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. Physics II

Approved by

Board of Studies in Physics (Photonics)

Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)

w.e.f. June, 2024

(In Accordance with NEP-2020)

Academic Year: 2024-25

Review Statement

The NEP Cell reviewed the Curriculum of **M.Sc. Physics II** Programme to be effective from the **Academic Year 2024-25.** It was found that, the structure is as per the NEP-2020 guidelines of Govt. of Maharashtra.

Date:

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 II** Programme to be effective from the **Academic Year 2024-25.**

Date:

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.R. 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.

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(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

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Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

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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**		RMC 4Cr	NA	NA	20Cr	Theory: 1Cr=25M Lab Course: 1Cr=50M	**PG Diploma (After 03 Year B.Sc. Degree)**
I 6.0	**I**	Major I 3Cr Major II 3Cr Major III 3Cr	MEC I 3Cr	LC-I 1Cr LC-II 1Cr LC-III 1Cr LC-IV 1Cr						
	II	Major IV 3Cr Major V 3Cr Major 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	**Major 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**	Major VII 3Cr Major VIII 3Cr Major 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	Major X 3Cr Major XI 3Cr Major XII 3Cr	MEC IV 3Cr	LC-XIII 1Cr LC-XIV 1Cr LC-XV 1Cr LC-XVI 1Cr	NA	NA	RP-II 6Cr	**22Cr**		
	Total	**Major 18Cr**	**MEC 06Cr**	**LC-8Cr**	**NA**	**NA**	**RP 10 Cr**	**42Cr**		
Cum. Total of I & II Year		**Major 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. 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

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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 Classical Mechanics 3Cr Quantum Mechanics 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	20Cr	Theory: 1Cr=25M Lab Course: 1Cr=50M	PG Diploma (After 03 Year UG Degree)
	II	Atomic and Molecular Spectroscopy 3Cr Condensed Matter Physics 3Cr Thermodynamics and Statistical Mechanics 3Cr	Modern Optics 3Cr Or Astronomy and Astrophysics 3Cr	LC-V 1Cr LC-VI 1Cr LC-VII 1Cr LC-VIII 1Cr	NA	Field Project-I 4Cr	NA	20Cr	OJT/FP: 1Cr=25M	
	Total	Major 18Cr	MEC 06Cr	LC-8Cr	RMC 04Cr	OJT/FP 04Cr	NA	40Cr		
Exit Option: PG Diploma with 44 Credits After 03 Year UG Degree										
II 6.5	III	Electrodynamics and Plasma Physics 3Cr Nuclear and Particle Physics 3Cr Laser Technology 3Cr	Thin film and Nanotechnology 3Cr Or Experimental Techniques 3 Cr	LC-IX 1Cr LC-X 1Cr LC-XI 1Cr LC-XII 1Cr	*NA*	*NA*	Research Project I 4Cr	20Cr	RP I & RP II: 01 Cr. = 25 M	PG Degree (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 36Cr	MEC 12Cr	LC-16Cr	RMC 04Cr	OJT/FP 04Cr	RP 10Cr	40+42 =82Cr		82 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:** Comprehensive in-depth relevant scientific knowledge and its execution in the specific area of study.
PO2	**Scientific Outlook:** The qualities such as observation, precision, analysis, logical thinking, clarity of thought and expression and systematic approach to work on research projects and explain scientific phenomena.
PO3	**Problem Solving Skills:** Analytical skills to solve problems, evaluate situations and act responsibly to communicate, cooperate and lead the team.
PO4	**Interpersonal Skills and Ethics:** Ability to integrate professional ethics and scientific knowledge in life, organization, society and individual to fulfill the needs of mankind in both moral and material aspects.
PO5	**Self-Directed Life-long Learning:** Ability to prepare for NET, SET, GATE and other national and international competitive examinations.
PO6	**Professional Competence:** Ability to apply the knowledge independently for continuous personal and professional development and identify business opportunities and initiate action to achieve it.
PO7	**Research and Related Skills:** Technical know-how about identification of local issues and develop lab to land solutions for the benefit of society at large.

Shiv Chhatrapati Shikshan Sanstha's
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Faculty of Science and Technology
Department of Physics and Electronics

Programme Specific Outcomes (PSOs) for M.Sc. Physics	
PSO No.	Upon completion of this programme, the students will be able to
PSO1	**Academic Competence:** Possess in-depth knowledge in Mathematical Methods in Physics, Classical Mechanics, Quantum Mechanics, Electronic Devices, Condensed Matter Physics, Atomic and Molecular Spectroscopy, Modern Optics, Thermodynamics and Statistical Mechanics, Electrodynamics and Plasma Physics, Nuclear and Particle Physics, Laser Technology, Thin Film and Nanotechnology.
PSO2	**Scientific Outlook:** Carry out experimental data interpretation and laboratory oriented numerical calculations. Work over execution of independent project and experiments. Demonstrate various, numerical methods mathematical techniques and experimental techniques to broaden independent thinking and scientific temper.
PSO3	**Personal and Professional Competence:** Apply hands-on training of soldering to connect electronic components to design circuits for various devices. Exhibit formulation of concepts in Physics, analytical skill, skills of technical report writing, presentation and effective communication skills.
PSO4	**Entrepreneurial Competence:** Develop skills related to Physics for engineering and industrial application, technology development and transfer. Work in solar energy, thin film technology, astrophysics, radiation dosimetry, energy generation and atmospheric science for academic research and industrial application.
PSO5	**Research Competence:** Identify research problem, using in-house laboratory set up for generation and interpretation of data. Examine the research findings and archival knowledge in physics and material sciences. Do review of research papers and books. Apply experimental skills for applied and interdisciplinary research. Integrate knowledge in Physics, Mathematics and Statistics for generating new knowledge

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Semester - III

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)

Faculty of Science & Technology

Department of Physics and Electronics

Course Type : Major-VII

Course Title : Electrodynamics and Plasma Physics

Course Code : 601PHY3101

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

Learning Objectives:

LO1 To equip students with the fundamentals of and latest trends in Electrodynamics and Plasma Physics required for CSIR-NET/SLET Examinations.

LO2 To make students familiar with the physics of electromagnetic waves and Plasma.

LO3 To train the students in analytical and numerical problem-solving skills in Electrodynamics.

Course Outcomes:

After completion of the course, students will be able to

CO1 Understand origin of Maxwell's equations in vacuum, dielectric, linear isotropic media,

CO2 Calculate reflection and transmission coefficients for waves at dielectric boundaries and show that laws of geometric optics originate with Maxwell's equations at dielectric boundaries,

CO3 Obtain scalar and vector potential equations in presence of sources,

CO4 Understand gauge invariance of Maxwell's equations, decoupling of scalar and vector potential equations in Lorentz gauge, coulomb gauge, and corresponding solutions,

CO5 Understand the term radiation zone and derive angular distribution of and power emitted by a dipole,

CO6 Derive Lienard-Wiechert potentials for a moving point charge,

CO7 Show that acceleration of the charge gives electromagnetic radiation,

CO8 Develop a knowledge and understanding of Plasma behavior.

Unit No.	Title of Unit & Contents	Hrs.
I	**Electromagnetic Waves**	**15**
	1. Maxwell's Equations: Microscopic and Macroscopic forms (revision), 2. Wave Equation in 1D: The Wave Equation, 3. Sinusoidal Waves, 4. Boundary Conditions: Reflection and Transmission;	

Unit No.	Title of Unit & Contents	Hrs.
	5. Polarization. 6. Electromagnetic Waves in Vacuum: The Wave Equation for E and B, Monochromatic Plane Waves. 7. Electromagnetic Waves in Matter: Propagation in Linear Media, 8. Reflection and Transmission at Normal Incidence, 9. Reflection and Transmission at Oblique Incidence, Laws of Reflection and Refraction.	
	Unit Outcomes: UO1. Understand origin of Maxwell's equations in vacuum, dielectric, linear isotropic media, UO2. Calculate reflection and transmission coefficients for waves at dielectric boundaries and show that laws of geometric optics originate with Maxwell's equations at dielectric boundaries.	
II	**Time Dependent Potentials and Fields**	**10**
	1. The potential formulation: Scalar and Vector Potentials, 2. Gauge transformation, 3. Coulomb Gauge and Lorentz Gauge, 4. Retarded Potentials, 5. Jefimenko's Equations. 6. Point Charges: Lienard-Wiechert Potentials, 7. The Fields of a Moving Point Charge.	
	Unit Outcomes: UO1. Obtain scalar and vector potential equations in presence of sources, UO2. Understand gauge invariance of Maxwell's equations, decoupling of scalar and vector potential equations in Lorentz gauge, coulomb gauge, and corresponding solutions,	
III	**Radiations and Radiation Reactions**	**10**
	1. Dipole Radiation: Electric Dipole Radiation (Approximation-1, 2, 3) 2. Magnetic Dipole Radiation (Approximation-1, 2, 3) 3. Radiation from Arbitrary Sources (Approximation-1, 2, 3) 4. Power Radiated by Point Charge: Larmer's Formula 5. Lienard's Generalization. 6. Radiation Reaction: Criteria for Validity 7. Abraham-Lorentz Formula 8. Physical Basis of Radiation Reaction- Self Force.	
	Unit Outcomes: UO1. Understand the term radiation zone and derive angular distribution of and power emitted by a dipole, UO2. Derive Lienard-Wiechert potentials for a moving point charge.	

