of Errors in Measurement. 2. Collection of Primary Data: Observation Method, Interview Method, Through Questionnaires, Through Schedules, Difference Between Questionnaire and Schedule 3. Collection of Secondary Data, Selection of Appropriate Methods for Data Collection, Case Study Method 4. Data Processing, Processing Operations: Editing, Coding, Classification, Tabulation, Graphical Representation, Types of Analysis, Statistical Tools and Techniques of Data Analysis-Measures of Central Tendency, Dispersion.	
	Unit Outcome: UO1. Identify and implement the essential components of a formal report, including the front matter (abstract, title page), core content (methodology, results), and back matter (references, appendices).	
IV	**Report Writing and Evaluations**	**15**
	1. Principles of Report Writing and Guide Lines According to Style Manuals. 2. Writing and Presentation of Preliminary, Main Body and Reference Section of Report. 3. Evaluation of Research Report. 4. Methods to Search Required Information Effectively, Reference Management Software Like Zotero/ Mendeley, Software for Paper Formatting Like Latex/ MS Office. 5. Software for Detection of Plagiarism.	
	Unit Outcome: UO1. Examine the plagiarism by using various apps.	

Learning Recourses:

1. Bajpai S. R. (1975) Methods of Social Survey and Research, Kitabghar, Kanpur.
2. Hans Raj (1988) Theory and Practice in Social Research, Surjeet Publication, Kolhapur.
3. Krishnaswami O. R. (1988) Methodology of Research in Social Science, Himalaya Pub. House.
4. Sadhu, Singh, Research Methodology in Social Science Bhandarkar, Research Methodology
5. Kothari, C. R. (2005) Quantitative Technique, New Delhi, Vikas Publication House.
6. Gautam, N. C. (2004) Development of Research tools, New Delhi, Shree Publishers.
7. Gupta, Santosh (2005) Research Methodology and Statistical Techniques, Deep and Deep Publications.
8. Chandera A. and Sexena T. P. (2000) Style Manual, New Delhi, Metropolitan Book Comp. Ltd.
9. Shukla, J. J. (1999) Theories of Knowledge, Ahmadabad, Karnavati Publication.
10. Bhattacharya, D. K. (2004) Research Methodology, New Delhi, Excel Books.
11. Brymann, Alan and Carmer, D. (1995) Qualitative data analysis for social scientist, New York, Routledge Publication.
12. Best J. W. and Khan J. V. (2005) Research in Education New Delhi, Prentice Hall India.

Internal Examination Pattern:

CAT – I: Home Assignment
CAT – II: PPT Presentation/ Open Book Test/ Poster Presentation/ Seminar/ Online Quiz/ Descriptive Test

Mapping of POs, PSOs and COs:

COs/POs & PSOs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6
CO1	1	2	3	2	2	2	3	1	2	0	0	3	3	1
CO2	1	2	3	2	2	2	3	1	2	0	0	3	3	1
CO3	1	1	2	2	1	2	3	1	1	0	0	2	3	1
CO4	1	1	2	3	2	2	3	1	1	0	0	2	3	1

Scale: 3 = High, 2 = Moderate, 1 = Low, 0 = No correlation.

Semester - II

Shiv Chhatrapati Shikshan Sanstha's

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Empowered Autonomous Institution

Faculty of Science and Technology

Department of Physics and Electronics

PG I Sem II

Course Type : MMC - V

Course Title : Advanced Atomic and Molecular Physics

Course Code : 601PHY2101

Credits : 03 **Max. Marks: 75** **Lectures: 45 Hrs.**

Learning Objectives:

LO1. To provide students with a strong conceptual foundation in the quantum states of single and multi-electron atoms, Pauli's principle, and advanced coupling interactions like LS and JJ coupling.

LO2. To develop students' ability to analyze and mathematically model the effects of external magnetic and electric fields on atomic systems, including the Zeeman, Paschen-Back, and Stark effects.

LO3. To enhance students' understanding of molecular rotational dynamics by classifying molecular typologies and analyzing rotational spectra using rigid and non-rigid rotor models.

LO4. To equip students with the knowledge and skills necessary to model complex molecular vibrational dynamics, interpret infrared spectroscopy principles, and analyze rotational-vibrational spectra (PQR branches).

Course Outcomes:

Upon successful completion of the course, students will be able to:

CO1. Analyze the quantum states of atomic systems, differentiate between equivalent and non-equivalent electrons, and calculate interaction energies using LS and JJ coupling schemes.

CO2. Evaluate the dynamic behavior of atomic systems under the influence of external fields, demonstrating a clear understanding of normal, anomalous, and high-field phenomena.

CO3. Classify molecules based on their rotational dynamics and mathematically determine their rotational energy levels, spectral line intensities, and microwave spectroscopic signatures.

CO4. Model diatomic molecules as both harmonic and anharmonic oscillators using the Morse potential, and interpret complex vibration-rotation spectra and IR spectrometer readouts.

Unit No.	Title of Unit & Contents	Hrs.
I	**Advanced Atomic States and Coupling Interactions**	**12**
	Quantum States: Quantum states of one-electron atoms, atomic orbitals, Pauli's principle, and the behavior of equivalent and non-equivalent electrons. **Advanced Couplings & Interactions:** Spin-orbit interaction and fine structure in alkali spectra. Two-electron systems and the calculation of interaction energy in LS and JJ Coupling. Qualitative treatment of Hyperfine structure and general ideas of line broadening mechanisms.	
	Unit Outcomes: UO1. Determine the quantum states of atoms utilizing atomic orbitals and Pauli's principle, and successfully distinguish between the behavior of equivalent and non-equivalent electrons.	

