DEPARTMENT OF OPTOELECTRONICS, UNIVERSITY OF KERALA
M.Tech. PROGRAMME IN ELECTRONICS AND COMMUNICATION
(OPTOELECTRONICS AND OPTICAL COMMUNICATION)
(Under Credit and Semester System w.e.f. 2017 Admission)

Programme Objectives: This M.Tech Programme in ***Electronics and Communication (Optoelectronics and Optical Communication)*** is designed to equip post graduate engineers 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.

Structure of the programme

Sem. No.	Course code	Name of the course	Number of credits
I	<u>Core courses</u>		
	OPE-C-611	Modern Optics	3
	OPE-C-612	Digital Communication	3
	OPE-C-613	Optoelectronic Devices	3
	OPE-C-614	Fiber Optics Technology	3
	OPE-C-615	Optoelectronics and Image Processing Lab	3
	<u>Internal elctives</u>		
	OPE-E-616	Lasers	3
	OPE-E-617	Advanced Digital Signal Processing	3
II	<u>Core courses</u>		
	OPE-C-621	Fiber Optic Sensors and Applications	3
	OPE-C-622	Optical Fiber Communication Systems	3
	OPE-C-623	Seminar	2
	OPE-C-624	Mini Project I (Design and Development)	2
	OPE-C-625	Photonic Design, Communication and Digital Signal Processing Lab	3
	<u>Internal electives</u>		
	OPE-E-626	Optical Signal Processing	3
	OPE-E-627	Artificial Neural Networks	3
	OPE-E-628	Nonlinear Optics	3
	OPE-E-629	Nanophotonics	3
	OPE-E-6210	Solar Photovoltaics	3
	OPE-E-6211	Mathematical Physics	3
III	<u>Core courses</u>		
	OPE-C-631	Research Methodology	4
	OPE-C-632	Mini Project II (Design and Development)	2
	OPE-C-633	Study on Current Advanced Research	2
	OPE-D-634	Dissertation Phase I	8
	<u>Internal electives</u>		
	OPE-E-635	Holography and Speckle Interferometry	4
IV	OPE-D-641	Dissertation Phase II	16
Extra Departmental elective courses			
I	OPE-X-611	Introduction to Photonics	2

Semester: I
Course Code: OPE-C-611
Course Title: MODERN OPTICS
Credits: 3

AIM: To help the student to develop a thorough understanding of the underlying physical principles of various modern optical phenomena and their applications.

OBJECTIVE: To learn the basic phenomena in Optics.

COURSE CONTENT

MODULE I: Harmonic waves, phase velocity and group velocity. Matrix representation of polarization, Jones vector, Jones matrices, Jones calculus, orthogonal polarization. Reflection and refraction at a plane boundary, Fresnel's equations, Brewster angle, total internal reflection, evanescent wave in total reflection.

MODULE II: Ray vectors and ray matrices, lens waveguide, identical-lens waveguide, Rays in lens like media, Gaussian beams in a homogeneous medium, fundamental Gaussian beam in a lens like medium- ABCD law, Gaussian beam focusing as an example.

MODULE III: Propagation of light in isotropic dielectric medium, dispersion, Sellmeier's formula, propagation of light in crystals, wave-vector surface, Ray-velocity surface.

MODULE IV: Diffraction – Kirchoff integral theorem, Fresnel-Kirchoff formula, Babinet's principle, Fraunhofer and Fresnel diffraction, Fraunhofer diffraction patterns, single slit, rectangular aperture, circular aperture, double slit, multiple slits, Fresnel diffraction patterns, zone plate, Cornu's spirals.

MODULE V: Fourier transforms in optics, application to diffraction, apodization, spatial filtering, phase contrast and phase grating, reconstruction of wave front – holography. Fourier transforming property of a thin lens. Fabry Perot etalon, Optical spectrum analyzer.

MODULE VI: Coherence- Theory of partial coherence, fringe visibility, temporal coherence, spatial coherence, coherence time and coherence length, intensity interferometry.Nonlinear optics-on the physical origin of nonlinear polarizations, nonlinear optical coefficients, second harmonic generation, phase matching, parametric amplification, phase matching, parametric oscillation, frequency tuning.

REFERENCES

- Amnon Yariv, Optical Electronics, Fourth Edition, Holt, Rinehart and Winston, 1991.
- E.Hecht and A.R.Ganesan, Optics, 4th Edition, Pearson, 2011
- Fowles G.R., Introduction to Modern Optics, 2nd Edition, Holt, Rienhart and Winston, 1975.
- Ghatak A and Thyagarajan K, Optical Electronics, Cambridge University Press, 1993.

ADDITIONAL REFERENCES

- Joseph N Goodman, Introduction to Fourier optics, McGrawHill, 1996
- Stark H, (Ed.), Applications of Optical Fourier Transforms, Academic Press, 1982

Semester: I
Course Code: OPE-C-612
Course Title: DIGITAL COMMUNICATION
Credits: 3

AIM: Enable the students to analyze the performance of various digital communication techniques.

OBJECTIVE: To introduce basic theory and techniques in digital communication.

COURSE CONTENT

MODULE I: Digital communication system (description of different Modules of the block diagram), Complex baseband representation of signals, Gram-Schmidt orthogonalization procedure.M-ary orthogonal signals, bi-orthogonal signals, simplex signal waveforms.

MODULE II: Pulse modulation – Sampling process – PAM – Quantization – PCM – Noise in PCM system - TDM – Digital multiplexers – Modifications of PCM – Delta modulation – DPCM – ADPCM – ADM. Base band pulse Transmission – Matched filter - Error rate due to noise – ISI – Nyquist criterion for distortion less transmission-MATLAB Practices for signal representation, Pulse modulation schemes.

MODULE III: Application of pass band transmission – Voice band Modems – Multichannel modulation – Discrete multitone. Synchronization. Spread spectrum communication – Pseudo–noise sequences – Spread Spectrum – Direct sequence spread spectrum with coherent binary phase shift keying – Signal space dimensionality and processing gain – Probability of error – Frequency Hop spread spectrum – Maximum length and Gold codes.

MODULE IV: Multiple Access Techniques. Statistical characterization of multi path channels. Binary signaling over a Rayleigh fading channel – Diversity techniques. TDMA and CDMA – RAKE receiver. Performance analysis of cellular DS-CDMA, power control, soft handoffs, IS-95A and 3G CDMA system.B3G systems, rate and power adaptation, LTE standard, its air interface. MATLAB practice: TDMA, Spread Spectrum Techniques.

