Shiv Chhatrapati Shikshan Sanstha's

Rajarshi Shahu Mahavidyalaya (Autonomous), Latur

Department of Physics and Electronics

M.Sc.-II (Physics)

Syllabus

Academic Year: 2022-23

Rajarshi Shahu Mahavidyalaya (Autonomous), Latur

Department of Physics (Photonics)

Curriculum Structure with effect from June, 2022

M.Sc. II [Physics (Photonics)] Semester III

Code No.	Title of the course	Hours/ Week	Marks (100)		Credits
			In Sem	End Sem	
P-EPP-321	Electrodynamics and Plasma Physics- IX	04	40	60	04
P-NPP-322	Nuclear and Particle Physics-X	04	40	60	04
P-LET-323	Laser Technology-XI	04	40	60	04
(Elective) P-TFN-324A P-EXT-324B	Thin film and Nanotechnology-XIIA Or Experimental Techniques- XIIB	04	40	60	04
P-LAC-325	Laboratory Course –V (Laser and Materials)	04	40	60	04
P-PRO-326	Project I	04	40	60	04
P-SEM-327	Seminar-III	01	25	--	01
	Total Credits				25

Student Stay Hours: 25/Week

M.Sc. II Physics (Photonics) Semester IV

Code No.	Title of the course	Hours/ Week	Marks (100)		Credits
			In Sem	End Sem	
P-FOA-419	Fiber Optics and its Applications-XIII	04	40	60	04
P-LSA-420	Laser system and its applications-XIV	04	40	60	04
P-PDS-421	Photonic Devices and Sensors	04	40	60	04
(Elective) P-IPE-422A P-ENP-422B	Industrial Photonic Engineering-XVIA Or Energy Physics-XVIB	04	40	60	04
P-LAC-423	Laboratory Course -VI (Laser System and Photonic Devices)	04	40	60	04
P-PRO-424	Project II	04	40	60	04
P-SEM-425	Seminar-IV	01	25	--	01
	Total Credits				25

Student Stay Hours: 25/Week

M. Sc. – II [Physics] Semester III

(4-credits)

P-EPP-321 Electrodynamics and Plasma Physics Total Lecturers: 60

Learning objectives:

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

(2) To make students familiar with the physics of electromagnetic waves and Plasma.

(3) To train the students in analytical and numerical problem solving skills in Electrodynamics.

Course outcomes:

Upon successful completion of the course, it is expected that students will be able to:

(1) Understand origin of Maxwell's equations in vacuum, dielectric, linear isotropic media,

(2) 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,

(3) Obtain scalar and vector potential equations in presence of sources,

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

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

(6) Derive Lienard-Wiechert potentials for a moving point charge,

(7) Show that acceleration of the charge gives electromagnetic radiation,

(8) Develop a knowledge and understanding of Plasma behavior.

Unit I: Electromagnetic Waves [17 Periods]

Maxwell’s Equations: Microscopic and Macroscopic forms (revision),

Wave Equation in 1D: The Wave Equation, Sinusoidal Waves, Boundary Conditions: Reflection and Transmission; Polarization. Electromagnetic Waves in Vacuum: The Wave Equation for E and B, Monochromatic Plane Waves. Electromagnetic Waves in Matter: Propagation in Linear Media, Reflection and Transmission at Normal Incidence, Reflection and Transmission at Oblique Incidence, Laws of Reflection and Refraction. Guided Waves: Wave Guides, TE and TM Waves, TE and TM Modes. **[Book-1, Ch. 9]**

Unit II: Time Dependent Potentials and Fields [13 Periods]

The potential formulation: Scalar and Vector Potentials, Gauge transformation, Coulomb Gauge and Lorentz Gauge, Retarded Potentials, Jefimenko's Equations.