	UO2. Calculate interaction energies for two-electron systems using LS and JJ coupling schemes, and qualitatively explain hyperfine structures and line broadening mechanisms.	
II	**Advanced Atomic Effects in External Fields**	**11**
	Zeeman and Stark Dynamics: Normal and anomalous Zeeman effects. **High-Field Phenomena:** The Paschen-Back effect. The Stark effect in atomic systems.	
	Unit Outcomes: UO1. Explain the splitting of atomic energy levels in weak magnetic fields by differentiating between the normal and anomalous Zeeman dynamics. UO2. Evaluate high-field atomic phenomena by analyzing the Paschen-Back effect in strong magnetic fields and the Stark effect in external electric fields.	
III	**Advanced Molecular Rotational Dynamics**	**11**
	Molecular Typology: Classification of molecules into diatomic linear, symmetric top, asymmetric top, and spherical top molecules. **Rotor Models**: Rotational spectra of diatomic molecules treated as a rigid rotor. Energy levels, spectra of non-rigid rotors, and the intensity of rotational lines. **Microwave Spectroscopy**: Principles and qualitative understanding of the Stark modulated microwave spectrometer.	
	Unit Outcomes: UO1. Explain the classification of molecules into diatomic linear, symmetric top, asymmetric top, and spherical top typologies based on their structural characteristics. UO2. Calculate the energy levels and spectral lines of rigid and non-rigid diatomic rotors, and interpret the foundational principles of a Stark modulated microwave spectrometer.	
IV	**Advanced Molecular Vibrational Dynamics**	**11**
	Harmonic and Anharmonic Models: Vibrational energy of a diatomic molecule treated as a simple harmonic oscillator, including its energy levels and spectrum. **Complex Rotational-Vibrational Systems**: The Morse potential energy curve and molecules operating as a vibrating rotator. Vibration spectrum of a diatomic molecule focusing on PQR branches. **Infrared Spectroscopy**: Qualitative understanding and principles of the IR spectrometer	
	Unit Outcomes: UO1. Explain the vibrational energy levels and spectrum of a diatomic molecule by modeling it as both a simple harmonic oscillator and an anharmonic system using the Morse potential energy curve. UO2. Analyze the complex rotational-vibrational spectrum of a diatomic molecule (specifically focusing on the PQR branches) and describe the qualitative principles of an IR spectrometer.	

Learning Resources:

1. Elements of Spectroscopy- S.L. Gupta, V. Kumar and R.C. Sharma, Pragati Prakashan Publications, 9th Edition, 2006.
2. Fundamental of Molecular Spectroscopy-Colin N. Banwell, and Elanie Tata McGraw Hill, New Delhi, 1994.

3. Straughan B.P and Walker. S., Spectroscopy – Vol.1,2,3, Chapman and Hall London, 1965.
4. Molecular Spectroscopy – G. Aruldhas.
5. Introduction to Atomic Spectra – H.E. White, Mac-Graw Hill (1934).
6. Spectroscopy Vol,II and III BP Stranghen and S Walkar
7. Introduction to Molecular spectroscopy, C.M. Barrow
8. Spectra of diatomic molecules, G. Herzberg

Internal Examination Pattern:

CAT – I: Home Assignment

CAT – II: PPT Presentation/ Open Book Test/ Poster Presentation/ Seminar/ Online Quiz/ Descriptive Test

Mapping of POs, PSOs and COs:

COs/POs & PSOs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6
CO1	3	2	3	0	2	0	1	2	3	1	0	2	2	3
CO2	3	2	3	0	2	0	1	2	3	1	0	2	2	3
CO3	3	1	2	0	2	0	1	1	2	1	0	2	2	3
CO4	3	2	3	0	2	0	1	2	3	1	0	2	2	3

Scale: 3 = High, 2 = Moderate, 1 = Low, 0 = No correlation.

PG I Sem II

Course Type : MMC Lab Course-IV
Course Title : MMC Lab Course-IV (Based on MMC-V)
Course Code : 601PHY2105
Credit : 01 **Max. Marks: 50** **Lectures: 30 Hrs.**

Learning Objectives:

LO1. To equip students with the foundational skills in algorithmic logic design and C programming required to solve mathematical problems using control structures, loops, recursion, and arrays.
LO2. To train students in advanced data handling and matrix algebra by applying multi-dimensional arrays and implementing file-management techniques (storing and retrieving data) in C.
LO3. To develop an understanding of computational physics by guiding students to write C programs that execute numerical methods for solving linear algebraic problems, specifically calculating eigenvalues and eigenvectors.
LO4. To foster proficiency in simulating statistical and stochastic physical phenomena by utilizing random number generation and sorting algorithms to organize and analyze large datasets.

Course Outcomes:

Upon successful completion of the course, students will be able to:

CO1. Implement fundamental algorithmic logic and execute C programs utilizing control structures (loops and recursion) to solve mathematical problems such as factorial calculations, series summation, and array manipulations.
CO2. Perform advanced matrix operations and data handling by applying multi-dimensional arrays for matrix algebra, and utilize file-handling techniques to store, retrieve, and process experimental data externally.
CO3. Execute numerical methods for physical problems by developing C programs to solve linear algebraic problems, specifically computing the eigenvalues and eigenvectors of 2×2 matrices using direct calculation and the Power Method.
CO4. Simulate statistical and stochastic processes by utilizing random number generation and sorting algorithms to model probabilistic physical phenomena and organize datasets for computational analysis.

Practical No.	Experiment
1	Implementation of Factorial Calculation Using C Programming
2	Finding the Largest Number in an Array Using C Programming
3	Matrix Addition Using C Programming
4	File Handling Operations Using C Programming
5	Matrix Addition Using File Handling in C Programming
6	Summation of a Series Using C Programming

7	Sorting Numbers in Ascending Order Using C Programming
8	Computation of Eigenvalues and Eigenvectors of a Real Asymmetric 2×2 Matrix Using C Programming
9	Generation of Random Numbers Using C Programming
10	Power Method for Eigenvalue Calculation Using C Programming

Learning Resources:

1. Engaged Learning for Programming in C++: A Laboratory Course by Jim Roberge, James Robergé, Matthew Bauer, George K. Smith (2001)
2. C and Data Structures (with Lab Manual) by V. V. Muniswamy (2007)
3. C Programming Made Easy: A Handbook for Laboratory by Z Fetcher (2020)
4. C Programming Language, By Brian W. Kernighan, Dennis M. Ritchie (2017)
5. C Programming Language First Edition (Part 2), By ARPAN SAHA (2019)
6. Learning the C Programming Language - 1st Edition, By Saiprasad Maharana (2021)
7. C Programming Language: Simple, Short, and Straightforward Way of Learning C Programming Language, by Sherwyn Allibang (2017)
9. C Language and Numerical Methods, By C. Xavier (2007)

Internal Examination Pattern:

CAT – I: Record Book Submission

CAT – II: Overall performance in the regular practical

Mapping of POs, PSOs and COs:

COs/POs & PSOs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6
CO1	2	3	3	0	2	2	2	2	3	2	0	2	2	1
CO2	2	3	3	0	2	2	2	2	3	2	0	2	2	1
CO3	2	3	3	0	2	2	2	2	3	2	0	2	2	1
CO4	2	3	3	0	2	2	2	2	3	2	0	2	2	1

Scale: 3 = High, 2 = Moderate, 1 = Low, 0 = No correlation.