Unit No.	Title of Unit & Contents	Hrs.
IV	**Plasma Physics**	**10**
	1. Introduction, 2. Occurrence of Plasma in nature, 3. Definition of Plasma, 4. Concept of temperature, 5. Debye shielding 6. The plasma parameter, criterion for plasma, 7. Applications of plasma physics, 8. Plasma oscillations.	
	Unit Outcomes: UO1. Develop a knowledge and understanding of Plasma behavior. UO2. Apply knowledge of Plasma to various applications.	

Learning Recourses:

1) Introduction to Electrodynamics – D.J. Griffiths. (PHI Learning Private LTD) (2009)
2) Classical Electrodynamics-J.D. Jackson, (John Wiley and Sons (Asia) Pvt. Ltd., Singapore, Reprint-2013)
3) Basic Principles of Plasma Physics, A Statistical Approach- S. Ichimaru, (W.A. Benjamin, Inc. 1973)
4) Foundation of Electromagnetic Theory- John R. Reitz, Frederick J. Milford, Robert W. Christy. (Pearson Education, Inc., Publishing Addison – Wasley)
5) Elementary Plasma Physics- Conrad L. Longmire (First U.S. Edition-1963, First Wiley Eastern Reprint, 1971)
6) Principles of Plasma Mechanics- Bishwanath Chakraborty, (Wiley Eastern Limited).
7) A Textbook of PLASMA PHYSICS, Professor Suresh Chandra (2012) CBS Publisher.

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Faculty of Science & Technology

Department of Physics and Electronics

Course Type : Major-VIII

Course Title : Nuclear and Particle Physics-VIII

Course Code : 601PHY3102

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

Learning Objectives:

LO1 Introduce students to the fundamental principles and concepts governing nuclear and Particle physics,

LO2 To provide a working knowledge of nuclear and particle physics to real-life problems,

LO3 To provide students with opportunities to develop basic knowledge and understanding of: Scientific phenomena, facts, laws, definitions, concepts, theories, scientific vocabulary, terminology, scientific quantities, and their determination in Nuclear Physics.

Course Outcomes:

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

CO1 Understand the fundamental principles and concepts governing nuclear and particle physics.

CO2 Demonstrate knowledge and understanding of scientific and technological applications, of Nuclear Physics as well as their social, economic, and environmental applications.

CO3 Explain Rutherford's experiment, Nuclear Radiation and Charged Particle Accelerators.

CO4 Identify and describe the fundamental particles.

CO5 Developing skills to present and discuss theoretical nuclear physics topics.

Unit No.	Title of Unit & Contents	Hrs.
I	**The Constitution of the Atomic nucleus and Nuclear Reactions**	**12**
	1. The proton-electron hypothesis of the constitution of the Nucleus, 2. The Angular Momentum of Nucleus, Failure of Proton–Electron hypothesis, 3. Nuclear Transmission and The Discovery of Neutron, 4. The Proton–Neutron Hypothesis, 5. Magnetic and Electrical Properties of Nucleus 6. Rutherford's Experiment, 7. Types of Nuclear Reactions, Conservation Laws in Nuclear Reactions,	

Unit No.	Title of Unit & Contents	Hrs.
	8. Discovery of Induced Radioactivity, 9. Reaction Induced by α-Particles, Proton Induced Reactions, Deuteron Induced Reactions, Neutron Induced Reactions, γ-Ray Induced Reactions.	
	Unit Outcomes: UO1. Understanding the basic structure of the atomic nucleus, including the arrangement of protons and neutrons, and the concept of nuclear shells. UO2. Knowledge of the principles governing nuclear reactions, including the conservation of charge, mass, energy, and reaction mechanisms.	
II	**Nuclear Models**	**11**
	1. Nature of Nuclear Forces 2. Liquid Drop Model, 3. Bethe-Weizsacker's Formula for binding energy, 4. Application of the Semi-empirical Binding Energy Formula, α-Decay 5. Fermi Gas Model of the Nucleus 5. Nuclear Shell Structure, 6. Single Particle Shell Model 7. Individual Particle Model, 8. Collective Model	
	Unit Outcome: UO1. Understanding the role of nuclear forces in determining the behavior of nucleons in the nucleus. UO2. Understanding the role of central, spin-orbit, and interactions of nucleons in the atomic nucleus.	
III	**Detection of Nuclear Radiation and Charged Particle Accelerators**	**11**
	1. Introduction to detectors, Methods for the Detection of Free Charge Carriers 2. Ionization Chamber, Proportional Counter, 3. Geiger-Muller Counter 4. Scintillation Detector 5. Wilson Cloud Chamber 6. Introduction to Accelerators, Classification and Performance characteristics of Accelerators, 7. Cyclotron, Synchrocyclotron, 8. Betatron, Electron Synchrotron.	
	Unit Outcomes: UO1. Understanding the working principles and characteristics of each type of radiation detector UO2. Knowledge of the diverse applications of particle accelerators,	

Unit No.	Title of Unit & Contents	Hrs.
	including in research, medicine, industry, and materials science.	
IV	**Elementary Particles**	**11**
	1 Introduction 2. Classification of Elementary Particles 3.Particle Interactions: Gravitational Interactions, Electromagnetic interactions, Strong Interactions, Weak Interactions, 4. Conservation Laws, 5. Electron and Positrons, Proton and Anti-Proton 6 Neutrons and Anti-Neutrons, Neutrinos and Anti-Neutrinos, 7. Photons, Mesons. Muons, Pions, 8. Quark, Experimental evidences of quarks	
	Unit Outcomes: UO1. Identification and description of elementary particles, including quarks, leptons, and bosons. UO2. Understanding the fundamental forces in nature, including electromagnetism, weak nuclear force, and strong nuclear force.	

Learning Resources: -

1) Nuclear Physics- Irving Kaplan, Reading: Addison-Wesley
2) Nuclear Physics- S.N. Ghoshal S. Chand Limited, 1997
3) Nuclear Physics- D.C. Tayal. Himalaya Publishing House (2011)
4) Nuclear Physics- S.B. Patel, Wiley Eastern Publishing House
5) Nuclear Physics- Jaahan Singh, Pragati Prakashan (2012)
6) Modern Physics- R Murugeshan, S. Chand Publisher, 1994
7) Atomic Physics- J.B. Rajam S. Chand & Company, New Delhi
8) Nuclear Physics- Raj Kumar
9) Nuclear Physics- S.P. Sahu.

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

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Faculty of Science & Technology

Department of Physics and Electronics

Course Type : Major-IX

Course Title : Laser Technology -IX

Course Code : 601PHY3103

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

Learning Objectives:

The course aims to present various aspects of the foundations, design, operation, and application of lasers.

LO1 To understand fundamentals of light-matter interaction,

LO2 To get Knowledge about Einstein treatment of transition rates,

LO3 To study finite laser bandwidth and spectral broadening mechanisms - population inversion and optical amplification gain,

LO4 To compare two, three, and four -level schemes - laser operation and gain saturation

LO5 To explain the construction and working of various lasers.

Course Outcomes:

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

CO1 Absorption, spontaneous and stimulated emission in two level system, effects of homogeneous and inhomogeneous line broadening, and conditions for laser amplification,

CO2 Operations of the Fabry-Perot cavity including mode separation and line-widths, laser gain conditions, gain clamping in both homogeneous and inhomogeneous line broadened media,

CO3 The four-level laser system, the simple homogeneous laser and its output behaviour and optimal operating conditions,

CO4 pectral properties of a single longitudinal mode, mode locked laser operation, schemes for active and passive mode locking in real laser system,

CO5 Operations and basic properties of the most common laser types, He-Ne, Argon-ion, and carbon-dioxide, ruby, Nd:YAG and glass, knowledge of other main laser types.

