Babu Banarasi Das University, Lucknow

Department of Electronics and Communication

School of Engineering
Master of Technology

Optical Communication

Evaluation Scheme (Full Time) (w.e.f Session 2015-16)

SEMESTER I										
Course Category	**Course Code**	**Course Title**	**Contact Hours**			**Evaluation Scheme**			**Credits**
			L	**T**	**P**	**CIA**	**ESE**	**Course Total**	
C	MAS2002	Linear algebra and random process	4	0	0	40	60	100	4
C	MEC2104	Laser Technology	4	0	0	40	60	100	4
C	MEC2105	Modern Optics	4	0	0	40	60	100	4
C	MEC2106	Basics of Optical Communication	4	0	0	40	60	100	4
C	MEC2107	Optoelectronics	4	0	0	40	60	100	4
C	MEC2154	Optical Fiber Lab	0	0	2	100	-	100	1
C	MEC2152	Seminar	0	0	2	100	-	100	1
C	MEC2153	Technical Paper Presentation *	0	0	2	100	-	100	1
	Total		20	0	6	500	300	800	23

Semester II									
Course Category	**Course Code**	**Course Title**	**Contact Hours**			**Evaluation Scheme**			**Credits**
			L	**T**	**P**	**CIA**	**ESE**	**Course Total**	
C	MEC2205	Fiber Optics and Laser Instrumentation	4	0	0	40	60	100	4
C	MEC2206	Optical Networks	4	0	0	40	60	100	4
C	MEC2207	Optical Communication Technology	4	0	0	40	60	100	4
C	MEC2208	Optical Signal Processing	4	0	0	40	60	100	4
GE		GenericElective-I	4	0	0	40	60	100	4
C	MEC2254	Optoelectronics & Communication Lab	0	0	2	40	60	100	1
C	MEC2252	Mini Project	0	0	2	100	-	100	1
C	MEC2253	Research Methodology & Practices **	0	0	2	100	-	100	1
	Total		20	0	6	440	360	800	23

SEMESTER III									
Course Category	**Course Code**	**Course Title**	**Contact Hours**			**Evaluation Scheme**			**Credits**
			L	**T**	**P**	**CIA**	**ESE**	**Course Total**	
C	MEC2351	State of Art Seminar ***	-	-	-	200	-	200	4
C	MEC2352	Thesis –I #	-	-	-	400	-	400	16
	Total					600		600	20

SEMESTER IV									
Course Category	**Course Code**	**Course Title**	**Contact Hours**			**Evaluation Scheme**			**Credits**
			L	**T**	**P**	**CIA**	**ESE**	**Course Total**	
C	MEC2451	Thesis –II ##	-	-	-	200	800	1000	28
	Total					200	800	1000	28

* Technical paper presentation provides a platform for the student to do some original research that has not been done before, have a latest research paper (for reference) published in a refereed journal, and then give a presentation.

** The mission of the course is to impart research skills to the beginners and help them to improve the quality of Research. The student is expected to develop the most appropriate methodology for their Research Studies, and then give a presentation on research overview and its methodologies. This may include various steps to conduct the research.

*** The student needs to perform a literature survey and will give a state of art presentation and will submit a synopsis clearly mentioning the problem statement. The presentation and synopsis will be evaluated internally within two months of the start of the semester and the result will be intimated to the students so as to proceed for Thesis-I.

The student will develop a workable model for the problem they have proposed in synopsis.

This is in continuation with Thesis-I. The required experimental/mathematical verification of the proposed model will be done in this semester.

Generic Elective – I		
1.	MEC2015	Optical Computing
2.	MEC2016	Physics of Advance Material
3.	MEC2031	Statistical Signal Processing
4.	MEC2032	Spread Spectrum Communication

Babu Banarasi Das University, Lucknow

Department of Electronics and Communication

School of Engineering

Master of Technology

Optical Communication

Evaluation Scheme (Part Time) (w.e.f Session 2015-16)

SEMESTER I

Course Category	Course Code	Course Title	Contact Hours			Evaluation Scheme			Credits
			L	T	P	CIA	ESE	Course Total	
C	MAS2002	Linear algebra and random process	4	0	0	40	60	100	4
C	MEC2104	Laser Technology	4	0	0	40	60	100	4
C	MEC2105	Modern Optics	4	0	0	40	60	100	4
	Total		12	0	0	120	180	300	12

SEMESTER II

Course Category	Course Code	Course Title	Contact Hours			Evaluation Scheme			Credits
			L	T	P	CIA	ESE	Course Total	
C	MEC2205	Fiber Optics and Laser Instrumentation	4	0	0	40	60	100	4
C	MEC2206	Optical Networks	4	0	0	40	60	100	4
GE		GenericElective-I	4	0	0	40	60	100	4
	Total		12	0	0	120	180	300	12

SEMESTER III									
Course Category	**Course Code**	**Course Title**	**Contact Hours**			**Evaluation Scheme**			**Credits**
			L	**T**	**P**	**CIA**	**ESE**	**Course Total**	
C	MEC2106	Basics of Optical Communication	4	0	0	40	60	100	4
C	MEC2107	Optoelectronics	4	0	0	40	60	100	4
C	MEC2154	Optical Fiber Lab	0	0	2	100	-	100	1
C	MEC2152	Seminar	0	0	2	100	-	100	1
C	MEC2153	Technical Paper Presentation *	0	0	2	100	-	100	1
	Total		8	0	6	380	120	500	11

