Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)

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

(Autonomous)

w.e.f. June, 2023

(In Accordance with NEP-2020)

Academic Year: 2023-24

Review Statement

The NEP Cell reviewed the Curriculum of **M.Sc. Physics** Programme to be effective from the **Academic Year 2023-24.** It was found that, the structure is as per the NEP-2020 guidelines of Govt. of Maharashtra.

Date: 09/08/2023

Place: Latur

NEP Cell

Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)

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 2023-24.**

Date: 14/07/2023

Place: Latur

(Dr A. A. Yadav)
Chairperson
Board of Studies in Physics
Rajarshi Shahu Mahavidyalaya, Latur
(Autonomous)

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)

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 (Autonomous)	Chairperson	HoD
2	**Dr. R.S. Mane** School of Physical Sciences, SRTMU, Nanded	Member	V.C. Nominee
3	**Dr V.B. Patil,** School of Physical Sciences, Solapur University, Solapur	Member	Academic Council Nominee
4	**Dr A.P. Torane,** Yashwantrao Chavan Institute of Science, Satara	Member	Academic Council Nominee
5	**Dr P.M. Watekar,** Sterlite Optics Aurangabad	Member	Expert from Industry
6	**Dr M.P. Sarode** DSM College, Parbhani	Member	P.G. Alumni
7	**Dr Mahesh Wavare,** HoD, Mathematics Rajarshi Shahu Mahavidyalaya, Latur (Autonomous)	Member	Faculty Member
8	**Dr Dayanand Raje**	Member	Member from same Faculty
9	**Mr Swapnil Undalkar**	Member	Member from same Faculty
10	**Mr Atul More**	Member	Member from same Faculty
11	**Miss Mayuri Hawaldar**	Member	Member from same Faculty
12	**Miss Vishakha Patil**	Member	Member from same Faculty
13	**Mr Suraj Gund**	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 A.A. Yadav)

Chairperson

Board of Studies in Physics

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)

Department of Physics and Electronics

Index

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)

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	MMC 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**	MMC I 3Cr MMC II 3Cr MMC III 3Cr	MEC I 3Cr	LC-I 1Cr LC-II 1Cr LC-III 1Cr LC-IV 1Cr	RMC 4Cr	NA	NA	20Cr	Theory: 1Cr=25M Lab Course: 1Cr=50M	**PG Diploma (After 03 Year B.Sc. Degree)**
	II	MMC IV 3Cr MMC V 3Cr MMC VI 3Cr	MEC II 3Cr	LC-V 1Cr LC-VI 1Cr LC-VII 1Cr LC-VIII 1Cr	NA	OJT-I 4Cr /FPI 4Cr	NA	20Cr	OJT/FP: 1Cr=25M	
	Total	**MMC 18Cr**	**MEC 06Cr**	**LC-8Cr**	**RMC 04Cr**	**OJT/FP 04Cr**	**NA**	**40Cr**		
Exit Option: PG Diploma with 40 Credits After 03 Year B.Sc. Degree										
II 6.5	**III**	MMC VII 3Cr MMC VIII 3Cr MMC IX 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=25M	**PG Degree (After 03 Year UG Degree)**
	IV	MMC X 3Cr MMC XI 3Cr MMC XII 3Cr	MEC IV 3Cr	LC-XIII 1Cr LC-XIV 1Cr LC-XV 1Cr LC-XVI 1Cr	NA	NA	RP-II 6Cr	**22Cr**		
	Total	**MMC 18Cr**	**MEC 06Cr**	**LC-8Cr**	**NA**	**NA**	**RP 10 Cr**	**42Cr**		
Cum. Total of I & II Year		**MMC 36Cr**	**MEC 12Cr**	**LC-16Cr**	**RMC 04Cr**	**OJT/FP 04Cr**	**RP 10Cr**	**40+42 =82 Cr**		**82 Credits**
	Exit Option: Two Years 04 Sem. PG Degree with 82 Credits After 03 Year UG Degree									

Abbreviations:

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

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)