Unit No.	Title of Unit & Contents	Hrs.
I	**Basics of Laser**	**12**
	1. Introduction, 2. Interaction of Light and Matter, 3. Quantum Behavior of Light,	

Unit No.	Title of Unit & Contents	Hrs.
	4. Energy Levels, Thermal Equilibrium, 5. Absorption, Spontaneous Emission, 6. Stimulated Emission of Light, 7. Light Amplification, 8. High Intensity, Einstein's Relations, 9. Conditions for Large Stimulated Emission, 10. Conditions for Light Amplification, 11. Population Inversion, 12. Pumping, Pumping Methods: Optical; Electrical; Direct Pumping, Active Medium, Metastable States, 13. Pumping Schemes.	
	Unit Outcomes: UO1. Gain the knowledge about fundamentals and principles of lasers. UO2 Able to observe interaction of light and matter.	
II	**Properties of Laser and Optical Resonator**	**11**
	1. Properties of Laser: Directionality, Intensity, Coherence, Monochromaticity, Polarization, 2. Optical Resonator: Introduction, Action of Optical Resonator, 3. Threshold Condition, 4. Critical Population Inversion, 5. Condition for Steady State Oscillation, 6. Cavity Resonance Frequency, 7. Line Broadening Mechanism, Natural or Intrinsic Broadening, Collective Model, 8. Collision Broadening, Doppler Broadening, 9. Gain Saturation and Bandwidth, 10. Laser Operating Frequencies.	
	Unit Outcomes: UO1. Distinguish the characteristics of Laser. UO2. Able to understand the basic physics behind the laser and its parts.	
III	**Laser Cavity Modes**	**10**
	1. Introduction, Cavity Configuration, 2. Modes: Longitudinal and Transverse Modes, 3. Single Mode Operation, 4. Laser Rate Equation: Two Level System, Three Level System and Four Level System, 5. Comparison of Three Level System and Four Level Lasers, 6. Optimum Output Power, 7. Properties of Laser Modes, Spatial and Spectral Hole Burning, 8. Q-Factor, Q-Switching for Giant Pulses,	
	Unit Outcomes:	

Unit No.	Title of Unit & Contents	Hrs.
	UO1. Discuss properties of Laser beam and its dependency on cavity. UO2. Understand how to generate short and ultrashorts laser pulses.	
IV	**Types of Lasers**	**12**
	1 Introduction 2. Solid State Laser, General Description, 3. Structure and Working: Ruby Laser, 4. Nd: YAG Laser, Alexandrite Laser, Titanium Sapphire Laser, 5. Nd: Glass Laser, 6 Gas Laser-General Description, 7. Structure and Working of He-Ne Laser, 8. Structure and Working of Argon Laser, 9. Structure and Working of CO_2 Laser, 10. Structure and Working of Tunable Dye Laser, 11. Copper Vapor Laser, He-Cd Laser, He-Se Laser	
	Unit Outcomes: UO1. Learn of applications of laser and some new phenomenon of physics in lasers. UO2. Can engrave and cut acrylate sheets using CO_2 Laser.	

Learning Resources: -

1. An Introduction to Laser: Theory and Applications-M.N. Avadhanulu (S. Chand and Company Ltd. Ram Nagar, New Delhi 2008)
2. Lasers and Non-Linear Optics- B.B. Laud (New Age International Publishers 2006)
3. Laser Fundamentals- William T. Silfvast Cambridge University, Press
4. Laser and its Applications – Ghatak and Thyagarajan (McMillan, India 2004)
5. Laser- Principles, Types and Applications- K.R. Nambiar, (New Age Inter. Publishers 2006)

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Faculty of Science & Technology

Department of Physics and Electronics

Course Type : MEC-III

Course Title : Thin Film and Nanotechnology (Elective)

Course Code : 601PHY3201

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

Learning Objectives:

LO1 To have a comprehensive overview on the thin film fundamentals preparation and characterization and nanotechnology,

LO2 To establish the correlation between processing variables and thin film materials characteristics,

LO3 To develop understanding of the fundamental atomistic mechanisms and processes controlling film formation and micro structural evolution,

LO4 To have insights in possibilities and the importance of different Nanomaterials.

Course Outcomes:

After completion of course the student will be able to-

CO1 Handle different types of thin film deposition techniques,

CO2 Explain the effect of various parameters on thin film growth,

CO3 Characterize thin films for the electrical, optical, and structural properties,

CO4 Explain the fundamental principles of nanotechnology including importance of reduction in materials dimensionality and their applications.

Unit No.	Title of Unit & Contents	Hrs.
I	**Thin Film Deposition Techniques**	**12**
	1. Introduction, Nature of Thin Film, 2. Physical Methods, Thermal Evaporation Methods: Flash Evaporation, Electron Bombardment, 3. Sputtering Process: Glow Discharge Sputtering, Reactive Sputtering, R.F. Sputtering, 4. Chemical Methods: Chemical Vapor Deposition, Electro Deposition, Anodic Deposition, Chemical Bath Deposition, Spray Pyrolysis.	
	Unit Outcomes: UO1. Describe and use various physical and chemical thin film deposition techniques. UO2. Differentiate between various thin film depositions techniques.	
II	**Nucleation, Film Growth and Structure of Films**	**12**
	1. Introduction,	

Unit No.	Title of Unit & Contents	Hrs.
	2. Nucleation: Thermodynamics of Nucleation; Condensation Process, 3. Langmuir-Frenkel Theory, 4. Nucleation Theories: Capillary Model, 5. Effect of Super Saturation: Temperature; 6. Lattice Strain; Impurity and Surface Imperfection, 7. Film Growth and its Various Stages, 8. Incorporation of Defects and Impurity, 9. Deposition Parameters and Grain Size, 10. Thin Film Structure: Influence of Substrate and Film Thickness.	
	Unit Outcomes: UO1. Learn about process of nucleation, various film growth stages. UO2. Learn about deposition parameters, grain size and thin film structure.	
III	**Properties of Thin Films**	**11**
	1. Mechanical Properties: Stresses in Thin Films, 2. Mechanical Constants of Thin Films, 3. Electrical Properties: Electrical Conduction in Thin Metallic Discontinuous Films, 4. Electrical Conduction in Thin Metallic Continuous Films, 5. Optical Properties: Reflection, Transmission, Absorption, 6. Energy Band Gap, Transition, 7. Reflection and Transmission from Single Film, 8. Reflection from Multilayer Film, 9. Methods for Determining Optical Constants: Reflection Methods, 10. Ellipsometry Methods.	
	Unit Outcomes: UO1. Learn about mechanical, electrical, and optical properties of thin films. UO2. Learn about mechanical and optical constants of thin films.	
IV	**Nanotechnology**	**10**
	1. Introduction 2. Nanomaterials: Metal Nano Clusters; Semiconductor Nano Particle, Nano Structure; Carbon Clusters, Carbon Nanotubes: Carbon Quantum Nano-Structure, 3. Application of Nano Materials: Medicine, Energy Sector, Water Purification, Communication, Automobiles.	
	Unit Outcomes: UO1. Know the applications of nanomaterials in different sectors. UO2. Differentiate between various nanomaterials.	

Learning Resources: -

1. Thin Film Fundamentals- A. Goswami, New Age International LTD, Publishers.
2. Thin Film Phenomena- K.L. Chopra.,
3. Physics of Thin Films- Ludmila Eckertova.
4. Element of Solid-State Physics- J.P. Srivastava (3rd Ed), PHI Learning Pvt. Ltd New Delhi.
5. Principle of Nano Science and Nano Technology- M.A. Shah; Toker Ahmad
6. Nanoscience & Nanotechnology, K. K. Chattopadhya, A. N. Banerjee, PHI, Pvt. Ltd. New Delhi.
7. Nanotechnology, Morris Sylvan, Sarup and Sons, New Delhi.
8. Thin Films and Its Applications, Dr. Bhise Ramesh B., Dr. Goswami Vishal H., Dr. Shinde Mahendra S., Dr. Dhiware Manisha.
9. Thin Film Materials: Stress, Defect Formation and Surface, L. B. Freund, S. Suresh-2004.
10. Thin Film Solar Cells, K. L. Chopra, S. R. Das-2013.

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)

Faculty of Science & Technology

Department of Physics and Electronics

Course Type : MEC-III

Course Title : Experimental Techniques-III

Course Code : 601PHY3201

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

Learning Objectives:

LO1 To familiarize with signal processing techniques.

LO2 To provide a technological background of the production of Vacuum.

LO3 To distinguish important types of sensing position and different types of radiations.

LO4 To acquaint the students about various structural characterization techniques.

Course Outcomes:

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

CO1 Explain how analog signals are converted into digital signals;

CO2 Identify, explain, and handle different types of vacuum systems;

CO3 Classify the Optical sources and detectors and to discuss their principle;

CO4 Identify and understand the principle components of microscope.