Point Charges: Lienard-Wiechert Potentials, The Fields of a Moving Point Charge. **[Book-1, Ch. 10; Book-2, Ch. 6]**

Unit III: Radiations and Radiation Reactions [15 Periods]

Dipole Radiation: Electric Dipole Radiation (Approximation-1, 2, 3), Magnetic Dipole Radiation (Approximation-1, 2, 3), Radiation from Arbitrary Sources (Approximation-1, 2, 3), Power Radiated by Point Charge: Larmer's Formula, Lienard's Generalization.

Radiation Reaction: Criteria for Validity, Abraham-Lorentz Formula and Physical Basis of Radiation Reaction- Self Force. **[Book-1, Ch. 11]**

Unit IV: Plasma Physics [15 Periods]

Introduction, Simple Consequence of Coulomb Interaction: Coulomb Cross-Section for Momentum Transfer, Debye Screening, Plasma Oscillations.

Parameters Describing the Plasma: Discreteness Parameter and Fluid Limit, The Plasma Parameter, Coulomb Collisions, Collective Versus Individual Particle Aspects of Density Fluctuations, Plasma as Dielectric Media: Dielectric Tensor and Dispersion Relation: Linearity, Translational, Invariance and Causality, Definition of Dielectric Tensor, Dispersion Relation, Isotropic Medium. **[Book-3, Ch. 1, 3]**

Recommended Books:

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)

Reference Books:

1. Foundation of Electromagnetic Theory- John R. Reitz, Frederick J. Milford, Robert W. Christy. (Pearson Education, Inc., Publishing Addison – Wasley)
2. Elementary Plasma Physics- Conrad L. Longmire (First U.S. Edition-1963, First Wiley Eastern Reprint, 1971)
3. Principles of Plasma Mechanics- Bishwanath Chakraborty, (Wiley Eastern Limited).

M. Sc. – II [Physics] Semester III

(4-credits)

P-NPP-322 Nuclear and Particle Physics Total Lecturers: 60

Learning Objectives:

(1) Introduce students to the fundamental principles and concepts governing nuclear and particle physics,

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

(3) 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:

Upon successful completion of this course, the student will:

(1) Understand the fundamental principles and concepts governing nuclear and particle physics,

(2) Demonstrate knowledge and understanding of scientific and technological applications, of Nuclear Physics as well as their social, economic and environmental applications,

(3) Demonstrate comprehension of physical reality through estimation, approximation, and mathematical modeling, and understand how small number fundamental physical principles underlie a huge variety of interconnected natural phenomena,

(4) Able to explain the Rutherford's experiment, Nuclear Radiation and Charged Particle Accelerators.

Unit I: The Constitution of Nucleus and Nuclear Reactions [15 Periods]

The Proton-Electron Hypothesis of the Constitution of the Nucleus, The Angular Momentum of Nucleus, Failure of Proton–Electron Hypothesis, Nuclear Transmission and The Discovery of Neutron, The Proton–Neutron Hypothesis, Magnetic and Electrical Properties of Nucleus**. [Book-1, Ch. 8]**

Nuclear Reactions: Rutherford's Experiment, Types of Nuclear Reactions, Conservation Laws in Nuclear Reactions, Reaction Induced by α-Particles, Discovery of Induced Radioactivity, Proton Induced Reactions, Deuteron Induced Reactions, Neutron Induced Reactions, γ-Ray Induced Reactions. **[Book-2, Ch. 10]**

Unit II: Nuclear Models **[15 Periods]**

Nature of Nuclear Force; **Nuclear Models:** Liquid Drop Model, Bethe-Weizsacker's Formula, Application of the Semi-Empirical Binding Energy Formula, α-Decay, Fermi Gas Model of the Nucleus, Nuclear Shell Structure, Single Particle Shell Model, Individual Particle Model, Collective Model. **[Book-2, Ch. 9]**

Unit III: Detection of Nuclear Radiation and Charged Particle Accelerators [15 Periods]

Detectors: Introduction, Methods for the Detection of Free Charge Carriers, Ionization Chamber, Proportional Counter, Geiger-Muller Counter, Scintillation Detector, Wilson Cloud Chamber.