SEMESTER IV									
Course Category	**Course Code**	**Course Title**	**Contact Hours**			**Evaluation Scheme**			**Credits**
			L	**T**	**P**	**CIA**	**ESE**	**Course Total**	
C	MEC2207	Optical Communication Technology	4	0	0	40	60	100	4
C	MEC2208	Optical Signal Processing	4	0	0	40	60	100	4
C	MEC2254	Optoelectronics & Communication Lab	0	0	2	40	60	100	1
C	MEC2252	Mini Project	0	0	2	100	-	100	1
C	MEC2253	Research Methodology & Practices **	0	0	2	100	-	100	1
	Total		8	0	6	320	180	500	11

SEMESTER V									
Course Category	**Course Code**	**Course Title**	**Contact Hours**			**Evaluation Scheme**			**Credits**
			L	**T**	**P**	**CIA**	**ESE**	**Course Total**	
C	MEC2351	State of Art Seminar ***	-	-	-	200	-	200	4
C	MEC2352	Thesis –I #	-	-	-	400	-	400	16
	Total					600		600	20

SEMESTER VI									
Course Category	**Course Code**	**Course Title**	**Contact Hours**			**Evaluation Scheme**			**Credits**
			L	**T**	**P**	**CIA**	**ESE**	**Course Total**	
C	MEC2451	Thesis –II ##	-	-	-	200	800	1000	28
	Total					200	800	1000	28

* Technical paper presentation provides a platform for the student to do some original research that has not been done before, have a latest research paper (for reference) published in a refereed journal, and then give a presentation.

** The mission of the course is to impart research skills to the beginners and help them to improve the quality of Research. The student is expected to develop the most appropriate methodology for their Research Studies, and then give a presentation on research overview and its methodologies. This may include various steps to conduct the research.

*** The student needs to perform a literature survey and will give a state of art presentation and will submit a synopsis clearly mentioning the problem statement. The presentation and synopsis will be evaluated internally within two months of the start of the semester and the result will be intimated to the students so as to proceed for Thesis-I.

The student will develop a workable model for the problem they have proposed in synopsis.

This is in continuation with Thesis-I. The required experimental/mathematical verification of the proposed model will be done in this semester.

Generic Elective – I		
1.	MEC2015	Optical Computing
2.	MEC2016	Physics of Advance Material
3.	MEC2031	Statistical Signal Processing
4.	MEC2032	Spread Spectrum Communication

MEC2104 Laser Technology

Course Objective:

The objective of the course is:

1. To provide the basic knowledge of laser technology.
2. To gain knowledge of semi-classical theory of laser.
3. To understand and study types of laser.
4. To study important application of laser.

Learning Outcome:

After completion of the subject, the students will:

1. Understand about theory of laser
2. Gain the knowledge of laser rate equation, optical resonators.
3. Understand the properties of laser beams.
4. Gain the knowledge of important application of laser.

Course Contents:

Module	**Course Topics**	**Total Hours**	**Credits**
I	**Einstein Coefficients and Light Amplification Introduction.** The Einstein's coefficients, Quantum Theory for the Evaluation of the Transition Rates and Einstein Coefficients, Interaction with radiation having a broad spectrum, Introduction of a near monochromatic wave with an atom having a broad frequency response, More accurate solution for the two level systems, Line broadening mechanisms, Saturation Behavior of homogeneously and in homogeneously broadening transitions. Laser Rate Equations, Introduction, The three Level System, The Four Level System, Variation of Laser Power around Threshold, Optimum Output coupling. Laser spiking.	30 Hours	1
II	**Semi classical Theory of Laser**: Introduction, Cavity Modes, Polarization of cavity medium: First order & Higher order theory. Optical Resonator: Introduction, modes of a rectangular Cavity and the open planar resonator, The Quality factor, The ultimate line width of the laser, Transverse and longitudinal mode selection switching, Mode locking in Lasers Co focal Resonator system, Planar resonators, General Spherical Resonator.	30 Hours	1

III	**Properties of Laser Beams and Laser Structures Coherence properties of Laser Light**: Temporal Coherence, Spatial Coherence, Directionality Semiconductor Laser: Structure and properties, operating principle, Threshold condition, Power output. Heterojunction laser: Principle and structure, Losses in heterostructure laser, Heterostructure laser materials. Distributed feedback lasers: Principle of working, Coupled mode theory. Quantum well laser, Strained quantum well laser	30 Hours	1
IV	**Some Important Application of lasers**: Laser induced fusion: Introduction, The fusion process, laser energy requirements, The laser induced Fusion Reactors. Lasers in Science: Harmonic Generation, Stimulated Raman Emission, Self focusing, Lasers in Chemistry, Rotation of the Earth, Lasers in Isotope Separation. Lasers for light detection and ranging (LIDAR).	30 Hours	1

Text/ Reference Books:

1. K.Thyagrajan and A.K.Ghatak, “Laser theory and applications”, Macmillan Publication W.T. Silfvast,
2. William T. Silfvast “Laser fundamentals”, Cambridge University Press.
3. Ghatak & Thyagarajan, “Essentials of Optoelectronics”, A. Rogers (Chapman Hall).

MEC2105 Modern Optics

Course Objective:

The objective of the course is:

1. To study about optical process and optical materials.
2. To gain knowledge of luminescence and eletroluminscence.
3. To understand and study optical design.
4. To study important issues of non linear optics.