Unit No.	Title of Unit & Contents	Hrs.
I	**Signal Processing**	**12**
	1. Analog to digital and digital to analog convertors, 2. Amplifiers, 3. Multiplexers, 4. Sample and hold circuits, 5. Data filtering, 6. Concepts of digital filters, 7. Time and frequency domain analysis, 8. Spectral analysis, 9. Random signals, 10. Auto and cross correlation, 11. Transfer functions of system etc.	
	Unit Outcomes: UO1. Analyze the characteristics and performance parameters of different types of converters. UO2. Explain the operation and characteristics of different types of amplifiers	
II	**Vacuum Physics**	**11**
	1. Important and fields applications of vacuum, 2. Gas properties,	

Unit No.	Title of Unit & Contents	Hrs.
	3. Gas flow regimes, 4. Gas transport properties, 5. Gas conductance of apertures, elbows, tubes etc. for viscous and molecular flow regimes, 6. Principles of pumping concepts (vacuum pumps), 7. Vacuum measurement, leak detection, 8. Source of gases in vacuum system, 9. Evaluation of gas load.	
	Unit Outcomes: UO1. Identify key applications of vacuum in fields such as semiconductor manufacturing, aerospace, vacuum coating, and medical technology. UO2. Apply knowledge of vacuum principles to solve practical engineering challenges in specific industries.	
III	**Sources and Detectors**	**11**
	1. Techniques of production of UV/Visible, 2. Microwave, IR radiations, 3. Classification of sensors/detectors, 4. Sensor characteristics, 5. Operation principles of sensors based on electric, acoustic, thermal, optical, and mechanical phenomena, 6. Important types of sensing position, temperature, humidity, pressure, and different types of radiations, 7. Basics of image processing	
	Unit Outcomes: UO1. Understand the principles and mechanisms of UV and visible radiation production. UO2. Evaluate methods for characterizing sensor performance through calibration, testing, and validation.	
IV	**Structural Characterization**	**11**
	1. Microscopy: Optical, Electron, FESEM, STM, AFM, Diffraction techniques: XRD, Electron and Neutron diffraction. 2. Spectroscopic Techniques: Spectroscopy: IR, UV-VIS, X-ray Abs, Mössbauer Spectroscopy.	
	Unit Outcomes: UO1. Understand the principles and operating mechanisms of various microscopy techniques including optical, electron, scanning probe, and diffraction techniques. UO2. Identify the different types of spectroscopies including infrared (IR), ultraviolet-visible (UV-VIS), X-ray absorption, and Mössbauer spectroscopy.	

Learning Resources:

1) Introduction to analysis and processing of signals, Paul Lynn, Howard W. (Samsand Company, 1983).

2) Probability, Random Variables and Stochastic Process, A. Papoulis, international Student Edition (McGraw-Hill International Book Company, 1984)
3) Vacuum Physics and Techniques, T. A. Delchar, Chapman, and Hall.
4) Vacuum technology, A. Roth, (North Holland, Elsevier Science B.V. 1990)
5) High vacuum techniques, J. Yarwood, (Chapman and Hall, Londong, 1967)
6) Nuclear Radiation Detectors, S.S. Kapoor, V. S. Ramamurthy, (Wiley-Eastern Limited, Bombay)
7) Experimental Principles and Methods below 1K, O. U. Lounasmaa, (Academic Press, London, and New York, 1974)
8) Cryophysics, K. Mendelssohn, Interscience (London, 1960)
9) Characterization of Materials, John B. Wachtman & Zwi. H. Kalman, Pub. Butterworth Heinemann (1992)

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)

Faculty of Science & Technology

Department of Physics and Electronics

Course Type : Lab Course

Course Title : Lab Course-IX (Based on Electrodynamics)

Course Code : 601PHY3104

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

Learning Objectives:

LO1 To develop proficiency in programming by creating a Python program to visualize sinusoidal plane waves,

LO2 To train the students about insights into the properties and behavior of sinusoidal plane waves through visualization and analysis.

Course Outcomes:

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

CO1 Gain familiarity with the concept of vector fields and their significance in physics and mathematics.

CO2 Gain understanding of wave packet propagation and standing electromagnetic waves.

CO3 Develop a Python program to verify Faraday's Law through numerical simulations.

CO4 Understand the concept of sinusoidal plane waves and their behavior.

Practical No.	Unit
1	Write and execute a python programme to create a simple vector field where at each point in space, the vector is pointing in the positive $\hat{x}$ direction.
2	Write and execute a python programme to show that the mechanical work generates electrical energy.
3	Write and execute a python programme to verify the Faraday's Law.
4	Write and execute a python programme to plot the wave packet propagation
5	Write and execute a python programme to plot the standing electromagnetic waves.
6	Write and execute a python programme to visualize a sinusoidal plane wave, moving along a line of y=x.
7	Write and execute a python programme to plot the Monochromatic

Practical No.	Unit
	electromagnetic plane waves as two in-phase, orthogonal sinusoidal functions.
8	Write and execute a python programme to calculate the current and charge in L and C over a time interval.

N.B.: At least six experiments should be performed from above.

Learning Resources: -

1) Taejoon Kouh and Minjoon Kouh, Electrodynamics Tutorials with Python Simulations (2024) by CRC Press

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(Autonomous)

Faculty of Science & Technology

Department of Physics and Electronics

Course Type : Lab Course

Course Title : Lab Course-X (Based on Nuclear Physics)

Course Code : 601PHY3105

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

Learning Objectives:

LO1 To provide skill in analyzing and interpreting graphs related to nuclear physics.

LO2 Learn how to retrieve information about chemical elements based on their atomic number.

LO3 To provide skill in conducting experiments to determine the operating voltage of a GM tube.

Course Outcomes:

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

CO1 Calculate and visualize the nuclear binding energy per nucleon graph using Python.

CO2 Understand the concept of mirror nuclei and their properties.

CO3 Understand the concept of the inverse square law and its application to radiation intensity.

CO4 Gain practical experience in using radiation detection equipment and analyzing experimental data.

Practical No.	Unit
1	Write and execute a python programme to plot Nuclear Binding Energy per Nucleon Graph
2	Write and execute a python programme to show information about chemical elements from atomic number
3	Write and execute a python programme to calculate the binding energy as per semiempirical mass formula.
4	Write and execute a python programme to calculate the coulomb energy for mirror nuclei.
5	Study the characteristics of a GM tube and determination of its operating voltage.

Practical No.	Unit
6	Determination of the dead time using single source.
7	Study of nuclear counting statistics.
8	Verification of inverse square law for γ- rays.
9	Attenuation coefficient of β- rays

N.B.: At least six experiments should be performed from above.

Learning Resources: -

1) https://tbc-python.fossee.in/convert-notebook/Introduction_To_Nuclear_And_Particle_Physics_by_V._K._Mittal,_R._C._Verma_And_S._C._Gupta/ch2.ipynb
2) Nuclear Physics- S.N. Ghoshal S. Chand Limited, 1997
3) Nuclear Physics- D.C. Tayal. Himalaya Publishing House (2011)
4) Nuclear Physics- S.B. Patel, Wiley Eastern Publishing House
5) Nuclear Physics- Jaahan Singh, Pragati Prakashan (2012)
6) Modern Physics- R Murugeshan, S. Chand Publisher, 1994
7) Atomic Physics- J.B. Rajam S. Chand & Company, New Delhi
8) Nuclear Physics- Raj Kumar
9) Nuclear Physics- S.P. Sahu.
10) Nuclear Physics- Irving Kaplan, Reading: Addison-Wesley

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)

Faculty of Science & Technology

Department of Physics and Electronics

Course Type : Lab Course

Course Title : Lab Course-XI (Based on Lasers)

Course Code : 601PHY3106

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

Learning Objectives:

LO1 Learn experimental methods for studying the patterns formed by laser light on CDs.

LO2 Gain proficiency in measuring and analyzing the data track spacing on CDs using laser diffraction.

Course Outcomes:

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

CO1 Understand the relationship between laser diffraction patterns and data track spacing on CDs.

CO2 Understand the concept of absorption of light by transparent materials.

CO3 Observe and analyze diffraction patterns produced by ruled gratings.

CO4 Understand the principles of interference and diffraction of light waves.

Practical No.	Unit
1	Study of pattern of a CD with lasers and determination of the data track spacing on CDs.
2	Determination of the absorption coefficient of transparent liquid.
3	Observe the diffraction pattern due to ruled grating and hence calculate the gating pitch.
4	To study the dependence of fluorescence depolarization on temperature, providing insights into the dynamics of Chlorophyll molecules in solution.
5	Determination of the wavelength of Laser using straight edge.
6	To determine the diameter of wire from the study of Fraunhofer diffraction pattern
7	To determine the wavelength of laser beam with the help of Fraunhofer diffraction pattern obtained by wire

Practical No.	Unit
8	To determine the Fraunhoffer diffraction pattern of Circular Aperture.

N.B.: At least six experiments should be performed from above.

Learning Resources: -

1. An Introduction to Laser: Theory and Applications-M.N. Avadhanulu (S. Chand and Company Ltd. Ram Nagar, New Delhi 2008)
2. Lasers and Non-Linear Optics- B.B. Laud (New Age International Publishers 2006)
3. Laser Fundamentals- William T. Silfvast Cambridge University, Press
4. Laser and its Applications – Ghatak and Thyagarajan (McMillan, India 2004)
5. Laser- Principles, Types and Applications- K.R. Nambiar, (New Age Inter. Publishers 2006)

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)

Faculty of Science & Technology

Department of Physics and Electronics

Course Type : Lab Course

Course Title : Lab Course-XII (Based on Thin Film)

Course Code : 601PHY3202

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

Learning Objectives:

LO1 Learn to measure and analyze the spectral response of solar cells.