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	Semester	Course Code	Course Title	Credits	No. of Hrs.
I 6.0	I	601PHY1101 (MMC I)	Mathematical Methods in Physics	03	45
			Lab Course-I	01	30
		601PHY1102 (MMC II)	Classical Mechanics	03	45
			Lab Course-II	01	30
		601PHY1103 (MMCIII)	Quantum Mechanics	03	45
			Lab Course-III	01	30
		601PHY1201 MEC-I (A) Or MEC-I(B)	Electronic Devices OR Electronic Communication Systems	03	45
			Lab Course-IV	01	30
		601PHY1301 (RMC)	Research Methodology Course	04	100
	Total Credits			**20**	
	II	601PHY2101 (MMC IV)	Atomic and Molecular Spectroscopy	03	45
			Lab Course-V	01	30
		601PHY2102 (MMCV)	Condensed Matter Physics	03	45
			Lab Course-VI	01	30
		601PHY2103 (MMC VI)	Thermodynamics and Statistical Mechanics	03	45
			Lab Course-VII	01	30
		MEC-I (A) Or MEC-I(B)	Modern Optics OR Astronomy and Astrophysics	03	45
			Lab Course-VIII	01	30
		OJT-I/Field Project (FP)	OJT/ Field Project	04	120
	Total Credits			**20**	
Total Credits (Semester I & II)				**40**	

Programme Outcomes (POs) for M.Sc. Programme	
PO1	Advanced knowledge in some areas in physics.
PO2	Some research experience within a specific field of physics, through a project.
PO3	Able to apply advanced theoretical and/or experimental methods, including the use of numerical methods and simulations.
PO4	Can combine and use knowledge from several disciplines.
PO5	Able to enter new problem areas that require an analytic and innovative approach.
PO6	Knows the historical development of physics, its possibilities and limitations, and understands the value of lifelong learning.
PO7	An international perspective on her/his discipline.

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

(Autonomous)

Department of Physics and Electronics

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 familiarize students with adequate background, conceptual clarity and knowledge of mathematical principles related to theory of matrices and its applications to understand the concept of Eigen values and Eigen vectors.

LO2. To equip students with standard matrix operations including addition, subtraction.

LO3. To make aware students about computation of the inverse of a matrix, if it exists, using different methods.

LO4. To develop understanding about formation and solution of partial differential equations.

LO5. Solving the homogeneous and non-homogeneous linear equations of the first order using different methods.

LO6. To develop understanding of Cauchy's Residues Theorem, Cauchy Principle value, to evaluate Definite real Integrals.

LO7. To use the tools and methodologies in formation of Fourier Series for different functions.

Course Outcomes:

After completion of 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. Know how computation is used to solve the most common mathematical problems frequently arising in engineering, science and technology.

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. Caley Hamilton Theorem and Applications, Similar Matrices and Diagonalizable Matrices, 5. Eigen Values of Some Special Complex Matrices, Quadratics Forms, and Problems.	
	Unit Outcomes: UO1. Develop an understanding of the role of computation as a tool in real-world problem-solving. UO2. Know how computation is used to solve the most common mathematical problems frequently arising in engineering, science and technology.	
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. Understand the concept and apply appropriate methods for solving Differential Equations. UO2. Know the methods of finding solutions of differential equations of the first order but not the first degree.	
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. Understand the definitions residue and singularities and poles.	
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, 6. Integral Transform, 7. Fourier Integral Theorem 8. Numerical Problems.	
	Unit Outcomes: UO1. Understand the harmonics analysis of arbitrary periodic functions. 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, (6th 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).

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)

Department of Physics and Electronics

Course Type: Lab Course

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

Course Code: 601PHY1104

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

Learning Objectives:

LO1. To make students familiar with the programming in MATLAB

LO2. To understand the fundamentals of the MATLAB program,

Course Outcomes:

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

CO1. Collect, analyze, and explain data from physics experiments,

CO2. Solve the matrix problem by using (MATLAB),

CO3. Solve complex number problems using MATLAB

CO4. Analyse Fourier Series using MATLAB

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	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)

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)

Department of Physics and Electronics

Course Type: MMC-II

Course Title: Classical Mechanics -II

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 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,

CO5. Solve complex problem in special theory of relativity,

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. To understand the concept of reduced mass.	

