Electronics and Communication Engineering Department

National Institute of Technology Delhi

Proposed Curriculum (2015 Onwards)

Master of Technology

(Electronics and Communication Engineering)

Semester I

Sl. No.	Course Code	Course Title	L	T	P	Credits
1.	ECL 561	Advanced Digital Communication Systems	3	0	0	3
2.	ECL 562	Computer Communication	3	0	0	3
3.	ECL 563	Advanced Optical Communication Systems	3	0	0	3
4.	ECL 5xx	Elective I	3	0	0	3
5.	ECL 5xx	Elective II	3	0	0	3
6.	ECP 5xx	Laboratory I	0	0	6	3
	Total Credits					18

Semester II

Sl. No.	Course Code	Course Title	L	T	P	Credits
1.	ECL 576	Advanced Photonic Devices	3	0	0	3
2.	ECL 577	Advanced Wireless Communication Networks	3	0	0	3
3.	ECL 5xx	Elective III	3	0	0	3
4.	ECL 5xx	Elective IV	3	0	0	3
5.	ECP 5xx	Laboratory II	0	0	6	3
6.	ECP 569	Minor Project	-	-	-	3
	Total Credits					18

Semester III

Sl. No.	Course Code	Course Title	L	T	P	Credits
1.	ECP 650 A	Dissertation I	-	-	-	8
2.	ECL 5xx	Elective V	3	0	0	3
3.	ECL 5xx	Elective VI	3	0	0	3
4.	ECP 656	Independent Study and Seminar	-	-	-	2
	Total Credits					16

Semester IV

Sl. No.	Course Code	Course Title	L	T	P	Credits
1.	ECP 650 B	Dissertation II	-	-	-	12
2.	ECP 652	Independent Study and Seminar	-	-	-	4
	Total Credits					16

List of Laboratory Subjects

Sl. No.	Course Code	Course Title	L	T	P	Credits
1.	ECP 561	Communication laboratory I	0	0	6	3
2.	ECP 571	Communication Laboratory II	0	0	6	3
3.	ECP 563	Fibre Optics Laboratory	0	0	6	3
4.	ECP 564	VLSI Laboratory	0	0	6	3
5.	ECP 572	VLSI Design with Cad Tools	0	0	6	3

List of Elective Subjects

Sl. No.	Course Code	Course Title	L	T	P	Credits
1.	ECL 511	Design of Analog and Mixed Mode VLSI Circuits	3	0	0	3
2.	ECL 512	Advanced Error Control Codes	3	0	0	3
3.	ECL 513	Introduction to MEMS	3	0	0	3
4.	ECL 514	Advanced Microwave Devices	3	0	0	3
5.	ECL 515	Low Power VLSI Devices	3	0	0	3
6.	ECL 516	Photonic Integrated Devices and Systems	3	0	0	3
7.	ECL 517	Computational Electromagnetics	3	0	0	3
8.	ECL 518	Semiconductor Optoelectronics	3	0	0	3
9.	ECL 519	Growth, Fabrication and Characterization of Semiconductor Devices	3	0	0	3
10.	ECL 520	Introduction to Nano-Electronics and Nano-Photonics	3	0	0	3
11.	ECL 521	Analog IC Design	3	0	0	3
12.	ECL 522	Advanced Image Processing	3	0	0	3
13.	ECL 523	Digital IC Design	3	0	0	3
14.	ECL 524	Microelectronics	3	0	0	3

15.	ECL 525	Physics of MOS Transistors	3	0	0	3
16.	ECL 526	VLSI Technology and Design	3	0	0	3
17.	ECL 527	Digital CMOS Integrated Circuits	3	0	0	3
18.	AS 601	Modeling and Simulation	3	0	0	3
19.	ECL 528	Advanced Numerical Analysis	3	0	0	3
20.	ECL 529	Advanced Mathematics	3	0	0	3
21.	ECL 530	Organic Electronics	3	0	0	3
22.	ECL 531	Nano Materials	3	0	0	3
23.	ECL 532	Nano Magnetics and Spintronics	3	0	0	3
	ECL 533	Testing and Verification of VLSI Circuits	3	0	0	3
24.	ECL 534	Artificial Neural Networks	3	0	0	3
25.	ECL 535	Speech Processing	3	0	0	3
26.	ECL 536	Wavelets	3	0	0	3
27.	ECL 537	Microelectronic Chip Design	3	0	0	3
28.	ECL 538	Solid State Microwave Devices	3	0	0	3
29.	ECL 539	Telematics	3	0	0	3
30.	ECL 540	Statistical Signal Analysis	3	0	0	3
31.	ECL 541	Embedded Core Design	3	0	0	3
32.	ECL 542	Wireless Sensor Networks	3	0	0	3
33.	ECL 543	Computer aided Design of VLSI Circuits	3	0	0	3
34.	ECL 544	Free Space Optical Networks	3	0	0	3
35.	ECL 545	Quantum Mechanics and Its Applications to Engineering	3	0	0	3
36.	ECL 546	Information and Network Security	3	0	0	3
37.	ECL 547	OFDM for Wireless Communication	3	0	0	3
38.	ECL 548	Carbon Nanotube and Nano Structures	3	0	0	3

Curriculum

Course no: ECL 561	**Open course (YES/NO)**	**HM Course (Y/N)**	**DC (Y/N)**		**DE (Y/N)**
	No	**No**	**Yes**		**No**
Type of Course	Theory				
Course Title	**ADVANCED DIGITAL COMMUNICATION SYSTEMS**				
Course Coordinator					
Course objectives:	• To introduce to various aspects of Digital Communication over various Channels, from design through performance issues to application requirement. • To have idea on the advances in Multichannel and Multicarrier Systems design				
POs	• Understand the design issues of Digital Communication over Additive Gaussian Noise Channels, over Band Limited Channels and Fading Multipath Channels. • Understand the design issues in spread spectrum and multi user communication systems. • Understand various digital communication receivers, equalization and diversity techniques.				
Semester	**Autumn: Yes**		**Spring: No**		
	Lecture	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours	3	0	0	3	36
Prerequisite course code as per proposed course numbers	NIL				
Prerequisite Credits	NIL				
Equivalent course codes as per proposed course and old course	NIL				
Overlap course codes as per proposed course numbers	NIL				
Text Books:					
1.	Title	Digital Communication			
	Author	John G. Proakis and Masoud Salehi			

	Publisher	McGraw-Hill Education
	Edition	5th edition, 2007.
2.	Title	Digital Communication: Fundamental and applications
	Author	Bernard Sklar and Pabitra Kumar Ray
	Publisher	Pearson Education
	Edition	2nd Edition. , 2009.
3.	Title	Fundamentals of digital Communication
	Author	Upamanyu Madhow,
	Publisher	Cambridge University Press
	Edition	2008.
Content	**Unit I:** **12** Objective and scope of this course; content of the course and reference materials; Elements of Digital Communication System; Review of Communication Channels, their characteristics and mathematical modeling, Preliminaries: Deterministic Signal Analysis: Band pass and low pass signal analysis. **Unit II:** **08** Deterministic Signal Analysis: Band pass and low pass signal analysis, Random signal analysis. Digital Modulation schemes, Optimum receivers for AWGN channels, Optimum receivers for AWGN channels (continued) with problem solving sessions, Carrier and symbol synchronization. Mathematical models for information sources, lossless coding of information sources. **Unit III:** **08** Sampling of band pass signals with problem solving sessions, Characterization of band limited channels, signal design for band limited channels, optimum receiver for ISI and AWGN, Linear equalization, adaptive linear equalization, adaptive decision feedback equalizer. **Unit IV:** **08** Model of Spread spectrum communication systems, direct sequence spread spectrum, Frequency hopped spread spectrum, Characterization of Fading multipath channels, Frequency non-selective slowly fading channel, MIMO systems: channel models, Capacity of MIMO channels.	
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%	

Course no: ECL 562	**Open course (YES/NO)**	**HM Course (Y/N)**	**DC (Y/N)**	**DE (Y/N)**

	No	**No**	**Yes**		**No**
Type of Course	Theory				
Course Title	**COMPUTER COMMUNICATION**				
Course Coordinator					
Course objectives:	To gain expertise in network designs and maintenance of individual networks.				
POs	Students will understand the functionalities of network devices and protocols of computer networks.				
Semester	**Autumn: Yes**		**Spring: No**		
	Lecture	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours	3	0	0	3	36
Prerequisite course code as per proposed course numbers	NIL				
Prerequisite Credits	NIL				
Equivalent course codes as per proposed course and old course	NIL				
Overlap course codes as per proposed course numbers	NIL				

Text Books:		
1.	Title	Data Communication and Networking, ,
	Author	Behrouz A Forouzan
	Publisher	McGraw-Hill Education (India) Pvt Limited
	Edition	2006.
2.	Title	Computer Networks,
	Author	Andrew Stanenbaum,
	Publisher	Dorling Kindersley Pvt Ltd;
	Edition	4th Edition edition, 2008.
3.	Title	Data and Computer Communication,
	Author	William Stalling
	Publisher	Pearson/ Prentice Hall,
	Edition	2007
Content	**Unit I:** **08** Content of the course and reference materials; Introduction to data communication, discussion with students about their background and	

	interest in this course, Concept of analog and digital Signal, bandwidth, Network architecture. **Unit II: 12** OSI and TCP/IP reference model, architecture of other reference model, Wired and wireless connectivity: FDM, TDM and CDMA, Circuit and packet switching, Frame relays, ATM, ISDN, IEEE standards for LAN and WAN. **Unit III: 08** Data link layer design issues, transport and application layer design issues, internet protocol, routing algorithm, congestion control, IP addressing schemes. Connection management, Cryptography: data encryption standards, key distribution, public key cryptography, authentication and digital signature. **Unit IV: 08** Modeling and analysis of communication networks, pure birth and pure birth death process, Bernoulli's trials, Markov chain, Exercise problems for practice, Poisson process, Little's formula. Queueing Models: M/M/1 queue, M/M/1/N queue, embeded Markov chain, M/G/1 queue, Network layout and reliability consideration.
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%

Course no: ECL 563	**Open course (YES/NO)**	**HM Course (Y/N)**	**DC (Y/N)**	**DE (Y/N)**
	No	**No**	**Yes**	**No**
Type of Course	Theory			
Course Title	**ADVANCED OPTICAL COMMUNICATION SYSTEMS**			
Course				

Coordinator					
Course objectives:	• Understand the basic concepts and advantages of fiber optics communication. • Calculate pulse spread in optical fiber and use it to calculate the bandwidth and data rate of an optical fiber link. • Be able to solve the wave equation and apply it in the analysis of symmetric slab waveguide. • Understand the concept and conditions for light guidance. • Understand the difference between single mode/multimode fibers as well as step index and graded index fibers and perform relevant calculations. • Know the origin of fiber optics losses, including intrinsic and extrinsic loss and know how to calculate link losses. • Design a basic optical fiber link. • To understand various optical amplifiers, WDM systems and Soliton systems				
POs	• Understand various principles of optical communications system operating characteristics • Knowledge of the basic design rules and trade-offs of modern optical transmitters and receivers • To understand various optical amplifiers • Know about multiplexing techniques • Understand Soliton systems				
Semester	**Autumn: Yes**		**Spring: No**		
	Lecture	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours	3	0	0	3	36
Prerequisite course code as per proposed course numbers	NIL				
Prerequisite Credits	NIL				
Equivalent course codes as per proposed course and old course	NIL				
Overlap course codes as per proposed course numbers	NIL				
Text Books:					
1.	Title	Optical Networks – A Practical Perspective, ,			
	Author	R. Ramaswami, K. N. Sivarajan and G. H. Sasaki,			

	Publisher	Elsevier
	Edition	Third edition, 2010.
2.	Title	Optical Fibre Communications, .,
	Author	G. Keiser
	Publisher	Tata McGraw Hill
	Edition	Third Edition, 2000
3.	Title	Fibre-Optic Communication Systems
	Author	G. P. Agarwal
	Publisher	John Wiley and Sons. , Inc
	Edition	3rd edition
Content	**Unit I:** **06** Introduction to optical communication systems, Signal Propagation in Optical Fibre, optical fibre principle, classification of fibres, fibre modes and related definitions, optical fibre as a waveguide and different waveguide equations. **Unit II:** **12** Attenuation and Dispersion, Loss and band width windows, various losses in optical fibres, dispersion effects, intermodal, chromatic, waveguide dispersions, dispersion compensation and shifted fibres. Fiber Non-Linear effects, Effective length and area, SBS and SRS effects, self-phase modulation, SPM induced chirp for Gaussian pulses, cross –phase modulation, four wave mixing, introduction to soliton and photonic crystal fibres. **Unit III:** **06** Optical Components, Couplers, isolators, multiplexers and filters, optical amplifiers, wavelength converters, optical Transmitters and Detectors, LEDs, lasers, Tunable lasers, photo detectors, switch. **Unit IV:** **06** Modulation and Demodulation, Modulation, sub carrier modulation and multiplexing schemes, different modulation formats, spectral efficiency, demodulation, bit error rate and noise effects in receivers, coherent detection, errors and detection, cross talk. **Unit V:** **06** Power launching and Coupling, Source to fibre power launching, LED coupling to fibres, fibre splicing, and optical fibre connectors. Optical Networks, Client layers, SONET/ SDH, transport network, Ethernet, IP, protocols, WDM network elements.	
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%	

Course no: ECL 576	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
	No	**No**	**Yes**	**No**
Type of Course	Theory			
Course Title	**ADVANCED PHOTONIC DEVICES**			
Course Coordinator				
Course objectives:	To introduce to the students with advanced Nanophotonics.			
POs	1. To make the students acquainted with the concepts of advanced Nanophotonics.			

	2. To describe the effects of quantization on the optical properties of semiconductors and metals. 3. To determine the areas of opportunity in nanophotonic research.				
Semester	**Autumn: No**		**Spring: Yes**		
	Lecture	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours	3	0	0	3	36
Prerequisite course code as per proposed course numbers	NIL				
Prerequisite Credits	NIL				
Equivalent course codes as per proposed course and old course	NIL				
Overlap course codes as per proposed course numbers	NIL				

Text Books:		
1.	Title	Electronic and Optoelectronic Properties of Semiconductor Structures
	Author	Jasprit Singh
	Publisher	Cambridge University Press
	Edition	2003
2.	Title	Physics of Photonic Devices
	Author	S. L. Chuang,
	Publisher	Wiley Series in Pure and Applied Optics
	Edition	2009
3.	Title	Solid State Electronic Devices,
	Author	B. G. Streetman and S. Banerjee,
	Publisher	Pearson Prentice Hall
	Edition	2000
Reference Books:		
1.	Title	Semiconductor Physics and Devices – Basic Principles
	Author	D. A. Neamen,
	Publisher	Tata McGraw Hill
	Edition	1992
Content	**Unit I:** **12** Basic Semiconductor Electronics and Basic Quantum Mechanics, Maxwell's equations and boundary conditions Strain effects on band structures,	

	Generation and Recombination in Semiconductors, Semiconductor *p-N* and Heterojunction, Metal-Semiconductor Junction, Schrodinger Equation, The Square Well, The Harmonic Oscillator, The Hydrogen Atom (3D and 2 0 Exciton Bound and Continuum States), Time-Independent and dependent Perturbation Theory. **Unit II:** **08** Theory of Band structures in semiconductor devices, The Bloch theorem and k.p method for simple bands, Strain effects on band structures, Electronic states and Kronig- Penney model, Band structure for strained and un strained quantum wells. **Unit III:** **08** Optical Processes in semiconductors, Fermi Golden rule, Spontaneous and stimulated emissions, Interband and intraband absorptions, Momentum Matrix elements for bulk and nano structures, Gain and Valence band mixing effects. **Unit IV:** **08** Low Dimensional Nano structures, Fundamentals of Quantum mechanics, quantization and low dimensional electron gas, alloying, electrons in nanostructures- Quantum wells, wires and dots. **Unit V:** **08** Electronic Transport in Semiconductors, Ohms' Law, mobility, Scattering mechanisms, Diffusion, Excess carriers, Transport in 1D and 2D systems, Resonant tunnelling, carrier lifetimes and recombination mechanisms, Statistics of electron transport. **Unit VI:** **08** Optical Properties, Basics of EM field, Photons, Scattering mechanisms, phonons, absorptions, spontaneous and stimulated emissions, Interband and intra band transitions, excitons, Franz-Keldysh effect, Exciton effect, Quantum confined Stark effect. **Unit VII:** **08** Advanced Photonic Devices, LEDs, Quantum Well and Multiple QW lasers, QD Lasers, Transistor laser, vertical cavity surface emitting lasers (VCSEL), Contemporary and advanced (Multi junction, intermediate band etc.) solar cells, Photonic crystals, surface plasmons, spintronic devices, photo detectors etc. **Unit VIII:** **08** Materials for Photonic Devices, Introduction to Si devices, optical interconnects Opto-electronic Integrated circuits (OEICs), Si Ge based devices, Inorganic-organic materials, carbon based materials, Sn based materials – their relative advantages and disadvantages.
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%

