ANNA UNIVERSITY, CHENNAI
UNIVERSITY DEPARTMENTS
REGULATIONS - 2019
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 centre 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 programmes and providing extension services in cutting edge technologies in materials science and laser engineering. The Department of Physics ensures the supportive campus climate in academic and research activities by meeting the need of the students, faculty and staff.

Attested

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

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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 the principles 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 four years of study, our Laser and Electro-Optical Engineering Post-Graduates will exhibit ability to:

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 should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should 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	Apply technical knowledge towards the development of socially relevant products in optical domain.
6.	Environment and sustainability	Ensure development of eco friendly 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 have following 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 specific needs 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 environment and to communicate effectively in multidisciplinary environments.

4. PEO / PO Mapping:

PROGRAMME EDUCATIONAL OBJECTIVES	PROGRAMME OUTCOMES					
	PO1	PO2	PO3	PO4	PO5	PO6
I	✓	✓			✓	✓
II	✓	✓	✓	✓		
III	✓	✓	✓	✓	✓	✓
IV	✓	✓		✓	✓	✓
V	✓			✓	✓	✓

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Mapping of Course Outcome
and
Programme Outcome

Year	Semester	Course Name	PO01	PO02	PO03	PO04	PO05	PO06
YEAR 1	Semester 1	Applied Electromagnetics	✓	✓	✓	✓		
		Principles of Optics and Lasers Systems	✓	✓	✓			
		Laser Engineering and Applications	✓	✓	✓	✓	✓	
		Mathematical Physics for Optical Engineering	✓	✓	✓	✓		
		Research Methodology and IPR	✓	✓	✓	✓		✓
		Audit Course – I	✓					
		Optics Laboratory	✓	✓	✓	✓		
		Laser Laboratory - I	✓	✓	✓	✓		
	Semester 2	Electro-Optics Theory and Applications	✓	✓	✓	✓		
		Nonlinear Optics	✓	✓	✓	✓		
		Optoelectronics	✓	✓	✓	✓		
		Program Elective I	✓	✓	✓	✓		
		Program Elective II	✓	✓	✓	✓		
		Program Elective III	✓	✓	✓	✓		
		Audit Course –II						
		Laser Laboratory - II	✓	✓	✓	✓		
		Mini Project	✓	✓	✓	✓		
YEAR 2	Semester 3	Program Elective IV	✓	✓	✓	✓		
		Program Elective V	✓	✓	✓	✓		
		Open Elective	✓	✓	✓	✓		
		Dissertation- I	✓	✓	✓	✓	✓	
		Technical Seminar	✓				✓	
	Semester 4	Dissertation- II	✓	✓	✓	✓	✓	

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CHOICE BASED CREDIT SYSTEM
M.TECH. LASER AND ELECTRO OPTICAL ENGINEERING (FT)
I - IV SEMESTER CURRICULUM AND SYLLABUS

SEMESTER I

S. NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	LO5101	Applied Electromagnetics	PCC	4	0	0	4	4
2.	LO5102	Principles of Optics and Lasers	PCC	3	0	0	3	3
3.	LO5103	Laser Engineering and Applications	PCC	3	0	0	3	3
4.	LO5104	Mathematical Physics for Optical Engineering	FC	3	1	0	4	4
5.	RM5151	Research Methodology and IPR	RMC	2	0	0	2	2
6.		Audit Course – I*	AC	2	0	0	2	0
PRACTICALS								
7.	LO5111	Optics Laboratory	PCC	0	0	4	4	2
8.	LO5112	Laser Laboratory - I	PCC	0	0	4	4	2
			TOTAL	**17**	**1**	**8**	**26**	**20**

* Audit Course is optional

SEMESTER II

S. NO.	COURSE CODE	COURSETITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	LO5201	Electro-Optics Theory and Applications	PCC	3	0	0	3	3
2.	LO5202	Nonlinear Optics	PCC	3	0	0	3	3
3.	LO5203	Optoelectronics	PCC	3	0	0	3	3
4.		Program Elective I	PEC	3	0	0	3	3
5.		Program Elective II	PEC	3	0	0	3	3
6.		Program Elective III	PEC	3	0	0	3	3
7.		Audit Course - II*	AC	2	0	0	2	0
PRACTICALS								
8.	LO5211	Laser Laboratory - II	PCC	0	0	4	4	2
9.	LO5212	Mini Project	EEC	0	0	6	6	3
			TOTAL	**20**	**0**	**10**	**30**	**23**

* Audit Course is optional

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SEMESTER III

S. NO.	COURSE CODE	COURSETITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.		Program Elective IV	PEC	3	0	0	3	3
2.		Program Elective V	PEC	3	0	0	3	3
3.		Open Elective	OEC	3	0	0	3	3
PRACTICALS								
4.	LO5311	Dissertation- I	EEC	0	0	12	12	6
5.	LO5312	Technical Seminar	EEC	0	0	2	2	1
			TOTAL	**9**	**0**	**14**	**23**	**16**

SEMESTER IV

S. NO.	COURSE CODE	COURSETITLE	CATEGORY	PERIODSPER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
PRACTICALS								
1.	LO5411	Dissertation - II	EEC	0	0	24	24	12
			TOTAL	**0**	**0**	**24**	**24**	**12**

TOTAL NO. OF CREDITS: 71

FOUNDATION COURSES (FC)

SL. NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEM
			L	T	P		
1.	LO5104	Mathematical Physics for Optical Engineering	3	1	0	4	1
				TOTAL CREDITS		4	

PROGRAM CORE COURSES (PCC)

SL. NO	CODE NO.	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEM
			L	T	P		
1.	LO5101	Applied Electromagnetics	4	0	0	4	1
2.	LO5102	Principles of Optics and Lasers	4	0	0	4	1
3.	LO5103	Laser Engineering and Applications	3	0	0	3	1
4.	LO5111	Optics Laboratory	0	0	4	2	1
5.	LO5112	Laser Laboratory - I	0	0	4	2	1
6.	LO5201	Electro-Optics Theory and Applications	3	0	0	3	2
7.	LO5202	Nonlinear Optics	3	0	0	3	2
8.	LO5203	Optoelectronics	3	0	0	3	2
9.	LO5211	Laser Laboratory - II	0	0	4	2	2
					TOTAL CREDITS	**26**	

PROGRAM ELECTIVE COURSE [PEC]

SL. NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	GROUP
			L	T	P		
SEMESTER II, ELECTIVE I							
1.	LO5001	Fiber Optics Sensors	3	0	0	3	1
2.	LO5002	Materials for Optical Devices	3	0	0	3	1
3.	LO5003	Fabrication of Optical Devices	3	0	0	3	1
SEMESTER II, ELECTIVE II							
4.	LO5004	Laser Materials Processing	3	0	0	3	2
5.	LO5005	Medical Applications of Lasers	3	0	0	3	2
6.	LO5006	Fourier Optics and Signal Processing	3	0	0	3	2
SEMESTER II, ELECTIVE III							
7.	LO5007	Nonlinear Fiber Optics	3	0	0	3	3
8.	LO5008	Optical Computing and Signal Processing	3	0	0	3	3
9.	LO5009	Ultrafast Optics	3	0	0	3	3
SEMESTER III, ELECTIVE IV							
10.	LO5010	Laser Spectroscopy	3	0	0	3	4
11.	LO5011	Holography and Speckle	3	0	0	3	4
12.	LO5012	Radiation Sources and Detectors	3	0	0	3	4

SEMESTER III, ELECTIVE V							
13.	LO5013	Integrated Optics	3	0	0	3	5
14.	LO5014	Nano-optics	3	0	0	3	5
15.	LO5015	Laser Dynamics	3	0	0	3	5

RESEARCH METHODOLOGY AND IPR COURSES (RMC)

SL. NO	CODE NO.	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			L	T	P		
1	RM5151	Research Methodology and IPR	2	0	0	2	1
					TOTAL CREDITS	2	

OPEN ELECTIVE COURSES (OEC)

*(out of 6 courses one course must be selected)

SI. NO	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			CONTACT PERIODS	CREDITS
				L	T	P		
1.	OE5091	Business Data Analytics	OEC	3	0	0	3	3
2.	OE5092	Industrial Safety	OEC	3	0	0	3	3
3.	OE5093	Operations Research	OEC	3	0	0	3	3
4.	OE5094	Cost Management of Engineering Projects	OEC	3	0	0	3	3
5.	OE5095	Composite Materials	OEC	3	0	0	3	3
6.	OE5096	Waste to Energy	OEC	3	0	0	3	3

AUDIT COURSES (AC)

SL.NO	CODE NO.	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			L	T	P		
1		Audit Courses I	2	0	0	0	1
2		Audit Courses II	2	0	0	0	2
					TOTAL CREDITS	0	

AUDIT COURSES (AC)

Registration for any of these courses is optional to students

SL. NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS
			Lecture	Tutorial	Practical	
1.	AX5091	English for Research Paper Writing	2	0	0	0
2.	AX5092	Disaster Management	2	0	0	0
3.	AX5093	Sanskrit for Technical Knowledge	2	0	0	0
4.	AX5094	Value Education	2	0	0	0
5.	AX5095	Constitution of India	2	0	0	0
6.	AX5096	Pedagogy Studies	2	0	0	0
7.	AX5097	Stress Management by Yoga	2	0	0	0
8.	AX5098	Personality Development Through Life Enlightenment Skills	2	0	0	0
9.	AX5099	Unnat Bharat Abhiyan	2	0	0	0
					TOTAL CREDITS	**0**

EMPLOYABILITY ENHANCEMENT COURSES (EEC)

SL. NO	CODE NO.	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			Lecture	Tutorial	Practical		
1	LO5312	Technical Seminar	0	0	2	1	1
2	LO5212	Mini Project	0	0	6	3	2
3	LO5311	Dissertation I	0	0	12	6	3
4	LO5411	Dissertation II	0	0	24	12	4
					Total Credits:	**22**	10

Summary

	NAME OF THE PROGRAMME					
	SUBJECT AREA	CREDITS PER SEMESTER				CREDITS TOTAL
		I	II	III	IV	
1.	FC	04	00	00	00	04
2.	PCC	14	11	00	00	25
3.	PEC	00	09	06	00	15
4.	RMC	02	00	00	00	02
5.	OEC	00	00	03	00	03
6.	EEC	00	03	07	12	22
7.	Non Credit/Audit course	✓	✓	00	00	00
	Total Credit	**20**	**23**	**16**	**12**	**71**

LO5101 **APPLIED ELECTROMAGNETICS** **L T P C**
4 0 0 4

OBJECTIVES:

- To educate the students the importance of electromagnetic radiation.
- To inculcate the student to gain knowledge in understanding many practical optical devices such as Fabry-Perot etalons, interference filters, special coatings etc.
- To introduce the students to anisotropic media which form the basis of a large number of polarization devices such as quarter wave plate, Wollaston prism etc.
- To study a detailed electromagnetic analysis of symmetric planar wave guides.
- To study the basic physics behind the evolution of different types of fibres.