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PG I Sem II

Course Type : MMC - VI

Course Title : Condensed Matter Physics

Course Code : 601PHY2102

Credits : 03 **Max. Marks: 75** **Lectures: 45 Hrs.**

Learning Objectives:

LO1. To equip students with the fundamentals of latest trends in condensed matter physics required for NET/SLET/GATE Examinations.

LO2. To develop the understanding of the basic concepts of Crystal Physics, Semiconductors, Magnetism and Superconductors.

LO3. To train students in analytical and numerical problem-solving skills in solid state physics and magnetism.

LO4. To foster an advanced understanding of crystal imperfections, lattice dynamics, and dielectric properties to address and solve real-world materials science challenges.

Course Outcomes:

Upon successful completion of the course, students will be able to:

CO1. Analyze advanced diffraction patterns and lattice dynamics to determine the structural, vibrational, and thermal characteristics of complex materials.

CO2. Classify various crystal imperfections (point, line, and planar) and evaluate their specific roles in the physical properties, crystal growth, and plastic deformation of solids.

CO3. Apply macroscopic thermodynamic principles and microscopic quantum theories to explain advanced superconducting phenomena.

CO4. Evaluate the classical and quantum mechanical origins of magnetic and dielectric properties, utilizing theories of paramagnetism, ferromagnetism, and local electric fields.

Unit No.	Title of Unit & Contents	Hrs.
I	**Diffraction and Lattice Dynamics**	**11**
	1. Diffraction: Bragg's Condition, 2. Reciprocal Lattice and Their Properties 3. Ewald Sphere, Structure Factor, Atomic Form Factor, 4. Comparison of X-ray, Electron and Neutron Diffraction Methods 5. Lattice Dynamics: Vibrations of monoatomic and diatomic linear lattices (Acoustical and Optical phonon branches). 6. Dispersion relations, Phonon momentum, and Inelastic scattering of neutrons by phonons.	
	Unit Outcomes: UO1. Compare and interpret X-ray, electron, and neutron diffraction methods using advanced concepts like the reciprocal lattice, Ewald sphere, and structure factor. UO2. Analyze the dispersion relations for monoatomic and diatomic linear lattices and differentiate between acoustical and optical phonon branches.	

Unit No.	Title of Unit & Contents	Hrs.
II	**Crystal Defects and Imperfections**	**11**
	1. Introduction to Crystal Imperfections 2. Point Defects: Schottky and Frenkel Defects, Thermodynamics of point defects and Equilibrium Concentration of Vacancies, Color Centers 3. Line Defects: Screw and Edge Dislocations, Berger's Vector and Circuit, Role of Dislocations in Plastic Deformation and Crystal Growth 4. Planar Defects: Stacking Faults, Grain boundaries 5. Observation of Imperfections in Crystals	
	Unit Outcomes: UO1. Explain the thermodynamics of point defects and calculate the equilibrium concentration of vacancies, including Schottky and Frenkel defects. UO2. Evaluate the role of line and planar imperfections, such as screw/edge dislocations and stacking faults, in crystal growth and mechanical deformation.	
III	**Superconducting Properties**	**12**
	1. Thermodynamics of the superconducting transition, 2. London Equations and Penetration Depth. 3. Type-I and Type-II Superconductors, Meissner Effect 4. Cooper Pair, Fundamentals of the BCS Theory of Superconductivity 5. Flux Quantization 6. Josephson Effects (AC and DC) and SQUIDs. 7. High-Tc Superconductivity	
	Unit Outcomes: UO1. Formulate the London equations and explain the macroscopic thermodynamic transitions and penetration depth of Type-I and Type-II superconductors. UO2. Explain the formation of Cooper pairs as a result of electron-phonon interactions in the lattice at low temperatures.	
IV	**Magnetic Properties**	**11**
	1. Introduction, 2. Origin of Magnetic Properties of Materials, 3. Magnetic Susceptibility, 4. Classification of Magnetic Materials, 5 Theory of Diamagnetism, 6. Classical and Quantum Theories of Paramagnetism, 7. Exchange Interactions, Magnetic Order (Ferro-, Anti-Ferro- and Ferrimagnetism), 8. Weiss Theory of Ferromagnetism, Ferromagnetic Domains.	
	Unit Outcomes: UO1. Distinguish between classical and quantum theories of paramagnetism, and analyze exchange interactions, Weiss theory, and spin waves (magnons) in ferromagnetism. UO2. Evaluate the local electric field at an atom in dielectrics and apply the Clausius-Mossotti relation to understand polarization and ferroelectricity.	

Learning Resources:

1. Introduction to solid state physics - C. Kittel, 5th Edn., John Wiley & Sons. Inc., New York (1976).
2. Solid State Physics by A. J. Dekker, MacMillan India Ltd. (1986).
3. Solid State Physics - N. W. Ashcroft and N. D. Mermin, HRW International edn. (1976).
4. Electronic Properties of Materials - R. E. Hummel, 2nd Edn., Springer International (1994).
5. Solid State Physics - J. S. Blakemore, 2nd Edn., Cambridge University Press (1985).
6. Elementary Solid-State Physics - Omer Ali.
7. Introduction to Solids – Azaroft.
8. Solid State Physics - Wahab.
9. Solid State Physics - Ajay kumar Saxena.
10. Solid State Physics - So Pillai.

Internal Examination Pattern:

CAT – I: Home Assignment
CAT – II: PPT Presentation/ Open Book Test/ Poster Presentation/ Seminar/ Online Quiz/ Descriptive Test

Mapping of POs, PSOs and COs:

COs/POs & PSOs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6
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CO2	3	1	2	0	2	0	2	1	2	1	0	2	2	3
CO3	3	1	3	0	2	0	2	2	3	2	0	3	2	3
CO4	3	1	3	0	2	0	2	2	3	1	0	3	2	3

Scale: 3 = High, 2 = Moderate, 1 = Low, 0 = No correlation.

