ANNA UNIVERSITY COIMBATORE

FACULTY OF

ELECTRONICS & COMMUNICATION

ENGINEERING

BOARD OF STUDIES -ECE

M.E. LASER AND ELECTRO-OPTICAL ENGINEERING

CURRICULUM AND SYLLABI

I –IV SEMESTERS

REGULATIONS - 2007

M.E. LASER AND ELECTRO-OPTICAL ENGINEERING

CURRICULUM 2007 - FULL TIME MODE

SEMESTER – I

Code No.	Course Title	L	T	P	M
Theory					
	Applied Mathematics	3	1	0	100
	Modern Optics	3	0	0	100
	Optical Engineering	3	0	0	100
	Solid State Laser Engineering	3	0	0	100
	Photonic crystals	3	0	0	100
	Elective I	3	0	0	100
Practical					
	Laser and Electro Optical Lab I	0	0	4	100
	Total	18	1	4	-

SEMESTER – II

Code No.	Course Title	L	T	P	M
Theory					
	Principles of Nano optics	3	0	0	100
	Laser Holographic Techniques	3	0	0	100
	Optical Detection Theory	3	0	0	100
	Photonic Devices and Systems	3	0	0	100
	Elective II	3	0	0	100
	Elective III	3	0	0	100
Practical					
07ML52	Laser and Electro Optical Lab II	0	0	4	100
	Total	18	0	4	-

SEMESTER – III

Code No.	Course Title	L	T	P	M
Theory					
	Elective IV	3	0	0	100
	Elective V	3	0	0	100
	Elective VI	3	0	0	100
Practical					
	Project Work (Phase I)	0	0	12	200
	Total	9	0	12	-

SEMESTER – IV

Code No.	Course Title	L	T	P	M
	Project Work (Phase II)	0	0	24	400
	Total	0	0	24	-

LIST OF ELECTIVES
M.E. LASER AND ELECTRO-OPTICAL ENGG

Code No.	Course Title	L	T	P	M
	Silicon Photonics	3	0	0	100
	Laser Safety Management	3	0	0	100
	Non Linear Fiber Optics	3	0	0	100
	High Speed Photonics and Optoelectronics	3	0	0	100
	Photonics Switching	3	0	0	100
	Laser Satellite Communication	3	0	0	100
	Soliton in Optical Communication	3	0	0	100
	Ultra fast lasers	3	1	0	100
	Micro Photonics	3	0	0	100
	Molecular lasers	3	0	0	100
	Spatial light modulators	3	0	0	100
	Optical MEMS	3	0	0	100
	Nanophotonics	3	0	0	100
	Quantum Electronics	3	0	0	100
	Laser beam shaping techniques	3	0	0	100
	Optical Computing	3	0	0	100
	Integrated Optics	3	0	0	100
	Optical waveguide technologies	3	0	0	100
	Laser application in surface science and technology	3	0	0	100
	Optical Imaging Techniques	3	0	0	100
	LASER and its Applications	3	0	0	100
	Special Elective	3	0	0	100

07ML01 APPLIED MATHEMATICS **3 1 0 100**

Unit-I:
LINEAR ALGEBRAIC EQUATION AND EIGEN VALUE PROBLEMS **9+3**

System of equations- Solution by Gauss Elimination, Gauss-Jordan and LU decomposition method- Jacobi, Gauss-Seidal iteration method- Eigen values of a matrix by Jacobi and Power method.

Unit-II:
WAVE EQUATION **9+3**

Solution of initial and boundary value problems- Characteristics- D'Alembert's Solution - Significance of characteristic curves - Laplace transform solutions for displacement in a long string - a long string under its weight - a bar with prescribed force on one end- free vibrations of a string.

Unit-III:
SPECIAL FUNCTIONS **9+3**

Bessel's equation - Bessel Functions- Legendre's equation - Legendre polynomials -Rodrigue's formula - Recurrence relations- generating functions and orthogonal property for Bessel functions - Legendre polynomials.

Unit-IV:
RANDOM VARIABLES **9+3**

One dimensional Random Variable - Moments and MGF – Binomial, Poisson, Geometrical, Normal Distributions- Two dimensional Random Variables – Marginal and Conditional Distributions – Covariance and Correlation Coefficient - Functions of Two dimensional random variable

Unit-V:
QUEUEING THEORY **9+3**

Single and Multiple server Markovian queueing models - Steady state system size probabilities – Little's formula - Priority queues - M/G/1 queueing system – P.K. formula.

L + T = 45 + 15 = 60

REFERENCES:

1. Sankara Rao.K. "Introduction to Partial Differential Equation ", PHI, 1995.
2. Taha. H.A., "Operations Research- An Introduction " 6th Edition, PHI, 1997.
3. Jain M.K. Iyengar, S.R.K. & Jain R.K., "International Methods for Scientific and Engineering Computation", New Age International (P) Ltd, Publlishers 2003..
4. *Kanpur J.N. & Saxena. H.C. "Mathematical Statistics", S.Chand & Co., New Delhi, 2003.*
5. Greweal B.S. "Higher Engineering Mathematics", Khanna Publishers, 2005.

07ML03 OPTICAL ENGINEERING **3 0 0 100**

Unit I **9**
Introduction: Ray Optics: , wave optics, photon optics

Unit II **9**
Prism and refractive optical components:, refractive optical components:

Unit III **9**

Diffractive optical components : Some lens optical devices:

Unit IV **9**

Telescopes: Spectrometers:

Unit V **9**

Basic interferometers: Modern fringe pattern analysis in interferometry: optical methods in metrology: Point methods, full filed methods

Total: 45

REFERENCES:

1. Malacara, Handbook of Optical Engineering, CRC (May 31, 2001)
2. 2. Bruce H. Walker, Optical Engineering Fundamentals (SPIE Tutorial Texts in Optical Engineering Vol. TT30), SPIE Publications (December 1997)

07ML04 SOLID-STATE LASER ENGINEERING **3 0 0 100**

Unit I **9**

Properties of solid state laser materials: Overview, Ruby Nd: lasers, Er: lasers, Tunable lasers, Yb:YAG, Laser Oscillators: Operation at threshold, Gain saturation, circulating power, Oscillator performance model, relaxation oscillations, examples, Ring laser

Unit II **9**

Laser amplifier: Single and multiple pass pulse amplifiers, regenerative amplifiers, cw amplifiers, signal distortions, depopulation losses, self focusing,

Unit III **9**

Optical resonator: transverse modes, longitudinal modes, intensity and frequency control, hardware design, unstable resonators, wavelength selection Optical pump systems: pump sources, pump radiation transfer methods

Unit IV **9**

Q switching : Q switch theory, Mechanical Q switches, electro optic Q switches, acousto optic Q switches, Passive Q switches, cavity dumping

Unit V **9**

Mode locking: Pulse formation, passive mode locking, active mode locking, picosecond lasers, femtosecond lasers.