Learning Outcome:

After completion of the subject, the students will:

1. Understand about light propagation.
2. Gain the knowledge of excitons and luminescence.
3. Understand the idea of optical design.
4. Gain the knowledge of non linear optics**.**

Course Contents:

Module	Course Topics	Total Hours	Credits
I	**Classification of optical processes**: Optical coefficients, complex refractive index and dielectric constant. Optical materials: Crystalline insulators and semiconductor, glasses, metal, molecular materials, Doped glass and insulator characteristics, optical physics in the Solid state, crystal symmetry, electronic bands, vibronic band, the density of state, delocalized states and collective excitation. Light propagation: Propagation of light in dense optical medium, Atomic oscillator, vibration oscillator, Free electron oscillation, the Kramers–Kronig relationship, Dispersion, Optical anisotropy, birefringence. Excitons: Basic concept, free excitons in external electric and magnetic fields, free excitons at light densities, frenkelexcitons.	30 Hours	1
II	**Luminescence**: Light emission in solids, Interband luminescence, Direct and indirect gap materials, photoluminescence Excitation and relaxation, degeneracy, Photoluminescence spectroscopy. Electroluminescence: General principles of	30 Hours	1

	electroluminescence, light emitting diodes, diode laser. Electromagnetism in dielectrics, Electromagnetism fields and Maxwell equation Electromagnetism waves, Quantum theory of radiative absorption and emission Einstein coefficients, Quantum transition rates, selection rules. Basic concept of phonons, Polaritons and polarons.		
III	**Nonlinear optics**: Physical origin of optical nonlinearities, Non resonant and resonant nonlinearities, second order nonlinearities Non linear frequency mixing, Crystal symmetry, Phase matching, Third order non linear media. Harmonic generation, mixing and parametric effects. Multiphonon processes Two-photon absorption, saturated absorption, Spectroscopy Rayleigh, Brillouin and Raman scattering. Stimulated Raman effect, Hyper Raman effect, Coherent Antistoke Raman scattering Self-focusing and self-phase modulation. Self-induced transparency, Solitons.	30 Hours	1
IV	**Optical Design**: Fourier Optics & Holography: Revision of geometrical optics. Fourier transforms. Impulse response and transfer functions. Scalar diffraction, spatial and temporal coherence. Image forming systems, coherent and incoherent imaging. Spatial filtering. Holography (Fresnel, Fraunhofer, Fourier). Holographic techniques and applications.	30 Hours	1

Text Books/ Reference Books:

1. A. Yariv Saunders, “Optical Electronics” Saunders College publications.
2. Ghatak & Thyagarajan, “Essentials of Optoelectronics”, A. Rogers (Chapman Hall).
3. A. Rogers, “Essentials of Optoelectronics” Chapman Hall.
4. Jasprit Singh, “Semi conductor Optoelectronics”, McGraw Hill, 1995.

MEC2106 Basics of Optical Communication

Course Objective:

1. Review of fundamentals of Fiber Optical Communication.
2. To study various fiber fabrication techniques and its applications.
3. To study the various parameters for the designing the system.
4. To study various optical transmitters such as LED, Laser, PIN photodetector.

Learning Outcome:

Students will have knowledge about

1. The advantages of optical communication over other means of communication.
2. The technology used in fiber optic communication and its various fabrication techniques.
3. The optical transmitters and receivers.
4. Wavelength division Multiplexing and its architecture.

Course Contents:

Module	**Course Topics**	**Total Hours**	**Credits**
I	**Review of Optical Fiber Communication:** Need for Fiber Optic Communication, evolution of light wave systems and its components. Optical fibres, their classification, total internal reflection, Goos Hanchen shifts, Dispersion in Single mode fiber, fiber losses, Non liner optical effects and polarization effect. Analysis of Optical fiber waveguides, electromagnetic mode. Theory for optical propagation, attenuation and single distortion in optical waveguide. Characteristic equation of step-index fibre, modes and their cut-off frequencies, single-mode fibres, weakly guiding fibres, linearly polarized modes, power distribution. Graded index fibres - WKB, propagation constant, leaky modes, power profiles. Dispersions: material, modal & waveguide.	30 Hours	1
II	**Physics and Technology of Optical Fiber** Passive photonic components: FO cables, Splices, Connectors, Couplers, Optical filter, Isolator, Circulator and Attenuator, switches. Fabrication of optical fibers: MOCVD, OVD, VAD, PCVD; measurement of RI, attenuation. Fiber devices, fiber Bragg gratings, long period gratings, fiber amplifiers and fiber lasers. Application of optical fibers in science, industry, medicine and defence.	30 Hours	1

