M. Tech in Optoelectronics and Laser Technology

SCHEME OF EXAMINATION, COURSE STRUCTURE
& SYLLABUS

M.Tech. in Optoelectronics & Laser Technology

Choice based Credit System (CBCS)
with
Learning Outcomes based Curriculum Framework (LOCF)

FACULTY OF SCIENCE

Approved by Joint Board of Studies in Electronics & Physics

EFFECTIVE FROM ACADEMIC SESSION

JULY – 2020

Joint Program of
School of Studies in
Electronics and Photonics
&
School of Studies in
Physics and Astro-Physics

Pt. Ravishankar Shukla University
Raipur (C.G.) 492010
WEBSITE: www. prsu.ac.in

PT. RAVISHANKAR SHUKLA UNIVERSITY, RAIPUR (C.G.)

School of Studies in Electronics and Photonics &
School of Studies in Physics and Astro-Physics

SCHEME & SYLLABUS

M. Tech in Optoelectronics and Laser Technology
(UGC & AICTE Approved)

SESSION – 2020-2021

Programme Objectives: The Master of Technology (M.Tech.) program in Optoelectronics and Laser Technology is designed to prepare students for technically demanding careers in industry as well as for post-master's graduate studies in photonics or related fields. The program is designed to equip motivated students who are willing to contribute to R&D activity towards the advancement of Optoelectronics technology. They shall (i) Engage in professional practice to promote the development of innovative systems and optimized solutions for Optoelectronics technologies in real life applications, (ii) Adapt to different roles and responsibilities in multidisciplinary working environment by respecting professionalism and ethical practices within an institution/organization at national and international levels, (iii) Enhancing skills and adopt existing and emerging technologies for innovations, professional excellence and research activity.

It requires students to build depth in a photonics specialization selected from areas such as lasers and applications, photonics materials and devices, and fiber optics and optical communications. It has a practicum requirement that is satisfied by doing a Minor Project and Industrial training and taking two project-intensive courses Dissertation Phase –I and Phase-II.

The main goal of the master degree program is to prepare professionals with a high level of expertise in cutting-edge photonics technologies and being able to innovate using them, with a practical vision, providing sustainable solutions in different environments, having the proper tools to get involved in an industry demanding experts on those technologies, for creating starts-up or researching in that field.

Optoelectronics & Laser Technology is a highly interdisciplinary Masters programme concerned with fundamental physics of light and optical components as well as a wide range of applications which are essential to our high-tech society, for example our ability to communicate using IT technology.

The field of photonics covers all technical applications of light over the entire spectrum from ultraviolet through visible to near, mid, and far infrared light—and from lasers in CD players through the development of new, energy-saving light sources to integrated light wave circuits and optical fibers. Moreover, photonics plays an increasing role in biology and medicine, for instance in connection with food control or medical therapy, measurement methods for efficiency improvement of wind farms, and technologies capable of measuring the efficiency of combustion processes or carbon dioxide levels in the atmosphere.

This master program aims at giving an extensive two-year teaching program from fundamentals to advanced research topics in Photonics and its interdisciplinary applications. Master students benefiting from this program will be able to work on today's new challenges in their academic or applied research carriers: understanding and control matter and optical phenomena at the ultimate nanometric scale, providing new imaging tools for the most complex biological processes from cells and tissues to clinical applications, bringing original tools in line with future optical devices.

It is worth-mentioning that in our country the number of postgraduate programmes on modern optics is a few, and in Chhattisgarh state, none of institutes and universities has M.Tech programme in Optoelectronics and Laser Technology. It is one of the programme in the country where Organic Electronics course was introduced after IIT, Kanpur This M.Tech. program is approved and supported by University Grants commission, New Delhi under its innovative Programme for Teaching and Research in Interdisciplinary and Emerging Areas and All India Council for Technical Education.

The interdisciplinary M. Tech Programme in Opto-Electronics and Laser Technology at PRSU, Raipur is offered jointly by S.O.S. in Electronics & Photonics and S.o.S. in Physics & Astro Physics, which has been running since 2008.. The main objective of the Programme is to generate trained professionals in the broad area of Opto-Electronics, Optical Communication and laser Technology with a strong background of engineering and science. Students who graduated in earlier batches are immensely contributing to growth of various industries and R&D organizations involved in the area of telecommunication, optical communication & networks, semiconductor technology, fiber integrated optics, Opto-Electronics, software etc.

Pt. Ravishankar Shukla University is one of the few Universities/ Institutions in India that have facilities for R & D activities and man Power training in Photonics and related areas. The department have collaboration with premier R & D institutes of national importance and students have an opportunity for one year project at BARC, Mumbai, RRCAT- Indore, CSIO-Chandigarh, CEERI –Pilani, IIT Mumbai, ISRO, RRI -Bangalore, PRL- Ahmadabad, IICT Hyderabad, , Raman Research Institute, Bangalore NPL New Delhi and other research centers of National & International reputation. They are getting placement in multinational companies, Industries, Academics and other private and Govt. Organizations.

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M. Tech in Optoelectronics and Laser Technology

1. Course Aim : The aim of the course is to train postgraduates with advanced knowledge and understanding of optoelectronics with higher order critical, analytical, problem solving and research skills; ability to think rigorously and independently, to meet higher level expectations of academia and research with sufficient transferrable skills.

2. Course Objectives : The course objectives of M.Tech. in Optoelectronics & laser Technology are to:

1. Impart higher level knowledge and understanding of optoelectronics & laser technology
2. Apply the principles of optoelectronics for newer applications
3. Enable students to analyse mathematical models of physical systems for enhancement of system performance and arrive at limitations of physical systems
4. Enhance students' ability to develop mathematical models of defined physical systems
5. Prepare students to evaluate the soundness of concepts proposed
6. Hone students' skills to pursue physics as a teaching and research career
7. Train students in team work and in lifelong learning for continuous professional development

	COURSE DESCRIPTION	
	Course Objectives:	▪ understanding basic laws and phenomena in the area of Optoelectronics and Lasers ▪ theoretical and practical preparation of students to acquire and apply knowledge and skills in Optoelectronics and Lasers ▪ Conducting experiments in laboratory and industrial environment.
	Learning outcomes: On successful completion of this course, student should be able to	1. explain fundamental physical and technical base of Optoelectronic systems, 2. describe basic laws and phenomena that define behaviour of optoelectronic systems, 3. analyse various premises, approaches procedures and results related to optoelectronic systems, 4. use optical fibre equipment, and data transfer using optical fiber. 5. conduct experiments and measurements in laboratory and on real components, devices and equipment of optoelectronic systems, 6. interpret the acquired data and measured

		results, 7. describe development and application of optoelectronic systems 8. take part in team work and be able to independently present various professional materials. 9. Understand fundamental properties of light and operation principles of basic optical components. 10. Demonstrate a mastery of basic mechanisms of light generation (including lasers) through detailed understanding and analysis of operation principles, characteristics, design architectures and trade-offs of semiconductor lasers. 11. Understand and compare operation principles, characteristics, design architectures and trade-offs of optical detectors and modulators of light. 12. Understand basic system design of fiber optic communication link and fundamental theory of fiber optics. 13. Hands-on testing, measurement and development of optical systems in a range of areas spanning the course

3. Program outcomes for M.Tech program suggested by NBA

PO1. Engineering knowledge: Apply the knowledge of mathematics, science,engineering fundamentals, and an engineering specialization to thesolution of complex engineering problems.

PO2. Problem analysis: Identify, formulate, research literature, and analyzecomplex Engineering problems reaching substantiated conclusions usingfirst principles of mathematics, natural sciences, and engineering sciences.

PO3. Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4. Conduct investigations of complex problems: Use research-basedknowledge and Research methods including design of experiments,analysis and interpretation of data, and Synthesis of the information toprovide valid conclusions.

PO5. Modern tool usage: Create, select, and apply appropriate techniques,resources, and

Modern engineering and IT tools including prediction andmodeling to complex engineering activities with an understanding of thelimitations.

PO6. The engineer and society: Apply reasoning informed by the contextualknowledge to Assess societal, health, safety, legal and cultural issues andthe consequent responsibilities relevant to the professional engineeringpractice.

PO7. Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8. Ethics: Apply ethical principles and commit to professional ethics andresponsibilities and norms of the engineering practice.

PO9. Individual and team work: Function effectively as an individual, and as amember or leader in diverse teams, and in multidisciplinary settings.

PO10. Communication: Communicate effectively on complex engineeringactivities with the engineering community and with the society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11. Project management and finance: Demonstrate knowledgeunderstanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manageprojects and in multidisciplinary environments.

PO12. Life-long learning: Recognize the need for, and have the preparation andability to engage in independent and life-long learning in the broadestcontext of technological change.