MODULE V: Introduction to Information Theory: Concept of amount of information, units-entropy, marginal, conditional and joint entropies - relation among entropies - mutual information, information rate. Source coding: Instantaneous codes- construction of instantaneous codes - Kraft's inequality, coding efficiency and redundancy, Noiseless coding theorem - construction of basic source codes - Shannon - Fano Algorithm.

MODULE VI: Channel capacity -redundancy and efficiency of a channel., binary symmetric channel (BSC), Binary erasure channel (BEC)- capacity of band limited Gaussian channels, Shannon- Hartley theorem - bandwidth - SNR trade off -capacity of a channel of infinite bandwidth, Shannon's limit. Quantum Error Correcting Codes, Coding for Cooperative Communication; Network Coding-MATLAB Practice: Channel coding theorems.

REFERENCES

- B. P. Lathi, Modern Digital and Analog Communication Systems, PHI, 1998
- Nielsen M.A. and Chuang I.L., Quantum Computation and Quantum Information, Cambridge University Press, 2006

- Sesia S., Toufik, I., Baker M., LTE – The UMTS Long Term Evolution, John Wiley and Sons, First Edn, 2009.
- Simon Haykin - Communication Systems, 4 thEdn. John-Wiley & Sons, 2001.
- Yeung R.W., Information Theory and Network Coding, Springer, 2008

ADDITIONAL REFERENCES

- Couch: Digital and Analog Communication Systems, 6th Edn, Pearson Education, 1997
- Goldsmith A., Wireless Communications, Cambridge Univ. Press, First Edn, 2005.
- Harold Kolimbris: Digital Communication Systems, 1st Edn, Pearson Education, 2000.
- Marvin K. Simon, Sami M. Hinedi, William C. Lindsey: Digital Communication Techniques, PHI.

Semester: I
Course Code: OPE-C-613
Course Title: OPTOELECTRONIC DEVICES
Credits: 3

AIM: To give a deeper understanding of the fundamental theories, fabrication, integration, characterization and applications of novel optoelectronic devices.

OBJECTIVE: To introduce the theory, working and applications of various optoelectronic devices.

COURSE CONTENT

MODULE I: Optoelectronic materials, Semiconductors, compound semiconductors, III-V and II-VI compounds, ZnO, ITO, GaN, direct and indirect band gap, electronic properties of semiconductors, Fermi level, density of states, life time and mobility of carriers, invariance of Fermi level at equilibrium, diffusion, continuity equation, excess carriers, Quasi-Fermi levels.

MODULE II: Optical properties, theory of recombination, radiative and non- radiative, absorption edge, photoconductivity, light emitting diodes, LED, device configuration and efficiency, LED structures, light current characteristics and device performance, frequency response and modulation band width, Blue LED, White light.

MODULE III: Laser diodes – basic concepts, heterojunction and injection lasers, output characteristics. Quantum well lasers, VCSEL, DFB and DBR lasers.

MODULE IV: Birefringence, uniaxial and biaxial crystals, index ellipsoid, electro-optic effect, electro optic retardation. Phase and amplitude modulators, transverse electro optic modulators and design considerations- high frequency modulation considerations, transit time limitations in lumped modulators, travelling wave modulators. Acousto-optic effect, Raman-Nath and Bragg regime, acousto-optic modulators, magneto optic effects, spatial light modulators.

MODULE V: Photodetectors, -performance criteria of a photodectetor, expressions for quantum efficiency, responsivity, photoconductors and photodiodes, PIN diodes, heterojunction diodes and APDs, characteristics and device performance, high speed measurement photoresistors, CCDs, photomultiplier tube, noises in photodetectors, SNR, noise equivalent power.

MODULE VI: Solar cell materials and their properties. solar cell research: technology-Silicon,Organic and Perovskite Characterization and analysis: ideal cell under illumination-solar cell parameters, optical losses; electrical losses, surface recombination velocity, quantum efficiency - measurements of solar cell parameters; I-V curve & L-I-V characteristics, internal quantum yield measurements – effects of series and parallel resistance and temperature - loss analysis.

REFERENCES

- AmnonYariv, Optical Electronics, Holt Rine hart & Winston, Philadelphia, 1991
- Ben G. Streetmann& Sanjay Banerjee, Solid State Electronic Devices, 5thEdn, 2000.
- Bhattacharya P., Semiconductor Optoelectronic Devices,, PHI, New Delhi.1995
- Martin A. Green, Solar Cells: Operating principles, Technology and System Applications, Prentice-Hall Inc, Englewood Cliffs, NJ, USA, 1981
- Poortmans J and Arkhipov V Thin Film Solar Cell: Fabrication, Characterizations and Applications, John Wiley & Sons, England 2006

ADDITIONAL REFERENCES

- AmnonYariv & PochiYeh, Optical Waves in Crystals, Wiley & Sons, 2003
- Bahaa E. A Saleh & Malvin Carl Teich, Fundamentals of Photonics, John Wiley & Sons, 1991
- Ghatak A. and Thyagarajan K., Optical Electronics, Cambridge University Press, New Delhi, 1994.
- Joachim Piprek, Semiconductor Optoelectronic Devices, Academic Press, 2003
- R. P. Khare, Fiber Optics and Optoelectronics, Oxford University Press, 2004
- Rampal V.V., Photonics Elements and Devices, Wheeler, Allahabad,1992.

Semester: I
Course Code: OPE-C-614
Course Title: FIBER OPTICS TECHNOLOGY
Credits: 3

AIM: To provide an introduction to operating principles and key properties of passive optical fiber technology and familiarize students about various fiber components and their conceptual operation with a view on the areas of its application.

OBJECTIVE: To introduce the principles and technologies of fiber optics.

COURSE CONTENT

MODULE I: Introduction to optical fibers-Total internal reflection-acceptance angle, numerical aperture, Fractional refractive index difference, skew rays, Classification of fibers: based on refractive index profiles, modes guided applications and materials. Mode theory of fibers- Different modes in fibers. Dominant mode, Derivations for modal equations for SI and GI fibers. Approximate number of guided modes in a fiber (SI and GI fibers). Comparison of single mode and multimode fibers for optical communications. Fiber drawing and fabrication methods:- Modified chemical vapor deposition (MCVD)and VAD techniques.

MODULE II: Transmission characteristics of optical fibers: Attenuation, absorption, scattering losses, bending losses. Phase and group velocities- V-parameter, Cut off wavelength, Dispersion parameter, bandwidth, rise time and Non linearity coefficient. Impairments in fibers: Group velocity dispersion (GVD), Wave guide and modal dispersions. Polarization mode dispersion (PMD), Birefringence- linear and circular.
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MODULE III: LED and LD modulators. Coupling of light sources to fibers- (LED and LD) – Derivations. Theory and applications of Passive optical components: Connectors, couplers, splices, Directional couplers, gratings: FBGs and AWGs, reflecting stars: optical add drop multiplexers and SLMs.

