INTERNATIONAL SCHOOL OF PHOTONICS (ISP)

COURSE STRUCTURE AND SYLLABI OF
M.Tech (Optoelectronics & Laser Technology)
&MPhil (Photonics)

COCHIN UNIVERSITY OF
SCIENCE AND TECHNOLOGY
COCHIN – 682 022

2008
Contact Address

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Cochin University of Science and Technology
Cochin-682 022
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PHOTONICS

Photonics is the technology of generating and harnessing light and other forms of radiant energy whose quantum unit is a photon. In addition to a good theoretical foundation of optical phenomena, the subject includes the technology related to emission, transmission, detection, amplification and other forms of manipulation of light using optical components, systems and devices. Lasers, fibre optics and related optoelectronic systems form an integral part of Photonics. In short Photonics is the science and technology for harnessing light for various beneficial human activities. Numerous consumer items using Photonics technology have already started to enter our daily lives as in a CD player or TV remote control.

The era of Photonics began with the invention of laser in 1960. It made a direct impact on telecommunications with the perfection in the late 1970’s of low loss optical fibers for long haul under sea and terrestrial communications. Photonics technology steadily penetrated into other industrial as well as military applications. Theoretically, almost any physical or environmental parameter can be measured using light, and consequently quantities like temperature, strain, electric current, vibration, chemical and biological pollutants can be accurately measured using a wide range of ultra sensitive optical sensors which have evolved in recent times. Another growing area is biophotonics, where Photonics technology is used to develop new procedures and techniques in biotechnology, microbiology, medicine, surgery and other life sciences. Photonics has a strong reputation of solving research problems through advanced spectroscopy, lasers, microscopy and fiber optic imaging. The use of light in meeting the demands of society’s growing needs is just beginning. The use of light will most certainly and dramatically change the quality of almost every aspect of our daily lives.

CUSAT is one of the few universities/institutions in India that have facilities for R&D activities and manpower training in Photonics and related fields. The integrated M.Sc. degree course in Photonics conducted by Center of Excellence in Lasers and Optoelectronic Sciences (CELOS), M.Tech in Optoelectronics and Laser Technology, M.Phil and Ph.D programme in Photonics offered by International School of Photonics (ISP) of CUSAT are designed specifically for the purpose of manpower training and R&D activities in the area of Photonics.
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# M.Tech Course Structure

## Semester I

<table>
<thead>
<tr>
<th>Course code</th>
<th>Paper</th>
<th>Core/Elective</th>
<th>Credits</th>
<th>Marks</th>
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<tr>
<td>ISP 3101</td>
<td>Modern Optics</td>
<td>C</td>
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<td>Lab course II</td>
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<td>Laser Applications</td>
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<td>ISP 3205</td>
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<td>ISP 3208</td>
<td>Advanced laser systems</td>
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<td>ISP 3209</td>
<td>Biophotonics</td>
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<td>ISP 3210</td>
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### Semester IV

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|            | Total credits | 8             | 72      | 1900  |

**Courses for outside departments (2-credit courses)**

- ISP 501 Lasers and Applications
- ISP 502 Fibre Optics and Applications
- ISP 503 Nonlinear Optics and Optical Computing
- ISP 504 Biophotonics
- ISP 505 Quantum Mechanics for Engineers.
M.Tech. (O E & L T)
Detailed Syllabus

SEMESTER I
ISP – 3101 MODERN OPTICS

MODULE I
ISP – 3101 MODERN OPTICS


Polarisation: Polarisation ellipse, Different polarization states, Stokes parameters and their measurements. Jone’s vectors and matrices.

MODULE II
Coherence: Young’s double slit, double slit with an extended source, Michelson’s interferometer, Mach-Zehnder interferometer, Multiple beam interference, Fabry-Perot interferometer, Resolving power, Free spectral range and Finesse of Fabry-Perot interferometer. Interference filters. Sagnac effect, Sagnac interferometer.


MODULE III

MODULE IV

MODULE V
Elements of Fourier optics: Concept of spatial frequencies, Effect of lens on a wave front, Lens as a Fourier transform element. Theory of Imaging.

Elements of Adaptive optics: Principles of Adaptive optics, Wave front distortion, wave front sensors, wave front reconstruction (qualitative treatment only).