PG I Sem II

Course Type : MMC Lab Course-V

Course Title : MMC Lab Course-V (Based on MMC-VI)

Course Code : 601PHY2106

Credit : 01 **Max. Marks: 50** **Lectures: 30 Hrs.**

Learning Objectives:

LO1. To equip students with the experimental skills necessary to investigate essential electrical properties of semiconductors, including charge carrier density, mobility, and bandgap energy.

LO2. To train students in structural characterization techniques by guiding them to interpret X-ray Diffraction (XRD) and Neutron Diffraction patterns for determining crystal structures.

LO3. To develop a practical understanding of macroscopic material properties by performing experiments to measure magnetic susceptibility, dielectric constants, and ferromagnetic hysteresis.

LO4. To foster practical proficiency in handling advanced solid-state characterization instruments, emphasizing rigorous data collection, error analysis, and the experimental validation of theoretical physics concepts.

Course Outcomes:

After completion of course the student will be able to-

CO1. Evaluate essential semiconductor parameters-such as majority carrier type, density, mobility, and bandgap-by executing the Hall Effect, Four-Probe, and Two-Point Probe experimental methods.

CO2. Analyze X-ray Diffraction (XRD) and Neutron Diffraction patterns to deduce the specific crystal structure and lattice constants of metallic (Al) and semiconducting (CdS) thin films.

CO3. Assess the magnetic susceptibility of solutions using Quincke's method, and examine the dielectric constants of liquids alongside the hysteresis behavior (B-H curve) of ferromagnetic materials.

CO4. Demonstrate practical proficiency in utilizing advanced instrumentation for materials characterization, validating theoretical solid-state physical principles through precise data collection and rigorous error analysis.

Practical No.	Unit
1	Determination of the type of majority charge carriers, charge carrier density and carrier mobility by using Hall Effect
2	Determination of the crystal structure of CdS thin film from given XRD Pattern.
3	Determination of the magnetic susceptibility of $FeCl_3$ solution by using Quincke's Method.
4	Determination of the crystal structure of Aluminium thin film from given XRD Pattern/Neutron diffraction
5	Determination of resistivity and band gap of semiconductors using Four Probe Method

6	Determination of dielectric constant of liquids.
7	Determination of electrical resistivity of semiconductor (DC Two Point Probe)
8	Hysteresis loop for a ferromagnetic material (B-H curve)

Learning Resources:

1. Introduction to solid state physics - C. Kittel, 5th Edn., John Wiley & Sons. Inc., New York (1976).
2. Solid state physics by A. J. Dekker, MacMillan India Ltd. (1986).
3. Solid state physics - N. W. Ashcroft and N. D. Mermin, HRW International edn.(1976).
4. Electronic properties of materials - R. E. Hummel, 2nd Edn., Springer International (1994).
5. Solid state physics - J. S. Blakemore, 2nd Edn., Cambridge University Press (1985).
6. Elementary Solid-State Physics - Omer Ali.
7. Introduction to Solids – Azaroft.
8. Solid State Physics - Wahab.
9. Solid State Physics - Ajay kumar Saxena.
10. Solid State Physics - So Pillai.

Internal Examination Pattern:

CAT – I: Record Book Submission

CAT – II: Overall performance in the regular practical

Mapping of POs, PSOs and COs:

COs/POs & PSOs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6
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CO2	3	3	2	0	1	2	3	2	3	2	2	3	2	3
CO3	2	3	2	0	1	2	2	2	2	2	3	2	2	2
CO4	2	3	3	2	2	2	3	3	2	2	3	3	2	2

Scale: 3 = High, 2 = Moderate, 1 = Low, 0 = No correlation

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PG I Sem II

Course Type : MMC - VII
Course Title : Thermodynamics and Statistical Mechanics
Course Code : 601PHY2103
Credits : 03 **Max. Marks: 75** **Lectures: 45 Hrs.**

Learning Objectives:

LO1. To establish a comprehensive understanding of the fundamental laws of thermodynamics and their direct correlation with statistical mechanics through the analysis of phase space, microstates, and entropy.

LO2. To train students in formulating partition functions and evaluating thermodynamic properties using microcanonical, canonical, and grand canonical ensemble theories.

LO3. To equip students with the analytical skills required to distinguish and apply Maxwell-Boltzmann, Bose-Einstein, and Fermi-Dirac quantum distributions to complex physical systems like ideal gases, phonons, and free electrons in metals.

LO4. To cultivate an advanced understanding of phase equilibrium and critical phenomena by examining the mathematical and structural principles of first and second-order phase transitions.

Course Outcomes:

Upon successful completion of the course, students will be able to:

CO1. Analyze the theoretical connection between microscopic statistics and macroscopic thermodynamics to calculate changes in entropy, internal energy, free energy, and physical fluctuations.

CO2. Construct and utilize partition functions within various statistical ensembles to derive thermodynamic functions, specific heat, and energy fluctuations for perfect gases.

CO3. Evaluate the thermal and quantum properties of Boson and Fermion gases by applying appropriate quantum distribution models to phenomena such as Bose-Einstein condensation and strongly degenerate electron gases.

CO4. Examine the conditions for phase equilibrium and differentiate between first-order and second-order phase transitions using the Clausius-Clapeyron equation and critical indices.

Unit No.	Title of Unit & Contents	Hrs.
I	**Statistical Mechanics and Thermodynamics**	**11**
	1. Basic Concepts-Phase Space, Ensemble, A Priori Probability, Liouville's Theorem, 2. Fluctuations of Physical Quantities, Statistical Equilibrium, 3. Thermodynamics: Thermodynamic Laws and Functions - Entropy, Free Energy, Internal Energy, Enthalpy (Definitions), 4. Contact Between Statistics and Thermodynamics – Entropy in Terms of Microstates,	