	UO2. Know how the planets are revolving around the sun and their orbits.	
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. Understand the concept and apply appropriate methods for solving mechanical problems. UO2. Able to 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. Understand the definitions and term related to the 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. Understand the Mass Energy relation and its physical significance. UO2. Understand the concept like time dilation, length contraction and unstable equilibrium.	

Learning Recourses: -

1) Classical Mechanics: Gupta, Kumar, Sharma, Pragati Prakashan (2010)

2) Classical Mechanics (3^{rd} 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

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)

Department of Physics and Electronics

Course Type: Lab Course

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

Course Code: 601PHY1105

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

Learning Objectives:

LO1. To make students familiar with the programming in PYTHON

LO2. To understand the fundamentals of the PYTHON program,

Course Outcomes:

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

CO1. Collect, analyze, and explain data from physics experiments,

CO2. Solve the quantum mechanical problems by using PYTHON,

CO3. Solve complex number problems using PYTHON

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 √(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 & Begineers by Vaishali B Bhagat (2020)

6. A Python Book: Beginning Python, Advanced Python, and Python Exercises, by Dave Kuhlman (2011)

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)

Department of Physics and Electronics

Course Type: MMC-III

Course Title: Quantum Mechanics -III

Course Code: 601PHY1103

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

Learning Objectives:

LO1. To equip students with the fundamentals of and latest trends in Quantum Mechanics required for CSIR-NET/SLET Examinations,

LO2. To develop the understanding about the concepts and principles of quantum Mechanics,

LO3. The Schrödinger equation, the wave function and its physical interpretation, and expectation values,

LO4. Solving simple potential problems using Schrödinger equation exactly,

Course Outcomes:

After completion of course, the student will be able to

CO1. Understand the basic principles of quantum mechanics,

CO2. Solve the Schrodinger equation to obtain wave functions for some basic, physically important potential, and estimate the shape of the wave function based on the shape of the potential,

CO3. Understand the role of uncertainty in quantum physics, and use the commutation relations of operators to determine whether or not two physical properties can be simultaneously measured,

CO4. Develop a knowledge and understanding of perturbation theory and level splitting,

Unit No.	Title of Unit & Contents	Hrs.
I	**Introduction to Quantum Theory**	11
	1. Introduction, Wave-Particle Duality, Matter Waves, 2. Group Velocity, Phase Velocity, Relation Between Group Velocity and Phase Velocity, 3. Heisenberg's Uncertainty Principle, Illustrations of Heisenberg's Uncertainty Principle, 4. Wave Function and Wave Packets, 5. Schrodinger Wave Equation in Time Dependent and Independent Form,	

	6. Concept of Probability and Probability Current Density, 7. Operators, Eigenvalues and Eigen Functions, 8. Basic Postulates of Quantum Mechanics,	
	Unit Outcomes: UO1. Understand the basic principles of quantum mechanics. UO2. Understand the role of uncertainty in quantum mechanics and use the commutations relation of operators to determine whether or not two physical properties can be simultaneously measured.	
II	**Simple potential problems**	**12**
	1. Particle in a One-Dimensional Box: Energy Quantization, Wave Function, Momentum, Quantization; 2. Particle in Three-Dimensional Box: Energy Quantization, 3. Infinite Square Well Potential; 4. Potential Step; 5. Rectangular Potential Barrier, 6. Bound States: Delta Function Potential, 7. Parity Operation, 8. Matrix Formulation of Quantum Mechanics: Dirac's Bra and Ket Notation, 9. 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 - Ghatak and Loknathan

2) Quantum mechanics - L. I. Schiff (McGraw Hill)

3) Modern quantum mechanics - J. J. Sakurai (Addison Wesely)

4) A Text book of Quantum Mechanics- P.M. Mathews and Venkaresan K. (McGraw Hill, 2007)

5) Quantum Mechanics-B.K. Agrwal and Hari Prakash (Prentice-Hall of India, New Delhi, 2004)

Shiv Chhatrapati Shikshan Sanstha's
Rajarshi Shahu Mahavidyalaya, Latur
(Autonomous)
Department of Physics and Electronics

Course Type: Lab Course

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

Course Code: 601PHY1106

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

Learning Objectives:

LO1. The main objective of practical course is to engage the student in the subject and help them get a better understudying of the topic studies in Physics lesson.