REFERENCES

Module I
Radiative transitions and emission line widths, Radiative decay of excited states of atoms, spontaneous emission, collisional depopulation in atomic and molecular gases, emission broadenings, homogeneous and inhomogeneous broadenings, radiation and Thermal equilibrium, Plank’s law for cavity radiation, absorption and stimulated emission. Einstein’s A and B coefficients, Conditions for producing laser action, absorption and gain of a homogeneously broadened radiative transition, gain coefficient and stimulated emission cross section for homogeneous and inhomogeneous broadening.

Module II
Necessary and sufficient conditions for laser action (population inversion and saturation intensity), growth of gain medium with homogeneous broadening and inhomogeneous broadening, threshold requirements for a laser with and without cavity, laser oscillation above threshold and saturation of laser gain, Principle of laser amplifiers. Requirements to obtain population inversion, rate equation for three and four level systems, three level system with upper laser level as the highest level, transient population inversion, pumping threshold requirements, pumping parameters associated with optical and particle pumping.

Module III
Laser cavity modes: Fabry Perot cavity modes, longitudinal and transverse modes, mode characteristics, spectral and spatial hole burning, stability of laser resonator, stability diagram, optimisation of output coupling, unstable resonators, ring cavity.

Module IV
Q switching general theory, active and passive Q-switching techniques, Mode locking, general theory, active and passive mode locking, mode locking by pulse shortening, tunable cavities, properties of laser beam, experimental techniques to characterize laser beam

Section V

References:
3. Lasers-Theory & Applications-Ghatak & Thyagarajan (McMillan, India 1991) (Text)
ISP 3103 OPTO ELECTRONICS

MODULE I

Nature of light, light sources, black body, colour temperature, units of light, radio metric and photometric units, basic semi conductors, PN junction, carrier recombination and diffusion, injection efficiency, heterojunction, internal quantum efficiency, External quantum efficiency, double hetero junction, fabrication of heterojunction, quantum wells and super lattices.

MODULE II

Opto electronic devices, Optical modulators, modulation methods and modulators, transmitters, optical transmitter circuits, LED and laser drive circuits, LED-Power and efficiency, double heterostructure LED, LED structures, LED characteristics, laser modes, strip geometry, gain guided lasers, index guided lasers.

MODULE III

Modulation of light, birefringence, electrooptic effect, EO materials, Kerr modulators, scanning and switching, self electro optic devices, MO devices, AO devices, AO modulators.

MODULE IV

Display devices, Photoluminescence, cathodo luminescence, EL display, LED display, drive circuitary, plasma panel display, liquid crystals, properties, LCD displays, numeric displays.

MODULE V

Photo detectors, thermal detectors, photoconductors, detectors, photon devices, PMT, photodiodes, photo transistors, noise characteristics of photo-detectors, PIN diode, APD characteristics, APD Design of detector arrays, CCD, Solar cells.

REFERENCES:

2. Optical fibre communication - J M Senior (Prentice Hall India (1985)
4. Introduction to optical electronics - J Palais (Prentice Hall, 1988)
ISP 3104 INDUSTRIAL MANAGEMENT

MODULE I

Definition of management, what is management, how managers carry out their functions, characteristics of management, levels of management, management skills. Evolution of management theory, scientific management, principles of scientific management, administrative management, modern management theories. Functions of management, planning, forecasting, organising, staffing, directing, motivating, controlling, coordinating, communicating, decision making.

MODULE II

Quality management, definition, QC function, qualify systems, quality control, quality cost, accounting for quality cost, and less-quality audit.

Marketing management, market, market research 4Ps of marketing, sales forecasting, materials management, purchasing, stores and store keeping, inventory control (ABC, VED, JIT). Programme evaluation and review techniques (PERT), Critical path method (CPM), introduction to MS projects.

MODULE III


Financial ratio, capital, classification of capital, working capital, need for working capital, assessment of working capital factors, affecting working capital. Break even analysis, depreciation, equipment replacement policy.