Course no: ECL 577	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
	No	**No**	**Yes**	**No**
Type of Course	Theory			
Course Title	**ADVANCED WIRELESS COMMUNICATION NETWORKS**			
Course Coordinator				
Course objectives:	To learn about the architecture, protocol stack, specifications and characteristics of Wi-Fi, WiMAX, WPAN, wireless internet, Ad-hoc and sensor networks.			
POs	Latest technologies in wireless networks especially the architecture, protocol stack and there network specification will be known by the students.			
Semester	**Autumn: No**		**Spring: Yes**	
	Lecture	**Tutorial**	**Practical**	**Credits**	**Total Teaching**

					Hours
Contact Hours	3	0	0	3	36
Prerequisite course code as per proposed course numbers	NIL				
Prerequisite Credits	NIL				
Equivalent course codes as per proposed course and old course	NIL				
Overlap course codes as per proposed course numbers	NIL				

Text Books:		
1.	Title	Wireless Communications, , 2007
	Author	Andrea Goldsmith,
	Publisher	Cambridge University Press
	Edition	Cambridge University Press
2.	Title	Fixed Broadband Wireless System Design
	Author	HARRY R. ANDERSON
	Publisher	John Wiley – India
	Edition	2003
3.	Title	Wireless Communications
	Author	Andreas.F. Molisch
	Publisher	John Wiley – India
	Edition	2006
Reference Books:		
1.	Title	Modern Wireless Communications
	Author	Simon Haykin& Michael Moher
	Publisher	Pearson Education
	Edition	2007

Content	**Unit I**: **08** Wireless channel propagation and model, Propagation of EM signals in wireless channel – Reflection, diffraction and Scattering-Small scale fading-channel classification- channel models – COST -231 Hata model, Longley-Rice Model, NLOS Multipath Fading Models: Rayleigh, Rician, Nakagami, Composite Fading –shadowing Distributions, Link power budget Analysis. **Unit II: 08** Diversity, Capacity of flat and frequency selective fading channels-Realization of independent fading paths, Receiver Diversity:

	selection combining, Threshold Combining, Maximum-ratio Combining, Equal gain combining. Transmitter Diversity: Channel known at transmitter, channel unknown at the transmitter. **Unit III: 06** MIMO communications, Narrowband MIMO model, Parallel decomposition of the MIMO channel, MIMO channel capacity, MIMO Diversity Gain: Beam forming, Diversity-Multiplexing trade-offs, Space time Modulation and coding: STBC, STTC, Spatial Multiplexing and BLAST Architectures. **Unit IV: 06** Multi user systems Multiple Access: FDMA, TDMA, CDMA, SDMA, Hybrid techniques, Random Access: ALOHA, SALOHA, CSMA, Scheduling, power control, uplink downlink channel capacity, multiuser diversity, MIMO-MU systems. **Unit V: 08** Wireless Networks: 3G Overview, Migration path to UMTS, UMTS Basics, Air Interface, 3GPP Network Architecture, 4G features and challenges, Technology path, IMS Architecture - Introduction to wireless LANs - IEEE 802.11 WLANs - Physical Layer- MAC sublayer.
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%

Course no: ECL 511	**Open course (YES/NO)**	**HM Course (Y/N)**	**DC (Y/N)**		**DE (Y/N)**
	No	**No**	**No**		**Yes**
Type of Course	Theory				
Course Title	**DESIGN OF ANALOG AND MIXED MODE VLSI CIRCUITS**				
Course Coordinator					
Course objectives:	To study analog integrated circuits features, design and analysis methods of analog and mixed mode VLSI circuits.				
POs	Students will able to design efficient analog and mixed mode VLSI circuits.				
Semester	**Autumn:**		**Spring:**		
	Lecture	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours	3	0	0	3	36
Prerequisite course code as per proposed course numbers	NIL				

Prerequisite Credits	NIL				
Equivalent course codes as per proposed course and old course	NIL				
Overlap course codes as per proposed course numbers	NIL				

Text Books:		
1.	Title	Design, Layout, Stimulation , CMOS Circuit
	Author	R. Jacaob Baker, Harry W Li, David E Boyce
	Publisher	PHI Edn
	Edition	2005
2.	Title	CMOS- Mixed Signal Circuit Design(Volll of CMOS: Circuit Design, Layout and Stimulation)
	Author	R. Jacaob Baker
	Publisher	IEEE Press and Wiley Inter science
	Edition	2002
3.	Title	Design of Analog CMOS Integrated Circuits,
	Author	B Razavi,
	Publisher	McGraw Hill
	Edition	First Edition, 2001
Reference Books:		
1.	Title	CMOS Analog Circuit Design
	Author	P e Allen and D R Holberg
	Publisher	Oxford University Press
	Edition	Second Edition, 2002
Content	**Unit I:** **08** Data converter fundamentals: Analog versus Digital Discrete Time Signals, Converting Analog Signals to Data Signals, Sample and Hold Characteristics, DAC Specifications, ADC Specifications, Mixed-Signal Layout Issues. **Unit II:** **08** Data Converters Architectures: DAC Architectures, Digital Input Code, Resistors String, R-2R Ladder Networks, Current Steering, Charge Scaling DACs, Cyclic DAC, Pipeline DAC, ADC Architectures, Flash, 2-Step Flash ADC, Pipeline ADC, Integrating ADC, Successive Approximation ADC. **Unit III:** **06** Non-Linear Analog Circuits: Basic CMOS Comparator Design, Analog Multipliers, Multiplying Quad, Level Shifting. **Unit IV:** **08**	

	Data Converter SNR: Improving SNR Using Averaging, Decimating Filters for ADCs Interpolating Filters for DAC, B and pass and High pass Sync filters. **Unit V: 06** Sub-Microns CMOS circuit design: Process Flow, Capacitors and Resistors, MOSFET Switch, Delay and adder Elements, Analog Circuits MOSFET Biasing, OP-Amp Design.
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%

Course no: ECL 512	**Open course (YES/NO)**	**HM Course (Y/N)**	**DC (Y/N)**	**DE (Y/N)**
	No	**No**	**No**	**Yes**
Type of Course	Theory			
Course Title	**ADVANCED ERROR CONTROL CODES**			
Course Coordinator				
Course objectives:	To explain the importance of modern coding techniques in the design of digital communication systems.			
POs	Students are able • To understand the need for error correcting codes in data communication and storage systems. • To identify the major classes of error detecting and error correcting codes and how they are used in practice. Construct codes capable of correcting a specified number of errors. • To use the mathematical tools for designing error correcting codes, including finite fields. • To explain the operating principles of block codes, cyclic codes, convolution codes, modulation codes, Turbo codes etc.			
Semester	**Autumn:**		**Spring:**	

	Lecture	**Tutorial**	**Practical**	**Credits**	**Total Teaching**

					Hours
Contact Hours	3	0	0	3	36
Prerequisite course code as per proposed course numbers	NIL				
Prerequisite Credits	NIL				
Equivalent course codes as per proposed course and old course	NIL				
Overlap course codes as per proposed course numbers	NIL				

Text Books:		
1.	Title	Essentials of Error Control Coding
	Author	Jorge Castineira Moreira and Patrik Guy Farrell
	Publisher	John Willy and Sons
	Edition	
2.	Title	Error Control Coding
	Author	Todd K. Moon
	Publisher	John Willy and Sons
	Edition	

Content

Unit I:

Introduction to information and coding theory**:** Entropy and Information Rate, Mutual Information, Capacity of discrete channel, Channel Capacity, Shannon Theorems: Source coding Theorem, Channel coding Theorem. Capacity of a Gaussian Channel, Limits to communication and their consequences.

Unit II:

Linear block codes: Generator and parity check matrices, Encoding circuits, Syndrome and error detection, Minimum distance considerations, Error detecting and error correcting capabilities, Standard array and syndrome decoding, decoding circuits, Hamming codes, Reed-Muller codes. Golay codes.

Unit III:

Cyclic codes: Introduction, Generator and parity check polynomials, Encoding using multiplication circuits, Systematic cyclic codes - Encoding using feedback shift register circuits, generator matrix for cyclic code, Syndrome computing and error detection..

Unit IV:

BCH codes: Introduction to minimal polynomial, BCH codes, decoding

	of BCH, Error-Location and Error Evaluation Polynomials, The Key Equation, decoding of BCH using Euclidean Algorithm, Reed -Solomon codes, decoding of RS codes. **Unit V:** **Convolution codes:** Encoding of convolutional codes, Distance properties, Viterbi decoding algorithm for decoding Extended and Modified State Diagram, Error Probabilty Analyisis for Convolutional codes. Hard and soft Decisions. **Unit VI:** Turbo codes: Introduction to Turbo coding and their distance properties, design of Turbo codes, Decoding of Turbo codes. **Unit VII:** LDPC Codes**:** Introduction to Low Density Parity Check Codes, Regular and Irregular LDPC Codes, Decoding of LDPC Codes using Tannar Graph. **Unit VIII:** Space-Time Block Codes: The Alalouti Code Coding and Decoding.
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%

Course no: ECL 513	**Open course (YES/NO)**	**HM Course (Y/N)**	**DC (Y/N)**		**DE (Y/N)**
	No	**No**	**No**		**Yes**
Type of Course	Theory				
Course Title	**INTRODUCTION TO MEMS**				
Course Coordinator					
Course objectives:	The course is designed to familiarize the student with the functions and applications of MEMS.				
POs	Students will able to design different type of MEMS based devices, circuits and subsystems.				
Semester	**Autumn:**		**Spring:**		
	Lecture	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours	3	0	0	3	36
Prerequisite course code as per proposed course numbers	NIL				
Prerequisite Credits	NIL				
Equivalent	NIL				

course codes as per proposed course and old course					
Overlap course codes as per proposed course numbers	NIL				

Text Books:		
1.	Title	Foundations of MEMS
	Author	Chang Liu
	Publisher	Prentice Hall
	Edition	2011
2.	Title	Microsystem Design
	Author	S. D. Senturia
	Publisher	Kluwer
	Edition	2002
3.	Title	Fundamental of Microfabrication
	Author	Marc Madou
	Publisher	CRC Press
	Edition	1997
Reference Books:		
1.	Title	Introduction to Microelectronic Fabrication
	Author	Richard C. Jaeger,
	Publisher	Addison-Wesley
	Edition	1993
2.	Title	MEMS Handbook
	Author	Edited by Gad-El-Hak
	Publisher	CRC Press,
	Edition	2001
3.	Title	Mechanical Microsensors,
	Author	M. Elwenspoek and R. Wiegerink
	Publisher	Springer Verlag
	Edition	2001

Content	**Unit I:** **08** Administrative Information, MEMS Roadmaps, Benefits of Miniaturization. Benefits of Scaling start Fabrication Process Modules I: oxidation, film deposition, lithography. Fabrication Process Modules II: etching, ion implantation, diffusion. Surface Micromachining I: basic process flow, release, stiction, material choices, residual stress, stringers and planarization. Surface Micromachining II: MUMPS, Summit, and electroplating, 3D out-of-plane. **Unit II:** **08** Bulk Micromachining: wet etch-based, dissolved wafer process, SOI MEMS, Scream, Hexsil MEMS, sealed cavity deep RIE. Process Integration: interleaved, MEMS-first, MEMS-last, bonded integration, wafer-to-wafer transfer, fluidic

	assembly. Mechanics of Materials for MEMS: stress, strain, material properties, measurement & characterization of mechanical parameters. Microstructural Elements: bending moment and strain, flexural rigidity, residual stress, boundary conditions, spring combinations. Energy Methods I: application to clamped-clamped beam under axial load. Energy Methods II: resonance frequency determination, free-free beam, disk, ring, lumped-element mechanical equivalent circuits. **Unit III: 08** Electrostatic Actuators I: charge control, voltage control, spring suspended C, pull-in voltage, linearization methods. Electrostatic Actuators II: comb drive, levitation, equivalent circuits. Circuit Modeling of MEMS: resonator equivalent circuits, thermal circuits, fluidic circuits. Alternative Transduction Principles: piezoelectric, magneto motive, thermal actuation, scaling comparisons. Signal Conditioning Circuits: op amp models & circuits, transistor-level design. **Unit IV: 06** Electronic and Mechanical Noise: electronic noise sources, Brownian motion noise, circuit noise calculation procedure, SNR, dynamic range. Capacitive Position Sensing: sensing configurations, divider, effect of parasitic capacitance, resolution, accelerometers & gyroscopes. Wireless Communication Basics: communication front-end block diagram, noise figure, focus on front-end filtering, importance of high Q. **Unit V: 06** Micromechanical Circuits I: general filter topologies, insertion loss (noise figure), and shape factor, design with k and q values, termination impedance. Micromechanical Circuits II: resonator and couplers, circuit modeling of coupled resonators, systematic micromechanical filter design procedure. Micromechanical Circuits III: nonlinear functions (mixing), coupled arrays, oscillators, RF MEMS switches.
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%

Course no: ECL 514	**Open course (YES/NO)**	**HM Course (Y/N)**	**DC (Y/N)**		**DE (Y/N)**
	No	**No**	**No**		**Yes**
Type of Course	Theory				
Course Title	**ADVANCED MICROWAVE DEVICES**				
Course Coordinator					
Course objectives:	• To study passive microwave components and their S- Parameters. • To study Microwave semiconductor devices & applications. • To study Microwave sources and amplifiers.				
POs	Students will familiar with active & passive microwave devices & components used in Microwave communication systems.				
Semester	**Autumn:**		**Spring:**		
	Lecture	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours	3	0	0	3	36
Prerequisite course code as per proposed course numbers	NIL				
Prerequisite Credits	NIL				
Equivalent course codes as per proposed course and old course	NIL				
Overlap course codes as per	NIL				

proposed course numbers					

Text Books:		
1.	Title	Microwave Devices and Circuits
	Author	S.Y. Liao
	Publisher	Prentice Hall India
	Edition	
2.	Title	Microwave Engineering
	Author	David M. Pozar
	Publisher	John Willey & Sons
	Edition	
3.	Title	Microwave Engineering
	Author	David M. Pozar
	Publisher	John Willey & Sons
	Edition	Microwave Devices and Circuits

Content

Unit I: **06**

Waveguides Introduction to microwaves, short history of microwave engineering, frequency band definitions, advantages and applications of microwaves (overall applications). Introduction to wave guides, advantages of waveguides, comparison of waveguides and co-axial cables, Rectangular waveguides, modes of propagation in waveguides, cut off frequency, dominant mode, waveguide characteristics and parameters, excitation in waveguides, coupling methods (probe, slot, loop), application of re-entrant cavities, coupling of cavities.

Unit II: **06**

Microwave Components Principle of S-parameters, S-parameters for multi-ports (2-port, 3-port, 4-port etc.) properties of S-matrix, waveguide Tees (E, H, E-H planes), Directional Couplers, waveguide joints, bends, corners, twists, coupling probes and coupling loops, matched termination, Ferrite devices for microwave applications, Circulators, Isolators, Microwave Filters, Microwave attenuators and loads, Co-axial to wave guide transitions, Slotted line, iris, tuners.

Unit III: **06**

Microwave Tubes Introduction to conventional vacuum tubes, High frequency limitations of conventional tubes, Microwave tubes and circuits, Klystrons (multi cavity, reflex); velocity modulation, bunching process, applications, TWT: slow-wave structure, wave modes, gain, and applications, Principle of operation, construction, characteristics, parameters with analytical treatment of Magnetron, Magnetron oscillator, types.