III	**Optical Signal Modulation and Amplifiers:** Optical fiber systems, modulation schemes, Digital and analog fiber communication system, system design consideration, fiber choice, wavelength conversion, switching and cross connect Semiconductor Optical amplifier (SOA), characteristics, advantages and drawback of SOA , Raman amplifier, erbium doped fiber amplifier, gain and noise in EDFA, Brillouin fiber amplifier wideband Hybrid amplifier, Noise characteristics, amplifier spontaneous emission, Noise amplifier, Noise figure, Cumulative and effective noise figure, Noise impairments, amplifier applications.	30 Hours	1
IV	**Optical Transmitters**: Basic concepts, Light emitting diodes, Semiconductor laser, Laser Characteristics, Transmitter design. Optical Receivers: Basic concepts, PN and pin photo detectors, Avalanche photo detector MSM photo detector, Receiver design, Receiver noise, Receiver sensitivity, Sensitivity degradation, Receiver performance. Wavelength division multiplexing (WDM): Multiplexing Techniques, Topologies and architectures, Wavelength shifting and reverse, Switching WDM demultiplexer, optical Add/drop multiplexers. Dense wavelength division multiplexing (DWDM): System considerations, multiplexers and demultiplexers, Fiber amplifier for DWDM, SONET/ SDH Transmission, Modulation formats, NRZ and RZ signalling, DPSK system modelling and impairments.	30 Hours	1

Text/ Reference Books:

1. John. M. Senior, "Optical fiber communications: principles and practice", Prentice Hall of India.
2. Gerd Keiser, "Optical fiber communications", McGraw Hill, 3rdedition.
3. D. K. Mynbaev and L. L. Scheiner, "Fiber optic communication technology", Pearson Technology
4. R. P. Khare, "Fiber optic and optoelectronics", Oxford University press.
5. John Gowar, "Optical Communication Systems", Prentice Hall of India

MEC2107 Optoelectronics

Course Objective:

The main objective of this course is

1. To study various optical process within semiconductors.
2. To gain knowledge about various different optoelectronic devices and circuits.
3. To study about various organic semiconductors and their properties.

Learning Outcome:

After completion of the subject, the students will understand

1. The basic concept of optical process in semiconductors and their fabrication techniques.
2. The principle and working of optoelectronics devices such as OLED's, OPVD's.
3. The mechanism of generation, conduction of charge carriers within semiconductors.

Course Contents:

Module	Course Topics	Total Hours	Credits
I	**Optical processes in Semiconductors and Fabrication** Electron hole pair formation and recombination, Absorption, Effect of electric field on Absorption, Franz-Keldysh and stark effects, Absorption in Quantum wells and Quantum confined stark effect, relation between Absorption and emission spectra, Stokes shift in optical transition, Deep level transitions, Measurement of absorption and luminescence Spectra, Time resolved Photoluminescence. Materials Growth & Fabrication: Growth of optoelectronic materials by MBE, MOCVD, Plasma CVD, photochemical deposition. Epitaxy, interfaces and junctions, interdiffusion and doping, Quantum wells and band gap engineering.	30 Hours	1
II	**Optoelectronic Devices and Integrated Circuits** Basic concepts, Optical constants, absorption and emission properties. Photodiodes: characteristics and fabrication, Photo detectors: types, PV and PC devices. Solar cells, photoresistors. Optoelectronic Integrated Circuits: Need for Integration, Hybrid and	30 Hours	1

	Monolithic Integration, Applications, Materials and Processing for OEIC. Integrated Transmitters and Receivers**:** Front End Photoreceivers, OEIC Transmitters, Complex Circuits and Arrays, Optical Control of Microwave Oscillators.		
III	**Organic Semiconductors** Molecular materials, Electronic state in conjugated molecules, Optical spectra of molecules, Electronic vibration transitions, Franck Condon principle, Aromatic hydrocarbons, Conjugated polymer. Organic Semiconductors: Conductivity and Mobility of nearly-free Charge Carriers. Charge Carriers in Organic Semiconductors: Polarons, Shallow Traps and Deep Traps, Generation of Charge Carriers and Charge Transport: Experimental Methods, The TOF Method, Gaussian Transport. Space-Charge Limited Currents. Bandor Hopping Conductivity, Electric-field Dependence, Charge Transport in Disordered Organic Semiconductors., The Bässler Model.	30 Hours	1
IV	**Optoelectronics Devices** Organic optoelectronic devices: Organic Light-Emitting Diodes (OLEDs), Principle, Multilayer OLEDs, Structure, Fundamental processes, Efficiency, Characterization of OLEDs. Organic photovoltaic diodes (OPVDs): Fundamental process, Exciton absorption, Exciton dissociation, Charge collection Characterization of OPVDs, Relevant performance parameters. Guided Wave Device: Waveguides and Couplers, Active Guided Wave Devices, Prospects For Optical Interconnects.	30 Hours	1

Text/Reference Book:

1. Pallabh Bhattacharya, “Semiconductor Optoelectronics Devices”,Pearson Education
2. A. Yariv Saunders, “Optical Electronics” Saunders College publications.
3. Ghatak & Thyagarajan, “Essentials of Optoelectronics”, A. Rogers (Chapman Hall).
4. A. Rogers, “Essentials of Optoelectronics” Chapman Hall.
5. Jasprit Singh, “Semi conductor Optoelectronics”, McGraw Hill, 1995.

MEC2154 Optical Fiber Lab (using MATLAB)

1. Calculate numerical aperture, Acceptance angle, Solid acceptance angle and Propagation constant (β) for Step Index Fibers.

2. Calculate Normalized propagation constant, V number (V), check whether the fiber is single mode or multi mode, graph between normalized propagation constant, V number, cut off wavelength (λ_c) and number of modes travelling in fiber (Ms) for Step Index Fibers.