UNIT I PROPAGATION OF ELECTROMAGNETIC WAVES 12

Introduction – Maxwell's equations – plane waves in a dielectric – Poynting vector – complex notation – wave propagation in lossy medium.

UNIT II REFLECTION AND REFRACTION OF ELECTROMAGNETIC WAVES 12

Interface of two homogeneous nonabsorbing dielectrics – total internal reflection and evanescent waves – reflection and transmission by a film – extension of two films – interference filters – periodic media – presence of absorbing media: reflection and transmission.

UNIT III WAVE PROPAGATION IN ANISOTROPIC MEDIA 12

Introduction – double refraction – polarization devices – plane waves in anisotropic media – wave refractive index – ray refractive index – ray velocity surface – index ellipsoid – phase velocity and group velocity

UNIT IV ELECTROMAGNETIC ANALYSIS- SIMPLE OPTICAL WAVEGUIDE 12

Introduction – classification of modes for planar waveguide – TE modes in a symmetric step index planar waveguide – TM modes – relative magnitudes – power – radiation modes – excitation – Maxwell's equations in inhomogeneous media.

UNIT V ANALYSIS OF OPTICAL WAVEGUIDES 12

Quasimodes in planar structure – leakage of power from the core – determination of propagation characteristics – calculation of bending loss – optical fiber – numerical aperture – modal analysis for step index and parabolic index medium – multimodes – modes in an asymmetric planar waveguide – Ray analysis – WKB analysis – coupled mode theory.

TOTAL: 60 PERIODS

OUTCOMES:

CO1: The students will understand how Maxwell's electromagnetic wave equations are derived from the basic laws of Physics and wave propagation.
CO2: The students will know the basis of the field of ellipsometry.
CO3: The students will understand various light modulators based on the electrooptic effect.
CO4: The students will understand easily the physical principles of planar wave guides.
CO5: The students will gain knowledge of the modal field distribution, splice losses at joints, bending losses and in development of fibre optic devices.

REFERENCES:

1. A. Ghatak and K. Thiagarajan, "Optical Electronics", Cambridge India, 2017.
2. M.N.O. Sadiku, "Elements of Electromagnetics", Oxford Univ. Press, 2014.
3. F.T. Ulaby, E.Michielssen and U.Ravaioli, "Fundamentals of Applied Electromagnetics", Pearson Education India, 2014.
4. A.Yariv, "Quantum Electronics", Wiley India Pvt. Ltd., 2012.
5. G. Agrawal, Nonlinear," Fiber Optics", Elsevier, 2012.
6. David J. Griffiths, "Introduction to Electrodynamics", Pearson Education, 2015.

CO	PO						PSO			
	1	2	3	4	5	6	1	2	3	4
1.	✓	✓	✓	✓			✓	✓	✓	
2.	✓	✓	✓	✓			✓	✓	✓	
3.	✓	✓	✓	✓			✓	✓	✓	
4.	✓	✓	✓	✓			✓	✓	✓	
5.	✓	✓	✓	✓			✓	✓	✓	

LO5102 PRINCIPLES OF OPTICS AND LASERS L T P C
3 0 0 3

OBJECTIVES:

- To impart the knowledge about the basic phenomenon of the light with wave equations
- To teach the students about the radiation related activities in the cavity of the Laser systems for better understanding of the Laser system
- Teaching the students about the conditions for various Laser systems
- To teach the students for getting knowledge about cavity optics and modes of operations in Laser systems
- To teach the students about the different methods of Laser beam controlling systems.

UNIT I APPLIED OPTICS 9

Wave equation – linearly polarized waves – circularly and elliptically polarized waves – physics of lenses – types of lenses – two beam interference – multiple reflections from a plane parallel film – modes of the Fabry-Perot cavity – spatial and temporal coherence – propagation and diffraction of a Gaussian beam.

UNIT II RADIATION IN A CAVITY 9

Black body radiation - Modes of oscillation - Einstein coefficients - relation between the absorption coefficients and Einstein coefficients - Lifetime of excited state- decay of excited states, Line Broadening mechanisms – quantum mechanical description of radiating atoms, molecules in gas, liquid & solid phase, selection rules for atoms and molecules, Spectral notation.

UNIT III INTRODUCTION TO LASERS 9

Condition for producing laser - 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 IV CAVITY OPTICS AND LASER MODES 9

Requirements for a resonator – gain and loss in a cavity – resonator as an interferometer – longitudinal modes – wavelength selection in multiline lasers – single frequency operation – characterization of resonator – resonator stability for Guassian beams – common cavity configurations. Spatial energy distributions: Transverse modes and limiting modes – resonator alignment – gain and saturation effects.

UNIT V Q-SWITCHING, MODE LOCKING AND COHERENCE OF LASERS 9

Concept of Q-switching and experimental methods – intracavity switches – energy storage in laser media – pulse power and energy – cavity dumping - Theory of Mode locking and experimental methods - Spatial and Temporal coherence - Auto and mutual correlation function - Analytical treatment of Visibility.

TOTAL: 45 PERIODS

OUTCOMES:

CO1: The students will gain the knowledge about the various light phenomenon through wave equations

CO2: The students will learn the radiation related activities in the cavity to understand the laser systems.

CO3: The students will understand about the conditions for various Laser systems

CO4: The students will have better knowledge about the cavity optics and different modes of operations in Laser systems

CO5: The students will get clear understanding of controlling the laser beam in various laser systems.

REFERENCES:

1. K. Thyagarajan and A. Ghatak, “Lasers: Fundamentals and Applications”, Springer, 2012.
2. A.Yariv, “Quantum Electronics”, Wiley India Pvt. Ltd., 2012.
3. J. Verdeyen, “Laser Electronics”, Prentice Hall, 1994.
4. O.Svelto, “Principles of Lasers”, Springer, 2016.
5. M.Csele, “Fundamentals of Light Sources and Lasers”, Wiley-Blackwell,2004.

CO	PO						PSO			
	1	2	3	4	5	6	1	2	3	4
1.	✓	✓	✓				✓	✓	✓	
2.	✓	✓	✓				✓	✓	✓	
3.	✓	✓	✓				✓	✓	✓	
4.	✓	✓	✓				✓	✓	✓	
5.	✓	✓	✓				✓	✓	✓	

LO5103 LASER ENGINEERING AND APPLICATIONS L T P C
3 0 0 3

OBJECTIVES:

- To educate the students about fabrication and configuration of different gas lasers.
- To make the students understand solid, semiconductor and liquid lasers.
- To demonstrate the generation of ultrafast pulses.
- To illustrate the metrological applications of lasers.
- To analyse the materials processing by lasers.

UNIT I GAS LASERS 9

Electrical discharge mechanism – Gas discharge processes, Glow discharge, RF discharge, Hollow cathode discharge and pulsed discharge- Selective Excitation processes in gas 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 II SOLID STATE, SEMICONDUCTOR AND LIQUID 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. Intrinsic semiconductor laser - Doped semiconductor - Conduction for laser actions – Injection laser - Threshold current – Homojunction – Hetrojunction. Double hetro- junction lasers - Quantum well laser - Distributed feedback laser - Liquid lasers - Organic dyes - dye laser - Threshold condition - Configuration - Tuning methods.

UNIT III ULTRA SHORT 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 ultrashort pulses.

UNIT IV MATERIAL PROCESSING 9

CW and Pulsed laser beam characteristics and its measurements- Beam focusing effects-spot size- Power and Energy density Measurements-Distance measurement - Models for laser heating - Choice of a laser for material processing - Laser welding, drilling, machining and cutting - Laser surface treatment: alloying, cladding, peening - Laser vapour deposition - Thin film applications.

UNIT V METROLOGICAL APPLICATIONS 9

Interferometric techniques – Calibration Methods -LIDARS - Theory and different experimental arrangements - Pollution monitoring by remote sensing - Applications - Laser gyroscope.

TOTAL: 45 PERIODS

OUTCOMES:

CO1: The students will learn about the engineering principles 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, semiconductor and liquid lasers lasers and their applications.

CO3: Students will know about pico, nano, femto and atto second pulse generation, Q-switching: methods etc.

CO4: The students will gain knowledge about metrological applications.

CO5: The students will learn about models for laser heating, choice of a laser for material processing and applications.

REFERENCES:

1. R.B. Laud, “Lasers and Non linear 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. W.M.Steen and J.Mazumdar, “Laser Material Processing”, Springer, 2010.

CO	PO						PSO			
	1	2	3	4	5	6	1	2	3	4
1.	✓	✓	✓	✓	✓		✓	✓	✓	
2.	✓	✓	✓	✓	✓		✓	✓	✓	
3.	✓	✓	✓	✓	✓		✓	✓	✓	
4.	✓	✓	✓	✓	✓		✓	✓	✓	
5.	✓	✓	✓	✓	✓		✓	✓	✓	

LO5104 MATHEMATICAL PHYSICS FOR OPTICAL ENGINEERING L T P C
3 1 0 4

OBJECTIVES:

- To show the students the importance of vectors and tensors in crystal physics.
- To familiarize the students to the concepts of random variables and probability methods
- To apply Fourier tools to understand the diffraction patterns.
- To introduce the students to special functions and their necessity in physics.
- To bring in the concepts of non linear dynamics and their applications.

UNIT I VECTORS AND TENSORS 12

Gauss divergence theorem – Stokes's theorem – Green's theorem – applications to electromagnetic field – definition of tensors – algebra of Cartesian tensors – outer product contraction and quotient theorems – Kronecker & Levi-Civita tensors – example – applications in physics – crystal optics.

UNIT II 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, Gaussian and sinusoidal 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 III FOURIER TRANSFORM AND APPLICATIONS 12

Fourier series -Fourier transform and spectra -Parseval's theorem -Dirac delta function – unit step function -two dimensional signals -Fresnel &Fraunhofer diffraction -examples FT by lens– point source -single slit, double slit-circular aperture -cosine grating - coherent optical filtering - holographic filters - discrete Fourier transform.

UNIT IV SPECIAL FUNCTIONS 12

Beta and Gamma functions -Legendre, Bessel, Hermite and Lagurre polynomials - generating functions -recurrence relations, orthogonal relations, associated polynomials and their properties - confluent hyper geometric functions and their properties.

UNIT V DYNAMICS OF OPTICAL SYSTEMS 12

Linear and nonlinear oscillators – autonomous and non-autonomous systems – classification of equilibrium points – bifurcations and chaos – chaos in a model laser system – linear and nonlinear dispersive waves – Nonlinear Schrodinger equation in optical fibers - solitary wave solutions and basic solitons, Nonlinear Schrodinger equation: envelope soliton, Hiroto's method, IST method. Numerical analysis: Euler method and 4^{th} order Runge - Kutta method for solving differential equations –finite difference and finite element analysis methods for solving partial differential equations.