MODULE IV: Active components: Optical Amplifiers (OAs) - Comparative study of OAs- SLA, FRA, FBA EDFA and PDFA based on signal gain, pump efficiency, Noise figure, insertion loss and bandwidth. Design and Characterization of forward pumped EDFA.

MODULE V: Fiber measurements: Attenuation measurement – cut back method. Measurement of dispersion- differential group delay, Refractive index profile measurement. Numerical aperture (NA) measurement, diameter measurement, Mode Field Diameter (MFD) measurement, V- parameter, cut off wavelength measurement, splicing and insertion losses- Eye diagram analysis.

MODULE VI: OTDR- working principle and applications. OSA- basic block schematic and applications in measurements. Fibers for specific applications: Polarization maintaining fibers (PMF), dispersion shifted and dispersion flattened fibers, doped fibers. Photonic crystal fibers, Holly fibers.

REFERENCES

- Allen H Cherin, “An introduction to Optical Fibers”, McGraw Hill Inc., Tokyo, 1995.
- Gerd Keiser, Optical Fiber Communications, McGraw Hill, 2000
- Govind P.Agrwal, “Fiber Optic Communication systems”, John Wiley & Sons Inc., New York, 1997.
- John M senior, Optical Fiber Communications, PHI, 1992
- Maynbav, Optical Fiber Technology, Pearson Education, 2001

ADDITIONAL REFERENCES

- Ajoy Ghatak and K. Thyagarajan. Introduction to Fiber optics: Cambridge University press, 1999.
- David Bailey and Edwin Wright, Practical Fiber Optics, Elsevier 2003
- Dennis Derikson, Fiber optic test and measurement, Prentice Hall, 1998.
- Franz and Jain, Optical Fiber Communication systems: Systems and Components, Narosa Publishers, 2004
- Joseph C Palais, Optical fiber Communications, Pearson Education.1998

Semester: I
Course Code: OPE-C-615
Course Title: OPTOELECTRONICS AND IMAGE PROCESSING LAB
Credits: 3

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 image processing.

COURSE CONTENT (List of Experiments)

Section A. Optoelectronics Laboratory
1. Measurement of beam characteristics of lasers
2. Characteristics of laser diode,
3. Characteristics of photodiodes,
4. Characteristics of phototransistors,
5. Characteristics of opto-coupler
6. Characteristics of LDR and other optoelectronic devices
7. Measurement of losses- attenuation, bending in optical fibers.
8. Measurement of numerical aperture
9. Measurement of power gain using Erbium Doped fiber amplifier
10. Study of dispersion in optical fibers
11. Wave length division multiplexing of signals
12. Characterization of FBG and circulator
13. Analog and digital fiber optic links
14. Time division multiplexing of digital signals
15. WDM fiber optic link
16. Optical amplification in a WDM link
17. Adding and dropping of optical channels in a WDM link
18. Testing and analysis of OTDR
19. Testing and analysis of bit error rate & eye pattern analysis
20. Testing and analysis of power budgeting

Section B. Digital Image Processing lab
1. Radon transforms
2. Histogram analysis of image
3. Image compression and resizing
4. Edge detection
5. Filtering of images
6. Image encryption and decryption using transforms
7. Image coding using ANN
8. Pattern classification using ANN
9. Loss measurements in image compression

(At least 10 experiments should be provided 5 each from Section A and Section B)

Semester: I
Course Code: OPE-E-616
Course Title: LASERS
Credits: 3

AIM: To provide a deeper knowledge about the theory, working and applications of lasers.

OBJECTIVE: To study the principle, construction and working of different lasers.

COURSE CONTENT

MODULE I: Black body radiation, Planck's law, spontaneous and induced transitions, Einstein's coefficients, gain coefficient, gain saturation and hole burning, homogenous and inhomogeneous broadened systems, laser oscillation conditions, population inversion, three and four level systems, rate equations, optimum output coupling.

MODULE II: Optical resonators, rectangular cavity- open planar resonators- spherical resonators, modes and mode stability criteria, losses in optical resonators-quality factor, unstable optical resonators

MODULE III: Q-switching, methods of Q-switching- methods, optomechanical methods of light- electro optic modulation- Pockel and Kerr modulators- magneto- optic modulators , acousto-optic modulators. Giant pulse lasers, mode locking in homogeneously and inhomogeneously broadened systems, passive and active mode locking beam diagnostics and characterization, thermal lensing effect, far field pattern.

MODULE IV: Descriptive and qualitative studies of laser applications in communication, remote sensing and interplanetary missions, laser gyro, Laser Doppler Aneometry (LDA). Applications of lasers in holography, material processing, Pulsed laser ablation.

MODULE V: Lasers in mechanical Engineering and industry, metrology, defense and security, laser cooling, lasers for fusion, lasers for biology and medicine, satellite communications, LIDAR

MODULE VI: Working principle of Ruby laser, dye laser, Argon ion laser, Tunable solid state lasers. Detailed study of semiconductor lasers Nd: YAG laser- flash lamp pumped and diode pumped lasers- -He-Ne laser, CO_2 laser, Excimer laser, Nitrogen laser,free electron laser, Fiber laser. Frequency convertors and Parametric Oscillators. Laser classification based on pulsewidth- nanosecond, picosecond and femtosecond lasers.

REFERENCES

- OrazioSvelto, Principles of Lasers, 4thEdn, Plenum Press, 1998
- Silfvast. W T., Laser Fundamentals, Cambridge University Press, New Delhi, 1998
- Thyagarajan .K & Ghatak A K Lasers, Theory and Applications Macmillan, 1991
- Yariv A, Optical Electronics, 4thEdn, Holt, Rinehart and Winston, 1991

ADDITIONAL REFERENCES

- Bahaa E. A Saleh & Malvin Carl Teich, Fundamentals of Photonics, John Wiley & Sons, 1991
- Jeff Hecht, The Laser Guide Book, McGraw Hill, 1986
- Koechner (Walter), Solid State Laser Engineering, Springer-Verlag, 1992
- Marvin J. Weber, Hand Book of Lasers, CRC Press, 2001

Semester: I
Course Code: OPE-E-617
Course Title: ADVANCED DIGITAL SIGNAL PROCESSING
Credits: 3

AIM: To introduce different digital signal processing techniques to the students.