LO2. To allow hand on experiments to learn and understand fundamental principle of operation.

LO3. To develop the scientific attitude amongst student.

Course Outcomes:

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

CO1. Understand different concepts and principles of Physical instrumentations.

CO2. Learn about validity of concepts by doing the experiment.

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

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)

Department of Physics and Electronics

Course Type: MEC-I (A)

Course Title: Electronic Devices

Course Code: 601PHY1201

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

Learning Objectives:

LO1. To enhance comprehension capabilities of students through understanding of electronic devices,

LO2. To explain how transistor can be used to amplify a signal,

LO3. To illustrate the concept about the basic characteristics, construction, open loop and close loop operations of Operational-Amplifiers,

LO4. To enable students to analyze and design linear and non-linear circuits using Op-amp,

LO5. To familiarize students about the conversion of data from Analog to Digital and Digital to Analog.

Course Outcomes:

After completion of 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. Be able to analyze characteristics of semiconductor junctions.	

	UO2. An ability to 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-Amp (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. To understand the basic concepts of operational amplifier.	
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 Be able to 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. Understand and classify the instruction set of 8085 Microprocessor	

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

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)

Department of Physics and Electronics

Course Type: MEC-I (B)

Course Title: Electronics Communication Systems

Course Code: 601PHY1201

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

Learning Objectives:

LO1. To introduce students to electronic communications, Basic electronic system, types of communication system, modulation and demodulation and its need,

LO2. To develop the understanding among students about modulation, AM, FM and PM, 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,

LO5. To develop problem solving skills among the students.

Course Outcomes:

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

CO1. Electronic communication system, need of modulation. Various types of modulation (AM, FM and PM) and demodulation,

CO2. How radio signal which contains information is received with the help of radio receivers,

CO3. Generation (transmission and receptions) of AM and FM information signal, such as class C, Varactor diode, TRF, Superhet, balanced slope, detection for FM, etc.

CO4. How the electronic communication is done (achieved) with satellite, cellular radio, networking, FSK, FAX, machine, function of transceiver (transponder).

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. Be able to analyze characteristics Basic Communication System and its classification. UO2. Able to 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. To understand the basic concepts of an Image Frequency.	
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 Be able to understand working principle of FM Receivers.	
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. Understand and classify the FSK Modem.	

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.

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)

Department of Physics and Electronics

Course Type: Lab Course

Course Title: Lab Course-IV (Based on MEC-I)

Course Code: 601PHY1203

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

Learning Objectives:

LO1. The main objective of practical course is to engage the student in the subject and help them get a better understudying of the topic studies in Physics lesson.

LO2. To allow hand on experiments to learn and understand fundamental principle of operation.

LO3. To develop the scientific attitude amongst student.

Course Outcomes:

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

CO1. Understand different concepts and principles of Physical instrumentations.

CO2. Learn about validity of concepts by doing the experiment.

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 microprocessor.

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

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)

Department of Physics and Electronics

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 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. Know the of report writing and evaluation methods.

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. Know the of report writing and evaluation methods	
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.

Semester - II

Course Type: MMC - IV

Course Title: Atomic and Molecular Spectroscopy

Course Code: 601PHY2101

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

Learning Objectives:

LO1. To explain the vector atom model for two valence electrons,

LO2. To study the Zeeman Effect, Paschen-Back effect, and Stark effect

LO3. To study the types of molecules and spectra of polyatomic molecules,

LO4. To study the energy levels and spectrum.

Course Outcomes:

Upon successful completion of this course, student able to:

CO1. Discuss the energy levels of the hydrogen atom and their effect on optical spectra,

CO2. State and explain the properties of two valence electron atoms and importance of the Pauli Exclusion Principle,

CO3. Explain the observed dependence of atomic spectral lines on externally applied electric and magnetic fields,

CO4. Discuss the importance of molecular physics,

CO5. Describe the difference between a singlet and triplet state,

CO6. State and justify the selection rules for various spectroscopic terms.