4. Intended Learning Outcomes of the Course

The intended learning outcomes are listed under four headings:

1. Knowledge and Understanding,
2. Cognitive Skills
3. Practical Skills and
4. Capability/ Transferable Skills.

1 **Knowledge and Understanding** After undergoing this course, a student will be able to:

KU1: Describe the functioning of lasers and optoelectronic devices

KU2: Explain working of a fiber optic communication system

KU3: Acquire a knowledge of optical networks

KU4: Select appropriate tools of nano-optics for desired applications

2 **Cognitive Skills** After undergoing this course, a student will be able to:

CS1: Explore new materials for optoelectronic applications

CS2: Design and simulate fiber optic communication systems

CS3: Design and characterize optical networks

CS4: Apply the techniques for optical engineering to fabricate novel devices

3 **Practical Skills** After undergoing this course, a student will be able to:
PS1: Perform measurements related to lasers and fiber optic communication system
PS2: Conduct experiments with a variety of scientific equipment with minimum guidance
PS3: Design PC based instrumentation
PS4: Use Scilab/MATLAB /MOEMS Software
4 **Capability /Transferable Skills** After undergoing the course, a student will be able to
TS1: Communicate and present ideas clearly and concisely
TS2: Perform under constraints to meet the desired objectives
TS3: Build, work and lead teams effectively
TS4: Adopt a reflective approach to personal development and embrace the philosophy of continual professional development

PT. RAVISHANKAR SHUKLA UNIVERSITY, RAIPUR (C.G.)

SYLLABUS

M. Tech. in Optoelectronics and Laser Technology

SEMESTER – I

JULY – DECEMBER, 2020

Course Code	Subject	Core/Elective	Marks			Credits
			Theory	Internal	Total	
OE-11	Modern Optics	C	80	20	100	4
OE-12	Laser Technology	C	80	20	100	4
OE-13	Optoelectronics	C	80	20	100	4
OE-14	Optical Communication	C	80	20	100	4
OE-15	Seminar	C	-	-	50	1
OE-16	Comprehensive Viva voce	C	-	-	Grade	
OE-17	Photonics Lab-I	C	External	Internal	150	3
			120	30		
OE-18	Quantum Optics	E	80	20	100	3
Total for Semester-I					700	23

M. Tech in Optoelectronics and Laser Technology

SEMESTER – II

JANUARY - JUNE, 2021

Course Code	Subject	Core/ Elective	Marks			Credits
			Theory	Interna l	Total	
OE-21	Physics of Advanced Materials	C	80	20	100	4
OE-22	Fiber Optics & Laser Instrumentation and Solar Photovoltaic Technologies	C	80	20	100	4
OE-23	Optical Networks	C	80	20	100	4
OE-24	Advance Optical Communication	C	80	20	100	4
OE-25	Seminar		-	-	50	1
OE-26	Comprehensive Viva Voce		-	-	Grade	
OE-27	Photonics Lab-II	C	External	Internal	150	3
			120	30		
OE 28	Theory-V	E	80	20	100	3
Total for Semester-II					**700**	**23**

Semester III
JULY – DECEMBER, 2021

Course Code	Subject	Core/Elective	Marks	Credits
OE-32	**Major Project Phase -I**	**C**	**400**	**18**

Semester IV

JANUARY - JUNE, 2022

Course Code	Subject	Marks	Credits
OE-41	**Major Project Phase -II**	400	18
OE-42	Comprehensive Viva- Voce	GRADE	
TOTAL CREDITS ALL SEMESTERS		**2200**	**82**

M. Tech in Optoelectronics and Laser Technology

PT. RAVISHANKAR SHUKLA UNIVERSITY, RAIPUR (C.G.)
SYLLABUS

SEMESTER – I
July-Dec. 2020

Course Code: OE-11
Course Title: MODERN OPTICS
Credits: 4

OE-11-MODERN OPTICS

Course Objectives :

1. To learn the basic phenomena in Optics.
2. To help the student to develop a thorough understanding of the underlying physical principles of various modern optical phenomena and their applications.

OBJECTIVE:

Course Outcomes :

On successful completion of this course, students should be able to:

1. explain the propagation of light in conducting and non-conducting media (understand level)
2. understand reflection/transmission behaviour of light interacting with a dielectric interface (under (understand level)
3. analyze the polarization state of a beam of light (analyze level)
4. use the principles of wave motion and superposition to explain the physics of polarization, dispersion, interference and diffraction. (apply level)
5. describe the operation of optical devices, including, polarisers, retarders, modulators, inteferometers, difraction gratings. (understand level)
6. have an understanding of light coherence, the coherent properties of light from various sources, and the measurement of degrees of coherence (understand level)
7. use Fourier transform theory to predict and interpret imaging under various Fourier transform filtering conditions.(apply level)

Unit I

Classification of optical processes, optical coefficients, complex refractive index and dielectric constant.

Optical materials : Crystalline insulators and semiconductor, glasses, metal, molecular materials, doped glass and insulator characteristics, Optical Physics in the Solid state, crystal symmetry, electronics bands, vibronic band, the density of state, delocalized states and collective excitation

Light propagation: Propagation of light in dense optical medium, Atomic oscillator, vibration oscillator, free electron oscillation, the Kramers – Kronig relationship, Dispersion, Optical anisotropy, birefringence. Matrix representation of polarization, Jones vector, Jones matrices, Jones calculus, orthogonal polarization. Reflection and refraction at a plane boundary, fresnel's equations.

Unit II

Excitons : Basic concept, free excitons in external electric and magnetic fields, Free Excitons at light densities, Frenkel excitons.

Luminescence: Light emission in solids, Interband luminescence, Direct and indirect gap materials, photoluminescence : Excitation and relaxation, degeneracy Photoluminescence spectroscopy.

Electroluminescence: General Principles of electroluminescence, light emitting diodes, diode laser.

Unit III

Electromagnetism in dielectrics, Electromagnetism fields and Maxwell equation.

Electromagnetism waves, Quantum theory of radiative absorption and emission. Einstein coefficients, Quantum transition rates, selection rules. Basic concept of phonons, Polaritons and polarons.

Laser Plasma Interaction: Basic concepts and two-fluid description of plasmas, electromagnetic wave propagation in plasmas.

Unit IV

Nonlinear optics : Non linear optics : Physical origin of optical nonlinearities, Non resonant and resonant nonlinearities, second order nonlinearities, Non liner frequency mixing, Crystal symmetry, Phase matching, Third order non linear media. Harmonic generation, mixing and parametric effects. multiphonon processes Two-photon absorption, saturated absorption, Spectroscopy Rayleigh, and Raman scattering. Stimulated Raman effect, Hyper Raman effect, Coherent Antistoke Raman scattering Self-focusing and self-phase modulation. Self-induced transparency. Solitons.

Unit V

Optical Design, Fourier Optics & Holography : Revision of geometrical optics. Fourier transforms. impulse response transfer function. Scalar diffraction, spatial and temporal coherence.

Holography: Image forming systems, The wavefront reconstruction process: Inline hologram, the off axis hologram, Fourier hologram, the lens less Fourier hologram. The reconstructed image: Image of a point, image magnification, orthoscopic and pseudoscopic images, effect of source size and spectral bandwidth. Thin hologram, volume hologram, volume transmission hologram and volume refraction holograms. Materials for recording holograms, holograms for displays, colour holography, holographic optical elements. Holographic interferometry: Real time holographic interferometry, double exposure holographic interferometry image hologram, Image forming systems, coherent and incoherent imaging. Spatial filtering. Holography (Fresnel, Fraunhofer, Fourier). Holographic techniques and applications. Fourier transforming property of thin lens.

REFERENCE BOOKS

1. Optical Electronics, A. Yariv Saunders
2. Optical Electronics, Ghatak & Thyagarajan, Cambridge U.K. 3.Essentials of Optoelectronics, A. Rogers (Chapman Hall) 4.Optical Properties of Solids Mark Fox
3. Jasprit Singh, Semi conductor Optoelectronics, McGraw Hill, 1995
4. P. Hariharan, Optical holography, (Cambridge University Press, 1984)

M. Tech in Optoelectronics and Laser Technology

Course Code: OE-12
Course Title: LASER TECHNOLOGY
Credits: 4

OE-12 -LASER TECHNOLOGY

Course Ojectives:

1. To study the principle, construction and working of different lasers.
2. To provide a deeper knowledge about the theory, working and applications of lasers.

Course Outcomes :

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

1. describe Einstein's treatment of absorption and emission of radiation (understand level)
2. describe the conditions required for laser action(understand level)
3. describe laser media with rate equations and solve them(evaluate level)
4. predict the stability of laser cavity (apply level)
5. identify the behavior and functionality of different lasers(analyze level)
6. identify a laser for a particular application(analyze level)
7. review the safety requirements of lasers(understand level)

Unit I

Einstein Coefficients and Light Amplification

Introduction: The Einstein's coefficients, Quantum Theory for the Evaluation of the Transition Rates and Einstein Coefficients, Interaction with radiation having a broad spectrum, Introduction of a near monochromatic wave with an atom having a broad frequency response, More accurate solution for the two level system, Line broadening mechanisms, Saturation Behavior of homogeneously and homogeneously broadening transitions.