3. Calculate for Graded Index Fibers:
   a) Graphical representation of core refractive index n1[r] w.r.t. radius (a) of core for different profile parameters.
   b) Graphical representation of numerical aperture NA[r] w.r.t. radius of core (r) for different profile parameters.
   c) Acceptance Angle (θ_a) for given value of radius Where $0 < r <= a$, Δ = refractive index difference.
4. Calculate: Numerical aperture (NA), V number (V), check whether the fiber is single mode or multi mode, graph between V number and wavelength (λ), cut off wavelength (λ_c), number of modes travelling in fiber (Ms) for Graded Index Fibers.
5. Calculate Mode Field Diameter for Step Index Fibers.

6. Calculate for pure Silica fibers:

   a) Graph for refractive index (n) with wavelength (λ)
   b) Graph for dn/dλ with wavelength (λ)
   c) Graph for d2n/dλ2 with wavelength (λ)
   d) Graph for material dispersion (Dm) with wavelength
   e) Calculate material dispersion (Dm) at given wavelength
   f) Find Zero material dispersion wavelength

7. Calculate V number (V), Cut off wavelength (λ_c), Waveguide dispersion at given wavelength, Plot of waveguide dispersion with wavelength for step index fibers.

8. Calculate:

   a) The Rayleigh Scattering Loss for Silica Fibers.
   b) Plot a graph for Loss with wavelength.
9. Calculate the Infrared absorption loss for silica fibers and plot a graph with wavelength.
10. Calculate the Ultraviolet absorption loss for Silica fibers and plot a graph with wavelength.

MEC2205 Fiber Optics and LASER Instrumentation

Course Objective:

1. To provide the concepts of optical fiber and their properties.
2. To provide the knowledge of use of fiber optic sensor in measurement.
3. To provide the knowledge of LASER measurement and testing.

Learning Outcome

Student will be able to learn

1. Medical applications of lasers in tissue interaction.
2. Laser modes like resonator configuration and Q-switching and mode locking.
3. Basic principles and methods of holography.

Course Contents:

Module	Course Topics	Total Hours	Credits
I	**Optical Fibers and Their Properties:** Principles of light propagation through a fiber, Different types of fibers and their properties, Fibre materials and their characteristics, Transmission characteristics of fiber- absorption. Losses: Scattering losses, Dispersion Measurement on optical fibers, Optical sources, Optical detectors.	30 Hours	1
II	**Fiber Optic Sensors in Measurement:** Fiber optic instrumentation system, Fiber optic sensors Different types of modulator, Application in instrumentation, interferometric method of measurement of length -Measurement of pressure, temperature, current, voltage, liquid level and strain. Medical applications of lasers: laser and tissue interaction - Laser instruments for surgery.	30 Hours	1
III	**Fundamentals of Laser Instruments:** Fundamental characteristics of laser, three level and four level lasers, properties of lasers, laser modes, resonator configuration, Q-switching and mode locking, cavity dumping types of laser gas laser, solid laser, liquid laser, semi conductor laser.	30 Hours	1
IV	**Lasers In Measurements and Testing:** Laser for measurement of distance, length, velocity, acceleration, current, voltage, and atmospheric effect, Laser application in Spatial Frequency Filtering,	30 Hours	1

	Holography: Basic principle, methods, Holographic interferometry and applications, Holography for non-destructive testing, Holographic components. Lasers in Industry: Applications in Material processing, Laser Welding, Hole drilling, Laser Cutting, Laser Tracking.		

Text/Reference Book:

1. W Stallings, “Data and Computer Communications”, Prentice Hall of India, 1997, PearsonEdu.
2. A. Forouzan Data Communications and networking”, TMH.
3. M Deprycker, “ATM-solutions for Broadband ISDN”, Prentice-Hall of USA,1995.

MEC2206 Optical Networks

Course Objective:

The objective of the course is:

1. To provide a comprehensive understanding of optical communication systems and networks.
2. To study multiple access techniques such as WDM.
3. To learn virtual topology design, routing and wavelength assignment.
4. To study design of multi path fiber network.

Learning Outcome:

After completion of the subject, the students will:

1. Understand various issues in WDM optical networks.
2. Gain the knowledge of next generation optical Internet networks.
3. Understand the idea behind wavelength convertible networks.
4. Understand the need for virtual topology reconfiguration

Course Contents:

Module	Course Topics	Total Hours	Credits
I	**WDM Technology and Issue in WDM optical networks:** Introduction, Optical networks, WDM, WDM optical networking evolution, Enabling Technologies for WDM optical networks, WDM optical network architecture, Issues in Wavelength routed networks, Next generation optical Internet networks.	30 Hours	1
II	**Wavelength Routing algorithms:** Introduction, Classification of RWA algorithms, RWA algorithms, Fairness and Admission control, Distributed control protocols, Permutation routing and Wavelength requirements. Wavelength Rerouting algorithms: Introduction, Benefits of Wavelength routing, Issues in Wavelength routing, Ligthpath Migration, Rerouting schemes, Algorithm AG, Algorithm MWPG, Rerouting in WDM networks with Sparse Wavelength conversion, Rerouting in Multi fiber Networks, Rerouting in Multi fiber Unidirectional Ring networks.	30 Hours	1

