**ANNA UNIVERSITY, CHENNAIUNIVERSITY**

**DEPARTMENTS**

**REGULATIONS - 2023**
**CHOICE BASED CREDIT SYSTEM**
**M.TECH. LASER AND ELECTRO OPTICAL ENGINEERING (FT)**

**VISION:**

- Department of Physics at Anna University shall strive towards the world class center by producing students with higher technical knowledge, professional skills and other values.
- The Department shall provide an outstanding experience in teaching, research and consultancy.
- The Department shall perform frontier research and create knowledge base in pure and applied physics, materials science, laser engineering and areas of technological importance.

**MISSION:**

- Department of Physics, Anna University shall provide high quality Physics education, producing well prepared students who are intellectually and technically equipped in their abilities and understanding of Physics and in particular Materials Science.
- The Department of Physics promotes high quality academic and research programs and proves extension services in cutting edge technologies in Materials Science and Laser Engineering.
- The Department of Physics ensures the supportive campus climate in academic andresearch activities by meeting the needs of the students, faculty and staff.

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**UNIVERSITY DEPARTMENTS**
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**M.TECH. LASER AND ELECTRO OPTICAL ENGINEERING (FT)**

## 1. PROGRAMME EDUCATIONAL OBJECTIVES (PEOs):

I. To prepare students to excel in research or to succeed in Laser and Electro Optical Engineering profession through global, rigorous post graduate education.
II. To provide students with a solid foundation in Mathematics, Physics of Lasers and optical devices, and Electro-optical engineering fundamentals required to apply theprinciples for optical engineering design.
III. To train students with good scientific and engineering knowledge so as to comprehend, analyze, design, and create novel products and solutions for the optical engineering domain.
IV. To inculcate students in professional and ethical attitude, effective communication skills, teamwork skills, multidisciplinary approach, and an ability to apply laser and electro optical engineering aspects.
V. To provide Student with an academic environment aware of excellence, leadership, written ethical codes and guidelines, and the life-long learning needed for a successful professional career.

## 2. PROGRAMME OUTCOMES (POs):

After going through the two years of study, our Laser and Electro-Optical Engineering Post-Graduates will have following abilities:

| PO# | Graduate | Programme Outcome |
|---|---|---|
| 1. | Research aptitude | An ability to independently carry out research /investigation and development work to solve practical problems |
| 2. | Technical documentation | An ability to write and present a substantial technical report/document |
| 3. | Technical competence | Students will be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery will be at a level higher than the requirements in the appropriate bachelor program |
| 4. | Engineering design and modern tool usage | An ability to apply various advanced tools and techniques to develop efficient optical engineering systems, optical signal processing devices and optical networking systems. |
| 5. | The engineer and society | An ability to apply technical knowledge towards the development of socially relevant products in optical domain. |
| 6. | Environment and sustainability | Students will be able to ensure development of ecofriendly indigenous optical engineering devices and products. |



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3. **PROGRAM SPECIFIC OUTCOMES (PSOs):**

By the completion of Laser and Electro Optical Engineering program the student will havefollowing Program Specific Outcomes.

1. To apply the knowledge of optics and laser fundamentals and engineering for the solution of complex optical engineering problems.
2. To design and develop new system components or processes for meeting the specificneeds of optical or laser industry.
3. To create, select and apply appropriate techniques, resources and modern engineering and IT tools for complex optical engineering activities in Industries and Research & Development organizations.
4. Recognize the need for, and have the preparation and ability to engage in independent and group environments and to communicate effectively in multidisciplinary environments.

4. **PEO / PO Mapping:**

| PROGRAMME EDUCATIONAL OBJECTIVES | PROGRAMME OUTCOMES | | | | | |
|---|---|---|---|---|---|---|
| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
| I | 2 | 2 | 3 | 3 | 3 | 2 |
| II | 3 | 2 | 3 | 3 | 2 | 2 |
| III | 3 | 3 | 3 | 3 | 3 | 2 |
| IV | 3 | 3 | 3 | 3 | 3 | 2 |
| V | 2 | 2 | 3 | 3 | 2 | 2 |

**Mapping of Course Outcome and Programme Outcome**

| Year | Sem | Course Name | PO01 | PO02 | PO03 | PO04 | PO05 | PO06 |
|---|---|---|---|---|---|---|---|---|
| YEAR 1 | Semester 1 | Applied Electromagnetics | 1.4 | 1.4 | 3 | 2 | 2.4 | 2.2 |
| | | Principles of Optics | 2 | 2.2 | 2.4 | 2.2 | 1.8 | 1.6 |
| | | Laser Engineering | 1.6 | 1.8 | 1.8 | 2.6 | 2.8 | 1.4 |
| | | Mathematical Physics for Optical Engineering | 2 | 1 | 2 | 1 | 1 | 1 |
| | | Research Methodology and IPR | | | | | | |
| | | Optics and Laser Laboratory | 2 | 2 | 2.4 | 2.8 | 2.8 | 3 |
| | Semester 2 | Electro-Optics Theory and Applications | 2 | 2 | 3 | 1.4 | 2 | 2.2 |
| | | Nonlinear Optics | 1.8 | 1.8 | 1.8 | 1 | 1 | 1 |
| | | Optoelectronics | 2.4 | 2.4 | 2.4 | 2.2 | 2 | 2.2 |
| | | Professional Elective I | | | | | | |
| | | Professional Elective II | | | | | | |
| | | Professional Elective III | | | | | | |
| | | Laser Laboratory | 1.8 | 1.8 | 2.6 | 2.8 | 2.6 | 2 |
| | | Simulation/ Computer Programming Laboratory | 2 | 2 | 2 | 3 | 3 | 3 |
| YEAR 2 | Semester 3 | Professional Elective IV | | | | | | |
| | | Professional Elective V | | | | | | |
| | | Professional Elective VI | | | | | | |
| | | Project Work - I | 3 | 3 | 3 | 3 | 3 | 3 |
| | | Industrial Training / Internship ( 4 Weeks)* | 3 | 3 | 3 | 3 | 3 | 3 |
| | Semester 4 | Project Work - II | 3 | 3 | 3 | 3 | 3 | 3 |

*During Summer vacation

## CO-PO Mapping of Program Elective Courses

| | | | Course Name | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|---|---|---|
| YEAR 1 | Semester 2 | Program Elective I (One from list of electives I) | Fiber Optics Sensors | 1.6 | 1.6 | 1.8 | 2.2 | 2.2 | 2 |
| | | | Materials for Optical Devices | 2.2 | 2.8 | 2.6 | 2.8 | 2.4 | 2.8 |
| | | | Fabrication of Optical Devices | 2 | 2 | 2.4 | 2.8 | 2.6 | 2.4 |
| | | Program Elective II (One from list of electives II) | Laser Materials Processing | 1.8 | 1.8 | 2.6 | 2.6 | 2.6 | 1.8 |
| | | | Medical Applications of Lasers | 2 | 2 | 2.2 | 2.4 | 2.2 | 2.4 |
| | | | Fourier Optics and Signal Processing | 2 | 2.4 | 2.6 | 2.6 | 2.6 | 2.2 |
| | | Program Elective III (One from list of electives III) | Nonlinear Fiber Optics | 2 | 2 | 2.2 | 2.8 | 2.8 | 2.6 |
| | | | Optical Computing and Signal Processing | 1.8 | 1.8 | 1.8 | 2.2 | 2.8 | 2.4 |
| | | | Ultrafast Optics | 1.6 | 1.6 | 2.4 | 2.4 | 2.4 | 1.6 |
| YEAR 2 | Semester 3 | Program Elective IV (One from list of electives IV) | Laser Spectroscopy | 1.8 | 1.8 | 1.8 | 1.8 | 1 | 1 |
| | | | Holography and Speckle | 2 | 1.6 | 1.8 | 2.6 | 2.4 | 2.2 |
| | | | Radiation Sources and Detectors | 2 | 2 | 1.8 | 2.8 | 2.4 | 2 |
| | | Program Elective V (One from list of electives V) | Integrated Optics | 2.4 | 2.8 | 2.6 | 2.8 | 2.8 | 2.8 |
| | | | Nano-optics | 1.6 | 1.6 | 1.8 | 2.4 | 2.2 | 1.6 |
| | | | Laser Dynamics | 2 | 2 | 2 | 2.6 | 2.6 | 2.2 |
| | | Program Elective VI (One from list of electives VI) | Technological applications of laser | 2.2 | 2.4 | 2.4 | 2 | 2.4 | 2.2 |
| | | | Digital Holography | 1.6 | 1.6 | 1.8 | 2.6 | 2.6 | 1.8 |
| | | | Optical Displays and Storage Devices | 2 | 2 | 2 | 3 | 3 | 2.6 |

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**CHOICE BASED CREDIT SYSTEM**
**M.TECH. LASER AND ELECTRO OPTICAL ENGINEERING**
**CURRICULUM AND SYLLABUS**

## SEMESTER I

| S. NO. | COURSE CODE | COURSE TITLE | CATE GORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| **THEORY** | | | | | | | | |
| 1. | LO3101 | Applied Electromagnetics | PCC | 4 | 0 | 0 | 4 | 4 |
| 2. | RM3151 | Research Methodology and IPR | RMC | 2 | 1 | 0 | 3 | 3 |
| 3. | LO3102 | Principles of Optics | PCC | 3 | 0 | 2 | 5 | 4 |
| 4. | LO3103 | Laser Engineering | PCC | 3 | 0 | 2 | 5 | 4 |
| 5. | LO3104 | Mathematical Physics for Optical Engineering | FC | 3 | 1 | 0 | 4 | 4 |
| **PRACTICALS** | | | | | | | | |
| 6. | LO3111 | Optics and Laser Laboratory | PCC | 0 | 0 | 4 | 4 | 2 |
| | | | **TOTAL** | **15** | **2** | **8** | **25** | **21** |

## SEMESTER II

| S. NO. | COURSE CODE | COURSE TITLE | CATE GORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| **THEORY** | | | | | | | | |
| 1. | LO3201 | Electro-Optics Theoryand Applications | PCC | 3 | 0 | 0 | 3 | 3 |
| 2. | LO3202 | Nonlinear Optics | PCC | 3 | 0 | 0 | 3 | 3 |
| 3. | LO3203 | Optoelectronics | PCC | 3 | 0 | 0 | 3 | 3 |
| 4. | | Professional Elective I | PEC | 3 | 0 | 0 | 3 | 3 |
| 5. | | Professional Elective II | PEC | 3 | 0 | 0 | 3 | 3 |
| 6. | | Professional Elective III | PEC | 3 | 0 | 0 | 3 | 3 |
| **PRACTICALS** | | | | | | | | |
| 7. | LO3211 | Laser Laboratory | PCC | 1 | 0 | 4 | 5 | 3 |
| 8. | LO3212 | Simulation/ Computer Programming Laboratory | EEC | 0 | 0 | 4 | 4 | 2 |
| | | | **TOTAL** | **19** | **0** | **8** | **27** | **23** |

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## SEMESTER III

| S. NO. | COURSE CODE | COURSE TITLE | CATE GORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| **THEORY** | | | | | | | | |
| 1. | | Professional Elective IV | PEC | 3 | 0 | 0 | 3 | 3 |
| 2. | | Professional Elective V | PEC | 3 | 0 | 0 | 3 | 3 |
| 3. | | Professional Elective VI | PEC | 3 | 0 | 0 | 3 | 3 |
| **PRACTICALS** | | | | | | | | |
| 4. | LO3311 | Project Work I | EEC | 0 | 0 | 12 | 12 | 6 |
| 5 | LO3312 | Industrial Training / Internship(4 Weeks)* | EEC | 0 | 0 | 4 | 4 | 2 |
| | | | **TOTAL** | **9** | **0** | **16** | **25** | **17** |

*During Summer vacation

## SEMESTER IV

| S. NO. | COURSE CODE | COURSE TITLE | CATE GORY | PERIODS PER WEEK | | | TOTAL CONTACT PERIODS | CREDITS |
|---|---|---|---|---|---|---|---|---|
| | | | | L | T | P | | |
| **PRACTICALS** | | | | | | | | |
| 1. | LO3411 | Project Work II | EEC | 0 | 0 | 24 | 24 | 12 |
| | | | **TOTAL** | **0** | **0** | **24** | **24** | **12** |

**TOTAL NO. OF CREDITS: 73**

## FOUNDATION COURSES (FC)

| SL. NO | COURSE CODE | COURSE TITLE | PERIODS PER WEEK | | | CREDITS | SEM |
|---|---|---|---|---|---|---|---|
| | | | L | T | P | | |
| 1. | LO3104 | Mathematical Physics for Optical Engineering | 3 | 1 | 0 | 4 | 1 |
| | | **TOTAL CREDITS** | | | | 4 | |

## PROGRAM CORE COURSES (PCC)

| SL. NO | COURSE CODE | COURSE TITLE | PERIODS PER WEEK | | | CREDITS | SEM |
|---|---|---|---|---|---|---|---|
| | | | L | T | P | | |
| 1. | LO3101 | Applied Electromagnetics | 4 | 0 | 0 | 4 | 1 |
| 2. | LO3102 | Principles of Optics | 3 | 0 | 2 | 4 | 1 |
| 3. | LO3103 | Laser Engineering | 3 | 0 | 2 | 4 | 1 |
| 4. | LO3111 | Optics and Laser Laboratory | 0 | 0 | 4 | 2 | 1 |
| 5. | LO3201 | Electro-Optics Theory andApplications | 3 | 0 | 0 | 3 | 2 |
| 6. | LO3202 | Nonlinear Optics | 3 | 0 | 0 | 3 | 2 |
| 7. | LO3203 | Optoelectronics | 3 | 0 | 0 | 3 | 2 |
| 8. | LO3211 | Laser Laboratory | 1 | 0 | 4 | 3 | 2 |
| | | | | TOTAL CREDITS | | 25 | |

## PROGRAM ELECTIVE COURSE [PEC]

| SL. NO | COURSE CODE | COURSE TITLE | PERIODS PER WEEK | | | CREDITS |
|---|---|---|---|---|---|---|
| | | | L | T | P | |
| 1. | LO3001 | Fiber Optic Sensors | 3 | 0 | 0 | 3 |
| 2. | LO3002 | Materials for Optical Devices | 3 | 0 | 0 | 3 |
| 3. | LO3003 | Fabrication of Optical Devices | 3 | 0 | 0 | 3 |
| 4. | LO3004 | Laser Materials Processing | 3 | 0 | 0 | 3 |
| 5. | LO3005 | Medical Applications of Lasers | 3 | 0 | 0 | 3 |
| 6. | LO3006 | Fourier Optics and Signal Processing | 3 | 0 | 0 | 3 |
| 7. | LO3007 | Nonlinear Fiber Optics | 3 | 0 | 0 | 3 |
| 8. | LO3008 | Optical Computing and SignalProcessing | 3 | 0 | 0 | 3 |
| 9. | LO3009 | Ultrafast Optics | 3 | 0 | 0 | 3 |
| 10. | LO3010 | Laser Spectroscopy | 3 | 0 | 0 | 3 |
| 11. | LO3011 | Holography and Speckle | 3 | 0 | 0 | 3 |
| 12. | LO3012 | Radiation Sources and Detectors | 3 | 0 | 0 | 3 |
| 13. | LO3013 | Integrated Optics | 3 | 0 | 0 | 3 |
| 14. | LO3014 | Nano-optics | 3 | 0 | 0 | 3 |
| 15. | LO3015 | Laser Dynamics | 3 | 0 | 0 | 3 |
| 16. | LO3016 | Technological Applications of Lasers | 3 | 0 | 0 | 3 |
| 17. | LO3017 | Digital Holography | 3 | 0 | 0 | 3 |
| 18. | LO3018 | Optical Displays and Storage Devices | 3 | 0 | 0 | 3 |