Unit II

Laser Rate Equations : Introduction, The three Level System, The Four level System, Variation of Laser Power around Threshold, Optimum Output coupling. Laser spiking.

Semi classical Theory of Laser: Introduction, Cavity Modes, Polarization of cavity medium : First order & Higher order theory.

Unit III

Optical Resonators: Introduction, modes of a rectangular cavity and the open planar resonator, The Quality factor, the ultimate line width of the laser, Transverse and longitudinal mode selection switching. Mode locking in Lasers Co focal Resonator system, Planar resonators, General Spherical Resonator.

Optical Pumping: Laser pumping requirement and techniques, Optical Pumping and Electrical discharge pumping. Introduction of Flash Lamp, Optically and diode pumped solid state lasers.

Unit IV

Properties of Laser Beams and laser Structures

Coherence properties of Laser Light : Temporal Coherence, Spatial Coherence, Directionality

Semiconductor: Interaction of photons with electrons and holes in semiconductors. Optical joint density of states, Structure and properties, operating principle, Threshold condition, Power output.

Heterojunction Laser: Principle and structure, Losses in heterostructure laser, Heterostructure laser materials.

Distributed feedback lasers: Principle of working, Coupled mode theory.

Quantum well laser, Gain in quantum well lasers, Multiquantum well lasers, Strained quantum well laser, Vertical cavity surface emitting lasers.

Free Electron Lasers: Basic Concepts.

Unit V

Types and Some important applications of laser:

Properties of solid state laser materials, Ruby, Nd:YAG lasers, Er:lasers, Ti: Saphire laser, Excimer lasers. Gas dynamic CO_2 lasers, High Power Laser. Laser induced fusion: Introduction, The fusion process, laser energy requirements. The laser induced Fusion Reactors.

Lasers in Science: Harmonic Generation, Stimulated Raman Emission, Self-focusing, Lasers in Chemistry, Rotation of the Earth, Lasers in isotope Separation. Laser in light detection and ranging (LIDAR)

TEXT BOOKS

1. Lasers Theory and Applications : K. Thyagrajan and A.K. Ghatak, Macmillan Publication
2. Laser Fundmentals - Willaim T Selfvast, Cambridge Univ-Press, 2nd edn (2008). (Text)
3. Optical Electronics, Ghatak & Thyagarajan, Cambridge U.P. 0-521-31408-9
4. Laser Physics, P W Milonni and J H Eberly, John Wiley and Sons, 2010
5. Lasers - Anthony E Siegman, University Science Books, USA, 1986
6. Essentials of Optoelectronic, A Rogers (Chapman Hall), 0-412-40890-2

REFERENCE BOOKS

1. Fowles G.R., Introduction to Modem Optics, 2nd Edition, Holt, Rienhart and Winston
2. Lasers and nonlinear optics, BB Laud, Wiley Eastern, 3rd edition (2004)
3. Optical Electronics – A Yariv (4th Ed. Saunders College Pub. (1991).

4. Principles of lasers - Svelto and DC Hanna, 4th edn, Plenum Press (1998)
5. Solid State Laser Engineering - Koechonar (Springer Verlag. 1991
6. Lasers, principles, types and applications-K R Nambiar, New Age International, Delhi (2004)
7. Free Electron Lasers by T.C. Marshall

Course Code: OE-13
Course Title: OPTOELECTRONICS
Credits: 4

OE-13- OPTOELECTRONICS

COURSE OBJECTIVE::

1. To give a deeper understanding of the fundamental theories, fabrication, integration, characterization and applications of novel optoelectronic devices.
2. To introduce the theory, working and applications of various optoelectronic devices.

Course Outcomes :On successful completion of the course the students will be able to
1.recall the properties of Photons and Electrons and recognise their applications in optoelectronic devices. (Remember level)
2.classify LED and laser diode structures and their applications (Understand level)
3.differentiate the types of optical modulators and their applications (Analyze level)
4.categorise different luminescence mechanisms involved in the modern display devices (Analyze level)
5.compare the modes of operations and characteristics of different optoelectronic detectors. (Evaluate level)

Unit I

Optical process in Semiconductors

Electron hole pair formation and recombination, absorption in semiconductor, effect of electric field on Absorption, Franz-keldysh and stark effects, Absorption in Quantum wells and Quantum confined stark effect, relation between Absorption and emission spectra, Stokes shift in optical transition, Deep level transitions, Measurement of absorption and luminescence Spectra, Time resolved Photoluminescence.

Unit II

Materials Growth & Fabrication Growth of optoelectronics materials by MBE, MOCVD, Plasma CVD, photochemical deposition. Epitaxy, interfaces and junctions (advantages/disadvantages of growth methods on interface quality, interdiffusion and doping. Quantum wells and band gap engineering

Equipments for Thin Film Deposition: Working principle of Vacuum Coating Unit , Spin Coating Unit, Dip coating unit, Basics of Ellipsometer and Spray pyrolysis apparatus and their specifications and features.

Unit III

Organic Electronics

Molecular materials, Electronic state in conjugated molecules, Optical spectra of molecules, Electronic vibration transitions, the Franck Condon principle hydrocarbons, conjugated polymer, Conductivity and Mobility of nearly-fee Charge Carriers, Charge Carriers in Organic Semiconductors: Polarons, Shallow Traps and Deep Traps, Generation of Charge Carriers and Charge Transport: Experimental Methods. The TOF Method: Gaussian Transport. Space-Charge Limited Currents. Band or Hopping Conductivity, Electric-field Dependence, Charge Transport in Disordered Organic Semiconductors. The Bassler Model

Unit IV

Organic Optoelectronic Devices:

Organic Light-Emitting Diodes (OLEDs). The Principle of the OLED, Multilayer OLEDs. Structure, Fundamental processes Efficiency, Characterization of OLEDs

Organic photovoltaic diodes (OPVDs): Fundamental process, Exciton absorption, Exciton dissociation, Charge collection characterization of OPVDs, Relevant performance parameters.

Unit V

Introduction to Semiconductor Device Simulation: Need of Simulation, Process Simulation, Device Simulation device simulation sequence, hierarchy of transport models, DD Model, Relationship between various transport regimes and significant length-scales.

Numerical Solution Methods - finite difference scheme, discretization of Poisson's and current continuity equations.

TEXT BOOKS

1. Organic Molecular Solids Markus Schwoerer (Author), Hans Christoph Wolf, Wiley-VCH; 1 edition (March 27, 2007)
2. Semiconductor Devices Modeling and Technology" by Nandita Das Gupta and Amitava Das Gupta, Prentice Hall of India Pvt.Ltd.
3. Fibre Optics and Opto-electronics, R P Khare (Oxford University Press, 2004)
4. Computational Electronics :Dragica Vasileska and Stephen M. Goodnick, CRC Press
5. Semiconductor Optoelectronics Devices: Pallabh Bhattacharya. Pearson Education
6. Optical Electronics, A. Yariv Saunders.
7. Optical Electronics, Ghatak & Thyagarajan, Cambridge U.P. 0-521-31408-9
8. Essentials of Electronic & Optoelectronics properties of semiconductor, Jasprit Singh, Cambridge University Press

REFERENCE BOOKS

1. Organic Electronics: Materials, Manufacturing, and Applications Hagen Klauk Wiley-VCH; 1 edition
2. Hand book of thin film technology, by L. I. Maissel and R. Glang
3. Thin film phenomena, By K. L. Chopra

4. Opto electronics -An introduction - J Wilson and J F B J iS Hawkers.(Prentice-Hall India, 1996)
5. Optical fibre communication - J M Senior (Prentice Hall India (1994)
6. Optical fibre communication systems - J Gowar (Prentice Hall 1995)
7. Introduction to optical electronics - J Palais (Prentice Hall, 1988)
8. Semiconductor opto electronics - J asprit Singh (McGraW-Hill, Inc, 1995)
9. Opto electronics-Thyagaraj an and Ghatak, Cambridge Uni, Press (1997)

Course Code: OE-14
Course Title: OPTICAL COMMUNICATION
Credits: 4

OE-14- OPTICAL COMMUNICATION

Course Objectives :

1. To enable the students to understand the principles and design considerations of different optical communication systems.
2. To provide basic understanding and knowledge about various types of optical fiber communication systems.
3. To equip students with understanding of Optical fiber communication systems, their analysis and design. Issues in advanced DWDM system, Impairments in optical system, etc.