Accelerators: Introduction, Classification & Performance Characteristics of Accelerators, Van-De Graff Generator, Cyclotron, Synchrocyclotron, Betatron, Electron Synchrotron. **[Book-2, Ch.7 12]**

Unit IV: Elementary Particles **[15 Periods]**

Introduction, Classification of Elementary Particles, Particle Interactions: Gravitational Interactions, Electromagnetic Interactions, Strong Interactions, Weak Interactions, Conservation Laws, Electron and Positrons, Proton and Anti-Proton, Neutrons and Anti-Neutrons, Neutrinos and Anti-Neutrinos, Photons, Mesons. Mions, Pions, Muons **[Book-3, Ch. 16].**

Recommended Books:

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)

Reference Books:

1. Nuclear Physics- S.B. Patel, Wiley Eastern Publishing House
2. Nuclear Physics- Jaahan Singh, Pragati Prakashan (2012)
3. Modern Physics- R Murugeshan, S. Chand Publisher, 1994
4. Atomic Physics- J.B. Rajam S. Chand & Company, New Delhi
5. Nuclear Physics- Raj Kumar
6. Nuclear Physics- S.P. Sahu.

M. Sc. – II [Physics] Semester III

(4-credits)

P-LET-323 Laser Technology Total Lecturers: 60

Learning Objectives:

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

(1) To understand fundamentals of light-matter interaction,

(2) To get Knowledge about Einstein treatment of transition rates,

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

(4) To compare two, three, and four -level schemes - laser operation and gain saturation

(5) To explain the construction and working of various lasers.

Course Outcomes:

On completion of this course a student should be able to demonstrate understanding of and be able to solve problems on:

(1) absorption, spontaneous and stimulated emission in two level system, effects of homogeneous and inhomogeneous line broadening, and conditions for laser amplification,

(2) 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,

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

(4) Spectral properties of a single longitudinal mode, mode locked laser operation, schemes for active and passive mode locking in real laser system,

(5) 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 I: Basics of Laser [15 Periods]

Introduction, Interaction of Light And Matter, Quantum Behavior of Light, Energy Levels, Thermal Equilibrium, Absorption, Spontaneous Emission and Stimulated Emission of Light, Light Amplification, High Intensity, Einstein's Relations, Conditions for Large Stimulated Emission, Conditions for Light Amplification, Population Inversion, Pumping, Pumping Methods: Optical; Electrical; Direct Pumping, Active Medium, Metastable States, Pumping Schemes. **[Book-1, 1.3 To 1.20]**

Unit II: Properties of Laser and Optical Resonator **[15 Periods]**

Properties of Laser: Directionality, Intensity, Coherence, Monochromaticity, Polarization. **Optical Resonator:** Introduction, Action of Optical Resonator, Threshold Condition, Critical Population Inversion, Condition for Steady State Oscillation, Cavity Resonance Frequency, Line Broadening Mechanism, Natural or Intrinsic Broadening, Collision Broadening, Doppler Broadening, Gain Saturation and Bandwidth, Laser Operating Frequencies.**[Book-1, 3.1 To 3.6, 1.23 To 1.32, Book-2 5.8]**

Unit III: Laser Cavity Modes **[15 Periods]**

Introduction, Cavity Configuration, Modes: Longitudinal and Transverse Modes, Single Mode Operation, Laser Rate Equation: Two Level System, Three Level System and Four Level System, Comparison of Three Level System and Four Level Lasers, Optimum Output Power, Properties of Laser Modes, Spatial And Spectral Hole Burning, Q-Factor, Q-Switching for Giant Pulses, [**Book-1, 1.33 To 1.37; 4.5 To 4.7]**

Unit IV: Types of Laser **[15 Periods]**

Introduction, Solid State Laser, General Description, Structure and Working: Ruby Laser, Nd:YAG Laser, Alexandrite Laser, Nd:Glass Laser, Titanium Sapphire Laser, Gas Laser-General Description, Structure and Working of : He-Ne Laser, Argon Laser, CO_2 Laser, Tunable Dye Laser, Copper Vapour Laser, He-Cd Laser, He-Se Laser **[Book-1, 2.1 To 2.4; Book-2, 8.2 To 8.4)**