## RESEARCH METHODOLOGY AND IPR COURSES (RMC)

| SL. NO | COURSE CODE | COURSE TITLE | PERIODS PER WEEK | | | CREDITS | SEMESTER |
|---|---|---|---|---|---|---|---|
| | | | L | T | P | | |
| 1. | RM3151 | Research Methodology and IPR | 2 | 1 | 0 | 3 | 1 |
| | | | | | TOTAL CREDITS | **3** | |

## EMPLOYABILITY ENHANCEMENT COURSES (EEC)

| SL.NO | COURSE CODE. | COURSE TITLE | PERIODS PER WEEK | | | CREDITS | SEMESTER |
|---|---|---|---|---|---|---|---|
| | | | L | T | P | | |
| 1. | LO3212 | Simulation/ Computer Programming Laboratory | 0 | 0 | 4 | 2 | 2 |
| 2. | LO3311 | Project Work I | 0 | 0 | 12 | 6 | 3 |
| 3. | LO3312 | Industrial Training / Internship (4 Weeks)* | 0 | 0 | 4 | 2 | 3 |
| 4. | LO3411 | Project Work II | 0 | 0 | 24 | 12 | 4 |
| | | | | | Total Credits: | **22** | |

*During Summer vacation

## SUMMARY

| | NAME OF THE PROGRAMME: M.TECH. LASER AND ELECTRO OPTICAL ENGINEERING | | | | | |
|---|---|---|---|---|---|---|
| | SUBJECT AREA | CREDITS PER SEMESTER | | | | CREDITS TOTAL |
| | | I | II | III | IV | |
| 1. | FC | 04 | 00 | 00 | 00 | 04 |
| 2. | PCC | 14 | 12 | 00 | 00 | 26 |
| 3. | PEC | 00 | 09 | 09 | 00 | 18 |
| 4. | RMC | 03 | 00 | 00 | 00 | 03 |
| 5. | EEC | 00 | 02 | 08 | 12 | 22 |
| | **Total Credit** | **21** | **23** | **17** | **12** | **73** |

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**LO3101 APPLIED ELECTROMAGNETICS L T P C**
**4 0 0 4**

**UNIT I PROPAGATION OF ELECTROMAGNETIC WAVES 12**

Maxwell's equations – wave equation in free space - Energy transfer: Poynting vector – plane waves, ideal co-axial cables – power transmission in coaxial cables carrying a time varying current – time varying fields in conductors: skin effect – power loss – induction heating

**UNIT II REFLECTION AND REFRACTION OF ELECTROMAGNETIC WAVES 12**

Wave reflection and transmission at normal incidence : lossless media and lossy media - Wave reflection and transmission at oblique incidence: perpendicular and parallel polarization – Brewster angle – Reflectivity and transmittivity - – total internal reflection and evanescent waves – reflection and transmission by a film – anti-reflection coatings – interference filters

**UNIT III CRYSTAL OPTICS 12**

Wave propagation in anisotropic media: Refractive indices, Propagation along a principal axis, Propagation along an arbitrary direction – double refraction index ellipsoid – Optical activity and Faraday effect – Optics of liquid crystals- polarization devices: Polarizers, wave retarders, polarization rotators

**UNIT IV OPTICAL WAVEGUIDES AND FIBERS 12**

Planar symmetric slab waveguides: Waveguide condition, single and multimode waveguides, TE and TM modes – Modal and waveguide dispersion in planar waveguides – Step index fibers: Numerical aperture – Single mode fibers : Different types of dispersion, bit rate, band width, attenuation

**UNIT V NUMERICAL METHODS 12**

Laplace equation ; parallel plate capacitor – Finite difference method with examples – Finite difference – time domain (FD-TD) technique - Finite element method: Continuous wave reflections, two dimensional electromagnetic filed problems, eddy current problems, single circular conductor in open space, transformers and DC machines.

**TOTAL: 60 PERIODS**

**REFERENCES**


1. A.Yariv, "Quantum Electronics", Wiley India Pvt. Ltd., 2012.
2. A. Ghatak and K. Thiagarajan, "Optical Electronics", Cambridge India, 2017.
3. A.Yariv and P.Yeh, "Optical waves in Crystals", John Wiley and Sons, 2002
4. Saleh B.E.A. and Teich M.C., "Fundamentals of Photonics", Wiley Interscience, 2001.
5. Ghatak A, "Optics", McGraw Hill Education, Pvt Ltd, 2014.


**COURSE OUTCOMES:**

**CO1:** The students will gain the knowledge about the propagation of electromagnetic waves

**CO2:** The students will learn about the basic concepts of reflection and refraction of electromagnetic waves.

**CO3:** The students will learn about the basic concepts of crystal optics.

**CO4:** The students will have better knowledge about optical waveguides and fibers.

**CO5:** The students will get clear understanding of numerical methods used in electromagnetic theory.

**CO-PO Mapping**

| CO | PO | | | | | |
|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 |
| 1. | 1 | 1 | 3 | 1 | 2 | 1 |
| 2. | 1 | 1 | 3 | 1 | 2 | 2 |
| 3. | 2 | 2 | 3 | 2 | 2 | 2 |
| 4. | 1 | 1 | 3 | 3 | 3 | 3 |
| 5. | 2 | 2 | 3 | 3 | 3 | 3 |
| Avg. | 1.4 | 1.4 | 3 | 2 | 2.4 | 2.2 |

High – 3, Medium – 2, Low - 1

**RM3151 RESEARCH METHODOLOGY AND IPR** **L T P C**
**2 1 0 3**

**UNIT I RESEARCH PROBLEM FORMULATION 9**

Objectives of research, types of research, research process, approaches to research; conducting literature review- information sources, information retrieval, tools for identifying literature, Indexing and abstracting services, Citation indexes, summarizing the review, critical review, identifying research gap, conceptualizing and hypothesizing the research gap

**UNIT II RESEARCH DESIGN AND DATA COLLECTION 9**

Statistical design of experiments- types and principles; data types & classification; data collection - methods and tools

**UNIT III DATA ANALYSIS, INTERPRETATION AND REPORTING 9**

Sampling, sampling error, measures of central tendency and variation,; test of hypothesis- concepts; data presentation- types of tables and illustrations; guidelines for writing the abstract, introduction, methodology, results and discussion, conclusion sections of a manuscript; guidelines for writing thesis, research proposal; References – Styles and methods, Citation and listing system of documents; plagiarism, ethical considerations in research

**UNIT IV INTELLECTUAL PROPERTY RIGHTS 9**

Concept of IPR, types of IPR – Patent, Designs, Trademarks and Trade secrets, Geographical indications, Copy rights, applicability of these IPR; , IPR & biodiversity; IPR development process, role of WIPO and WTO in IPR establishments, common rules of IPR practices, types and features of IPR agreement, functions of UNESCO in IPR maintenance.

**UNIT V PATENTS 9**

Patents – objectives and benefits of patent, concept, features of patent, inventive steps, specifications, types of patent application; patenting process - patent filling, examination of patent, grant of patent, revocation; equitable assignments; Licenses, licensing of patents; patent agents, registration of patent agents.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES**
Upon completion of the course, the student can
CO1: Describe different types of research; identify, review and define the research problem
CO2: Select suitable design of experiment s; describe types of data and the tools for collection of data
CO3: Explain the process of data analysis; interpret and present the result in suitable form
CO4: Explain about Intellectual property rights, types and procedures
CO5: Execute patent filing and licensing

**REFERENCES:**

1. Cooper Donald R, Schindler Pamela S and Sharma JK, “Business Research Methods”, Tata McGraw Hill Education, 11e (2012).
2. Soumitro Banerjee, “Research methodology for natural sciences”, IISc Press, Kolkata, 2022,
3. Catherine J. Holland, “Intellectual property: Patents, Trademarks, Copyrights, Trade Secrets”, Entrepreneur Press, 2007.
4. David Hunt, Long Nguyen, Matthew Rodgers, “Patent searching: tools & techniques”, Wiley, 2007.
5. The Institute of Company Secretaries of India, Statutory body under an Act of parliament, “Professional Programme Intellectual Property Rights, Law and practice”, September 2013.


| **LO3102** | **PRINCIPLES OF OPTICS** | **L T P C** |
|---|---|---|
| | | **3 0 2 4** |

**UNIT I GEOMETRICAL OPTICS** **9**
Fermat’s Principle – Laws of reflection and refraction – Ray paths in an inhomogeneous medium – Refraction at a concave surface – Refraction at a convex surface (virtual and real images) – Transverse and longitudinal magnification – Langrange’s law – Refraction through a lens – Equivalent focal length of two lenses – Power of a lens – Coaxial lens system: Equivalent focal length and Cardinal points – Spherical aberration of a lens – Coma – Astigmatism – Distortion – Chromatic aberration – Dispersion by a prism – Refraction through a prism – Cauchy’s dispersion formula – Dispersive power.

**UNIT II WAVE OPTICS** **9**
Huygene’s Principle – Rectilinear Propagation – Interference : Young’s Experiment – Coherent Sources – Phase difference and Path Difference –Interference in Thin Films : Due to Reflected and Transmitted Light – Air Wedge – Newton’s Rings – Refractive Index of a Liquid - Michelson Interferometer – Diffraction : Fresnel’s assumptions – Zone plate - Diffraction at a circular Aperture - Diffraction Due to a narrow slit – Plane Diffraction Grating : Theory and Width of Central Maxima - Polarization of Transverse Waves – Polarization by Reflection – Brewster’s Law – Brewster Window – Polarization by Refraction – Malus Law.

**UNIT III FOURIER OPTICS AND BEAM OPTICS** **9**
Correspondence Between the Spatial Harmonic Function and the Plane Wave - Transfer Function of Free Space - Impulse-Response Function of Free Space – Optical Fourier Transform: Fourier Transform in the Far Field - Fourier Transform Using a Lens – Image Formation: Ray Optics

Description – Spatial Filtering - Gaussian Beam: Complex Amplitude and Properties – Hermite Gaussian Beams – Laguerre-Gaussian and Bessel Beams.

**UNIT IV OPTICAL INSTRUMENTS 9**

Photographic Camera – Microscopes: Simple Microscope – Compound Microscope - Telescopes: Angular Magnification, Retracting Astronomical Telescope – Terrestrial; Telescope – Huygens Eyepiece – Spectrometer – Dispersive prisms and Gratings – Scanners- Polarimetry.

**UNIT V OPTICAL MEASUREMENTS 9**

Radiometry: Definitions and basic concepts - Spectral Dependence of Radiometric Quantities - Photometry: Luminous Flux - Actinometry - Radiant Power Transfer – Measurement of Transmission, Absorption, Emission and Reflection: Transmittance, absoptance, reflectance, emittance: Definition and Measurements – Ellipsometry: Introduction – Modelling – Transmission Ellipsometry – Optical Metrology: Length and straightness measurements – Interferometric measurement of small and medium distances.

**TOTAL: 45 PERIODS**

**OPTICS LABORATORY**

Any **FIVE** experiments:

1. Geometrical optics experiments: Verification of Snell's law, use of lens equations, determination of focal length of lens
2. Determination of dispersive power and resolving power of a prism/ Grating
3. Newton's ring in transmitted and reflected white light
4. Determination of refractive index of given liquid using hallow prism
5. Air wedge - Determination of thickness of micro objects and thin film.
6. Verifying the imaging laws with a collecting lens
7. Determination of elastic constants: Hyperbolic fringes
8. Determination of elastic constants: Elliptical fringes

**TOTAL: 30 PERIODS**

**COURSE OUTCOMES:**

**CO1**: The students will gain the knowledge about the various phenomenon of geometrical optics.

**CO2**: The students will learn about the basic concepts of wave optics including interference, diffraction and polarization.

**CO3**: The students will understand about the subject of Fourier Optics and beam optics.

**CO4**: The students will have better knowledge about the various optical instruments and their applications.

**CO5**: The students will get clear understanding of measuring and manipulating various optical measurements like radiation, absorption, emission etc.

**REFERENCES:**


1. Saleh B.E.A. and Teich M.C., "Fundamentals of Photonics", Wiley Interscience, 2001.
2. Ghatak A, "Optics", McGraw Hill Education, Pvt Ltd, 2014.
3. Michael Bass (Editor in Chief), "Handbook of Electronics", McGraw Hill Inc, 1995.
4. M. Csele, "Fundamentals of Light Sources and Lasers", Wiley-Blackwell,2004.
5. Brij Lal and Subramanyam, "Optics", S. Chand and Company Ltd., 2006

**CO-PO Mapping**

| CO | PO | | | | | |
|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 |
| 1. | 1 | 1 | 2 | 3 | 2 | 1 |
| 2. | 2 | 2 | 2 | 2 | 1 | 1 |
| 3. | 3 | 3 | 3 | 2 | 2 | 2 |
| 4. | 1 | 2 | 2 | 2 | 2 | 2 |
| 5. | 3 | 3 | 3 | 2 | 2 | 2 |
| Avg. | 2 | 2.2 | 2.4 | 2.2 | 1.8 | 1.6 |

High – 3, Medium – 2, Low - 1

**LO3103 LASER ENGINEERING L T P C**
**3 0 2 4**

**UNIT I INTRODUCTION TO LASERS 9**

Introduction to Laser - Condition for producing laser - Einstein coefficients - relation between the absorption coefficients and Einstein coefficients – Laser characteristics - population inversion, gain and gain saturation – saturation intensity - Threshold condition – requirements for obtaining population inversion – 2,3 and 4 level systems –steady state and transient population processes – variation of laser power around threshold – optimum output coupling conditions for CW and pulsed laser action.

**UNIT II SOLID STATE LASERS 9**

Pumping mechanism: optical, electrical and laser diode pumping-Cavity configuration-Ruby laser Nd: YAG; Nd: Glass; disk laser, Ti - Sapphire laser – fiber laser - Fiber Raman laser.

**UNIT III SEMICONDUCTOR AND LIQUID LASERS 9**

Intrinsic semiconductor laser - Doped semiconductor - Conduction for laser actions – Injection laser -Threshold current – Homo junction – Hetro junction. Double Hetro junction lasers - Quantum well laser – Distributed feedback laser - Liquid lasers - Organic dyes - dye laser - Threshold condition -Configuration-Tuning methods.