III	**Wavelength Convertible networks:** Introduction, Need for Wavelength converters, Wavelength convertible switch architecture, Routing in convertible networks, Performance evaluation of convertible networks, Networks with Sparse Wavelength conversion, Converter placement problem, Converter allocation problem. Virtual Topology Design: Introduction, Virtual topology design problem, Virtual topology design sub problems, Virtual Topology Design Heuristics, Regular virtual topology design, predetermined virtual topology and light path routes, Design of multi fiber networks.	30 Hours	1
IV	**Virtual Topology Reconfiguration:** Introduction, Need for virtual topology reconfiguration, Reconfiguration due to Traffic changes, Reconfiguration for Fault restoration. Network Survivability and Provisioning: Failures and Recovery, Restoration schemes, Multiplexing techniques, Distributed control protocols. Optical Multicast routing, Next Generation optical Internet networks.	30 Hours	1

Text/ Reference Books:

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

MEC2207 OPTICAL COMMUNICATION TECHNOLOGY

Course Objective:

The objective of the course is:

1. To gain an understanding of various issues in designing an optical network.
2. To study first generation optical networks: SONET/SDH and wavelength division multiplexing.
3. To understand FTH and PON Technology.
4. To study important issues of OTDM.

Learning Outcome:

After completion of the subject, the students will:

1. Understand optical amplifiers, multiplexer and demultiplexer.
2. Gain the knowledge fiber Inter satellite link hops (ISL).
3. Understand the idea behind various military, civil, consumer and industrial applications.
4. Gain the knowledge of second generation optical network layers.

Course Contents:

Module	Course Topics	Total Hours	Credits
I	**Components** Introduction to optical components, optical amplifiers, types, issues in optical amplifiers, photonic switching, cross connect, wavelength conversion, multiplexer, demultiplexer, filters, tunable filters, introduction to OICs and its applications.	30 Hours	1
II	**First Generation Optical Networks** SONET/SDH, multiplexing, elements of a SONET/SDH infrastructure, SONET/SDH physical layer. Computer interconnects, ESCON, Fiber channel, HIPPI. Metropolitan area networks, FDDI, ATM. Layered architecture, SONET/SDH layers, Second generation optical network layers.	30 Hours	1
III	**WDM Technology** Introduction, WDM optical networking evolution,	30 Hours	1

	enabling technologies for WDM optical networks, WDM optical network architecture DWDM – issues in WRN. OTDM Technology: Important issues of OTDM, optical solitons, applications of solitons. Optical pulse compression, fiber grating compressor, soliton effect compressor.		
IV	**FTH and PON Technology** Proposed architecture and issues of Fiber to the home (FTH), Passive optical networks (PON), Near space communication, Open air optical communication, Inter satellite link hops (ISL). Introduction to all optical networks (AON). Military, civil, consumer and industrial applications.	30 Hours	1

Text/Reference Book:

1. Rajiv Ramaswami and Kumar N. Sivarajan, " Optical networks – A Practical Perspective", A Harcourt Publishers International Company, 2000.
2. R.G. Junsperger, "Integrated Optics – Theory and Technology, Springer Series in Optical Sciences", 3rd Edition 1991.
3. Gerg Keiser, "Optical Fiber Communications", McGraw Hill International Edition, 1991.
4. G.P. Agarwal, "Non-Linear Optics", Academic Press.
5. Stamatios V.Kartalopoulos, "Understanding SONET/SDH and ATM Communication Network for Next Millennium", PHI, 2000.
6. C.SivaRam Murthy and Mohan Gurusamy, "WDM Optical Networks: Concepts, Design and Algorithms" PHI , India, 2002.

MEC2208 Optical Signal Processing

Course Objective:

1. To know the basic parameters of signals.
2. To know the operations that can be performed on signals.
3. To know the different filtering methods of the signals.
4. To know the optical devices and analyze the power spectrum.

Learning Outcome:

1. Student will acquire knowledge of different parameters of signals.
2. Student will analyze signals using different techniques.
3. Student will learn about different types of filtering techniques.
4. Student will learn about optical devices and analyze the power spectrum of signal.

Course Contents:

Module	Course Topics	Total Hours	Credits
I	**Basic signal parameters** Characterization, Sample function, geometrical optics, basic laws, refraction by prisms, lens formula, imaging condition, optical invariants, physical optics, Transforms: Fresnel. Fourier, Inverse fourier and extended fourier.	30 Hours	1
II	**Spectral analysis** Spectral light modulators, detection process, System performance process, dynamic range, raster format, spectral analysis.	30 Hours	1
III	**Spatial filtering and filtering system** Types of spatial filters, optical signal processing and filter generation, read out module, orientation and sequential search, applications of optical spatial filter.	30 Hours	1
IV	**Optical spectrum analysis** Types of optical spectrum analyzer: Interferometer based optical spectrum analyzer. Diffraction grating based optical spectrum analyzer: Wavelength tuning and repeatability, wavelength resolution bandwidth, dynamic range, sensitivity.	30 Hours	1

Text/ Reference Books:

1. Wabnitz, Stefan, Eggleton, and Benjamin J. “All Optical Signal Processing”, Springer.
2. Joseph Horner “Optical Signal Processing”, Elseiver.

MEC2254 Optoelectronics and Communication Lab

1. To study the comparison of a Schmitt trigger and Phototransistor.
2. To study the similarities and differences between conventional LEDs and fiber optic LEDS.
3. To study the Phototransistor characteristics
4. Study of signal sampling and reconstruction techniques and to verify Nyquist criteria and tracing.
5. Study of PAM, PWM and PPM modulation and demodulation techniques.
6. Study of TDM pulse amplitude modulation and demodulation.
7. Study of pulse code modulation and demodulation techniques.
8. Study of delta modulation methods.
9. Study of adaptive-delta modulation methods.
10. Study of Phase Shift Keying Modulation and Demodulation Technique.