Recommended Books:

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)

Reference Books:

1. Laser Fundamentals- William T. Silfvast Cambridge University, Press
2. Laser and its Applications – Ghatak and Thyagarajan (Mcmillan, India 2004)
3. Laser- Principles, Types and Applications- K.R. Nambiar, (New Age Inter.Publishers 2006)

M. Sc. – II [Physics] Semester III

(4-credits)

P-TFN-324 Thin Film and Nanotechnology Total Lecturers: 60

Learning Objectives:

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

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

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

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

Course Outcomes:

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

1) Handle different types of thin film deposition techniques,

2) explain the effect of various parameters on thin film growth,

3) Characterize thin films for the electrical, optical and structural properties,

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

Unit I: Thin Film Deposition Techniques [15 Periods]

Introduction, Nature of Thin Film, Physical Methods, Thermal Evaporation Methods: Flash Evaporation, Electron Bombardment, Sputtering Process: Glow Discharge Sputtering, Reactive Sputtering, R.F. Sputtering.

Chemical Methods: Chemical Vapor Deposition, Electro Deposition, Anodic Deposition, Chemical Bath Deposition, Spray Pyrolysis. **[Book 1: Ch. 1]**

Unit II: Nucleation, Film Growth and Structure of Films [15 Periods]

Nucleation: Introduction, Thermodynamics of Nucleation; Condensation Process, Langmuir- Frenkel Theory, Nucleation Theories: Capillary Model, Effect of Super Saturation: Temperature; Lattice Strain; Impurity and Surface Imperfection. Film Growth and its Various Stages, Incorporation of Defects and Impurity, Deposition Parameters and Grain Size.

Thin Film Structure: Influence of Substrate and Film Thickness. **[Book-1; Ch. 5, Book-2: Ch. 4]**

Unit III: Properties of Thin Films **[15 Periods]**

Mechanical Properties: Stresses in Thin Films, Mechanical Constants of Thin Films.

Electrical Properties: Electrical Conduction in Thin Metallic Discontinuous Films, Electrical Conduction in Thin Metallic Continuous Films,

Optical Properties: Reflection, Transmission, Absorption, Energy Band Gap, Transition, Reflection and Transmission From Single Film, Reflection from Multilayer Film, Methods for Determining Optical Constants: Reflection Methods, Elipsometric Methods. **[Book-1; Ch. 11, Book 3; Ch. 4]**

Unit IV: Nanotechnology **[15 Periods]**

Introduction, Nanomaterial's: Metal Nano Clusters; Semiconductor Nano Particle, Nano Structure; Carbon Clusters, Carbon Nanotubes: Carbon Quantum Nano-Structure **[Book-4; Ch. 16]**, Application of Nano Materials: Medicine, Energy Sector, Water Purification, Communication, Automobiles. **[Book-5; Ch. 7]**

Recommended Book:

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.

M. Sc. – II [Physics] Semester III

(4-credits)

P-LAC-325 **Laboratory course-V** **Total Lecturers: 60**

Learning Objectives:

(1) The objective of this lab to make students familiar with the fundamental properties of light, explore optical phenomena in a laboratory setting, make careful measurements, and draw own conclusions about the models and theories that describe these phenomena,

(2) Understanding and relating the applications of laser to study indices of refraction for water and glass,

(3) To identify the use of lasers and photonic devices in emerging frontiers of Physics,

(4) To gain knowledge of different synthesis techniques used for photonic materials,

(5) To inculcate experimental skills using various experiments.

Course Outcomes:

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

(1) Accurately measure refractive index of given liquids,

(2) Handle the spray pyrolysis machine carefully and take deposition,

(3) Measure the characteristics of photo electrochemical solar cell and hence determine efficiency and fill factor,

(4) Estimate the band gap of given semiconductor in thin film form.