**UNIT IV GAS LASERS 9**

Electrical discharge mechanism–Gas discharge processes, Glow discharge, RF discharge, Hollow cathode discharge and pulsed discharge-Selective Excitation processing as discharges-Excitation mechanism - Power supplies for pulsed and CW gas lasers – He-Ne laser, Argon-ion laser, He-Cd laser. Excitation mechanism - Nitrogen laser - Carbon-dioxide laser - Excimer laser –Chemical laser -X-ray laser -Free electron laser.

**UNIT V ULTRASHORT PULSE GENERATION AND MEASUREMENT 9**

Nano second pulse generation- Pico, nano, femto and atto second pulse generation-Q-switching: methods-Cavity dumping- Mode locking Configurations–Methods of detection and measurement of ultra-short pulses.

**TOTAL: 45 PERIODS**

**LASER ENGINEERING LABORATORY**

**<u>Any FIVE experiments</u>**

1. Measurement of divergence and diode laser characteristics

2. Measurement of wavelength of a given laser using a grating
3. Determination of slit width, aperture diameter using He - Ne laser and Fraunhofer diffraction
4. Verification of Malu's law
5. Experimental system for polarized light using Laser
6. Precision interferometer
7. Laser characterization (Diode Laser IV Characterization)
8. Coherence characteristics of laser

**TOTAL: 30 PERIODS**

**COURSE OUTCOMES:**

**CO1**: The students will learn about the basic principles of lasers. and working of different types of gas lasers and their applications

**CO2**: The students will learn about the engineering principles and working of different types of solid lasers

**CO3**: The students will learn about the engineering principles and working of different types of semiconductor and liquid lasers

**CO4**: The students will learn about the engineering principles and working of different types of gas lasers

**CO5**: Students will know about pico, nano, femto and atto second pulse generation, Q-switching:methods etc.

**REFERENCES:**


1. R.B. Laud, "Lasers and Nonlinear Optics", New Age International (P) Ltd., 2016.
2. W. Koechner, "Solid-State Laser Engineering", Springer, 2014.
3. A. Sennaroglu, "Photonics and Laser Engineering: Principles, Devices, and Applications", McGraw-Hill Education, 2010.
4. K.R.Nambiar, "Lasers: Principles, Types and Applications", New Age International, 2004.
5. John.C.ION," Laser Processing and Engineering Materials" Elsevier 2005
6. Thyagarajan K and Ajoy Ghatak, "Lasers: Fundamentals and Applications", Trinity Press, 2023.


**CO-PO Mapping**

| **CO** | **PO** | | | | | |
|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 |
| **1.** | 1 | 1 | 2 | 2 | 3 | 1 |
| **2.** | 2 | 2 | 2 | 3 | 3 | 1 |
| **3.** | 2 | 2 | 2 | 3 | 3 | 2 |
| **4.** | 2 | 2 | 2 | 3 | 3 | 1 |
| **5.** | 1 | 2 | 1 | 2 | 2 | 2 |
| Avg. | 1.6 | 1.8 | 1.8 | 2.6 | 2.8 | 1.4 |

High – 3, Medium – 2, Low - 1

**LO3104 MATHEMATICAL PHYSICS FOR OPTICAL ENGINEERING** **L T P C**
**3 1 0 4**

**UNIT I VECTOR CALCULUS 12**

Geometrical and physical interpretation of vector differentiation, Gradient, Divergence and Curl and their significance. Vector integration, Line, Surface (flux)and Volume integrals of vector fields. Gradient theorem, Gauss- divergence theorem, Stoke- curl theorem, Greens theorem and Helmholtz theorem (statement only). Introduction to Dirac delta function – Applications to Maxwells equations

**UNIT II TENSORS AND COMPLEX ANALYSIS 12**

Tensors: Principle of invariance of physical laws w.r.t. different coordinate systems as the basis for defining tensors. Coordinate transformations for general spaces of nD, contravariant, covariant & mixed tensors and their ranks, 4-vectors. Index notation and summation convention. Symmetric and skew-symmetric tensors. Invariant tensors, Kronecker delta and Epsilon (Levi Civita) tensors. Quotient rule- Examples of tensors in physics and crystal optics. Complex numbers- Algebraic properties of complex numbers- Analytic functions of z and the Cauchy-Riemann conditions. The real and imaginary parts of an analytic function - Cauchy integral formula – Residue Theorem.

**UNIT III PROBABILITY AND RANDOM VARIABLES 12**

Introduction -sets -probability and relative frequency -random variables -cumulative distribution functions and probability density functions -ensemble average and moments -binomial, poisson, uniform and Gaussian distributions -functional transformations of random variables -multivariate statistics -central limit theorem (statement and applications) - power spectral density -dc and rms values for ergodic random processes.

**UNIT IV FOURIER TRANSFORM AND LAPLACE TRANSFORMS 12**

Fourier transform and spectra - Parseval's formula for Fourier transforms - The convolution theorem -Dirac delta function –unit step function -Fresnel & Fraunhofer diffraction - examples FT by lens–point source -single slit, double slit-circular aperture -grating -coherent optical filtering. Definition of the Laplace transform. The convolution theorem. Laplace transforms of derivatives. The inverse transform, Mellon's formula. The LCR series circuit. Laplace transform of the Bessel functions.

**UNIT V DYNAMICS OF OPTICAL SYSTEMS 12**

Numerical analysis: Euler method and 4thorder Runge-Kutta method for solving differential equations –finite difference and finite element analysis methods for solving partial differential equations Linear and nonlinear oscillators –autonomous and non-autonomous systems – classification of equilibrium points –bifurcations and chaos -basic solitons.

**TOTAL: 60 PERIODS**

**COURSE OUTCOMES:**

**CO1**: The students will able to Understand electromagnetic fields, Maxwell's electrodynamics, and wave equation and apply vector calculus extensively in optical engineering problems

**CO2**: Understand and apply tensors in nonlinear optics and complex number analysis in the discussion of nonlinear optics and diffraction concepts in Fourier optics.

**CO3**: Understand and apply a suitable statistic to any statistical problems in the context of noise in optical communication and detection systems.

**CO4**: Solve optical diffraction related problems using fourier methods and electrical engineering and signal processing related problems using Laplace transform methods.

**CO5**: Understand choas, solitons and solve PDE numerically using Euler and RK methods.

**REFERENCES:**


1. E. Kreyszig, "Advanced Engineering Mathematics", Wiley, 2015.
2. Peter V.O'Neil, "Advanced Engineering Mathematics", Cengage, 2012.
3. M.Greenberg, "Advanced Engineering Mathematics", Pearson Education, 2002.
4. K. F. Riley, M.P. Hobson and S.J. Bence, "Mathematical Methods for Physics and Engineering", Cambridge Univ. Press, 2018.
5. Leon W. Couch, "Digital and Analog Communication Systems", Pearson Education, 2013.
6. W.Lauterborn and T. Kurz.Coherent, "Optics: Fundamentals and Applications", Springer, 2010.
7. M.Lakshmanan and K. Murali, "Chaos in Nonlinear Oscillators: Controlling and Synchronization",World Scientific, 1996.


**Suggestive digital platforms web links:**

1. MIT Open Learning-Massachusetts Institute of Technology, https://openlearning.mit.edu/
2. National Programme on Technology Enhanced Learning (NPTEL), https://www.youtube.com/user/nptelhrd
3. Swayam-Government of India,https://swayam.gov.in/explorer?category=Physics
4. Coursera,https://www.coursera.org/browse/physical-science-and-engineering/physics-and-astronomy
5. edX,https://www.edx.org/course/subject/physics

**CO-PO Mapping**

| **CO** | **PO** | | | | | |
|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 |
| **1.** | 2 | 1 | 2 | 1 | 1 | 1 |
| **2.** | 2 | 1 | 2 | 1 | 1 | 1 |
| **3.** | 2 | 1 | 2 | 1 | 1 | 1 |
| **4.** | 2 | 1 | 2 | 1 | 1 | 1 |
| **5.** | 2 | 1 | 2 | 1 | 1 | 1 |
| Avg. | 2 | 1 | 2 | 1 | 1 | 1 |

High – 3, Medium – 2, Low - 1

**LO3111** **OPTICS AND LASER LABORATORY** **L T P C**
**0 0 4 2**

**ANY TEN EXPERIMENTS:**

1. Chromatic aberration in lens imaging
2. Determination of focal length of liquid lens
3. Determination of refractive index of the liquid using liquid lens
4. Compound lens systems
5. Calibration of metal scale using He-Ne laser
6. Diffraction-Single slit and double slit diffraction

7. Determination of particle size of lycopodium powder and blood cells using laser diffraction
8. Determination of slit width, aperture diameter using He - Ne laser and Fraunhofer diffraction
9. Determination of velocity of ultrasonic waves using acoustic grating
10. Measurement of numerical aperture and bending Loss of fiber
11. Verification of law of refraction and finding refractive index of water using laser.
12. Michelson interferometer: Determination of wavelength of a monochromatic light source andthickness of transparent film
13. Optical absorption: UV-Vis Spectrophotometer
14. Characteristics of LEDs and determination of Planck's constant
15. Opto-electronic Characterization using laser (Solar Cell, Photodiode)

**TOTAL:60 PERIODS**

**COURSE OUTCOMES**:

**CO1**: Have basic skills in in using and handling the optical components

**CO2**: Gain knowledge about choosing the light sources

**CO3**: Have basic skills in understanding geometrical and ray otics

**CO4**: Have the skills in handling the optical instruments

**CO5**: Understand the various optical phenomena through experiments

**CO-PO Mapping**

| CO | PO | | | | | |
|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 |
| 1. | 2 | 2 | 2 | 3 | 3 | 3 |
| 2. | 2 | 2 | 3 | 3 | 3 | 3 |
| 3. | 2 | 2 | 2 | 3 | 3 | 3 |
| 4. | 2 | 2 | 2 | 2 | 2 | 3 |
| 5. | 2 | 2 | 3 | 3 | 3 | 3 |
| Avg. | 2 | 2 | 2.4 | 2.8 | 2.8 | 3 |

High – 3, Medium – 2, Low - 1

**LO3201 ELECTRO-OPTICS THEORY AND APPLICATIONS L T P C**
**3 0 0 3**

**UNIT I CRYSTAL OPTICS 9**

Propagation of light in anisotropic crystals - Double refraction – Indicatrix – Effect of crystal symmetry – Introduction to electrooptic effect - – Primary and secondary electooptical effects – Effect of symmetry – Propagation of light in an uniaxial crystal – Field in an electrooptic medium – Field in $LiNBO_3$ and KDP.

**UNIT II LINEAR ELECTROOPTIC EFFECT 9**

Pockels effect – KDP crystals : longitudinal mode : Amplitude modulation, phase modulation – modulator design – High frequency modulator – Electro-optic Fabry-Perot modulator - Q switching – scanning and switching – Electrooptic effects in liquid crystals : Orientational effect and twist effect.

**UNIT III NONLINEAR ELECTROOPTIC EFFECTS 9**

Kerr effect – DC Kerr effect – AC Kerr effect – Kerr-lens mode locking – Kerr modulator – Bistable Fabry-Perot resonator – Bistable modulator – Frequency shifting and pulse compression- Beam deflectors - Self phase modulation.

**UNIT IV ACOUSTOOPTICS : THEORY AND APPLICATIONS 9**

The photo-elastic effect– Basic concepts of acousto-optic interactions –Elastooptic effect – acousto-optic interactions – Bragg diffraction in an anisotropic medium – Raman-Nath diffraction – Acousto-optic modulators – Deflectors – Tunable filters – Spectrum analyzers – Signal correlators.

**UNIT V MAGNETOOPTIC EFFECTS AND DEVICES 9**

Magneto optic effect – Faraday effect : Faraday rotator, optical isolator – Atomic line filter - Magneto-optic Kerr effect (MOKE) – Different types of MOKEs – Applications: Data storage, reading and writing, MO Drive – Kerr microscope MO deflectors - Franz-Keldysh modulator.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

**CO1**: The students will gain the knowledge about the various phenomenon of crystal optics.
**CO2**: The students will learn about the basic concepts of linear electrooptic effect.
**CO3**: The students will learn about the basic concepts of nonlinear electrooptic effect.
**CO4**: The students will have better knowledge about acoustooptics and its applications.
**CO5**: The students will get clear understanding of magnetooptic effects and devices.

**REFERENCES**


1. C.C.Davis, "Lasers and Electro-optics: Fundamentals and Engineering", Cambridge UniversityPress, 2014.
2. R.W. Munn and C.N. Ironside, "Principles and Applications of Nonlinear Optical Materials",Springer, 2013.
3. A.Yariv, "Quantum Electronics", Wiley India Pvt. Ltd., 2012.
4. A. Ghatak and K. Thiagarajan, "Optical Electronics", Cambridge India, 2017.
5. A.Yariv and P.Yeh, "Optical waves in Crystals", John Wiley and Sons, 2002


**CO-PO Mapping**

| CO | PO | | | | | |
|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 |
| 1. | 2 | 2 | 3 | 1 | 2 | 1 |
| 2. | 2 | 2 | 3 | 1 | 2 | 2 |
| 3. | 2 | 2 | 3 | 1 | 2 | 2 |
| 4. | 2 | 2 | 3 | 2 | 2 | 3 |
| 5. | 2 | 2 | 3 | 2 | 2 | 3 |
| Avg. | 2 | 2 | 3 | 1.4 | 2 | 2.2 |

High – 3, Medium – 2, Low - 1

**LO3202** **NONLINEAR OPTICS** **L T P C**
**3 0 0 3**

**UNIT I ORIGIN OF OPTICAL NONLINEARITIES 9**

Effects due to quadratic and cubic polarization – Response functions – Susceptibility tensors – Linear, second order and $n^{th}$ order susceptibilities – Wave propagation in isotropic and crystalline media – The index ellipsoid.

**UNIT II SECOND HARMONIC GENERATION (SHG) AND PARAMETRIC OSCILLATIO 9**

Optical SHG – Phase Matching – Experimental verification – Parametric oscillation – Frequency tuning – Power output and pump saturation – Frequency up conversion – Materials.

**UNIT III THIRD ORDER NONLINEARITIES 9**

Intensity dependent refractive index – Nonlinearities due to molecular orientation – Self-focusing oflight and other self-action effects - Optical phase conjugation – Optical bistability and switching - Pulse propagation and temporal solitons.

**UNIT IV ELECTRO –OPTIC AND PHOTOREFRACTIVE EFFECTS 9**

Electro-optic effects – Electro-optic modulators - Photorefractive effect - Two beam coupling in Photorefractive materials – Four wave mixing in Photorefractive materials.