Generic Elective I

MEC2015 Optical Computing

Course Objective:

The objective of the course is to:

1. Introduce new concept and basic knowledge of computing using linear optical processing.
2. Study various analog optical arithmetic operations.
3. Learn about digital optical computing devices.
4. Gain knowledge optical matrix processing which includes matrix operations and multiplication using convolution.

Learning Outcome:

After completion of the subject:

1. Students will learn about properties of lens, sampling and quantization, image enhancement.
2. Students will know about various types of filters: matched filter, amplitude modulated recognition filters.
3. Students will learn about optical computing devices, POSC logic operations, POSC multiprocessor and parallel ALU using POSC.
4. Will gain the concepts of optical implementations, interconnections, artificial intelligence.

Course Contents:

Module	Course Topics	Total Hours	Credits
I	**Mathematical and digital image fundamentals:** Introduction, Fourier Transform, discrete Fourier transform, basic diffraction theory. Fourier transform property of lens, sampling and quantization, image enhancement, image restoration. Linear Optical Processing: Introduction, Photographic film, Spatial filtering using binary filters, Holography, Inverse filtering, Deblurring.	30 Hours	1
II	**Analog optical arithmetic:** Introduction, Halftone processing, Nonlinear Optical Processing, Arithmetic operations. Recognition using analog optical systems: Introduction, Matched filter, Joint transform correlation Phase-only filter, Amplitude	30 Hours	1

	Modulated Recognition Filters Generalized correlation filter, Mellin transform based correlation.		
III	**Digital optical computing devices:** Introduction, Nonlinear devices, Integrated optics, Threshold devices. Spatial high modulators, Theta modulation devices. Shadow-casting and symbolic substitution: Introduction, Shadow casting system and Design algorithm, POSC logic operations, POSC multiprocessor, Parallel ALU using POSC, Sequential ALU using POSC, POSC image processing, Symbolic substitutions, Optical implementation of symbolic substitution, Limitations and challenges.	30 Hours	1
IV	**Optical matrix processing:** Introduction, Multiplication, Multiplication using convolution, Matrix operation, Cellular logic architecture, Programmable logic array. Artificial intelligent computations: Introduction, Neural networks, Associative memory, Optical implementations, Interconnections, Artificial Intelligence.	30 Hours	1

TEXT BOOK:

1. Mohammed A. Karim, “Optical Computing: An Introduction”, John Wiley & Sons.

REFERENCES:

1. Vanderlugnt “Optical Signal Processing” John Wiley & Sons.
2. Bradly G Boore “Signal Processing in Optics”, Oxford University Press.

MEC2016 Physics of Advance Material

Course Objective:

1. To provide the basic idea of geometry of metal nano particles.
2. To provide the basic idea of methods of synthesis of Bulk nano structured materials.
3. To provide a detailed description of Quantum nano structures and nano devices.
4. To provide the basic idea of solid state laser structures.

Learning Outcome:

Students will be able to learn the

1. Concepts of nano electromechanical devices.
2. Working of electroluminescent materials.
3. Methods of Epitaxial thin film techniques.
4. Basic idea of Microscopic Techniques like optical microscope, Scanning Electron Microscope (SEM), Transmission Electron microscope (TEM).

Course Contents:

Module	Course Topics	Total Hours	credits
I	**Properties of Individual Nano-Particle:** Metal nanoparticles, geometric and electronic structure, magnetic clusters, Semiconductor nanoparticles, optical properties, rare gas and molecular clusters, methods of synthesis of nanoparticles, Carbon nanostructure, C60 carbon nanotube and applications. Bulk nano structured materials: Solid disordered nanostructures, methods of synthesis, properties, metal nano-cluster composite glasses, porous silicon, Nano structured crystals.	30 Hours	1
II	**Quantum Nanostructures and Nano-Machines/Devices:** Quantum wells, wires and dots, preparation, size & dimensionality effects, excitons, single electron tunneling, applications of quantum nanostructures. Super conductivity. Self assembly, process of self assembly, semiconductor islands, monolayers. Catalysis, surface area of nanoparticles, porous, and colloidal materials. Nanomachines and nano devices; microelectromechanical systems (MEMSs), nanoelectromechanical systems (NEMSs), Material requirement for solid state lasers, Activator ions and centers, Material design parameters for semiconductor laser diode, choosing alloy composition and thickness, making ohmic contacts, Other III-V hetrojunction laser materials, Introduction to organic laser, Material selection for light emitting diodes.	30 Hours	1

III	**Electroluminescent materials:** Inorganic electroluminescence, AC powder EL, ACTFEL device, EL characteristics, EL excitation mechanism. Electroluminescence in Organic solids, Material useful for organic thin film EL devices, polymeric material for EL. Characterization of Materials, Introduction to emission and absorption spectroscopy: Nature of electromagnetic radiation, electromagnetic spectrum, atomic, molecular, vibrational and X-ray energy levels. Basics of UV-VIS spectroscopy: Radiation sources, wavelength selection, Cells and sampling devices, Detectors, Basic idea of IR spectrometry, Correlation of Infrared spectra with Molecular structure, Fundamental of X-ray diffraction, Powder diffraction method, Quantitative determination of phases; Structure analysis. Epitaxial thin film techniques: Liquid phase epitaxy, vapour phase epitaxy, Metal Organic chemical vapour deposition, Molecular beam epitaxy, Atomic layer epitaxy.	30 Hours	1
IV	**Experimental techniques:** High resolution X ray diffraction, Double Crystal diffraction, Drift mobility and Hall mobility, Hall effect for Carrier density and Hall mobility, Photoluminescence (PL) and Excitation Photoluminescence (PLE) Optical pump probe experiments. Basic idea of Microscopic Techniques: optical microscope, Scanning Electron Microscope (SEM), Transmission Electron microscope (TEM), Atomic Force Microscopy (AFM), Scanning Tunneling Microscopy (STM), Thickness measurement gravimetric method Basics of Ellipsometry: optical parameter measurements (n and k).	30 Hours	1