Course Outcomes: On successful completion of this course students should be able to

1. describe the properties and advantages of optical guided communication (knowledge level)
2. identify the various components of optical fiber communication system (understand level)
3. describe the operation of optical receivers including the types of preamplifiers (understand level)
4. classify various multiplexing schemes and operation principles of wavelength division multiplexing (understand level)
5. distinguish semiconductor optical amplifier and erbium doped fiber amplifier and calculate its gain and power conversion efficiency (understand level)
6. describe various optical network topologies and its performance (understand level)
7. design and prepare optical power loss/gain budget with various line coding(application level)

Unit I

Need for fiber optic Communication, evolution of light wave systems and its components. Optical Fiber – their classification, essentials of electromagnetic theory – total internal reflection, Goos Hanchen shifts Dispersion in Single mode fiber, fiber losses, Non liner optical effects and polarization effect. Analysis of Optical fiber waveguides, electromagnetic mode. Theory for optical propagation attenuation and single distortion in optical waveguide. Characteristic equation of step-index fiber, modes and their cut-off frequencies, single-mode fibers, weakly guiding fibers, linearly polarized modes, power distribution. Graded-index fibers- WKB and other analysis, propagation constant, leaky modes, power profiles, dispersions – material, modal & waveguide, impulse response.

Unit II

Physics and Technology of Optical Fiber

Passive photonic components: FO cables, Splices, Connectors, Couplers, Optical filter, Isolator, Circulator and Attenuator, switches.

Fabrication of optical fibers: MOCVD, OVD, VAD, PCVD; measurement of RI, attenuation. Etc. Fiber devices, fiber Bragg gratings, long period gratings, fiber amplifiers and lasers. Application of optical fibers in science, industry, medicine and defense.

Unit III

Optical fiber systems, modulation schemes, Digital and analog fiber communication system, system design consideration, fiber choice, wavelength conversion, switching and cross connect Semiconductor Optical amplifier (SOA), characteristics, advantages and drawback of SOA, Raman amplifier, erbium doped fiber amplifier, gain and noise in EDFA, Brillion fiber amplifier, wideband Hybrid amplifier, noise characteristic, amplifier spontaneous emission, noise amplifier, noise figure, Cumulative and effective noise figure, Noise impairments, amplifier applications.

Unit IV

Optical Transmitters and Receivers : Basic concepts, Light emitting diodes, Semiconductor laser, characteristics, Transmitter design, Optical Receivers; Basic concepts, P-n and pin photo detector. Avalanche photo detector MSM photo detector, Receiver design, Receiver noise, Receiver sensitivity, Sensitivity degradation, performance.

Electro-optic effect, electro optic retardation. Phase and amplitude modulators, transverse electro optic modulators, Acousto-optic effect, Raman-Nath and Bragg regime, acousto-optic modulators, magneto optic effects.

Unit V

Optical Multiplexing Techniques

Wavelength division multiplexing (WDM): Multiplexing Technique, Topologies and architectures, Wavelength shifting and reverse, Switching WDM demultiplexer, optical Add/drop multiplexer. Dense wavelength division multiplexing (DWDM): System consideration, Multiplexer and demultiplexers, fiber amplifier for DWDM, SONET/SDH Transmission, Modulation formats, NRZ and RZ signaling, DPSK system modeling and impairments.

REFERENCES

1 Optical Fibre Communication - G Keiser, McGraw Hill(4th Ed), 2006

2 OpticalFibre Communications - JM Senior(Prentice Hall India 1994)

3 Fibre Optic Communication - CAgarwa1(Wheeler, 1993)

4 OpticalFibre Communication Systems- J Gowar(Prentice Hall, 1995).

5. Fibre Optic Communication -J Palais (Prentice Hall International 1988).

6 Optical networks: A practical perspective Kumar N Sivarajan and Rajeev Ramaswami, MarcourtAsia, 2010

Course Code: OE-15
Course Title: SEMINAR
Credits: 1

Course Objectives: Expertise in understanding research topics in photonics and improving skills such as imparting knowledge and presentation.The seminar should be on a topic of current research. Students have to submit a detailed report and they have to make a presentation of 45 minutes-duration before the seminar committee.

Course outcomes :

1. Presentation Skills

1. In terms of content, students will be able to show competence in identifying relevant information, defining and explaining topics under discussion.
2. They will demonstrate depth of understanding, use primary and secondary sources; they will demonstrate complexity, insight, cogency, independent thought, relevance, and persuasiveness.
3. They will be able to make use of visual, audio and audio-visual material to support their presentation, and will be able to speak cogently with or without notes. Students will present either in groups or as individuals.

2. **Discussion Skills**

Students will be able to judge when to speak and how much to say, speak clearly and audibly in a manner appropriate to the subject, ask appropriate questions, use evidence to support claims, respond to a range of questions, take part in meaningful discussion to reach a shared understanding, speak with or without notes, show depth of understanding, demonstrate breadth of reading, use primary and secondary sources, show independence and flexibility of thought, help discussions to move forward, show intellectual leadership and effective time management.

3. Listening Skills

1. Students will demonstrate that they have paid close attention to what others say and can respond constructively.
2. Through listening attentively, they will be able to build on discussion fruitfully, supporting and connecting with other discussants.

4. **Argumentative Skills and Critical Thinking**

1. Students will develop persuasive speech, present information in a compelling, well-structured, and logical sequence, respond respectfully to opposing ideas, show depth of knowledge of complex subjects, and develop their ability to synthesize, evaluate and reflect on information.
2. Students will be able to demonstrate use of appropriate methodologies, test the strength

of their thesis statement, show insight into a topic, appropriate signposting, and clarity of purpose.

3. They will also demonstrate problem-solving skills and apply theoretical knowledge.

5. Questioning

Through asking appropriate questions, students will demonstrate their understanding of discussions and spark further discussion.

Course Code: OE -16

Course Title: Comprehensive Viva voce

Credits: GRADE

Comprehensive Viva-Voce

A comprehensive viva -voce will be held immediately after the end of Semester. The Comprehensive Viva- Voce is intended to assess the student's understanding of various subjects he has studied during the M.Tech. course of study. The Viva-Voce would be conducted by a Board of Examiners consisting of the Head, Course Coordinator and all concerned Faculty Members of the both Electronics and Physics department. The Comprehensive Viva- Voce is evaluated on the basis of Grade. A candidate has to secure a minimum Grade to be declared successful. If he fails to obtain the minimum Grade, he has to reappear for the viva-voce during the next examination. The Grades are as follows.

Course Objetive: The objective of comprehensive viva-voce is to assess the overall knowledge of the student in the relevant field of Engineering acquired over 4 years of study in the undergraduate program .

Course outcomes: Viva will be conducted at the end of 1st,2nd and 4th semester which will be covering the complete syllabus. This will test the student's learning and understanding during the course of their M.Tech programme. In doing so, the main objective of this course is to prepare the students to face interview both in the academic and the industrial sector.

RANGE	QUALITATIVE_ASSESSMENT/GRADE
91% - 100%	O Outstanding
81% - 90%	A Very Good
71% - 80%	B Good
61% - 70%	C Fair
50% - 60%	D Pass

Below 50%	F	Failure

OE-17- Photonics Lab- I

AIM: Laboratory experience.

OBJECTIVE: To empower the students with hands-on experience and to provide practical knowledge about Optoelectronic sources, detectors, devices, optical fibers and Laser.

Course Outcomes: Students will have achieved the ability to:

1. Understand the behaviour of electronic and photonics components and perform analysis and design of bias circuits for diodes, transistors etc.
2. Set up testing strategies and select proper instruments to evaluate performance characteristics of photonic circuit.
3. Choosing testing and experimental procedures on different types of photonic circuit and analyse their operation different operating conditions.
4. To apply the most commonly used simulation tools in photonics applications.
5. To use laboratory test equipment useful in photonics applications.
6. To design and develop full opto-electronic systems by using the photonics-related components and technologies studied along the master.
7. To design and develop the required test and measurements procedures to evaluate the working operation of an optoelectronic system.
8. To apply the knowledge within the photonic engineering field in a real-life environment both at component and at system level.
9. To work effectively in a multidisciplinary group in the photonic field with the ability to react to technical and operative difficulties in a technological project.

Experiments are to be performed in the Advance Photonics Laboratory of S. O.S. in Electronics & Photonics

L 1 Fiber Optics Lab:

1. Study of setting up a Optic Analog Link.
2. Study of setting up a fiber Optic Digital Link.
3. Study of Losses in Optical Fiber.
4. Measurement of Numerical aperture of a optical fiber.
5. Study of Manchester Coding & Decoding of optical Signal.
6. Study of Time Division Demultiplexing through fiber optic link – B.
7. Measurement of Bit Error Rate of an optical signal through fiber optic link – B.
8. Study of Eye Pattern of fiber through fiber optic ling – B.
9. Forming PC to PC Communication Link-using Optical Fiber & RS – 232 Interface.

L 2 – Laser Lab:

1. Study of Diode Laser characteristic.
2. Construction of laser beam expander.

3. Measurement of screw parameter.
4. Measurement of electro-optic coefficient.
5. Magneto-optic effect (Faraday Rotation)
6. High voltage sensor based on electro-optic effect.
7. Molecular Weight Measurement.
8. Holography.