OBJECTIVE: To learn the principles of advanced digital signal processing techniques.

COURSE CONTENT

MODULE I: Multi-dimensional discrete signals and multi-dimensional systems: frequency domain characterization of multi-dimensional signals and systems, sampling two dimensional signals, processing continuous signals with discrete systems.

MODULE II: Discrete Fourier analysis of multi-dimensional signals: discrete Fourier series representation of rectangularly periodic sequences, multi-dimensional DFT, definition and properties, calculation of DFT, vector radix FFT, discrete Fourier transforms for general periodically sampled signals, relationship between M dimensional and one dimensional DFTs.

MODULE III: Multi-rate digital signal processing: sampling the continuous time signal. Basic sampling alteration schemes: time domain representation of down-sampling and up-sampling, frequency domain characterization of down-sampling and up-sampling.

MODULE IV: Decimation and interpolation, identities, cascading, sampling-rate alteration devices, poly-phase decomposition, multi-stage systems.

MODULE V: Design and implementation of FIR filters: implementation and design using windows and frequency transformation methods. Lth-band FIR digital filters: definitions and properties, poly-phase implementation of FIR Lth-band filters, separable linear-phase Lth-band FIR filters, half-band FIR filters.

MODULE VI: Adaptive filters: introduction to LMS adaptive FIR filters, basic Wiener theory and LMS algorithm.

REFERENCES

- Ljiljana Milic, Multi-rate Filtering for Digital Signal Processing- MATLAB Applications, Information Science Reference, Hershey- New York, 2009
- N.J. Fliege, Multi-rate Digital Signal Processing, John Wiley, 1994.
- P.P. Vaidyanathan, Multi-rate Systems and Filter Banks, Prentice Hall, PTR, 1993.

ADDITIONAL REFERENCES

- J S Lim, Two dimensional Signal and Image Processing, Prentice Hall, 1990.
- Li Tan & Jean Jiang, Digital Signal Processing, Academic Press, Elsevier Inc., 2013
- R.E. Crochiere, Multirate Digital Signal Processing, Prentice Hall. Inc., 1983.
- Tamal Bose, Digital Signal and Image Processing, John Wiley publishers, 2004

Semester: II
Course Code: OPE-C-621
Course Title: FIBER OPTIC SENSORS AND APPLICATIONS
Credits: 3

AIM: To equip the students to acquire knowledge on the fundamentals of sensors and extend it to the fiber optics sensor technology and their real time applications.

OBJECTIVE: Familiarise the students with the use of optical fibers in sensing applications.

COURSE CONTENT

MODULE I: MM and SM fibers for sensing, Lasers & LEDs suitable for sensing, PIN & APDs for fiber optic sensing. Principles of electro optic modulators bulk & integrated optic modulators. Optical sensor types, advantages and disadvantages of fiber optic sensors, Sensor system performance: basic specifications, Sensor functions. Intensity modulated sensors, reflective concept, micro-bend concept, evanescent fiber sensors, polarization modulated sensors.

MODULE II: In-fiber Bragg grating based sensors – sensing principles – temperature and strain sensing, integration techniques, cross sensitivity, FBG multiplexing techniques. Long period fiber grating sensors- temperature and strain sensing, refractive index sensing, optical load sensors and optical bend sensors, Signal processing techniques for fiber optic sensor.

MODULE III: Interferometric sensors, Mach-Zehnder& Michelson interferometric sensors, Theory-expression for fringe visibility, Fabry-Perot fiber optic sensor – theory and configurations, optical integration methods and multiplication techniques, applications – temperature, pressure and strain measurements, encoded sensors.

MODULE IV: Sagnac interferometers for rotation sensing Fiber gyroscope sensors – Sagnac effect – open loop biasing scheme – Closed loop signal processing scheme – fundamental limit – performance accuracy and parasitic effects – phase-type bias error – Shupe effect – anti-Shupe winding methods – applications of fiber optic gyroscopes. Faraday effect sensors. Magnetostriction sensors. Lorentz force sensors.

MODULE V: Biomedical sensors, sensors for physical parameters, pressure, temperature, blood flow, humidity and radiation loss, sensors for chemical parameters. pH, oxygen, carbon dioxide, spectral sensors.

MODULE VI: Distributed fiber optic sensors – intrinsic distributed fiber optic sensor – optical time domain reflectometry based Rayleigh scattering – optical time domain reflectometry based Raman scattering – optical time domain reflectometry based Brillouin scattering – optical frequency domain reflectometry – quasi-disrtibuted fiber optic sensor. An overview on the optical fiber sensors in nuclear power industry, fly-by-light aircraft, oil field services, civil and electrical engineering, industrial and environmental monitoring.

REFERENCES

- Dakin J and Culshow B., (Ed), Optical fiber sensors, Vol I,II, III, Artech House, 1998
- Francis T.S Yu, Shizhuo Yin (Eds), Fiber Optic Sensors,Marcel Dekker Inc., New York,2002
- Pal B. P, Fundamentals of fiber optics in telecommunication and sensor systems,

Wiley Eastern, 1994.

ADDITIONAL REFERENCES

- Anna Grazia Mignani and Francesco Baldini, Bio-medical sensors using optical fibers, Report on Progress in Physics Vol 59.1, 1996
- B.D Gupta, Fiber optic sensors: Principles and applications, New India Publishing Agency, New Delhi. , 2006
- Eric Udd (Ed), Fiber optic sensors: An introduction for engineers and scientists, John Wiley and Sons Ltd., 1991
- Jose Miguel Lopez-Higuera (Ed), Handbook of optical fiber sensing technology, John Wiley and Sons Ltd., 2001

Semester: II
Course Code: OPE-C-622
Course Title: OPTICAL FIBER COMMUNICATION SYSTEMS
Credits: 3

AIM: To enable the students to understand the principles and design considerations of different optical communication systems

OBJECTIVE: To provide basic understanding and knowledge about various types of optical fiber communication systems.

COURSE CONTENT

MODULE I: Classification of light wave systems, need for fiber based and all-optical systems. Non linear effects in fibers: Kerr effect, SPM, XPM and FWM, SRS, SBS, nonlinear effects in PCF-super continuum generation and its application in DWDM, nonlinear optical switching, modulation instabilities.

MODULE II: Soliton based systems: introduction to soliton theory and its applications, free space optical communication systems-applications. Noise in laser diodes relative intensity noise (RIN), phase noise and amplified spontaneous emission (ASE) noise. Effects of laser diode nonlinearity and noise in fiber communications, noises in detection, signal to noise ratio, optical fiber cable construction.