**UNIT V STIMULATED SCATTERING PROCESSES 9**

Stimulated scattering processes – Stimulated Brillouin scattering – Phase conjugation – Spontaneous Raman effect – Stimulated Raman Scattering – Stokes – Anti-Stokes Coupling in SRS - Stimulated Rayleigh - Wing Scattering.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

**CO1**: The students will understand the origin of optical nonlinearities

**CO2**: The students will able to appreciate the importance of optical SHG and parametric oscillations.

**CO3**: The students will able to understand the role of third-order optical nonlinearities in generationof optical solitons

**CO4**: The students will understand the use of electro-optic effect and photorefractive effect.

**CO5**: The students will understand different types of stimulated scattering processes.

**REFERENCES**


1. Robert W. Boyd, “Non-linear Optics”, Academic Press, 2008.
2. Y.V.G.S.Murti and C.Vijayan, “Essentials of Nonlinear Optics”, Wiley-Blackwell, 2014.
3. P.E. Powers, “Fundamentals of Nonlinear Optics”, Taylor & Francis, 2017.
4. G.New, “Introduction to Nonlinear Optics”, Cambridge University Press, 2014.
5. Jereme V. Moloney and Alan C. Newell, “Nonlinear Optics”, Taylor & Francis, 2003.
6. A.Yariv and P. Yeh, “Optical waves in Crystals: Propagation and Control of Laser Radiation”,Wiley-Blackwell, 2002.

**CO-PO Mapping**

| CO | | | | | | PO |
|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 |
| 1. | 1 | 1 | 1 | 1 | 1 | 1 |
| 2. | 2 | 2 | 2 | 1 | 1 | 1 |
| 3. | 2 | 2 | 2 | 1 | 1 | 1 |
| 4. | 2 | 2 | 2 | 1 | 1 | 1 |
| 5. | 2 | 2 | 2 | 1 | 1 | 1 |
| Avg. | 1.8 | 1.8 | 1.8 | 1 | 1 | 1 |

High – 3, Medium – 2, Low - 1

**LO3203 OPTOELECTRONICS** **L T P C**
**3 0 0 3**

**UNIT I REVIEW OF SEMICONDUCTOR DEVICE PHYSICS 9**
Energy bands in solids, the E-k diagram, Density of states, Occupation probability, Fermi level and quasi Fermi levels, p-n junctions, Schottky junction and Ohmic contacts. Semiconductor optoelectronic materials, Bandgap modification, Heterostructures and Quantum Wells.

**UNIT II SEMICONDUCTOR PHOTON SOURCES 9**
Rates of emission and absorption, Condition for amplification by stimulated emission, the laser amplifier. Electroluminescence. The LED: Device structure, materials and characteristics. The Semiconductor Laser: Basic structure, theory and device characteristics; direct current modulation.Quantum-well lasers; DFB-, DBR- and vertical-cavity surface-emitting lasers (VCSEL); Laser diode arrays. Semiconductor optical amplifiers (SOA), SOA characteristics and their applications.

**UNIT III DETECTORS AND IMAGING DEVICES 9**
Types of photodetectors, Photoconductors, Single junction under illumination: photon and carrier-loss mechanisms, Noise in photodetection; Photodiodes, PIN diodes and APDs: structure, materials, characteristics, and device performance. Photo-transistors and CCDs – Noise in photodetectors – Laser imaging – ICCD, Scanning Laser Optamology.

**UNIT IV OPTOELECTRONIC MODULATION AND SWITCHING DEVICES 9**
Analog and digital modulation – Franz-Keldysh and Stark effect modulators – quantum well electo-absorption modulators. Optical switching and logic devices: self-electro-optic device – bipolar controller-modualtor – switching speed and energy.

**UNIT V OPTOELECTRONIC INTEGRATED CIRCUITS 9**
Hybrid and monolithic integration – applications of Optoelectronic Integrated Circuits (OEICs) – materials and processing for OEICs – integrated transmitters and receivers – guided wave devices - optical interconnects.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

**CO1**: Students would gain knowledge on the foundations of Physics of Semiconductors
**CO2**: Students would gain knowledge on the Physics of Semiconductor light Sources
**CO3**: Students would gain knowledge on the photodetectors and various imaging devices
**CO4**: Students would gain knowledge on the different semiconductor modulation devices
**CO5**: Students would gain knowledge on fabrication and applications of Integrated Chips

**REFERENCES**


1. Pallab Bhattacharya, "Semiconductor Optoelectronic Devices", Pearson Education, 2017.
2. S.O. Kasap, "Optoelectronics and Photonics", Pearson, 2013.
3. J. Wilson and J. Hawkes, "Optoelectronics", Pearson Education, 2018.
4. A.Yariv, "Quantum Electronics", Wiley India Pvt. Ltd., 2012.
5. A. Ghatak and K. Thiagarajan, "Optical Electronics", Cambridge India, 2017.
6. B.E.A. Saleh and M.C. Teich, "Fundamentals of Photonics",. Wiley India Pvt Ltd., 2012.
7. Jasprit Singh, "Semiconductor Optoelectronics: Physics and Technology", McGraw-Hill,1995.
8. E. Rosencher, B.Vinter and P. G. Piva, "Optoelectronics", Cambridge University Press, 2002.


**CO-PO Mapping**

| CO | PO | | | | | |
|---|---|---|---|---|---|---|
| | **1** | **2** | **3** | **4** | **5** | **6** |
| **1.** | 2 | 2 | 2 | 3 | 2 | 3 |
| **2.** | 2 | 2 | 2 | 2 | 2 | 2 |
| **3.** | 3 | 3 | 3 | 2 | 2 | 2 |
| **4.** | 2 | 2 | 2 | 2 | 2 | 2 |
| **5.** | 3 | 3 | 3 | 2 | 2 | 2 |
| Avg. | 2.4 | 2.4 | 2.4 | 2.2 | 2 | 2.2 |

High – 3, Medium – 2, Low – 1

**LO3211 LASER LABORATORY L T P C**
**1 0 4 3**

**ANY TEN EXPERIMENTS**

1. Determination of Brewster angle, refractive index and absorption coefficient of a transparentmaterial
2. Characterization of Nonlinear optical material using Z-Scan set up. Normal method
3. Characterization of Nonlinear optical material using Z-Scan set up- Eclipse method.
4. Optical Fourier-filtering experiment
5. Holographic recording and reconstruction
6. Determination of Thickness and Refractive index of a thin film using Variable Angle Ellipsometer
7. Digital Hologram
8. Laser Raman spectrometer- Characteristics of given molecule/ sample
9. Setting up of fiber optic analog and digital link
10. Spectrometer – Goniometer: Determination of wavelength of light.
11. Michelson Interferometer-Determination of wavelength of laser
12. Fabry Perot Interferometer - Determination of wavelength of laser, etalon spacing,

Finesse andfree spectral range of the etalon

13. Faraday effect using He-Ne laser
14. Kerr effect and Pockels effect using laser
15. Characteristics of light dependent resistor and phototransistor

**TOTAL: 75 PERIODS**

**COURSE OUTCOMES:**

**CO1**: Perform advanced level experiments using lasers.

**CO2**: Develop observational skills and assemble laser and other optical components to analyze optical phenomena like polarization, interference and diffraction.

**CO3**: Understand nonlinear optics and prepare various experiments on the applications of nonlinear optics

**CO4**: Operate a variety of optical instruments like UV Spectrometer and Laser Raman Spectrometer etc.

**CO5**: Construct and perform experiments on holography.

**CO-PO Mapping**

| CO | PO | | | | | |
|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 |
| 1. | 1 | 1 | 2 | 2 | 2 | 2 |
| 2. | 2 | 2 | 2 | 3 | 2 | 2 |
| 3. | 2 | 2 | 3 | 3 | 3 | 2 |
| 4. | 2 | 2 | 3 | 3 | 3 | 2 |
| 5. | 2 | 2 | 3 | 3 | 3 | 2 |
| Avg. | 1.8 | 1.8 | 2.6 | 2.8 | 2.6 | 2 |

High – 3, Medium – 2, Low - 1

**LO3212 SIMULATION/ COMPUTER PROGRAMMING LABORATORY L T P C**
**0 0 4 2**

**ANY TEN EXPERIMENTS**

1. Using MATLAB
1. 2x2 and 3x3 Matrices
    2. Solving Linear equations
    3. Ordinary Differential Equations
    4. Shallow Water Equations
2. Using MAPLE
    1. Solving quadratic equation using Maple
    2. Circle and Sphere
    3. Loci
    4. Solving logarithmic function
3. Using COMSOL
    1. Waveguide Simulation
    2. LASERs

3. Fibre Optics
4. Geometric Ray Optics

4. Using Zemax
   1. Ray tracing
   2. Aberration correction
   3. building custom lenses
   4. Designing lighting for automobile industries or Designing optics system for microscopy.

5. Using Ansys
   1. Photonic integrated circuit
   2. Simulation for Photonic Components

**TOTAL: 60 PERIODS**

**COURSE OUTCOMES:**

**CO1**: Have basic understanding of different programming techniques using MATLAB
**CO2**: Gain knowledge in simulation programming methods using MAPLE
**CO3**: Have basic skills in solving mathematical equations through simulations by COMSOL
**CO4**: Have the skills in working of optical instruments through simulation using Zemax
**CO5**: Understand the various optical phenomena through various simulation experiments using Ansys

**CO-PO Mapping**

| CO | PO | | | | | |
|---|---|---|---|---|---|---|
| | **1** | **2** | **3** | **4** | **5** | **6** |
| **1.** | 2 | 2 | 2 | 3 | 3 | 3 |
| **2.** | 2 | 2 | 2 | 3 | 3 | 3 |
| **3.** | 2 | 2 | 2 | 3 | 3 | 3 |
| **4.** | 2 | 2 | 2 | 3 | 3 | 3 |
| **5.** | 2 | 2 | 2 | 3 | 3 | 3 |
| Avg. | 2 | 2 | 2 | 3 | 3 | 3 |

High – 3, Medium – 2, Low - 1

**LO3001 FIBER OPTIC SENSORS L T P C**
**3 0 0 3**

**UNIT I FIBER OPTICS 9**

Total internal reflection - Phase shift & attenuation during total internal reflection - Hybrid modes - cutoff frequencies - meridinal rays & skew rays - different types of fibers.

**UNIT II CHARACTERISTICS AND FABRICATION OF OPTICAL FIBERS 9**

Dispersion - Fiber attenuation, absorption loss & scattering loss measurement - Optical Time Domain Reflectometer (OTDR) and its uses - Interferometric method to measure fiber refractive index profile. Fiber materials - Fiber fabrication- fiber optic cables design - fiber connectors - fiber splices - Lensing schemes for coupling improvements.

**UNIT III OPTICAL FIBER COMMUNICATION AND NETWORKS 9**

Elements of an optical fiber communication system – optical sources -–Surface Emitting, edge emitting and super luminescent LEDs – Optical Detectors: Pin photodiodes – Avalanche photodiodes Multiplexers: wavelength division multiplexing - Electrooptic and Acoustooptic modulation - Coherent optical fiber communication system - ASK, FSK and PSK modulated waveforms - heterodyne and homodyne detections. Local Area Networks - Bus, ring and star topologies - optical fiber regenerative repeater - optical amplifiers - basic applications. Passive components – Couplers Multiplexing and De-multiplexing.

**UNIT IV INTENSITY AND POLARIZATION SENSORS 9**

Intensity sensor: Transmissive concept - Reflective concept - Microbending concept - Transmissionand Reflection with other optic effect - Interferometers - Mach Zehnder - Michelson - Fabry-Perot and Sagnac – Phase sensor: Phase detection - Polarization maintaining fibers. Displacement and temperature sensors: reflective and Microbending Technology - Applications of displacement and temperature sensors.

**UNIT V INTERFEROMETRIC SENSORS 9**

Pressure sensors: Transmissive concepts -Microbending - Intrinsic concepts - Interferometric concepts – Applications. Flow sensors: Turbine flow meters - Differential pressure flow sensors - Laser Doppler velocity sensors - Applications - Sagnac Interferometer for rotation sensing. Magnetic and electric field sensors: Intensity and phase modulation types – applications.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

**CO1**: The students will acquire knowledge in fundamentals of fiber optics.
**CO2**: Students will learn about characteristics and fabrication of optical fibers.
**CO3**: The students will gain knowledge in communication equipments, construction and working of optical communication networks.
**CO4**: The students will learn about intensity and polarization sensors and their applications.
**CO5**: The students will acquire knowledge about pressure sensors with fundamental concepts and applications.

**REFERENCES:**


1. EricUdd and W.B. Spillman (Eds.). Fiber optic sensors: An introduction for engineers andscientists. Wiley, 2011.
2. J. M. Senior. Optical Fiber Communications. Pearson Education, 2014.
3. Govind P. Agrawal. Fiber-Optic Communication Systems. Wiley, 2018.
4. Gerd Keiser. Optical Fiber Communication. McGraw Hill Education, 2017.
5. A. Mendez, D.A. Krohn and T.W. MacDougall. Fiber Optic Sensors.Fundamentals and Applications.SPIE Press, 2015.
6. B.P. Pal (Ed.). Fundamentals of Fibre Optics in Telecommunication and Sensor systems. NewAge International Pvt Ltd, 2015.


**CO-PO Mapping**

| CO | PO | | | | | |
|---|---|---|---|---|---|---|
| | **1** | **2** | **3** | **4** | **5** | **6** |
| **1.** | 1 | 1 | 1 | 1 | 1 | 1 |
| **2.** | 1 | 1 | 1 | 2 | 2 | 1 |
| **3.** | 2 | 2 | 2 | 2 | 2 | 2 |

| | | | | | | |
|---|---|---|---|---|---|---|
| **4.** | 2 | 2 | 2 | 3 | 3 | 3 |
| **5.** | 2 | 2 | 3 | 3 | 3 | 3 |
| Avg. | 1.6 | 1.6 | 1.8 | 2.2 | 2.2 | 2 |

High – 3, Medium – 2, Low - 1

**LO3002 MATERIALS FOR OPTICAL DEVICES** **L T P C**
**3 0 0 3**

**UNIT I OPTICAL PROCESSES 9**

Refractive index and dispersion – transmission, reflection and absorption of light – glass and amorphous materials – optical material for UV and IR. Semiconductors: electron-hole pair formation and recombination – absorption in semiconductors – radiation in semiconductors – Augur recombination- photoluminescence – electroluminescent process – choice of LED materials.

**UNIT II LASER CRYSTALS 9**

Single crystal growth: Bridgmann and Czochralski techniques – characterization of crystals: Single X-ray diffraction (Laue & rotating crystal method), UV Visible spectroscopy, and SEM - Spectroscopy of laser crystals: spectroscopic notation and energy band diagram of $Er^{3+}$, $Nd^{3+}$ and $Cr^{3+}$ - laser crystals for high gain: Nd:YAG laser, tunable laser ($BeAl_2O_4:Cr^{3+}$), Ti:$Al_2O_3$ laser, $Er^{3+}$:glass, and homojunction and heterojunction semiconductor lasers.

**UNIT III OPTICS OF ANISOTROPIC CRYSTALS 9**

Biaxial, uniaxial crystals – double refraction – index ellipsoid – optical activity – nonlinear optical crystals – liquid crystals – photorefractive materials – theory of photorefractivity – application of photorefractive materials.