Unit IV: **06**

Solid State Microwave Devices Introduction, Principle of operation, construction, characteristics, parameters with analysis of Microwave transistors, MOSFET, Varactor diodes, Parametric amplifiers, PIN diodes, Tunnel diodes, application as amplifiers, oscillators, modulators, demodulators, Schottky Barrier diodes, Transferred Electron devices: Gunn diode, Avalanche diode, Transit Time devices like IMPATT, TRAPATT diodes.

	Unit V: **06** Microwave measurements Introduction to microwave measurements, definition and measurement methods of parameters such as frequency, power, attenuation, phase shift, VSWR, impedance, insertion loss, dielectric constant, noise factor, Q of a cavity resonator, etc. using the X band microwave bench set-up. Block diagram and classification of network analyzer and its applications. General overview and applications of power meter/dB meter/VSWR meter. **Unit VI:** **06** Radar Communication Basic principles and fundamentals, block diagram of basic radar, classification, radar performance factors, radar range equation, factors influencing maximum range, effects of noise, Pulsed radar systems, block diagram and description, antennas and scanning, display methods, moving target indication, radar beacons, other radar systems such as CW Doppler radar, FM CW Doppler radar, phased array radars, planar array radars, various applications of radar such as navigational aids, military, surveillance.
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%

Course no: ECL 515	**Open course (YES/NO)**	**HM Course (Y/N)**	**DC (Y/N)**	**DE (Y/N)**
	No	**No**	**No**	**Yes**
Type of Course	Theory			
Course Title	**LOW POWER VLSI DEVICES**			
Course Coordinator				
Course objectives:	• Awareness regarding the importance of low power design and the possibilities. • Aware students design optimizations with special focus on circuit level. • Aware students the class of art techniques in VLSI design with power and delay tradeoffs.			
POs	• Understand various power optimization techniques. • Understand importance of delay power tradeoffs. • Understand the ultra low power design concepts.			
Semester	**Autumn:**		**Spring:**	

	Lecture	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours	3	0	0	3	36
Prerequisite course code as per proposed course numbers	NIL				
Prerequisite Credits	NIL				
Equivalent course codes as per proposed course and old course	NIL				
Overlap course codes as per proposed course numbers	NIL				

Text Books:		
1.	Title	Practical Low Power Digital VLSI Design
	Author	Gary K. Yeap
	Publisher	KAP
	Edition	2002
2.	Title	Low Power Design Methodologies
	Author	Rabaey, Pedram
	Publisher	Kluwer Academic
	Edition	
3.	Title	Low-Power CMOS VLSI Circuit Design
	Author	Kaushik Roy, Sharat Prasad
	Publisher	Wiley
	Edition	2000
Content	**Unit I:** **12** Introduction: Need for low power VLSI chips, Sources of power dissipation on Digital Integrated circuits. Emerging Low power approaches. Device& Technology Impact on Low Power: Dynamic dissipation in CMOS, Transistor sizing& gate oxide thickness, Impact of technology Scaling, Technology & Device innovation. Simulation Power analysis: SPICE circuit simulators, gate level logic simulation, capacitive power estimation, static state power, gate level capacitance estimation, architecture level analysis, data correlation analysis in DSP systems, Monte Carlo simulation. **Unit II:** **08** Probabilistic power analysis: Random logic signals, probability & frequency, probabilistic power analysis techniques, signal entropy. Low Power Circuit's: Transistor and gate sizing, network restructuring and Reorganization. Special Flip Flops & Latches design, high capacitance nodes, low power digital cells library. **Unit III:** **08** Logic level: Gate reorganization, signal gating, logic encoding, state machine encoding, pre-computation logic. Low power Architecture & Systems: Power & performance management, switching activity reduction, parallel architecture with voltage reduction, flow graph transformation, low power arithmetic components. **Unit IV:** **08** Low power Clock Distribution: Power dissipation in clock distribution, single driver Vs distributed buffers, Zero skew Vs tolerable skew, chip & package co design of clock network. Special Techniques: Power Reduction in Clock networks, CMOS Floating Node, Low Power Bus Delay balancing, and Low Power Techniques for SRAM.	
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%	

Course no: ECL 516	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)		DE (Y/N)
	No	**No**	**No**		**Yes**
Type of Course	Theory				
Course Title	**PHOTONIC INTEGRATED DEVICES AND SYSTEMS**				
Course Coordinator					
Course objectives:	The course aims at developing a deep insight into modern photonic devices and circuits through a thorough understanding of the underlying physics.				
POs					
Semester	**Autumn:**		**Spring:**		
	Lecture	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours	3	0	0	3	36
Prerequisite course code as per proposed course numbers	NIL				
Prerequisite Credits	NIL				
Equivalent course codes as per proposed course and old course	NIL				
Overlap course codes as per proposed course numbers	NIL				
Text Books:					
1.	Title	Integrated Optics- Theory and Technology, ,			
	Author	Robert G. Hunsperger,			
	Publisher	Springer			
	Edition	6th edition			
2.	Title	Integrated Photonics			
	Author	C R Pollock and M Lipso			
	Publisher	Kluwer Pub			
	Edition	2003			
3.	Title	Guided wave opto-electronics			
	Author	T Tamir			

	Publisher	Springer Verlag
	Edition	1990
Content	**Unit I:** **06** Analysis of optical waveguides and devices, planar waveguides, channel waveguides, graded index waveguides, coupled mode theory, variational method, beam propagation method. **Unit II:** **12** Materials and Fabrication technology, materials, general fabrication steps. Photolithography. Ti: LiNbO3 process. Proton exchange process. Silicon based IC process. Compound semiconductor process. **Unit III:** **08** Dynamic and Active devices, electro-optic devices, acousto-optic devices, thermo-optic and magneto-optic device, integrated optical amplifiers, optical communications, fiber optic sensors, optical signal processing, optical computing **Unit IV:** **10** Nonlinear integrated optics, opto-electronic integrated circuits, silicon based photonic integrated circuits, nano photonic structures, micro-opto-electro-mechanical systems, recent Developments in PICS.	
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%	

Course no:	**Open course**	**HM**	**DC (Y/N)**	**DE (Y/N)**

ECL 517	**(YES/NO)**	**Course (Y/N)**			
	No	**No**	**No**		**Yes**
Type of Course	Theory				
Course Title	**COMPUTATIONAL ELECTROMAGNETICS**				
Course Coordinator					
Course objectives:	To give idea about Numerical methods for solving complex Electromagnetic problems.				
POs	• Understand the Numerical methods for Electromagnetic problems • Understand the Finite Difference Method and Finite Difference Time Domain Method for Electromagnetic Analysis. • Understand Finite Element Method for Electromagnetic Problems. Understand use of Method of Moments and Spectral Analysis				
Semester	**Autumn:**		**Spring:**		
	Lecture	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours	3	0	0	3	36
Prerequisite course code as per proposed course numbers	NIL				
Prerequisite Credits	NIL				
Equivalent course codes as per proposed course and old course	NIL				
Overlap course codes as per proposed course numbers	NIL				
Text Books:					
1.	Title	Fundamentals of Electromagnetics with MATLAB			
	Author	2e Karl E. Lonngren, Sava V. Savov, Randy J			
	Publisher	Jost, SciTech Publishing			
	Edition	Inc., 2007			
2.	Title	Wavelets in Electromagnetics and Device Modeling			
	Author	George W.Pan			
	Publisher	Wiley			
	Edition				
3.	Title	Numerical Methods in Engineering with Python,			
	Author	JaanKiusalaas,			

	Publisher	Cambridge
	Edition	Fundamentals of Electromagnetics with MATLAB
Content	**Unit I:** **08** Introduction**.** Applications of Electromagnetics in the 21st century. Historical development of Computational Methods. Numerical Methods. ODE solvers. Euler. Runge – Kutta method, Boundary conditions. Propagation of errors. Survey of numerical packages. Scientific programming with Python and Matlab. **Unit II:** **12** Review of Basic Electromagnetics Electrostatics. Magnetostatics. Wave equations. TE, TM and Hybrid modes. Guided wave structures Metallic waveguides. Dielectric waveguides. Radiating structures. Numerical Techniques. Method of Curvilinear Squares. Method of Moments. Finite Element Method. Finite Difference Method. Monte Carlo Method. Understanding boundary conditions. **Unit III:** **08** Time varying Electromagnetic Fields. FDTD simulations with the Yee cell. Courant's stability condition. Eddy currents and skin depth. Multi-resolution Time Domain Methods. Introduction to wavelets. Families of wavelets and orthogonality conditions. Motors. Micro Electro Mechanical Systems. Ferro-fluids. Electromagnetic Acoustic Transducer. Effects of stress in an optical waveguide. **Unit IV:** **08** Microwaves. Waveguides. MMICs. Antennas. Scattering Optics. Fibre optics. Integrated optics. Plasmonics. Micro magnetics. Hysteresis. Non-volatile memory, Spin waves Effects of EM radiation.
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%	

Course no: ECL 518	**Open course (YES/NO)**	**HM Course (Y/N)**	**DC (Y/N)**	**DE (Y/N)**
	No	**No**	**No**	**Yes**

Type of Course	Theory				
Course Title	**SEMICONDUCTOR OPTOELECTRONICS**				
Course Coordinator					
Course objectives:	This course is designed to provide junior graduate students background in the optical properties of semiconductors and semiconductor heterostructures and superlattices. Applications of these properties will also be discussed.				
POs					
Semester	**Autumn:**		**Spring:**		
	Lecture	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours	3	0	0	3	36
Prerequisite course code as per proposed course numbers	NIL				
Prerequisite Credits	NIL				
Equivalent course codes as per proposed course and old course	NIL				
Overlap course codes as per proposed course numbers	NIL				
Text Books:					
1.	Title	Organic Electronics: Materials, Manufacturing, and Applications			
	Author	Hagen Klauk			
	Publisher	Wiley-VCH			
	Edition	1 edition			
2.	Title	Organic Molecular Solids Markus Schwoerer (Author), Wiley-VCH;			
	Author	Hans Christoph Wolf			
	Publisher	Hans Christoph Wolf			
	Edition	1 edition (March 27, 2007)			
3.	Title	Semiconductor Devices Modeling and Technology"			
	Author	Nandita Das Gupta and Amitava Das Gupta			
	Publisher	Prentice Hall of India Pvt. Ltd.			
	Edition	Organic Electronics: Materials, Manufacturing, and			

		Applications
Reference Books:		
1.	Title	Computational Electronics
	Author	Dragica Vasileska and Stephen M. Goodnick
	Publisher	CRC Press
	Edition	
2.	Title	Semiconductor Optoelectronics Devices: .
	Author	Pallab Bhattacharya
	Publisher	Pearson Education
	Edition	
Content	**Unit I:** **08** Optical process in Semiconductors Electron hole pair formation and recombination, absorption in semiconductor, effect of electric field on Absorption, Franz-keldysh and stark effects, Absorption in Quantum wells and Quantum confined stark effect, relation between Absorption and emission spectra, Stokes shift in optical transition, Deep level transitions, Measurement of absorption and luminescence Spectra, Time resolved Photoluminescence. **Unit II:** **08** Materials Growth & Fabrication Growth of optoelectronics materials by MBE, MOCVD, Plasma CVD, photochemical deposition. Epitaxy, interfaces and junctions (advantages/disadvantages of growth methods on interface quality, inter diffusion and doping. Quantum wells and band gap engineering Equipments for Thin Film Deposition: Working principle of Vacuum Coating Unit, Spin Coating Unit and Spray pyrolysis apparatus and their specifications and features. **Unit III:** **08** Organic Electronics Molecular materials, Electronic state in conjugated molecules, Optical spectra of molecules, Electronic vibration transitions, the Franck Condon principle hydrocarbons, conjugated polymer, Organic Semiconductors: Conductivity and Mobility of nearly-fee Charge Carriers, Charge Carriers in Organic Semiconductors: Polarons, Shallow Traps and Deep Traps, Generation of Charge Carriers and Charge Transport: Experimental Methods. The TOF Method: Gaussian Transport. Space-Charge Limited Currents. Band or Hopping Conductivity, Electric-field Approved by joint Board of Studies in Electronics & Physics on 20th September 2013 Page 9 Dependence, Charge Transport in Disordered Organic Semiconductors. The Bassler Model **Unit IV:** **06** Organic Optoelectronic Devices: Organic Light-Emitting Diodes (OLEDs). The Principle of the OLED, Multilayer OLEDs. Structure, Fundamental processes Efficiency, Characterization of OLEDs Organic photovoltaic diodes (OPVDs): Fundamental process, Exciton absorption, Exciton dissociation, Charge collection characterization of OPVDs, Relevant performance parameters	

	Unit V: 06 Introduction to Semiconductor Device Simulation: Need of Simulation, Process Simulation, Device Simulation device simulation sequence, hierarchy of transport models, DD Model, Relationship between various transport regimes and significant length-scales. Numerical Solution Methods - finite difference scheme, discretization of Poisson's and current continuity equations.
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%

Course no: ECL 519	**Open course (YES/NO)**	**HM Course (Y/N)**	**DC (Y/N)**	**DE (Y/N)**
	No	**No**	**No**	**Yes**
Type of Course	Theory			
Course Title	**GROWTH, FABRICATION AND CHARACTERIZATION OF SEMICONDUCTOR DEVICES**			
Course Coordinator				
Course	To provide rigorous foundation in MOS and CMOS fabrication process.			

objectives:					
POs	Students are able to: • appreciate the various techniques involved in the VLSI fabrication process. • understand the different lithography methods and etching process. • appreciate the deposition and diffusion mechanisms. • analyse the fabrication of NMOS, CMOS memory and bipolar devices • understand the nuances of assembly and packaging of VLSI devices.				
Semester	**Autumn:**		**Spring:**		
	Lecture	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours	3	0	0	3	36
Prerequisite course code as per proposed course numbers	NIL				
Prerequisite Credits	NIL				
Equivalent course codes as per proposed course and old course	NIL				
Overlap course codes as per proposed course numbers	NIL				

Text Books:		
1.	Title	VLSI Technology
	Author	S.M. Sze
	Publisher	Tata McGraw Hill
	Edition	1983
2.	Title	Introduction to VLSI, ,
	Author	Eshraghian&Pucknell
	Publisher	Tata McGraw-Hill Publishing Company Ltd., New Delhi
	Edition	2007
3.	Title	VLSI Fabrication Principles
	Author	S.K. Gandhi
	Publisher	Wiley-Blackwell
	Edition	2nd Edition 1994.
Reference Books:		
1.	Title	CMOS Digital Integrated Circuits-Analysis and Design
	Author	S.M. Kang & Y. Leblibici
	Publisher	McGraw-Hill

	Edition	3rd edition, 2003
Content	**Unit I:** **08** Miniaturization & its impact on characterization of Electronic Systems: Introduction, Trends & Projections in IC Design & Technology. Comparison between semiconductor materials. Basics of Thick and thin Film Hybrid Technology and monolithic chips. Advantages, limitations & Classification of ICs. Bipolar & MOS Techniques: Flow chart of Bipolar, NMOS and CMOS technologies. Basics of VLSI Design & Process Simulation, SUPREM. **Unit II:** **08** Monolithic Techniques: Silicon Refining for EGS, Single Silicon Wafer Preparation & Crystal Defects, Epitaxial Process, Diffusion,Ficks' Laws, Oxidation, Ion-Implantation, Photolithography, Basics of Vacuum Deposition & CVD, Etching techniques, Plasma Etching, Metallization and Isolation Techniques. **Unit III:** **08** Monolithic Components: Diodes and Transistors, JFETs, MOSFETs, Resistors, Capacitors, MESFETs, Basics of VLSI CMOS technology, Reliability issues in CMOS VLSI, Latching, and Electromigration. **Unit IV:** **06** Assembly Techniques & Packaging of VLSI Devices: Introduction to packaging, Package design considerations, VLSI Assembly techniques, Packaging fabrication technology. Surface Mount Technology (SMT): Through hole technology, Surface Mount Technology, applications & SM Components. **Unit V:** **06** Special Techniques for Modern Processes: Self aligned silicides, hallow junction formation, nitride oxides etc. process flows for CMOS and bipolar IC processes.	
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%	

Course no: ECL 520	**Open course (YES/NO)**	**HM Course (Y/N)**	**DC (Y/N)**	**DE (Y/N)**
	No	**No**	**No**	**Yes**
Type of Course	Theory			
Course Title	**INTRODUCTION TO NANO-ELECTRONICS AND NANO-PHOTONICS**			
Course Coordinator				
Course objectives:	To provide the structural and electronic properties of small MOSFETs, carbon nanotubes, functionalized carbon nanotubes in field effect transistor, carbon nanotube device and single electron devices and to introduce to the students the basic principles of Nanophotonics.			