REFERENCES:

1. Industrial organisation and Management - Bethel te (McGraw Hill).
2. Principles of Industrial management - Koonz nad Doel
6. Projects - Prasanna Chandra (Tata McGraw Hill)
7. Industrial Finance India - S.K. Basu
8. First Steps in Book Keeping - J.B. Batliboi
12. The essentials of Project Mafmejife Dennis Lock; (GoverPub)
13. Organization Theory-Mary Jo Hatch
MODULE I

Unguided optical communication system, transmission parameters, beam divergence, atmospheric attenuation, guided wave communication, merits of optical fibre communication systems, basic network information rates, time evolution of fibre optic systems, elements of optical fiber transmission link, repeaters, integrated optics, active and passive components, opto-mechanical switches, all optical switches.

MODULE II


MODULE III

Digital transmission systems. Point to point links, system considerations, link power budget, rise time budget, first window transmission distance, transmission distance for single mode links, line coding, NRZ codes, RZ codes, block codes. Coherent systems, homodyne and heterodyne detection. Multiplexing schemes, TDM, WDM concepts and components, operational principles of WDM, passive components, 2 x 2 fibre coupler, fiber grating filters, Tunable filters, system consideration and tunable filter types.

MODULE IV

Optical amplifiers, general applications and amplifier types, semiconductor optical amplifiers, external pumping, amplifier gain, erbium doped fiber amplifiers, amplification mechanism, EDFA architecture, EDFA power conversion efficiency and gain, amplifier noise.

MODULE V


REFERENCES

1. Optical Fibre Communications – J M Senior (Prentice Hall India 1994) (Text)
2. Fibre Optic Communication – C Agarwal (Wheeler, 1993)
6. Optical Fibre Communication – G Keiser (3rd Ed), 2000 (Text)
SEMESTER II

ISP 3201 FIBRE OPTICS AND APPLICATIONS

MODULE I

MODULE II
Optical fibre connection: joints and couplers Fibre splices, fusion splices, mechanical splices. Fibre connectors, Expanded beam connectors. Fibre couplers. Source to fibre and fibre to fibre coupling. Coupling losses.

MODULE III

MODULE IV
Optical fibre measurements: Attenuation measurements, Dispersion measurements (time domain and frequency domain) Measurements of NA, Diameter and refractive index profile.

MODULE V
Fibre Bragg Grating, Long-period fibre Bragg Grating. Fabrication of Fibre Gratings.

REFERENCES
1. Introduction to fiber optics – Ajoy Ghatak and K. Thyagarajan, Cambridge Univ Press, 1999 (Text)
2. Optical Fiber communication – John M Senior, PHI 1994 (Text)
3. Fundamentals of Opto electronics – Clifford R. Pollock and Iswing (1008)
ISP 3204 LASER APPLICATIONS

MODULE I
Nonlinear optics, nonlinear optical coefficient, second order Non linear effects, electromagnetic formulation of 2nd order -nonlinear interaction, optical parametric oscillator.

MODULE II
Industrial applications: Absorption of laser radiation by metals, semi conductors and insulators, laser drilling, welding, cutting and surface cleaning, optical fibre splicing, laser deposition of thin films.

MODULE III
Lasers in chemistry: schemes of laser isotope separation, laser induced chemical reactions, infrared photo chemistry, ultra fast processes.

MODULE IV
Holography and speckle interferometry: Theory of hologram recording and reconstruction, thin and thick holograms, application of holography to character recognition and NDT, theory and applications of speckle interferometry.

MODULE V
Other applications of lasers: Laser pollution monitoring, LIDAR laser gyros, laser induced fusion, laser energy requirements, laser induced fusion reactor, CD and CD ROM, laser cooling trapping

REFERENCES
4. Laser Handbook Vol II and III - Arechi (Ed) (North Holland)
5. Nd YAG laser surgery - Joffy S N and Y Ogurov (Springer Verlag)
8. Lasers in Medicine - H K Kobener (Wiley)
MODULE I
Nonlinear optical coefficients, second order and third order susceptibility tensors. Third order optical nonlinear phenomena - FWM OPC - stimulated Raman and Brillouin scattering, CARS, intensity dependent refractive index, self focussing, SIT, nonlinear F-P etalon, Optical bistability, Optical transistor, SEED, optical logic gates, implementation and their application in optical computers (optical computing by Feitelson).