**UNIT IV SEMICONDUCTORS 9**

Band gap modification by alloying, optical properties of quantum well, quantum wire and quantum dot structures – photonic band gap (PBG) materials – growth of PBG materials – light transmission in PBG materials.

**UNIT V OPTICS OF THIN FILMS 9**

Reflection, transmission and absorption in thin films – antireflection (AR) coating: single layer AR coating – double layer AR coatings – multilayer AR coatings – inhomogeneous AR coatings. Reflection coatings: metal reflectors – all dielectric reflectors. Interference filters: edge filters – band pass filters – Fabry-Perot filters – multicavity filters – thin film polarizers – beam splitters – thin film optical integrated structures and devices.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

**CO1**: The students will gain knowledge about aspects of crystal growth and characterization.

**CO2**: The students will acquire knowledge about the behavior of optical radiation in anisotropiccrystals

**CO3**: The students will learn about the optics of semiconductors

**CO4**: The students will learn about photonic crystals.

**CO5**: The students will learn about the optics of thin films.

**REFERENCES**

1. Pallab Bhattacharya. Semiconductor Optoelectronic Devices.Pearson Education, 2017.
2. B.E.A. Saleh and M.C. Teich. Fundamentals of photonics. Wiley India Pvt Ltd. 2012.
3. W.Koechner. Solid-State Laser Engineering. Springer, 2014.
4. R.W. Munn and C.N. Ironside. Principles and Applications of Nonlinear optical materials. Springer, 2013.
5. G.I.Stegeman and R.A.Stegeman. Nonlinear Optics: Phenomena, Materials and Devices. Wiley-Blackwell, 2012.
6. A.Yariv. Quantum Electronics. Wiley India Pvt. Ltd., 2012.
7. A. Ghatak and K. Thiagarajan. Optical electronics. Cambridge University Press, 2017.
8. Mark Fox. Optical properties of solids. Oxford University Press, 2012.

**CO-PO Mapping**

| **CO** | **PO** | | | | | |
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| | **1** | **2** | **3** | **4** | **5** | **6** |
| **1.** | 2 | 3 | 2 | 3 | 2 | 3 |
| **2.** | 3 | 2 | 3 | 3 | 3 | 2 |
| **3.** | 2 | 3 | 3 | 2 | 2 | 3 |
| **4.** | 2 | 3 | 2 | 3 | 2 | 3 |
| **5.** | 2 | 3 | 3 | 3 | 3 | 3 |
| Avg. | 2.2 | 2.8 | 2.6 | 2.8 | 2.4 | 2.8 |

High – 3, Medium – 2, Low – 1

**LO3003 FABRICATION OF OPTICAL DEVICES** **L T P C**
**3 0 0 3**

**UNIT I NEW APPROACHES IN NANOPHOTONICS 9**

Near-Field Optics-Aperture near-field optics - Apertureless near-field optics -Near-field scanning optical microscopy (NSOM or SNOM):- SNOM based detection of plasmonic energy transport-SNOM based visualization of waveguide structures- SNOM in nanolithography- SNOM based optical data storage and recovery.

**UNIT II QUANTUM-CONFINED MATERIALS 9**

Materials: -Optical properties- Non-linear optical properties - Quantum dots -Structure –Cores - Shells: - Coating:- Fabrication - Inks and pigments -Patterning of thin films / lithography- Optical lithography- E-beam Lithography- X-ray Lithography - Nanoimprint lithography and soft lithography.

**UNIT III PLASMONICS 9**

Total internal reflection and evanescent waves: - Plasmons and surface plasmon resonance (SPR): Attenuated total reflection -Grating SPR coupling- Optical waveguide SPR coupling- SPR dependencies and materials - Plasmonics and nanoparticles -Applications of metallic nanostructures –Plasmonic wave guiding and photonic circuit elements -SPR based harmonic generation: - Light generation.

**UNIT IV PHOTONIC CRYSTALS 9**

Important features of photonic crystals - Presence of photonic bandgap - Anomalous Group Velocity Dispersion -Anomalous Refractive Index Dispersion -Microcavity-Effect in Photonic Crystals-Fabrication of photonic crystals -Colloidal self assembly:- Gravity sedimentation:- Cell method:- Two-photon-lithography - Photosensitive materials -E-Beam lithography- Defects in photonic crystals- Photonic Crystal Laser - PC based LEDs - Photonic crystal fibers (PCFs).

**UNIT V PHOTONIC DEVICES 9**

Laser Diodes - Quantum well lasers - Quantum cascade lasers - Cascade surface-emitting photonic crystal laser - Quantum dot lasers - Quantum wire lasers –LEDs - White LEDs based on quantum dots -LEDs based on nanotubes- LEDs based on nanowires - LEDs based on nanorods: - Quantum well infrared photodetectors – Single electron transistors and quantum computing -White LEDs – quantum well and wires

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

**CO1**: The students will learn about the physics of nanophotonics

**CO2**: The students will acquire knowledge about nonlinear optical properties, Quantum dots andlithography

**CO3**: Students will gain knowledge about plasmons and surface plasmon resonance.

**CO4**: The students will study about the important features of photonic crystals and fabrication ofphotonic crystals and various devices

**CO5**: Students will gain knowledge about photonic devices like laser diodes, quantum well lasers,LEDs etc.

**REFERENCES:**

1. M.Fukuda. Optical Semiconductor Devices. Wiley-Interscience, 2008.
2. Jia-Ming Liu. Photonic Devices. Cambridge University Press, 2009.
3. E. Fred Schuber. Light Emitting Diodes. Cambridge University Press, 2005.
4. Harry J. Levinson. Principles of Lithography. SPIE Press, 2011.
5. P. Rai-Choudhury. Handbook of Microlithography, Micromachining and Microfabrication: Micromachining and microfabrication. SPIE Press, 1999.

**CO-PO Mapping**

| CO | PO | | | | | |
|---|---|---|---|---|---|---|
| | **1** | **2** | **3** | **4** | **5** | **6** |
| **1.** | 2 | 2 | 2 | 2 | 2 | 2 |
| **2.** | 2 | 2 | 3 | 3 | 3 | 3 |
| **3.** | 2 | 2 | 3 | 3 | 3 | 2 |
| **4.** | 2 | 2 | 2 | 3 | 2 | 2 |
| **5.** | 2 | 2 | 2 | 3 | 3 | 3 |
| Avg. | 2 | 2 | 2.4 | 2.8 | 2.6 | 2.4 |

High – 3, Medium – 2, Low - 1

**LO3004** **LASER MATERIALS PROCESSING** **L T P C**
**3 0 0 3**

**UNIT I BASIC LASER OPTICS AND INDUSTRIAL LASER SYSTEMS 9**

Laser parameters-High power laser systems-Focusing optics Reflection and refraction – Optical Components-Steering optics scan head--Mechanisms-Over view of industrial lasers-CW & pulsed-Q-switched and Mode locking Fiber laser–disk laser.

**UNIT II THERMAL PROCESSES IN INTERACTION ZONE 9**

Depth of penetration with respect to laser energy density - Reflectivity of Metals with respect to wavelength-Rate of heating and cooling –Maximum temperature rise and depth of hardened layer Different gases used during laser materials processing-Operational parameters in laser materials processing -Keyhole effect–heat affected zone.

**UNIT III A THERMAL PROCESSING AND STRUCTURAL CHANGES 9**

Annealing, quenching effects – basic thermodynamics of material processing and preparation – photo physical effect-laser printing-stereolithography-optical lithography-micromachining-shock processing-thermodynamic changes-calibration-kinetic changes- process properties of structurally changed materials-laser assisted vapour deposition-industrial application.

**UNIT IV SURFACE TREATMENT 9**

Surface modification- surface hardening- surface melting- surface cladding - surface alloying - laser parameters for surface alloying - process variables - Beam profiles- surface texturing-Shock hardening –shock peeling - Different methods to obtain desired penetration depths-Experimental set-up.

**UNIT V LASER WELDING, DRILLING AND CUTTING 9**

Laser parameters for welding, drilling, cutting –dependence of wavelength, pulse width, repetition rate, modulation and gas shielding factors influencing the parameters. Recent developments – hybrid welding. Cooling parameters for welding processes–.Advantages of laser processing versus conventional methods

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

**CO1**: The students will gain knowledge about industrial laser systems and interaction of laser radiation with matter

**CO2**: The students will understand the disturbances that affect process quality, and finally, the advantages and disadvantages of laser processing based on the operational parameters

**CO3**: The students will learn about laser surface modification

**CO4**: The students will know different ways in which laser cutting may take place, different forms of laser drilling and the behavior of different materials after welding.

**CO5**: The student will know the implications of preprocessing and processing parameters while preparing the materials.

**REFERENCES**

1. J.Wilson and J.Hawkes, “Optoelectronics”, Pearson Education, 2018.

2. J.F.Ready, "Industrial Applications of Lasers", Academic Press, 2012.
3. J.F.Ready and D.F.Farson (Eds), "LIA Handbook of Laser Materials Processing", LIA, 2001.
4. W.M.Steen and J.Mazumdar, "Laser Materials Processing", Springer, 2010.
5. Ian W. Boyd, "Laser Processing of Thin Films and Microstructures", Springer-Verlag, 2011.
6. W.W.Duley, "Laser Processing and Analysis of Materials", Springer-Verlag, 2012.

**CO-PO Mapping**

| CO | PO | | | | | |
|---|---|---|---|---|---|---|
| | **1** | **2** | **3** | **4** | **5** | **6** |
| **1.** | 1 | 1 | 2 | 2 | 2 | 1 |
| **2.** | 2 | 2 | 2 | 2 | 2 | 2 |
| **3.** | 2 | 2 | 3 | 3 | 3 | 2 |
| **4.** | 2 | 2 | 3 | 3 | 3 | 2 |
| **5.** | 2 | 2 | 3 | 3 | 3 | 2 |
| Avg. | 1.8 | 1.8 | 2.6 | 2.6 | 2.6 | 1.8 |

High – 3, Medium – 2, Low - 1

**LO3005 MEDICAL APPLICATIONS OF LASERS**

**L T P C**
**3 0 0 3**

**UNIT I FUNDAMENTALS OF LASER-TISSUE INTERACTION 9**

Laser Characteristics as applied to medicine and biology - Laser tissue interaction – Photophysical process - Photo biological process - Absorption by biological systems - Different types of interactions - Thermal photochemical (one photon and multiphoton) - Electromechanical - Photo ablative processes

**UNIT II PHOTOBIOLOGY AND MEDICAL LASERS 9**

Study of biological functions - Microradiation of cells - optical properties of tissues (normal and tumor) - Experimental methods to determine the reflectance, absorption, transmittance and emission properties of tissues - Laser systems in medicine and biology - Nd:YAG, Ar ion, $CO_2$, Excimer, $N_2$, Gold Vapour laser - Beam delivery system and control.

**UNIT III THERMAL APPLICATIONS 9**

Surgical applications of lasers - Sterilization - hemostasis– Cancer, Liver, stomach, gynecological, urological and cardiac surgeries - Lasers in Ophthalmology - Dermatology and Dentistry – CosmeticSurgery.

**UNIT IV NON THERMAL APPLICATIONS 9**

Trace element detection - Laser induced fluorescence studies - Cancer diagnosis - Photo radiation therapy of tumours - Lasers in endoscopy – Lasers in laparoscopy - Lasers in trapping of cells and genetic engineering - Bio simulation.

**UNIT V LASER SAFETY REGULATIONS 9**

Laser use risk management – Types of hazards: eye hazards, skin hazards, electrical hazards – Protection standards for lasers - safety regulations - specific precautions- laser medical surveillance.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

**CO1**: The students will learn about laser tissue interaction, absorption by biological systems, andphoto ablative processes.

**CO2**: The students will be trained in photobiology, experimental methods to determine the reflectance, absorption, transmittance and emission properties of tissues

**CO3**: The students will gain knowledge about thermal applications of lasers

**CO4**: The students will acquire knowledge about non-thermal applications of lasers.

**CO5**: The students will be aware of safety regulations while using lasers like protection standards,specific precautions and medical surveillance

**REFERENCES**


1. S. S. Martellucci and A.N.Chester. Laser Photobiology and Photomedicine. Springer, 2012.
2. R. Pratesi and C.A.Sacchi. Lasers in Photomedicine and Photobiology. Springer, 2013.
3. H.Jelinkova (Ed). Lasers for Medical Applications: Diagnostics, Therapy and Surgery. Woodhead Publishing, 2013.
4. D.R.Vij and K.Mahesh (Eds). MedicalApplications of Lasers. Springer, 2014.
5. M.H.Niemz. Laser-Tissue Interactions: Fundamentals and Applications. Springer, 2007.
6. R.W.Waynant (Ed). Lasers in Medicine. CRC Press, 2001.
7. H.P.Berlien and G.J.Muller (Eds). Applied Laser Medicine. Springer, 2012.


**CO-PO Mapping**

| CO | PO | | | | | |
|---|---|---|---|---|---|---|
| | **1** | **2** | **3** | **4** | **5** | **6** |
| **1.** | 2 | 2 | 1 | 2 | 1 | 2 |
| **2.** | 2 | 2 | 2 | 2 | 2 | 2 |
| **3.** | 2 | 2 | 3 | 3 | 3 | 3 |
| **4.** | 2 | 2 | 3 | 3 | 3 | 3 |
| **5.** | 2 | 2 | 2 | 2 | 2 | 2 |
| Avg. | 2 | 2 | 2.2 | 2.4 | 2.2 | 2.4 |

High – 3, Medium – 2, Low - 1

**LO3006 FOURIER OPTICS AND SIGNAL PROCESSING L T P C**
**3 0 0 3**

**UNIT I SIGNALS AND SYSTEMS 9**

Fourier analysis in two dimensions: Fourier transform - separable functions – Fourier-Bessel transforms. Linear and space-invariant systems. Sampling theory:Shannon-Nyquist sampling theorem – space-bandwidth product – discrete Fourier transform from continuous transform – periodic convolution.

**UNIT II DIFFRACTION THEORY 9**

Scalar diffraction – monochromatic fields and irradiance – optical path length and field phase representation – Rayleigh-Sommerfeld formulation – angular spectrum of plane waves- Fresnel approximation – Fraunhofer approximation – Fraunhofer diffraction patterns – Fresnel diffraction calculations.

**UNIT III COHERENT OPTICAL SYSTEMS 9**

Thin lens as a phase transformation – Fourier transforming properties of lenses and image formation by lens – frequency response of a diffraction-limited system under coherent and incoherent illumination – aberrations and their effects – comparison of coherent and incoherent imaging – super-resolution.