The students are required to perform 5 programs using MATLAB platform

Course Code: OE-18
Course Title: Quantum Optics
Credits: 4

OE 18 Quantum Optics

Course Objectives :

1. To provide knowledge on the evolution of Quantum optics and its impact in technological applications.
2. To introduce the basic concepts and theory of Quantum Optics.

Course Outcomes

After taking this course, the student will be able to :

1. Discuss the basic theory of nonlinear optics including sum and difference frequency generation (understand level)
2. Analyze the origin of optical bistability and its implications (analyze level)
3. Examine different mathematical transforms used in optical signal processing and compute the transforms of given functions (Analyze level)
4. Construct spatial filtering geometries based on the Fourier transform property of lens (Apply level)
5. Analyze the role of various light modulators in signal processing (Analyze level)
6. Describe the basic concepts of optical computing and optical neural networks and their practical implementation (Understand level)

Unit-I

Introduction: What is quantum optics, A brief history of quantum optics

Classical optics Maxwell's equations and electromagnetic waves ,Electromagnetic fields ,Maxwell's equations ,Electromagnetic waves , Polarization , Diffraction and interference

Unit-II

Formalism of quantum mechanics , The Schr¨ odinger equation,Properties of wave functions m, Measurements and expectation values, the uncertainty principle, The Stern–Gerlach experiment ,The band theory of solids

Unit III

Radiative transitions in atoms, Einstein coefficients, Radiative transition rates , Selection rules

Photon statistics : Introduction, Photon-counting statistics, Coherent light, Classification of light by photon statistics.

Coherent states and squeezed light , Light waves as classical harmonic oscillators , Light as a quantum harmonic oscillator , Coherent states , Squeezed states , Detection of squeezed light .

Unit IV

Quantum information processing, Quantum cryptography, Classical cryptography , Basic principles of quantum cryptography Quantum key distribution according to the BB84 protocol , System errors and identity verification , Error correction , Identity verification , Practical demonstrations of quantum cryptography ,Quantum cryptography in optical fibres .

Unit V

Quantum computing

Introduction , Quantum bits (qubits) ,The concept of qubit, Quantum logic gates and circuits , Preliminary concepts Single-qubit gates , Two-qubit gates , Practical implementations of qubit operations optical realization of some quantum gates.

Reference Books:

1. Quantum Optics by M. Fox, Oxford Master series in Atomic, Optical and Laser physics
2. Introductory Quantum Optics by C.C. Gerry and P.L. Knight, Cambridge University Press
3. Quantum Optics by M.O. Scully and M.S. Zubairy, Cambridge University Press
4. Quantum Theory of Light by R. Loudon, Oxford science publication

PT. RAVISHANKAR SHUKLA UNIVERSITY, RAIPUR (C.G.)

SYLLABUS
M. Tech in Optoelectronics and Laser Technology

SEMESTER – 2
JANUARY – JUNE, 2021

Course Code: OE-21
Course Title: PHYSICS OF ADVANCED MATERIALS
Credits: 4

Course objectives

1. Use the fundamental science and engineering principles relevant to materials that include the relationships between nano/microstructure, characterization, properties, processing, performance and design of materials.
2. Use their knowledge of the significance of research, the value of continued learning and environmental/social issues surrounding materials.
3. Use the technical and communication skills developed in the program as a foundation for careers in engineering, research and development, the pursuit of advanced education and other professional careers.

Course outcomes

1. an ability to identify, formulate, and solve complex engineering problems by applying principles of engineering, science, and mathematics
2. an ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factors
3. an ability to acquire and apply new knowledge as needed, using appropriate learning strategies

OE-21- PHYSICS OF ADVANCED MATERIALS

UNIT I

Nano Particles and Nano Structured Materials:

Properties of Individual Nano-Particle: metal nanoparticles, geometric and electronic structure, magnetic clusters, Semiconductor nanoparticles, optical properties, rare gas and molecular clusters, methods of synthesis of nanoparticles. Carbon nanostructure, C60 carbon nanotube and application.

Bulk nano structured materials: Solid disordered nanostructures, methods of synthesis, properties, metal nano-cluster composite glasses, porous silicon; Nano structured crystals.

UNIT II

Quantum Nanostructures and Nano-Machines/Devices:

Quantum wells, wires and dots, preparation, size & dimensionality effects, excitons, single electron tunneling, applications of quantum nanostructure. Super conductivity. Self-assembly, process of self-assemby, semiconductor islands, monolayers. Catalysis, surface area of nanoparticles, porous, and colloidal materials.

Nanomachines and Devices: Microelectromechanical system (MEMSs), Nanoelectromechanical system (NEMSs), Photonic nano & micro circuits, nano and micro fluidics. Application of NEMS and MEMS in Rf, Microfluilds, Optics, BioScience, and Precious Manufacturing.

UNIT- III

Solid state lasers: Material requirement for solid state lasers, Activator ions and centers, Material design parameters for semiconductor laser diode, choosing alloy composition and thickness, making ohmic contracts, Other III-V heterojunction laser materials. Introduction to organic laser. Material selection for light emitting diodes.

Electrical, Optical and Thermal properties of III-V and II-VI semiconductors required for optoelectronics devices for visible and IR range.

Electroluminescent materials: Inorganic electroluminescence, AC powder EL, ACTFEL device, EL characteristics, EL excitation mechanism. Electroluminescence in Organic solids, Material useful for organic thin film EL devices, polymeric material for EL. LED Technologies for Light Emission and Displays. QLED.

UNIT IV

Characterization of Materials: Introduction to emission and absorption spectroscopy: Nature of electromagnetic radiation, electromagnetic spectrum, atomic, molecular, vibrational and X-ray energy levels Basics of UV-VIS spectroscopy: Radiation sources, wavelength selection, Cells and sampling devices, Detectors, Basic ideal of IR spectrometry: Correlation of Infrared spectra with Molecular Structure.

Fundamental of X-ray diffraction, Powder diffraction method, Quantitative determination of phases; Structure analysis. EDAX, Lithography (top down and bottom up), Contact preparation of thin films for device fabrication.

Epitaxial thin film techniques : Liquid phase epitaxy, vapour phase epitaxy, Metal Organic chemical vapour deposition, Atomic layer epitaxy.

UNIT V

Experimental Techniques: High resolution X ray diffraction, Double Crystal diffraction, Drift mobility and Hall mobility, Hall effect for Carrier density and Hall mobility, Photoluminescence (PL) and Excitation Photoluminescence (PLE) Optical pump probe experiments.

Basic idea of Microscopic Techniques: Optical microscope, Scanning Electron Microscope (SEM), Transmission Electron microscope (TEM), Atomic Force Microscopy (AFM), Scanning Tunneling Microscopy (STM), Thickness measurement – Gravimetric method, Basics of Ellipsometry: Optical parameter measurements (n and k).

TEXTS BOOKS

1. Nanotechnology by Charles P. Poole Jr. and Frank J. Owens (Willey Inter. Science pub 2003).
2. Nanostructures and Nanomaterials – Synthesis properties and Applications by Guozhong Cao (Empirical College Press World Scientific Pub. 2004).
3. Physics of Semiconductor Devices by S. M. Sze(Willey Int., 1981)
4. Instrumental methods of analysis, H. H. Willard, L. L. Merritt, J A Dean, F A Sellte, CBs Publishers New Delhi 1996.

REFERENCE BOOKS

1. Scanning Electron Microscopy : OOtley
2. Handbook of Electroluminescent Materials Ed. D. R. Vij Inst of Physics, Bristol and Philadelphia
3. Electronic and Optoelectronic properties of Semiconductor, Jaspreet Singh, Cambridge University Press
4. H. Baltes, O. Brand, Enabling Technology for MEMS and Nanodevices, Wiley, New York, 2004

M. Tech in Optoelectronics and Laser Technology

JANUARY – JUNE, 2021

Course Code: OE-21
Course Title: FIBER OPTICS , LASER INSTRUMENTATION AND SOLAR PHOTOVOLTAIC TECHNOLOGIES
Credits: 4

OE-22- FIBER OPTICS LASER INSTRUMENTATION AND SOLAR PHOTOVOLTAIC TECHNOLOGIES

Course Objectives :

1. To introduce students the fundamental theories and technological aspects of power generation using solar photovoltaic technology**.**
2. To learn theory, working and applications of solar cells.