POs	1. To investigate the use of carbon nanotubes as active components. 2. To explore the working of SWNT and its characteristics. 3. Understand single electron devices. 4. To make the students acquainted with the concepts of Nanophotonics. 5. To describe the effects of quantization on the optical properties of semiconductors and metals.				
Semester	**Autumn:**		**Spring:**		
	Lecture	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours	3	0	0	3	36
Prerequisite course code as per proposed course numbers	NIL				
Prerequisite Credits	NIL				
Equivalent course codes as per proposed course and old course	NIL				
Overlap course codes as per proposed course numbers	NIL				

Text Books:		
1.	Title	Electronic and Optoelectronic Properties of Semiconductor Structures,
	Author	Jasprit Singh,
	Publisher	Cambridge University Press
	Edition	2003.
2.	Title	Physics of Photonic Devices
	Author	S. L. Chuang
	Publisher	Wiley Series in Pure and Applied Optics
	Edition	2009
3.	Title	Solid State Electronic Devices
	Author	Streetman and Banerjee
	Publisher	PHI Learning Ltd
	Edition	2009
Reference Books:		
1.	Title	Semiconductor Physics and Devices – Basic Principles,
	Author	D. A. Neamen
	Publisher	Tata McGraw Hill
	Edition	3rd edition, 2003
Content	**Unit I:**	**05**

	Introduction and Overview, Semiconductor Fundamentals in Nanotechnology, Details of Band theory, Energy bands and sub bands, density of states and effective mass, carrier density, degeneracy, Kronig- Penney model, crystal momentum, band alignment, carrier mobility.. **Unit II:** **05** Introduction to low dimensional nano-structures and Quantum Mechanics, Fundamentals of Quantum mechanics, quantization and low dimensional electron gas, alloying, electrons in nanostructures- Quantum wells, wires and dots, Schrodinger equation and its applications. **Unit III:** **05** Electronic transport in nano-structures, Ohms' Law, mobility, Scattering mechanisms, Diffusion, Excess carriers, Transport in 1D and 2 D systems, Resonant tunneling, carrier lifetimes and recombination mechanisms, Statistics of electron transport. **Unit IV:** **06** Optical properties of nano-structures, Basics of EM field, Photons, Scattering mechanisms, phonons, absorptions, spontaneous and stimulated emissions, Interband and intraband transitions, excitons, Strain Engineering, Basics of strain, classifications of strain, effect of strain in various quantum structures. **Unit V:** **05** Photonic devices based on nano structures, LEDs, Quantum Well and Multiple QW lasers, QD Lasers, Transistor laser, vertical cavity surface emitting lasers (VCSEL), Contemporary and advanced (Multi junction, intermediate band etc.) solar cells, Photonic crystals, surface plasmons, spintronic devices, photo detectors etc. **Unit VI:** **05** Electronic Devices based on nano structures, Advance Heterostructure Devices: HBT and HEMT, downscaling of the MOSFETs., resonant tunneling Devices and circuits, single Electron Transistor and Coulomb blockade - applications of all devices in present day electronic circuits in terms of increasing speed, band width, time delay etc. **Unit VII:** **05** Materials for Nanostructures and evolution of Silicon Base Devices, Introduction to Si devices, optical interconnects, Optoelectronic Integrated circuits (OEICs), Si Ge based devices, Inorganic-organic materials, carbon based materials, Sn based materials – their relative advantages and disadvantages.
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%

Course no: ECL 521	**Open course (YES/NO)**	**HM Course (Y/N)**	**DC (Y/N)**	**DE (Y/N)**
	No	**No**	**No**	**Yes**
Type of Course	Theory			
Course Title	**ANALOG IC DESIGN**			
Course Coordinator				
Course objectives:	• To develop the ability design and analyze MOS based Analog VLSI circuits to draw the equivalent circuits of MOS based Analog VLSI and analyze their performance. • To develop the skills to design analog VLSI circuits for a given specification.			
POs	Students are able to • draw the equivalent circuits of MOS based Analog VLSI and analyze their performance. • design analog VLSI circuits for a given specification. • analyse the frequency response of the different configurations of a			

	amplifier. • understand the feedback topologies involved in the amplifier design. • appreciate the design features of the differential amplifiers.				
Semester	**Autumn:**		**Spring:**		
	Lecture	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours	3	0	0	3	36
Prerequisite course code as per proposed course numbers	NIL				
Prerequisite Credits	NIL				
Equivalent course codes as per proposed course and old course	NIL				
Overlap course codes as per proposed course numbers	NIL				

Text Books:		
1.	Title	Analysis & Design of Analog Integrated Circuits, 2001.
	Author	Gray& Meyer
	Publisher	Wiley
	Edition	4th edition,
2.	Title	Design of Analog CMOS Integrated Circuits,
	Author	BehzadRazavi
	Publisher	Tata McGraw Hill
	Edition	2005.
3.	Title	CMOS Mixed Signal Circuit Design, , .
	Author	Jacob Baker
	Publisher	Wiley India Pvt. Limited
	Edition	2008
Reference Books:		
1.	Title	Design of Analog Integrated Circuits and Systems
	Author	Kenneth R. Laker, Willy M.C. Sansen
	Publisher	Tata McGraw-Hill Companies
	Edition	1994.
Content	**Unit I:** **07** Small Signal & large signal Models of MOS & BJT transistor. Analog MOS Process. Passive & Active Current Mirrors: Basic current mirrors, Cascode	

	current mirror, Active loads, and voltage and current references; **Unit II: 08** Frequency response of integrated circuits: Single Stage (CS,CG,CD) amplifiers, Cascade Stage; frequency response(miller effect) of CG, CS, CD, Operation of Basic Differential Pair, differential pair with MOS loads, Frequency response of Cascade & Differential Pair. **Unit III: 07** Operational Amplifiers with single ended outputs: Applications of operational amplifiers, basic two stage MOS operational amplifiers, Deviations from ideality in real operational amplifiers, Basic two-stage MOS operational amplifier, MOS Folded –Cascode operational amplifiers. **Unit IV: 07** Feedback: Ideal feedback equation, gain sensitivity, feedback configurations, practical configuration and effect of loading **Unit V: 07** Nonlinear Analog circuits & other applications: Precision rectification, phased locked loops, Sampling Switches, switched capacitor integrator, oscillators, ADC, DAC.
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%

Course no: ECL 522	**Open course (YES/NO)**	**HM Course (Y/N)**	**DC (Y/N)**	**DE (Y/N)**
	No	**No**	**No**	**Yes**
Type of Course	Theory			
Course Title	**ADVANCED IMAGE PROCESSING**			
Course Coordinator				
Course objectives:	• Understand the various steps in digital image processing. • Get a thorough understanding of digital image representation and processing techniques. • Ability to process the image in spatial and transform domain for better enhancement.			
POs	• Understand various techniques for image representation • Understand various low level image processing techniques including reconstruction from Projections • Understand the fundamentals of high level image processing			
Semester	**Autumn:**		**Spring:**	

	Lecture	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours	3	0	0	3	36
Prerequisite	NIL				

course code as per proposed course numbers					
Prerequisite Credits	NIL				
Equivalent course codes as per proposed course and old course	NIL				
Overlap course codes as per proposed course numbers	NIL				

Text Books:		
1.	Title	Digital Image Processing, Gonzalez, R.E., 3rd edition, 2008.
	Author	R.C& Woods
	Publisher	Pearson Education
	Edition	3rd edition, 2008.
2.	Title	Digital Image Processing
	Author	Kenneth R Castleman
	Publisher	Pearson Education
	Edition	1995
3.	Title	Digital Image Procesing
	Author	S. Jayaraman, S. Esakkirajan, T. Veerakumar,
	Publisher	Tata McGraw Hill Education,.Pvt Ltd, NewDelhi
	Edition	2009
Reference Books:		
1.	Title	Fundamentals of Digital image Processing
	Author	Anil Jain. K
	Publisher	Prentice Hall of India
	Edition	1989.

Content	**Unit I:** **08** Digital image fundamentals Introduction: Digital Image- Steps of Digital Image Processing Systems-Elements of Visual Perception - Connectivity and Relations between Pixels. Simple Operations- Arithmetic, Logical, Geometric Operations. Mathematical Preliminaries - 2D Linear Space Invariant Systems - 2D Convolution - Correlation 2D Random Sequence - 2D Spectrum. **Unit II:** **08** Image transforms and enhancement Image Transforms: 2D Orthogonal and Unitary Transforms-Properties and Examples. 2D DFT- FFT – DCT - Hadamard Transform - Haar Transform - Slant Transform - KL Transform -Properties And Examples. Image Enhancement- Histogram Equalization Technique- Point Processing-Spatial Filtering-In Space and Frequency - Nonlinear Filtering-Use of Different Masks.

	Unit III: **08** Image restoration and construction Image Restoration: Image Observation and Degradation Model, Circulant and Block Circulant Matrices and Its Application in Degradation Model - Algebraic Approach to Restoration- Inverse by Wiener Filtering - Generalized Inverse-SVD and Interactive Methods. **Unit IV:** 06 Image compression & segmentation Image Compression: Redundancy and Compression Models -Loss Less and Lossy. Loss Less- Variable-Length, Huffman, Arithmetic Coding - Bit-Plane Coding, Loss Less Predictive Coding, Lossy Transform (DCT) Based Coding, JPEG Standard - Sub Band Coding. Image Segmentation: Edge Detection - Line Detection - Curve Detection - Edge Linking and Boundary Extraction, Boundary Representation. **Unit V:** **06** Color and multispectral image processing Color Image-Processing Fundamentals, RGB Models, HSI Models, Relationship Between Different Models. Multispectral Image Analysis - Color Image Processing Three Dimensional Image Processing-Computerized Axial Tomography-Stereometry-Stereoscopic Image Display-Shaded Surface Display.
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%

Course no: ECL 523	**Open course (YES/NO)**	**HM Course (Y/N)**	**DC (Y/N)**	**DE (Y/N)**
	No	**No**	**No**	**Yes**
Type of Course	Theory			
Course Title	**DIGITAL IC DESIGN**			
Course Coordinator				
Course objectives:	To develop expertise in full custom, digital integrated circuit design.			
POs	Student will be able to: • Design CMOS inverters with specified noise margin and propagation delay. Synthesize digital circuit using Verilog HDL. • Implement efficient techniques at circuit level for improving power and speed of combinational and sequential circuits • Design a processor meeting timing constraints. • Design memories with efficient architectures to improve access times, power consumption.			
Semester	**Autumn:**		**Spring:**	

	Lecture	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours	3	0	0	3	36
Prerequisite course code as per proposed course numbers	NIL				
Prerequisite	NIL				

Credits					
Equivalent course codes as per proposed course and old course	NIL				
Overlap course codes as per proposed course numbers	NIL				

Text Books:		
1.	Title	Essentials of VLSI Circuits and Systems –
	Author	Kamran Ehraghian, Dauglas A. Pucknell and SholehEshraghiam,
	Publisher	Prentice Hall of India Pvt. Ltd
	Edition	2005
2.	Title	CMOS VLSI Design
	Author	Neil H. E. Weste and David. Harris Ayan Banerjee,
	Publisher	Pearson Education
	Edition	
3.	Title	CMOS Digital Integrated Circuits",
	Author	Sung-Mo Kang, Yusuf Leblebici,
	Publisher	TMH
	Edition	2003
Reference Books:		
1.	Title	Fundamentals of Digital image Processing
	Author	Anil Jain.K
	Publisher	Prentice Hall of India
	Edition	1989.
2.	Title	Digital Integrated Circuits
	Author	Jan M. Rabaey,
	Publisher	Pearson Education
	Edition	2003
	Title	Modern VLSI Design
Content	**Unit I:** **08** Implementation Strategies for Digital ICs: Introduction, From Custom to Semicustom and Structured Array Design Approaches, Custom Circuit Design, Cell-Based Design Methodology, Standard Cell, Compiled Cells, Macro cells, Mega cells and Intellectual Property, Semi-Custom Design Flow, Array-Based Implementation Approaches, Pre-diffused (or Mask-Programmable) Arrays, Prewired Arrays, Perspective—The Implementation Platform of the Future. **Unit II:** **08** Coping with Interconnect: Introduction, Capacitive Parasitics, Capacitance and Reliability—Cross Talk, Capacitance and Performance in CMOS,	

	Resistive Parasitics, Resistance and Reliability— Ohmic Voltage Drop, Electro migration, Resistance and Performance—RC Delay. **Unit III:** **08** Timing Issues in Digital Circuits: Introduction, Timing Classification of Digital Systems, Synchronous Interconnect, Mesochronous interconnect, Plesiochronous Interconnect, Asynchronous Interconnect, Synchronous Design — An In-depth Perspective, Synchronous Timing Basics, Sources of Skew and Jitter, Clock-Distribution Techniques, Synchronizers and Arbiters, Synchronizers— Concept and Implementation, Arbiters, Clock Synthesis and Synchronization Using a Phase-Locked Loop, Basic Concept, Building Blocks of a PLL. **Unit IV:** **06** Designing Arithmetic Building Blocks: Introduction, the Adder, The Binary Adder: Definitions, The Full Datapaths in Digital Processor Architectures, Adder: Circuit Design Considerations, The Binary Adder: Logic Design Considerations, The Multiplier, The Multiplier: Definitions, Partial- Product Generation, Partial Product Accumulation, Final Addition, Multiplier Summary, The Shifter, Barrel Shifter, Logarithmic Shifter. **Unit V:** **06** Designing Memory and Array Structures: Introduction, Memory Classification, Memory Architectures and Building Blocks, The Memory Core, Read Only Memories, Nonvolatile Read-Write Memories, Read-Write Memories (RAM), Contents Addressable or Associative Memory (CAM), Memory Peripheral Circuitry, The Address Decoders, Sense Amplifiers, Voltage References, Drivers/Buffers, Timing and Control.
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%

Course no: ECL 524	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
	No	**No**	**No**	**Yes**
Type of Course	Theory			
Course Title	**MICROELECTRONICS**			
Course Coordinator				
Course objectives:				
POs	Students will demonstrate at least the abilities to: • Analyze semiconductor devices, through numerical problems, using fundamental characteristics of semiconductor materials, such as carrier densities, transport, lifetime, generation and recombination. • Use basic governing equations to calculate carrier concentrations, position of Fermi energy level, carrier drift current in given field, built-in potential barrier at the space charge region, and current-voltage characteristics of p-n junctions. • Analyze main characteristics of electronic and optoelectronic devices such as BJTs, MOSFETs and LEDs. • Conduct literature search, review and report findings; demonstrate teamwork and develop communication skill through group report and presentation. • Demonstrate an understanding of professional and ethical responsibility through a report analyzing real or hypothetical ethic issues			
Semester	**Autumn:**		**Spring:**	

	Lecture	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours	3	0	0	3	36
Prerequisite course code as per proposed course	NIL				

numbers					
Prerequisite Credits	NIL				
Equivalent course codes as per proposed course and old course	NIL				
Overlap course codes as per proposed course numbers	NIL				

Text Books:		
1.	Title	Microelectronic Circuits, 5th Edition, 2009
	Author	Adel Sedra and K.C. Smith
	Publisher	Oxford University Press, International Version
	Edition	5th Edition, 2009
2.	Title	Fundamentals of Microelectronics
	Author	BehzadRazavi
	Publisher	John Wiley India Pvt. Ltd
	Edition	2008
3.	Title	Microelectronics – Analysis and Design
	Author	SundaramNatarajan,
	Publisher	Tata McGraw-Hill
	Edition	2007

Content

Unit I: **06**

MOSFETS: Device Structure and Physical Operation, V-I Characteristics, MOSFET Circuits at DC, Biasing in MOS amplifier Circuits, Small Signal Operation and Models, MOSFET as an amplifier and as a switch, biasing in MOS amplifier circuits, small signal operation modes, single stage MOS amplifiers. MOSFET internal capacitances and high frequency modes, Frequency response of CS amplifiers, CMOS digital logic inverter, and detection type MOSFET.

Single Stage IC Amplifier: IC Design philosophy, Comparison of MOSFET and BJT, Current sources, Current mirrors and Current steering circuits, high frequency response.