Total: 45

References:

1. Walter Koechner, Solid-State Laser Engineering, Springer; 6th, rev. and updated ed. edition (April 19, 2006)

2. Walter Koechner (Author), Michael Bass (Author), Solid-State Lasers: A Graduate Text, Springer; 1 edition (May 12, 2003)

3. Yehoshua Kalisky, The Physics and Engineering of Solid State Lasers, SPIE Publications (March 28, 2006)

07ML05 PHOTONIC CRYSTALS **3 0 0 100**

Unit I **9**

Introduction : types of photonic crystals, light state in a photonic crystal Features of photonics crystals: One dimensional photonic crystal, concept of light cone, band structure, defect modes, application of photonic crystals

Unit II **9**

Basic photonic band: 2D or 3D photonic band structure, parity of mirror reflection of 2D PBS, light transmission and reflection, photonic crystals of finite thickness, Gallery modes and Mie resonances, heavy photons and tight binding bonds

Unit III **9**

Advanced photonic band: Group theory of photonic crystals, leaky modes of slab type photonic crystals, layer doubling method, band gap modes, inhomogeneous Maxwells equations, Optics of photonic crystals

Unit IV **9**

2D photonic crystals of arrayed fiber type, 2D photonic crystals fabricated based on anodic porus alumina, other methods of fabrication of photonic 2D crystals, photonic crystal fibers, 2D photonic crystals: Guided mode and photonic band gap, 3 types of PC slabs, samples, optical properties, non-bulk PC slabs, Q-values of leaky photonic band modes, dispersion relation and life time.

Unit V **9**

3D photonic crystals: 3D photonic crystal by wafer fusion and alignment, 3D photonic crystals at infrared wavelengths, near infrared wavelengths, autocloning technology, mechanism of auto cloning, features of auto cloning, lattice modulation of photonic crystals and its application, expansion of band gaps, Double periodic photonic crystals, Quantum well photonic crystals, isotropic photonic crystals, metallic photonic crystals, other methods

Total: 45

References:

1. K. Inoue, K. Ohtaka, Photonic Crystals: Physics, Fabrication and Applications (Springer Series in Optical Sciences)
2. John D. Joannopoulos, Robert D. Meade, and Joshua N. Winn , Photonic Crystals**,** Princeton University Press (July 3, 1995)

07ML51 LASER AND OPTICAL COMMUNICATION LABORATORY I 0 0 4 100

1. Simulation of Modulation and Coding in a AWGN Communication Channel using Simulation Packages.
2. Performance evaluation of Digital Data Transmission through Fiber Optic Link
3. Characterization of Glass /Plastic Optical Fibers.
4. P-I Characteristics of LED and LASER Diode.
5. DC Characteristics of PIN PD and APD.
6. System Bandwidth determination for Analog Fiber Link.
7. Optical Link Simulation using Simulation Packages.
8. Optical Device Modeling using SPICE

07ML06 PRINCIPLES OF NANO OPTICS 3 0 0 100

Unit I **9**

Theoretical foundations: macroscopic electrodynamics, wave equations, constitutive relations, spectral representation, time harmonic fields, complex dielectric constants, homogeneous media, boundary condition, conservation of energy, Dyadic Green's function, evanescent fields, field propagators, paraxial approximation, polarized electric and magnetic field, far fields, focusing of field and higher order fields,

focal fields, limit of weak focusing, focusing near planar interfaces, reflected image of a strongly focused spot.

Unit II **9**

Spatial Resolution: The point spread function, resolution limit, principles of confocal microscopy, axial resolution in multi photon microscopy, position accuracy, principles of near filed optical microscopy, Nanoscale optical microscopy: Far field illumination an detection, near field illumination and far field detection, far field illumination and near field detection, near field illumination and detection, energy transfer microscopy

Unit III **9**

Near field optical probes: dielectric probes, light propagation, aperture probes, fabrication of aperture probes, optical antennas, Light emission and optical interactions: Multipole expansion, classical particle field Hamiltonian, radiating electric dipole, spontaneous decay, classical life time and decay, Quantum emitters

Unit IV **9**

Photonic crystals and resonators: photonic crystals and optical; micro cavities, surface plasmas: optical properties of noble metals, surface plasmon polarization, surface plasmon in nano optics, Forces in confined fields: Maxwell's stress tensor, radiation pressure, dipole approximation, optical tweezers, angular momentum and torque, forces in optical near field

Unit V **9**

Fluctuation induced interactions: Fluctuation-dissipation theorem, emission by fluctuation sources, fluctuation induced forces, Theoretical methods in nano optics: multiple multi pole method, volume integral method, effective polarizability, Green's function.

Total: 45

References:

1. Lukas Novotny, Bert Hecht, Principles of Nano-Optics, Cambridge University Press (June 19, 2006)
2. Craig F. Bohren (Author), Donald R Huffman, Absorption and Scattering of Light by Small Particles, Wiley-Inter science; New Edition (1998)

07ML07 LASER HOLOGRAPHIC TECHNIQUES **3 0 0 100**

UNIT I **9**

OPTICAL HOLOGRAPHY

Light wave interference patterns, Diffraction, Hologram formation, wavefront construction, plane and volume hologram, formation geometries, In line and Off axis holograms.

UNIT II **9**

FOURIER TRANSFORM AND DIFFRACTION

Linear space invariant systems, correspondences and transform relations, convolution operation, operational and functional correspondences. Plane waves, Diffraction from periodic objects relation to Fresnel and Kirchhoff integral. Optical systems with spherical lenses.

UNIT III **9**

LIGHT SOURCES AND PLANE HOLOGRAMS

Light sources for hologram formation, fringe visibility in hologram recoding, illumination with expanded laser beams, division and attenuation of laser beams, stability in hologram formation, light sources for hologram reconstruction, simple holographic techniques. Analysis of plane holograms, Mediums and Geometries.

UNIT IV **9**

HOLOGRAM RECORDING MATERIALS

Photosensitive materials, exposure sensitivity, resolution, erasability, noise in recording, wavefront reconstruction, ideal materials, exposure characteristics of real materials, Photographic emulsions, gelatin films, thermo plastics, photo chromatic and ferroelectric materials.

UNIT V **9**

PULSED LASER HOLOGRAPHY

Pulsed laser holograms, recording materials, Non linear recording, Holographic interferometry, information storage, real image applications.

TOTAL : 45

REFERENCES

1) Graham Saxby, Practical Holography, Prentice Hall, London, 1988.
2) P.Hariharan, P.L.Knight & A.Miller, Optical Holography :Principles : Techniques and Applications, Cambridge University press, 2nd Edition,1996.