MODULE II
Mathematical transforms in signal processing, Fresnel transform, Hilbert transform, Radon transform, Mellin transform, Two dimensional Fourier transforms and their properties, convolution and correlation. Effect of lens on wavefront, FT properties of single lens, optical transform function. (Signal processing using optics by Boone).

MODULE III
Time and space integrating architecture, spectrum analysis, Vanderlugt filter, image spatial filtering, SLMS - AO, MO, EO and ; LC based SLMs (Boone).

MODULE IV
Optical numerical processing - Simple arithmetic, evaluation of polynomials, optical implementation of Matrix vector multiplication, Matrix-matrix multipliers, differentiation, integration and solutions of partial differential equations (Optical computing by Feitelson).

MODULE V
Optical neural network - characteristics of ANN, use of optics in ANN, neuron as nonlinear element, Associative memory using pattern matching by vector-matrix multiplication, double and multilayer NN structure, training a NN, Hopfield net, optical implementation of NN.

REFERENCES:
6. Digital image processing B Jahne, Springer Verlag
ISP 3206 DIGITAL COMMUNICATION

MODULE I
Digital signals and systems, digital PAM signals, transmission limitations, Power spectra of PAM, binary error probabilities, regenerative repeaters, Nyquist pulse shaping, equalisation, synchronization techniques, bit and frame synchronization.

MODULE II
Pulse code modulation, PCM generation and reconstruction of multiplexing PCM signals, DPCM, DM, adaptive delta modulation.

MODULE III
Information Theory, concept of amount of information, average information, entropy, coding to increase average information per bit, Shannon's Theorem, Channel Capacity, Band Width, S/N tradeoff.

MODULE IV
Error detection and correction, repetition and parity of checky codes, convolutional codes, performance of ARQ systems.

MODULE V
Digital CW modulation, spectral analysis of band pass digital signals, amplitude-phase and frequency modulation methods.

REFERENCES:
1. Communication systems A B Carlson (McGraw Hill)
2. Principles of Communication systems - Taub and Schilling
4. Digital Communication - S. Hayken (John Wiley'95)

ISP 3207 INDUSTRIAL PHOTONICS

MODULE I
Photonics Technology: Passive Components- couplers, isolators, circulators, terminators, attenuators, multiplexers and filters, Fused fibre components based on Biconical TaperTechnology, Star and Tree couplers. Fibre delay lines, Clip-on couplers, Fibre gratings. Mode conditioning Patchcords, Optical switches, WDMs, arrayed waveguide gratings, lensed fibres, thermally expanded core fibres, polarization maintaining components.

MODULE II
Active Components: Media converters, Mode converters, Transponders, Optical Nodes, Regenerators, Modulators, Optical Cross Connects, EDFA, Raman Amplifiers.
MODULE III


MODULE IV

Optical Networks: Network architecture, HFC, FTTC, Optical Access Network Architecture, deployment considerations - upgrading the transmission capacity, SDM, TDM, WDM, OTDM, Multiplexing and demultiplexing, Synchronization, broadcast OTDM Network, OTDM testbeds, Application areas - interexchange, undersea, local exchange networks.

MODULE V

Control and Management: Network management function, configuration, performance and fault managements, Channel Health Monitoring, Dark and Active fibre monitoring, Optical Protection - Effect of PDL and PMD on high speed optical networks, Attacks on fibre networks, Intrusion detection and prevention techniques. Network Test Equipments - OTDR measurements.

MODULE VI

Reliability Concepts: Concepts on product reliability, Reliability of Optical Components, Thermal stability, Factors affecting the reliability of fused fibre components, reliability tests and test setups, High power optical requirements, Effects of dirt on fibre endfaces, Reliability and Test Standards in Fibre optics.


TEXTS:
2. Optoelectronic Packaging, Nagesh R. Bassavanhally.

REFERENCES
5. Reliability of passive optical components: Telcordia GR -1209

INTERNATIONAL SCHOOL OF PHOTONICS
MODULE I


MODULE II


MODULE III


MODULE IV


MODULE V


REFERENCES

2) Dye Laser - Schaffer (Springer Verlag) 2nd ed., 1977
4) Laser Physics - Tarasov (Mir Publishers) 1995
5) Semiconductor optoelectronic Devices-Pallab Bhattacharya, (Prentice Hall India).1995
7) Lasers-Peter-W Miloni and Joseph H Eberly
**Topics for initial reading:** Fundamentals of light as matter, basics of biology, fundamentals of light matter interactions, lasers, laser technology, nonlinear optics (introduction to Bio-photonics by PN Prasad, Chapter 1 – 6).

