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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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

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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

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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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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	

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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.

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

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

<u>ANY TEN EXPERIMENTS</u>

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					
	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:

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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