**UNIT IV WAVEFRONT MODULATION 9**

Wavefront modulation with photographic film : physical processes of exposure, development and fixing – film in an incoherent optical system – film as coherent optical system – modulation transfer function. Spatial light modulators: liquid crystals – spatial light modulators using liquid crystals – magneto-optic spatial light modulators – quantum well spatial light modulators and acousto-optic spatial light modulators. Diffractive optical elements: Binary optics – types of diffractive

**UNIT V OPTICAL INFORMATION PROCESSING 9**

Abbe-Porter experiment – phase contrast microscopy and other simple applications. Coherent image processing: vanderLugt filter – joint-transform correlator – character recognition – invariant pattern recognition – image restoration – data processing from synthetic aperture radar – acousto-optic signal processing – discrete analog processors.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

**CO1**: The students will learn about Fourier transform, sampling theory, space-bandwidth productand discrete Fourier transform from continuous transform.

**CO2**: The students will gain knowledge about diffraction theory

**CO3**: The students will acquire knowledge about Fourier transforming properties of lenses andimage formation by lens etc

**CO4**: Students will learn about wave front modulation with photographic films.

**CO5**: The students will acquire knowledge about the principles of analog optical information processing.

**REFERENCES:**


1. J.W. Goodman. Introduction to Fourier optics. WH Freeman, 2017.
2. O.K.Ersoy. Diffraction, Fourier optics and imaging. Wiley-Blackwell, 2007.
3. E.G.Stewart. Fourier optics: an introduction. Dover Publications, 2004.
4. D.G. Voelz. Computational Fourier optics: A MATLAB Tutorial. SPIE Press, 2011.
5. T.C.Poon and P.P.Banerjee. Contemporary Optical Image Processing with MATLAB. ElsevierScience, 2011.


**CO-PO Mapping**

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| **3.** | 2 | 3 | 3 | 3 | 3 | 2 |
| **4.** | 2 | 3 | 3 | 3 | 3 | 2 |

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|---|---|---|---|---|---|---|
| **5.** | 2 | 2 | 3 | 3 | 3 | 3 |
| Avg. | 2 | 2.4 | 2.6 | 2.6 | 2.6 | 2.2 |

High – 3, Medium – 2, Low – 1

**LO3007 NONLINEAR FIBER OPTICS L T P C**
**3 0 0 3**

**UNIT I FIBER NONLINEARITIES 9**

Introduction - Nonlinear Refraction - Maxwell's Equations - Fiber Modes - Eigen value Equations - Single Mode Condition - Nonlinear pulse Propagation - Higher Order Nonlinear Effects.

**UNIT II GROUP VELOCITY DISPERSION AND PHASE MODULATION 9**

Gaussian Pulse - Chirped Gaussian Pulse - Higher Order Dispersions - Changes in Pulse Shape – Self Phase Modulation (SPM) induced Spectral Broadening - Non-linear Phase Shift - Effect of GroupVelocity Dispersion - Self Steepening - Application of SPM- Cross Phase Modulation (XPM) - Coupling between Waves of Different Frequencies - Non-linear Birefringence - Optical Kerr Effect - Pulse Shaping.

**UNIT III OPTICAL SOLITONS AND DISPERSION MANAGEMENT 9**

Soliton Characteristics - Soliton Stability - Dark Solitons – Other kinds of Solitons - Effect of Birefringence in Solitons - Solitons based Fiber Optic Communication System (Qualitative treatment) - Demerits - Dispersion Managed Solitons (DMS).

**UNIT IV SOLITON LASERS 9**

Non-linear Fiber Loop Mirrors - Soliton Lasers - Fiber Raman Lasers - Fiber Raman Amplifiers - FiberRaman Solitons - Erbium doped fiber amplifiers.

**UNIT V APPLICATIONS OF SOLITONS 9**

DMS for single channel transmission – WDM transmission - Fiber Gratings- Fiber Couplers – Fiber Interferometers – Pulse Compression – Soliton Switching – Soliton light wave systems.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

**CO1**: The students will gain knowledge about nonlinear fiber optics, and nonlinear pulse propagation.
**CO2**: Students will be educated about group velocity dispersion, self-phase modulation, couplingbetween waves of different frequencies, and nonlinear birefringence.
**CO3**: Students will learn about soliton characteristics, and different kind of solitons
**CO4**: Students will be trained in the applications of solitons
**CO5**: Students will acquire knowledge in fiber lasers, fiber couplers, soliton switching, optical Kerreffect, etc.

**REFERENCES**


1. G. P. Agrawal, “Nonlinear Fiber Optics”, Academic Press, 2012.
2. Y.V.G.S.Murti and C.Vijayan, “Essentials of Nonlinear Optics”, Wiley-Blackwell, 2014.
3. A. Hasegawa and M. Matsumoto, “Optical Solitons in Fibers”, Springer, 2003.
4. G. P. Agrawal, “Applications of Nonlinear Fiber Optics”, Academic Press, 2013.

5. M. Lakshmanan and S. Rajasekar, "Nonlinear Dynamics: Integrability", Chaos and Patterns.Springer, 2003.
6. Y. S. Kivshar and G.P.Agrawal, "Optical Solitons: From Fibers to Photonic Crystals", AcademicPress, 2003.

**CO-PO Mapping**

| CO | PO | | | | | |
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| | 1 | 2 | 3 | 4 | 5 | 6 |
| **1.** | 2 | 2 | 2 | 2 | 2 | 2 |
| **2.** | 2 | 2 | 3 | 3 | 3 | 2 |
| **3.** | 2 | 2 | 2 | 3 | 3 | 3 |
| **4.** | 2 | 2 | 2 | 3 | 3 | 3 |
| **5.** | 2 | 2 | 3 | 3 | 3 | 3 |
| Avg. | 2 | 2 | 2.2 | 2.8 | 2.8 | 2.6 |

High – 3, Medium – 2, Low - 1

**LO3008 OPTICAL COMPUTING AND SIGNAL PROCESSING L T P C**
**3 0 0 3**

**UNIT I FOURIER OPTICS AND IMAGE PROCESSING 9**

A short history of the Field of Optical Computing – Fourier Optics – Correlation and Convolution – Fourier Transform with lenses – Grating filters – Complex transform filters – Fourier holograms – Optical image processing.

**UNIT II OPTICAL COMPUTING WITH SPATIAL LIGHT MODULATOR (SLM) 9**

Introduction – Liquid crystal light valve – Micro channel Spatial Light Modulator – Numerical optical computing basics – Logic gates using SLMs – Flip-flops – Optical binary temporal integrator – optical circuits – Optical switching network – Optical matrix computations – Optical matrix vector multiplier – Matrix-Matrix Multiplier – Optical implementation of Matrix-vector multiplier.

**UNIT III OPTICAL SWITCHING DEVICES 9**

Types of switching devices – some requirements of switching devices – Networks – Role of optical switching – Implications of optical switching – Circuit switches – Four port Directional coupler switches and switch matrices – active path optical switches with electrical control – optical logic devices for switching – The electronics-optics interface – A self routing wideband switching matrix.

**UNIT IV OPTICAL INTERCONNECTIONS 9**

Introduction – Types of optical interconnections – Specific properties of optical interconnections – Power requirements of optical interconnections – Fan-in and Fan-out properties of Optical interconnections – Multistage interconnections.

**UNIT V OPTICAL NEURAL NETWORKS 9**

Optical computing and neural networks – Optical linear neural nets – Non-linear neural networks-Auto associative and self-organizing networks – Recent advances.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

**CO1**: The students will learn about optical computing and application of Fourier optics in image processing.

**CO2**: Students will be educated about liquid crystal light valve, micro-channel spatial light modulator,logic gates using SLMs, etc

**CO3**: Students will gain knowledge in types of switching devices, circuit switches, and electronics-optics interface

**CO4**: Students will gain knowledge in types of optical interconnections.

**CO5**: The students will learn about optical computing and neural networks.

**REFERENCES**


1. M. A. Karim and A.A.S. Awwal, "Optical Computing: An Introduction', Wiley India, 2010.
2. A.D. McAulay, "Optical Computer Architectures", Wiley-Blackwell, 1991.
3. Dror G. Fritelson, "Optical Computing", The MIT Press, 1988.
4. B.S. Wherrett, and F.A.P. Toole, "Optical Computing", CRC Press, 1989.
5. H.H.Arsenault, T.Szoplik and B.Macukow, "Optical Processing and Computing", AcademicPress, 2012.


**CO-PO Mapping**

| CO | PO | | | | | |
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| | **1** | **2** | **3** | **4** | **5** | **6** |
| **1.** | 2 | 2 | 2 | 2 | 3 | 3 |
| **2.** | 2 | 2 | 2 | 2 | 3 | 3 |
| **3.** | 2 | 2 | 2 | 2 | 3 | 3 |
| **4.** | 1 | 1 | 1 | 2 | 2 | 1 |
| **5.** | 2 | 2 | 2 | 3 | 3 | 2 |
| Avg. | 1.8 | 1.8 | 1.8 | 2.2 | 2.8 | 2.4 |

High – 3, Medium – 2, Low – 1

**LO3009 ULTRAFAST OPTICS L T P C**

**3 0 0 3**

**UNIT I ULTRAFAST PULSE GENERATION 9**

Introduction – laser basics – short pulse generation via mode-locking – active mode-locking: frequency domain treatment – passive-mode locking with saturable absorbers – solid state model locking using the optical Kerr effect – solid state mode locking including phase effects.

**UNIT II ULTRASHORT PULSE MEASUREMENT 9**

Introduction – electric filed autocorrelation – intensity auto correlation – electric field-cross correlation and spectral interferometry – chirped pulses and measurement in the time-frequency domain – frequency-resolved optical gating – characterization of noise and jitter.

**UNIT III DISPERSION AND DISPERSION COMPENSATION 9**

Introduction – group velocity dispersion – temporal dispersion based on angular dispersion – dispersion with grating and prism sequences – dispersion properties of lenses – dispersion properties of mirror structures – measurement of group velocity dispersion – frequency dependent storage time.

**UNIT IV ULTRAFAST NONLINEAR OPTICS 9**

Propagation equation for nonlinear refractive index media – self-phase modulation – pulse compression and solitons – higher order propagation effects: delayed nonlinear index and Raman scattering – higher-order propagation effects: delayed nonlinear index and Raman scattering – soliton effects in mode-locked lasers with fast self-amplitude modulation – mode locked frequency combing - Supercontinuum generation.

**UNIT V ULTRAFAST SPECTROSCOPY 9**

Ultra short pulse amplification – Fourier transform pulse shaping – space-time duality and temporalimaging – ultrafast spectroscopy: degenerate pump-probe transmission measurements – coherent short pulse spectroscopy –dephasing phenomena – impulsive stimulated Raman scattering.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

**CO1**: The students will learn about the concept, technology and applications of ultrashort laserpulse generation..

**CO2**: Students will acquire knowledge about electric filed autocorrelation, intensity auto correlation,electric field-cross correlation and spectral interferometry

**CO3**: The students will learn about dispersion and dispersion compensation

**CO4**: Students will gain knowledge about propagation equation for nonlinear refractive index media,self-phase modulation, pulse compression and solitons

**CO5**: Students will acquire knowledge about ultra short pulse amplification, Fourier transform pulseshaping

**REFERENCES**


1. A. Weiner, “Ultrafast Optics”, Wiley-Blackwell, 2009.
2. J.-C. Diels and W. Rudolph, “Ultra Short Laser Phenomena”, Academic Press, 2006.
3. S. Watanabe and K. Midorikawa (Eds.), “Ultrafast Optics V, Springer, 2007.
4. M.E. Fermann, A.Galvanauskas and G.Sucha (Eds.), “Ultrafast Lasers: Technology andApplications”, Marcel Dekker, 2003.
5. H. Ishikawa, “Ultrafast all-Optical Signal Processing Devices”, Wiley-Blackwell, 2008.




**CO-PO Mapping**

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| | **1** | **2** | **3** | **4** | **5** | **6** |
| **1.** | 1 | 1 | 2 | 2 | 2 | 1 |
| **2.** | 1 | 1 | 2 | 2 | 2 | 1 |
| **3.** | 2 | 2 | 2 | 2 | 2 | 2 |
| **4.** | 2 | 2 | 3 | 3 | 3 | 2 |
| **5.** | 2 | 2 | 3 | 3 | 3 | 2 |
| Avg. | 1.6 | 1.6 | 2.4 | 2.4 | 2.4 | 1.6 |

High – 3, Medium – 2, Low – 1

**LO3010 LASER SPECTROSCOPY** **L T P C**
**3 0 0 3**

**UNIT I BASIC PRINCIPLES 9**

Comparison between conventional Light Sources and Lasers **–** Saturation – Excitation methods: Single-step excitation – Multistep excitation – Multi-photon absorption - Detection Methods: Fluorescence – Photoionization – Collisional ionization – field ionization – Laser wavelength setting.

**UNIT II DOPPLER – LIMITED TECHNIQUES 9**

Absorption measurements – Intra-cavity absorption measurements – Absorption measurements on excited states – Level labeling – Two-photon absorption measurements – Opto-Galvanic spectroscopy **–** Single atom detection **–** Opto-acoustic spectroscopy **–** Optical double resonance and level-crossing experiments with laser excitation.

**UNIT III TIME-RESOLVED SPECTROSCOPY 9**

Generation of short optical pulses – generation of ultrashort optical pulses – Measurement techniques for Optical Transients: Transient – Digitizer - Boxcar – Delayed coincidence– Streak-camera & Pump-probe techniques. Basics of lifetime measurements – Methods of measuring radiative properties – linewidth measurements – ODR and LC – Beam foil techniques – Beam laser techniques – Time resolved spectroscopy with pulsed lasers – Phase-shift method and emission method – The hook method – Quantum-Beat spectroscopy.

**UNIT IV HIGH RESOLUTION SPECTROSCOPY 9**

Spectroscopy on collimated atomic beams: Detection through fluorescence - detection by photoionization - detection by the recoil effect - detection by magnetic deflection. Saturation spectroscopy and related techniques - Doppler-free two-photon absorption - spectroscopy of trapped ions and atoms.

**UNIT V APPLICATIONS OF LASER-SPECTROSCOPY 9**

Diagnostics of combustion processes: Background - Laser-induced fluorescence and related techniques - Raman spectroscopy - coherent anti-stokes Raman scattering - Velocity measurements. Laser remote sensing of the atmosphere: Optical heterodyne detection - long path absorption techniques - LIDAR techniques. Laser-induced fluorescence and Raman spectroscopy in liquids and solids: Hydrospheric remote sensing - monitoring of surface layers. Laser-induced chemical processes: Laser-induced chemistry - laser isotope separation - spectroscopic aspects oflasers in medicine.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

- **CO1**: The students will gain knowledge about the fundamentals of spectroscopy, different types ofspectroscopy and applications of laser spectroscopy.
- **CO2**: The students will know various methods to reduce Doppler broadening and record spectra.
- **CO3**: The students will know techniques to measure optical transients and line width of ultra-shortpulses.
- **CO4**: The students will gain knowledge about the techniques to detect the signals with highresolutions reducing various broadening mechanisms
- **CO5**: The students will acquire knowledge of how lasers are used in medical, diagnostic, combustion and remote sensing fields.