TOTAL: 60 PERIODS

OUTCOMES:

The students will be able to

CO1: Apply calculus methods in solving real physics problems.
CO2: Understand and apply a suitable statistical distribution to any statistical problem.
CO3: Solve optical problems using fourier methods.
CO4: Write recurrence relation, orthogonal relations and solve problems in special functions.
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 S. Rajasekar, "Nonlinear Dynamics: Integrability", Chaos and Patterns. Springer, 2003.
8. M.Lakshmanan and K. Murali, "Chaos in Nonlinear Oscillators: Controlling and Synchronization", World Scientific, 1996.

CO	PO						PSO			
	1	2	3	4	5	6	1	2	3	4
1.	✓	✓	✓	✓			✓	✓	✓	
2.	✓	✓	✓	✓			✓	✓	✓	
3.	✓	✓	✓	✓			✓	✓	✓	
4.	✓	✓	✓	✓			✓	✓	✓	
5.	✓	✓	✓	✓			✓	✓	✓	

RM5151 **RESEARCH METHODOLOGY AND IPR** **L T P C**
2 0 0 2

OBJECTIVES:

- To impart knowledge and skills required for research and IPR:
- Problem formulation, analysis and solutions.
- Technical paper writing / presentation without violating professional ethics
- Patent drafting and filing patents.

UNIT I RESEARCH PROBLEM FORMULATION 6

Meaning of research problem- Sources of research problem, criteria characteristics of a good research problem, errors in selecting a research problem, scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, necessary instrumentations

UNIT II LITERATURE REVIEW 6

Effective literature studies approaches, analysis, plagiarism, and research ethics.

UNIT III TECHNICALWRITING /PRESENTATION 6

Effective technical writing, how to write report, paper, developing a research proposal, format of research proposal, a presentation and assessment by a review committee.

UNIT IV INTRODUCTION TO INTELLECTUAL PROPERTY RIGHTS (IPR) 6

Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

UNIT V INTELLECTUAL PROPERTY RIGHTS (IPR) 6

Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications. New Developments in IPR: Administration of Patent System, IPR of Biological Systems, Computer Software etc.
Traditional knowledge Case Studies, IPR and IITs.

TOTAL: 30 PERIODS

OUTCOMES:

CO1: Ability to formulate research problem
CO2: Ability to carry out research analysis
CO3: Ability to follow research ethics
CO4: Ability to understand that today's world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity
CO5: Ability to understand about IPR and filing patents in R & D.

REFERENCES:

1. Asimov, "Introduction to Design", Prentice Hall, 1962.
2. Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd ,2007.
3. Mayall, "Industrial Design", McGraw Hill, 1992.
4. Niebel, "Product Design", McGraw Hill, 1974.
5. Ranjit Kumar, 2nd Edition, "Research Methodology: A Step by Step Guide for beginners" 2010

CO	PO						PSO			
	1	2	3	4	5	6	1	2	3	4
1.	✓	✓	✓	✓		✓	✓	✓	✓	✓
2.	✓	✓	✓	✓		✓	✓	✓	✓	✓
3.	✓	✓	✓	✓		✓	✓	✓	✓	✓
4.	✓	✓	✓	✓		✓	✓	✓	✓	✓
5.	✓	✓	✓	✓		✓	✓	✓	✓	✓

LO5111 **OPTICS LABORATORY** **L T P C**
0 0 4 2

OBJECTIVES:

- To Prepare the students to develop the basicskills in using and handling the opticalcomponents
- To develop and gainingknowledgeaboutchoosing the light sources
- To develop the basicskills in understandinggeometrical and rayoptics
- To develop the skills in handling the opticalintruments
- To develop the skills in understandingvariousopticalphenimenonthroughexperiments

Any **TEN** experiments:

1. Geometrical optics experiments: Verification of Snell's law, use of lens equations, determination of focal length of lens
2. Chromatic aberration in lens imaging
3. Verifying the imaging laws with a collecting lens
4. Michelson interferometer: Determination of wavelength of a monochromatic light source and thickness of transparent film
5. Determination of dispersive power and resolving power of a prism/ Grating
6. Determination of elastic constants: Hyperbolic fringes
7. Determination of elastic constants: Elliptical fringes
8. Optical absorption: Spectrophotometer
9. Newton's ring in transmitted and reflected white light
10. Determination of focal length of liquid lens
11. Determination of refractive index of the liquid using liquid lens
12. Characteristics of LEDs and determination of Planck's constant
13. Determination of refractive index of given liquid using hallow prism
14. Diffraction-Single slit and double slit diffraction
15. Air wedge-Determination of thickness of micro objects and thin film.

TOTAL:60 PERIODS

Attested

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OUTCOMES:

After completion of this course, the student should be able to

CO1: Have basic skills in in using and handling the opticalcomponents
CO2: Gainknowledgeaboutchoosing the light sources
CO3: Havebasicskills in understandinggeometrical and rayoptics
CO4: Havethe skills in handling the opticalintruments
CO5: Understandthe variousopticalphenimenathroughexperiments

CO	PO						PSO			
	1	2	3	4	5	6	1	2	3	4
1.	✓	✓	✓	✓		✓	✓	✓	✓	
2.	✓	✓	✓	✓		✓	✓	✓	✓	
3.	✓	✓	✓	✓		✓	✓	✓	✓	
4.	✓	✓	✓	✓		✓	✓	✓	✓	
5.	✓	✓	✓	✓		✓	✓	✓	✓	

LO5112 **LASER LABORATORY- I** **L T P C**
0 0 4 2

OBJECTIVES:

- To Prepare the students to develop the basicskills in using and handling the lasers, sensors and detector components
- To educate and gain knowledgeaboutchoosing the laser sources
- To develop the basicskills in understandinggeometrical and rayoptics
- To demonstrate and practice response characteristics of components like solar cell, photodiode etc.
- To develop the skills in understandingvariousopticalphenomenathrough laser experiments

Any TEN experiments

1. Measurement of divergence and diode laser characteristics
2. Measurement of wavelength of a given laser using a grating
3. Determination of particle size of lycopodium powder and blood cells using laser diffraction
4. Calibration of metal scale using He-Ne laser
5. Michelson Interferometer-Determination of wavelength of laser
6. Fabry Perot Interferometer - Determination of wavelength of laser, etalon spacing, Finesse and free spectral range of the etalon
7. Determination of slit width, aperture diameter using He - Ne laser and Fraunhofer diffraction
8. Determination of velocity of ultrasonic waves using acoustic grating
9. Verification of Malu's law
10. Studies on lenses using laser
11. Verification of inverse square law using laser
12. Verification of law of refraction and finding refractive index of water using laser.
13. Measurement of numerical aperture and bending Loss of fiber
14. Characteristics of light dependent resistor and phototransistor
15. Response Characteristics of Solar Cell, Photodiode and other components

Attested

TOTAL: 60 PERIODS

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OUTCOMES:

After completion of this course, the student should be able to

CO1: Have basic skills in in using and handling the lasers, sensors and detectors
CO2: Gainknowledgeaboutchoosing the laser sources
CO3: Havethe skills in handling the opticalintruments
CO4: Gain knowledegeaboutresponse characteristics of components like solar cell, photodiode etc.
CO5: Understand the variousopticalphenomenathroughexperimentsusingLasers

	PO						PSO			
	1	2	3	4	5	6	1	2	3	4
1.	✓	✓	✓	✓		✓	✓	✓	✓	
2.	✓	✓	✓	✓		✓	✓	✓	✓	
3.	✓	✓	✓	✓		✓	✓	✓	✓	
4.	✓	✓	✓	✓		✓	✓	✓	✓	
5.	✓	✓	✓	✓		✓	✓	✓	✓	

LO5201 ELECTRO-OPTICS THEORY AND APPLICATIONS L T P C
3 0 0 3

OBJECTIVES:

- To educate the students to understand about crystal optics.
- To educate the student the importance of propagation of electromagnetic waves
- To educate the student about electro and acousto optic effects.
- To inculcate knowledge to students about the technological applications of electro-optic effect.
- To instill proper knowledge to students about the various applications of acousto and magneto optic effects.

UNIT I CRYSTAL OPTICS 9

Point group and space group – matrix representation of symmetry operations – the effect of crystal symmetry in crystal properties – Neumann's principle – tensors – first-order electro-optical tensor - piezo-optical and elasto-optical tensors – dielectric description of a crystal - double refraction – polarization devices – crystal structures of $LiNBO_3$, KDP and $BaTiO_3$.

UNIT II PROPAGATION OF ELECTROMAGNETIC WAVES 9

Wave equation in isotropic material – wave equation in anisotropic materials – aniso-tropic materials – index ellipsoid – propagation in uniaxial and biaxial crystals – birefringence – wavel plates and compensators – optical activity.

UNIT III GROWTH OF ELECTRO-OPTIC AND ACOUSTO-OPTIC MATERIALS 9

Growth of single crystals – Electro-optic crystals – acousto-optic crystals – magneto-optic crystals – photorefractive crystals – Techniques for growing single crystals – zone refining technique – growth of molecular crystals.

UNIT IV ELECTRO AND ACOUSTO OPTICS 9

The electro-optic effect (EOE)– linear and quadratic electro-optic effect – physical properties of electro-optic coefficients – retardation – EOE based amplitude and phase modulation – EOE in KDP and cubic crystals – integrated optical modulators. Elastooptic effect – acousto-optic interactions – Bragg diffraction in an anisotropic medium – Raman-Nath diffraction – surfactacoustooptics – magneto optic effect – magneto-optic Kerr effect – Franz-Keldysh effect.

UNIT V OPTICAL MODULATORS 9

Electro-optic(EO) light modulators – electro-optic Fabry-Perot modulators – bistable EO devices. EO based beam deflection – Q-swtiching. Acousto-optic (AO) modulators – AO deflectors – AO tunable filters. Thephotoeleastic effect – Bragg diffraction of light by acoustic waves. Electro-absorption modulators.

TOTAL: 45 PERIODS

OUTCOMES:

CO1: The students will learn about the principles of tensors, various optical phenomena in crystals like photoelasticity, Faraday effect etc.

CO2: Student will understand how Maxwell's electromagnetic wave equations are derived from the basic laws of Physics and propagation of electromagnetic waves in different media and to analyze the interaction.

CO3: The students will gain knowledge about electro and acousto optical effects that have a lot of industrial applications.

CO4: Students would have learned about some technological applications of electro-optic effect like modulators, deflectors, bistable devices etc.

CO5: The students would have gained knowledge about some interesting devices which use the principle of acousto optic and magneto optic effects.