LO2 Learn experimental methods for determining the thermoelectric power of thin films.

Course Outcomes:

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

CO1 Gain knowledge of how spectral response affects solar cell efficiency.

CO2 Understand the principles underlying thermoelectric phenomena in thin films.

CO3 Understand the spray pyrolysis technique for thin film deposition.

CO4 Understand the power output characteristics of photo-electrochemical solar cells.

Practical No.	Unit
1	Study of the spectral response of Photo-electrochemical solar cell.
2	Thermoelectric power of thin films.
3	Deposition of CdS thin film by spray pyrolysis and determination of its thickness by gravimetric weight difference method.
4	Deposition of PbS thin film by spray pyrolysis and determination of its thickness by gravimetric weight difference method.
5	Study of the power output characteristics of photo electrochemical solar cell and determination of efficiency and fill factor.
6	To deposit thin film using Chemical bath deposition technique.
7	Determination of the bandgap of given semiconducting thin film using UV-Vis-Spectrophotometer.
8	To study the optical characteristics of CdS/PbS thin films using UV-Vis-Spectrophotometer.

Practical No.	Unit
9	To study the supercapacitive performance of thin films using cyclic voltammetry.
10	Determination of electrical resistivity by Vander paw technique.

N.B.: At least six experiments should be performed from above.

Learning Resources: -

1. Thin Film Fundamentals- A. Goswami, New Age International LTD, Publishers.
2. Thin Film Phenomena- K.L. Chopra.,
3. Physics of Thin Films- Ludmila Eckertova.
4. Element of Solid-State Physics- J.P. Srivastava (3rd Ed), PHI Learning Pvt. Ltd New Delhi.
5. Principle of Nano Science and Nano Technology- M.A. Shah; Toker Ahmad
6. Nanoscience & Nanotechnology, K. K. Chattopadhya, A. N. Banerjee, PHI, Pvt. Ltd. New Delhi.
7. Nanotechnology, Morris Sylvan, Sarup and Sons, New Delhi.
8. Thin Films and Its Applications, Dr. Bhise Ramesh B., Dr. Goswami Vishal H., Dr. Shinde Mahendra S., Dr. Dhiware Manisha.
9. Thin Film Materials: Stress, Defect Formation and Surface, L. B. Freund, S. Suresh-2004.
10. Thin Film Solar Cells, K. L. Chopra, S. R. Das-2013.

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Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)

Faculty of Science & Technology

Department of Physics and Electronics

Course Type : Lab Course

Course Title : Research Project I

Course Code : 601PHY3601

Credit: 04 **Max. Marks: 100** **Lectures: 60 Hrs.**

Research Project I

Every student admitted to M.Sc. Physics in the third semester must complete one project dissertation of 4 credits (100 marks) under the guidance of the faculty member assigned to them at the beginning of the third semester. The performance of the student in the project work shall be assessed in both modes, i.e., the CIA of 50 marks and the SEE of 50 marks. SEE will be conducted by a panel of external examiners, where the candidate shall give a presentation on the work that they have conducted during the semester.

Semester - IV

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)

Faculty of Science & Technology

Department of Physics and Electronics

Course Type : Major - X

Course Title : Fibre Optics and its Applications

Course Code : 601PHY4101

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

Learning Objectives:

LO1 To develop the understanding of elements of an optical fiber transmission link, block diagram, advantages of optical fiber communication,

LO2 To develop a knowledge and understanding of the Ray theory of transmission, total internal reflection, acceptance angle, numerical aperture, meridional and skew rays,

LO3 Understanding Modes, electromagnetic mode theory and propagation,

LO4 Comparing single mode and multimode fibers, linearly polarized modes,

LO5 Describing various types of optical fibre losses,

LO6 Understanding of digital and analogue modulations-demodulation using LED and Laser diodes.

Course Outcomes:

After completion of course the student will be able to-

CO1 Analyze fiber optics and optical detectors components associated with fiber optics systems,

CO2 Distinguish internal reflection, acceptance angle, numerical aperture, and skew rays,

CO3 Identify difference between Coherent and non-coherent sources, quantum efficiency, modulation capability of optical sources,

CO4 Explain bending losses, modal dispersion, waveguide dispersion and pulse broadening,

CO5 Apply the skills necessary to solve practical and design problems for fiber optic communication systems.

Unit No.	Title of Unit & Contents	Hrs.
I	**Ray Theory of Transmission**	**11**
	1. Introduction, Propagation of Light in Different Media: 2. Propagation of Light in an Optical Fibre, 3. Basic Structure and Optical Path of an Optical Fibre, 4. Acceptance Angle and Acceptance Cone, 5. Numerical Aperture (NA) (General), 6. Modes of Propagation, Meridional and Skew Rays,	

Unit No.	Title of Unit & Contents	Hrs.
	7. Number of Modes and Cut-Off Parameters of Fibres, 8. Classification of Fibres: Stepped Index Fibre, 9. Stepped Index Monomode Fibre, Graded Index Multimode Fibre, 10. Comparison of Step Index and Graded Index Fibres, 11. Numerical Problems.	
	Unit Outcomes: UO1 Understand the basic structure of optical fiber and its related terms. UO2. Classify different types of fibers.	
II	**Fibre Fabrication Techniques and Fibre Losses**	**12**
	1. Introduction, 2. Classification of Fibre Fabrication Techniques, 3. External Chemical Vapour Deposition, 4. Axial Vapour Deposition, 5. Internal Chemical Vapour Deposition Technique (ICVD), 6. Comparison of Various Fabrication Processes, 7. Fibre Drawing and Coating, Double Crucible Method, 8. Fibre Losses: Attenuation in Optic Fibres, 9. Materials or Impurity Losses, 10. Rayleigh Scattering Losses, 11. Absorption Loss, Leaky Modes, 12. Bending Losses, Radiation Induced Losses, 13. Temperature Dependence of Fibre Losses, 14. Core and Cladding Losses.	
	Unit Outcomes: UO1. Learn about fiber fabrication techniques. UO2. Learn about fiber losses.	
III	**Communication Systems and Modulation**	**11**
	1. Communication Systems: Introduction, 2. Transmitter for Fibre Optic Communication, 3. High Performance Transmitter Circuit (LED–Digital Transmitter), 4. LED–Analog Transmitter, 5. LASER Transmitter, 6. Digital and Analog Laser Transmitter, Transmitter Design, 7. Fibre Optic Receiver, High Performance Receiver, 8. Fibre Based Modems: Trans receiver, 9. Modulation 10. LED Analog Modulation, 11. Digital Modulation, Laser Modulation, 12. Pulse Code Modulation (PCM), Intensity Modulation (IM).	

Unit No.	Title of Unit & Contents	Hrs.
	Unit Outcomes: UO1. Learn about various components used in fiber optic communication system. UO2. Explain modulation and its types.	
IV	**Optical Fibre Communication & Measurements on Optical Fibres**	**11**
	1. Optical Fibre Communication Systems: Introduction, 2. Important Applications of Integrated Optic Fibre Communication Technology, 3. Long Haul Communication, 4. Coherent Optical Fibre Communication, 5. Principle of Coherent Detection, 6. Measurements on Optical Fibres: Introduction, 7. Measurements of Numerical Aperture (NA), 8. Measurements of Fibre- Attenuation, 9. Optical Time Domain Reflectometry (OTDR), 10. Measurements of Dispersion Losses, Measurements of Refractive Index, 11. Cut-Off Wavelength Measurement, 12. Measurements of Mode Field Diameter (MFD), 13. Near Field Scanning Technique.	
	Unit Outcomes: UO1. Understand the importance of optical fiber communication system. UO2. Learn about measurement of different parameters in optical fiber communication system.	

Learning Resources: -

1. Optical Fibre and Fibre Optic Communication Systems, S.K. Sarkar (S. Chand and Comp., Ltd New Delhi 2010)
2. Optical Fiber Communications: Principles and Practice- J M Senior (PHI) 2nd Ed (2007)
3. Optical Fiber Communication- G. Keiser (Mc Graw Hill) Third Edition
4. Fundamentals of Fiber Optics in Telecommunication and Sensor Systems, Edited by B. P. Pal, New Age International Publisher, New Delhi, 1st Edition (2006)
5. Introduction to Fibre Optics- A. Ghatak and Thyagarajan (Cambridge University Press) New Delhi.

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)

Faculty of Science & Technology

Department of Physics and Electronics

Course Type : Major - XI

Course Title : Laser system and its applications

Course Code : 601PHY4102

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

Learning Objectives:

LO1 To demonstrate general understanding of use of laser in industry,

LO2 To learn applications of lasers in cutting, hole drilling, welding, and heat treatment,

LO3 To understand the wide advantages of using laser in medicine,

LO4 To acquaint the students with the optical arrangement and exposure technique of hologram,

LO5 To understand cooling and trapping of neutral atoms using laser.