07ML08 OPTICAL DETECTION THEORY **3 0 0 100**

Unit I **9**

Review of statistical methods, decision making process, optical detection techniques, diffraction theory, free space propagation, truncated obscured Gaussian beam, Fourier optics and array theorem, antenna and mixing theorem, analysis of coherent and direct system

Unit II **9**

Optical coherence theory, surface scattering, propagation through turbulent media,

Unit III **9**

Single pulse direct detection statistics:Single point and summed statistics of fully developed speckle, Poisson signal in Poisson noise, negative and non central binomial signal in Poisson Noise, parabolic cylinder signal in Gaussian noise, detection of signal in APD excess noise, detection in atmospheric turbulence, detection in atmospheric clutter, polarization diversity, multiple un correlated signals.

Unit IV **9**

Single pulse coherent detection statistics: Introduction, constant amplitude signal in Gaussian noise, Rayleigh fluctuating signal in Gaussian noise, one dominant plus Rayleigh signal in Gauusian noise, Rician signal in Gaussian noise, detection in atmospheric turbulence, various performance

Unit V **9**

Multiple pulse detection: Introduction – Direct detection systems – Coherent detection systems – Binary integration

Total: 45

References:

1. Gregory R. Osche, Optical Detection Theory for Laser Applications (Wiley Series in Pure and Applied Optics) (Hardcover), Wiley-Interscience (August 8, 2002)
2. Mark P. Silverman, Probing the Atom, Princeton University Press (January 17, 2000)

07ML09 PHOTONIC DEVICES AND SYSTEMS 3 0 0 100

Unit I **9**

Electro absorption modulators and electro absorption EA monolithically integrated with distributed feed back lasers – High speed $LiNbO_3$ optical modulators

Unit II **9**

III-V Compound semiconductors electro optic modulators – High speed polymer optical modulators and their application

Unit III **9**

High speed photo detectors and photo receivers

Unit IV **9**

High speed IC technologies for future communication systems

Unit V **9**

High speed all optical technologies for photonics

Total: 45

References:

1. Nadir Dagli, High-Speed Photonic Devices (Series in Optics and Optoeletronics), Taylor & Francis (December 1, 2003)
2. Robert G. Hunsperger (Editor), Photonic Devices and Systems, CRC (July 15, 1994)
3. Ronald W. Waynant, John K. Lowell, Electronic and Photonic Circuits and Devices (Ieee Press Series on Microelectronic Systems), Wiley-IEEE Press (December 9, 1998)

07ML52 LASER AND OPTICAL COMMUNICATION LAB II 0 0 4 100

1) Study of spatial light modulator

2) Response of optical filters

3) Characteristics of optical switches

4) Optical convolution

5) Optical matrix multiplication

6) Study of Machzender interferometer

07ML11 SILICON PHOTONICS **3 0 0 100**

Unit I **9**

Basic of guided waves : ray optic approach to describing planar waveguide – reflection coefficient – phase of a propagating and its wave vector – mode of a planar waveguide – simplifying and solving the wave equation – propagation coefficient – mode profiles – confinement factor – characteristics- modes of a optical fiber – numerical aperture and acceptance angle – dispersion in optical fiber – single mode fiber – normalized frequency, propagation constant and cut-off wavelength.

Unit II **9**

SOI photonics : SOI waveguides – effective index method of analysis – single mode rib waveguide – refractive index and loss coefficient – the contribution to loss – coupling – optical modulation mechanism – advantages and disadvantages of silicon photonics

Unit III **9**

Fabrication of silicon waveguide devices : silicon on insulators – fabrication of surface edged features – oxidation - formation sub micro silicon waveguide –silicon doping – metallization

Unit IV **9**

Photonics devices : Optical phase modulator and variable optical attenuators – Mach – Zehnder interferometer – waveguide bend – waveguide to waveguide coupler – AWG waveguide coupler for small dimension waveguide

Unit V **9**

Polarization dependent losses : effect of waveguide thickness – surface scattering loss – polarization dependent coupling loss – birefringes – effect of stress – silicon light emitting devices – erbium doping – low dimensional structures – dislocation engineered emitters – Raman excitation.

Total: 45

References:

1. Graham T. Reed, Andrew P. Knights, Silicon Photonics: An Introduction, Wiley (March 12, 2004)
2. Lorenzo Pavesi (Editor), David J. Lockwood, Silicon Photonics (Hardcover), Springer; 1 edition (April 14, 2004)
3. Vittorio M., N. Passaro Silicon Photonics 2006 Research Signpost; First edition (January 1, 2006)

07ML12 LASER SAFETY MANAGEMENT **3 0 0 100**

Unit I **9**

Introduction : Traditional laser safety – life cycle – classification – responsibilities – biological effects on eye – signs of eye exposure – damage mechanism – laser radiation on skin – tissue optics – laser safety officer – laser safety committee – inventory – training – signs – warning lights – audits

Unit II **9**

Standard operating procedure : Flow – sample format – follow to the SOP – laser control boiler plate – sample laser SOP 1 – laser system SOP guidelines – laser safety toolbox – LOS and laser systems users – laser safety traps

Unit III **9**

Laser safety management program : Benefits – file structure – institutional binder sections – institutional binder – laser safety training – user training – awareness training – on the job safety training – exploring training option – new trainee suggestion – refresher trainee – laser quizzes – training matrix – laser pointer awareness – personal protection equipment - full attenuation – visual light transmission – comfort and fit – damage threshold consideration – prescription – sensor cord use – weight – labeling – ultra fast lasers – alignment eyeware – additional PPE

Unit IV **9**

Laser accidents : alignment activities – protective eyeware – electrical hazards – improper restoration of laser – lack of planning - wearing wrong eyeware – fatigue and stress – work face culture – perceive incident – accident investigation – laser pointer incidents – guidance for laser pointer use – exaples of laser accidents – laser accidents action plan – medical facility – control measures – administrative controls – research lab – engineering – measures

Unit V **9**

Various regulation and standards : user regulation – user standards – manufacturer regulation – British regulation and standards – laser safety calculations – converting irradiants and radiant exposure – optical density – choosing exposure duration times – non beam hazards – electrical – physical – chemical – fire – mechanical – supplemental electrical hazards.

Total: 45

References:

1. En Barat (Author), Laser Safety Management (Optical Science and Engineering) CRC (February 22, 2006)
2. Roy Henderson (Author), Karl Schulmeister, Laser Safety (Hardcover), Taylor & Francis (November 1, 2003)

07ML13 NON LINEAR FIBER OPTICS **3 0 0 100**

UNIT I **9**

GROUP VELOCITY DISPERSION

Fiber characteristics, Fiber non-linearities, Basic propagation equation, Group velocity dispersion: Different propagation regimes, Dispersion-induced pulse broadening, Higher-order dispersion.

UNIT II **9**

NONLINEAR REFRACTION

SPM induced spectral broadening, Effect of group velocity dispersion, Higher order nonlinear effects, XPM induced non-linear coupling and modulation instability, spectral and temporal effects.