REFERENCES

1. C.C.Davis, "Lasers and Electro-optics: Fundamentals and Engineering", Cambridge University Press, 2014.
2. W.Koechner, "Solid-State Laser Engineering", Springer, 2014.
3. R.W. Munn and C.N. Ironside, "Principles and Applications of Nonlinear Optical Materials", Springer, 2013.
4. J.A.K. Tareen and T.R.N. Kutty, "A Basic course in Crystallography", University Press, 2000.
5. T.S.Narasimhamurty, "Photoelastic and Electro-Optic Properties of Crystals", Springer-Verlag, 2012.
6. H.L. Bhat, "Introduction to Crystal Growth: Principles and Practice", CRC Press, 2016.
7. A.Yariv, "Quantum Electronics", Wiley India Pvt. Ltd., 2012.
8. A. Ghatak and K. Thiagarajan, "Optical Electronics", Cambridge India, 2017.
9. A.Yariv and P.Yeh, "Optical waves in Crystals: Propagation and Control of Laser Radiation", Wiley-Blackwell, 2002.

CO	PO						PSO			
	1	2	3	4	5	6	1	2	3	4
1.	✓	✓	✓	✓		✓	✓	✓	✓	
2.	✓	✓	✓	✓		✓	✓	✓	✓	
3.	✓	✓	✓	✓		✓	✓	✓	✓	
4.	✓	✓	✓	✓		✓	✓	✓	✓	
5.	✓	✓	✓	✓		✓	✓	✓	✓	

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LO5202	NONLINEAR OPTICS	L T P C
		3 0 0 3

OBJECTIVES:

- To introduce the students the origin of nonlinearity in optical medium.
- To make the students to learn about second harmonic generation and the concept of parametric oscillation.
- To equip the students to understand the origin of third-order optical nonlinearity and its effects in the manifestation of self-focussing, optical phase conjugation and soliton
- To introduce the concept of optical signal modulation with electro-optic effect and photorefractive effect.
- To introduce the students the concept of stimulated scattering processes.

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 OSCILLATION 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 of light 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

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 generation of 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						PSO			
	1	2	3	4	5	6	1	2	3	4
1.	✓	✓	✓	✓		✓	✓	✓	✓	
2.	✓	✓	✓	✓		✓	✓	✓	✓	
3.	✓	✓	✓	✓		✓	✓	✓	✓	
4.	✓	✓	✓	✓		✓	✓	✓	✓	
5.	✓	✓	✓	✓		✓	✓	✓	✓	

LO5203 **OPTOELECTRONICS** **L T P C**
3 0 0 3

OBJECTIVES;

- To learn the Physics behind the Semiconductor devices
- To learn about the Physics behind the Semiconductor light sources
- To learn about the Physics of Semiconductor photodetectors
- To learn about the Physics of Semiconductor optoelectronic modulators
- To learn about how optoelectronic IC chips are fabricated and their applications

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 SEMICONDUCTOR PHOTODETECTORS AND SOLAR CELLS 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 – photovoltaic device principles – PN junction photovoltaic characteristics – temperature effects – solar cells materials, devices and efficiencies.

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

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 Semiconductor photodetectors and solar cells including the latest CCD devices used for astronomical applications
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.
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8. E. Rosencher, B.Vinter and P. G. Piva, “Optoelectronics”, Cambridge University Press, 2002.

CO	PO						PSO			
	1	2	3	4	5	6	1	2	3	4
1.	✓	✓	✓	✓		✓	✓	✓	✓	
2.	✓	✓	✓	✓		✓	✓	✓	✓	
3.	✓	✓	✓	✓		✓	✓	✓	✓	
4.	✓	✓	✓	✓		✓	✓	✓	✓	
5.	✓	✓	✓	✓		✓	✓	✓	✓	

LO5211 LASER LABORATORY - II L T P C
0 0 4 2

OBJECTIVES:

- To educate the students on the advanced level experiments using lasers.
- To introduce the students to the concepts of polarization, interference and diffraction using suitable experiments.
- To analyze the phenomena of nonlinear optics.
- To develop the skill for handling various optical instruments
- To develop observational and analytical skills in the concepts of holography.
- To train the students in setting up of fiber optic communication links

Attested

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ANY TEN EXPERIMENTS

1. Determination of Brewster angle, refractive index and absorption coefficient of a transparent material
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. Nonlinear Optics : Optical limiting
5. Optical Fourier-filtering experiment
6. Holographic recording and reconstruction
7. Optical addition : Logic gates
8. Determination of Thickness and Refractive index of a thin film using Variable Angle Ellipsometer
9. Opto-electronic chaos : Usage of LEDs
10. Digital Hologram
11. Study of Kerr effect
12. UV Spectrophotometer- Transmission characteristics of optical materials
13. Laser Raman spectrometer- Characteristics of given molecule/ sample
14. Setting up of fiber optic analog and digital link
15. Spectrometer – Goniometer : Determination of wavelength of light.

TOTAL: 60 PERIODS

OUTCOMES:

On the successful completion of the course the students will be able to

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.

CO6: Set up various types of fiber optic communication links.

CO	PO						PSO			
	1	2	3	4	5	6	1	2	3	4
1.	✓	✓	✓	✓		✓	✓	✓	✓	
2.	✓	✓	✓	✓		✓	✓	✓	✓	
3.	✓	✓	✓	✓		✓	✓	✓	✓	
4.	✓	✓	✓	✓		✓	✓	✓	✓	
5.	✓	✓	✓	✓		✓	✓	✓	✓	

Attested

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LO5001 **FIBER OPTIC SENSORS** **L T P C**
3 0 0 3

OBJECTIVES:

- To educate the students the basic concepts and practices of fiber optics.
- To teach the students about the characteristics and fabrications of optical fibers.
- To educate the students the basic concepts and practices of fiber optic communication.
- To train the students in the basic principles of various types of fiber sensors.
- To analyse about different interferometric sensors.

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 superluminescent 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 - Transmission and 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

OUTCOMES:

- The students will acquire knowledge in fundamentals of fiber optics.
- Students will learn about characteristics and fabrication of optical fibers.
- The students will gain knowledge in communication equipments, construction and working of optical communication networks.
- The students will learn about intensity and polarization sensors and their applications.
- 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 and scientists. Wiley, 2011.
2. J. M. Senior. Optical Fiber Communications. Pearson Education, 2014.
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6. B.P. Pal (Ed.).Fundamentals of Fibre Optics in Telecommunication and Sensor systems. New Age International Pvt Ltd, 2015.

CO	PO						PSO			
	1	2	3	4	5	6	1	2	3	4
1.	✓	✓	✓	✓		✓	✓	✓	✓	
2.	✓	✓	✓	✓		✓	✓	✓	✓	
3.	✓	✓	✓	✓		✓	✓	✓	✓	
4.	✓	✓	✓	✓		✓	✓	✓	✓	
5.	✓	✓	✓	✓		✓	✓	✓	✓	

LO5002 MATERIALS FOR OPTICAL DEVICES L T P C
3 0 0 3

OBJECTIVES:

- To emphasize the importance of various optical processes of light propagating in a dielectric medium.
- To educate the students about the growth and characterization (X-ray, UV-Vis-absorption, morphology & PL) of single crystals for laser devices.
- To understand the basic property of uniaxial and biaxial crystals.
- To study the changes in the optical properties of semiconductors by alloying, quantization and fabrication of photonic bandgap (PBG) materials devices.
- To analyze the reflection, transmission and absorption of light in thin films on single, double and multilayer non-metallic coatings

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: X-ray diffraction, UV Visible spectroscopy, SEM and Photoluminescence studies - 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.

Attested

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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

OUTCOMES:

Students will understand various optical processes.

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 anisotropic crystals.

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

CO4: The students will learn about the optics of thin films.

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2. B.E.A. Saleh and M.C. Teich. Fundamentals of photonics. Wiley India Pvt Ltd.. 2012.
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8. A.Yariv. Quantum Electronics. Wiley India Pvt. Ltd., 2012.
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1.	✓	✓	✓	✓		✓	✓	✓	✓	
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LO5003 **FABRICATION OF OPTICAL DEVICES** **L T P C**
3 0 0 3

OBJECTIVES:

- To teach the students about new approaches in nanophotonics.
- To educate the students about quantum confined materials.
- To teach the students about plasmonics.
- To educate the students about different photonic crystals.
- To educate the students about various photonic devices.

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 -Plasmonicwaveguiding 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

OUTCOMES:

CO1: The students will learn about the physics of nanophotonics.
CO2: The students will acquire knowledge about nonlinear optical properties, Quantum dots and lithography.
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 of photonic 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.

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1.	✓	✓	✓	✓		✓	✓	✓	✓	
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LO5004 LASER MATERIALS PROCESSING L T P C
3 0 0 3

OBJECTIVES:

- To educate the students about the applications of lasers in materials processing.
- To study the system-related parameters that have the most significant effect on process output.
- To introduce the student about the criteria that is necessary for successful laser surface treatment.
- To introduce the principles of the cutting, welding and drilling process.
- To educate the student about the basic thermodynamics of materials processing**.**

UNIT I INDUSTRIAL LASER SYSTEMS 9

Laser parameters - High power laser systems - Focusing optics – collimation - Steering optics scan head -- Mechanisms - Overview 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 - Key hole effect – heat affected zone.

UNIT III PRE-PROCESSING AND PROCESSING PARAMETERS 9

Annealing , quenching effects – basic thermodynamics of material processing and preparation – laser heads, geometry, selection cutting nozzle – copper and Teflon cone design. Laser assisted process – powder feeding – wire feeder, plasma interaction – pulse shaping – gas dynamics – microstructure checking and analysis – viewing optics – CCD recording. Marking and galvo interaction.

UNIT IV SURFACE TREATMENT 9

Surface modification- surface cladding - surface alloying - Hard facing - Shock hardening - shock peeling - laser parameters for surface alloying - process variables - Beam profiles - 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

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.
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LO5005 **MEDICAL APPLICATIONS OF LASERS** **L T P C**
3 0 0 3

OBJECTIVES:

- To guide the students in the fundamentals of laser-tissue interaction.
- To educate the students about photobiology and medical lasers.
- To teach the students about thermal applications of lasers.
- To teach the students about non-thermal applications of lasers.
- To make the students aware of safety regulations.

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 - Photoablative 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 - hermostasis– Cancer, Liver, stomach, gynecological, urological and cardiac surgeries - Lasers in Opthalmology - Dermatology and Dentistry – Cosmetic Surgery.

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 laproscopy - 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

OUTCOMES:

CO1: The students will learn about laser tissue interaction, absorption by biological systems, and photoablative 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.
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LO5006 FOURIER OPTICS AND SIGNAL PROCESSING L T P C
3 0 0 3

OBJECTIVES:

- To make the students understand the concepts of signals and systems.
- To educate the students about diffraction theory.
- To teach the students about coherent optical systems.
- To illustrate the concepts of wavefront modulation.
- To educate the students about optical information processing.

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 optics.