**REFERENCES:**
1. W.Demtroder, "Laser Spectroscopy 1: Basic Principles", Springer, 2014.
2. W.Demtroder, "Laser Spectroscopy 2: Experimental Techniques", Springer, 2016.
3. S.Stenholm, "Foundations of Laser Spectroscopy", Dover Publications, 2012.
4. S. Svanberg, "Atomic and Molecular Spectroscopy", Springer, 2007.
5. J. R. Lakowicz, "Topics in Fluorescence Spectroscopy: Principles", Springer, 2014.
6. Z. Wang and H. Xia, "Molecular and Laser Spectroscopy", Springer, 2011.

**CO-PO Mapping**

| CO | PO | | | | | |
|---|---|---|---|---|---|---|
| | **1** | **2** | **3** | **4** | **5** | **6** |
| **1.** | 1 | 1 | 1 | 1 | 1 | 1 |
| **2.** | 2 | 2 | 2 | 2 | 1 | 1 |
| **3.** | 2 | 2 | 2 | 2 | 1 | 1 |
| **4.** | 2 | 2 | 2 | 2 | 1 | 1 |
| **5.** | 2 | 2 | 2 | 2 | 1 | 1 |
| Avg. | 1.8 | 1.8 | 1.8 | 1.8 | 1 | 1 |

High – 3, Medium – 2, Low – 1

**LO3011 HOLOGRAPHY AND SPECKLE L T P C**
**3 0 0 3**

**UNIT I OPTICAL HOLOGRAPHY 9**
General theoretical Analysis - Types of Holograms - Requirements to record and reconstruct holograms - Experimental techniques - Recording materials - Silver halide - Dichromated Gelatin - Ferroelectric Crystals - Inorganic Photo chromatic Materials - Thermo plastic Materials - Photoresists

**UNIT II HOLOGRAMS FOR DISPLAY 9**
$360^0$ holograms - Double sided holograms - Holographic stereograms - Rainbow Holograms - Color Holography - Volume Reflection Holograms - Multicolor Rainbow Holograms - Holographic Optical elements - Holographic Scanners

**UNIT III HOLOGRAPHIC INTERFEROMETRY 9**
Theoretical Analysis of Double Exposure - Real-Time and Time-averaged Interferometric Techniques - Contour holography - Sandwich Holography - Double Pulsed Holography - Acousticaland Microwave Holography

**UNIT IV APPLICATIONS OF HOLOGRAPHY IN ENGINEERING AND MEDICINE 9**
Measurement of displacement, deformation, strain, stress and bending movements for opaque and transparent objects - Holographic NDT - Holography in Biology and Medicine – holographic data storage.

**UNIT V SPECKLE PHOTOGRAPHY AND INTERFEROMETRY 9**
In-plane and out-of-plane translations – Pointwise and whole field analysis - Time averaged Speckle

Photography - Speckle Interferometry - Speckle Shear Interferometry -displacements and strain measurements - Electronic speckle pattern Interferometry(ESPI), speckle NDT.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

**CO1**: The students will learn about how experimentally holograms and speckle grams could be recorded and reconstructed

**CO2**: Students will be educated about different types of holograms.

**CO3**: Further they will learn about the concept of holographic interferometry and its applications.

**CO4**: Students will gain knowledge about applications of holography in engineering and medicine.

**CO5**: Students will be taught about the theory and applications of speckle photography andinterferometry.

**REFERENCES**


1. Robert K. Erf (Ed), "Holographic Nondestructive Testing", Academic press, 2012.
2. C.M.Vest, "Holographic Interferometry", John-Wiley & Sons Inc., 1979.
3. P.Hariharan, "Optical Holography: Principles, Techniques and Applications", Cambridge University Press, 1996.
4. Robert K. Erf (Ed), "Speckle Meterology", Academic press, 2012.
5. R.S.Sirohi (Ed), "Speckle Meterology", Marcel Dekker, 1993.


**CO-PO Mapping**

| CO | PO | | | | | |
|---|---|---|---|---|---|---|
| | 1 | **2** | **3** | **4** | **5** | **6** |
| **1.** | 2 | 1 | 1 | 2 | 2 | 1 |
| **2.** | 2 | 1 | 2 | 2 | 1 | 1 |
| **3.** | 2 | 2 | 2 | 3 | 3 | 3 |
| **4.** | 2 | 2 | 2 | 3 | 3 | 3 |
| **5.** | 2 | 2 | 2 | 3 | 3 | 3 |
| Avg. | 2 | 1.6 | 1.8 | 2.6 | 2.4 | 2.2 |

High – 3, Medium – 2, Low – 1



**LO3012 RADIATION SOURCES AND DETECTORS** **L T P C**
**3 0 0 3**

**UNIT I SOURCES OF RADIATION 9**

Basic radiative transfer - Radiance and radiometric quantities - The angular range – Radiometric – Photometric units and their relationship – geometrical radiation transfer - Radiant intensity and their profiles – Lambertian – point – exponent profiles - Optical transfer function – Numerical aperture - Sources - Natural and luminescent sources of radiation., blackbody radiation - Infrared, Ultraviolet, Visible radiation sources - radiometric measurements and calibration.

**UNIT II SPECTROSCOPY AND OPTICAL DEVICES 9**

Electromagnetic spectrum – Wave and quantum aspects - Atomic, molecular and vibrational spectroscopy - Electronic, vibrational and rotational transitions - Selection rules – IR, VIS, UV radiation - Absorption & Emission Spectroscopy - Devices – Materials for reflection and transmission - Reflective losses and their reduction - Different types of filters and their applications.

**UNIT III DETECTOR CHARACTERISTICS 9**

Basic detector mechanisms - radiometric instruments and detector interfaces - Photon detection process – Photon effects – Thermal effect – wave interaction effect – Noise in radiation detectors – Figure of merit - Spectral response – Responsivity – Noise equivalent power – Detectivity – Frequency response – Response time – Negative Electron Affinity (NEA) - Optical receivers - preamplifiers.

**UNIT IV CONVENTIONAL DETECTORS 9**

Photomultipliers, microchannel analyzer, photoresistors, photodiodes, nonselective detectors - Thermal and photo emissive detectors - Photoconductive and photovoltaic detectors, performance limits. Photographic, thermoplastic materials - Sensitivity, time and frequency response - eye and vision, photographic film - Camera tubes.

**UNIT V MODERN DETECTORS 9**

Hybrid photodetectors - Imaging detectors - solid-state arrays, video, Detector electronics, detector interfacing - Different CCD cameras- Digital camera – Optical Multichannel Analyzer – Monochromator – Photo transistors – Photo thyristors – Triac - Box-car Average – Integrating Sphere – Streak Camera.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

**CO1**: The students will learn about physics of radiation from different sources in different signals ofelectromagnetic spectrum.

**CO2**: They will understand the principle involved in fabrication of optical devices and principles of spectroscopy.

**CO3**: The students will learn about detector characteristics.

**CO4**: The students will learn about different conventional radiation detectors

**CO5**: The students will understand about modern detectors.

**REFERENCES:**


1. H.E.White, “Introduction of Atomic Spectra”, McGraw Hill, 2005.
2. G.M.Barrow, “Molecular Spectroscopy’, McGraw Hill, 2018.
3. R.H.Kingston, “Detection of Optical and Infrared Radiation”, Springer, 2013.
4. J.R.Meyer-Arendt, “Introduction to Classical and Modern Optics”, Pearson, 1994.
5. R.M.Wood, “Laser induced damage of Optical Materials’, CRC Press, 2003.
6. E.L.Dereniak and D.G.Crowe, “Optical Radiation Detector”, Wiley, 2008.
7. J.Wilson and J.Hawkes, “Optoelectronics” Pearson Education, 2018.
8. P.Bhattacharya. Semiconductor Optoelectronic Devices. Pearson Education, 2017.

**CO-PO Mapping**

| CO | PO | | | | | |
|---|---|---|---|---|---|---|
| | **1** | **2** | **3** | **4** | **5** | **6** |
| **1.** | 2 | 2 | 1 | 2 | 1 | 1 |
| **2.** | 2 | 2 | 2 | 3 | 2 | 1 |
| **3.** | 2 | 2 | 2 | 3 | 3 | 3 |
| **4.** | 2 | 2 | 2 | 3 | 3 | 2 |
| **5.** | 2 | 2 | 2 | 3 | 3 | 3 |
| Avg. | 2 | 2 | 1.8 | 2.8 | 2.4 | 2 |

High – 3, Medium – 2, Low – 1

**LO3013 INTEGRATED OPTICS L T P C**
**3 0 0 3**

**UNIT I OPTICAL AMPLIFIERS 9**

Concepts – principles of optical amplification – optical amplifiers: general considerations – semiconductor optical amplifier – applications – advantages and drawbacks – EDFAs – optical fiber amplifiers – coherent sources for IO – MQW – photonic switching principles.

**UNIT II OPTICAL WAVEGUIDES AND INTEGRATED CIRCUITS 9**

Theory of gratings in waveguide structures –Applications of coupled mode theory – guided wave control – electrooptic, acoustooptic, magnetooptic, thermooptic and nonlinear optical effects – fabrication of optical waveguides in glass, Lithium Niobate substrates. Microfabrication techniques in optical integrated circuits – guided wave excitation and waveguide evaluation – passive waveguide devices – functional optical waveguide devices.

**UNIT III ACTIVE OPTICAL INTEGRATED CIRCUITS AND APPLICATIONS 9**

Integrated semiconductor sources, detectors and active switches on substrates – optoelectronic integrated circuits – recent trends in optical integrated circuits. Optical switches – A/D converters – RF spectrum analyzers –modulators – integrated optic sensors.

**UNIT IV PHOTONIC MATERIALS GROWTH & FABRICATION 9**

Types of photonic materials – growth methods – nucleation – homogeneous – heterogeneous – LEC technique – epitaxy - growth of photonic materials by LPE, VPE, MBE, MOCVD, Plasma CVD, photochemical deposition. Interfaces and junctions - interface quality, interdiffusion and doping. Quantum wells and bandgap engineering (examples of structures).Post-growth processing (patterning by photolithography, contacting, annealing).

**UNIT V PHOTONIC DEVICES 9**

Photodiodes: current-voltage equation – operation-spectral response – quantum efficiency – response time – diffusion time – drift – capacitance of diodes, measurement – photoconductivity – LEDs: electroluminescent process – choice of LED materials – device configuration and efficiency – structures – device performance – manufacturing process – defects and reliability – laser diode:

junction laser operating principles – threshold current – heterojunction lasers – distributed feedback lasers – quantum well lasers – surface emitting lasers – rare-earth doped lasers – device fabrication – mode locking.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

**CO1**: Students will gain knowledge about optical amplifiers.

**CO2**: Students will acquire knowledge about fabrication of waveguide devices y.

**CO3**: The students will learn about functions of optical switches, A/D converters etc.

**CO4**: Students will gain knowledge about optoelectronic devices fabricated using photonic materialsby various epitaxial techniques

**CO5**: Students will acquire broad understanding of photonic device operation and its performancewill be understood.

**REFERENCES**


1. H. Nishihara, M. Haruna and T. Suhara, "Optical Integrated Circuits", McGraw Hill Book Co.,1989.
2. Robert G. Hunsperger, "Integrated Optics: Theory and Technology", Springer, 2010.
3. Theodor Tamir (Ed.), "Guided-wave Optoelectronics", Springer-Verlag, 2012.
4. D.K. Mynbaev and L.L. Scheiner, "Fiber-Optics Communications Technology", Pearson Education, 2002.
5. G. Keiser, "Optical Fiber Communications", McGraw Hill Education, 2017.
6. P.Bhattacharya, "Semiconductor Optoelectronic Devices", Pearson Education, 2017.
7. A.Ghatak and K.Thyagarajan, 'Optical Electronics", Cambridge India, 2017.
8. B.E.A. Saleh and M.C. Teich, "Fundamentals of Photonics", Wiley India Pvt. Ltd., 2012.
9. L.A.Coldren, S.W.Corzine and M.L.Mashanovitch, "Diode Lasers and Photonic Integrated Circuits", Wiley-Blackwell, 2012.


**CO-PO Mapping**

| CO | PO | | | | | |
|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 |
| 1. | 3 | 3 | 2 | 3 | 3 | 3 |
| 2. | 3 | 2 | 3 | 3 | 3 | 2 |
| 3. | 2 | 3 | 3 | 2 | 3 | 3 |
| 4. | 2 | 3 | 2 | 3 | 2 | 3 |
| 5. | 2 | 3 | 3 | 3 | 3 | 3 |
| Avg. | 2.4 | 2.8 | 2.6 | 2.8 | 2.8 | 2.8 |

High – 3, Medium – 2, Low – 1

**LO3014 NANO-OPTICS L T P C**
**3 0 0 3**

**UNIT I OPTICS AT NANOMETER SCALE 9**

Nanometer science: Basics – near-field optics – near-field optical microscopy (NOM): standard design, probes, image formation, modes of operation, image interpretation, applications.

**UNIT II NEAR-FIELD PHOTONICS 9**

Theory of forces due to electromagnetic fields: Maxwell's stress tensor – dipole approximation –

dipolar particle due to evanescent wave – force on particles upon surfaces – forces and surface topography – optical binding – optical tweezers – nano-manipulation with a photonic crystal.

**UNIT III SINGLE QUANTUM SYSTEMS 9**

Interaction of light with single two-level quantum systems – local field probes – mapping the filed distribution – energy transfer and quenching.Near-field microscopy of second-harmonic generation - SHG at metal surfaces – apertureless SHG – imaging of functional materials.

**UNIT IV NANOSCALE OPTICAL MICROSCOPY 9**

Far-field optical microscopy technique – confocal, localization and solid immersion lens – near field excitation microscopy – near field detection microscopy – near-field excitation and detection microscopy – tip-enhanced spectroscopy – optical antennas.

**UNIT V PLASMONICS 9**

Drude model of electrons in metal – surface waves at metal-dielectric interface – surface plasmon waves – nonsymmetricplasmonic waveguides – field distribution – coupling into plasmon waves – plasmonic waveguides - plasmonic structures – characterization – surface plasmonpolaritons – surface plasmon resonances – nano-optical experiments: semiconductor films – hybrid plasmonicnanoparticles – near-field optical response of plasmon-exciton hybrid nanoparticles.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

**CO1**: Understand the basics of near-field optics.
**CO2**: Use the knowledge of near filed photonics
**CO3**: Understand the importance of single quantum systems.
**CO4**: Know the working principles of nanoscale optical microscopes.
**CO5**: Understand the different aspects of plasmonics.

**REFERENCES**

1. L.Novotny and B. Hecht. Principles of Nano-optics. Cambridge University Press, 2012.
2. A.Zayats and D.Richards. Nano-optics and Near-field Optical Microscopy. Artech House, 2009.
3. B.DiBartolo, J.Collins and L.Silvestri (Eds.).Nano-optics. Springer, 2017.
4. J.Jahns and S.Helfert. Introduction to Micro- and Nanooptics. Wiley-VCH, 2012.
5. S.Kawata, M.Ohtsu and M.Irie (Eds.). Nano-optics. Springer, 2002.