Unit No.	Title of Unit & Contents	Hrs.
I	**Atomic Spectroscopy**	**12**
	1. Investigation of Spectra, 2. Theoretical Principles-Quantum States of An Electron in An Atom, 3. Hydrogen Atom Spectrum, 4. Electron Spin and Stern-Gerlach Experiment, 5. Spin–Orbit Coupling, 6. Fine Structure, Spectroscopic Terms and Selection Rules, Hyperfine Structure, 7. Pauli Exclusion Principle- Alkali Type Spectra- LS & JJ Coupling- Zeeman Effect, 8. Paschen-Back Effect, Stark Effect	
	Unit Outcomes:	

	UO1. Apply their knowledge of atomic spectroscopy to practical situations, such as material analysis. UO2. Develop critical thinking skills to analyze complex atomic spectra and solve spectroscopy related problems. UO3. If applicable, perform experiments related to atomic spectroscopy, interpret experimental results and use spectroscopic equipment.	
II	**Rotational and Vibrational Spectroscopy**	**11**
	1. The Rotation of The Molecule, 2. Rotational Spectra-Rigid Diatomic Molecule, 3. The Intensities of Spectral Lines-Effect of Isotopic Substitution, 4. The Non-Rigid Rotator Techniques and Instrumentation – Applications, 5. The Vibrating Diatomic Molecule, 6. The Simple Harmonic Oscillator, 7. The Anharmonic Oscillator, Diatomic Vibrating Rotator	
	Unit Outcome: UO1. Explain the fundamental principles and concepts behind rotational and vibrational spectroscopy, including the interaction of molecules with electromagnetic radiation. UO2. Apply rotational and vibrational spectroscopy techniques to identify and quantify chemical compounds in real-world scenarios. UO3. Understand and apply the rigid rotor and harmonic oscillator models to describe the rotational and vibrational spectra of molecules, respectively.	
III	**Raman and Electronic Spectroscopy**	**11**
	1. Introduction- Classical and Quantum Theory of Raman Effect, 2. Spectra- Pure Rotational Raman Spectra, 3. Vibrational Raman Spectra - Techniques and Instrumentation Applications 4. Electronic Spectra of Diatomic Molecules, 5. Vibrational Coarse Structure, Franck-Condon Principle, 6. Dissociation Energy, 7. Rotational Fine Structure of Electronic Vibration, Fortrat Diagram	
	Unit Outcomes: UO1. Explain the Raman effect and how it differs from other spectroscopic techniques such as infrared spectroscopy UO2. Discuss real-world applications of Raman spectroscopy, including its use in material characterization.	

	UO3. Explain the principles of electronic transitions in molecules, including the relationship between electronic energy levels and absorption/emission of photons.	
IV	**Resonance Spectroscopy**	**11**
	1 Introduction, Nature of Spinning Particle, 2. Interaction Between Spin and a Magnetic Field, Larmor Precession 3. Theory of NMR-Chemical Shift, Relaxation Mechanism Experimental Study of NMR 4. Theory and Experimental Study of NQR, 5 Theory of ESR, Hyperfine Structure and Fine Structure of ESR- Experimental Studies and Applications, 6. Mossbauer Spectroscopy - Principle-Isomer Shift-Quadrupole Effect - Effect of Magnetic Field,	
	Unit Outcomes: UO1. Explain the fundamental principles and concepts of resonance spectroscopy, including the concept of resonance and its significance in spectroscopic techniques UO2. Discuss how resonance spectroscopy provides chemical and structural information about molecules and materials. UO3. Develop the ability to quantitatively analyse resonance spectra.	

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

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)

Department of Physics and Electronics

Course Type: Lab Course

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

Course Code: 601PHY2104

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

Learning Objectives:

LO1. To engage the students in the subject andhelp them get a better understudying of the topic studies in Physics lesson.

LO2. To allow hand on experiments to learn and understand fundamental principle ofoperation.

LO3. To develop the scientific attitude amongst student.

Course Outcomes:

After completion of course the student will be able to-

CO1. understand different concepts and principles of physicalinstrumentations.