Unit No.	Title of Unit & Contents	Hrs.
	5. Change in Entropy with Volume and Temperature.	
	Unit Outcomes: UO1. State the laws of thermodynamics and to differentiate between various forms of energy. UO2. Apply the principles of statistical mechanics to selected problems.	
II	**Statistical Ensemble Theory**	**11**
	1. Introduction, Micro Canonical Ensemble-Micro Canonical Distribution, 2. Entropy and Specific Heat of a Perfect Gas, 3. Canonical Ensemble-Canonical Distribution, 4. Partition Function, 5. Calculation of Free Energy of An Ideal Gas, 6. Thermodynamic Functions, Energy Fluctuations, 7. Grand Canonical Ensemble - Grand Canonical Distribution	
	Unit Outcome: UO1. Differentiate between different ensemble theories. UO2. Learn the Maxwellian distributions of speeds in ideal gas.	
III	**Formulation of Quantum Statistics**	**12**
	1. Distinction Between MB, BE and FD Distributions, 2. Quantum Distribution Functions Boson and Fermion Gas and Their Boltzmann Limit, Partition Function, 3. Ideal Bose Gas, 4. Bose Einstein Condensation, Phonon Gas, 5. Liquid He^4: Second Sound. 6. Ideal Fermi Gas: Weakly and Strongly Degenerate, 7. Electron Gas: Free Electron Theory of Metals.	
	Unit Outcomes: UO1. Define and discuss the concept of microstates and macrostates of model system, the Boltzmann distribution and the role of partition function. UO2. Define the Fermi Dirac and Boltz Einstein Distribution; State their applicability.	
IV	**Phase Transitions and Critical Phenomenon**	**11**
	1 Introduction, 2. Phase Transitions, Conditions for Phase Equilibrium, 3. First Order Phase Transition, 4. Clausius - Clapeyron Equation, 5 Second Order Phase Transition, 6. The Critical Indices, 7. Problems.	
	Unit Outcomes:	

Unit No.	Title of Unit & Contents	Hrs.
	UO1. Explain the fundamental principles and concepts of Phase Transitions and its significance in day-to-day life. UO2. Discuss how Second order phase transition provides chemical and structural changes in materials.	

Learning Resources:

1. Introduction to Statistical Mechanics, B. B. Laud, Macmillan, N Delhi, (1981).

2. Statistical Mechanics by R K Pathria, Pergamon press (1972).

3. Statistical and thermal Physics F Reif, McGraw-Hill (1965).

4. Statistical Physics, L D Landau and E M Lifshitz, Pergamon press (1958).

Internal Examination Pattern:

CAT – I: Home Assignment

CAT – II: PPT Presentation/ Open Book Test/ Poster Presentation/ Seminar/ Online Quiz/ Descriptive Test

Mapping of POs, PSOs and COs:

COs/POs & PSOs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6
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CO2	3	0	3	0	2	0	1	1	3	0	0	1	2	3
CO3	3	0	3	0	2	0	2	2	3	1	0	2	2	3
CO4	3	0	3	0	2	0	1	1	3	0	0	1	2	3

Scale: 3 = High, 2 = Moderate, 1 = Low, 0 = No correlation.

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Department of Physics and Electronics

PG I Sem II

Course Type **: MMC Lab Course-VI**

Course Title **: MMC Lab Course-VI (Based on MMC-VII)**

Course Code **: 601PHY2107**

Credit **: 01** **Max. Marks: 50** **Lectures: 30 Hrs.**

Learning Objectives:

LO1. To equip students with the experimental techniques required to analyze the thermal and optical characteristics of semiconductor devices (p-n junctions, thermistors) and evaluate fundamental physical constants like Planck's constant.

LO2. To develop an empirical understanding of electromagnetism and AC circuit dynamics through the practical measurement of dielectric constants, mutual inductance, and the frequency response of resonant circuits.

LO3. To train students in the foundational principles of analog communication systems by guiding them to generate, measure, and analyze Amplitude Modulated (AM) signals.

LO4. To foster proficiency in embedded systems and low-level programming by instructing students to design and execute assembly language code for fundamental arithmetic operations using the 8051 microcontrollers.

Course Outcomes:

Upon successful completion of the course, students will be able to:

CO1. Evaluate the thermal and optical properties of semiconductor materials to determine the energy bandgap of p-n junctions and thermistors, and experimentally deduce Planck's constant using light-emitting diodes.

CO2. Analyze the electromagnetic and frequency-response characteristics of passive components by experimentally quantifying dielectric constants, mutual inductance, and the impedance behavior of series and parallel resonant circuits.

CO3. Examine the principles of electronic signal transmission by generating Amplitude Modulated (AM) waveforms and calculating the modulation index to assess transmission efficiency.

CO4. Develop and execute structured assembly language programs utilizing the 8051-microcontroller instruction set to perform core arithmetic operations (addition, subtraction, multiplication, division), demonstrating competency in hardware-software interfacing.

Practical No.	Unit
1	Temperature dependence of current of p-n junction diode – estimation of band gap of semiconductor materials
2	To study the band gap of thermistor
3	To determine value of Planks constant using LED
4	Determination of dielectric constant of some dielectric materials
5	Mutual inductance of coil
6	Series & parallel resonant circuits

7	Amplitude Modulation to measure the modulation index.
8	Programmes to perform the addition and subtraction of two 8-bit numbers by using micro controller 8051 instruction set.
9	Programmes to perform the multiplication and division of two 8-bit numbers by using micro controller 8051 instruction set.

Learning Resources:

1. Solid state electronic devices by B. G. Streetman.
2. Physics of semiconductor devices by S. M. Sze.
3. Solid State and Semiconductor Physics by McKelvey.
4. Principles of Electronic Materials and Devices by S.O. Kasap.

Internal Examination Pattern:

CAT – I: Record Book Submission

CAT – II: Overall performance in the regular practical

Mapping of POs, PSOs and COs:

COs/POs & PSOs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6
CO1	2	3	3	0	1	2	2	3	2	2	3	2	2	2
CO2	2	3	2	0	1	2	2	2	2	2	3	2	2	2
CO3	2	3	2	1	1	2	2	3	2	3	3	2	2	2
CO4	1	3	3	1	2	2	2	3	2	3	3	2	2	1

Scale: 3 = High, 2 = Moderate, 1 = Low, 0 = No correlation.