**CO-PO Mapping**

| CO | PO | | | | | |
|---|---|---|---|---|---|---|
| | **1** | **2** | **3** | **4** | **5** | **6** |
| **1.** | 1 | 1 | 2 | 2 | 1 | 1 |
| **2.** | 1 | 1 | 1 | 2 | 2 | 1 |
| **3.** | 2 | 2 | 2 | 2 | 2 | 2 |
| **4.** | 2 | 2 | 2 | 3 | 3 | 2 |
| **5.** | 2 | 2 | 2 | 3 | 3 | 2 |
| Avg. | 1.6 | 1.6 | 1.8 | 2.4 | 2.2 | 1.6 |

High – 3, Medium – 2, Low - 1

**LO3015** **LASER DYNAMICS** **L T P C**
**3 0 0 3**

**UNIT I QUANTUM OSCILLATORS 9**
Induced and spontaneous emission – methods of producing an inverted population – amplification in quantum systems without population inversion – dynamic properties of lasers – relaxation rates –ring-cavity filed dynamics – Equations for the dynamics of the material: master equations – two-level medium, three-level medium, four-level media – self-consistent semiclassical set of laser equations.

**UNIT II SINGLE MODE LASERS 9**
Dynamic models of homogeneously broadened lasers – travelling-wave laser with homogeneous active medium – single-mode standing wave class B laser – instabilities and chaos in a travelling-wave single-model laser – dynamics of three-level lasers with coherent pumping – effect of inhomogeneous broadening on the laser dynamic characteristics – instability threshold.

**UNIT III MULTI-MODE LASERS 9**
Rate equations model with spatial mode competition – relaxation oscillations as low-frequency normal laser modes – time-dependent processes – mode-coupling – in homegeneously broadenedsolid-state lasers – dynamical instability – two-mode class B laser with FP resonator – bidirectional class B laser – lasers with periodic parameter modulation: Nonlinear response, bifurcations and chaos – instabilities.

**UNIT IV LASERS WITH NONLINEAR PARAMETERS 9**
Laser with an op-electronic feedback – laser with a nonlinear absorber – laser with a nonlinear dielectric – passive mode locking – travelling wave laser with saturable absorber – active Q-switching – giant pulse generation.

**UNIT V LASER SYSTEMS 9**
Phase locking in laser dynamics – laser with an injected signal – coupled lasers – HOPE bifurcation dynamics – driven laser systems – strongly modulated lasers – slow passage – optically injected semiconductor lasers - delayed feedback dynamics – far-infrared lasers – optical parametric oscillator.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**
**CO1**: Know the principle of operation and practical implementation of quantum oscillators..
**CO2**: Use the knowledge of dynamical models in single-mode lasers.
**CO3**: Understand the different types of multi-mode laser systems.
**CO4**: Know the importance of nonlinear parameters in laser systems.
**CO5**: Understand the Understand the working principles of different laser systems.

**REFERENCES:**

1. Ya I. Khanin, “Fundamentals of Laser Dynamics”, Cambridge International Science Publishing Ltd., 2006.
2. T. Erneux and P.Glorieux, “Laser Dynamics”, Cambridge University Press, 2010.
3. Ya I. Khanin, “Principles of Laser Dynamics”, North Holland, 2012.

4. Kathy Ludge (Ed.,), “Nonlinear Laser Dynamics”, Wiley-VCH, 2012.
5. C.O.Weib and R.Vilaseca, “Dynamics of Lasers”, Wiley-VCH , 1991.

**CO-PO Mapping**

| CO | PO | | | | | |
|---|---|---|---|---|---|---|
| | **1** | **2** | **3** | **4** | **5** | **6** |
| **1.** | 2 | 2 | 2 | 2 | 2 | 2 |
| **2.** | 2 | 2 | 2 | 2 | 2 | 2 |
| **3.** | 2 | 2 | 2 | 3 | 3 | 2 |
| **4.** | 2 | 2 | 2 | 3 | 3 | 2 |
| **5.** | 2 | 2 | 2 | 3 | 3 | 3 |
| Avg. | 2 | 2 | 2 | 2.6 | 2.6 | 2.2 |

High – 3, Medium – 2, Low – 1

**LO3016 TECHNOLOGICAL APPLICATIONS OF LASERS** **L T P C**
**3 0 0 3**

**UNIT I PRINCIPLES OF LASERS 9**

Einstein coefficients, ratio of rates of stimulated and spontaneous emission – Population inversion in three level and four level systems - Resonant cavities, Gaussian beam characteristics, resonator Stability – Q-switching and Mode locking concepts and techniques-Cavity Modes, Solid state lasers: Ruby laser, Nd-YAG laser, Gas lasers: He-Ne laser, Carbon dioxide gas laser- fiber laser- Semiconductor Laser.

**UNIT II LASERS IN SCIENCE & TECHNOLOGY 9**

Introduction-second harmonic generation- intensity dependent-refractive index- lasers in chemistry- Ether Drift-Gravitational waves-Rotation of the earth-photon statistics-laser in isotope separation-photochemical separation - lasers in medicine- laser Interferometry-Holography and speckle metrology- Laser ranging and tracking - Laser Doppler velocimetry-Precision length measurement.

**UNIT III LASERS IN INDUSTRIAL APPLICATIONS 9**

Laser power density – surface treatment-heat affected zone - Welding - Fusion depth and welding geometry - Welding speeds - Advantages and uses of laser welding - Drilling hole geometry - Advantages and uses of laser drilling - resistor trimming - Capacitor height adjustment and fabrication, Scribing - Controlled fracturing.

**UNIT IV LASERS IN MEDICAL SCIENCE AND HAZARDS 9**

Medical lasers-laser Diagnostic-Photomedicine-lasers in Opthalmologn-photocoagulation-treatment of corneal ulcers- laser in the treatment of Glucoma-laser for general surgery-surgery with free electron lasers-lasers in dermatology-cardiology-lasers against viruses-laser used in medicine-laser hazardous-classification of laser hazardous.

**UNIT V MILITARY APPLICATION OF LASERS 9**

Laser range finders-design of a laser range Finder-Tracking by lasers-Target Designators-Beam Riding-Laser Radar-Laser communication with Submarines-Ocean Attenuation-Laser Gyro-Sea-skimming missilies-Merits of laser Weapons-Types of lasers for Anti-missile role-Damage to the Target.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

**CO1**: Understood the principle laser, optical resonator and laser systems
**CO2**: The students have gained knowledge on laser in science and Technology
**CO3**: The students would have known the laser applications on industrial fields.
**CO4**: Understood the lasers in medical science and Hazards
**CO5**: The students have gained knowledge on military application of lasers

**REFERENCES:**


1. D.C.O'Shea, W.R.Callen and W.T.Rhodes. An Introduction to Lasers and their Applications. Pearson, 1977.
2. J.T.Verdeyen. Laser Electronics. Prentice Hall, 1990.
3. S.S. Charchan. Lasers in Industry. Van Nostrand Reinhold Co., 1975.
4. K.R. Nambiar. Lasers Principles, Types and Applications. New Age International (P) Ltd. 2004.
5. B.B.Laud. Lasers and Non-Linear Optics. New Age International (P) Ltd. 2011
6. M.Steen William. Laser Material Processing. Springer, 2010.
7. K.Thayarajan . Ajoy Ghatak. Lasers Fundamentals and Applications, Springer-2010.
8. John C. ION. Laser Processing & Engineering Materials –Elsevier, 2005.


**CO-PO Mapping**

| CO | PO | | | | | |
|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 |
| 1. | 1 | 2 | 2 | 2 | 3 | 2 |
| 2. | 2 | 2 | 2 | 2 | 2 | 2 |
| 3. | 3 | 3 | 3 | 2 | 3 | 3 |
| 4. | 2 | 2 | 2 | 2 | 2 | 2 |
| 5. | 3 | 3 | 3 | 2 | 2 | 2 |
| Avg. | 2.2 | 2.4 | 2.4 | 2 | 2.4 | 2.2 |

High – 3, Medium – 2, Low – 1

**LO3017 DIGITAL HOLOGRAPHY L T P C**
**3 0 0 3**

**UNIT I COMPUTER GENERATED HOLOGRAMS 9**

Introduction – mathematical preliminaries – Fourier transform – phase transformation of a spherical lens - principles of holography – numerical reconstruction – separation of virtual image, real image and DC-term – recording digital holograms. Digital holography for bulk image acousto optical reconstruction: Main assumptions – system architecture – computer simulations –

modeling and color image processing.

**UNIT II DIGITAL HOLOGRAPHIC MICROSCOPY 9**

Introduction – diffraction theory – hologram formation and wavefront reconstruction -reconstruction algorithms – direct method- phase shifting method: image formation – measurement of surface shape and deformation - instruments – applications.

**UNIT III OPTICAL RECONSTRUCTION 9**

Introduction – compensating aberrations – controlling numerical reconstructions – controlling reconstructions in MWDH compensating chromatic aberrations – application of digital holography for investigation and testing of MEMS structures. Comparative digital holography – encryption of information with digital holography – synthetic apertures.

**UNIT IV INTERFEROMETRY AND SPECKLE METROLOGY 9**

General principles – deformation measurement – shape measurement – measurement of refractive index variations – distant measurements – data compression and decompression. Electronic speckle pattern interferometry – digital shearography – digital speckle photography.

**UNIT V THREE DIMENSIONAL DISPLAYS 9**

Computer generated holograms for white light reconstruction – wide-angle computer generated holograms for 3D display – optical scanning holography – 3D display projection system – 3D display and information processing based on integral imaging – autostereoscopic, partial pixel, spatially multiplexed and 3D display technologies.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

**CO1**: Understood the concept of mathematics, computer programming, physics, technology and applications of digital holography

**CO2**: The students have gained knowledge on optical holography reconstruction and digital microscopy

**CO3**: The students will gain knowledge about the important laser applications on holography.

**CO4**: Understood the digital interferometry and speckle technology

**CO5**: The students have gained knowledge on three dimensional display imaging technologies

**REFERENCES**:


1. Ulf Schnars and Werner Jueptner. Digital holography. Springer,Berlin (2005).
2. Ting-Chung Poon. Digital Holography and Three-Dimensional Display: Principles and Applications. Springer, Berlin (2010).
3. Leonid Yaroslavsky. Digial holography and digital image processing: Principles, methods and algorithms. Kluwer (2004).
4. Pascal Picart and Jun-chang Li. Digital holography. Wiley (2012).
5. Anand Asundi. Digital Holography for MEMS and Microsystem Metrology. Wiley (2011).


**CO-PO Mapping**

| CO | PO | | | | | |
|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 |
| 1. | 1 | 1 | 1 | 2 | 2 | 1 |

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| 2. | 1 | 1 | 2 | 2 | 2 | 1 |
| 3. | 2 | 2 | 2 | 3 | 3 | 2 |
| 4. | 2 | 2 | 2 | 3 | 3 | 2 |
| 5. | 2 | 2 | 2 | 3 | 3 | 3 |
| Avg. | 1.6 | 1.6 | 1.8 | 2.6 | 2.6 | 1.8 |

High – 3, Medium – 2, Low - 1

**LO3018 OPTICAL DISPLAYS AND STORAGE DEVICES**

**L T P C**
**3 0 0 3**

**UNIT I VISUAL SYSTEM, COLOUR VISION AND COLORIMETRY 9**

Introduction – evolution of display technologies – eye anatomy and eye optics – visual performance of the eye – models of visual performance and photometry. Colour vision and colorimetry: colour vision basics – colour matching – colour systems and spaces – colorimetry. Holographic optical elements – optical holography.

**UNIT II 2D DISPLAY TECHNOLOGY 9**

Display system interfaces and performance parameters – CRT displays – Transmissive displays, reflective displays, transreflective displays – emissive displays. Flat panel displays: AMLCD, LCOS, Plasma, OLED – projection systems – new display technologies: high dynamic range display – bidirectional displays – projection displays - enriched colour display. Display metrology: display performance measurement and calibration – display evaluation – colour management and calibration.

**UNIT III BINOCULAR VISION AND 3D DISPLAY TECHNOLOGY 9**

Binocular vision and perception basics – 3D display principles and techniques: Basics, spatial stereoscopic displays – autostereoscopic displays – light-field displays – computer generated holograms – 3D media encoding. Near-Eye displays (NEDs): Eye physiology – brightness and power consumption – technologies for NEDs – examples – optical design – laser displays – holographic image generation for NEDs – optical combiners – contact lens displays – adaptive displays and eye tracking – image integration.

**UNIT IV DIGITAL VIDEO DISPLAY 9**

General principles – interlaced versus progressive video signals and displays – differences between displaying video and graphics. Digital video deinterlacing/interlacing: Algorithms imported from graphics – vertical-temporal deinterlacing – film source – field rate conversion – display of graphics on interlaced displays. Digital image display: standard and high definition television formats – integrating video data with digital processing parameters.

**UNIT V OPTICAL DATA STORAGE SYSTEMS 9**

Overview – basics of optical storage – theoretical aspects of phase-change alloys – thermal modeling of phase-change recording – data recording characteristics – recording media. Optical data media formats – materials for optical data storage - Holographic data storage – applications.

**TOTAL: 45 PERIODS**

**COURSE OUTCOMES:**

After discussed the concept of physics, technology and applications of optical displays and optical information storage devices.

**CO1**: The students will gain knowledge about different optical display and storage devices

**CO2**: The students will gain brief knowledge about 2D and 3D display technologies.

**CO3**: The students will gain knowledge about the different optical displays and optical information storage devices. .

**CO4**: Understood the comparison between different imaging and display techniques

**CO5**: The students have gained knowledge about optical data storage techniques

**REFERENCES:**


1. Rolf R. Hainich and Oliver Bimber. Displays: Fundamentals and applications. CRC Press
2. (2011).
3. Lindsay MacDonald and A.C. Lowe (Eds.). Display systems: Design and applications. Wiley (1997).
4. G. Berbecel. Digital image display: Algorithms and implementation. Wiley (2003).
5. E.R. Meinders, A.V. Mijiritskii, Liesbeth van Pieterson and M. Wuttig. Optical data storage:
6. Phase-changing media and recording. Springer (2006).
7. Demetri Psaltis, G. T. Sincerbox and A.M. Glass. Holographic data storage. Springer (2000).


**CO-PO Mapping**

| CO | PO | | | | | |
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| | 1 | 2 | 3 | 4 | 5 | 6 |
| 1. | 2 | 2 | 2 | 3 | 3 | 2 |
| 2. | 2 | 2 | 2 | 3 | 3 | 2 |
| 3. | 2 | 2 | 2 | 3 | 3 | 3 |
| 4. | 2 | 2 | 2 | 3 | 3 | 3 |
| 5. | 2 | 2 | 2 | 3 | 3 | 3 |
| Avg. | 2 | 2 | 2 | 3 | 3 | 2.6 |

High – 3, Medium – 2, Low – 1