Course Outcomes: At the end of the course the student should be able to

1. explain the theory of propagation of light in an optical fiber (Understand level)
2. analyze the formation of modes in a planar optical wave guide (Analyze level)
3. examine single mode and multimode optical fibers and classify optical fibers based on their refractive index profiles (Analyze level)
4. compare the loss mechanisms in optical fibers and to compute various losses (Analyze level) 5. distinguish between different techniques to provide optical connections in fibers (Analyze level)
5. summarize the functioning of optical fiber sensors that use amplitude, phase, frequency and polarization type modulation schemes (Evaluate level)
6. analyze the different nonlinear processes associated with light-matter interaction. (Analyze level)
7. Identify lasers with appropriate wavelength for various applications (Understand level)
8. to understand the role of solar energy in the context of regional and global energy system, its economic, social and environmental connotations, and the impact of technology on a local and global context.
9. to understand the physical principles of the photovoltaic (PV) solar cell and what are its sources of losses.
10. to understand and apply the basic concepts of solar radiation necessary for dimensioning (sizing) PV systems installations.
11. to know the electrical (current-voltage and power-voltage) characteristics of solar cell, panel or generator and how the environment parameters influence it

Unit I
OPTICAL FIBER AND THEIR PROPERTIES

Principle of light propagation through a fiber – Different types of fiber and their properties –

Fiber materials and their characteristics – Transmission characteristic of fibers – absorption losses – scattering losses – Dispersion – measurement of optical fibers – optical sources – Optical detectors. Dispersion shifted Fiber Technologies.

Unit II

FIBER OPTIC SENSORS IN MEASUREMENTS

Fiber optic instrumentation system – Fiber optic sensors, Different types of modulators, Applicationin instrumentation, Interferometric method of length Measurement, Measurement of pressure, temperature, current, voltage, liquid level and strain. Magnetic and electric field sensors based on the characteristics like intensity, phase, polarization, frequency and wavelength of light wave , Plasmonic nano-sensors.

Laser Plasma Interaction: Basic concepts and two-fluid description of plasmas, electromagnetic wave propagation in plasmas.

Unit III

LASERS IN MEASUREMENTS AND TESTING

Laser for measurement of distance, velocity, acceleration, current, voltage, and atmospheric effect, Laser application in Spatial Frequency filtering. surface topology & optical component testing, beam modulation telemetry, laser Doppler velocimetry, surface velocity measurement using speckle patterns, measurements of rate and rotation using laser gyroscope.

Holography: Basic principle, methods; Holographic interferometry and applications; Holography for non–destructive testing – Holographic components. The wavefront reconstruction process: Inline hologram, the off axis hologram, Fourier hologram, the lens less Fourier hologram, image hologram.

Unit IV

Lasers in Industry – Laser material processing: Laser matter interactions, mode of coupling energy from beam to the material. CW and pulsed heating and the resulting effect. Thermal processing of materials with lasers, Application in material processing, Laser Welding, Hole Drilling, Laser cutting, Laser Tracking, heat treatment, glazing, alloying, cladding, hardening of surfaces, semiconductor annealing and trimming.

BioMedical Application of Lasers: Medical applications of lasers; laser and tissue interaction – Laser instrument of surgery. Laser light scattering, application in biomedicine. Light transport in tissue.

Photochemical, photothermal, photomechanical effects and their therapeutic applications. Optical imaging and diagnosis. Biomedical Instruments.

Unit V

Solar Photovoltaic Technologies

Generation of Photo voltage, Light Generated current,, I-V equation, Solar Cell Characteristics, parameters of solar cells, Relation of Voc and Eg

Design of solar cells: Upper limit of cell parameters, Losses in Solar Cell, Design for High Isc, Voc and FF Analytical Techniques: Solar Simulator-IV measurement, Quantum efficiency measurement, Minority carrier lifetime & diffusion length measurement.

TEXT BOOKs

1. Optical fiber communication-G Keiser ,McGraw Hill Education; Fifth edition (2017)
2. Introduction to fiber optics , Ajoy Ghatak and K. Thyagarajan, Cambridge Univ Press (2017)
3. Optical Fiber Communications: Principles and Practice, John M Senior, Pearson Education India, 3rd edition (2010)
4. Fundamentals Of Fibre Optics In Telecommunication And Sensor Systems, B P Pal, new age publishers (1992)
5. Solar Photovoltaics: Fundamentals, Technologies and Applications, C. S. Solanki, 2nd Edition Prentice Hall of India, 2011.
6. Understanding fiber optics, J Hecht, Laser Light Press, 5 edition (2016)
7. John F Ready, Industrial application of lasers. Academic press 1978
8. John Crisp, Introduction to Fibre Optics , an imprint of Elsevier Science 1996
9. Understanding Fiber Optics, 4th or 5th edition; Jeff Hech; Prentice Hall Publishers
10. Optical Fiber Communication Principles and Systems, A. Selvarajan, S. Kar and T. Srinivas TMH

REFERENCE BOOK

1. Fiber Optic Communication System, G. P. Agarwal, Willey Eastern
2. Laser Material processing by W.M. Steen
3. Industrial Laser and their applications, John and Harry, McGraw Hill
4. M.L. Wolbarshi, Ed. Laser Applications in Medicine & Biology, Vol.1, 2 & 3 (Plenum, New York, 1971,74,77)
5. Solar cells: Operating principles, technology and system applications, by Martin A. Green, Prentice- Hall Inc, Englewood Cliffs, NJ, USA

JANUARY – JUNE, 2021

Course Code: OE-23
Course Title: OPTICAL NETWORKS
Credits: 4

OE-23- OPTICAL NETWORKS

Course Objectives:

The main objectives of the course are to:

1. Familiarize students with the optical network evolution, from the point-to-point link to the intelligent transport
2. Introduce the main elements and components of the all-optical networking solution
3. Explore the capabilities and limitations of the optical network
4. Expose students to recent research articles on various optical networking issues

Course Outcomes

After completion of the course students are expected to be able to:

1. Identify the three generations of optical networking evolution
2. Name the all-important technological issues that affect how optical networks are implemented Comprehend the potentialities and limitations of optical networks
3. Underline how these networks fit in the more classical communication networks based on electronic time division
4. Compare the performance of optical networks via computer discrete-event simulation
5. Review current optical networking trends like optical packet, burst or label switching from research articles

Unit I

WDM Technology and Issue in WDM Optical networks: Introduction – Optical networks – WDM – WDM optical network evolution- Enabling Technology for WDM optical networks – WDM optical network architecture – Issue in Wavelength routed networks – Next generation optical Internet networks, The XG Network architecture, spectrum sensing, spectrum management, spectrum mobility, spectrum sharing, upper layer issues, cross – layer design.

Unit II

Wavelength Routing Algorithms : Introduction – Classification of RWA algorithms – Fairness and Admission control – Distributed control protocols – Permutation routing and Wavelength requirements Wavelength Rerouting algorithms : Introduction – benefits of wavelength routing – Issue in Wavelength routing – Light path Migration – Rerouting schemes – Algorithm AG – Algorithm MWPG – Rerouting in WDM networks with Sparse Wavelength conversion – Rerouting in Multifiber networks – Rerouting in Multifiber Unidirectional ring Networks .

Unit III

Wavelength Convertible networks : Introduction - need for Wavelength converters – Wavelength convertible switch architecture – routing in convertible networks – Performance evaluation of convertible networks – Networks with Sparse Wavelength conversion – Converter placement problem – Converter allocation problem.

Unit IV

Virtual topology Design: Introduction – Virtual Topology design problem – Virtual topology sub problems – Virtual topology design Heuristics – Regular virtual topology design – predetermined virtual topology and lightpath routes – Design of multi fiber networks.

Virtual Topology Reconfiguration: Introduction – Need for virtual topology reconfiguration – Reconfiguration due to Traffic changes – reconfiguration for fault restoration.

Unit V

Network Survivability and provisioning: Failures and Recovery – Restoration schemes – Multiplexing techniques – Distributed control protocols. Optical Multicast routing – Next generation optical internet network.

JANUARY – JUNE, 2021

TEXT BOOKS

1. C. Siva Ram Murthy and Mohan Gurusamy, "WDM Optical Networks : Concepts, Design and Algorithms ", Prentice Hall India 2002.
2. Rajiv Ramasami and Kumar N. Sivarajan, " Optical networks : A Practical Perspective", A Harcourt publishers international company 2000.

Course Code: OE-24
Course Title: ADVANCED OPTICAL COMMUNICATION
Credits: 4

Course Objectives:

- To learn the basic elements of optical fiber transmission link, fiber modes configurations and structures.
- To understand the different kind of losses, signal distortion, SM fibers.
- To learn the various optical sources, materials and fiber splicing
- To learn the fiber optical receivers and noise performance in photo detector.
- To learn link budget, WDM, solitons and SONET/SDH network.

Course Outcomes:

CO1: Demonstrate an understanding of optical fiber communication link, structure, propagation and transmission properties of an optical fiber.

CO2: Estimate the losses and analyze the propagation characteristics of an optical signal in different types of fibers CO3: Describe the principles of optical sources and power launching-coupling methods.

CO4: Compare the characteristics of fiber optic receivers

CO5: Design a fiber optic link based on budgets

CO6: To assess the different techniques to improve the capacity of the system

OE-24-ADVANCED OPTICAL COMMUNICATION

Unit I

Introduction to optical components – optical amplifiers – types – issue in optical amplifiers – photonic switching – Cross connect – Wavelength conversion – Multiplexer – Demultiplexer, Filters– tunable filters, Photonic Crystal Fibers : Introduction, Guiding mechanism, modified total internal reflection and photonic bandgap guidance, properties and applications, introduction to OICs and its applications.