UNIT III **9**

STIMULATED INELASTIC SCATTERING

Stimulated Raman Scattering: Raman gain and threshold, Quasi-CW SRS, Ultrashort SRS.
Stimulated Brillouin Scattering: Brillouin gain and threshold, Quasi-CW SBS, Dynamic aspects, Brillouin fiber lasers, SBS applications.

UNIT IV **9**

OPTICAL SOLITONS AND POLARIZATION EFFECTS

Solitons: Modulation instability, Fiber solitons, other types of solitons, Pertubation of solitons, Nonlinear birefringence and phase shift, Evolution of polarization state, vector modulation instability, Birefringence and solitons.

UNIT V **9**

PARAMETRIC PROCESSES

Origin and theory of Four-Wave Mixing, Phase-matching techniques, Parametric amplification, FWM applications.
Pulse Compression: Physical mechanism, Grating-Fiber Compressors, solition –effect compressors, other compression techniques.

TOTAL : 45

REFERENCES:

1) G.P.Agrawal, Non-linear fiber optics, 3rd Edition, Academic press, 2001
2) G.P.Agrawal, Applications of nonlinear fiber optics, Academic press, 2001
3) E.G.Sauter, Nonlinear Optics, Wiley Interscience, 1996
4) D.L.Mills, Nonlinear Optics-Basic Concepts, Narosa publishing House, New Delhi, 1991.

07ML14 HIGH SPEED PHOTONICS AND OPTO ELECTRONICS ` 3 0 0 100

UNIT I **9**

ELECTRONICS PROPERTIES OF SEMICONDUCTORS

Semiconductor materials, Band structure, Band structure modification by alloying, Heterostructure, Intrinsic carrier concentration, Defect levels, excess carriers, recombination process, charge injection and non radiative effects.

UNIT II **9**

HIGH SPEED PHENOMENA

Picosecond process in carrier transport theory, carrier-carrier interaction, excitation interaction in super lattices, excitation life time reduction, reduction of electrons – photon scattering rates, hot electron diffusion.

UNIT III **9**

HIGH SPEED OPTOELECTRONIC DEVICES
Mode locked lasers, Fast multiple quantum well absorbers, suppressing of timing and energy fluctuation in lasers, Parametric oscillation in lasers, Ultra fast detectors – metal semiconductor photodiodes, Photoconductors, Switches.

UNIT IV **9**

SELF PULSATION AND ULTRA SHORT PULSE GENERATORS
Gas switching in semiconductor lasers, Self-pulsation in semiconductor laser, bistable laser, Short pulse generation using fiber non-linearity. Period doubling in modulated laser diodes. Optical chaos, Mode locking in laser diodes, Monolithic mode locked laser diodes.

UNIT V **9**

APPLICATIONS
Application to long distance and high speed communication, High speed optical signal processing, Picosecond electro optic sampling, logic gates, parallel processing and inter connectors.

TOTAL : 45

REFERENCES:

1) M.L.Riaziat, " Introduction to high speed electronics and Opto electronics", John Wiley, New York, 1995.
2) Sueta.T, Okoshi.t, " Fundamental of Ultra fast and Ultra parallel opto electronics", John Wiley, New York, 1996.

3) Mourou.G.A., Bloom O.M and Lee. C.H, " Principle electronics and Opto Electronics", Springer Vering, Berlin, 1995.

07ML15 PHOTONIC SWITCHING **3 0 0 100**

UNIT I **9**

PHOTONIC DEVICES

Light sources and laser diodes: semiconductor diode lasers, free-electron lasers, Mode-locking, Q-switching, pulse shaping – Photo detectors – Optical Amplifiers(SOAs) – Integrated Optical Modulators.

UNIT II **9**

OPTICAL SWITCHES

Basic 2X2 switch, layered switch designs, blocking, crosstalk, dilation. Optical cross connects. Add Drop Multiplexers-Routing switches: Kerr gates, four-wave mixing gates, directional couplers, Mach-Zehnder interferometer switches- Acoustic optics.

UNIT III **9**

OPTICAL SWITCHING

Free-space optical switching, optical memory for switching, photonic switch architectures based on TDM, WDM,OCX,ATM.

UNIT IV **9**

SOLITON GATES

Soliton - dragging logic gates; Time domain chirp switch architecture;- Soliton-trapping logic gates; Soliton ring network.

UNIT V **9**

APPLICATIONS OF PHOTONIC SWITCHING

High speed data transmission systems, Clock distribution, All optical fibre communication systems: Clock extraction & dispersion compensation, Power mixing & Frequency division switching, Space switches.

TOTAL : 45

REFERENCES:

1) Bahaa E.A. Saleh, Malvin Carl Teich, "Fundamentals of Photonics" Wiley Interscience ; 1st edition, 2002.
2) Mohammed N.Islam, P.L. Knight, A.Miller, "Ultrafast Fiber Switching Devices and Systems" Cambridge University Press 1992.
3) H. Kawaguchi, "Bistabilities and Non-Linearities in Laser Diodes" , Artech house Inc,Norwood, 1994.

07ML16 LASER SATELLITE COMMUNICATION **3 0 0 100**

UNIT I **9**

INTRODUCTION TO LASER COMMUNICATIONS

Atmospheric low loss windows, optical sources and detectors for these windows, Characteristics of source and detectors. Optical transmitting and receiving antennas.

UNIT II **9**

SYSTEM DESIGN

Link equation, Transmitter terminal, Antenna design, Antenna gain, Beam width, C/N, Optical detectors, Optical modulation formats, Deriving error statistics, Signal requirements for acquisition and tracking, Fundamentals of system design.

UNIT III **9**

SEMICONDUCTOR AND METAL LASER SOURCES FOR SATELLITE COMMUNICATIONS

Performance and Geometries, output wavelength control, Semiconductor laser lifetime, Direct and indirect modulation techniques and radiation effects.

UNIT IV **9**

OPTICAL RECEIVERS AND SYSTEM DESIGN

Direct detection, coherent detection and demodulation. Gimbals in transceiver design, Receiver options and optics; Lasers; antennas / Telescope, Internal optical systems, Transmitter analysis.

UNIT V **9**

LASER BEAM POINTING CONTROL

Acquisition and Tracking systems, System description, Acquisition methodology, racking and pointing control system, RF cross link system design, link equation

TOTAL : 45

REFERENCES:

1. Morris Katzman, “Laser Satellite Communications”, Prentice Hall Inc, New York, 1991.
2. J. Franz and V.K.Jain, “Optical Communication Systems”, Narosa Publication, New Delhi, 1994.

07ML17 SOLITONS IN OPTICAL COMMUNICATION **3 0 0 100**

UNIT I **9**

INTRODUCTION

Solitons – an Introduction, Soliton based communication systems, fiber solitons, Non Linear Schrodinger equation and a solitary wave solution, temporal soliton dynamics, Parameters for Soliton transmission, Loss Managed Soliton, Dispersion Managed Soliton.