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Empowered Autonomous Institution

Faculty of Science and Technology

Department of Physics and Electronics

PG I Sem II

Course Type : MMC - VIII

Course Title : Preparation of NET/SET Examination-II

Course Code : 601PHY2104

Credits: 02 **Max. Marks: 50** **Lectures: 30 Hrs.**

Learning Objectives:

Course Outcomes:

Upon successful completion of the course, students will be able to:

Learning Resources:

Internal Examination Pattern:

CAT – I: Home Assignment

CAT – II: PPT Presentation/ Open Book Test/ Poster Presentation/ Seminar/ Online Quiz/ Descriptive Test

Mapping of POs, PSOs and COs:

COs/POs & PSOs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6
CO1														
CO2														
CO3														
CO4														

Scale: 3 = High, 2 = Moderate, 1 = Low, 0 = No correlation.

PG I Sem II

Course Type : MEC-II (A)
Course Title : Modern Optics
Course Code : 601PHY2201A
Credits : 03 **Max. Marks: 75** **Lectures: 45 Hrs.**

Learning Objectives:

LO1. To establish a rigorous understanding of light as an electromagnetic field by deriving its propagation, energy density, and momentum from first principles using Maxwell's equations.

LO2. To equip students with the analytical frameworks needed to evaluate complex polarization states and manipulate electromagnetic fields using tools like Stokes parameters and Jones matrices.

LO3. To train students in analyzing optical interference and coherence phenomena, enabling them to comprehend the operational principles of advanced interferometers (Michelson, Fabry-Perot, Sagnac, and Hanbury Brown-Twiss).

LO4. To cultivate an advanced understanding of wave optics by applying mathematical theories, such as the Fresnel-Kirchhoff integral and Huygens-Fresnel theory, to solve real-world diffraction problems.

Course Outcomes:

Upon successful completion of the course, students will be able to:

CO1. Derive and analyze the generation and propagation of electromagnetic waves from Maxwell's equations, clearly determining the relationship between the direction of propagation and the electric/magnetic fields.

CO2. Evaluate and forecast the outcomes of optical experiments that manipulate the polarization of light, utilizing theoretical tools like the polarization ellipse and Jones vectors.

CO3. Examine the concepts of spatial and temporal coherence to predict the behavior, resolving power, and free spectral range of various common interferometers.

CO4. Apply Fresnel and Fraunhofer diffraction theories to differentiate between various optical diffraction patterns, and evaluate the functions of optical components like zone plates and spatial filters.

Unit No.	Title of Unit & Contents	Hrs.
I	**Electromagnetic Theory**	**11**
	1. Maxwell's Equations, 2. Energy Density and Momentum of the Electromagnetic Field, 3. Poynting's Theorem, Boundary Conditions on an Interface, 4. Electromagnetic Waves in a Conducting Medium, 5. Polarization: Polarization Ellipse, Different Polarization States, 6. Stokes Parameters and their Measurements,	

Unit No.	Title of Unit & Contents	Hrs.
	7. Jone's Vectors and Matrices, Numerical Problems	
	Unit Outcomes: UO1. Explain how electromagnetic waves arises from Maxwell’s equation. UO2. Demonstrate the transverse nature of electromagnetic waves by showing that the electric field (E), magnetic field (B), and the direction of propagation (k) are mutually perpendicular.	
II	**Interference In Thin Films**	**12**
	1. Introduction, Thin Film, Plane Parallel Thin Film, 2. Twyman and Green Interferometer, 3. Multiple Beam Interference, 4. Fabry-Perot Interferometer and Etalon, Lummer and Gehrcke Plate, 5. Resolving Power, Free Spectral Range and Fineness of Fabry Perot Interferometer, 6. Interference Filters. 7. Sagnac Effect, Sagnac Interferometer, 8. Numerical Problems.	
	Unit Outcomes: UO1. Predict the behavior of common interferometers: Michelson, Fabry – Perot, Mach Zehnder and Sagnac. UO2. Apply the knowledge of superposition to interference	
III	**Coherence**	**11**
	1. Introduction, 2. Theory of Partial Coherence: Spatial and Temporal Coherence, 3. Coherence Length and Coherence Time, Degree of Coherence 4. Fourier Transforms Spectroscopy, 5. Intensity Interferometry, 6. Hanbury Brown-Twiss Interferometer, 7. Numerical Problems.	
	Unit Outcomes: UO1. Explain the phenomenon of coherence UO2. Formulate the relationship between a time-domain (or path-difference) signal and its frequency-domain spectrum using the Fourier Transform integral.	
IV	**Diffraction**	**11**
	1. Introduction, 2. Theory of Diffraction: Fresnel- Kirchhoff Integral Formula and its Application to Diffraction Problems. 3. Huygens-Fresnel Theory, 4. Fresnel’s assumptions, Rectilinear Propagation of light, 5. Zone Plate, Action of Zone Plate for an incident Spherical Wave Front,	

Unit No.	Title of Unit & Contents	Hrs.
	6. Difference between a Zone Plate and a Convex Lens 7. Fresnel Diffraction, Fresnel Zones, Fresnel Integrals, 8. Spatial Filters, 9. Numerical Problems.	
	Unit Outcomes: UO1. Identify the diffraction of light wave as a change in its direction of travel that does not occur due to changes in the medium in which the wave travels. UO2. Relate the angle that light waves spread out after passing through a single slit to the wavelength of the light	

Learning Resources:

1. Optics E. Hecht Pearson Edn (4th Ed) 2004 (Text)
2. Optics 3rd edition Ajoy Ghatak, Tata Mcgraw Hill companies (2005)
3. Quantum Electronics - Amnon Yariv, Academic Press (1998)
4. Principles of optics - Born and Wolf, Cambridge University Press (1981)
5. Fundamentals of Photonics - Saleh and Teich Wiley Intsc (2007)
6. Modern Optics -R. D, Guenther, John Wiley (1990) (Text)

Internal Examination Pattern:

CAT – I: Home Assignment

CAT – II: PPT Presentation/ Open Book Test/ Poster Presentation/ Seminar/ Online Quiz/ Descriptive Test

Mapping of POs, PSOs and COs:

COs/POs & PSOs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6
CO1	3	1	3	0	2	0	1	2	3	2	0	1	2	3
CO2	3	2	3	0	2	0	2	3	3	3	1	2	2	3
CO3	3	2	3	0	2	0	2	3	3	2	1	2	2	3
CO4	3	2	3	0	2	0	1	2	3	2	0	1	2	3

Scale: 3 = High, 2 = Moderate, 1 = Low, 0 = No correlation.