Unit II:

First Generation Optical Networks

SONET/SDH – multiplexing , element of a SONET/SDH infrastructure - SONET/SDH physical layer, Computer interconnects – ESCON, Fiber channel, HIPPI , Metropolitan area networks – FDDI, ATM, Layered Architecture - SONET/SDH layers – Second generation optical network layers.

Unit III

DWDM: Networks, Devices, and Technology :Fundamentals of DWDM Technology, Architecture and components, Working of DWDM, Topologies and Protection Schemes for DWDM, IP over DWDM Networks, Ethernet switching over DWDM, OTN (Optical Transport Networking), Capacity expansion and Flexibility in DWDM, Future of DWDM, Survivability in DWDM Networks.

Unit IV

OTDM Technology

Important issues of OTDM – optical solitons. Optical pulse compression – fiber grating compressor soliton effect compressor. Modulation instability, fundamental and higher-order solitons, soliton lasers, soliton-based communication systems, fiber loss, frequency chirp, soliton interaction, design aspects, higher-order nonlinear effects. Broadcast OTDM networks, bit interleaving and packet interleaving, optical AND gates, nonlinear optical loop mirrors, terahertz optical asymmetric demultiplexer, switch based networks. Applications of solitons.

Unit -V

FTH and PON Technology

Proposed architecture and issues of Fiber to the home (FTH) – Passive Optical Network (PON), Near space communication – open air optical communication. Inter satellite link hops (ISL). Introduction to all optical networks (AON), Military, Civil, consumer and industrial applications.

TEXT BOOKS :

1. Rajiv Ramaswami and Kumar N. Sivrajan, " Optical networks – A practical perspective", A Harcourt Publishers International Company 2000
2. R. G. Junsperger, " Integrated Optics – Theory and Technology, Springer Series in Optical Sciences", 3rd Edition 1991
3. Gerd Keiser, " Optical Fiber Communications" ,McGraw Hill International Edition 191
4. G. P. Aggarwal," Non Linear Optics", Academic Press.
5. Stamations V. Kartalopoulos, "Understanding SONET/ SDH and ATM Communication network for Next Millennium", PHI 2000.
6. C. Sivaram and mohan Gurusamy, " WDM Optical Networks : Concepts, Design and Algorithms" PHI India 2002.

REFERENCE BOOKS:

1. DWDM: Networks, Devices, and Technology 1st Edition, by "Stamatios, V. Kartalopoulos"
2. Broadband Networking ATM, Adh and SONET, " Mike Sexton, Andy Reid"
3. F. Poli, A. Cucinotta and S. Selleri : Photonic crystal fiber properties and application, Springer, 2007

OE-27- PHOTONICS LAB –II

The Photonics Laboratory is a mandatory course for students aiming to use the experimental facilities of the photonics group. It provides students a hands - on experience with sophisticated instruments under the mentorship of senior students. The experiments are designed carefully to motivate the students towards design, analysis and interpretation. This lab enables scholars to deal with difficulties encountered and precautions to be taken while performing experiments and hence serves as a preparatory course for their research.

M. Tech in Optoelectronics and Laser Technology

Course Outcomes

1. Acquire a theoretical knowledge base in photonics related areas of physics (Optics, Electrodynamics, Physics of Semiconductors, Quantum Mechanics)
2. Develop understanding of application of fundamental laws of physics in such engineering areas as telecommunications, optoelectronics, nano and microfabrication, growth techniques
3. Learn fundamentals of computerized modeling of diverse optical and photonics systems and gain working experience with standard computational tools used in industry.
4. Acquire essential laboratory skills in designing experiments, assembling standard optical tools for optical experimentation, carrying out measurements with customary optical instruments and analyzing acquired data
5. Become familiar with economics and management of photonics related engineering projects
6. Learn to communicate scientific and engineering ideas both orally and in written form
7. Acquire experience working in industrial or research lab settings as a part of a team

Experiments are to be performed in the Advance Photonics Laboratory of S.O.S. in Electronics & Photonics

EXPERIMENTS

1. To calculate the wavelength of Laser using Michelson interferometer.
2. To determine the size of tiny particles using Laser.
3. To determine the grating pitch of transmission grating.
4. To determine the wavelength of a Laser using meter scale ruling.
5. To find the refractive index of glass (transparent materials) by measuring Brewster angle.
6. To determine the bending losses that occurs in a multimode fiber when it is bent along various radii.
7. To determine the absorption coefficient of transparent materials (glass slide).
8. To study the variation of splice losses due to transverse offset, angular tilt and longitudinal separation.
9. To observe the refraction of light in liquid and to calculate its refractive index.
10. To study the wavelength dependence of attenuation in the given optical fiber.
11. To determine insertion loss of each channel of WDM mux, loss uniformity and optical cross talk in channels.
12. To setup optical Add/Drop multiplexer (OADM) using fiber Bragg grating .
13. To setup the WDM link with the given components and determine the total loss for each wavelength.
14. To find the refractive index of transparent Bar using diode Laser.
15. To observe the absorption of Laser light when various colors are introduced in its path.
16. Preparation of thin films with the help of Dip Coating Unit and resistance/ impedance measurement using Source measuring unit.
17. Preparation of thin films with the help of Spray pyrolysis method and resistance/ impedance measurement using Source measuring unit.

18. Preparation of thin films with the help of Spin Coating Unit and optical constant measurement using ellipsometer .

Note: Students have to perform at least 15 experiments

OE 28 Theory-V

The motivation for the course is to make the students understand the fundamentals and physics of photonic materials, devices and nano photonics, as well as nano-photonic devices. **The student may elect one from OE 28 [A] or OR 28 [B].**

Course Code: OE-28[A]
Course Title: PHOTONICS MATERIALS AND DEVICES
Credits: 4

This course covers the theory, design, fabrication and applications of photonic materials and devices. After a survey of optical materials design for semiconductors, dielectrics and polymers, the course examines ray optics, electromagnetic optics and guided wave optics; physics of light-matter interactions; and device design principles of LEDs, lasers, photodetectors, modulators, fiber and waveguide interconnects, optical filters, and photonic crystals. Device processing topics include crystal growth, substrate engineering, thin film deposition, etching and process integration for dielectric, silicon and compound semiconductor materials. The course also covers microphotonic integrated circuits and applications in telecom/datacom systems.

Course Objectives:

1. Photonics is the technology of this century and this course aims to develop an interest and awareness about Photonics in the students.
2. To learn the fundamentals of Lasers and its applications, optical fiber technology, holography and nanophotonics.
3. analyze transmission properties of optical guides
4. describe the mechanisms contributing to signal degradation in optical transmission links
5. describe the performance characteristics of active components, including fiber amplifiers, laser diode, light emitting diode, and photodetector
6. evaluate spectral characteristics of passive components, such as grating and coupler using coupled-mode theory
7. design optical guides and passive guided-wave components with prescribed transmission characteristics

Course Outcomes:

1. Acquire a theoretical knowledge base in photonics related areas of physics (Optics, Electrodynamics, Physics of Semiconductors, Quantum Mechanics)
2. Develop understanding of application of fundamental laws of physics in such engineering areas as telecommunications, optoelectronics, nano and microfabrication, growth techniques

3. Learn fundamentals of computerized modeling of diverse optical and photonics systems and gain working experience with standard computational tools used in industry.
4. Acquire essential laboratory skills in designing experiments, assembling standard optical tools for optical experimentation, carrying out measurements with customary optical instruments and analyzing acquired data
5. Become familiar with economics and management of photonics related engineering projects
6. Learn to communicate scientific and engineering ideas both orally and in written form
7. Acquire experience working in industrial or research lab settings as a part of a team.

OE 28[A] PHOTONICS MATERIALS AND DEVICES

Course Objectives:

1. Acquire a theoretical knowledge base in photonics related areas of physics
2. Learn the fundamental principles of photonics and light-matter interactions,
3. Develop the ability to formulate problems related to photonic structures/processes and analyze them, and
4. Understand processes that help to manipulate the fundamental properties of light.

Course Outcomes : Students should be able to do the following upon completion of this module:

1. Be able to analyze the properties of materials and associated technologies and make judicious choice of the appropriate material/technology for a given application
2. To have a grasp of the state-of-the-art materials and technologies relevant for current and emerging topics in optics and photonics.
3. Explain working principles of basic photonic devices,
4. Make simple calculations to quantify performances of various photonic devices,
5. Choose appropriate photonic devices for achieving certain system requirements,
6. Tell technological limits of several photonic devices such as solar cells, displays, LED bulbs, and describe potential solutions to those problems.

UNIT I

Materials for nonlinear optics, preparation and characterization, evaluations of second order and third order nonlinear coefficients, 3 wave and 4 wave mixing in uniaxial and biaxial crystals.