UNIT II **9**

DARK SOLITONS AND PERTURBATION METHODS

Dark solitons, Kerr medium- Inverse scattering transforms, Non- kerr Media- Soliton solutions- Perturbation methods- Conservation Laws- Stability.

UNIT III **9**

SOLITON RESHAPING AND TRANSMISSION CONTROL

Reshaping schemes – Lie transformation – guiding centre soliton – Reshaping of solitons in Erbium doped fiber amplifiers and Raman amplifiers, Soliton transmission control : The Gordon Haus limit, Guiding Filter, Soliton control in frequency and time domains, Synchronization techniques.

UNIT IV **9**

INTERACTION BETWEEN SOLITONS

Two soliton interaction in the same element, suppression, Soliton interaction in different channels: Wavelength division multiplexing, Birefringence effects and polarization division multiplexing.

UNIT V **9**

SOLITON TRANSMISSION AND APPLICATIONS

Soliton based communication system design, High capacity Soliton systems, long distance soliton transmission, Soliton laser, Optical soliton switching, WDM Soliton systems, spatial soliton application.

TOTAL : 45

REFERENCES:

1) Akira Hazegawa an Yuji Kodama, Solitons in Optical Communication, Oxford University Press Inc, Oxford, 1995.
2) Y.S. Kivshar, Optical Solitons : From fibers to Photonic Crystals, Academic Press, 2003.
3) Iannone Engenio, Matera Francesco, Mecozzi Antonio & Settembre Marina , Non Linear Optical Communication Networks, John Wiley and Sons, NewYork, 1998.
4) Govind P. Agarwal, Non Linear fiber Optics, Academic Press, New York, 1995.

07ML18 ULTRAFAST LASERS **3 0 0 100**

Unit I **9**

Ultra short pulse measurement techniques : photodetectors and sampling oscilloscopes, electron optical chronography, characterization of pulses by intensity autocorrelation, nonlinear optical materials, interferometric autocorrelation and chirp determination.

Gain and Q switching : Gain switching, active Q switching in diode lasers, passive Q switching,

Unit II **9**

Mode locked lasers: Active mode locking, passive and hybrid mode locking, colliding puse mode locking, monolithic mode locked lasers, additive pulse mode locking in diode lasers, timing jitter of mode locked lasers, performance characteristics of mode locked lasers,

Unit III **9**

Optical pulse compression and ultra fast non-linear phenomenon : Propagation of ultra short laser pulses through optical fibers, soliton effect compression and soliton propagation of pulses, ultra fast nonlinear phenomenon in semiconductor laser amplifiers

Unit IV **9**

Ultra fast diode laser in optical communication: high speed modulation of diode lasers, spectral broadening and spectral control under high speed modulation, high bit rate data encoding, Optical TDM, all optical clock extraction, limitations.

Unit V **9**

Diode laser in optoelectronics and instrumentations: generation of ultra fast electrical waveforms, pico second and sub picosecond electro optic sampling, picosecond optoelectronic diagnostics of high speed electronic devices, high speed optoelectronic devices, optical time domain reflectrometry systems, diode laser radars, High power lasers: surface emitting lasers, Bow-Tie lasers, ultra fast semiconductor laser amplifiers.

Total: 45

References:

1. Peter Vasil'ev, Ultrafast Diode Lasers: Fundamentals and Applications, Artech House Publishers (May 1995)
2. Martin E. Fermann, Almantas Galvanauskas, Gregg Sucha, Ultrafast Lasers: Technology and Applications, CRC (October 25, 2002)
3. Introduction to Laser Diode-Pumped Solid State Lasers (SPIE Tutorial Texts in Optical Engineering Vol. TT53) (Paperback), SPIE Publications (January 11, 2002)

07ML19 MICROPHOTONICS **3 0 0 100**

Unit I **9**

Fundamental of interaction of light with matter: wave equation, band gap in solid, index of refraction, polarization, reflection and transmission, total internal reflection, optical waveguides, dispersion in dielectrics, dispersion in semiconductors, wave propagation in non linear media, electroabsorption, Braggs reflection, photonic gap ban d structure, photonic crystal fibers, stimulated emission in semiconductors, the sagnac effect, evanescent waves, smart thin film coatings, Quantum photonic effects, Fabry-Ferot cavities.

Unit II **9**

Photonic node : Microphotonic node, Transmitters: transmission systems, optical sources, modulators, Couplers and switches: Couplers and splitters, optical isolators, gratings, waveguide collimators, total internal reflection T junction, optical switches, MOEMs based switches, waveguide switches, SOA switches, waveguide grating routers, evanescent switches, optical cross connects, hybrid PBG/MOEMS switches, multiplexers: TDM, WDM, filters, reconfigurable optical add-drop multiplexers

Unit III **9**

New technologies: MOEMS, PBG structures, ring resonators, smart coatings, hybrid structures, Materials, fabrication and integration: Materials, fabrication, integration approaches, fabrication of smart coatings

Unit IV **9**

Advanced microphotonic devices: Photonic Computer, optical memory storage devices, band gap sensors, cascade lasers, Miniature- IR spectrometers, FP filters, shutter arrays, superprism Quantum photonic devices: Quantum Communication, building blocks, quantum computers

Unit V **9**

Future systems and their applications: microphotonic in space: optical interconnects for spacecraft, satellite optical communication link, quantum communication link in space, optical beamformers in SAR antennas, photonic sensing systems, satellite navigating systems, thermal radiator devices, sun shields.

Total: 45

References:

1. Wes R. Jamroz, Roman Kruzelecky, Emile I. Haddad, Applied Microphotonics (Optical Science and Engineering Series), CRC (June 27, 2006).
2. O. Bisi (Author), INTERNATIONAL SCHOOL OF PHYSICS ENRICO (Author), S. U. Campisano (Editor), L. Pavesi (Editor), F. Priolo (Editor), Silicon-based Microphotonics (Proceedings of the International School of Physics) (Hardcover), Ios Pr Inc (January 1, 2000).
3. K. Wada (Editor), Thomas F. Krauss (Editor), Pierre Wiltzius (Editor), Kiyoshi Asakawa (Editor), Edwin L., Ph.D. Thomas (Editor), Microphotonics--Materials, Physics, and Applications: Symposium Held November 27-29, 2000, Boston, Massachusetts, U.S.A (Materials Research Society Symposia Proceedings, V. 637,) (Hardcover), Materials Research Society (November 2001)

07ML20 MOLECULAR LASERS **3 0 0 100**

Unit I **9**

Emission spectra of molecular lasers : Introduction, Vibrational –rotational spectra of molecules, laser spectroscopy of CO_2 molecules, infrared and far infrared laser transitions,

Unit II **9**

RF discharge excited CO_2 lasers: Introduction, waveguide lasers, propagation in hallow dielectric waveguides, waveguide laser resonators, RF gas discharge, electrical characteristics of RF waveguide lasers, development in RF excited CO_2 waveguide lasers.