Course Outcomes:

After completion of course the student will be able to-

CO1 Recognize applications of laser in industry,

CO2 Impart basic knowledge related to lasers in chemistry and medicine,

CO3 Communicate the concepts and results on biological effects of electromagnetic radiation,

CO4 Understand that making a hologram requires the recording of interference patterns between light from a fixed-point source and light from each point on an object,

CO5 Provide an insight into applications of laser in defense.

Unit No.	Title of Unit & Contents	Hrs.
I	**Industrial application of lasers**	**11**
	1. Introduction, 2. Optical fiber lasers (Low and High power) for Industrial, 3. Medical and Communication applications, 4. High Power Gas Lasers, 5. Material Processing with Lasers, 6. Metals and Laser, 7. Material Processing Mechanism, 8. Hole Drilling with Lasers, 9. Cutting Process with Lasers, 10. Laser Welding Process,	

Unit No.	Title of Unit & Contents	Hrs.
	11. Micro Laser Welding, Deep Penetration Welding, 12. Laser Hardening.	
	Unit Outcomes: UO1 Understand the application of laser in various material processing like cutting and welding. UO2 Understand the application of laser in various material processing like cutting and welding.	
II	**Lasers in Chemistry and Medicine**	**12**
	1. Lasers in Chemistry: Introduction, 2. Laser Induced Collision Processes- Pair Excitations, 3. Nuclear Fusion with Lasers, 4. Laser Aided Fusion Reactor, 5. Lasers in Spectroscopy, 6. Laser in Isotopes Separation, Separation Using Radiation Pressure, 7. Separation by Selective Photo-Ionization or Photo Dissociation, 8. Photo-Chemical Separation, 9. Lasers in Medicine: Biological Effect of Electromagnetic Radiation, 10. Laser in Medicine, Laser Diagnostics, 11. Photocoagulation, 12. Lasers in Situ Keratomileusis (LASIK), 13. Lasers in Dermatology, Photodynamic Therapy.	
	Unit Outcomes: UO1. Understand the use of laser in therapy. UO2. Understand the nuclear fusion reaction in nuclear power plant.	
III	**Holography and its Applications**	**11**
	1. Introduction, 2. Principle of Holography: Recording and Reconstruction of Hologram, 3. Some Distinguish Characteristics of Hologram, 4. Types of Holograms, 5. Intensity Distribution in a Hologram, 6. In-Line Holography, Off-Axis Holography, 7. Thin and Thick Hologram, 8. Reflection Holography, 9. Application of Holography: Holographic Microscopy, 10. Particle Size Analysis, 11. Holographic Memory, Holographic Interferometry.	

Unit No.	Title of Unit & Contents	Hrs.
	Unit Outcomes: UO1. Understand the holography offers realistic 3D visualization by recording and reconstruction of hologram. UO2. Describe the various application of holography such as particle size analysis, holographic memory etc.	
IV	**Other Applications of Lasers**	**11**
	1. Introduction, 2. Tracking of Bodies in Motion by Using Lasers, 3. LIDAR, 4. Velocity Measurement of a Moving Object, 5. Laser Gyro, Design of Laser Range Finder, 6. Laser Cooling and Trapping of Neutral Atom, 7. Optical Computers, 8. Laser in Communication, 9. Laser in Astronomy, 10. Laser in CD Read-Write.	
	Unit Outcomes: UO1. Learn about tracking of bodies in motion by using lasers. UO2. Explain laser cooling and trapping of neutral atoms.	

Learning Resources: -

1. Lasers- Principles, Types and Applications- K.R. Nambiar, (New Age International Publishers 2006)
2. Lasers, Theory and Applications – Ghatak and Thyagarajan (Mcmillan, India 2004)
3. Lasers and Non-Linear Optics- B.B. Loud, (New Age International Publishers 2006)
4. An Introduction to Laser: Theory and Applications-M.N. Avadhanulu, (S. Chand And Company Ltd. Ram Nagar New Delhi 2008)
5. Solid State Physics, P. K. Palaniswamy, Scitech Publications (India) Pvt. Ltd.

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)

Faculty of Science & Technology

Department of Physics and Electronics

Course Type : Major - XII

Course Title : Photonic Devices and Sensors

Course Code : 601PHY4103

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

Learning Objectives:

LO1 To introduce basic concepts governing optical waveguides, fibres, and lasers,

LO2 To have understanding and knowledge of optical communication technology and devices (including photonic integrated circuits, optical amplifiers, semiconductor lasers and optoelectronic),

LO3 To acquaint the students about important areas of photonics,

LO4 To foster a physical and quantitative understanding of key photonic devices,

LO4 To develop an understanding of the use of photonics in sensing and communications applications.

Course outcomes:

On completion of this course a student should be able to:

CO1 Understand the general principles of light propagation and basic physical concepts of material responses to optical fields,

CO2 Characterize the performance of optical fibers based on understanding and mathematical description of their principle of operation,

CO3 Understand characteristics and evaluate the performance of photo detecting devices,

CO4 Describe the technical and physical fundamentals of various optical sensors,

CO5 Gain the knowledge about status and future trends in development of photonic devices.

Unit No.	Title of Unit & Contents	Hrs.
I	**Light Beam as Sensing Tool**	**11**
	1. Single Electro-Optic Detector: Photoelectric Cells, Photomultipliers, Semiconductor Detectors; Thermal Detectors (Bolometer); CCD Detector. **2. Optical Systems for Spectral Measurements**: Emission Spectra; Absorption Spectra; Scattering Spectra; Luminescence Spectra; Reflectance and Transmittance of a Condensed Media, Spectrophotometry, Optical Methods for Temperature Measurement,	

Unit No.	Title of Unit & Contents	Hrs.
	Optical Methods for Distance and Size Measurement: Range Finder and Size Measurement with Lasers.	
	Unit Outcomes: UO1. Understand the principles and operation of various single electro-optic detectors, including photoelectric cells, photomultipliers, and semiconductor detectors. UO2. Understand the principles of temperature measurement based on thermal emission and absorption spectra.	
II	**Optical Fibre Sensors**	**11**
	1. Introduction, Key Features of Optical Fibre Sensors, Classification of Optical Fibre Sensors Based on Intensity, Phase, Wavelength and Polarization, 2. Types of OFS- Intrinsic and Extrinsic Sensors, Intensity Modulated Sensor, Shutter Based Multimode OFS, Reflective Optical Fibre Sensors, Micro Bend Optical Fibre Sensors, Intensity Modulated Thermometers, Fabry Perot Fibre Optic Sensor, Fibre Optic Gyroscope	
	Unit Outcome: UO1. Understand the fundamentals of optical fiber sensors and their importance in various applications. UO2. Gain knowledge of microbend optical fiber sensors and their applications in strain and pressure sensing.	
III	**Liquid Crystal Displays**	**12**
	1. Introduction, Orientational and Positional Ordering, Liquid Crystal Phases: Nematic; Cholesteric; Smectic A and C, 2. Types of Liquid Crystals: Thermotropic and Lyotropic Liquid Crystals, Pitch of Ordering, 3. Experimental Identification of Liquid Crystals, Optical Properties of Liquid Crystals, Liquid Crystal Displays	
	Unit Outcomes: UO1. Understand the fundamental properties and characteristics of liquid crystals. UO2. Understand the principles of operation and construction of liquid crystal displays (LCDs).	
IV	**Plasma Display Panels**	**11**
	1. Introduction, Physics of Gas Discharge: I-V Characteristics; Penning Reaction and Paschen Curve; Priming Mechanism, 2. Plasma Display Panels: DC PDP; AC PDP; Panel Processes, Front Plate Techniques: Substrate; Sustain Electrode; Dielectric; Protection Layer, 3. Rear Plate Techniques: Substrate; Address Electrode; Dielectric; Barrier Rib; Phosphor; Working of PDP, Advantages and Disadvantages of PDP.	

Unit No.	Title of Unit & Contents	Hrs.
	Unit Outcomes: UO1. Understand the fundamentals of gas discharge phenomena and its applications in various technologies. UO2. Understand the differences between DC and AC plasma display panels (PDPs) in terms of operation, construction, and performance.	

Learning Resources: -

1) Practical Optics, Naftaly Menn, Academic Press (2004)
2) Fundamentals of Fiber Optics in Telecommunication and Sensor System, Edited by B. P. Pal, New Age International Publisher, New Delhi, First Edition Reprint 2006
3) Optical Fiber Communications: Principles and Practice- J M. Senior (PHI) 2nd Ed (2007)
4) Optical Fiber and Fiber Optic Communication Systems S.K. Sarkar (S. Chand and Comp., Ltd New Delhi)
5) Peter J. Collings, Michael Hird, Introduction to Liquid Crystals: Chemistry and Physics CRC Press, (1997)
6) Jiun-Haw Lee, David N. Liu, Shin-Tson Wu, Introduction to Flat Panel Displays, John Wiley and Sons First Edition (2008)
7) Optical Fiber Communication- G. Keiser (Mc Graw Hill) Third Edition
8) Introduction to Fiber Optics- A. Ghatak and Thyagarajan (Cambridge University Press)
9) Shruti Mohanty, Liquid Crystals - The 'Fourth' Phase of Matter, RESONANCE November 2003 Page 52-70.