Faculty of Science and Technology
Department of Physics and Electronics
PG I Sem II

Course Type : MEC-II (B)
Course Title : Advanced Astrophysics and Cosmology
Course Code : 601PHY1201B
Credits : 03 Max. Marks: 75 Lectures: 45 Hrs.

Learning Objectives:

LO1. To equip students with the fundamentals of latest trends in astrophysics and cosmology required for NET/SLET/GATE Examinations.
LO2. To develop the understanding of the basic concepts of the expanding universe, stellar evolution, cosmic rays, and astrophysical plasmas.
LO3. To train students in analytical and numerical problem-solving skills in astrophysics, cosmology, and plasma dynamics.
LO4. To foster an advanced understanding of the universe's origin, the life cycle of stars, and the role of thermonuclear fusion in stellar cores.

Course Outcomes:

Upon successful completion of the course, students will be able to:

CO1. Analyze the fundamental concepts of cosmology, including the expanding universe, cosmic background radiation, and the Big Bang theory.
CO2. Evaluate the stages of stellar formation and evolution, distinguishing between the characteristics of various stellar remnants like white dwarfs, neutron stars, and black holes.
CO3. Examine the origin, composition, and effects of primary and secondary cosmic rays, including their interactions with the Earth's magnetic field and solar modulation.
CO4. Apply the principles of plasma physics and magnetohydrodynamics (MHD) to astrophysical phenomena and understand the conditions required for thermonuclear fusion in stars.

Unit No.	Title of Unit & Contents	Hrs.
I	**The Physical World-View and Cosmology**	11
	1. The world at very large distances: Heavenly bodies including star-clusters, nebulae, galaxies, pulsars, and quasars 2. The Expanding Universe: Determination of velocity and distance of a heavenly body 3. Doppler shift and its applications in deep space observation 4. Cosmic background radiation at 3 K 5. The Big Bang Theory and the origins of the universe	
	Unit Outcomes: UO1. Explain the methods used to determine the velocity and distance of heavenly bodies, including the practical applications of Doppler shifts in deep space observation.	

Unit No.	Title of Unit & Contents	Hrs.
	UO2. Understand the foundational theories of the universe, particularly the Big Bang theory and the physical significance of the 3 K cosmic background radiation.	
II	**Stellar Formation and Evolution**	**12**
	1. Formation and evolution of stars and galaxies 2. First-generation stars and their characteristics 3. Late stages of stellar evolution: White dwarfs, red giants, and neutron stars 4. Black holes: Formation and physical significance **5.** Second-generation stars and the evolution of our galaxy	
	Unit Outcomes: UO1. Describe the evolutionary track of stars and galaxies from formation to their late stages, identifying the differences between first and second-generation stars. UO2. Analyze the physical characteristics and formation processes of end-stage stellar remnants such as white dwarfs, red giants, neutron stars, and black holes.	
III	**Cosmic Rays in Astrophysics**	**11**
	1. Discovery of cosmic rays; distinction between hard and soft components 2. Primary cosmic rays and their origins in space 3. Extensive air showers caused by cosmic rays 4. Solar modulation of primary cosmic rays 5. The effect of the Earth's magnetic field on cosmic ray trajectories	
	Unit Outcomes: UO1. Differentiate between the hard and soft components of cosmic rays and identify the origins of primary cosmic rays in space. UO2. Evaluate the generation of extensive air showers and the effects of solar modulation and the Earth's magnetic field on the trajectories of cosmic rays.	
IV	**Astrophysical Plasmas and Thermonuclear Fusion**	**11**
	1. Introduction to the Plasma State and its occurrence/importance in astrophysical applications 2. Single particle orbit theory: Drifts of charged particles under the effect of electric and magnetic fields in space 3. Fluid description of plasmas: Macroscopic parameters of plasma and Magnetohydrodynamic (MHD) approximations 4. Thermonuclear fusion in stellar cores: Status, problems, and conditions required for fusion	
	Unit Outcomes: UO1. Apply single-particle orbit theory and macroscopic fluid descriptions (MHD approximations) to analyze the behavior of plasmas in varying astrophysical environments. UO2. Trace the step-by-step nuclear reactions in the Proton-Proton (P-P) chain and the CNO cycle to explain energy generation in Main Sequence stars.	

Learning Resources:

1. Modern Astrophysics – B.W. Carroll and D.A. Ostlie, 1996, Addison-Wesley Publishing Co., Inc.
2. The Physical Universe: An Introduction to Astronomy – Frank H. Shu, 1982, University Science Books, Sausalito, California
3. Astrophysics by Baidyanath Basu
4. Introduction to Astrophysics by K D Abhyankar

Internal Examination Pattern:

CAT – I: Home Assignment

CAT – II: PPT Presentation/ Open Book Test/ Poster Presentation/ Seminar/ Online Quiz/ Descriptive Test

Mapping of POs, PSOs and COs:

COs/POs & PSOs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6
CO1	3	0	2	0	2	0	2	0	2	0	0	3	2	3
CO2	3	1	3	0	2	0	2	0	3	0	0	3	2	3
CO3	3	1	2	0	2	0	2	0	2	0	0	2	2	3
CO4	3	1	3	0	2	0	2	1	3	0	0	2	2	3

Scale: 3 = High, 2 = Moderate, 1 = Low, 0 = No correlation.

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Department of Physics and Electronics
PG I Sem II

Course Type : MEC Lab Course-II
Course Title : MEC Lab Course-II (Based on MEC-II)
Course Code : 601PHY2202
Credit : 01 **Max. Marks: 50** **Lectures: 30 Hrs.**

Learning Objectives:

LO1. To equip students with the hands-on skills required to align and utilize advanced interferometric setups, such as the Michelson Interferometer and laser-based wedge systems, for the precise measurement of wavelengths and micro-scale physical dimensions.

LO2. To develop a practical understanding of wave optics by conducting experiments on Fraunhofer diffraction using single slits and transmission gratings to analyze how light interacts with periodic and non-periodic obstacles.

LO3. To train students in characterizing the fundamental optical properties of materials through the experimental verification of Malus's Law, Total Internal Reflection (TIR), and Hartmann's dispersion formula.

LO4. To foster analytical proficiency in experimental optics by guiding students to meticulously collect, mathematically model, and translate raw optical data (such as interference fringes and intensity variations) into accurate physical constants.