CO2. learn about validity of concepts by doing the experiment.

Practical No.	Unit
1	Factorial
2	Largest number
3	Addition of matrix
4	File handling
5	Addition of matrix by using file handling
6	Addition of series
7	Ascending order
8	Eigen values & Eigen vectors of real asymmetric 2×2 matrix.
9	Generation of Random numbers
10	Power method

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 Laboratoryby 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)
8. C Language and Numerical Methods, By C. Xavier (2007)

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)

Department of Physics and Electronics

Course Type: MMC - V

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.

Course Outcomes:

After successful completion of laboratory course, the students will be able:

CO1. To account for crystalline materials using diffraction with concepts like the Ewald sphere, form factor, structure factor, reciprocal lattice, Brillouin zones and scattering amplitude, etc.

CO2. To determine structure of crystalline materials,

CO3. To estimate the charge carrier mobility and density in semiconductors,

CO4. To outline the importance of magnetic materials and superconductors in the present era.

Unit No.	Title of Unit & Contents	Hrs.
I	**Crystal Physics**	11
	1. Crystalline State of Solids 2. Space Lattice, Unit Cell and Primitive Cell, Bravais Lattice in Two/Three Dimensions, 3. Co-ordination number, Some Important Crystal Structures: SC, BCC, FCC, HCP. 4. Bragg's Condition, Brillion Zones for two- and three-dimensional Lattice, 5. Reciprocal Lattice and Their Properties, Structure Factor, 6. Comparison of X-ray, Electron and Neutron Diffraction Methods.	
	Unit Outcomes: UO1. Apply their knowledge of crystal structure for material analysis. UO2. Develop critical thinking skills to analyze crystalline state of solids.	
II	**Crystal Defects**	11

	1. Introduction 2. Point Defects (Schottky and Frenkel Defects, 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), 5. Observation of Imperfections in The Crystals.	
	Unit Outcomes: UO1. Explain the fundamental principles and concepts behind the defects like point, line defects. UO2. Understand and apply the concept to real world Cystal physics.	
III	**Semiconducting and Superconducting Properties**	**12**
	1. Semiconductors: Energy Band Gap of Metals, 2. Insulators and Semiconductors, 3. Effective Mass, 4. Intrinsic Carrier Concentration, 5. Conductivity of Semiconductors, 6. Impurity Levels in Doped Semiconductors. 7. Superconductors: Critical Temperature, 8. Meissner Effect, Type-I and Type-II Superconductors, 9. Cooper Pair, BCS Theory of Superconductivity, 10. Flux Quantization, High-Tc Superconductivity.	
	Unit Outcomes: UO1. Explain the difference between conductor and superconductors. UO2. Discuss real-world applications of superconductors, including its use in day-to-day life.	
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. Explain the fundamental principles and concepts of Magnetic Properties of Materials. UO2. Develop the ability to quantitatively analyse ferromagnetic materials.	

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.

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)

Department of Physics and Electronics

Course Type: Lab Course

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

Course Code: 601PHY2105

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

Learning Objectives:

LO1. To engage the student in the subject andhelp them get a better understudying of the topic studies in Physics lesson.

LO2. To allow hand on experiments to learn and understand fundamental principle of operation.

LO3. To develop the scientific attitude amongst student.

Course Outcomes:

After completion of course the student will be able to-

CO1. Understand different concepts and principles of physicalinstrumentations.

CO2. Learn about validity of concepts by doing the experiment.

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 ProbeMethod
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.

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)

Department of Physics and Electronics

Course Type: MMC - VI

Course Title: Thermodynamics and Statistical Mechanics

Course Code: 601PHY2103

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

Learning Objectives:

LO1. To acquaint students about basic knowledge of thermodynamical quantities and its Laws

LO2. To acquaint students about applying the equipartition theorem to the number of degrees of freedom of a thermodynamical system.

LO3. To quantify entropy changes using a statistical approach.

LO4. To identify the relationship and correct usage of work, energy, heat capacity, specific heat and entropy.