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)

Faculty of Science & Technology

Department of Physics and Electronics

Course Type : MEC II

Course Title : Industrial Photonic Engineering

Course Code : 601PHY4201

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

Learning Objectives:

LO1 To make aware the students about photonic technology, fibre optic communications systems and principles of photonic networks,

LO2 To understand how the various network testbeds are designed and implemented,

LO3 To overview the aspects of the safe and effective uses of lasers in communication.

LO4 To train the student about network management and wavelength routing testbeds,

LO5 To design various techniques used for upgrading transmission capacity of optical networks

Course Outcomes:

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

CO1 Professionally apply systematic engineering methods to address complex, multi-disciplinary real-world engineering problems related to photonic and optoelectronic systems.

CO2 Proficiently apply advanced, integrated technical knowledge in photonics and network management function.

CO3 Identify and critically evaluate current developments and emerging trends within the photonics sector.

CO4 Understand design of various photonics components,

CO5 Develop a knowledge and understanding of signal formats and detectors used in photonics.

Unit No.	Title of Unit & Contents	Hrs.
I	**Photonic Technology**	**15**
	1. Introduction, 2. Components: Couplers- Directional Couplers, 3. Principle of Operation and Conservation of Energy, 4. Isolators and Circulators (Principle of Operation), 5. Multiplexers and Filters-Grating, 6. Bragg Grating, Fiber Grating, 7. Fabry-Perot Filters, Multilayer Dielectric Thin Films Filters, 8. FO Amplifiers, Erbium Doped Fiber Amplifier, 9. Transmitters- Lasers, LED,	

Unit No.	Title of Unit & Contents	Hrs.
	Unit Outcomes: UO1 Learn about the principle of operation of an isolators and circulators. UO2 Apply the systematic engineering methods to address the complex, multidisciplinary, real-world problems related to photonics.	
II	**Modulation and Demodulation**	**10**
	1. **Modulation**: Introduction, Signal Formats, 2. Demodulation: An Ideal Receivers; A Practical Direct Detection Receivers, Coherent Detection, 3. **Test Beds**- LAMBDA NET, RAINBOW, STARNET, 4. **Wavelength Routing Network**: Optical Layer in Network, 5. Node Design; Networking Design and Operation, 6. Routing and Wavelength Assignment,	
	Unit Outcome: UO1. Understand the concept of modulation and demodulation and need of modulation. UO2. Attain the knowledge about testbeds such as RAINBOWS, STARNET.	
III	**Control and Management**	**10**
	1. Introduction, 2. Network Management Function: Configuration; Performance; Fault; Security; 3. Accounting Managements, 4. Configuration Managements: Equipment and Connection Management, 5. Performance and Fault Managements, 6. Optical Safely, 7. Service Interface 8. Wavelength Routing Test Beds- AON, NTTR, MWTN, ONTC, MONET,	
	Unit Outcomes: UO1. Develop insight knowledge about network management. UO2. Explain the various connection management, performance, and fault management.	
IV	**Access Network**	**10**
	1. Introduction, 2. Network Architecture Overview, 3. Today's Access Network, 4. Future Access Network-HFC. FTTC 5. Optical Access Network Architecture, 6. **Deployment Considerations**-Upgrading the Transmission	

Unit No.	Title of Unit & Contents	Hrs.
	Capacity- SDM, TDM, WDM Approach, 7. Application Areas -Inter Exchange Network, 8. Undersea Network 9. Local Exchange Networks, 10. Photonic Packet Switching, 11. OTDM, Multiplexing and Demultiplexing, 12. Bits and Packet Interleaving.	
	Unit Outcomes: UO1. Attain the knowledge about transmission media employed in access network. UO2. Various technique used for upgrading transmission capacity of optical network.	

Learning Resources: -

1. Optical Networks - A Practical Perspective - R Ramaswami and K N Sivarajan – Marcourt Asia (2000)
2. Photonic Switching Technology System and Networks- H T Mouftah, J M H Elmirghani – IEEE Press (1999)
3. Deploying Optical Networking Components - Oil Held, McCraw Hill (2001)
4. Optical Interconnection-C Tocci, Hi Caulfield, Artech House (1999).

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)

Faculty of Science & Technology

Department of Physics and Electronics

Course Type : MEC II

Course Title : Energy Sources

Course Code : 601PHY4201

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

Learning Objectives:

LO1 To make students familiar with the Basics of energy.
LO2 To explore the students about energy conversion technologies
LO3 To equip students with latest Photo thermal conversion technologies
LO4 To acquaint the knowledge of Fuel cells

Course Outcomes:

After successful completion of this course, students will be able to:

CO1 Study various non-conventional sources of energy and its applications in remote areas of the country.
CO2 Understand the working criteria of various direct energy conversion systems and study its applications.
CO3 Understand the importance of non-conventional energy resources for the present energy scenario.
CO4 Understand and pursue further research work behind the development of nonconventional energy sources as a part of their research work.
CO5 Understand other direct energy conversion systems like fuel cells

Unit No.	Title of Unit & Contents	Hrs.
I	**Conventional and Non-conventional Energy Sources**	**11**
	1. Man and energy, 2. World production and reserves of commercial energy sources - fossil fuel, hydroelectric power, nuclear energy, 3. Indian energy scenario- fossil fuel, 4. Hydroelectric power, nuclear energy power plants, 5. Non-conventional Energy Sources- scope and potential, 6. Concept of Solar constant, Solar intensity on earth's surface, 7. Direct and diffused radiation,	

Unit No.	Title of Unit & Contents	Hrs.
	8. Measurements of Solar Radiations – Moll-Gorezynsky pyranometer, 9. Sunshine Recorder	
	Unit Outcomes: UO1. Understand the relationship between human civilization and energy consumption throughout history. UO2. Analyze factors affecting solar intensity on the Earth's surface, including latitude, time of day, and atmospheric conditions.	
II	**Photovoltaic Conversion Technologies**	**12**
	1. Crystalline Solar Cell Technology- purification of Silicon, conversion of metallurgical grade silicon to semiconductor grade 2. Czocharlski crystalline silicon formation process, 3. Processes involved in the conversion of silicon wafer to solar cell, 4. Modular design of solar cell, 5. Power generation through satellite solar power station, 6. Advantages and Disadvantages of solar cell	
	Unit Outcomes: UO1. Understand the purification processes involved in converting metallurgical-grade silicon to semiconductor-grade silicon for solar cell production. UO2. Explore the advantages and challenges associated with space-based solar power generation technologies.	
III	**Photo thermal conversion technologies**	**11**
	1. Basic principles of flat plate collector (FPC), 2. Elements of flat plate collector, 3. Selective coatings and ideal characteristics of absorber plate of flat plate collector, 3. Solar cooker, Hot water system, Solar dryer, 4. Solar Pond, Design of central tower receiving system for power generation, 5. Essential elements of Solar Concentrators, parameters, and efficiency of solar concentrators, 6. Cylindrical paraboloid concentrators (PTC), 7. Compound paraboloid concentrators (CPC), 8. Applications of solar concentrators	
	Unit Outcomes: UO1. Learn about the working mechanism, components, and	

Unit No.	Title of Unit & Contents	Hrs.
	operation of flat plate collectors. UO2. Understand the ideal characteristics of absorber plates in terms of optical properties, thermal conductivity, and durability.	
IV	**Fuel Cells**	**11**
	1. Hydrogen as source of energy, 2. Photo electrochemical cell, 3. Source of hydrogen, solar hydrogen through electrolysis and photo catalytic process, hydrogen storage, 4. Brief discussion of various processes, 5. Concept of fuel cell, thermodynamics of fuel cell, merits, and demerits of fuel cell.	
	Unit Outcomes: UO1. Learn about the properties of hydrogen, its production methods, and its applications in various energy sectors. UO2. Explore methods and technologies for hydrogen storage, including compression, liquefaction, and solid-state storage.	

Learning Resources: -

1) Solar Energy -S. P. Sukhatme (TMH)
2) Solar Energy -Garg and Prakash (PHI)
3) Solar Cells -M. A. Green (PHI)
4) Biogas Technology -B. R. Veena (Ashish Pub. House)
5) Non-conventional energy sources - G D Rai

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)

Faculty of Science & Technology

Department of Physics and Electronics

Course Type : Lab Course

Course Title : Lab Course-XII (Based on Fiber Optics)

Course Code : 601PHY4104

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

Learning Objectives:

LO1 Learn experimental methods for measuring electrical-to-optical and optical-to-electrical conversion characteristics.

LO2 Gain proficiency in measuring and interpreting numerical aperture values.