MODULE III: Optical amplifiers (overview), design and characterization of EDFA, pumping schemes, noise in EDFA – ASE and noise factor. Transmitters - Fiber to source coupling, driving circuits, direct modulation, limitations, external modulation, electro-optic, acousto-optic modulators, dispersion management, pre-compensation and post compensation schemes. Receivers: front end, post detection circuit and data recovery. Quantum limit of performance-noise and jitter, extinction ratio and BER performance.

MODULE IV: Wavelength division multiplexing, WDM components- add/ drop multiplexers, tunable filters, optical cross connects, system performance parameters, BER, eye diagram, SNR, ASE noise, cross talk, dense wavelength division multiplexing technology – need and requirements- concept of polarization division multiplexing. Photonic systems: system components, basics of optical switching, optical and optoelectronic switching devices, SEEDs, switching architecture, space switching, time switching, wave length switching and ATM switching system.

MODULE V: Systems: IMDD systems-design of systems with and without repeaters. - Power budget and rise time budget. Coherent Systems: sensitivity of a coherent receiver – ASK, FSK and PSK systems- comparison with IMDD systems. Overview of Digital Transmission Systems.

MODULE VI: Various Types Higher Order Digital Multiplexing, hierarchy for PDH systems, PDH multiplexer, Frame structure of 2Mb/s, 34 Mb/s & 140 Mb/s, Limitations of PDH, SDH evolution, SDH standards, Merits of SDH, Advanced features of SDH, Principles of SDH, SDH hierarchy, STM1(155 mbps) to STM-64 (10 Gbps), frame representation, SDH Network Elements, Multiplexers, Digital Cross Connect, Regenerators, Network Management System, SDH network topologies, SONET, IP over WDM, Ethernet over fiber, classic SDH to data centric NGSDH, OTN, Passive optical networks, FTTH, GPON and GEPON.

REFERENCES

- Franz and Jain, Optical Fiber Communication systems: Systems and Components, Narosa Publishers, New Delhi, 2004.
- Gerd Keiser- Optical Fiber Communications- McGraw Hill, 2013
- Govind P Agrawal, Optical Communications- John Wiley, 2008
- John. M. Senior, Optical Fiber Communications, PHI, 1992

ADDITIONAL REFERENCES

- Harold Kolimbiris- Fiber Optics Communications – Pearson education, 2004
- Joseph C. Palais, Fiber Optic Communications, Pearson Education, 2001
- Liu, Principles and applications of optical communication, TMH, 2010

Semester: II
Course Code: OPE-C-623
Course Title: SEMINAR
Credits: 2

AIM: Expertise in understanding research topics in photonics and improving skills such as imparting knowledge and presentation.

OBJECTIVE: 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.

Semester: II
Course Code: OPE-C-624
Course Title: MINI PROJECT I (DESIGN AND DEVELOPMENT)
Credits: 2

AIM: To execute a project related to the field of optoelectronics and optical communication.

OBJECTIVE: To carry out a project relevant to the field of optoelectronics and optical communication. The students have to submit a report, exhibit (if any) and have to make a presentation before the expert committee.

Semester: II
Course Code: OPE-C-625
Course Title: PHOTONIC DESIGN, COMMUNICATION AND DIGITAL SIGNAL PROCESSING LAB
Credits: 3

AIM: Laboratory experience.

OBJECTIVE: To provide programming skills in various simulation software like MATLAB, COMSOL MULTIPHYSICS, OPTIGRATING, OPTIFIBER, OPTISYSTEM, OPTSIM, LABVIEW etc. for advanced digital signal processing, communication systems etc.

COURSE CONTENT (List of Experiments)

Section A. Digital Communication Lab (using MATLAB and LABVIEW)
1. Generation of standard waveforms
(a) Unit Impulse
(b) Unit Step
(c) Ramp
(d) Sine Wave
(e) Cosine wave
(f) Square Wave
2.Analog modulation schemes (a) AM (b) FM (c) PM (d) PAM(e)PWM(f)PPM
3.Digital modulation schemes (a) ASK (b) FSK (c) PSK
4.Design and simulation of various PSK systems-BPSK,DPSK,M-Ary PSK
5.Design and simulation of Channel Coding theorems

Section B. Digital Signal Processing Lab (using MATLAB)
1. DFT & IDFT
2. Convolution (with & without conv)
3. Scaling & Shifting
4. Digital Butterworth filters
5. Digital Chebyshev filters
6. Digital filters using FIR

Section C. Designing of Optical Systems and Optical Fibers
1. Design and analysis of various FBGs using OPTIGRATING
2. Design and analysis of different types of optical fibers using OPTIFIBER
3. Design and performance analysis of optical communication systems using OPTISYSTEM and OPTSIM
4. Design and performance analysis of various optical networks using OPTISYSTEM and OPTSIM
5. Design and analysis of various types of photonic crystal fibers using COMSOL MultiPhysics

(At least 9 experiments should be provided 3 each from Section A, B and C)

Semester: II
Course Code: OPE-E-626
Course Title: OPTICAL SIGNAL PROCESSING
Credits: 3

AIM: To provide ideas on fundamentals of optical signal processing and its design considerations.

OBJECTIVE: To expertise students in the fundamentals of optical signal processing.

COURSE CONTENT

MODULE I: Need for optical signal processing (OSP), fundamentals of OSP. A brief introductory study on digital signal processing (DSP), and mixed signal processing (MSP) and optical signal processing(OSP).

MODULE II: Optical clock generation, design of a soliton based optical clock generator. optical bistability, applications-optical gates.

MODULE III: The Fresnel transform, convolution and impulse response, transform of a slit, Fourier transforms in optics, transforms of aperture functions, inverse Fourier transform, resolution criteria. A basic optical system, imaging and Fourier transform conditions.

MODULE IV: Cascaded systems, scale of Fourier transform condition, maximum information capacity and optimum packing density. Block schematic of an optical spectrum analyzer (OSA): description of working.

MODULE V: Ideal photo detector, noise in detection. CCD arrays: fabrication and layout, specifications, challenges faced in fabrication and design of photo detector arrays.

MODULE VI: Optical computing based on optical polarizations. Encoding and decoding of binary data using polarization states. Design of decoding and encoding systems.

REFERENCES

- Anthony Vander Lugt, Optical Signal Processing, John Wiley & Sons. 2005.
- Damask and Jay, Polarization Optics in Telecommunications, Springer, 2005

ADDITIONAL REFERENCES

- D. Casasent, Optical Data Processing-Applications Springer- Verlag, Berlin, 1978
- J. Horner, Optical Signal Processing, Academic Press 1988
- P.M. Dufffieux, The Fourier Transform and Its Applications to Optics, John Wiley and sons 1983

Semester: II
Course Code: OPE-E-627
Course Title: ARTIFICIAL NEURAL NETWORKS
Credits: 3

AIM: To provide ideas inspired by human brain hybridized to perform learning tasks.
OBJECTIVE: To learn fundamentals of artificial neural networks.