Unit II: **06**

Single Stage IC amplifiers (continued): CS and CF amplifiers with loads, high frequency response of CS and CF amplifiers, CG and CB amplifiers with active loads, high frequency response of CG and CB amplifiers, Cascade amplifiers. CS and CE amplifiers with source (emitter) degeneration source and emitter followers, some useful transfer parings, current mirrors with improved performance. SPICE examples.

Unit III: **06**

Differences and Multistage Amplifiers: The MOS differential pair, small signal

	operation of MOS differential pair, the BJT differences pair, other non-ideal characteristics and differential pair, Differential amplifier with active loads, frequency response and differential amplifiers. Multistage amplifier. SPICE examples. **Unit IV:** **06** Feedback. General Feedback structure. Properties of negative feedback. Four basic feedback topologies. Series-Shunt feedback. Determining the loop gain. Stability problem. Effect of feedback an amplifier poles. Stability study using Bode plots. Frequency compensation. SPICE examples. **Unit V:** **06** Operational Amplifiers: The two stage CMOS Op-amp, folded cascade CMOS op-amp, 741 op-amp circuit, DC analysis of the 741, small signal analysis of 741, gain, frequency response and slew rate of 741. Data Converters. A-D and D-A converters. **Unit VI:** **06** Digital CMOS circuits. Overview. Design and performance analysis of CMOS inverter. Logic Gate Circuits. Pass-transistor logic. Dynamic Logic Circuits. SPICE examples.
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%

Course no: ECL 525	**Open course (YES/NO)**	**HM Course (Y/N)**	**DC (Y/N)**	**DE (Y/N)**
	No	**No**	**No**	**Yes**
Type of Course	Theory			
Course Title	**PHYSICS OF MOS TRANSISTORS**			
Course Coordinator				
Course objectives:	The objective of this course is to gain knowledge of semiconductor physics and to develop model for MOS Transistor at different region(linear or triode or saturation). This course also provides study of downscaling of technology and its effects on transistors.			
POs	At the end of the course students will have good knowledge of semiconductor physics and mathematical modeling of MOS transistor at Level 1, Level 2 and level 2 which is the fundamental of digital as well as analog circuit design.			
Semester	**Autumn:**		**Spring:**	

	Lecture	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours	3	0	0	3	36
Prerequisite course code as per proposed course numbers	NIL				
Prerequisite Credits	NIL				
Equivalent course codes as per proposed course and old course	NIL				
Overlap course codes as per proposed course numbers	NIL				

Text Books:		
1.	Title	Operation and Modeling of the MOS Transistor

	Author	Y. Tsividis
	Publisher	
	Edition	
2.	Title	S. M. Sze, Physics of Semiconductor Devices, (2e)
	Author	Wiley Eastern
	Publisher	
	Edition	
3.	Title	MOSFET Models for VLSI Circuit Simulation, Springer-Verlag
	Author	N. D. Arora
	Publisher	Operation and Modeling of the MOS Transistor
	Edition	Y. Tsividis
Content	**Unit I:** **08** Semiconductors, Junctions, and MOSFET Overview Semiconductors, Conduction, Contact Potentials, pn junction, Overview of MOS Transistor. Two-Terminal MOS Structure Introduction, Flat-band voltage, Potential and Charge balance, Effect of Gate-Substrate Voltage on Surface Condition, Regions of Inversion and Analysis, Small-Signal Capacitances **Unit II:** **08** Three-Terminal MOS Structure Introduction, Contacting the Inversion layer, Body effect, Regions of Inversion and Mathematical Analysis, Study of MOS Structure from "VCB" Control Point of View. **Unit III:** **10** Four-Terminal MOS Structure Transistor Regions of Operation, General Charge Sheet Models, Strong Inversion, Weak Inversion, Moderate Inversion, Interpolation Models, Source Referenced versus Body Referenced Modeling, Effective Mobility, Temperature Effects, Breakdown, p-channel MOS Transistor, Enhancement mode and Depletion-Mode Transistors, Model Parameter Values, Model Accuracy, Model Comparison. **Unit IV:** **05** Small-Dimension Effects Introduction, Channel Length Modulation, Barrier Lowering, Two Dimensional Charge Sharing, Threshold Voltage, Punch-through, Carrier Velocity Saturation, Hot Carrier Effects, Scaling, Effects of Surface and Drain Series Resistances, Effects due to Thin Oxides and High Doping. **Unit V:** **05** MOSFET Modeling for Circuit Simulation Introduction, Types of Models, Combining Several Effects into One Physical Model, Parameter Extraction, Accuracy, Properties of Good Models, General Considerations, Benchmark Tests, Nontechnical Considerations.	
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%	

Course no: ECL 526	**Open course (YES/NO)**	**HM Course (Y/N)**	**DC (Y/N)**	**DE (Y/N)**
	No	**No**	**No**	**Yes**
Type of Course	Theory			
Course Title	**VLSI TECHNOLOGY AND DESIGN**			
Course Coordinator				
Course objectives:	The course helps the students to understand the design and analysis of digital VLSI chips using CMOS technology.			
POs	The students will able to understand the design issues at the layout, transistor logic and register-transfer level.			
Semester	**Autumn:**		**Spring:**	

	Lecture	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours	3	0	0	3	36
Prerequisite course code as per proposed course numbers	NIL				
Prerequisite Credits	NIL				
Equivalent course codes as per proposed course and old course	NIL				
Overlap course codes as per proposed course numbers	NIL				

Text Books:		
1.	Title	Essentials of VLSI Circuits and Systems
	Author	K. Eshraghian Eshraghian. D, A. Pucknell
	Publisher	PHI.
	Edition	2005
2.	Title	Modern VLSI Design
	Author	Wayne Wolf
	Publisher	Pearson Education

	Edition	3rd Ed., 1997
3.	Title	Introduction to VLSI Systems: A Logic, Circuit and System Perspective
	Author	Ming-BO Lin
	Publisher	CRC Press
	Edition	2011.
Content	**Unit I:** **09** Review of Microelectronics and Introduction to MOS Technologies: MOS, CMOS, BiCMOS Technology. Basic Electrical Properties of MOS, CMOS &BiCMOS Circuits: Ids – V_{ds}relationships, Threshold Voltage V_T, G_m, G_{ds}andω_o, Pass Transistor, MOS, CMOS & Bi CMOS Inverters, Z_{pu}/Z_{pd}, MOS Transistor circuit model, Latch-up in CMOS circuits. **Unit II:** **09** Layout Design and Tools: Transistor structures, Wires and Vias, Scalable Design rules, Layout Design tools. Logic Gates & Layouts: Static Complementary Gates, Switch Logic, Alternative Gate circuits, Low power gates, Resistive and Inductive interconnect delays. **Unit III:** **09** Combinational Logic Networks: Layouts, Simulation, Network delay, Interconnect design, Power optimization, Switch logic networks, Gate and Network testing. **Unit IV:** **09** Sequential Systems: Memory cells and Arrays, Clocking disciplines, Design, Power optimization, Design validation and testing. **UNIT –V:** Floor Planning: Floor planning methods, Global Interconnect, Floor Plan Design, Off-chip connections.	
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%	

Course no: ECL 527	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
	No	**No**	**No**	**Yes**
Type of Course	Theory			
Course Title	**DIGITAL CMOS INTEGRATED CIRCUITS**			
Course Coordinator				
Course objectives:	• To get Fundamental idea of Analog Circuits. • To give ideas about the basic amplifiers, current Mirrors and Differential Amplifiers. • To get an idea of static and switching characteristics of the CMOS Inverter. • Operation of pass transistor logic and transmission gates • Operational Amplifiers are discussed with its design and stability factors • Different types of Memory and its decoder Circuits are discussed			
POs	Able to understand, design and analyse various analog and digital CMOS Circuits			
Semester	**Autumn:**		**Spring:**	

	Lecture	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours	3	0	0	3	36
Prerequisite course code as per proposed course numbers	NIL				
Prerequisite Credits	NIL				
Equivalent course codes as per proposed course and old course	NIL				
Overlap course codes as per proposed course numbers	NIL				

Text Books:		
1.	Title	CMOS Analog Circuit Design -
	Author	Philip E. Allen and Douglas R. Holberg,
	Publisher	Oxford University Press,
	Edition	International Second Edition/Indian Edition, 2010.

2.	Title	Analysis and Design of Analog Integrated Circuits
	Author	Paul R. Gray, Paul J. Hurst, S. Lewis and R. G. Meyer,
	Publisher	Wiley India
	Edition	Fifth Edition, 2010.
3.	Title	Analog Integrated Circuit Design-
	Author	David A. Johns, Ken Martin,
	Publisher	Wiley Student
	Edition	Edn, 2013
Reference Books:		
1.	Title	Design of Analog CMOS Integrated Circuits- Edition
	Author	Behzad Razavi
	Publisher	TMH
	Edition	
Content	**Unit I:** **08** MOS Devices and Modeling: The MOS Transistor, Passive Components-Capacitor & Resistor, Integrated circuit Layout, CMOS Device Modeling - Simple MOS Large-Signal Model, Other Model Parameters, Small-Signal Model for the MOS Transistor, Computer Simulation Models, Sub-threshold MOS Model. **Unit II:** **08** Analog CMOS Sub-Circuits: MOS Switch, MOS Diode, MOS Active Resistor, Current Sinks and Sources, Current Mirrors-Current mirror with Beta Helper, Degeneration, Cascode current Mirror and Wilson Current Mirror, Current and Voltage References, Band gap Reference. **Unit III:** **08** CMOS Amplifiers: Inverters, Differential Amplifiers, Cascode Amplifiers, Current Amplifiers, Output Amplifiers, High Gain Amplifiers Architectures. **Unit IV:** **08** CMOS Operational Amplifiers: Design of CMOS Op Amps, Compensation of Op Amps, Design of Two-Stage Op Amps, Power Supply Rejection Ratio of Two-Stage Op Amps, Cascode Op Amps, Measurement Techniques of OP Amp. **Unit V:** **04** Comparators: Characterization of Comparator, Two-Stage, Open-Loop Comparators, Other Open-Loop Comparators, Improving the Performance of Open-Loop Comparators, Discrete-Time Comparators.	
Course Assessment	Continuous Evaluation 25% Mid Semester 25%; End Semester 50%	

Course no: AS 601	**Open course (YES/NO)**	**HM Course**	**DC (Y/N)**	**DE (Y/N)**

		(Y/N)			
	No	**No**	**No**		**Yes**
Type of Course	Theory				
Course Title	**MODELING AND SIMULATION**				
Course Coordinator					
Course objectives:	To learn how to create a successful simulation study based on simulation methodologies and to design and analyse the simulation model.				
POs	Students will able to understand the concept of modelling and simulation.				
Semester	**Autumn:**		**Spring:**		
	Lecture	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours	3	0	0	3	36
Prerequisite course code as per proposed course numbers	NIL				
Prerequisite Credits	NIL				
Equivalent course codes as per proposed course and old course	NIL				
Overlap course codes as per proposed course numbers	NIL				
Text Books:					
1.	Title	Numerical Methods for Scientists and Engineers,			
	Author	R.W. Hamming			
	Publisher	Dover Publication			
	Edition	(2nded.) 1987			
2.	Title	Introduction to the Finite Element Method			
	Author	R Reddy			
	Publisher	McGraw Hill Education			
	Edition	(3rd ed.) 2005			
3.	Title	Numerical Methods for Scientific and Engineering Computation			
	Author	M. K. Jain, S. R. K. Iyengar and R. K. Jain			
	Publisher				
	Edition	(5th ed.) 2007			
Reference Books:					
1.	Title	Design of Analog CMOS Integrated Circuits- Edition			

	Author	Behzad Razavi
	Publisher	TMH
	Edition	
Content	**Unit I:** **06** Basic Mathematical Definition, Norms and related ideas, Convergence of sequences, Consistency. **Unit II:** **06** Classification of PDEs, Equation type, form of nonlinearity, Well Posedness of PDE problems. **Unit III:** **06** Continuum Mechanics, Basics Information about vectors and tensors, introductory mechanics, Discretization techniques, Gridding methods. **Unit IV:** **08** Introduction to Programming in MATLAB, Simple Calculation with MATLAB, Writing script and MATLAB functions, Loop and Conditional statements, Plots. **Unit V:** **04** Finite Difference method (FDM), Approximation of first and higher order derivatives, Analysis of truncation error, 1Dand 2D Poison equation. **Unit VI:** **04** Finite Element Methods (FEM), Functional and variational formulation, weak formulation of PDE, Triangulation, Galerkin method. Writing script and MATLAB functions, Loop and Conditional. **Unit VII:** **02** Boundary Element Methods (BEM), Boundary element solution of 2D Laplace and Helmholtz equation, 2D diffusion equation, Green function for potential problems.	
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%	

Course no: ECL 528	**Open course (YES/NO)**	**HM Course (Y/N)**	**DC (Y/N)**	**DE (Y/N)**
	No	**No**	**No**	**Yes**
Type of Course	Theory			

Course Title	ADVANCED NUMERICAL ANALYSIS				
Course Coordinator					
Course objectives:	To learn tools and techniques to analyse PDEs related to science and engineering including: types of PDEs. finite-difference methods applied to parabolic, elliptic and hyperbolic equations; explicit and implicit schemes; multi-level schemes; convergence and stability; error control; theory of characteristics; semi-discrete approximations; iterative methods of solution (including conjugate gradients) and acceleration techniques; matrix and eigen system analysis; direct methods for sparse systems; perturbation of matrices; applications to heat flow and computational aerodynamics; shock waves in traffic and fluid flow, electrical potential, and structural mechanics.				
POs	The purpose of this course is to provide to Engineering/Physical Science graduate students a background in numerical methods that will prepare them to at least begin computational work on essentially arbitrarily difficult problems in partial differential equations (PDEs).				
Semester	Autumn:		Spring:		
	Lecture	Tutorial	Practical	Credits	Total Teaching Hours
Contact Hours	3	0	0	3	36
Prerequisite course code as per proposed course numbers	NIL				
Prerequisite Credits	NIL				
Equivalent course codes as per proposed course and old course	NIL				
Overlap course codes as per proposed course numbers	NIL				

Text Books:		
1.	Title	Numerical Solutions to Partial Differential Equations
	Author	G. D. Smith
	Publisher	Oxford University Pres
	Edition	3rd Edn., 1986
2.	Title	Finite Difference Schemes and Partial Differential Equations, 2004.
	Author	J. C. Strikwerda,
	Publisher	SIAM

	Edition	SIAM
3.	Title	Numerical Solution of Partial Differential Equations in Science and Engineering,
	Author	L. Lapidus and G. F. Pinder,
	Publisher	John Wiley
	Edition	1982.
Reference Books:		
1.	Title	Numerical Solution of Partial Differential Equations in Science and Engineering
	Author	L. Lapidus and G. F. Pinder,
	Publisher	John Wiley,
	Edition	1982.
2.	Title	The finite Difference Methods in Partial Differential Equations
	Author	A. R. Mitchell and D. F. Griffiths
	Publisher	Wiley,
	Edition	1980
Content	**Unit I:** **08** Iterative methods for linear systems: Jacobi method, Gauss Seidel method, SOR method, ADI Method, Incomplete LU method, Conjugate gradient, method, Multigrid methods. **Unit II:** **10** Introduction and classification of PDEs. Finite difference schemes for partial, differential equations: Explicit and Implicit schemes; Consistency, stability, and convergence - Stability analysis by matrix method and von Neumann, method, Lax's equivalence theorem. **Unit III:** **10** Finite difference schemes for initial and boundary value problems: FTCS, backward Euler and Crank-Nicolson schemes, ADI methods, Lax Wendr off, method, upwind scheme; CFL conditions. **Unit IV:** **08** Finite element method for ordinary differential equations: Variational, methods, method of weighted residuals, finite element analysis of one-dimensional problems.	
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%	

Course no: ECL 529	**Open course (YES/NO)**	**HM Course (Y/N)**	**DC (Y/N)**	**DE (Y/N)**
	No	**No**	**No**	**Yes**
Type of Course	Theory			