Course Outcomes:

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

CO1 Understand the principles of signal transmission in optical fibers.

CO2 Learn experimental methods for determining the numerical aperture of optical fiber cables.

CO3 Understand the relationship between fiber curvature and signal attenuation in optical fibers.

CO4 Understand the principles of modulation and its application in fiber optic communication.

Practical No.	Unit
1	To study electrical to optical characteristics of given optical fiber.
2	To study optical to electrical characteristics of given optical fiber.
3	To determine the numerical aperture of the PMMA fiber cables
4	To determine bending loss in optical fiber
5	To study AM Modulation and Demodulation using Fiber Optics
6	To study FM Modulation and Demodulation using Fiber Optics
7	To study PAM Modulation and Demodulation using Fiber Optics
8	To study PWM Modulation and Demodulation using Fiber Optics
9	To study PPM Modulation and Demodulation using Fiber Optics

N.B.: At least six experiments should be performed from above.

Learning Resources: -

1. Optical Fibre and Fibre Optic Communication Systems, S.K. Sarkar (S. Chand and Comp., Ltd New Delhi 2010)
2. Optical Fiber Communications: Principles and Practice- J M Senior (PHI) 2nd Ed (2007)
3. Optical Fiber Communication- G. Keiser (Mc Graw Hill) Third Edition
4. Fundamentals of Fiber Optics in Telecommunication and Sensor Systems, Edited by B. P. Pal, New Age International Publisher, New Delhi, 1st Edition (2006)
5. Introduction to Fibre Optics- A. Ghatak and Thyagarajan (Cambridge University Press) New Delhi.

Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya, Latur

(Autonomous)

Faculty of Science & Technology

Department of Physics and Electronics

Course Type : Lab Course

Course Title : Lab Course-XIV (Based on Laser Applications)

Course Code : 601PHY4105

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

Learning Objectives:

LO1 Learn experimental methods for measuring absorption coefficients using laser techniques.

LO2 Learn experimental methods for measuring the divergence angle of laser beams.

Course Outcomes:

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

CO1 Understand the concept of absorption coefficient and its significance in optical materials.

CO2 Understand the concept of laser beam divergence and its importance in laser optics.

CO3 Understand the principle of total internal reflection and its application to refractive index measurements.

CO4 Understand the principles underlying optical sensing and its use in concentration measurements.

Practical No.	Unit
1	To determine the absorption coefficient of transparent solid by using laser.
2	To find the divergence angle of laser beam
3	To determine the refractive index of liquids by total internal reflection.
4	To determine the unknown concentration of sugar solution using laser (Sucrose meter)
5	To determine the Spot size of the laser beam
6	To determine the refractive index of a thin glass plate using Michelsons interferometer
7	Determination of refractive index of transparent material by finding Brewster's angle
8	To study CO_2 laser for cutting and engraving

N.B.: At least six experiments should be performed from above.

Learning Resources: -

1. Lasers- Principles, Types and Applications- K.R. Nambiar, (New Age International Publishers 2006)
2. Lasers, Theory and Applications – Ghatak and Thyagarajan (Mcmillan, India 2004)
3. Lasers and Non-Linear Optics- B.B. Loud, (New Age International Publishers 2006)
4. An Introduction to Laser: Theory and Applications-M.N. Avadhanulu, (S. Chand And Company Ltd. Ram Nagar New Delhi 2008)
5. Solid State Physics, P. K. Palaniswamy, Scitech Publications (India) Pvt. Ltd.

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Rajarshi Shahu Mahavidyalaya, Latur

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Faculty of Science & Technology

Department of Physics and Electronics

Course Type : Lab Course

Course Title : Lab Course-XV (Based on Photonic Devices and Sensors)

Course Code : 601PHY4106

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

Learning Objectives:

LO1 Learn experimental methods for calibrating optical sensors and determining their sensitivity.

LO2 Learn experimental methods for observing diffraction patterns from vernier scales.

LO3 To provide skill in experimental techniques and data analysis for measuring small distances using diffraction.

Course Outcomes:

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

CO1 Understand the principles of calibration and sensitivity in optical sensors.

CO2 Demonstrate diffraction patterns from vernier scales and use them to determine minimum distances between lines.

CO3 Understand the concept of laser beam profile and power distribution.

CO4 Understand the concept of power loss in optical fibers and its measurement methods.

CO5 Understand the principles of operation and characteristics of photonic devices.

Practical No.	Unit
1	To calibrate the given optical sensor and find its sensitivity
2	Show the diffraction pattern from the vernier scale and hence determine the minimum distance between adjacent two lines on vernier.
3	To study the power distribution within laser beam
4	To determine speed of microwaves using Microwave oven
5	To determine the power loss in optical fibre by micro bend pressure sensor and calculate its pitch.
6	To study the characteristics of Light dependent resistor (LDR)
7	To study the characteristics of Phototransistor

Practical No.	Unit
8	To study the characteristics of Photodiode
9	To study the characteristics of Optocoupler
10	To study the characteristics of Microwave test bench

N.B.: At least six experiments should be performed from above.

Learning Resources: -

1) Practical Optics, Naftaly Menn, Academic Press (2004)
2) Fundamentals of Fiber Optics in Telecommunication and Sensor System, Edited by B. P. Pal, New Age International Publisher, New Delhi, First Edition Reprint 2006
3) Optical Fiber Communications: Principles and Practice- J M. Senior (PHI) 2nd Ed (2007)
4) Optical Fiber and Fiber Optic Communication Systems S.K. Sarkar (S. Chand and Comp., Ltd New Delhi)
5) Peter J. Collings, Michael Hird, Introduction to Liquid Crystals: Chemistry and Physics CRC Press, (1997)
6) Jiun-Haw Lee, David N. Liu, Shin-Tson Wu, Introduction to Flat Panel Displays, John Wiley and Sons First Edition (2008)
7) Optical Fiber Communication- G. Keiser (Mc Graw Hill) Third Edition
8) Introduction to Fiber Optics- A. Ghatak and Thyagarajan (Cambridge University Press)
9) Shruti Mohanty, Liquid Crystals - The 'Fourth' Phase of Matter, RESONANCE November 2003 Page 52-70.

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Rajarshi Shahu Mahavidyalaya, Latur

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Faculty of Science & Technology

Department of Physics and Electronics

Course Type : Lab Course

Course Title : Lab Course-XVI (Based on Industrial Photonics Engineering)

Course Code : 601PHY4202

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

Learning Objectives:

LO1 Learn about the encoding process and modulation techniques used in DPSK.

LO2 Gain knowledge of the methods and devices used for DPSK demodulation in optical communication systems.

LO3 Learn experimental methods for measuring optical power loss using attenuators.

Course Outcomes:

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

CO1 Understand the principles of Differential Phase Shift Keying (DPSK) modulation.

CO2 Understand the principles of optical communication systems for transmitting voice and data signals.

CO3 Understand the principles of optical power attenuation and the role of attenuators.

CO4 Understand the factors contributing to optical power loss in optical fiber spools.

Practical No.	Unit
1	DPSK Modulation
2	DPSK Demodulation
3	Study of Optical communication for Voice and Data signals
4	To study optical power loss in Attenuators
5	To study optical power loss in optical fiber spools
6	To study optical power splitting using coupler
7	To study power loss in fiber spool with OTDR
8	To study of mechanical splice loss with OTDR
9	To study FSK Modulation

N.B.: At least six experiments should be performed from above.

Learning Resources: -

1. Optical Networks - A Practical Perspective - R Ramaswami and K N Sivarajan – Marcourt Asia (2000)
2. Photonic Switching Technology System and Networks- H T Mouftah, J M H Elmirghani – IEEE Press (1999)
3. Deploying Optical Networking Components - Oil Held, McCraw Hill (2001)
4. Optical Interconnection-C Tocci, Hi Caulfield, Artech House (1999).

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Department of Physics and Electronics

Course Type : Lab Course

Course Title : Research Project II

Course Code : 601PHY4601

Credits: 06 **Max. Marks: 150** **Lectures: 90 Hrs.**

Research Project II

Every student admitted to M.Sc. Physics in the third semester must complete one project dissertation of 6 credits (150 marks) under the guidance of the faculty member assigned to them at the beginning of the third semester. The performance of the student in the project work shall be assessed in both modes, i.e., the CIA of 75 marks and the SEE of 75 marks. SEE will be conducted by a panel of external examiners, where the candidate shall give a presentation on the work that they have conducted during the semester.

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Rajarshi Shahu Mahavidyalaya, Latur

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Faculty of Science & Technology

Department of Physics and Electronics

PG Second 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.

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Rajarshi Shahu Mahavidyalaya, Latur

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Faculty of Science & Technology

Department of Physics and Electronics

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			
DSC/DSE	75	05	10	15	10	-	-	30	45	75
Lab Course	50	-	-	-	-	05	20	-	25	50
Research Project	100	10	10	20	10	-	-	50	50	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.