COURSE CONTENT

MODULE I: Introduction – uses of neural networks, Biological neural networks- neuro physiology, models of a neuron-McCulloch&Pitts model, Activation functions- types, multiple input neurons. Learning processes- learning paradigms- supervised and unsupervised learning.

MODULE II: Single layer perceptrons-Architecture-learning rule- Perceptron convergence theorem. Performance learning-Quadratic functions-performance optimization-steepest descent algorithm, learning rates, Widrow-Hoff learning- ADALINE networks, LMS algorithm, linear separability- The XOR problem, Multilayer perceptrons (MLPs) – Backpropagation algorithm.

MODULE III: RBF networks- Cover's theorem on separability of patterns, comparison of RBF networks and MLPs. Associative learning- Unsupervised Hebb rule, Instar and outstar rules.

MODULE IV: Competitive learning- Winner –Take-All networks, Learning Vector Quantizers, Counter propagation networks, Adaptive Resonance Theory (ART) - ART1 clustering algorithm, ART1 network architecture.

MODULE V: Self-organizing maps (SOM), Support vector machines: optical hyperplane for linearly separable and non-separable patterns, design of support vector machines. Principal component analysis (PCA) networks.

MODULE VI: Hopfield networks – Discrete Hopfield networks- energy function- storage capacity of Hopfield networks, Optimization using Hopfield networks- Travelling salesperson problem, solution of simultaneous linear equations, character retrieval. Boltzmann machines. Simulated annealing.

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- Mohamad H. Hassoun, Fundamentals of Artificial Neural Networks, 1995.
- Simon Haykin,Neural Networks,A Comprehensive Foundation, Pearson Education, 1999.

ADDITIONAL REFERENCES

- Bose &Liang,Neural Network Fundamentals, McGraw Hill, 1995
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- KishanMehrotra, Chilukuri K. Mohan, Sanjay Ranka: Elements of Artificial Neural Networks, Penram International Publishing (India), 2009.

Semester: II
Course Code: OPE-E-628
Course Title: NONLINEAR OPTICS
Credits: 3

AIM: To provide knowledge on the evolution of nonlinear optics and its impact in technological applications.

OBJECTIVE: To introduce the basic concepts and theory of Nonlinear Optics.

COURSE CONTENT

MODULE I: Nonlinear optical susceptibility tensor, on the physical origins of the nonlinear optical coefficients, electromagnetic formulation of nonlinear interactions- harmonic generation, sum and difference frequency generation. Optical second harmonic generation-experimental set up.

MODULE II: Parametric generation of light, Basic equations of parametric amplification, parametric oscillation, frequency tuning, experimental arrangement, frequency up and down conversion.

MODULE III: Third order optical nonlinearities: nonlinear absorption- Saturable and reverse saturable absorption, two photon absorption, optical limiting, nonlinear refractive index - intensity dependent refractive index, self focusing and defocusing, optical bi-stability-absorptive and dispersive, optical switching.

MODULE IV: Stimulated Raman Scattering, Stimulated Brilliouin scattering. Nonlinear optical materials: growth and characterization- Degenerate four wave mixing and Z-scan technique.

MODULE V: Propagation through a distorting medium, image transmission in fibers, theory of phase conjugation by four wave mixing, optical phase conjugation by four wave mixing, OPC by stimulated nonlinear scattering.

MODULE VI: Beam coupling and phase conjugation by photorefractive effect, self- induced transparency, self- phase modulation.

REFERENCES

- Ammon Yariv, Quantum Electronics 3rd Edn, John Wiley, New York, 1989
- Govind P. Agrawal, Nonlinear Fiber Optics, 3rd Edn, Academic Press, New Delhi, 2001.
- Pochi Yeh, Introduction to Photorefractive Nonlinear Optics, John Wiley & Sons, New York, 1993

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- Fischer R.A (Ed), Optical Phase Conjugation, Academic Press, San Diego, 1983
- R.D. Guenther, Modern Optics, John Wiley & Sons, 1990
- Rampal V.V, Photonics, Elements and Devices, Wheeler, Allahabad, 1992
- Richard L. Sutherland, Handbook of Non Linear Optics, Marcal Dekker, 1996
- Robert W Boyd, Non Linear Optics, 2nd Edn, Academic Press, 2003
- Singh N.B, Growth and characterization of Nonlinear Optical Materials, Pergamon, 1990

Semester: II
Course Code: OPE-E-629
Course Title: NANOPHOTONICS
Credits: 3

AIM: To introduce the students to fields of confinement of matter and light matter interaction at the nanoscale and its applications.

OBJECTIVE: To learn fundamentals of nanotechnology and its applications in Photonics.

COURSE CONTENT

MODULE I: Introduction to nanoscale interaction of photons and electrons. Near field interaction and microscopy- near field optics and microscopy- single molecule spectroscopy- nonlinear optical process. Mesoscopic physics and nanotechnologies - trends in microelectronics and optoelectronics, characteristic lengths in mesoscopic systems, quantum mechanical coherence.

MODULE II: Materials for nanophotonics -quantum confined materials -inorganic semiconductors-quantum wells, wires dots and rings-quantum confinement-optical properties with examples-dielectric confinement- super lattices. Compound semiconductors- properties- applications-white light-GaN properties-blue LED-white light.

MODULE III: Plasmonics-metallic nanoparticles and nanorods-metallic nanoshells-local field enhancement-plasmonic wave guiding-applications of metallic nanostructures. Nanocontrol of excitation dynamics-nanostructure and excited states-rare earth doped nanostructures-up converting nanophores-quantum cutting.

MODULE IV:. Growth and characterization of nanomaterials- epitaxial growth-MBE-PLD-CVD-nanochemistry-XRD- Raman-IR-XPS-SEM- TEM- SPM.

MODULE V: Organic quantum confined structures- carbon nanotubes-gaphene-characterization, properties and applications. Concept of photonic band gap – photonic crystals - theoretical modeling - features-optical circuitry-photonic crystal in optical communication-nonlinear photonic crystal-applications.

MODULE VI: Current at the nanoscale-nanoelectronic devices-introduction-single electron transistor. Basic ideas of nanolithography and biomaterials-nanophotonics for biotechnology and nanomedicine-nanophotonics and the market place.