**MODULE I**

Photobiology; interaction of light with cells with cells and tissues, Photo-process in Biopolymers-human eye and vision, Photosynthesis; Photo-excitation – free space propagation, optical fibre delivery system, articulated arm delivery, hollow tube wave-guides.

Optical coherence Tomography, Spectral and time-resolved imaging. Fluorescence, resonance energy transfer imaging, nonlinear optical imaging.

**MODULE II**


Applications of bio-imaging; Bio-imaging probes and fluoropores, imaging of microbes, cellular imaging and tissue imaging.

**MODULE III**

Optical Biosensors: Florescence and energy transfer sensing, molecular beacons and optical geometries of bio-sensing, Biosensors based on fibre optics, planer waveguides, evanescent waves, interferometric and surface plasmon resonance.

Flow Cytometry: basis, fluorochromes for flow cytometry, DNA analysis.

**MODULE IV**

Laser activated therapy; Photodynamic therapy, photo-sensitizers for photodynamic therapy, applications of photodynamic therapy, two photon photodynamic therapy. Tissue engineering using light; contouring and restructuring of tissues using laser, laser tissue regeneration, femto-second laser surgery.

**MODULE V**


**REFERENCES**

Introduction to bio-photonics – P.N. Prasad Wiley Interscience (2003) (Text)

**MODULE I**

*Foundations for Nanophotonics*


**MODULE II**


**GROWTH AND CHARACTERIZATION OF NANOMATERIALS**


**MODULE III**

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


**MODULE IV**


MODULE V

Bio Nanophotonics and Nanomedicine: Bioderived Materials, Bioinspired Materials
Biotemplates, Bacteria as Biosynthesizers, Near-Field Bioimaging, Nanoparticles for Optical Diagnostics and Targeted Therapy, Semiconductor Quantum Dots for Bioimaging
Biosensing, Nanoclinics for Optical Diagnostics and Targeted Therapy, Nanoclinic Gene Delivery
Nanoclinics for Photodynamic Therapy.

REFERENCES

ISP 3211 DIGITAL SIGNAL PROCESSING

MODULE I
Discrete time signals and systems domain representation, transform, discrete Fourier transform,
Discrete convolution and correlation.

MODULE II
Two dimensional signals and systems, frequency domain representation, discrete Hilbert transform,
Fast Fourier Transform algorithms, computational considerations.

MODULE III
Nonlinear time series analysis - Grassberger and Procaccia technique, correlation dimension and
entropy and their evaluation from time series. Broomhead and King’s algorithm for Noise filtering,
application to chaotic signals.

MODULE IV
Digital filters, representations, forms of realization and design, specification and design techniques,
MR and FIR filters.

MODULE V
Finite word length effect in digital signal procatekig, signal processing chips LES - TMS 320 and
AM 2900.

REFERENCES
3. Theory and applications of digital signal processing - L R Rabiner and B Gold (Prentice Hall, India ’88)
5. Electronic Filter design hardware - A Wilhelm & F.J. tauler

INTERNATIONAL SCHOOL OF PHOTONICS

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MODULE I

Spectroscopy technique, General ideas of spectroscopic studies and their importance - conventional spectroscopic recording in UV - Vis-IR region using dispersing spectrographs, Photoacoustic spectroscopy - PA effect in gases, liquids and solids, RG theory - design of PA spectrometer, applications of PAS - evaluation of optical and thermal parameters, imaging and microscopy.

MODULE II

Thermal Lens Spectroscopy, Focal Length of TL, single and double beam configurations. Applications of TLS - overtone spectroscopy, evaluation of thermal and optical parameters.

Optogalvanic spectrometry, basic theory, experimental setup, applications of OGS.

MODULE III

High resolution spectroscopy; saturation spectroscopy, Doppler free spectroscopy, single atom spectroscopy, Rydberg atoms and their spectra. Application of laser Spectroscopy in pollution monitoring, trace analysis, Laser Raman spectroscopy, SRS, CARS, PARS.