Text/ Reference Books:

1. Charles P. Poole Jr. and Frank J. Owens “Introduction to Nanotechnology” (Willey Inter. Science Pub 2003).
2. Guozhong Cao “Nanostructures and Nanomaterials-Synthesis properties and Applications”, Empirical College Press World Scientific Pub., 2004.
3. S. M. Sze, “Physics of Semiconductor devices” Willey Int., 1981.
4. H.H. Willard, L.L Merritt, J.A. Dean and F.A. Settle, “Instrumental Methods of Analysis”, CBS Publishers, New Delhi, 1996.

MEC2031-Statistical Signal Processing

Course Objective:

1. The main purpose of this course is to provide the basic theory and methods necessary for the design of optimal signal processing algorithms.
2. It explores the role of probability modelling in the development of robust and consistent (matched) signal transformations.
3. The course reviews a range of frequency transforms and spectrum estimation techniques.

Learning Outcome:

1. At the end of the course students will have a good understanding of statistical signal processing of discrete signals and systems.
2. Students will learn about the tools and methods for using stochastic processes for signal modeling, filtering and estimation.

Course Contents:

Module	Course Topics	Total Hours	Credits
I	**Signal modeling-** least square method, pade approximation, prony's method - linear prediction, Applications. FIR least squares Inverse filters, finite data records, stochastic models.	30 Hours	1
II	**Levinson-Durbin Recursion-** The lattice filter, Levinson Recursion, split Levinson Recursion.	30 Hours	1
III	**Wiener filtering-** FIR & IIR Wiener filter , discrete Kalman filter.	30 Hours	1
IV	**Spectrum estimation** - Non parametric methods, minimum variance spectrum estimation, maximum entropy method, parametric method.	30 Hours	1

Text/ Reference Books:

1. Monson Hayes, "Statistical Digital signal processing and modelling" John Wiley, & sons 1996.

2. D.G. Manolakis, V.K.Ingle, S.M.Kogon, "Statistical & Adaptive Signal Processing" McGrawHill, 2000.

3. Simon Haykin, " Adaptive Filter Theory" PHI, 1996.

4. S.M. Kay "Modern Spectral Estimation" PHI, 1987.

MEC2032-Spread Spectrum Communication

Course Objective:

1. The main purpose of this course is to make our students aware of basic concepts of spread spectrum (SS) communications and its major applications (e.g. anti-jamming, positioning, CDMA) and techniques for analyzing the systems.
2. The course will review these concepts and emphasize the various trade-offs in the design of such systems.

Learning Outcome:

1. At the end of the course students will have a good understanding of the principles and theory of spread spectrum communications with emphasis on Direct Sequence Spread Spectrum System and Frequency Hopping Spread Spectrum System.
2. Student will have in-depth knowledge about CDMA techniques and their applications in wireless communications like jamming and anti-jamming.

Course Contents:

Module	Course Topics	Total Hours	Credits
I	**Introduction:** Origins of SS communications – Advantages of Spectrum spreading – Types of techniques used for spread spectrum – Processing gain and other fundamental parameters – Jamming methods – Linear Feedback shift register sequence generation – Msequence and their statistical properties. Introduction to Non-linear sequences – Gold codes; Kasami sequences & chaotic sequences	30 Hours	1
II	**Direct Sequence Spread Spectrum System:** Coherent direct sequence systems – Model of a DS/BPSK system, Chernoff bound – Performance of encoded DS/BPSK – Constant power and pulse jammer. Coded DS/BPSK Performance for known and unknown channel states	30 Hours	1
III	**Frequency Hopping SS System:** Non-coherent FH system model – Uncoded FH/BFSK performance under constant power broadband jammer – Partial band noise jammer – Multitone jammer. Coded FH/BFSK performance for partial and multitone jammer. Performance of FH/MDPSK in the presence of partial band multitone jamming	30 Hours	1

IV	**Synchronization of SS Receivers & Applications:** Acquisition and tracking in DS SS receivers & FH SS receivers – Sequential estimation – Matched filter techniques of acquisition and tracking – Delay locked loop – Tau-Dither loop. Applications:Space systems – Satellite communication. Anti-jam military communication – Low probability of intercept communication – Mobile communications.	30 Hours	1

Text/ Reference Books:

1. R.C. Dixon, "Spread spectrum systems", John Wiley, 1984.

2. M.K. Simon, J.K.Omura, R.A. Schiltz and B.K.Levitt, "Spread spectrum communication", Vol-I, II & IV, Computer Science Press, USA, 1985.

3. G.R.Coopeand, CD.Mc.Gillem, "Modern communications and spread spectrum", McGraw Hill, 1986.