Course Title	ADVANCED MATHEMATICS				
Course Coordinator					
Course objectives:	• To understanding of fundamental mathematics and to solve problems of algebraic and differential equations, simultaneous equation, partial differential equations. • To provide an overview of discovering the experimental aspect of modern applied mathematics				
POs	• Ability to solve the model by selecting and applying a suitable mathematical method. • Ability to interpreting the mathematical results in physical or other terms to see what it practically means and implies				
Semester	Autumn:		Spring:		
	Lecture	Tutorial	Practical	Credits	Total Teaching Hours
Contact Hours	3	0	0	3	36
Prerequisite course code as per proposed course numbers	NIL				
Prerequisite Credits	NIL				
Equivalent course codes as per proposed course and old course	NIL				
Overlap course codes as per proposed course numbers	NIL				

Text Books:		
1.	Title	Schaum's Outlines of Theory and Problems of MatrixOperations
	Author	Richard Bronson,
	Publisher	McGraw-H
	Edition	
2.	Title	Higher Engineering Mathematics
	Author	Venkataraman M K
	Publisher	National Pub. Co
	Edition	1992
3.	Title	Differential Equations and Calculus of Variations
	Author	Elsgolts, L.,

	Publisher	Mir,
	Edition	1977.
Reference Books:		
1.	Title	Elements of Partial differential equations
	Author	Sneddon,I.N.
	Publisher	Dover Publications
	Edition	2006.
2.	Title	Introduction to partial differential equations
	Author	SankaraRao, K.,
	Publisher	Prentice – Hall of India
	Edition	1995
Content	**Unit I:** **08** Matrix Theory, QR, EL Decomposition – Eigen values using shifted QR, algorithm- Singular Value EL Decomposition approximations. **Unit II:** **08** Calculus of Variations, Concept of Functional- Euler's equation – function al dependent on first and higher order derivatives, variables – Isoperimetric problems- Variational problems with moving boundaries. **Unit III:** **08** Transform Methods, Laplace transform methods for one dimensional wave equation– Displacements in a string, Longitudinal transform methods for one dimensional heat conduction problems in infinite and semi infinite rod. **Unit IV:** **06** Elliptic Equation, Laplace equation – Properties of harmonic functions – Fourier transforms methods for Laplace equations, Solutransforms method. **Unit V:** **06** Linear and Non Linear Programming, Simplex Algorithm- Two Phase and Big M techniques, Duality theory- Dual Simplex method. Non Linear, problems- Lagranges multiplier method, Kuhn- Tucker conditions and solutions.	
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%	

Course no: ECL 530	**Open course (YES/NO)**	**HM Course (Y/N)**	**DC (Y/N)**	**DE (Y/N)**
	No	**No**	**No**	**Yes**
Type of Course	Theory			
Course Title	**ORGANIC ELECTRONICS**			
Course Coordinator				
Course	This course will cover the design and synthetic methods of organic materials			

objectives:	for electronic, optical, and electrochemical applications such a s organic light-emitting diodes (OLED), organic thin-film transistors (OTFT), and organic solar cell (OSC).				
POs	Students will be exposed to semiconductor technologies by presenting images from the clean room, and also a brief description of the most important processes used in semiconducting technologies. The photolithography process will be described in a PowerPoint presentation containing images of each step. A comparison between organic and inorganic semiconductors will emphasize the advantages and disadvantages of organic semiconductors.				
Semester	**Autumn:**		**Spring:**		
	Lecture	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours	3	0	0	3	36
Prerequisite course code as per proposed course numbers	NIL				
Prerequisite Credits	NIL				
Equivalent course codes as per proposed course and old course	NIL				
Overlap course codes as per proposed course numbers	NIL				
Text Books:					
1.	Title	Organic Electronics: Materials, Manufacturing and Applications			
	Author	Hagen Klauk,			
	Publisher	Wiley-VCH VerlagGmbh& Co. KGaA, Germany			
	Edition				
2.	Title	Organic Electronics: Materials, Manufacturing and Applications			
	Author	Hagen Klauk			
	Publisher	Wiley-VCH VerlagGmbh& Co. KGaA, Germany.			
	Edition				
3.	Title	Organic Electronics II: More Materials and Applications			
	Author	Hagen Klauk			

	Publisher	Wiley-VCH VerlagGmbh& Co. KGaA, Weinheim, Germany
	Edition	2012
Content	**Unit I:** **06** Organic and Inorganic Materials & Charge Transport, Introduction; Organic Materials: Conducting Polymers and Small, Molecules, Organic Semiconductors: *p*-type, *n*-type, Ambipolar, Semiconductors, Charge Transport in Organic Semiconductors, Charge Transport Models, Energy Band Diagram, *Organic and inorganic*, materials for: Source, Drain and Gate electrodes , Insulators, Substrates, Comparison between Organic and Inorganic Semiconductors. **Unit II:** **06** Device Physics and Structures: Organic Thin Film Transistors: Overview of Organic Field Effect Transistor (OFET); Operating Principle; Classification of Various Structures of OFETs; Output and Transfer Characteristics; OFETs Performance Parameters: Impact of Structural Parameters on OFET; Extraction of Various Performance Parameters, Advantages, Disadvantages and Limitations. **Unit III:** **06** Organic Device Modeling and Fabrication Techniques, Modeling of OTFT Different Structures, Origin of Contact Resistance, Contact Resistance Extraction, Analysis of OFET Electrical, Characteristics, Validation and Comparison of OFETs. Organic Devices and Circuits Fabrication Techniques. **Unit IV:** **06** OLEDs and Organic Solar Cells, Introduction; Different Organic Materials for OLEDs, Classification of OLEDs, Output and Transfer haracteristics; Various Optical, Electrical and Thermal properties, Advantages, Disadvantages and Limitations, *Organic Solar Cells*: Introduction, Materials, various properties, Characteristics, Advantages, Disadvantages and Limitations and applications. **Unit V:** **06** OTFT applications: Organic Inverters: Inverter circuits based on different materials **Unit VI:** **06** Combination and Configurations; All-*p*-type, Organic Complementary Inverter Circuits, Hybrid Complementary Inverters, Comparison between All P-Type, Fully Organic and Hybrid Complementary Inverters, Circuits; Logic Circuit Implementation; Organic Memory: Organic Static Random Access Memory (OSRAM) Organic DRAM, Shift registers and other Important Organic Memory Designs. OTFT as Driver for organic, Light Emitting Diodes (OLEDs). Addition of More Applications based on Recent Technology Development.
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%

Course no: ECL 531	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
	No	**No**	**No**	**Yes**
Type of Course	Theory			
Course Title	**NANO MATERIALS**			
Course Coordinator				
Course objectives:	1. Appreciate the different material preparation methods 2. Identify the various methods of material growth and deposition 3. Understand the equipment used in characterization of nanomaterials			
POs	1. Understand the materials in NanoTechnology 2. Understand principles of material characterization.			
Semester	**Autumn:**		**Spring:**	

	Lecture	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours	3	0	0	3	36
Prerequisite course code as per proposed course numbers	NIL				
Prerequisite Credits	NIL				
Equivalent course codes as per proposed course and old course	NIL				
Overlap course codes as per proposed course numbers	NIL				

Text Books:		
1.	Title	Introduction to Nanotechnology
	Author	C. P. Poole Jr. and F. J. Owens
	Publisher	Wiley Inter Science
	Edition	
2.	Title	Nano Structures and Nano Materials: Synthesis, Properties and Applications
	Author	Guozhong CaoImperial
	Publisher	College Press
	Edition	
3.	Title	Nanostructured Materials Processing, Properties and Applications,

	Author	Carl C Koch,
	Publisher	Jaico Publishing House.
	Edition	
Content	**Unit I:** **04** Introduction to Nanotechnology: Nano technology, nano science, MEMS, CNT, fullerene, nano machines, semiconductor technology etc. **Unit II:** **04** Solid State Physics: Introduction, structure (physics of solid state), FCC nanoparticle, semiconductor structures lattice vibration, energy band, reciprocal space, fermi surfaces, localized particles, mobility, exciton, etc. **Unit III:** **04** Methods of Measuring Properties: Measurement methods, structure – atomic, crystallography, particle size, mass spectroscopy, LEED, RHEED, surface structures, microscopy – TEM, SEM, FIM, AFM etc. **Unit IV:** **04** Properties of Nanoparticles: Properties of nano-particles, metal nano-clusters, semi conducting nano-particles, semi conducting nano-particles, rare gas & molecular clusters, methods of synthesis. **Unit V:** **04** Carbon Nanostructures: Carbon nano-structures, carbon-molecule, carbon clusters, C60, C20H20, C8H8, CNT, applications. **Unit VI:** **06** Bulk Nanostructured Materials: Solid disordered nanostructures: synthesis, failure, mechanical properties, multilayers, electrical properties, other properties, composite glasses, porous silicon, nanostructured crystals: natural crystals, array in zeolites, metal nanoparticles, photonic crystals. **Unit VII:** **06** Nanostructured Ferromagnetism: Basic, para, ferro, ferri, antiferro-magnetism, effect of bilk nanostructuring on magnetic properties, dynamics of nanomagnets, nanopore containment, nanocarbonferromagnets, giant and colossal magnetoresistance, ferrofluids. **Unit VIII:** **04** Quantum Nanostructure, Self-assembly and Deposition: Quantum wells, wires and dots, preparation, size effect, single electron tunneling, etc., monolayer, multiplayer, LB film deposition, CVD, PVD, sputtering etc.	
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%	

Course no: ECL 532	**Open course (YES/NO)**	**HM Course (Y/N)**	**DC (Y/N)**	**DE (Y/N)**
	No	**No**	**No**	**Yes**

Type of Course	Theory				
Course Title	**NANO MAGNETICS AND SPINTRONICS**				
Course Coordinator					
Course objectives:					
POs	At the end of the courses the student should be able to: • Understand the basics of magnetic materials and building blocks of a magnetic devices • Know the basic properties of magnetic nanostructures • Use the LLG equation for understanding the control of the magnetization • Analysing rigorously the scientific literature • Know the basic principles of various applications (sensors, memories, oscillators)				
Semester	**Autumn:**		**Spring:**		
	Lecture	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours	3	0	0	3	36
Prerequisite course code as per proposed course numbers	NIL				
Prerequisite Credits	NIL				
Equivalent course codes as per proposed course and old course	NIL				
Overlap course codes as per proposed course numbers	NIL				
Text Books:					
1.	Title	Introduction to spintronics			
	Author	S. Bandyopadhyay and M. Cahay			
	Publisher	CRC Press			
	Edition	2008			
2.	Title	Spin Current			
	Author	Ed. S. Maekawaet. al.			
	Publisher	Oxford Science Publications			
	Edition	2011			
3.	Title	Nanomagnetism and spintronics.			

	Author	Ed. T. Shinjo,
	Publisher	Elsevier
	Edition	
Content	**Unit I:** **12** Introduction to spin, quantum mechanics of spin, spin-orbit interaction, spins and magnetism in confined structures, spin relaxation, passive Spintronic devices: **Unit II:** **12** Spin valve, magnetic tunnel junctions (MTJ), spin transfer torque based MTJ, micromagnetics, Magnetic RAM (MRAM) technology, **Unit III:** **12** Active Spintronics devices: spin transistors, advanced topics: spin currents, magneto-optic effects, spin caloritronic devices, spin-Hall devices, all spin logic and spin based quantum computing.	
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%	

Course no: ECL 533	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
	No	**No**	**No**	**Yes**
Type of Course	Theory			
Course Title	**TESTING AND VERIFICATION OF VLSI CIRCUITS**			
Course Coordinator				
Course objectives:	• To expose the students, the basics of testing techniques for VLSI circuits and Test Economics.			
POs	Students are able to • apply the concepts in testing which can help them design a better yield in IC design. • tackle the problems associated with testing of semiconductor circuits at earlier design • levels so as to significantly reduce the testing costs. • analyse the various test generation methods for static & dynamic CMOS circuits. • identify the design for testability methods for combinational & sequential CMOS circuits.			
Semester	**Autumn:**		**Spring:**	

	Lecture	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours	3	0	0	3	36
Prerequisite course code as per proposed course numbers	NIL				
Prerequisite Credits	NIL				
Equivalent course codes as per proposed course and old course	NIL				
Overlap course codes as per proposed course numbers	NIL				

Text Books:		
1.	Title	Essentials of Electronic Testing for Digital, Memory and Mixed-Signal VLSI Circuits, Kluwer Academic Publishers

	Author	M. Bushnell and V. D. Agrawal
	Publisher	M. Bushnell and V. D. Agrawal
	Edition	2000
2.	Title	Digital Systems Testing and Testable Design
	Author	M. Abramovici, M. A. Breuer and A. D. Friedman
	Publisher	IEEE Press
	Edition	1990
3.	Title	Introduction to Formal Hardware Verification
	Author	T. Kropf
	Publisher	Springer Verlag
	Edition	2000
Content	**Unit I:** **12** Scope of testing and verification in VLSI design process. Issues in test and verification of complex chips, embedded cores and SOCs. **Unit II:** **12** Fundamentals of VLSI testing. Fault models. Automatic test pattern generation. Design for testability. Scan design. Test interface and boundary scan. System testing and test for SOCs. Iddq testing. Delay fault testing. BIST for testing of logic and memories. Test automation. **Unit III:** **12** Design verification techniques based on simulation, analytical and formal approaches. Functional verification. Timing verification. Formal verification. Basics of equivalence checking and model checking. Hardware emulation.	
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%	

Course no: ECL 534	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
	No	**No**	**No**	**Yes**
Type of Course	Theory			
Course Title	**ARTIFICIAL NEURAL NETWORKS**			
Course Coordinator				
Course objectives:	• To study basics of biological Neural Network. • To study basics of artificial Neural Network • To study applications of ANN • To study different pattern recognition task using ANN.			
POs	*At the end of the course, students should be able to understand and appreciate:* The role of neural networks in engineering, artificial intelligence, and cognitive modeling. Feed-forward neural networks of increasing complexity, gradient decent learning and extensions, learning and generalization theory Hopfield model of content-addressable memory, Hopfield-Tank approach to optimisation, resistive networks for vision models, complex dynamical learning models. To have a knowledge of sufficient theoretical background to be able to reason about the behaviour of neural networks. To be able to evaluate whether neural networks are appropriate to a particular application. To have knowledge of research literature on neural networks in one particular domain, and be able to put new work into context of that literature.			
Semester	**Autumn:**		**Spring:**	

	Lecture	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours	3	0	0	3	36
Prerequisite course code as per proposed course numbers	NIL				
Prerequisite Credits	NIL				
Equivalent course codes as per proposed course and old course	NIL				
Overlap course codes as per proposed course	NIL				

numbers					
Text Books:					
1.	Title	Elements of Artificial Neural Networks			
	Author	K. Mehrotra, C.K. Mohan and Sanjay Ranka,			
	Publisher	MIT Press, 1997 - [Indian Reprint Penram International Publishing (India			
	Edition	1997			
2.	Title	Neural Networks - A Comprehensive Foundation			
	Author	Simon Haykin			
	Publisher	Macmillan Publishing Co., New York			
	Edition	1994			
3.	Title	Neural Networks for Optimization and Signal Processing			
	Author	ACichocki and R. Unbehauen			
	Publisher	John Wiley and Sons			
	Edition	1993			
Content	**Unit I:** **10** Introduction: Biological neurons and memory: Structure and function of a single neuron; Artificial Neural Networks (ANN); Typical applications of ANNs: Classification, Clustering, Vector Quantization, Pattern Recognition, Function Approximation, Forecasting, Control, Optimization; Basic Approach of the working of ANN - Training, Learning and Generalization. **Unit II:** **10** Supervised Learning: Single-layer networks; Perceptron-Linear separability, Training algorithm, Limitations; Multi-layer networks-Architecture, Back Propagation Algorithm (BTA) and other training algorithms, Applications. Adaptive Multi-layer networks-Architecture, training algorithms; Recurrent Networks; Feed-forward networks; Radial-Basis-Function (RBF) networks. **Unit III:** **08** Unsupervised Learning: Winner-takes-all networks; Hamming networks; Maxnet; Simple competitive learning; Vector-Quantization; Counter propagation networks; Adaptive Resonance Theory; Kohonen's Self-organizing Maps; Principal Component Analysis. **Unit IV:** **08** Associated Models: Hopfield Networks, Brain-in-a-Box network; Boltzmann machine.; Optimization Methods: Hopfield Networks for-TSP, Solution of simultaneous linear equations; Iterated Gradient Descent; Simulated Annealing; Genetic Algorithm.				
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%				