Laboratory courses:

1) Determination of the Refractive Index of Given Liquids using Total internal reflection.

2) Laser based liquid prism sucrose meter to determine the unknown concentration of sugar in sugar solution.

3) Study of the power distribution within the laser beam.

4) Determination of the speed of microwaves using microwave oven.

5) Study of pattern of a CD with lasers and determination of the data track spacing on CDs.

6) Deposition of CdS thin film by spray pyrolysis and determination of its thickness by gravimetric weight difference method.

7) Study of the power output characteristics of photo electrochemical solar cell and determination of efficiency and fill factor.

8) Determination of the absorption coefficient of transparent liquid.

9) Determination of the bandgap of given semiconducting thin film using UV-Vis Spectrophotometer.

10) Determination of DC electrical resistivity of semiconducting thin films.

Reference Books:

1. An Introduction to Laser: Theory and Applications-M.N. Avadhanulu (S. Chand and Company Ltd. Ram Nagar, New Delhi 2008)

2. Laser- Principles, Types and Applications- K.R. Nambiar, (New Age Inter.Publishers 2006)

3. Thin Film Fundamentals- A. Goswami , New Age International LTD, Publishers.

4. Photoelectrochemical Solar Cells (Electrocomponent Science Monographs) 1st Edition Suresh Chandra, Electrocomponent Science Monographs Series Vol 5, Publisher: Routledge (1985)

M. Sc. – II [Physics] Semester IV

(4-credits)

P-FOA-419 Fibre Optics and its Applications Total Lecturers: 60

Learning Objectives:

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

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

(3) Understanding Modes, electromagnetic mode theory and propagation,

(4) Comparing single mode and multimode fibers, linearly polarized modes,

(5) Describing various types of optical fibre losses,

(6) Understanding of digital and analogue modulations-demodulation using LED and Laser diodes.

Course Outcomes: On satisfying the requirements of this course, students will have the knowledge and skills to:

(1) Analyze fiber optics and optical detectors components associated with fiber optics systems,

(2) Distinguish internal reflection, acceptance angle, numerical aperture and skew rays,

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

(4) Explain bending losses, modal dispersion, waveguide dispersion and pulse broadening,

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

Unit I: Ray Theory of Transmission [15 Periods]

Introduction, Propagation of Light in Different Media: Propagation of Light in an Optical Fibre, Basic Structure and Optical Path of an Optical Fibre, Acceptance Angle and Acceptance Cone, Numerical Aperture(NA) (General), Modes of Propagation, Meridional and Skew Rays, Number of Modes and Cut-Off Parameters of Fibres, Numerical Problems.

Classification of Fibres: Stepped Index Fibre, Stepped Index Monomode Fibre, Graded Index Multimode Fibre, Comparison of Step Index and Graded Index Fibres, Numerical Problems. **[Book 1, Ch. 2, 3]**

Unit II: Fibre Fabrication Techniques and Fibre Losses [15 Periods]

Classification of Fibre Fabrication Techniques, External Chemical Vapour Deposition, Axial Vapour Deposition, Internal Chemical Vapour Deposition Technique (ICVD), Comparison of Various Fabrication Processes, Fibre Drawing and Coating, Double Crucible Method.

Fibre Losses: Attenuation in Optic Fibres, Materials or Impurity Losses, Rayleigh Scattering Losses, Absorption Loss, Leaky Modes, Bending Losses, Radiation Induced Losses, Temperature Dependence of Fibre Losses, Core and Cladding Losses. **[Book 1, Ch. 4, 7]**

Unit III: Communication Systems and Modulation [15 Periods]

Communication Systems: Introduction, Transmitter for Fibre Optic Communication, High Performance Transmitter Circuit (LED–Digital Transmitter), LED–Analog Transmitter, LASER Transmitter, Digital and Analog Laser Transmitter, Transmitter Design, Fibre Optic Receiver, High Performance Receiver, Fibre Based Modems: Transreceiver.