Course Outcomes:

After successful completion of laboratory course, the students will be able:

CO1. To state the laws of thermodynamics and to differentiate between various forms of Energy,

CO2. To apply the principles of statistical mechanics to selected problems,

CO3. To discuss the concepts of microstate and macrostate of a model system, the Boltzmann distribution and the role of the partition function,

CO4. To define the Fermi-Dirac and Bose-Einstein distributions;

CO5. To apply the Fermi-Dirac distribution to the calculation of thermal properties of electrons in metals.

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, 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: 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).

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)

Department of Physics and Electronics

Course Type: Lab Course

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

Course Code: 601PHY2106

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

Learning Objectives:

LO1. To engage the student in the subject andhelp them get a better understudying of the topic studies in Physics lesson.

LO2. To allow hand on experiments to learn and understand fundamental principle of operation.

LO3. To develop the scientific attitude amongst student.

Course Outcomes:

After completion of course the student will be able to-

CO1. Understand different concepts and principles of physicalinstrumentations.

CO2. Learn about validity of concepts by doing the experiment.

Practical No.	Unit
1	Temperature dependence of current of p-n junction diode – estimation of bandgap 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.

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)

Department of Physics and Electronics

Course Type: MEC II (A)

Course Title: Modern Optics

Course Code: 601PHY2201

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

Learning Objectives:

LO1. Develop understanding of optical phenomena based on the wave description of light, LO2. Develop the knowledge of light as an electromagnetic field as it arises from first principles in Maxwell's equations,

LO3. To acquaint students about interference, and common interferometers,

LO4. To study the key concepts used in optics.

LO5. To study light polarization, and optics that manipulate polarization.

Course Outcomes:

Upon successful completion of this course, student able to:

CO1. Explain how electromagnetic waves arise from Maxwell's equations,

CO2. Understand the relationship between the direction of propagation, and the directions of the electric and magnetic field.,

CO3. Explain fundamental concepts in optics, including: amplitude, wavelength, frequency, phase, intensity, power, and refractive index.

CO4. Forecast the outcome of simple experiments that manipulate the polarization of the electromagnetic field.

CO5. Predict the behavior of common interferometers: Michelson, Fabry-Perot, Mach Zehnder, and Sagnac.

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,	

	7. Jone's Vectors and Matrices, Numerical Problems	
	Unit Outcomes: UO1. Explain how electromagnetic waves arises from Maxwell's equation. UO2. Understand the relationship between the direction of propagation and the direction of the electric and magnetic field.	
II	**Interference**	**12**
	1. Introduction, Michelson's Interferometer, 2. Mach-Zehnder Interferometer, 3. Multiple Beam Interference, 4. Fabry- Perot Interferometer 5. Resolving Power, Frees 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. Ability to 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. Understand the formation of radiant energy into a Fourier transform of the spectrum	
IV	**Diffraction**	**11**
	1 Introduction, 2. Theory of Diffraction: Fresnel- Kirchhoff Integral Formula and its Application to Diffraction Problems.	

	3. Fraunhoffer and Fresnel Diffraction. Fraunhoffer Diffraction by Single Slit, Double Slit, Multiple Slits, 4. Diffraction Grating, and Circular Aperture. 5. Fresnel Diffraction, Fresnel Zones, Fresnel Integrals, 6. Spatial Filters, 7. 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. Qualitatively 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)

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)

Department of Physics and Electronics

Course Type: MEC II (B)

Course Title: Astronomy and Astrophysics

Course Code: 601PHY1201

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

Learning Objectives:

LO1. Develop understanding of how planets are revolving around the sun,

LO2. Develop the knowledge of co-ordinate systems,

LO3. To acquaint students about distance measurement in astronomy-stellar parallax,

LO4. To study the key concepts like Kepler's laws of planetary motion,

LO5. To study Earth's and Moon's orbit around the sun.

Course Outcomes:

Upon successful completion of this course, student able to:

CO1. Explain the terrestrial and Jovian planets and their structure, composition and atmospheres,

CO2. Understand the relationship ring systems and satellites of the planets,

CO3. Explain fundamental concepts in Astrophysics, including: asteroids, meteors and meteorites, comets and their origin,

CO4. Understand the Origin of the Solar System: The Nebular hypothesis,

CO5. Explain the Brief history of astronomy.