Course no: ECL 535	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
	No	**No**	**No**	**Yes**
Type of Course	Theory			
Course Title	**SPEECH PROCESSING**			
Course Coordinator				
Course objectives:	• Familiarize the basic mechanism of speech production and get an overview of articulatory and acoustic Phonetics. • Learn the basic concepts of methods for speech analysis and parametric representation of speech. • Acquire knowledge about various methods used for speech coding. • Get an overall picture about various applications of speech processing			
POs	• Understand basic concepts of speech production, speech analysis, speech coding and parametric representation of speech and apply it in practical applications. • Ability to develop systems for various applications of speech processing			
Semester	**Autumn:**		**Spring:**	

	Lecture	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours	3	0	0	3	36
Prerequisite course code as per proposed course numbers	NIL				
Prerequisite Credits	NIL				
Equivalent course codes as per proposed course and old course	NIL				
Overlap course codes as per proposed course numbers	NIL				

Text Books:

1.	Title	Speech Communication: Human and Machine
	Author	D O'Shaughnessy
	Publisher	Addison Wesley
	Edition	1987
2.	Title	Digital Processing of Speech Signals, ,
	Author	L R Rabiner and RW Schafer,

	Publisher	Prentice Hall
	Edition	1978
3.	Title	Speech Analysis, Synthesis, and Perception
	Author	J.L Flanagan
	Publisher	Springer Verlag
	Edition	1972.Selected papers
Content	**Unit I:** **12** Speech production and acoustic phonetics, speech perception; Speech analysis: time and frequency domain techniques for pitch and formant estimation, cepstral and LPC analysis. **Unit II:** **12** Speech synthesis: articulatory, formant, and LPC synthesis, voice response and text-to-speech systems. **Unit III:** **12** Applications: data compression, vocoders, speech enhancement, speech recognition, speaker recognition, aids for the speech and hearing impairments.	
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%	

Course no: ECL 536	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
	No	**No**	**No**	**Yes**
Type of Course	Theory			
Course Title	**WAVELETS**			
Course Coordinator				
Course objectives:	• To understand the fundamentals of multirate signal processing and its applications • To study the theory and construction of wavelets and its practical implementations.			
POs	• To design perfect reconstruction filter bank systems • To design and implement wavelet based systems.			
Semester	**Autumn:**		**Spring:**	

	Lecture	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours	3	0	0	3	36
Prerequisite course code as per proposed course numbers	NIL				
Prerequisite Credits	NIL				
Equivalent course codes as per proposed course and old course	NIL				
Overlap course codes as per proposed course numbers	NIL				

Text Books:		
1.	Title	Wavelet Basics,
	Author	Y.T. Chan,
	Publisher	Kluwer Publishers, Boston
	Edition	1993
2.	Title	Ten Lectures on Wavelets, Society for Industrial and Applied Mathematics, ,
	Author	Daubechies
	Publisher	Philadelphia, PA
	Edition	1992
3.	Title	An Introduction to Wavelets

	Author	C. K. Chui
	Publisher	Academic Press Inc., New York
	Edition	1992.
Reference Books:		
1.	Title	A Friendly Guide to Wavelets,
	Author	Gerald Kaiser,
	Publisher	Birkhauser, New York
	Edition	1995
2.	Title	Multirate Systems and Filter Banks
	Author	P. P. Vaidyanathan
	Publisher	Prentice Hall, New Jersey
	Edition	
Content	**Unit I:** **09** Introduction to time frequency analysis; the how, what and why about wavelets. Short-time Fourier transform, Wigner-Ville transforms. **Unit II:** **09** Continuous time wavelet transform, Discrete wavelet transform, tiling of the time-frequency plane and wave packet analysis. **Unit III:** **09** Construction of wavelets. Multiresolution analysis. Introduction to frames and biorthogonal wavelets. Multirate signal processing and filter bank theory. **Unit IV:** **09** Application of wavelet theory to signal denoising, image and video compression, multi-tone digital communication, transient detection.	
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%	

Course no: ECL 537	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
	No	**No**	**No**	**Yes**
Type of Course	Theory			
Course Title	**MICROELECTRONICS CHIP DESIGN**			
Course Coordinator				
Course objectives:				
POs				

Semester	**Autumn:**		**Spring:**		
	Lecture	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours	3	0	0	3	36
Prerequisite course code as per proposed course numbers	NIL				
Prerequisite Credits	NIL				
Equivalent course codes as per proposed course and old course	NIL				
Overlap course codes as per proposed course numbers	NIL				

Text Books:		
1.	Title	CMOS Circuit Design, Layout and Simulation
	Author	R.JacobBaker, H.W.Li
	Publisher	Prentice-Hall of India
	Edition	1998
2.	Title	Mixed Analog and Digital VLSI Devices and Technology,
	Author	Y.P. Tsividis
	Publisher	McGraw Hill
	Edition	1996
Content	**Unit I:**	**07**

	Introduction to RF and Wireless Technology: Complexity, design and applications. Choice of Technology. Basic concepts in RF Design: Nonlinearly and Time Variance, inter-symbol Interference, random processes and Noise. Definitions of sensitivity and dynamic range, conversion Gains and Distortion. **Unit II: 08** Analog and Digital Modulation for RF circuits: Comparison of various techniques for power efficiency. Coherent and Non coherent defection. Mobile RF Communication systems and basics of Multiple Access techniques. Receiver and Transmitter Architectures and Testing heterodyne, Homodyne, Image-reject, Direct-IF and sub-sampled receivers. Direct Conversion and two steps transmitters. **Unit III: 06** BJT and MOSFET behavior at RF frequencies Modeling of the transistors and SPICE models. Noise performance and limitation of devices. Integrated Parasitic elements at high frequencies and their monolithic implementation. **Unit IV: 08** Basic blocks in RF systems and their VLSI implementation: Low Noise Amplifiers design in various technologies, Design of Mixers at GHz frequency range. Various Mixers, their working and implementations, Oscillators: Basic topologies VCO and definition of phase noise. Noise-Power trade-off. Resonator less VCO design. Quadrature and single-sideband generators. **Unit V: 07** Radio Frequency Synthesizes: PLLS, Various RF synthesizer architectures and frequency dividers, Power Amplifiers design. Linearization techniques, Design issues in integrated RF filters. Some discussion on available CAD tools for RF VLSI designs.
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%

Course no: ECL 538	**Open course (YES/NO)**	**HM Course (Y/N)**	**DC (Y/N)**	**DE (Y/N)**
	No	**No**	**No**	**Yes**
Type of Course	Theory			

Course Title	SOLID STATE MICROWAVE DEVICES				
Course Coordinator					
Course objectives:					
POs					
Semester	Autumn:		Spring:		
	Lecture	Tutorial	Practical	Credits	Total Teaching Hours
Contact Hours	3	0	0	3	36
Prerequisite course code as per proposed course numbers	NIL				
Prerequisite Credits	NIL				
Equivalent course codes as per proposed course and old course	NIL				
Overlap course codes as per proposed course numbers	NIL				

Text Books:		
1.	Title	Microwave Circuit Analysis and Amplifier Design
	Author	S.Y. Liao
	Publisher	Prentice Hall
	Edition	1987
2.	Title	Microwave Circuit Design, Using Linear and Non-linear Techniques
	Author	G.D. Vendelin, A.M. Pavio, U.L. Rohde
	Publisher	John Wiley
	Edition	1990
Content	**Unit I:** **12** Amplifiers - Microwave semiconductor devices and models; Power gain equations, stability, impedance matching, constant gain and noise figure circles. **Unit II:** **12** Small signal, low noise, high-power and broadband amplifier designs;	

	Oscillators - One port, two port, YIG dielectric and Gunn-diode oscillators.; Two terminal microwave devices and circuits:; **Unit III: 12** PIN diodes and uses as switches, phase shifters and limiters; Varactor diodes, IMPATT and TRAPATT devices, transferred electron devices.; Microwave BJTs. GaAs FETs, low noise and power GaAs FETs and their applications. Microwave Mixers
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%

Course no: ECL 539	**Open course (YES/NO)**	**HM Course (Y/N)**	**DC (Y/N)**	**DE (Y/N)**
	No	**No**	**No**	**Yes**
Type of Course	Theory			
Course Title	**TELEMATICS**			
Course				

Coordinator					
Course objectives:					
POs					
Semester	**Autumn:**		**Spring:**		
	Lecture	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours	3	0	0	3	36
Prerequisite course code as per proposed course numbers	NIL				
Prerequisite Credits	NIL				
Equivalent course codes as per proposed course and old course	NIL				
Overlap course codes as per proposed course numbers	NIL				

Text Books:		
1.	Title	Switching and Traffic Theory for Integrated Broadband Networks
	Author	Joseph Y. Hui
	Publisher	Kluwer Academic Publishers
	Edition	1990
2.	Title	Mathematical Theory of Connecting Networks and Telephone Traffic
	Author	V.E. Benes
	Publisher	Academic Press
	Edition	1965
Content	**Unit I:** **0** Basics of Telephony: Telephone Network overview; Subscriber Loop; Signaling in the Telephone Network; Overview of ISDN, BISDN and ATM Technologies. **Unit II:** **0** Circuit Switching in Telephone Networks: Crossbar switch; Clos networks; Clos and Slepian-Duguid theorems; Recursive construction of Clos Networks; Time switching, TMS and TST switches; Lee and Jacobeus blocking analysis.	

	Unit III: **0** Routing in R-NB network; Switch processor, Call processing and overload control; Example telephone switches.; Cell Switching: Generic Switch; Input and output queued switches; Shared memory and Shared medium switches, Crossbar switch, Complexity and scaling disadvantage of output queued switches, Knockout principle; Interconnections for large switches, Self-routing architectures, Batcher-banyan networks; Un buffered banyan switches, Buffered banyan, Tandem banyan, Speedup, Parallelism and Channel grouping to enhance input queued switches; Concentrators super concentrators and Copy networks, **Unit IV:** **0** Examples of ATM switches, IP Switching from VC based fixed length packet switches.; Multiplexing and Routing in Circuit Switched Networks: Abstract System Models Erlang Blocking Models; Overflow Models, Equivalent Random Theory, Haywards Approxmn and Introductory Non Poisson Arrival Processes; Product form solution; Erlang Fixed Point Solution; Techniques to choose good routes; Alternate Routing; Dynamic Routing, Least Busy Alternate Routing.
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%

Course no: ECL 540	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
	No	**No**	**No**	**Yes**
Type of Course	Theory			
Course Title	**STATISTICAL SIGNAL ANALYSIS**			
Course Coordinator				
Course objectives:	• Introduction to the various techniques used to predict the outcomes of a random process. • Ability to appreciate the various filters, their inherent assumptions and the statistics they require.			
POs	• Top-level understanding of the convergence issues, computational complexities and optimality of different filters. • Ability to develop adaptive systems for various applications.			
Semester	**Autumn:**		**Spring:**	

	Lecture	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours	3	0	0	3	36
Prerequisite course code as per proposed course numbers	NIL				
Prerequisite Credits	NIL				
Equivalent course codes as per proposed course and old course	NIL				
Overlap course codes as per proposed course numbers	NIL				

Text Books:		
1.	Title	Probability, Random Variables and stochastic processes,
	Author	A. Papoulis

	Publisher	McGraw Hill
	Edition	2nd Ed, 1983
2.	Title	Stochastic Processes
	Author	A. Larson and B.O. Schubert
	Publisher	Holden-Day
	Edition	Vol. I and II, 1979
Content	**Unit I:** **12** Review of probability theory and random variables: Transformation (function) of random variables, Conditional expectation **Unit II:** **12** Sequences of random variables: convergence of sequences of random variables; Stochastic processes: wide sense stationary processes, orthogonal increment processes, Wiener process, and the Poisson process, KL expansion. **Unit III:** **12** Ergodicity, Mean square continuity, mean square derivative and mean square integral of stochastic processes.; Stochastic systems: response of linear dynamic systems (e.g. state space or ARMA systems) to stochastic inputs, Lyapunov equations, correlation function, power spectral density function, introduction to linear least square estimation, Wiener filtering and Kalman filtering.	
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%	

Course no: ECL 541	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
	No	**No**	**No**	**Yes**
Type of Course	Theory			
Course Title	**EMBEDDED CORE DESIGN**			
Course Coordinator				
Course objectives:	To study the various types of processors, concept of inter-communication and real time operating systems.			
POs	Students will understand the principles, components and architectures of embedded systems.			
Semester	**Autumn:**		**Spring:**	

	Lecture	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours	3	0	0	3	36
Prerequisite course code as per proposed course numbers	NIL				
Prerequisite Credits	NIL				
Equivalent course codes as per proposed course and old course	NIL				
Overlap course codes as per proposed course numbers	NIL				

Text Books:

1.	Title	Embedded Core Design With FPGAs
	Author	ZainalabedinNavabi
	Publisher	Tata McGraw Hill
	Edition	2008
2.	Title	VHDL Coding Styles and Methodologies
	Author	Ben Cohen
	Publisher	Kluwer Academic Publishers
	Edition	2007

Content	**Unit I:** **08** Elements of Embedded System-Abstraction levels — Transistors to Programs — Mixed level hardware — Design Specification —Embedded system design flow — Hardware / Software Partitioning — Hardware port — Software Port —Interconnection Specification — Common Hardware / Software Simulation — Hardware Synthesis —Software Compilation — Interconnection Hardware Generation — Design Integrator — Design Tools —Block Diagram Description — HDL and other hardware Simulators — Hardware synthesis tool —Compiler for Machine Language Generation — Software Builder and Debugger — Embedded System Integrator — Hardware design trends — Configurable processors — Standard Bus Structure — Software Programming — Software Utilities. **Unit II:** **08** RTL Design with VHDL-Basic Structures of VHDL — VHDL Overview and Concepts — VHDL Types — VHDL Object Classes —VHDL Design Units — Basic Language Elements — Lexical Elements — Syntax — Types and Subtypes —Attributes — Control Structures — if statement — case statement — loop statement — Drivers —Resolution function — Drivers — Ports — VHDL Timing — Signal Attributes — Wait Statement — Modeling with zero time delays — Inertial / Transport Delay —Elements of Entity / Architecture — Entity —Architecture — Process Statement — Concurrent Signal Assignment Statement — Component Instantiation Statement — Concurrent Procedure Call — Generate Statement — Concurrent Assertion Statement Block Statement — Subprograms — Subprogram Definition — Functions and Procedures —Packages. **Unit III:** **06** Field Programmable Devices-Read Only Memories — Basic ROM Structure — NOR Implementation — Distributed Gates — Array Programmability — Memory View — ROM Variations — Programmable Logic Arrays — PAL Logic Structure — Product Term Expansion — Three State Outputs — Registered Outputs — Commercial Parts, Complex Programmable Logic Devices — Altera's MAX 70005 CPLD — Field Programmable Gate Arrays — Altera's Flex 10K FPGA Altera's Cyclone FPGA. **Unit IV:** **06** Design with Embedded Processors-Embedded Design Steps — Processor Selection — Processor Interfacing — Developing Softyare — Filter Design — Filter Concepts — FIR Filter Hardware Implementation — FIR Embedded Implementation —Building the FIR filter — Design of a Microcontroller — System Platform — Microcontroller Architecture. **Unit V**: **08** Design of an Embedded System-Designing an Embedded System — Nios II Processor — Configurability -Features of Nios II — Processor Architecture — Instruction Set — Nios II Alternative Cores — Avalon Switch Fabric — Avalon Specification — Address Decoding Logic — Data Path Multiplexing — Wait — state insertion — Pipelining Endian Conversion — Address Alignment and Dynamic Bus sizing — Arbitration for Multi-Mastersystems — Burst management — Clock Domain Crossing — Interrupt Controller—Reset Distribution —SOPC Builder Overview — Architecture of SOPC Builder Systems — Functions of SOPC Builder -Integrated Development Environment — OE Project Manager — Source Code Editor — C/C++ CompilerDebugger — Flash Programmer- Case Study: Calculator — System Specification — Calculator 10 Interface — Design of Calculating Engine — Building Calculator Software — Calculator Program Completing the calculator System.
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%

Course no: ECL 542	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
	No	**No**	**No**	**Yes**
Type of Course	Theory			
Course Title	**WIRELESS SENSOR NETWORKS**			
Course Coordinator				
Course objectives:	• Introduction to the concepts of wireless sensors and associated circuits and networking. • To enable students to appreciate various applications of wireless sensor networks. • To impart design principles of wireless networks			
POs	By the end of the course students will be able to understand analyse, design and optimize wireless sensors and networks.			
Semester	**Autumn:**		**Spring:**	

	Lecture	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours	3	0	0	3	36
Prerequisite course code as per proposed course numbers	NIL				
Prerequisite Credits	NIL				
Equivalent course codes as per proposed course and old course	NIL				
Overlap course codes as per proposed course numbers	NIL				

Text Books:		
1.	Title	Protocols and Architectures for Wireless Sensor Networks
	Author	Holger Karl and Andreas Willig
	Publisher	John Wiley & Sons Limited
	Edition	2008.