Modulation: Introduction, LED Analog Modulation, Digital Modulation, Laser Modulation, Pulse Code Modulation (PCM), Intensity Modulation (IM). **[Book 1, Ch.15, 17]**

Unit IV: Optical Fibre Communication & Measurements on Optical Fibres [15 Periods]

Optical Fibre Communication Systems: Introduction, Important Applications of Integrated Optic Fibre Communication Technology, Long Haul Communication, Coherent Optical Fibre Communication, Principle of Coherent Detection.

Measurements on Optical Fibres: Introduction, Measurements of Numerical Aperture (NA), Measurements of Fibre- Attenuation, Optical Time Domain Reflectometry (OTDR), Measurements of Dispersion Losses, Measurements of Refractive Index, Cut-Off Wavelength Measurement, Measurements of Mode Field Diameter (MFD), Near Field Scanning Technique. **[Book 1, Ch.18, 20]**

Recommended Books:

1. Optical Fibre and Fibre Optic Communication Systems, S.K. Sarkar (S. Chand and Comp., Ltd New Delhi 2010)

Reference Books:

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

M. Sc. – II [Physics] Semester IV

(4-credits)

P-LSA-420 Laser system and its applications Total Lecturers: 60

Learning objectives:

(1) To demonstrate general understanding of use of laser in industry,

(2) To learn applications of lasers in cutting, hole drilling, welding and heat treatment,

(3) To understand the wide advantages of using laser in medicine,

(4) To acquaint the students with the optical arrangement and exposure technique of hologram,

(5) To understand cooling and trapping of neutral atoms using laser.

Course outcomes:

Upon successful completion, students will have the knowledge and skills to:

(1) Recognize applications of laser in industry,

(2) Impart basic knowledge related to lasers in chemistry and medicine,

(3) Communicate the concepts and results on biological effects of electromagnetic radiation,

(4) 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,

(5) Provide an insight into applications of laser in defense.

Unit I: Industrial application of lasers [15 Periods]

Introduction, High Power Gas Lasers, Material Processing with Lasers, Metals and Laser, Material Processing Mechanism, Hole Drilling with Lasers, Cutting Process with Lasers, Laser Welding Process, Micro Laser Welding, Deep Penetration Welding, Laser Hardening, Laser Generated Plasma. **[Book-1 Part C; Ch.1; Book-2; Ch.14]**

Unit II: Lasers in Chemistry and Medicine [15 Periods]

Lasers in Chemistry: Introduction, Laser Induced Collision Processes- Pair Excitations **[Book-3, Ch. 16]**, Nuclear Fusion with Lasers, Laser Aided Fusion Reactor, Lasers in Spectroscopy, **[Book-1Part C; Ch.1],** Laser in Isotopes Separation, Separation Using Radiation Pressure, Separation by Selective Photo-Ionization or Photo Dissociation, Photo-Chemical Separation **[Book- 2, Chap–13],**

Lasers In Medicine: Biological Effect of Electromagnetic Radiation, Laser in Medicine, Laser Diagnostics, Photocoagulation, Lasers in Situ Keratomileusis (LASIK), Lasers in Dermatology, Photodynamic Therapy **[Book-4, Ch. 5, Book-1 Part C; Ch.7]**

Unit III: Holography and its Applications [15 Periods]

Introduction, Principle of Holography: Recording and Reconstruction of Hologram, Some Distinguish Characteristics of Hologram **[Book-3, Ch. 2],** Types of Hologram, Intensity Distribution in a Hologram, In-Line Holography, Off-Axis Holography, Thin and Thick Hologram, Reflection Holography, Application of Holography: Holographic Microscopy, Particle Size Analysis, Holographic Memory, Holographic Interferometry **[Book-1, Part C; Ch. 5]**

Unit-IV: Other Applications of Lasers [15 Periods]

Introduction, Tracking of Bodies in Motion by Using Lasers, LIDAR, Velocity Measurement of A Moving Object **[Book-2, Ch. 14],** Laser Gyro, Design of Laser Range Finder **[Book-1, Part-C; Ch. 6]**, Laser Cooling and Trapping of Neutral Atom, **[Book-3, Ch. 16],** Optical Computers **[Book-4, Ch. 5],** Laser in Communication, Laser in Astronomy, Laser in CD Read-Write. **[Book-5, Ch. 16]**

Recommended Books:

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.