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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

OUTCOMES:

CO1: The students will learn about Fourier transform, sampling theory, space-bandwidth product and 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 and image 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.
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1.	✓	✓	✓	✓		✓	✓	✓	✓	
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LO5007 NONLINEAR FIBER OPTICS L T P C
3 0 0 3

OBJECTIVES:

- To make the students understand the fundamentals of nonlinear fiber optics.
- To educate the students about the concepts of group velocity dispersion and nonlinear phase modulation.
- To illustrate the fundamentals of optical solitons to the students.
- To make the students aware of applications of solitons.
- To train the students in the applications of nonlinear fiber optics.

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 Group Velocity 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 - Fiber Raman 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

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, coupling between 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 Kerr effect, 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.
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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”, Academic Press, 2003.

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1.	✓	✓	✓	✓		✓	✓	✓	✓	
2.	✓	✓	✓	✓		✓	✓	✓	✓	
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LO5008 OPTICAL COMPUTING AND SIGNAL PROCESSING L T P C
3 0 0 3

OBJECTIVES:

- To introduce the concept of Fourier optics and image processing.
- To train the students in optical computing.
- To educate the students about optical switching devices.
- To make the students aware of optical interconnections.
- To make the students understand about optical neural networks.

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

OUTCOMES:

- The students will learn about optical computing and application of Fourier optics in image processing.
- Students will be educated about liquid crystal light valve, micro-channel spatial light modulator, logic gates using SLMs, etc.
- Students will gain knowledge in types of switching devices, circuit switches, and electronics-optics interface.
- Students will gain knowledge in types of optical interconnections.
- 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”, Academic Press, 2012.

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LO5009 **ULTRAFAST OPTICS** **L T P C**
3 0 0 3

OBJECTIVES:

- To study about the ultrashort laser pulse generation.
- To educate the students about ultrashort pulse measurement.
- To teach the students about dispersion management.
- To educate the students about ultrafast nonlinear optics.
- To educate the students about ultrafast spectroscopy.

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 – solidstate 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.

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UNIT V ULTRAFAST SPECTROSCOPY 9

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

TOTAL: 45 PERIODS

OUTCOMES:

CO1: The students will learn about the concept, technology and applications of ultrashort laser pulse 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 pulse shaping.

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 and Applications”, Marcel Dekker, 2003.
5. H. Ishikawa, “Ultrafast all-Optical Signal Processing Devices”, Wiley-Blackwell, 2008.

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1.	✓	✓	✓	✓		✓	✓	✓	✓	
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LO5010 LASER SPECTROSCOPY L T P C
3 0 0 3

OBJECTIVES:

- To introduce the students to the importance of laser spectroscopy.
- To make the students learn about various broadening mechanisms and the significance of doppler broadening and necessity to limit it in spectroscopy.
- To educate the students about techniques to generate ultra-short laser pulses
- To teach the students about high resolution spectroscopic techniques.
- To inform the students about the applications of laser spectroscopy in various fields.

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 of lasers in medicine.

TOTAL: 45 PERIODS

OUTCOMES:

CO1: The students will gain knowledge about the fundamentals of spectroscopy, different types of spectroscopy 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-short pulses.
CO4: The students will gain knowledge about the techniques to detect the signals with high resolutions 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.
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5. J. R. Lakowicz, “Topics in Fluorescence Spectroscopy: Principles”, Springer, 2014.
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CO	PO						PSO			
	1	2	3	4	5	6	1	2	3	4
1.	✓	✓	✓	✓		✓	✓	✓	✓	
2.	✓	✓	✓	✓		✓	✓	✓	✓	
3.	✓	✓	✓	✓		✓	✓	✓	✓	
4.	✓	✓	✓	✓		✓	✓	✓	✓	
5.	✓	✓	✓	✓		✓	✓	✓	✓	

LO5011 HOLOGRAPHY AND SPECKLE L T P C
3 0 0 3

OBJECTIVES:

- To introduce the principles of holography and speckle to the students.
- To educate the students about holograms for display.
- To teach the students the concept and applications of holographic interferometry.
- To train the students on the applications of holography in engineering and medicine.
- To make the students aware of speckle photography and interferometry.

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 Photochromatic Materials - Thermo plastic Materials - Photoresists

UNIT II HOLOGRAMS FOR DISPLAY 9

360^0 holograms - Double sided holograms - Holographic stereograms - Rainbow Holograms - Colour Holography - Volume Reflection Holograms - Multicolour 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 - Acoustical and 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.

Attested

TOTAL: 45 PERIODS

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OUTCOMES:

CO1: The students will learn about how experimentally holograms and specklegrams 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 and interferometry.

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						PSO			
	1	2	3	4	5	6	1	2	3	4
1.	✓	✓	✓	✓		✓	✓	✓	✓	
2.	✓	✓	✓	✓		✓	✓	✓	✓	
3.	✓	✓	✓	✓		✓	✓	✓	✓	
4.	✓	✓	✓	✓		✓	✓	✓	✓	
5.	✓	✓	✓	✓		✓	✓	✓	✓	

LO5012 RADIATION SOURCES AND DETECTORS L T P C
3 0 0 3

OBJECTIVES:

- To educate the students the importance of radiation sources and detectors.
- To educate the students about spectroscopy and optical devices.
- To teach the students about detectors.
- To educate the students about conventional detectors.
- To make the students understand about modern detectors.

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 photoemissive 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 Averager – Integrating Sphere – Streak Camera.

TOTAL: 45 PERIODS

OUTCOMES:

CO1: The students will learn about physics of radiation from different sources in different signals of electromagnetic 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						PSO			
	1	2	3	4	5	6	1	2	3	4
1.	✓	✓	✓	✓		✓	✓	✓	✓	
2.	✓	✓	✓	✓		✓	✓	✓	✓	
3.	✓	✓	✓	✓		✓	✓	✓	✓	
4.	✓	✓	✓	✓		✓	✓	✓	✓	
5.	✓	✓	✓	✓		✓	✓	✓	✓	

Attested

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LO5013 **INTEGRATED OPTICS** **L T P C**
3 0 0 3

OBJECTIVES:

- To understand the basic principles, fabrication and characterization of optical amplifiers.
- The fundamentals of microfabrication technique and the waveguide control device properties will be discussed.
- To learn about the fabrication of integrated semiconductor sources.
- To study the growth and fabrication of photonic materials.
- To study the input current to output spectral characteristic of various optoelectronic devices.

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

Applications of coupled mode theory – theory of gratings in waveguide structures – 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 – convolvers – correlators – 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

OUTCOMES:

CO1: Students will gain knowledge about optical amplifiers.
CO2: Students will acquire knowledge about fabrication of waveguide devices.
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 materials by various epitaxial techniques.
CO5: Students will acquire broad understanding of photonic device operation and its performance will 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						PSO			
	1	2	3	4	5	6	1	2	3	4
1.	✓	✓	✓	✓		✓	✓	✓	✓	
2.	✓	✓	✓	✓		✓	✓	✓	✓	
3.	✓	✓	✓	✓		✓	✓	✓	✓	
4.	✓	✓	✓	✓		✓	✓	✓	✓	
5.	✓	✓	✓	✓		✓	✓	✓	✓	

LO5014 **NANO-OPTICS** **L T P C**
3 0 0 3

OBJECTIVES:

- To make the students to understand the basics of near-field optics.
- To equip the students with the knowledge of near filed photonics.
- To elucidate the importance of single quantum systems.
- To make the students to understand the working principles of nanoscale optical microscopes.
- To make the students to understand the different aspects of plasmonics.

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

OUTCOMES:

After completion of this course, the students should able to

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 theworking 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						PSO			
	1	2	3	4	5	6	1	2	3	4
1.	✓	✓	✓	✓		✓	✓	✓	✓	
2.	✓	✓	✓	✓		✓	✓	✓	✓	
3.	✓	✓	✓	✓		✓	✓	✓	✓	
4.	✓	✓	✓	✓		✓	✓	✓	✓	
5.	✓	✓	✓	✓		✓	✓	✓	✓	

LO5015 **LASER DYNAMICS** **L T P C**
3 0 0 3

OBJECTIVES:

- To make the students to understand the principle of operation and practical implementation of quantum oscillators.
- To make the students to use the knowledge of dynamical models in single-mode lasers.
- To equip the students to ably understand the different types of multi-mode laser systems.
- To introduce the concepts of nonlinear parameters in laser systems.
- To elucidate the working principles of different laser systems.

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 broadened solid-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

OUTCOMES:

After completion of this course, the students should able to

- Know the principle of operation and practical implementation of quantum oscillators.
- Use the knowledge of dynamical models in single-mode lasers.
- Understand the different types of multi-mode laser systems.
- Know the importance of nonlinear parameters in laser systems.
- 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						PSO			
	1	2	3	4	5	6	1	2	3	4
1.	✓	✓	✓	✓		✓	✓	✓	✓	
2.	✓	✓	✓	✓		✓	✓	✓	✓	
3.	✓	✓	✓	✓		✓	✓	✓	✓	
4.	✓	✓	✓	✓		✓	✓	✓	✓	
5.	✓	✓	✓	✓		✓	✓	✓	✓	

OE5091 **BUSINESS DATA ANALYTICS** **L T P C**
3 0 0 3

OBJECTIVES:

- To understand the basics of business analytics and its life cycle.
- To gain knowledge about fundamental business analytics.
- To learn modeling for uncertainty and statistical inference.
- To understand analytics using Hadoop and Map Reduce frameworks.
- To acquire insight on other analytical frameworks.

UNIT I OVERVIEW OF BUSINESS ANALYTICS **9**

Introduction – Drivers for Business Analytics – Applications of Business Analytics: Marketing and Sales, Human Resource, Healthcare, Product Design, Service Design, Customer Service and Support – Skills Required for a Business Analyst – Framework for Business Analytics Life Cycle for Business Analytics Process.

Suggested Activities:

- Case studies on applications involving business analytics.
- Converting real time decision making problems into hypothesis.
- Group discussion on entrepreneurial opportunities in Business Analytics.

Suggested Evaluation Methods:

- Assignment on business scenario and business analytical life cycle process.
- Group presentation on big data applications with societal need.
- Quiz on case studies.

UNIT II ESSENTIALS OF BUSINESS ANALYTICS **9**

Descriptive Statistics – Using Data – Types of Data – Data Distribution Metrics: Frequency, Mean, Median, Mode, Range, Variance, Standard Deviation, Percentile, Quartile, z-Score, Covariance, Correlation – Data Visualization: Tables, Charts, Line Charts, Bar and Column Chart, Bubble Chart, Heat Map – Data Dashboards.

Suggested Activities:

- Solve numerical problems on basic statistics.
- Explore chart wizard in MS Excel Case using sample real time data for data visualization.
- Use R tool for data visualization.

Suggested Evaluation Methods:

- Assignment on descriptive analytics using benchmark data.
- Quiz on data visualization for univariate, bivariate data.

UNIT III MODELING UNCERTAINTY AND STATISTICAL INFERENCE 9

Modeling Uncertainty: Events and Probabilities – Conditional Probability – Random Variables – Discrete Probability Distributions – Continuous Probability Distribution – Statistical Inference: Data Sampling – Selecting a Sample – Point Estimation – Sampling Distributions – Interval Estimation – Hypothesis Testing.