REFERNCES

- Colm Durkan, Current at the Nanoscale, Imperial College Press, 2007
- J.M. Martinez-Duart,R.J. Martin Palma,F. Agulle Rueda, Nanotechnology for Microelectronics and Optoelectronics , Elsevier,2006.
- Lukas Novotny and Bert Hecht, Principles of Nano-Optics, Cambridge University Press, 2006
- Paras N. Prasad, Nanophotonics, Wiley Interscience,2004

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- Herve Rigneault, Jean-Michel Lourtioz, Claude Delalande, Juan Ariel Levenson,Nanophotonics, ISTE Publishing Company, 2006.
- John D. Joannopoulo, Robert D. Meade and Joshua N. Winn, Photonic Crystals, Prienceton University Press, 2008
- Mark L. Brongersma and Pieter G. Kik, Surface Plasmon Nanophotonics, Springer – Verlag, 2006.

Semester: II
Course Code: OPE-E-6210
Course Title: SOLAR PHOTOVOLTAICS
Credits: 3

AIM: To introduce students the fundamental theories and technological aspects of power generation using solar photovoltaic technology.

OBJECTIVE: To learn theory, working and applications of solar cells.

COURSE CONTENT

MODULE I: Solar cell materials and their properties. Solar cell research: technology (silicon, organic, Dye sensitized, perovskites), applications and limitations. Device fabrication: Semiconductor junctions: P-N junction, P-I-N junction and its properties. Solar cell structures: homo & hetero junction solar cells, single & multi-junction solar cells. Substrate and Superstrate configuration.

MODULE II: Fabrication techniques: Diffusion, Electrodeposition, Thin film technology: physical vapour deposition (PVD) techniques, chemical vapour deposition (CVD) techniques-MOCVD and PECVD.

MODULE III: Solar cell parameters, Losses in a solar cell: optical losses and electrical losses. Effects of series & parallel resistance, solar radiation and temperature on efficiency. Minimization of optical losses and recombination.

MODULE IV: Design of solar cells: high I_{sc}, high V_{oc}, high FF. Characterization of solar cells: Measurements of solar cell parameters, Solar Simulator- I-V measurement, L-I-V characteristics, quantum efficiency measurement.

MODULE V: PV Modules: solar PV modules from solar cells, series and parallel connections, design and structure of PV modules, power output, batteries for PV systems.

MODULE VI: DC-DC converters, DC-AC converters, PV system configurations, Hybrid PV systems. Photovoltaic system design and applications.

REFERENCES

- Chetan Singh Solanki, Solar Photovoltaic: Fundamentals, Technologies and Applications, PHI, Newdelhi, 2011.
- Larry D Partain (ed.), Solar Cells and their Applications, John Wiley and Sons, Inc, New York, 1995.
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- Poortmans J and Arkhipov V, Thin Film Solar Cell: Fabrication, Characterizations and Applications, John Wiley & Sons, England 2006

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- H. J. Moller, Semiconductors for Solar Cells, Artech House Inc, MA, USA, 1993.
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- M. D. Archer, Clean Electricity from Photovoltaics, R. Hill, Imperial College Press, 2001.

- R. Brendel, Thin-Film Crystalline Silicon Solar Cells: Physics and Technology, Wiley-VCH, Weinheim, 2003.
- Richard H Bube, Photovoltaic Materials, Imperial College Press, 1998

Semester: II
Course Code: OPE-E-6211
Course Title: MATHEMATICAL PHYSICS
Credits: 3

AIM: To provide fundamental exposure to students in understanding theories in Optoelectronics & Laser Technology.

OBJECTIVE: To give awareness in the application of mathematics in physics and engineering.

COURSE CONTENT

MODULE I: Fourier series – Dirichlet's conditions – Fourier series of even and odd functions – Complex form of Fourier series – Fourier integral and it's complex form – Applications – Square wave, full wave rectifier, wave equation

MODULE II: Fourier transforms – Fourier sine and cosine transforms – Convolution theorem and Parseval's identity– Applications –FT by lens, FT of Gaussian function, FT of derivatives. Laplace transform of elementary functions – Inverse Laplace transforms – Methods of finding Inverse Laplace transforms – Solutions of simple differential equations– Applications. Z Transform.

MODULE III: Vector space – Inner product space- unitary space- Hilbert space- Linear independence- basis and dimensions – orthonormal basis – Schmidt orthogonalisation– finite dimensional vector spaces.

MODULE IV: Linear Transformations – change of bases – matrix representation of linear transformation. Eigen values – Eigen vectors – Hermitian and unitary matrices (transformation) β, γ, δ Functions: Properties and applications of each.

MODULE V: Special functions : LEGENDRE-Frobenius method for solving second order ordinary differential equations with variable coefficients. Bessel ,Legendre, Hermite equations. Recurrence relations, generating functions and Rodrigues formulae for the Bessel, Legendre and Hermite functions.

MODULE VI: Special functions : BESSEL-Bessel equation – series solution - Recurrence relations, generating functions and Rodrigues formulae for the Bessel functions.

REFERENCES

- G.B. Arfken, H J Weber, Mathematical Methods for Physicist, 4th ed. Academic Press, 1995.
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- Dr. B.S. Grewal, Higher Engineering Mathematics, 2005.
- Hassani**,** Sadri, Mathematical Methods of Physics and Related Fields2nd ed., 2009.

- Jon Mathews and Robert L. Walker, Mathematical Methods of Physics, University of Cambridge, 1970
- Kreyszig, Erwin, Advance Engineering Mathematics, Loyola Marymount University, 10^{th} Edition, 2012.

Semester: III
Course Code: OPE-C-631
Course Title: RESEARCH METHODOLOGY
Credits: 4

AIM: Enable students in formulating research aims and objectives in an appropriate manner which help them to build a systematic approach towards research.

OBJECTIVE: To understand basic concepts of research and its methodologies.

COURSE CONTENT

MODULE I: Introduction to Research Methodology - objectives and types of research: motivation towards research - research methods vs. methodology. Type of research: descriptive vs. analytical, applied vs. fundamental, quantitative vs. qualitative, and conceptual vs. empirical.

MODULE II: Research formulation - defining and formulating the research problem - selecting the problem - necessity of defining the problem - importance of literature review in defining a problem. Literature review: primary and secondary sources - reviews, treatise, monographs, patents. Web as a source: searching the web. Critical literature review - identifying gap areas from literature review - development of working hypothesis.

MODULE III: Research design and methods: research design - basic principles- need for research design - features of a good design. Important concepts relating to research design: observation and facts, laws and theories, prediction and explanation, induction, deduction.