M.Sc. – II [Physics] Semester IV

(4-credits)

P-PDS-421 Photonic Devices and Sensors Total Lecturers: 60

Learning objectives:

(1) To introduce basic concepts governing optical waveguides, fibres, and lasers,

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

(3) To acquaint the students about important areas of photonics,

(4) To foster a physical and quantitative understanding of key photonic devices,

(5) 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:

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

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

(3) Understand characteristics and evaluate the performance of photo detecting devices,

(4) Describe the technical and physical fundamentals of various optical sensors,

(5) Gain the knowledge about current status and future trends in development of photonic devices.

Unit I: Light Beam as Sensing Tool [15 Periods]

Single Electro-Optic Detector: Photoelectric Cells, Photomultipliers, Semiconductor Detectors; Thermal Detectors (Bolometer); CCD Detector.

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, Optical Methods for Distance and Size Measurement: Range Finder and Size Measurement with Lasers. **[Book 1, Ch. 4-8].**

Unit II: Optical Fibre Sensors [15 Periods]

Introduction, Key Features of Optical Fibre Sensors, Classification of Optical Fibre Sensors Based on Intensity Phase, Wavelength and Polarization, **[Book 2, Ch. 22].**

Types of OFS- Intrinsic and Extrinsic Sensors, **[Book 3, Ch. 14] Intensity** Modulated Sensor, Shutter Based Multimode OFS, Reflective Optical Fibre Sensors, Micro Bend Optical Fibre Sensors, Intensity Modulated Thermometers, **[Book 2, Ch. 23]**, Fabry Pérot Fibre Optic Sensor, Fibre Optic Gyroscope **[Book 4, Ch. 16].**

Unit III: Liquid Crystal Displays **[15 Periods]**

Introduction, Orientational and Positional Ordering, Liquid Crystal Phases: Nematic; Cholesteric; Smectic A and C, Types of Liquid Crystals: Thermotropic and Lyotropic Liquid Crystals, Pitch of Ordering, Experimental Identification of Liquid Crystals, Optical Properties of Liquid Crystals, Liquid Crystal Displays **[Book 5, Ch. 1]**

Unit IV: Plasma Display Panels **[15 Periods]**

Introduction, Physics of Gas Discharge: I-V Characteristics; Penning Reaction and Paschen Curve; Priming Mechanism, Plasma Display Panels: DC PDP; AC PDP; Panel Processes, Front Plate Techniques: Substrate; Sustain Electrode; Dielectric; Protection Layer, Rear Plate Techniques: Substrate; Address Electrode; Dielectric; Barrier Rib; Phosphor; Working of PDP, Advantages and Disadvantages of PDP. **[Book 6, Ch. 5]**

Recommended Books:

[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)

References:

1. Optical Fiber Communication- G. Keiser (Mc Graw Hill) Third Edition

2. Introduction to Fiber Optics- A. Ghatak and Tyagrajan (Cambridge University Press)

3. Shruti Mohanty, Liquid Crystals - The 'Fourth' Phase of Matter, RESONANCE November 2003 Page 52-70

M.Sc. – II [Physics] Semester IV

(4-credits)

P-IPE-422 Industrial Photonic Engineering Total Lecturers: 60

Learning objectives:

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

(2) To understand how the various network testbeds are designed and implemented,

(3) To overview the aspects of the safe and effective uses of lasers in communication.

(4) To train the student about network management and wavelength routing testbeds, and

(5) To design various techniques used for upgrading transmission capacity of optical networks.

Course outcomes:

Upon successful completion, students will have the knowledge and skills to:

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

(2) Proficiently apply advanced, integrated technical knowledge in photonics and network management function.