MODULE IV

Fluorescence spectroscopy, spectra of rare earth ions and atoms, spectra of RE ions in sulphide and fluoride crystals, Phosphorescence, colour centres, fluorescence of dyes, evaluation of quantum efficiency.

MODULE V

Plasma spectroscopy, evaluation of plasma parameters from plasma spectra. Nonlinear optical spectroscopy.

REFERENCES

1. Photoacoustic spectroscopy - Rosenewaig (Wiley, NY)
3. Laser spectroscopy - Chebatyes (Springer Verlag)
4. Luminescence spectra of rare earth ions - Maufrainun (Springer Varlag)
6. NonlinearOptics-ZRSaen (JohnWiely)
ISP 3213 PHOTONICS MATERIALS AND DEVICES

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

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

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

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

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

REFERENCES
1. Handbook of Nonlinear optical crystals - Dmtriev et al, (Springer Verlag)
2. Photorefractive materials I and II - Gunter et al (Springer Verlag)
5. Optical fibre sensors - Hunsperger (Springer Verlag)

ISP 3214 SCIENCE AND TECHNOLOGY OF PLASMA

MODULE I
Motion of charged particles in EF and MF, particles in oscillating EF and Constant MF - over all charge neutrality, plasma state.

MODULE II

MODULE III
Nonlinear processes in plasma, feedback mechanism, instabilities in plasma waves, radiation from plasma, ionospheric plasma.

MODULE IV
MODULE V

Energy generation: Pinch effect, MHD generator, Tokomak, Linear accelerators, free electron lasers, Flat panel display systems, laser fusion.

REFERENCES

3. Gas discharge Physics - Z P Razer (Springer Verlag)
5. Plasma Physics - S N Sen (Pragati Prakashan Meerut)

ISP 3215 INTEGRATED OPTICS

MODULE I

Advantages of Integrated optics - Comparison of optical integrated circuits (OIC) with electronic integrated circuits Substrate materials for OIC - Modes in planar waveguide structure - Channel waveguides, strip loaded wave guides.

MODULE II

Wave guide fabrication techniques - electro optic waveguides Losses in optical waveguides - measurements of waveguide losses waveguide input/output couplers, coupling between waveguides.

MODULE III

Electro optic and acousto optic modulators Direct modulation of semiconductor lasers - Integrated optical detectors – Depletion layer photodiodes APD, Pin and MSM photo diodes – modification of spectral response of detectors.

MODULE IV

Quantum well modulators, Quantum well detectors, SEED, Applications of integrated optics - RF spectrum analyser, ADC.

MODULE V

10 optical Disk Readhead OIC Temperature and voltage sensor, optoelectronic fC Transmitter and receiver, Devices and systems for Telecommunications, Opto - microwave applications.

REFERENCES

1. Integrated optics - Theory & Technology R – G. Hunsperger (Springer Verlag, 4th Ed 1995)
3. Elements of opto electronics and Fibre optics (ch 7) Chin-Lin Chen (Irwin, 1966)
5. Guided wave opto electronics (ch 6) T Tamir (Ed) (Springer Verlag 1990)
ISP 501 LASERS AND APPLICATIONS

MODULE I
Properties of laser beam, Stimulated emission and Einstein's treatment, necessary and sufficient conditions for laser action, three and four level lasers.
Line broadening, homogeneous and inhomogeneous, laser cavity and stability of laser cavities, stability diagram, multimode and single mode lasers.

MODULE II
Q-switching and mode locking, experimental techniques, generation of ultra short optical pulses
Laser systems: Classification, Ruby, NdYAG, He-Ne, Argon ion, Eximer, Dye, Semiconductor lasers.

MODULE III
Lasers for communication, external and internal Modulation schemes,
Lasers in industry, Cutting, welding, drilling
Lasers in Medicine, bloodless surgery, photodynamic therapy
Lasers in chemistry: laser induced chemical reactions, laser induced fluorescence
Laser spectroscopy: Thermal lens and photoacoustic spectroscopy

MODULE IV
Nonlinear optical effect of lasers, second harmonic and sum-difference frequency generation,
Intensity dependent refractive index, saturable and reverse saturable absorbers, two photon absorption.

MODULE V
Holography and applications: recording and reconstruction, thin and thick holograms, Holography in NDE, Realization of optical logic gates.