Suggested Activities:

- Solving numerical problems in sampling, probability, probability distributions and hypothesis testing.
- Converting real time decision making problems into hypothesis.

Suggested Evaluation Methods:

- Assignments on hypothesis testing.
- Group presentation on real time applications involving data sampling and hypothesis testing.
- Quizzes on topics like sampling and probability.

UNIT IV ANALYTICS USING HADOOP AND MAPREDUCE FRAMEWORK 9

Introducing Hadoop– RDBMS versus Hadoop–Hadoop Overview – HDFS (Hadoop Distributed File System) – Processing Data with Hadoop– Introduction to MapReduce – Features of MapReduce – Algorithms Using Map-Reduce: Matrix-Vector Multiplication, Relational Algebra Operations, Grouping and Aggregation – Extensions to MapReduce.

Suggested Activities:

- Practical – Install and configure Hadoop.
- Practical – Use web based tools to monitor Hadoop setup.
- Practical – Design and develop MapReduce tasks for word count, searching involving text corpus etc.

Suggested Evaluation Methods:

- Evaluation of the practical implementations.
- Quizzes on topics like HDFS and extensions to MapReduce.

UNIT V OTHER DATA ANALYTICAL FRAMEWORKS 9

Overview of Application development Languages for Hadoop – PigLatin – Hive – Hive Query Language (HQL) – Introduction to Pentaho, JAQL – Introduction to Apache: Sqoop, Drill and Spark, Cloudera Impala – Introduction to NoSQL Databases – Hbase and MongoDB.

Suggested Activities:

- Practical – Installation of NoSQL database like MongoDB.
- Practical – Demonstration on Sharding in MongoDB.
- Practical – Install and run Pig
- Practical – Write PigLatin scripts to sort, group, join, project, and filter data.
- Design and develop algorithms to be executed in MapReduce involving numerical methods for analytics.

Suggested Evaluation Methods:

- Mini Project (Group) – Real time data collection, saving in NoSQL, implement analytical techniques using Map-Reduce Tasks and Result Projection.

TOTAL: 45 PERIODS

OUTCOMES:

On completion of the course, the student will be able to:

CO1: Identify the real world business problems and model with analytical solutions.
CO2: Solve analytical problem with relevant mathematics background knowledge.
CO3: Convert any real world decision making problem to hypothesis and apply suitable statistical testing.
CO4: Write and Demonstrate simple applications involving analytics using Hadoop and MapReduce
CO5: Use open source frameworks for modeling and storing data.
Apply suitable visualization technique using R for visualizing voluminous data.

REFERENCES:

1. VigneshPrajapati, “Big Data Analytics with R and Hadoop”, Packt Publishing, 2013.
2. Umesh R Hodeghatta, UmeshaNayak, “Business Analytics Using R – A Practical Approach”, Apress, 2017.
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4. Jeffrey D. Camm, James J. Cochran, Michael J. Fry, Jeffrey W. Ohlmann, David R. Anderson, “Essentials of Business Analytics”, Cengage Learning, second Edition, 2016.
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	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	1	1	2	3	1
CO2	2	1	1	2	1	1
CO3	1	1	2	3	3	1
CO4	2	2	1	2	1	1
CO5	1	1	2	2	1	1
CO6	1	1	1	3	2	1

OE5092 **INDUSTRIAL SAFETY** **LT P C**
3 0 0 3

OBJECTIVES:

- Summarize basics of industrial safety
- Describe fundamentals of maintenance engineering
- Explain wear and corrosion
- Illustrate fault tracing
- Identify preventive and periodic maintenance

UNIT I INTRODUCTION **9**

Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act 1948 for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc, Safety color codes. Fire prevention and firefighting, equipment and methods.

UNIT II FUNDAMENTALS OF MAINTENANCE ENGINEERING **9**

Definition and aim of maintenance engineering, Primary and secondary functions and responsibility of maintenance department, Types of maintenance, Types and applications of tools used for maintenance, Maintenance cost & its relation with replacement economy, Service life of equipment.

UNIT III WEAR AND CORROSION AND THEIR PREVENTION **9**

Wear- types, causes, effects, wear reduction methods, lubricants-types and applications, Lubrication methods, general sketch, working and applications, i. Screw down grease cup, ii. Pressure grease gun, iii. Splash lubrication, iv. Gravity lubrication, v. Wick feed lubrication vi. Side feed lubrication, vii. Ring lubrication, Definition, principle and factors affecting the corrosion. Types of corrosion, corrosion prevention methods.

UNIT IV FAULT TRACING **9**

Fault tracing-concept and importance, decision tree concept, need and applications, sequence of fault finding activities, show as decision tree, draw decision tree for problems in machine tools, hydraulic, pneumatic, automotive, thermal and electrical equipment's like, I. Any one machine tool, ii. Pump iii. Air compressor, iv. Internal combustion engine, v. Boiler, vi. Electrical motors, Types of faults in machine tools and their general causes.

UNIT V PERIODIC AND PREVENTIVE MAINTENANCE **9**

Periodic inspection-concept and need, degreasing, cleaning and repairing schemes, overhauling of mechanical components, overhauling of electrical motor, common troubles and remedies of electric motor, repair complexities and its use, definition, need, steps and advantages of preventive maintenance. Steps/procedure for periodic and preventive maintenance of: I. Machine tools, ii. Pumps, iii. Air compressors, iv. Diesel generating (DG) sets, Program and schedule of preventive maintenance of mechanical and electrical equipment, advantages of preventive maintenance. Repair cycle concept and importance

TOTAL: 45 PERIODS

OUTCOMES:

Students will be able to:

CO1: Ability to summarize basics of industrial safety
CO2: Ability to describe fundamentals of maintenance engineering
CO3: Ability to explain wear and corrosion
CO4: Ability to illustrate fault tracing
CO5: Ability to identify preventive and periodic maintenance

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓											
CO2	✓											
CO3	✓	✓	✓									
CO4	✓	✓	✓									
CO5	✓	✓	✓									

REFERENCES:

1. Audels, Pump-hydraulic Compressors, Mcgrew Hill Publication, 1978.
2. Garg H P,Maintenance Engineering, S. Chand and Company,1987.
3. Hans F. Winterkorn, Foundation Engineering Handbook, Chapman & Hall London, 2013.
4. Higgins & Morrow, Maintenance Engineering Handbook, Eighth Edition,2008

Attested

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OE5093 **OPERATIONS RESEARCH** **L T P C**
3 0 0 3

OBJECTIVES:

- Solve linear programming problem and solve using graphical method.
- Solve LPP using simplex method
- Solve transportation, assignment problems
- Solve project management problems
- Solve scheduling problems

UNIT I LINEAR PROGRAMMING **9**

Introduction to Operations Research – assumptions of linear programming problems - Formulations of linear programming problem – Graphical method

UNIT II ADVANCES IN LINEAR PROGRAMMING **9**

Solutions to LPP using simplex algorithm- Revised simplex method - primal dual relationships – Dual simplex algorithm - Sensitivity analysis

UNIT III NETWORK ANALYSIS – I **9**

Transportation problems -Northwest corner rule, least cost method, Voges's approximation method - Assignment problem -Hungarian algorithm

UNIT IV NETWORK ANALYSIS – II **9**

Shortest path problem: Dijkstra's algorithms, Floyds algorithm, systematic method -CPM/PERT

UNIT V NETWORK ANALYSIS – III **9**

Scheduling and sequencing - single server and multiple server models - deterministic inventory models - Probabilistic inventory control models

TOTAL: 45 PERIODS

OUTCOMES:

Students will be able to:

CO1: To formulate linear programming problem and solve using graphical method.
CO2: To solve LPP using simplex method
CO3: To formulate and solve transportation, assignment problems
CO4: To solve project management problems
CO5: To solve scheduling problems

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓											
CO2	✓											
CO3	✓	✓	✓									
CO4	✓	✓	✓									
CO5	✓	✓	✓									

REFERENCES:

1. Harvey M Wagner, Principles of Operations Research: Prentice Hall of India 2010
2. Hitler Libermann, Operations Research: McGraw Hill Pub. 2009
3. Pant J C, Introduction to Optimisation: Operations Research, Jain Brothers, Delhi, 2008
4. Pannerselvam, Operations Research: Prentice Hall of India 2010
5. Taha H A, Operations Research, An Introduction, PHI, 2008

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OE5094 **COST MANAGEMENT OF ENGINEERING PROJECTS** **L T P C**
3 0 0 3

OBJECTIVES:

- Summarize the costing concepts and their role in decision making
- Infer the project management concepts and their various aspects in selection
- Interpret costing concepts with project execution
- Develop knowledge of costing techniques in service sector and various budgetary control techniques
- Illustrate with quantitative techniques in cost management

UNIT I INTRODUCTION TO COSTING CONCEPTS 9

Objectives of a Costing System; Cost concepts in decision-making; Relevant cost, Differential cost, Incremental cost and Opportunity cost; Creation of a Database for operational control.

UNIT II INTRODUCTION TO PROJECT MANAGEMENT 9

Project: meaning, Different types, why to manage, cost overruns centres, various stages of project execution: conception to commissioning. Project execution as conglomeration of technical and nontechnical activities, Detailed Engineering activities, Pre project execution main clearances and documents, Project team: Role of each member, Importance Project site: Data required with significance, Project contracts.

UNIT III PROJECT EXECUTION AND COSTING CONCEPTS 9

Project execution Project cost control, Bar charts and Network diagram, Project commissioning: mechanical and process, Cost Behavior and Profit Planning Marginal Costing; Distinction between Marginal Costing and Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis, Various decision-making problems, Pricing strategies: Pareto Analysis, Target costing, Life Cycle Costing.

UNIT IV COSTING OF SERVICE SECTOR AND BUDGETERY CONTROL 9

Just-in-time approach, Material Requirement Planning, Enterprise Resource Planning, Activity-Based Cost Management, Bench Marking; Balanced Score Card and Value-Chain Analysis, Budgetary Control: Flexible Budgets; Performance budgets; Zero-based budgets.

UNIT V QUANTITATIVE TECHNIQUES FOR COST MANAGEMENT 9

Linear Programming, PERT/CPM, Transportation problems, Assignment problems, Learning Curve Theory.