UNIT II

Frequency up and Frequency down conversions, Photorefractive materials, phase conjugation and its applications.

UNIT III

AO Phenomenon, Raman-Nath and Bragg modulators, deflectors, spectrum analyser devices based on EO and MO effects.

UNIT IV

EL and POS devices, fluoride glass based fibres and their applications, optical fibre based signal processing.

UNIT V

Optical Integrated Circuits, architecture fabrication and applications, CD read/write mechanism, memory storage, information storage and retrivel using holography.

REFERENCE BOOKS

l. Optoelectronic devices and systems, SC Gupta, Prentice Hall India (2005) (Text)
2. Handbook of Nonlinear optical crystals - Dmtriev (Springer Verlag), 2003
3. Optical Electronics - Thyagaraj an and Ghatak W (Cambridge University Press), 1997

Course Code: OE-28[B]
Course Title: NANOPHOTONICS
Credits: 4

[OE 28 B] NANOPHOTONICS

Course Objectives : This advanced topical course shall introduce the basic principles, applications and latest advances in the area of nanophotonics. Student shall have a clear view about this excited new area and ready to contribute to the advances of photonic technology for a broad area of applications, from telecommunication/data communications to solid state display, energy and sensing technologies. Students shall have an opportunity to get the latest update on this new field from the seminars offered by the experts in this area. The main objectives are :

1. To introduce the students to fields of confinement of matter and light matter interaction at the nanoscale and its applications.
2. To learn fundamentals of nanotechnology and its applications in Photonics.

Course Outcomes :

After completing this course students will be able to:

1. Learn about the background on Nanophotonics
2. Understand the synthesis of nanomaterials and their application and the impact of nanomaterials on environment

3. Apply their learned knowledge to develop Nanomaterial's.

UNIT I

Foundations for Nanophotonics

Confinement of Photons and Electrons, Propagation Through a Classically Forbidden Zone: Tunneling, Localization Under a' Periodic Potential: Bandgap, Cooperative Effects for Photons and Electrons, Nanoscale Optical Interactions, Axial and Lateral Nanoscopic Localization, Nanoscale Confinement of Electronic Interactions, Quantum Confinement Effects, Nanoscopic Interaction Dynamics, Nanoscale Electronic Energy Transfer.

Near-Field Interaction and Microscopy : Near-Field Optics, Modeling of Near-Field Nanoscopic Interactions, Near-Field Microscopy, Aperture less Near-Field Spectroscopy and Microscopy, Nanoscale Enhancement of Optical Interactions, Time- and Space-Resolved Studies of Nanoscale Dynamics.

UNIT II

Quantum-Confined Materials : Quantum Wells, Quantum Wires, Quantum Dots Quantum Rings, Manifestations of Quantum Confinement, Optical Properties, Quantum-Confined Stark Effect, Dielectric Confinement Effect, Single-Molecule Spectroscopy, Quantum-Confined Structures as Lasing Media, Metallic Nanoparticles and Nanorods, Metallic Nanoshells Applications of Metallic Nano structures.

Growth and Characterization of Nanomaterials : Growth Methods for Nano materials, Epitaxial Growth, Laser-Assisted Vapor Deposition (LAND) Nano chemistry, Characterization of Nano materials, X-Ray Characterization, Transmission Electron Microscopy (TEM) Scanning Electron Microscopy (SEM), Scanning Probe Microscopy (SPM).

UNIT III

Nanostructured Molecular Architectures :Non covalent Interactions, Nanostructured Polymeric Media, Molecular Machines, Dendrimers, Supramolecular Structures, Monolayer and Multilayer Molecular Assemblies.

Photonic Crystals : Basics Concepts, Theoretical Modelling of Photonic Crystals, Features of Photonic Crystals, Methods of Fabrication, Photonic Crystal Optical Circuitry Nonlinear Photonic Crystals, Photonic Crystal Fibers (PCF), Photonic Crystals and Optical Communications, Photonic Crystal Sensors.

UNIT IV

Nanocomposites ,Nanocomposites as Photonic Media, Nanocomposite Waveguides, Random Lasers: Laser Paints, Local Field Enhancement, Multiphasic Nanocomposites, Nanocomposites for Optoelectronics.
Industrial nanophotonics: Nanolithography, Nanosphere Lithography, Dip-Pen Nanolithography, Nanoimprint Lithography, Nanoparticle Coatings, Sunscreen Nanoparticles, Self-Cleaning Glass Fluorescent Quantum Dots, Nano barcodes.

UNIT-V

Bio N ano photonics and nanomedicine :Bioderived Materials, Bioinspired Materials Bio templates, Bacteria as Biosynthesizers, Near-Field Bio imaging, Nanoparticles for Optical Diagnostics and Targeted Therapy, Semiconductor Quantum Dots for Bio imaging Bio sensing, Nano clinics for Optical Diagnostics and Targeted Therapy, Nanoclinic Gene Delivery Nano clinics for Photodynamic Therapy.

REFERENCE BOOKS

Nanophotonics : P N Prasad, Wiley Interscience (2003) (Text)
Biophotonics: P N Prasad, Wiley Publications (2004)
L. Novotny and B. Hecht, Principles of Nano-optics, Second Edition, Cambridge University Press, 2012

Comprehensive Viva-Voce

A comprehensive viva -voce will be held immediately after the end of Semester I, II and IV. The Comprehensive Viva- Voce is intended to assess the student's understanding of various subjects he has studied during the M.Tech. course of study. The Viva-Voce would be conducted by a Board of Examiners consisting of the Head, Course Coordinator and all concerned Faculty Members of the both Electronics and Physics department. The Comprehensive Viva- Voce is evaluated on the basis of Grade. A candidate has to secure a minimum Grade to be declared successful. If he fails to obtain the minimum Grade, he has to reappear for the viva-voce during the next examination. The Grades are as follows.

RANGE	**QUALITATIVE_ASSESSMENT/GRADE**
91% - 100%	O Outstanding
81% - 90%	A Very Good
71% - 80%	B Good
61% - 70%	C Fair
50% - 60%	D Pass
Below 50%	F Failure

M. Tech in Optoelectronics and Laser Technology

SEMESTER III (July – December, 2021)

Course Code: OE
Course Title: Major Project Phase- I
Credits: 16

Major Project Phase - I

AIM: To enable students to develop deep knowledge, understanding, capabilities and attitudes in Photonics. It should improve their subject knowledge level, experimental and report making skills. It should also enhance aptitude for research and assist career growth.

OBJECTIVE: Each student has to submit a first level of report of the M.Tech project that they are undergoing at the end of the 3rd semester.

Student Outcomes

The Master of Technology in optoelectroics & laser Technology is comprised of rigorous coursework followed by a full year of research project in two phases.

In addition to communication, team work and research skills, each student will attain at least the following learning outcomes from this degree course:

- Demonstrate a depth of knowledge of Photonics
- Complete an independent research project, resulting in at least a thesis publication, and research outputs in terms of publications in high impact factor journals, conference proceedings, and patents.
- Demonstrate knowledge of contemporary issues in their chosen field of research.
- Demonstrate an ability to present and defend their research work to a panel of experts.

Project Work Scheme

Project evaluation shall be done at the end of III and IV semesters and the students will have to submit a dissertation on his / her project work as per the Regulation for M.Tech. The problem may be selected form an appropriate Industry or Institution. The candidate is expected to work under the guidance of a project guide for at least for a period as decided. In case the project work is taken up in an external Industry/Institution, the project shall have two guides: one in the participating organization (Industry/Institution) who is the external guide and the other shall be one of the faculty members form Department who is the internal guide. The dissertation should be submitted within tow calendar years form the starting date of the third semester, Six copies of the dissertation have to be submitted to the M.Tech. Course Coordinator. These copies shall be distributed to the External examiner, Internal Examiner, Project guide (Faculty), Department Library and University Library and the Candidate.

Evaluation of Project Work

The project evaluation committee shall be responsible for the project work evaluation The project evaluation committee as per M.Tech. Regulation. The project guide (faculty from department) shall be the internal examiner. The external examiner shall be a technical expert in the concerned subject form any organization other than that of the project guide and is selected form the panel of experts submitted by the Course Coordinator. The dissertation shall be evaluated by the external examiner.

Three bound copies along with a soft copy of the dissertation shall be submitted to the Head of the Department/Coordinator within the last date prescribed by the Department / School for the purpose. The project work shall be evaluated through presentations and viva voce. The grade/marks shall be given to the students according to the level and quality of work and presentation/documentation.

SEMESTER IV (January – June, 2022)

Major Project Phase- II

Course Code: OE

Course Title: Major Project Phase- II

Credits: 16

AIM: To enable the students to develop deep knowledge, understanding, capabilities and attitudes in Photonics. It should improve their subject knowledge level, experimental and report making skills. It should also enhance aptitude for research and assist career growth.

OBJECTIVE: At the end of 4th semester, each student has to submit a dissertation consisting of the work they have done and findings obtained during their project.