Course Outcomes:

Upon successful completion of the course, students will be able to:

CO1. Evaluate the wavelength of laser light and determine the physical dimensions (thickness and angle) of micro-scale components by utilizing advanced optical setups like the Michelson Interferometer and wedge plates.

CO2. Analyze Fraunhofer diffraction patterns generated by single slits and transmission gratings to precisely quantify slit widths and grating pitches, demonstrating a clear understanding of light-matter interactions.

CO3. Assess the refractive and polarization properties of optical materials by experimentally validating Malus's Law, demonstrating Total Internal Reflection (TIR), and applying Hartmann's formula to find unknown wavelengths.

CO4. Construct robust mathematical models from raw experimental observations (fringe shifts, diffraction spots, and light intensity) to expertly align complex optical systems and accurately extract fundamental physical constants.

Practical No.	Unit
1	Calculation the wavelength of laser using Michelson Interferometer.
2	Observation of polarization properties of light and to verify Malu's law

3	Unknown wavelength of a given light source using Hartmann's formula.
4	Diffraction pattern due to ruled grating and hence calculating the grating pitch.
5	Observation of total internal reflection of light in transparent bar and finding the refractive index of transparent bar.
6	Diffraction using transmission grating and hence determining the grating pitch of transmission grating
7	Determination of the angle of given wedge plate using laser and finding the thickness of wedge plate.
8	Diffraction using single slit and hence determining the slit width

Learning Resources:

1. Optics E. Hecht Pearson Edition (4th Ed) 2004 (Text)
2. Optics 3rd edition Ajoy Ghatak, Tata McGraw Hill companies (2005)
3. Quantum Electronics — Amnon Yariv, Academic Press (1998)
4. Principles of optics — Born and Wolf, Cambridge University Press (1981)
5. Fundamentals of Photonics — Saleh and Teich Wiley Intsc (2007)
6. Modern Optics — R.D, Guenther, John Wiley (1990) (Text)

Internal Examination Pattern:

CAT – I: Record Book Submission

CAT – II: Overall performance in the regular practical

Mapping of POs, PSOs and COs:

COs/POs & PSOs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6
CO1	3	3	3	0	1	2	3	3	3	2	3	2	2	2
CO2	3	3	2	0	1	2	2	2	3	2	2	2	2	2
CO3	3	3	2	0	1	2	2	2	3	2	3	2	2	2
CO4	3	3	3	1	2	2	3	3	3	2	3	3	2	3

Scale: 3 = High, 2 = Moderate, 1 = Low, 0 = No correlation.

Extra Credit Activities

Sr. No.	Course Title	Credits	Hours T/P
1	MOOCs	Min. of 02 credits	Min. of 30 Hrs.
2	Certificate Courses	Min. of 02 credits	Min. of 30 Hrs.
3	IIT Spoken Tutorial Courses	Min. of 02 credits	Min. of 30 Hrs.

Guidelines:

Extra -academic activities

1. All extra credits claimed under this heading will require sufficient academic input/ contribution from the students concerned.
2. Maximum 04 extra credits in each academic year will be allotted.
3. These extra academic activity credits will not be considered for calculation of SGPA/CGPA but will be indicated on the grade card.

Additional Credits for Online Courses:

1. Courses only from SWAYAM and NPTEL platform are eligible for claiming credits.
2. Students should get the consent from the concerned subject Teacher/Mentor/Vice Principal and Principal prior to starting of the course.
3. Students who complete such online courses for additional credits will be examined/verified by the concerned mentor/internal faculty member before awarding credits.
4. Credit allotted to the course by SWAYAM and NPTEL platform will be considered as it is.

Additional Credits for Other Academic Activities:

1. One credit for presentation and publication of paper in International/National/State level seminars/workshops.
2. One credit for measurable research work undertaken and field trips amounting to 30 hours of recorded work.
3. One credit for creating models in sponsored exhibitions/other exhibits, which are approved by the concerned department.
4. One credit for any voluntary social service/Nation building exercise which is in collaboration with the outreach center, equivalent to 30 hours
5. All these credits must be approved by the College Committee.

Additional Credits for Certificate Courses:

1. Students can get additional credits (number of credits will depend on the course duration) from certificate courses offered by the college.
2. The student must successfully complete the course. These credits must be approved by the Course Coordinators.
3. Students who undertake summer projects/ internships/ training in institutions of repute through a national selection process, will get 2 credits for each such activity. This must be done under the supervision of the concerned faculty/mentor.

Note:

1. The respective documents should be submitted within 10 days after completion of Semester End Examination.
2. No credits can be granted for organizing or for serving as office bearers/ volunteers for Inter-Class / Associations / Sports / Social Service activities.
3. The office bearers and volunteers may be given a letter of appreciation by the respective staff coordinators. Besides, no credits can be claimed for any services/activities conducted or attended within the college.
4. All claims for the credits by the students should be made and approved by the mentor in the same academic year of completing the activity.
5. Any grievances of denial/rejection of credits should be addressed to Additional Credits Coordinator in the same academic year.
6. Students having a shortage of additional credits at the end of the third year can meet the Additional Credits Coordinator, who will provide the right advice on the activities that can help them earn credits required for graduation.

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Empowered Autonomous Institution

Faculty of Science and Technology

Examination Framework

Theory:

40% Continuous Assessment Tests (CATs) and 60% Semester End Examination (SEE)

Practical:

50% Continuous Assessment Tests (CATs) and 50% Semester End Examination (SEE)

Course	Marks	CAT & Mid Term Theory				CAT Practical		Best Scored CAT & Mid Term	SEE	Total
1	2	3				4		5	6	5 + 6
		Att.	CAT I	Mid Term	CAT II	Att.	CAT			
Research Methodology	100	10	10	20	10	-	-	40	60	100
DSC/DSE	75	05	10	15	10	-	-	30	45	75
Lab Course	50	-	-	-	-	05	20	-	25	50
Field Project	100	10	10	20	10	-	-	40	60	100

Note:

1. All Internal Exams are compulsory
2. Out of 02 CATs best score will be considered
3. Mid Term Exam will be conducted by the Exam Section
4. Mid Term Exam is of Objective nature (MCQ)
5. Semester End Exam is of descriptive in nature (Long & Short Answer)
6. CAT Practical (20 Marks): Lab Journal (Record Book) 10 Marks, Overall Performance 10 Marks.