(3) Identify and critically evaluate current developments and emerging trends within the photonics sector.

(4) Understand design of various photonics components,

(5) Develop a knowledge and understanding of signal formats and detectors used in photonics.

Unit I: Photonics Technology [15 Periods]

Introduction, Components: Couplers- Directional Couplers, Principle of Operation and Conservation of Energy, Isolators and Circulators (Principle of Operation), Multiplexers and Filters-Grating; Bragg Grating; Fiber Grating; Fabry-Perot Filters, Multilayer Dielectric Thin Films Filters, FO Amplifiers, Erbium Doped Fiber Amplifier, Transmitters- Lasers, LED. **[Book- 1 Ch. 3]**

Unit II: Modulation and Demodulation [15 Periods]

Modulation: Introduction, Signal Formats, Demodulation: An Ideal Receivers; A Practical Direction Detection Receivers, Coherent Detection,

Test Beds- LAMBDA NET **[BOOK- 2 PAGE 548],** RAINBOWS, STARNET

Wavelength Routing Network: Optical Layer in Network; Node Design; Networking Design and Operation, Routing and Wavelength Assignment. **[Book- 1 Ch. 4, 7, 8]**

Unit III: Control and Management [15 Periods]

Introduction, Network Management Function: Configuration; Performance; Fault; Security; Accounting Managements. Configuration Managements: Equipment and Connection Management, Performance and Fault Managements, Optical Safely, Service Interface Wavelength Routing Test Beds- AON. NTTR, MWTN, ONTC, MONET. [Book-1, Ch. 10-11]

Unit IV: Access Network [15 Periods]

Introduction, Network Architecture Overview, Today's Access Network, Future Access Network-HFC. FTTC, Optical Access Network Architecture,

Deployment Considerations-Upgrading The Transmission Capacity- SDM, TDM, WDM Approach, Application Areas -Inter Exchange Network, Undersea Network, Local Exchange Networks.

Photonic Packet Switching, OTDM, Multiplexing and Demultiplexing, Bits and Packet Interleaving. [Book-1, Ch. 12-14]

Recommended Books:

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)

Reference Books:

1. Deploying Optical Networking Components - Oil Held, Mccraw Hill (2001)

2. Optical Interconnection-C Tocci, Hi Caulfield, Artech House (1999)

M.Sc. – II [Physics] Semester IV

(4-credits)

P-LAC-423 Laboratory Course-VI Total Lecturers: 60

Learning objectives:

(1) To make students familiar with the fundamental properties of light,

(2) To explore the students about optical phenomena in a laboratory setting, make careful measurements and draw own conclusions about the models and theories that describe these phenomena.

Course Outcomes:

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

(1) Utilize the four probe set up for measurement of electrical resistivity of semiconductor.

(2) Handle the G.M. counter.

(3) Handle the spray pyrolysis machine carefully and take deposition

(4) Measure the numerical aperture of given optical fiber.

(5) Gain the knowledge of the electrical to optical and optical to electrical characteristics of given optical fiber.

(6) Develop knowledge and understanding bending losses in optical fiber.

Laboratory Courses:

1) Calibrate the given optical sensor and find its sensitivity.

2) Measurement of the resistivity of semiconductor at different temperature by four probe method.

3) Study of the spectral response of Photoelectrochemical solar cell.

4) Study the inverse square law of Gamma rays.

5) Deposition of PbS thin film by spray pyrolysis and determination of its thickness by gravimetric weight difference method.

6) Study of electrical to optical and optical to electrical characteristics of given optical fiber.

7) Determination of the numerical aperture of given optical fiber.

8) Determination of the optical power loss in Attenuators.

9) Determination of the optical power splitting using coupler.

10) Estimation of the bending loss in a given optical fiber

11) Determination the power loss in optical fiber spool with OTDR.

12) Thermoelectric power of thin films.

Recommended Books:

[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 and Fiber Optic Communication Systems S.K. Sarkar (S. Chand and Comp., Ltd New Delhi)