Unit III **9**

High power electron beam controlled CO_2 lasers:Overview of CO_2 laser process, electron beam controlled lasers, electron beam generators, electron beam stability, molecular kinetics, the pump process, energy extraction, parasitic oscillation, suppression of parasitic oscillation effects of spontaneous emission, materials.

Unit IV **9**

Optically pumped FIR lasers: Introduction, system characteristics, continuous wave three level systems, pulsed systems, optically pumped molecules

Unit V **9**

Transient and instabilities in FIR lasers: Introduction, FIR laser action, vibration dynamics and the bottleneck effect, two level model of the FIR laser, transient regime of the FIR laser, , three level model of the FIR laser, far infrared laser instabilities.

Total: 45

References:

1. Peter Cheo, Handbook of Molecular Lasers (Optical Engineering), CRC (August 31, 1987)
2. Bandrauk (Author) , Molecules in Laser Fields (Hardcover), CRC (December 14, 1993)
3. Sergei I. Anisimov, Instabilities in Laser-Matter Interaction (Hardcover), CRC (March 23, 1995)

07ML21 SPATIAL LIGHT MODULATOR **3 0 0 100**

Unit I **9**

Nematic liquid crystals : physical properties of liquid crystals, physical mechanism for modulating light, electro-optics of nematics crystals, electro-optics of polymer dispersed liquid crystals, Physical properties of Smectic liquid crystals and novel electro-optic effects: molecular structures, space symmetry in Smectics, new electro-optical properties, applications

Unit II **9**

Nonlinear optical properties of organic materials: Basic mechanism, dispersion measurement, squaraines, excited state enhanced mechanism, electro-optic polymer devices, Photorefractive materials: photorefractive effect, current status, development of tungsten bronze crystal, application,

Unit III **9**

Devices: basic MQW structures and electro-optic properties, MQW spatial light modulator arrays, Ferroelectric liquid crystal spatial light modulators: ferroelectric liquid crystal structures, surface alignment, optically addressed SLMs, matrix addressed SLMs, active backplane SLMs, Ferroelectric liquid crystal SLM in perspective

Unit IV **9**

Magneto Optic Spatial light modulators : crystal growth, electromagnetic switching operation, optical properties, sample reflectivity, contrast ratio -consideration, measurement, modeling, application in pattern recognition, NIFFTE DYNAMO correlator, OPID DYNAMO correlator, compact rugged field versions of the DYNAMO correlator, Litton miniature HOCKEY PUCK DYNAMO correlator, reflector mode MOSLM

UNIT V **9**

Charge transfer plate membrane mirror light modulators: Charge transfer plate, membrane mirror light modulators, Acousto-optic Bragg cell devices: Acousto-optic Bragg interaction, Acousto-optic Bragg cells, Smart Pixels: Design Parameters, materials and devices, integration technologies, potentials for smart pixels.

Total: 45

References:

1. Uzi Efron, Spatial Light Modulator Technology (Optical Engineering), CRC (September 29, 1994)
2. Spatial Light Modulators: 28-29 January 1998 San Jose, California (Proceedings of Spie--the International Society for Optical Engineering, V. 3292.) by Society of Photo-Optical Instrumentation Engineers and Richard L. Sutherland, SPIE-International Society for Optical Engine (January 1998)
3. Uzi Efron , Spatial Light Modulators: Technology and Applications: 31 July-1 August 2001, San Diego, USA (SPIE Proceedings), SPIE-International Society for Optical Engine (January 2001)

07ML22 OPTICAL MEMS **3 0 0 100**

Unit I: Introduction **9**

Micromechanical photonics, fabrication methods, miniaturized systems with microoptics and micromechanics, Integrated systems with LDs and micromechanics

Unit II: Short external cavity laser diode **9**
Theoretical analysis, experimental analysis, applications design for related problems of an ESEC LD

Unit III: Optical Tweezers, **9**
Theoretical analysis, experimental measurement and comparison, application of optical tweezers,

Unit IV: Optical Rotor **9**
Introduction, theoretical analysis I and II, fabrication and evaluation, Mixer application of μ-TAS

Unit V: Near Field **9**
Introduction, theoretical analysis, experimental analysis and future application

Total: 45

References:

1. H. Ukita , Micromechanical Photonics (Microtechnology and MEMS) , Springer; 1 edition (June 2, 2006)

07ML23 NANOPHOTONICS **3 0 0 100**

Unit I: Introduction to Nano photonics **9**

Foundation for nanophotonics : Photons and electrons, nanoscale optical interactions, nanoscale confinement of electronic interactions, Near field interaction and microscopy: near field optics, theoretical modeling of near field nanoscopic interactions, Near field microscopy, examples of near field studies, apertureless near field spectroscopy and microscopy, nanoscale enhancement of optical interactions, time and space resolved studies of nanoscale dynamics, available sources for near field microscope.

Unit II: Quantum confined materials **9**

Inorganic semiconductors, manifestation of quantum confinement, dielectric confinement effect, superlattices, core shell quantum dots and quantum dot-quantum wells, organic quantum-confined structures,

Unit III: Plasmonics and nanocontrol of excitation dynamics **9**

Plasmonics: Metallic nanoparticles and nanorodsmetallic nanoshells,local field enhancement, aperture plasmonics, plasmonic wave guiding, applications of metallic nanostructures, radiativity decay engineering, nanocontrol of excitation dynamics: Nanostrucres and excited states, rare earth doped nanostructures, up-converting nanopores, photon avalanche, quantum cutting, site isolating nanoparticles

Unit IV: Nanomaterials and Nanocomposites: **9**

Growth methods of nanomaterials, characterization of nanomaterials, Photonic crystals: basic concepts, theoretical modeling of photonic crystal, features of photonic crystal, methods of fabrication, photonic crystal optical circuitry, nonlinear photonic crystals, photonic crystal fibers, photonic crystal and optical communications, photonic crystal sensors, Nanocomposites: Nanocomposites as photonic media, Nanocomposite waveguide, random lasers, local field enhancement, multiphasic nanocomposites, Nanocomposites for optoelectronics, polymer dispersed liquid crystals (PDLC), Nanocomposite materials

Unit V: Biomaterials and nanophotonics: **9**

Bioderived materials, bioinspired materials, biotemplates, bacteria as biosynthesizers, Nanophotonics for biotechnology and nanomedicines: Near field bioimaging, nanoparticles for optical diagnostics and targeted therapy, semiconductor quantum dots for bioimaging, up converting nanophores for bioimaging, biosensing, nanoclinics for optical diagnostics and targeted therapy, nanoclinic gene delivery, nanoclinic for photodynamic theraphy,

Total 45

References:

1. Paras N. Prasad, Nanophotonics, Wiley-Interscience, 2004
2. Paras N. Prasad, Introduction to Biophotonics , Wiley-Interscience, 2003.
3. Stefan A. Maier, Plasmonics: Fundamentals and Applications, Springer; 1 edition (May 15, 2007)
4. Thomas E., Ph.D. Twardowski , Introduction to Nanocomposite Materials: Properties, Processing, Characterization, Destech Publications (April 15, 2007)
5. Buddy D. Ratner , Allan S. Hoffman , Frederick J. Schoen , Jack E. Lemons , Biomaterials Science, Second Edition: An Introduction to Materials in Medicine, Academic Press; 2 edition (July 29, 2004)

07ML24 QUANTUM ELECTRONICS **3 0 0 100**

UNIT I: BASIC THEOREMS AND POSTULATES OF QUANTUM MECHANICS **9**

The Schrodinger wave equation, some solutions of time independent Schrodinger equation, Matrix formulation of quantum mechanics, Lattice vibration and their quantization, Electromagnetic fields and their quantization.