TOTAL: 45 PERIODS

OUTCOMES:

Students will be able to:

CO1 – Understand the costing concepts and their role in decision making
CO2–Understand the project management concepts and their various aspects in selection
CO3–Interpret costing concepts with project execution
CO4–Gain knowledge of costing techniques in service sector and various budgetary control techniques
CO5 - Become familiar with quantitative techniques in cost management

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓		✓			✓	✓		✓	✓
CO2	✓	✓	✓		✓				✓		✓	✓
CO3	✓	✓	✓		✓	✓					✓	✓
CO4	✓	✓	✓		✓		✓				✓	✓
CO5	✓	✓	✓		✓	✓	✓				✓	✓

REFERENCES:
1.Ashish K. Bhattacharya, Principles & Practices of Cost Accounting A. H. Wheeler publisher, 1991
2. Charles T. Horngren and George Foster, Advanced Management Accounting, 1988
3. Charles T. Horngren et al Cost Accounting A Managerial Emphasis, Prentice Hall of India, New Delhi, 2011
4. Robert S Kaplan Anthony A. Alkinson, Management & Cost Accounting, 2003
5. Vohra N.D., Quantitative Techniques in Management, Tata McGraw Hill Book Co. Ltd, 2007

OE5095 COMPOSITE MATERIALS L T P C
3 0 0 3

OBJECTIVES:

- Summarize the characteristics of composite materials and effect of reinforcement in composite materials.
- Identify the various reinforcements used in composite materials.
- Compare the manufacturing process of metal matrix composites.
- Understand the manufacturing processes of polymer matrix composites.
- Analyze the strength of composite materials.

UNIT I INTRODUCTION 9

Definition – Classification and characteristics of Composite materials - Advantages and application of composites - Functional requirements of reinforcement and matrix - Effect of reinforcement (size, shape, distribution, volume fraction) on overall composite performance.

UNIT II REINFORCEMENTS 9

Preparation-layup, curing, properties and applications of glass fibers, carbon fibers, Kevlar fibers and Boron fibers - Properties and applications of whiskers, particle reinforcements - Mechanical Behavior of composites: Rule of mixtures, Inverse rule of mixtures - Isostrain and Isostress conditions.

UNIT III MANUFACTURING OF METAL MATRIX COMPOSITES 9

Casting – Solid State diffusion technique - Cladding – Hot isostatic pressing - Properties and applications. Manufacturing of Ceramic Matrix Composites: Liquid Metal Infiltration – Liquid phase sintering. Manufacturing of Carbon – Carbon composites: Knitting, Braiding, Weaving - Properties and applications.

UNIT IV MANUFACTURING OF POLYMER MATRIX COMPOSITES 9

Preparation of Moulding compounds and prepregs – hand layup method – Autoclave method – Filament winding method – Compression moulding – Reaction injection moulding - Properties and applications.

UNIT V STRENGTH 9

Laminar Failure Criteria-strength ratio, maximum stress criteria, maximum strain criteria, interacting failure criteria, hygrothermal failure. Laminate first play failure-insight strength; Laminate strength-ply discount truncated maximum strain criterion; strength design using caplet plots; stress concentrations.

TOTAL: 45 PERIODS

OUTCOMES:
Students will be able to:

- CO1 - Know the characteristics of composite materials and effect of reinforcement in composite materials.
- CO2 – Know the various reinforcements used in composite materials.
- CO3 – Understand the manufacturing processes of metal matrix composites.
- CO4 – Understand the manufacturing processes of polymer matrix composites.
- CO5 – Analyze the strength of composite materials.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		✓	✓	✓								
CO2		✓	✓	✓	✓						✓	
CO3			✓	✓	✓		✓				✓	
CO4			✓	✓	✓		✓				✓	
CO5			✓	✓	✓		✓					

REFERENCES:

1. Cahn R.W. - Material Science and Technology – Vol 13 – Composites, VCH, West Germany.
2. Callister, W.D Jr., Adapted by Balasubramaniam R, Materials Science and Engineering, An introduction, John Wiley & Sons, NY, Indian edition, 2007.
3. Chawla K.K., Composite Materials, 2013.
4. Lubin.G, Hand Book of Composite Materials, 2013.

OE5096 **WASTE TO ENERGY** **L T P C**
3 0 0 3

OBJECTIVES:

- Interpret the various types of wastes from which energy can be generated
- Develop knowledge on biomass pyrolysis process and its applications
- Develop knowledge on various types of biomass gasifiers and their operations
- Invent knowledge on biomass combustors and its applications on generating energy
- Summarize the principles of bio-energy systems and their features

UNIT I INTRODUCTION TO EXTRACTION OF ENERGY FROM WASTE 9

Classification of waste as fuel – Agro based, Forest residue, Industrial waste - MSW – Conversion devices – Incinerators, gasifiers, digestors

UNIT II BIOMASS PYROLYSIS 9

Pyrolysis – Types, slow fast – Manufacture of charcoal – Methods - Yields and application – Manufacture of pyrolytic oils and gases, yields and applications.

UNIT III BIOMASS GASIFICATION 9

Gasifiers – Fixed bed system – Downdraft and updraft gasifiers – Fluidized bed gasifiers – Design, construction and operation – Gasifier burner arrangement for thermal heating – Gasifier engine arrangement and electrical power – Equilibrium and kinetic consideration in gasifier operation.

UNIT IV BIOMASS COMBUSTION **9**

Biomass stoves – Improved chullahs, types, some exotic designs, Fixed bed combustors, Types, inclined grate combustors, Fluidized bed combustors, Design, construction and operation - Operation of all the above biomass combustors.

UNIT V BIO ENERGY **9**

Properties of biogas (Calorific value and composition), Biogas plant technology and status - Bio energy system - Design and constructional features - Biomass resources and their classification - Biomass conversion processes - Thermo chemical conversion - Direct combustion - biomass gasification - pyrolysis and liquefaction - biochemical conversion - anaerobic digestion - Types of biogas Plants – Applications - Alcohol production from biomass - Bio diesel production -Urban waste to energy conversion - Biomass energy programme in India.

TOTAL: 45 PERIODS

OUTCOMES:

Students will be able to:

CO1 – Understand the various types of wastes from which energy can be generated
CO2 – Gain knowledge on biomass pyrolysis process and its applications
CO3 – Develop knowledge on various types of biomass gasifiers and their operations
CO4 – Gain knowledge on biomass combustors and its applications on generating energy
CO5 – Understand the principles of bio-energy systems and their features

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓		✓									✓
CO2	✓		✓									✓
CO3	✓	✓	✓		✓							✓
CO4	✓	✓	✓		✓		✓					✓
CO5	✓	✓	✓		✓							✓

REFERENCES:

1. Biogas Technology - A Practical Hand Book - Khandelwal, K. C. and Mahdi, S. S., Vol. I & II, Tata McGraw Hill Publishing Co. Ltd., 1983.
2. Biomass Conversion and Technology, C. Y. WereKo-Brobby and E. B. Hagan, John Wiley & Sons, 1996.
3. Food, Feed and Fuel from Biomass, Challal, D. S., IBH Publishing Co. Pvt. Ltd., 1991.
4. Non Conventional Energy, Desai, Ashok V., Wiley Eastern Ltd., 1990.

AUDIT COURSES (AC)

AX5091 ENGLISH FOR RESEARCH PAPER WRITING **L T P C**
2 0 0 0

OBJECTIVES

- Teach how to improve writing skills and level of readability
- Tell about what to write in each section
- Summarize the skills needed when writing a Title
- Infer the skills needed when writing the Conclusion
- Ensure the quality of paper at very first-time submission

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UNIT I INTRODUCTION TO RESEARCH PAPER WRITING 6

Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness

UNIT II PRESENTATION SKILLS 6

Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticizing, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts, Introduction

UNIT III TITLE WRITING SKILLS 6

Key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check

UNIT IV RESULT WRITING SKILLS 6

Skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions

UNIT V VERIFICATION SKILLS 6

Useful phrases, checking Plagiarism, how to ensure paper is as good as it could possibly be the first- time submission

TOTAL: 30 PERIODS

OUTCOMES

CO1 –Understand that how to improve your writing skills and level of readability
CO2 – Learn about what to write in each section
CO3 – Understand the skills needed when writing a Title
CO4 – Understand the skills needed when writing the Conclusion
CO5 – Ensure the good quality of paper at very first-time submission

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1										✓		✓
CO2										✓		✓
CO3										✓		✓
CO4										✓		✓
CO5										✓		✓

REFERENCES

1. Adrian Wallwork , English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011
2. Day R How to Write and Publish a Scientific Paper, Cambridge University Press 2006
3. Goldbort R Writing for Science, Yale University Press (available on Google Books) 2006
4. Highman N, Handbook of Writing for the Mathematical Sciences, SIAM. Highman's book 1998.

AX5092 DISASTER MANAGEMENT L T P C
2 0 0 0

OBJECTIVES

- Summarize basics of disaster
- Explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.
- Illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
- Describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
- Develop the strengths and weaknesses of disaster management approaches

UNIT I INTRODUCTION 6

Disaster: Definition, Factors and Significance; Difference between Hazard And Disaster; Natural and Manmade Disasters: Difference, Nature, Types and Magnitude.

UNIT II REPERCUSSIONS OF DISASTERS AND HAZARDS 6

Economic Damage, Loss of Human and Animal Life, Destruction Of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts And Famines, Landslides And Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks And Spills, Outbreaks Of Disease And Epidemics, War And Conflicts.

UNIT III DISASTER PRONE AREAS IN INDIA 6

Study of Seismic Zones; Areas Prone To Floods and Droughts, Landslides And Avalanches; Areas Prone To Cyclonic and Coastal Hazards with Special Reference To Tsunami; Post-Disaster Diseases and Epidemics

UNIT IV DISASTER PREPAREDNESS AND MANAGEMENT 6

Preparedness: Monitoring Of Phenomena Triggering a Disaster or Hazard; Evaluation of Risk: Application of Remote Sensing, Data from Meteorological And Other Agencies, Media Reports: Governmental and Community Preparedness.

UNIT V RISK ASSESSMENT 6

Disaster Risk: Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques of Risk Assessment, Global Co-Operation in Risk Assessment and Warning, People's Participation in Risk Assessment. Strategies for Survival

TOTAL : 30 PERIODS

OUTCOMES

CO1: Ability to summarize basics of disaster
CO2: Ability to explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.
CO3: Ability to illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
CO4: Ability to describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
CO5: Ability to develop the strengths and weaknesses of disaster management approaches

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓											
CO2	✓											
CO3	✓	✓	✓									
CO4	✓	✓	✓									
CO5	✓	✓	✓									

REFERENCES

1. Goel S. L., Disaster Administration And Management Text And Case Studies",Deep & Deep Publication Pvt. Ltd., New Delhi,2009.
2. NishithaRai, Singh AK, "Disaster Management in India: Perspectives, issues and strategies "'NewRoyal book Company,2007.
3. Sahni, PardeepEt.Al. ," Disaster Mitigation Experiences And Reflections", Prentice Hall OfIndia, New Delhi,2001.

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AX5093 **SANSKRIT FOR TECHNICAL KNOWLEDGE** **L T P C**
2 0 0 0

OBJECTIVES

- Illustrate the basic sanskrit language.
- Recognize sanskrit, the scientific language in the world.
- Appraise learning of sanskrit to improve brain functioning.
- Relate sanskrit to develop the logic in mathematics, science & other subjects enhancing the memory power.
- Extract huge knowledge from ancient literature.