Unit No.	Title of Unit & Contents	Hrs.
I	**Fundamentals of Astronomy**	**11**
	1. Dimensions and Units; Order-of-Magnitude Problems; Scales in The Universe, 2.Time and Seasons, Brief History of Astronomy (Geocentric Universe, Heliocentric Universe), 3. Co-Ordinate Systems (Celestial Sphere, Horizon, Equatorial Co-Ordinate Systems), 4. Greenwich Sideral Time, Local Sideral Time, Zonal Time, 5. Hour Angle and Mean Solar Time, 6. Astronomical Distance, Astronomical Unit (AU), Light Year, Parsec, 7. Distance Measurement in Astronomy-Stellar Parallax.	
	Unit Outcomes:	

	UO1. Explain the concept of Local Sideral time, Zonal time. UO2. Understand the relationship between the Hour angle and mean solar time.	
II	**The Solar Family**	**12**
	1. Introduction, Kepler's Laws of Planetary Motion, 2. The Earth's Orbit and Spin, The Moon's Orbit and Spin, 3.The Planets in The Solar System - The Terrestrial and Jovian Planets, Structure, Composition and Atmospheres of The Planets, 4. Ring Systems and Satellites of The Planets, 5. Asteroids, Meteors and Meteorites, Comets and Their Origin, 6. Solar and Lunar Eclipses, 7. Origin of The Solar System: The Nebular Hypothesis,	
	Unit Outcomes: UO1. Predict the behavior of planets, Asteroids, meteors and meteorites. UO2. Ability to apply the knowledge of Origin of the Solar System.	
III	**Astronomical Techniques**	**11**
	1. Introduction, Photon and Non-Photon Astronomy, 2. Photons (Electromagnetic Waves), Wavelength and Frequency, Photon Energy, 3. Temperature, Electromagnetic Frequency Bands – Windows in Astronomy, 4. Black Body Radiation- Planck Laws, Wien Displacement Law, 5. Brightness, Radiant Flux and Luminosity, 6. Magnitude Systems: Apparent and Absolute Magnitudes, 7. Distance Modulus; Determination of Temperature and Radius of a Star Atmospheric Effects (Absorption, Seeing), 8. Basics of Telescopes - Noise and Statistics, 10. Photon Detectors - Basics of Photometry - Spectroscopy and Polarimetry.	
	Unit Outcomes: UO1. Explain the Photon and non-photon astronomy. UO2. Understand the Black body radiation- Planck laws, Wien displacement law.	
IV	**The Sun as a Star**	**11**
	1 Introduction, The Sun as a Star, Solar Parameters, Solar Atmosphere, 2. Solar Photosphere, Chromosphere, Corona, Solar Activity, Sunspots and Sunspot Cycle, Solar Limb Darkening, Solar Neutrino Puzzle, 3. Overview of Solar System - Dynamics: Two-Body Problem, Three-Body Problem (Lagrangian Points), 4. Minor Bodies: Meteorites, Asteroids, Comets, Minor Planets, 5. Trans-Neptunian Objects, Centaurs - Planetary Rings.	

	6. Planet Formation: Evolution of Protoplanetary Disks.	
	Unit Outcomes: UO1. Identify the different types of solar parameters, UO2. Qualitatively relate the Two-body problem and Three-Body Problem.	

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

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)

Department of Physics and Electronics

Course Type: Lab Course

Course Title: Lab Course-VIII (Based on MEC - II)

Course Code: 601PHY2107

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

Learning Objectives:

LO1. To engage the student in the subject andhelp them get a better understudying of the topic studies in Physics lesson.

LO2. To allow hand on experiments to learn and understand fundamental principle of operation.

LO3. To develop the scientific attitude amongst student.

Course Outcomes:

After completion of course the student will be able to-

CO1. Understand different concepts and principles of physicalinstrumentations.

CO2. Learn about validity of concepts by doing the experiment.

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 Edn (4^{th} Ed) 2004 (Text)
2. Optics 3^{rd} 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)

PG First Year

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.

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)

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)

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

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.