UNIT II: LASER **9**

Gaussian beam in a homogenous medium, Gaussian beam in a lens waveguide, Elliptic Gaussian beams, Optical resonators, Spontaneous and induced transitions, gain coefficient, homogenous and inhomogeneous broadening, Laser oscillations, Semiconductor laser, quantum well laser, modulation of optical radiation, Q switching and Mole locking of laser, Quantum wires and dots, Laser arrays, Concept of super modes, Phase amplitude in laser, Free electron lasers.

UNIT III: NONLINEAR OPTICS **9**

The nonlinear optical susceptibility tensor, Second harmonic generation, parametric oscillations, parametric amplifiers, Applications.

UNIT IV: STIMULATED RAMAN AND BRILLOUIN SCATTERING 9

Stimulated Raman scattering, Antisokes scattering, stimulated Brillouin scattering, self focusing of optical beams.

UNIT V: NOISE 9

Introduction, noise in laser amplifier, spontaneous emission noise in laser oscillators, some mathematical background, laser equation, laser spectra, laser spectra measurement, the α parameter, the measurement of $(\Delta\nu)_{laser}$ **TOTAL : 45**

REFERENCES:

1. Schubert Max, Wilhelmi Bernd, Non liner Optics and Quantum Electronics, John Wiley, New York, 1998.
2. D.Marcuse, Principle of Quantum Electronics, Academic Press, New York, 1980.
3. J.T. Verdeyen, Laser Electronics, Prentice Hall of India, New Delhi, 1981.
4. A.Yariv, Optical Electronics, Holt Reinhart and Winston, Cambridge, 1983.
5. G.P.Agarwal and N.K.Dutta, Long Wavelength Semiconductor lasers, Von Nostrand Reinholt, New York, 1985.
6. Harisson Paul, Quantum Wells, Wires and Dots, John Wiley, New York, 2000.
7. A.Yariv, Quantum Electronics, 3rd ed, John Wiley, New York, 1989.

07ML25 LASER BEAM SHAPING TECHNIQUES 3 0 0 100

Unit 1 **9**
Mathematical and physical theory of lossless beam shaping

Unit 2 **9**
Gaussian beam shaping : Diffraction theory and Design, Geometrical methods,

Unit 3 **9**
Beam shaping for optical data storage, laser beam shaping by means of flexible mirrors

Unit 4 **9**
Optimization based techniques for laser shaping optics, Beam shaping with diffractive diffusers

Unit 5 **9**
Multi aperture beam integration systems

Total: 45

References:

1. Fred M. Dickey (Editor), Scott C. Holswade (Editor), Laser Beam Shaping: Theory and Techniques, TF-CRC (2000).

2. Fred M. Dickey (Editor), Scott C. Holswade (Editor), David L. Shealy (Editor), Laser Beam Shaping Applications, CRC (July 26, 2005)

07ML26 OPTICAL COMPUTING **3 0 0 100**

UNIT I **9**

BASICS OF OPTICAL COMPUTING

Sources, Basic elements of Optical System, Acousto-Optic System, Limitations, Detectors, Holographic techniques

UNIT II **9**

OPTICAL IMAGING AND NUMERICAL PROCESSING

Spectral analysis and filtering, Pattern Recognition, Picture Deblurring, Synthetic Aperture Radar Imaging , Transforms, Simple Arithmetic, Matrix Operations, Differentiation and Integration.

UNIT III **9**

ANALOG OPTICAL COMPUTING

Linear optic processing, Analog optical arithmetic, Recognition by analog optical system.

UNIT IV **9**

DIGITAL LOGIC

Logic elements and Operations, Combinational Logic, Sequential Logic.

UNIT V **9**

DIGITAL OPTICAL COMPUTING

Devices, Shadow casting, Symbolic substitution, Optical matrix processing

TOTAL : 45

REFERENCES

1) Karim Mohammed and A.S. Abdul Awwall, Optical computing-An introduction, John Wiley, New York ,1992.
2) Dror Feitelsen. Optical Computing, MIT press, Cambridge, 1988

07ML27 INTEGRATED OPTICS **3 0 0 100**

UNIT I **9**

OPTICAL MODES

Advantages of Integrated Optics, Substrate Materials for Optical Integrated Circuits, Optical Waveguide modes, Modes in a Planar Waveguide structure, Ray Optic approach to Optical Mode theory, theory of Optical Waveguides.

UNIT II **9**

OPTICAL WAVEGUIDES

Waveguide fabrication techniques, Polymer and Fiber Integrated Optics, Losses in Waveguides, Waveguide Input and Output Couplers, Coupling between waveguides.

UNIT III 9

OPTICAL INTEGRATED CIRCUIT

Microfabrication techniques in optical integrated circuits, Pattern fabrication, passive waveguide devices-Functional devices.

UNIT IV 9

SEMICONDUCTOR INTEGRATED OPTIC DEVICES

Basic principles of Light Emission in Semiconductors, Semiconductor Lasers, Heterostructure, Confined Lasers, DFB Lasers, Direct modulation of Semiconductor lasers, Quantum well Devices, Micro optic Electromechanical Devices.

UNIT V 9

APPLICATIONS OF OPTICAL INTEGRATED CIRCUITS

Application of OI circuits, Optoelectronic IC, Optical switches, convolvers and correlators, Devices & systems for Telecommunications, Photonic and Microwave Wireless Systems.

TOTAL : 45

REFERENCES:

1. Hiroshi Nishihara, Masamitsu Haruna, Toshiaki Suhara, Optical Integrated Circuits, McGraw –Hill, New York, 1992.
2. Robert .G. Hunsperger, Integrated Optics, Springer – Verlag, 5th Edition, New York 2002.

07ML28 OPTICAL WAVEGUIDE TECHNOLOGIES 3 0 0 100

Unit I 9

Wave theory of optical waveguides, Planar optical waveguides: Slab waveguides, rectangular waveguides, radiation field from waveguides, MMI device.