MODULE IV: Development of models and research plans: exploration, description, diagnosis, experimentation and sample designs. Data collection and analysis: execution of the research - observation and collection of data - methods of data collection - sampling methods- data processing and analysis strategies - data analysis with statistical packages - hypothesis-testing - generalization and interpretation.

MODULE V: Reporting and thesis writing - structure and components of scientific reports - types of report - technical reports and thesis - significance - different steps in the preparation, layout, structure and language of typical reports, illustrations and tables, bibliography, referencing and footnotes. Presentation; oral presentation - planning - preparation -practice - making presentation - use of audio-visual aids - importance of effective communication.

MODULE VI: Application of results of research outcome: environmental impacts – professional ethics - ethical issues - ethical committees. Commercialization of the work - copy right - royalty - intellectual property rights and patent law - trade related aspects of intellectual property rights - reproduction of published material - plagiarism - citation and acknowledgement - reproducibility and accountability, impact factor of journals, paper submission procedures.

REFERENCES

- C.R Kothari, Research Methodology, Sultan Chand & Sons, New Delhi, 1990.
- Panneerselvam, Research Methodology, Prentice Hall of India, New Delhi, 2012.

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- Donald Cooper, Business Research Methods, Tata McGraw Hill, New Delhi, 2013.
- J.W Bames, Statistical Analysis for Engineers and Scientists, McGraw Hill, New York, 1994.
- Leedy P D, Practical Research: Planning and Design, MacMillan Publishing Co, 2001
- Manna, Chakraborti, Values and Ethics in Business Profession, Prentice Hall of India, New Delhi, 2012.
- Sople, Managing Intellectual Property: The Strategic Imperative, Prentice Hall of India, New Delhi, 2012.

Semester: III
Course Code: OPE-C-632
Course Title: MINI PROJECT II (DESIGN AND DEVELOPMENT)
Credits: 2

AIM: To perform a project relevant to the field of optoelectronics and optical communication.

OBJECTIVE: To carry out a project relevant to the field of optoelectronics and optical communication. The students have to submit a report, exhibit (if any) and have to make a presentation before the expert committee.

Semester: III
Course Code: OPE-C-633
Course Title: STUDY ON CURRENT ADVANCED RESEARCH
Credits: 2

AIM: To introduce students to recent developments in Photonics and technologies of Photonics for solving real life problems.

OBJECTIVE: Students have to select a technologically important relevant topic for this investigation. They have to submit a detailed report on this investigation at the end of the 3rdsemester.

Semester: III
Course Code: OPE-D-634
Course Title: DISSERTATION PHASE I
Credits: 4

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.

Semester: III
Course Code: OPE-E-635
Course Title: HOLOGRAPHY AND SPECKLE INTERFEROMETRY
Credits: 4

AIM: To provide theoretical fundamentals and conditions for realization of Holographic and Speckle Interferometric techniques.

OBJECTIVE: To understand the basic concepts, theory and applications of Holography and Speckle Interferometry.

COURSE CONTENT

MODULE I: Optical Holography: basic principle, recording and reconstruction, types of holograms: transmission hologram, reflection hologram, phase holograms, rainbow hologram (qualitative analysis only).

MODULE II: Experimental techniques, detectors and recording materials, holographic optical elements, holographic scanners, application of holography: pattern recognition, information storage.

MODULE III: Holographic interferometry : theory of fringe formation and measurement of displacement vector, Holographic nondestructive testing, Different Techniques: double exposure, real time, time average, sandwich, acoustic, comparative and TV holography.

MODULE IV: Loading methods, holographic contouring/shape measurement, dual wavelength method, dual refractive index method, digital holography, holographic photoelasticity, optical coherence tomography.

MODULE V: Speckle Metrology: speckle phenomena, statistics of speckle pattern, classification, objective speckle pattern, subjective speckle pattern, speckle techniques: speckle photography, speckle interferometry, speckle shear interferometry.

MODULE VI: Electronic speckle pattern interferometry, theory of fringe formation and measurement of displacement vector, out of plane and in plane measurements, surface roughness measurement, vibration measurement, detection of defects.

REFERENCES

- Goodman J.W , Speckle phenomena in optics, Robert & company 2007
- Hariharan, Optical Holography, Academic Press, 1983
- Sirohi R.S., (Ed), Speckle Metrology, Mercel Dekker, 1993
- Vest.C.M., Holographic Interferometry, John Wiley & Sons Inc., 1979

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- H. J. Caulfield, Handbook of Optical Holography, Academic Press. 1979
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- John Wiley & Sons, 2001
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- Robert K Erf, Holographic Non-destructive Testing, Academic Press, 1974

- Wolfgang Steinchen & Lianxiang Yang, Digital Shearography, Spei Press, 2003
- Yu.Iostrovsky, Holography and its Application, Mir Publishers, 1977

Semester: IV
Course Code: OPE-D-641
Course Title: DISSERTATION 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.

Semester: I
Course Code: OPE-X-611
Course Title: INTRODUCTION TO PHOTONICS
Credits: 2

AIM: Photonics is the technology of this century and this course aims to develop an interest and awareness about Photonics in the students.

OBJECTIVE: To learn the fundamentals of Lasers and its applications, optical fiber technology, holography and nanophotonics.

COURSE CONTENTS

MODULE I : Laser Fundamentals: Fundamentals of Interference – superposition principle – Coherence – spatial and temporal coherence. Einstein's coefficients – population inversion and optical pumping.

MODULE II: Laser Systems: Threshold condition – Optical Resonator – quality factor- Two - Three level –Four level systems. Ruby – He-Ne - Nd:YAG – CO_2 – Dye Laser systems.

MODULE III: Industrial and Medical applications of Lasers- Holography – principle – special features of Holograms – Applications.

MODULE IV: Introduction to optical fibers, total internal reflection, acceptance angle, numerical aperture, fractional refractive index difference, skew rays, classification of fibers: based on refractive index profiles, modes guided applications and materials - Introduction to Optical Communication systems.

MODULE V: Solid state devices: Principle and working of - Photodiodes – Phototransistors – Solar cell – LEDs -Semiconductor lasers.

MODULE VI: Nanophotonics: Semiconductor nanoparticles-low dimensional structures-metal nanoparticles- Gold nanoparticles-plasmons- Carbon nanotubes- Graphene- properties and applications.

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- Gerd Keiser- Optical Fiber Communications- McGraw Hill, 2013
- H. J. Caulfield, Handbook of Optical Holography, Academic Press. 1979
- Paras N. Prasad, Nanophotonics, Wiley Interscience,2004
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