UNIT I ALPHABETS **6**

Alphabets in Sanskrit

UNIT II TENSES AND SENTENCES **6**

Past/Present/Future Tense - Simple Sentences

UNIT III ORDER AND ROOTS **6**

Order - Introduction of roots

UNIT IV SANSKRIT LITERATURE **6**

Technical information about Sanskrit Literature

UNIT V TECHNICAL CONCEPTS OF ENGINEERING **6**

Technical concepts of Engineering-Electrical, Mechanical, Architecture, Mathematics

TOTAL: 30 PERIODS

OUTCOMES

- CO1 - Understanding basic Sanskrit language.
- CO2 - Write sentences.
- CO3 - Know the order and roots of Sanskrit.
- CO4 - Know about technical information about Sanskrit literature.
- CO5 - Understand the technical concepts of Engineering.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1										✓		✓
CO2										✓		✓
CO3												✓
CO4												✓
CO5												✓

REFERENCES

1. “Abhyaspustakam” – Dr. Vishwas, Samskrita-Bharti Publication, New Delhi
2. “Teach Yourself Sanskrit” Prathama Deeksha-Vempati Kutumbshastri, Rashtriya Sanskrit Sansthanam, New Delhi Publication
3. “India’s Glorious Scientific Tradition” Suresh Soni, Ocean books (P) Ltd., New Delhi, 2017.

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AX5094 **VALUE EDUCATION** **L T P C**
2 0 0 0

OBJECTIVES
Students will be able to
- Understand value of education and self-development
- Imbibe good values in students
- Let the should know about the importance of character

UNIT I
Values and self-development–Social values and individual attitudes. Work ethics, Indian vision of humanism. Moral and non-moral valuation. Standards and principles. Value judgements

UNIT II
Importance of cultivation of values. Sense of duty. Devotion, Self-reliance. Confidence, Concentration. Truthfulness, Cleanliness. Honesty, Humanity. Power of faith, National Unity. Patriotism. Love for nature, Discipline

UNIT III
Personality and Behavior Development-Soul and Scientific attitude. Positive Thinking. Integrity and discipline. Punctuality, Love and Kindness. Avoid fault Thinking. Free from anger, Dignity of labour. Universal brother hood and religious tolerance. True friendship. Happiness Vs suffering, love for truth. Aware of self-destructive habits. Association and Cooperation. Doing best for saving nature

UNIT IV
Character and Competence–Holy books vs Blind faith. Self-management and Good health. Science of reincarnation. Equality, Nonviolence, Humility, Role of Women. All religions and same message. Mind your Mind, Self-control. Honesty, Studying effectively.

TOTAL: 30 PERIODS

OUTCOMES
Students will be able to
- Knowledge of self-development.
- Learn the importance of Human values.
- Developing the overall personality.

SUGGESTED READING
1. Chakroborty, S.K."Values and Ethics for organizations Theory and practice", Oxford University Press, New Delhi

AX5095 **CONSTITUTION OF INDIA** **L T P C**
2 0 0 0

OBJECTIVES
Students will be able to:
- Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.
- To address the growth of Indian opinion regarding modern Indian intellectuals' constitutional
- Role and entitlement to civil and economic rights as well as the emergence nation hood in the early years of Indian nationalism.
- To address the role of socialism in India after the commencement of the Bolshevik Revolutionin1917and its impact on the initial drafting of the Indian Constitution.

UNIT I HISTORY OF MAKING OF THE INDIAN CONSTITUTION:
History, Drafting Committee, (Composition & Working)

UNIT II PHILOSOPHY OF THE INDIAN CONSTITUTION:
Preamble, Salient Features

UNIT III CONTOURS OF CONSTITUTIONAL RIGHTS AND DUTIES:
Fundamental Rights, Right to Equality, Right to Freedom, Right against Exploitation, Right to Freedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies, Directive Principles of State Policy, Fundamental Duties.

UNIT IV ORGANS OF GOVERNANCE:
Parliament, Composition, Qualifications and Disqualifications, Powers and Functions, Executive, President, Governor, Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualifications, Powers and Functions.

UNIT V LOCAL ADMINISTRATION:
District's Administration head: Role and Importance, Municipalities: Introduction, Mayor and role of Elected Representative, CEO, Municipal Corporation. Pachayati raj: Introduction, PRI: Zila Pachayat. Elected officials and their roles, CEO Zila Pachayat: Position and role. Block level: Organizational Hierarchy(Different departments), Village level:Role of Elected and Appointed officials, Importance of grass root democracy.

UNIT VI ELECTION COMMISSION:
Election Commission: Role and Functioning. Chief Election Commissioner and Election Commissioners - Institute and Bodies for the welfare of SC/ST/OBC and women.

TOTAL: 30 PERIODS

OUTCOMES
Students will be able to:
- Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.
- Discuss the intellectual origins of the framework of argument that informed the conceptualization
- of social reforms leading to revolution in India.
- Discuss the circumstances surrounding the foundation of the Congress Socialist Party[CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution.
- Discuss the passage of the Hindu Code Bill of 1956.

SUGGESTED READING

1. The Constitution of India,1950(Bare Act),Government Publication.
2. Dr.S.N.Busi, Dr.B. R.Ambedkar framing of Indian Constitution,1st Edition, 2015.
3. M.P. Jain, Indian Constitution Law, 7th Edn., Lexis Nexis,2014.
4. D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.

AX5096 PEDAGOGY STUDIES L T P C
2 0 0 0

OBJECTIVES
Students will be able to:
- Review existing evidence on there view topic to inform programme design and policy
- Making under taken by the DfID, other agencies and researchers.
- Identify critical evidence gaps to guide the development.

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UNIT I INTRODUCTION AND METHODOLOGY:

Aims and rationale, Policy background, Conceptual framework and terminology - Theories of learning, Curriculum, Teacher education - Conceptual framework, Research questions **-** Overview of methodology and Searching.

UNIT II THEMATIC OVERVIEW

Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries - Curriculum, Teacher education.

UNIT III EVIDENCE ON THE EFFECTIVENESS OF PEDAGOGICAL PRACTICES

Methodology for the in depth stage: quality assessment of included studies - How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy? - Theory of change - Strength and nature of the body of evidence for effective pedagogical practices - Pedagogic theory and pedagogical approaches - Teachers' attitudes and beliefs and Pedagogic strategies.

UNIT IV PROFESSIONAL DEVELOPMENT

Professional development: alignment with classroom practices and follow up support - Peer support - Support from the head teacher and the community - Curriculum and assessment - Barriers to learning: limited resources and large class sizes

UNIT V RESEARCH GAPS AND FUTURE DIRECTIONS

Research design – Contexts – Pedagogy - Teacher education - Curriculum and assessment - Dissemination and research impact.

TOTAL: 30 PERIODS

OUTCOMES

Students will be able to understand:

- What pedagogical practices are being used by teachers informal and informal classrooms in developing countries?
- What is the evidence on the effectiveness of these pedagogical practices, in what conditions, and with what population of learners?
- How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy?

SUGGESTED READING

1. Ackers J, HardmanF (2001) Classroom interaction in Kenyan primary schools, Compare, 31(2): 245-261.
2. Agrawal M (2004)Curricular reform in schools: The importance of evaluation, Journal of Curriculum Studies, 36(3):361-379.
3. Akyeampong K (2003) Teacher training in Ghana-does it count? Multi-site teacher education research project (MUSTER) country report 1.London:DFID.
4. Akyeampong K, Lussier K, Pryor J, Westbrook J (2013) Improving teaching and learning of basic maths and reading in Africa: Does teacher preparation count? International Journal Educational Development, 33(3): 272–282.
5. Alexander RJ(2001) Culture and pedagogy: International comparisons in primary education. Oxford and Boston: Blackwell.
6. Chavan M(2003) Read India: Amass scale, rapid, 'learning to read' campaign.
7. www.pratham.org/images/resource%20working%20paper%202.pdf

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AX5097 **STRESS MANAGEMENT BY YOGA** **L T P C**
2 0 0 0

OBJECTIVES

- To achieve overall health of body and mind
- To overcome stress

UNIT I

Definitions of Eight parts of yoga.(Ashtanga)

UNIT II

Yam and Niyam - Do`s and Don't's in life - i) Ahinsa, satya, astheya, bramhacharya and aparigraha, ii) Ahinsa, satya, astheya, bramhacharya and aparigraha.

UNIT III

Asan and Pranayam - Various yog poses and their benefits for mind & body - Regularization of breathing techniques and its effects-Types of pranayam

TOTAL: 30 PERIODS

OUTCOMES

Students will be able to:

- Develop healthy mind in a healthy body thus improving social health also
- Improve efficiency

SUGGESTED READING

1. 'Yogic Asanas for Group Tarining-Part-I":Janardan Swami Yoga bhyasi Mandal, Nagpur
2. "Rajayoga or conquering the Internal Nature" by Swami Vivekananda, Advaita Ashrama (Publication Department), Kolkata

AX5098 **PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTENMENT SKILLS** **L T P C**
2 0 0 0

OBJECTIVES

- To learn to achieve the highest goal happily
- To become a person with stable mind, pleasing personality and determination
- To awaken wisdom in students

UNIT I

Neetisatakam-holistic development of personality - Verses- 19,20,21,22 (wisdom) - Verses- 29,31,32 (pride & heroism) – Verses- 26,28,63,65 (virtue) - Verses- 52,53,59 (dont's) - Verses- 71,73,75,78 (do's)

UNIT II

Approach to day to day work and duties - Shrimad Bhagwad Geeta: Chapter 2-Verses 41, 47,48 - Chapter 3-Verses 13, 21, 27, 35 Chapter 6-Verses 5,13,17,23, 35 - Chapter 18-Verses 45, 46, 48.

UNIT III

Statements of basic knowledge - Shrimad Bhagwad Geeta: Chapter2-Verses 56, 62, 68 Chapter 12 -Verses 13, 14, 15, 16,17, 18 - Personality of role model - shrimad bhagwad geeta - Chapter2-Verses 17, Chapter 3-Verses 36,37,42 - Chapter 4-Verses 18, 38,39 Chapter18 – Verses 37,38,63

TOTAL: 30 PERIODS

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OUTCOMES

Students will be able to

- Study of Shrimad-Bhagwad-Geeta will help the student in developing his personality and achieve the highest goal in life
- The person who has studied Geeta will lead the nation and mankind to peace and prosperity
- Study of Neet is hatakam will help in developing versatile personality of students.

SUGGESTED READING

1. Gopinath, Rashtriya Sanskrit Sansthanam P, Bhartrihari's Three Satakam, Niti-sringar-vairagya, New Delhi,2010
2. Swami Swarupananda , Srimad Bhagavad Gita, Advaita Ashram, Publication Department, Kolkata, 2016.

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