Unit II 9

Optical fibers : Basic equation, wave theory of step index fibers, optical power carried by each mode, linearly polarized mode, fundamental HE_{11} mode, dispersion characteristics of step index fibers, wave theory graded index fibers, relation between dispersion and transmission capacity, birefingent optical fibers, dispersion control in single mode optical fibers, photonic crystal fibers.

Unit III 9

Coupled mode theory: derivation of coupled mode equations based on perturbation theory, codirectional couplers, contradirectional coupling in corrugated waveguides, derivation of coupling coefficients, optical waveguide devices using directional couplers, fiber Bragg gratings.

Unit IV 9

Non linear optical effects in optical fibers: Figure of merit for nonlinear effects, Optical Kerr effects, optical solitons, optical pulse compressions, light scattering in isotropic media, stimulated Raman scattering, simulated brillouin scattering, second harmonic generation, Erbium doped fiber amplifier, four wave mixing in optical fibers.

Unit V 9

Finite element methods : FEM analysis of slab waveguides, FEM analysis of optical fibers, FEM analysis of rectangular waveguides, Stress analysis of optical waveguides, semi vector FEM analysis high index contrast.

Total: 45

References:

1. Katsunari Okamoto, Fundamentals of Optical Waveguides, Second Edition, Academic Press; 2 edition (December 13, 2005)
2. Maria L. Calvo (Editor), Vasudevan Lakshminarayanan (Editor), Optical Waveguides: From Theory to Applied Technologies, CRC (January 19, 2007)
3. John A. Buck, Fundamentals of Optical Fibers, Wiley-Interscience; 2 Sub edition (April 27, 2004)

07ML29 LASER APPLICATIONS IN SURFACE SCIENCE AND TECHNOLOGY 3 0 0 100

Unit I **9**

Light and matter : Coherent light sources, surfaces, adsorption desorption, and diffusion: laser induced thermal desorption, desorption following electronic excitation, other laser induced desorption process.

Unit II **9**

Spectroscopy: Spectroscopic methods, fluorescence spectroscopy near interfaces, surface enhanced Raman scattering, second harmonic generation, sum frequency generation, higher order wave mixing,

Unit III **9**

Dynamics and ultra fast studies: Electron relaxation dynamics, relaxation of nuclear motion, ultra fast phase transitions, photochemistry, picosecond electron diffraction,

Unit IV **9**

Fundamental laser surface treatment : heating and melting, plasma generation, laser Medicine : medical laser surface treatment, laser in ophthalmology, basic mechanism,

Unit V **9**

Advanced treatment: Laser Annealing, Laser ablation, laser cleaning,laser induced periodic structures, laser LICA, laser CVD, pulsed laser deposition,

Total: 45

References:

1. H.-G. Rubahn, Laser Applications in Surface Science and Technology, Wiley (May 11, 1999)
2. John C. Miller, Laser Ablation: Principles and Applications (Springer Series in Materials Science) (Hardcover), Springer (December 1994).

07ML30 OPTICAL IMAGING TECHNIQUES 3 0 0 100

UNIT I **9**

INTRODUCTION

Coherance and light source, optical image formation, Franhoufer diffraction, Single slit, double slit circular aperture, double aperture gratings, 1D and 2D lens aperture, Interference.

UNIT II **9**

FOURIER SERIES AND TRANSFORM

Fourier series, Fourier coefficients, optical and crystal diffraction gratings, Fourier series formulation, Fourier transform and single slit diffraction, grating pattern, Fourier transform of light waves, correlation.

UNIT III **9**

OPTICAL IMAGING AND PROCESSING

Incoherent optical imaging, transfer function, coherent optical imaging, periodic and non periodic objects, optical transform, Holography, coherent and incoherent optical processing.

UNIT IV **9**

IMAGE CONSTRUCTION TECHNIQUES

X- ray computed tomography, reconstruction by simple back projection, iterative reconstruction, analysis methods, magnetic resonance imaging, Ultrasonic computed tomography.

UNIT V **9**

APPLICATIONS

Michelsons stellar interferometry, spectral interferometer, fringe visibility and spectral distribution, partial coherence and correlation, Fourier transform spectroscopy, Synthetic aperture radar, Intensity interferometer, Imaging by holographic techniques.

Total: 45

References:

1) E.G. Stewart, Fourier Optics an Introduction, 2nd Edition, Ellis Harwood limited, Chichester, 1987.
2) Dror.G. Feitelson, Optical Computing, MIT press, Cambridge, 1988.

07ML31 LASER AND ITS APPLICATIONS **3 0 0 100**

UNIT I **9**

LASER THEORY

Laser Theory and Principles, Wave Nature of Light – The Interaction of Light with Matter, Atomic Absorption, Energy Levels and Radiative Properties of Molecules, Liquids, Solids and Semiconducators, Radiative Transition and Emission Line Width, optical Resonators, Q Switching and Mode Locking Techniques, Rate Equation.

UNIT II **9**

TYPES OF LASERS

He-Ne Lasers, Co2 Laser, He-Cd Laser, Ruby Laser, Pulsed Laser, Nd-Yag Laser, Chemical and Dye Laser, Excimer Laser, Nitrogen- Lasers , Xenon – Helium Laser.

UNIT III **9**

SEMICONDUCTOR LASERS

Semiconductor Laser Theory, Structure, Excitation, Gain Coefficient and Threshold
Density, Passive, Active and Injection Locking Mode, HetroStructure,Large Optical Cavity and Quantum Well and Quantum Dot Lasers, External Cavity Lasers,Vertical
Cavity Surface Emitting Lasers, Pumped Lasers.

UNIT IV **9**

LASER AMPLIFIERS

Absorption and Gain, Laser Oscillation above Threshold, Amplification of Short and Long Duration Pulses, Pumping Requirements and Techniques. Fiber Non-Linearity, Optical Amplifiers, Rare Earth Doped Fiber Amplifiers, Fiber Lasers, Soliton Lasers, Raman Fiber Laser.

UNIT V **9**

APPLICATIONS

Holography,Optical Communication, LIDAR, Remote Sensing, Bio Medical Applications.Industrial Applications: Metal Cutting and Welding Processes. Optical Metrology and Precision Measurements.

Total: 45

References:

1) J.T.Verdeyan,Laser Electronics – Prentice Hall India, New Delhi, 1995.
2) Jeff Hecht, The Laser Guide Book, McGraw Hill Professional, 2nd Edition,1999.
3) Anthony E.Siegman, Lasers, University Science Books, 1986.
4) William T.Silfvast, Laser fundamentals, Cambridge University Press, 2nd Edition, 2004.
5) H.Koebner, Ed, Industrial Applications of Lasers, John Wiley, New York, 1984.
6) Olbarshi. M.L,Laser Applications in Medicine and Biology, Plenum press, New York,1989.