REFERENCES
2. Laser Electronics - J T Vardeyan, Prentice Hall India
7. Laser Physics - Tarasov (MIR Pub)
ISP 502 FIBRE OPTICS AND APPLICATIONS

MODULE I

Brief historical background of development of optical fibre, structure of optical fibre, numerical aperture, step index and graded index fibre, single mode and multi mode fibres.

MODULE II

Fabrication of optical fibres, silica and polymer fibres, measurement of optical fibre parameters like refractive index profile, losses, dispersion effect in optical fibre.

MODULE III

Sources and detectors: Laser diodes and LEDs, photodetectors: photodiodes, LDR, photo transistor, APD and PiN diodes, OTDR, Splicers, connectors, FBG.

MODULE IV

Optical fibre for communication, modulation, EDFA, optical repeaters, fibre optic network, Medical application: endoscopy.

MODULE V

Fibre optic sensors: extrinsic and intrinsic sensors, Intensity modulated sensors, interferometric sensors, evanescent field sensors, chemical sensors, temperature, pressure, displacement sensors.

REFERENCES

1. Introduction to fiber optics – Ajoy Ghatak and K. Thyagarajan
2. Optical Fiber communication – John M Senior
3. Fundamentals of Opto electronics – Clifford R. Pollock

ISP 503 NONLINEAR OPTICS AND OPTICAL COMPUTING

MODULE I

Maxwell’s equations in vacuum, dielectric and conducting media, linear optics, nonlinear EMW equation.

MODULE II

Nonlinear optical coefficients, second order nonlinearity, OSHG, TWM, frequency down and up conversions, optical parametric oscillation.

MODULE III

Third order nonlinear phenomena, TPA, FWM, OPC, Stimulated Raman scattering, Intensity dependent refractive index, saturable and reverse saturable absorbers, CARS.

MODULE IV

Linear and nonlinear F-P etalon, Optical transistor, Optical implementation of mathematical operations, vector–matrix and matrix–matrix multiplications.
MODULE V

Optical implementation of neurons, supervising and unsupervised neural network, training of neural network, modeling of association, pattern recognition.

REFERENCES

1. Signal Processing using optics  B G Boone (Oxford Univ Presses
4. Nonlinear optics.  Snen (Jonn WeilY & Sons
5. Fourier Optics  Joseph Goodman
6. Digital image processing  B Jahne (Springer Variag
7. Textbook of Optical phase conjuaction  Fisher

ISP 504 BIOPHOTONICS

MODULE I

Electromagnetic spectrum, coherent and incoherent light, Einstein’s theory of light-matter interaction and stimulated emission, energy levels of atoms and molecules, singlet and triplet levels of dye molecules.

MODULE II

Classification of lasers, pulsed and CW lasers, pumping, different types of lasers- Ruby, He-Ne, CO2, Nd:YAG, Excimer, Argon ion, Nitrogen lasers.

MODULE III

Guiding of light, Optical fibre, basic principle of light guiding through fibre, single and multimode fibres, optical fibre for bio sensing applications, fibre endoscope and bio imaging.

MODULE IV

Classification of EMW in relations to biological effects, tissue-laser interactions, laser surgery, tissue engineering using lasers, optical tweezers, scissors and molecular machines.

MODULE V

Photodynamic therapy, singlet oxygen and its importance in PDT, photobiology of vision, applications of fluorescence in bio imaging.

REFERENCES

MODULE I
Wave particle –duality, Heisenberg’s uncertainty principle, time independent and time dependent Schrodinger equations, particle in a box, tunneling.

MODULE II
Linear vector space, Dirac notations, linear operators, matrix representation, eigen values and eigen functions, Hermitian operator and its properties.

MODULE III
Schrodinger equation for hydrogen atom and linear harmonic oscillator, matrix formalism of harmonic oscillator.

MODULE IV
Perturbation theory, time independent and time dependent perturbations (first order), semi classical theory of radiation.

MODULE V
EPR paradox, Bell’s theorem, Experimental verifications, entangled states, qubits, principles of quantum communications and computing.

REFERENCES
Quantum Mechanics Merzbacher Wiley International 3rd Ed 1996
Modern Quantum Mechanics Sakurai Addison Wesley 1998