2.	Title	Sensor Technology hand book
	Author	Wilson
	Publisher	Elsevier publications
	Edition	2005.
Content	**Unit I:** **08** Introduction Cellular and Ad Hoc Wireless Networks-Application of Ad Hoc Wireless Networks, Issues in Ad Hoc Wireless Networks: Medium Access Scheme-Routing-Multicasting-Transport Layer Protocols-Pricing Scheme-Quality of Service Provisioning-Self Organization-Security-Addressing and Service Discovery-Energy management-Scalability-Deployment Considerations, Ad Hoc Wireless Internet. **Unit II:** **08** Sensor Networks Comparison with Adhoc wireless networks-Challenges for WSNs - Difference between sensor networks and Traditional sensor networks —Types of Applications —Enabling Technologies for Wireless Sensor Networks —Single Node Architectures —Hardware Components — Energy Consumption of Sensor Nodes, Issues in Designing a Multicast Routing Protocol, **Unit III:** **08** Sensor Network Architecture Data Dissemination-Flooding and Gossiping-Data gathering Sensor Network Scenarios —Optimization Goals and Figures of Merit — Design Principles for WSNs- Gateway Concepts — Need for gateviay —WSN to Internet Communication — Internet to WSN Communication —WSN Tunneling **Unit IV:** **06** MAC Protocols MAC Protocols for Sensor Networks -Location Discovery-Quality of Sensor Networks-Evolving Standards-Other Issues- Low duty cycle and wake up concepts- The IEEE 802.15.4 MAC Protocols-Energy Efficiency -Geographic Routing Mobi!e nodes **Unit V:** **06** Routing Gossiping and Agent based Unicast Forwarding-Energy Efficient Unicast-Broadcast and Multicast-Geographic Routing-Mobile nodes-Security-Application Specific Support - Target detection and tracking-Contour/ edge detection-Field Sampling,
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%

Course no: ECL 543	**Open course (YES/NO)**	**HM Course (Y/N)**	**DC (Y/N)**	**DE (Y/N)**

	No	**No**	**No**	**Yes**
Type of Course	Theory			
Course Title	**COMPUTER AIDED DESIGN OF VLSI CIRCUITS**			
Course Coordinator				
Course objectives:	Understand new theoretical or practical developments and techniques in VLSI design and CAD algorithms.			
POs	Familiarity with computer assisted VLSI design process.			
Semester	**Autumn:**		**Spring:**	

	Lecture	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours	3	0	0	3	36
Prerequisite course code as per proposed course numbers	NIL				
Prerequisite Credits	NIL				
Equivalent course codes as per proposed course and old course	NIL				
Overlap course codes as per proposed course numbers	NIL				

Text Books:		
1.	Title	Algorithms for VLSI Physical Design Automation
	Author	NI .A. Sherwani
	Publisher	Kluwer Academic Publisher
	Edition	2007
2.	Title	Algorithms for VLSI Design Automation
	Author	S. H. Gerez
	Publisher	John Wiley & Sons
	Edition	2007
Content	**Unit I:** **08** Design Methodologies Introduction to VLSI Methodologies – VLSI Physical Design	

	Automation - Design and Fabrication of VLSI Devices - Fabrication process and its impact on Physical Design. **Unit II: 08** Introduction to Graph Theory and Computational Complexity A Quick Tour of VLSI Design Automation Tools - Data structures and Basic Algorithms - Algorithmic Graph theory and computational complexity - Tractable and Intractable problems. **Unit III: 06** General Purpose Methods for Combinatorial Optimization General purpose methods for combinational optimization — Circuit representation -Wire length estimation - Placement algorithms - Partitioning algorithms -Floor planning floor planning concepts - Shape functions and floor planning sizing - Pin assignment - Routing - Local routing - Area routing -Channel routing - global routing and its algorithms. **Unit IV: 08** VLSI Simulation, Logic Synthesis and Verification Simulation-logic synthesis - gate level and switch level modeling and simulation - Introduction to combinational logic synthesis - ROBDD principles, implementation, construction and manipulation -Two level logic synthesis - High-level synthesis- hardware model for high level synthesis - Internal representation of input algorithms - Allocation, assignment and scheduling - Scheduling algorithms—Aspects of assignment - High level transformations -Verification-High level synthesis = Layout Compaction - Design rules - symbolic layout - Applications of compaction - Formulation methods -Algorithms for constrained graph compaction. **Unit V: 06** Physical Design of FPGA and VHDL Implementation Physical Design Automation of FPGAs, MCIV1S-VHDL-Implementation of Simple circuits using VHDL.
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%

Course no: ECL 544	**Open course (YES/NO)**	**HM Course (Y/N)**	**DC (Y/N)**	**DE (Y/N)**
	No	**No**	**No**	**Yes**
Type of Course	Theory			
Course Title	**FREE SPACE OPTICAL NETWORKS**			

Course Coordinator					
Course objectives:	To introduce wireless Gigabit technology by means of optical wireless communications.				
POs	Students can understand the deployment of free space optics.				
Semester	**Autumn:**		**Spring:**		
	Lecture	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours	3	0	0	3	36
Prerequisite course code as per proposed course numbers	NIL				
Prerequisite Credits	NIL				
Equivalent course codes as per proposed course and old course	NIL				
Overlap course codes as per proposed course numbers	NIL				

Text Books:		
1.	Title	Free Space Optical Net works for Ultra-Broad Band Services
	Author	Stamatios V. Kartalopoulos
	Publisher	IEEE Press
	Edition	2011
2.	Title	Free-Space Optics: Propagation and Communication
	Author	Olivier Bouchet, HerveSizun,Christian Boisrobert and Frederique De Fornel
	Publisher	John Wiley and Sons
	Edition	2010
Content	**Unit I:** **07** Introduction: Propagation of light in unguided media - laser beam characteristics - atmospheric effects on optical signals - coding for atmospheric optical propagation - LIDAR.	

	Unit II: **07** FSO Transceiver Design, Light Sources: Modulators - photo detectors and receivers - optical amplification - optical signal to noise ratio - acquisition, pointing and tracking - adaptive and active optics - laser safety - node housing and mounting. **Unit III:** **08** Point to Point FSO Systems, Simple PtP Design: Transponder nodes - hybrid FSO and RF - FSO point to multipoint - FSO point to mobile; Ring FSO Systems: Ring topologies and service protection - ring nodes with add drop - concatenated rings - ring to network connectivity. **Unit IV**: **08** Mesh FSO Systems, FSO Nodes for Mesh Topology: Hybrid mesh FSO with RF - hybrid FSO fiber networks; WDM Mesh FSO: DWDM and CWDM optical channels - WDM FSO links - WDM mesh FSO networks - service protection in mesh FSO networks. **Unit V:** **06** FSO Network Security and Applications, Cryptography: Security levels - security layers - FSO inherent security features; FSO Specific Applications: FSO networks for highway assisted communications - mesh FSO in disaster areas - visual light communication.
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%

Course no: ECL 545	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
	No	**No**	**No**	**Yes**
Type of Course	Theory			
Course Title	**QUANTUM MECHANICS AND ITS APPLICATIONS TO ENGINEERING**			
Course Coordinator				
Course objectives:	The course is structured to make the students to get exposure on applications of engineering mathematics and quantum mechanics.			
POs	Students will able to solve application oriented mathematical problems.			
Semester	**Autumn:**		**Spring:**	

	Lecture	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours	3	0	0	3	36
Prerequisite course code as per proposed course numbers	NIL				
Prerequisite Credits	NIL				
Equivalent course codes as per proposed course and old course	NIL				
Overlap course codes as per proposed course numbers	NIL				

Text Books:		
1.	Title	Advanced Engineering Mathematics
	Author	R K Jain and S R K Iyengar
	Publisher	Narosa Publishing
	Edition	4 th Edition, 2010.
2.	Title	An Introduction to Theory and Applications of Quantum Mechanics
	Author	AmnonYariv
	Publisher	Dover Publications
	Edition	2012
Content	**UNIT I:** **08** Linear Algebra, Vector Spaces: Linear vector space - linear independence - basis and dimension - linear transformation - matrix representation -	

	diagonalizable matrices - inner product of vectors - Euclidian - frobenius and generalized *p*-norm of vectors and matrices - orthogonal and orthonormal vectors and matrices - Gram-Schmidt orthogonalization procedure - unitary matrices - diagonally dominant matrix - permutation matrix - hermitian and skew - hermitian matrices - symmetric and skew-symmetric matrices - positive definite matrices - properties of special matrices - quadratic forms - reduction of quadratic form to canonical form by orthogonalization method - condition number of a matrix - singular value decomposition. **UNIT II: 08** Ordinary Differential Equations, Higher order linear ODE's: Homogeneous and inhomogeneous cases - method of variation of parameters - method of undetermined coefficients - Euler-Cauchy equations -power series solution of ODE's - definition of ordinary and singular points of an ODE - series solution of homogeneous ODE about a regular singular point - Frobenius method - Legendre, Bessel, Chebyshev, Hermite and Laguerre differential equations - special functions - generating functions - Rodrigue formula - recurrence relations - orthogonality properties - systems of linear homogeneous differential equations - matrix methods for their solution - fundamental matrix - matrix exponential - planar autonomous systems - classification of critical points - stability - introduction to nonlinear differential equations. **UNIT III: 08** Partial Differential Equations, Curvilinear Coordinates: Cylindrical polar and spherical polar systems - conversion of coordinates from cartesian to polar and vice-versa (transformation matrices) - expressions for divergence, curl and gradient operators in spherical and cylindrical coordinate systems - classification of PDE's - Neumann and Dirichlet boundary conditions - method of separation of variables to solve (*a*) Laplace equation, (*b*) Poisson equation, (*c*) Helmholtz equation, (*d*) Wave equation and (*e*) Diffusion equations in spherical polar and cylindrical polar coordinate systems. **UNIT IV: 06** Quantum Mechanics Theory, Review of Stern - Gerlach Experiment and Inadequacy of Classical Theory: Wave-particle duality - wave packets - Fourier transforms - postulation of time dependent Schrödinger equation in three dimension - time independent Schrödinger equation -physical interpretation of wave function - continuity equation - expectation values. **UNIT V: 06** Applications, Definition of Bound States and Scattering States: One dimensional potentials - calculation of reflection and transmission coefficients for the following problems - Dirac-Delta potential - potential step - infinite square well - finite square well (or potential well) - potential barrier and quantum tunneling effect - Kronig-Penney model.
Course	Continuous Evaluation 25%

Assessment	Mid Semester 25% End Semester 50%

Course no: ECL 546	**Open course (YES/NO)**	**HM Course (Y/N)**	**DC (Y/N)**	**DE (Y/N)**
	No	**No**	**No**	**Yes**
Type of Course	Theory			

Course Title	INFORMATION AND NETWORK SECURITY				
Course Coordinator					
Course objectives:	To study the various security attacks, data security and network security algorithms and wireless security mechanism.				
POs	Students will understand the various symmetric and asymmetric cryptographic techniques, authentication mechanism and network security.				
Semester	Autumn:		Spring:		
	Lecture	Tutorial	Practical	Credits	Total Teaching Hours
Contact Hours	3	0	0	3	36
Prerequisite course code as per proposed course numbers	NIL				
Prerequisite Credits	NIL				
Equivalent course codes as per proposed course and old course	NIL				
Overlap course codes as per proposed course numbers	NIL				

Text Books:		
1.	Title	Security in Computing
	Author	Charles P. Pleeger,
	Publisher	Prent ice Hall, New Delhi,
	Edition	2006
2.	Title	Network Security
	Author	Simands
	Publisher	McGraw Hill, New Delhi
	Edition	1998

Content	Unit I: 06
	Security Issues, Issues: Security problem in computing - attacks - security services - security mechanism - OSI security architecture - standards and standard setting organizations.

	Unit II: **10** Data Security and Authentication, Introduction: Basic encryption and decryption - substitution - transposition - block ciphers - data encryption standard encryption and decryption - differential & linear cryptanalysis - advanced encryption standard encryption and decryption-block cipher modes - triple DES with two keys - stream cipher - RC4 - RSA algorithm – Diffie-Hellmann key exchange algorithm - elliptical curve cryptography algorithm; Message Authentication: HASH functions - MD5 - HASH algorithm - SHA 512 logic - authentication protocols - digital signature standards. **Unit III:** **06** Network Security, Network Security: IP security overview - IP security architecture - authentication header - encapsulating security payload - combining security association - key management - web security considerations - secure socket layer and transport layer security - secure electronic transaction. **Unit IV:** **08** System Security, Intruders and Intrusion Detection: Malicious software - viruses and related threats - virus counter measures - distributed denial of service attack - firewalls design principles - trusted systems. **Unit V:** **06** Security for Wireless System, Wireless Security: Security requirements and standards - security mechanism in IEEE 802.11 - WiMAX security scheme - security in North American cellular system - security in European cellular system.
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%

Course no: ECL 547	**Open course (YES/NO)**	**HM Course (Y/N)**	**DC (Y/N)**	**DE (Y/N)**
	No	**No**	**No**	**Yes**
Type of Course	Theory			
Course Title	**OFDM FOR WIRELESS COMMUNICATION**			
Course Coordinator				
Course	To impart OFDM modulation and receiver synchronization techniques.			

objectives:					
POs	Students able to use OFDM techniques for wireless systems.				
Semester	**Autumn:**		**Spring:**		
	Lecture	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours	3	0	0	3	36
Prerequisite course code as per proposed course numbers	NIL				
Prerequisite Credits	NIL				
Equivalent course codes as per proposed course and old course	NIL				
Overlap course codes as per proposed course numbers	NIL				

Text Books:		
1.	Title	OFDM for Wireless Communication Systems
	Author	Ramjee Prasad
	Publisher	Artech House
	Edition	2004
2.	Title	OFDM for Wireless Multimedia Communication
	Author	Richard D. J. Van Nee and Ramjee Prasad
	Publisher	Artech House
	Edition	1999
Content	**Unit I:** **07** OFDM Principles**,** System Model: Generation of sub carrier using IFFT - guard time - cyclic extensions - windowing - choice of OFDM parameters - signal processing - OFDM bandwidth. **Unit II:** **07** PAPR Reduction Techniques, Peak to Average Power Ratio (PAPR): Peak power problem - distribution of PAPR - clipping and peak windowing - peak cancellation - PAPR reduction codes - symbol scrambling. **Unit III:** **07** OFDM Time and Frequency Domain Synchronization, System performance with	

	frequency and timing errors; Synchronization algorithms - comparison of frequency acquisition algorithms - BER performance with frequency synchronization. **Unit IV:** **07** Adaptive Single and Multiuser OFDM Techniques, Adaptive Modulation for OFDM: Adaptive OFDM speech system - pre-equalization; Comparison of adaptive techniques - near optimum power and bit allocation in OFDM - multiuser AOFDM. **Unit V:** **08** Multiuser OFDM Systems, Multiuser Systems: Maximum likelihood enhanced sphere decoding of MIMO OFDM - classification of smart antennas; Introduction to Space Time Processing: SDM OFDM system model - optimized hierarchy reduced search algorithm - aided SDM detection.
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%

Course no: ECL 548	**Open course (YES/NO)**	**HM Course (Y/N)**	**DC (Y/N)**		**DE (Y/N)**
	No	**No**	**No**		**Yes**
Type of Course	Theory				
Course Title	**CARBON NANOTUBE AND NANO STRUCTURES**				
Course Coordinator					
Course objectives:					
POs					
Semester	**Autumn:**		**Spring:**		
	Lecture	**Tutorial**	**Practical**	**Credits**	**Total Teaching**

					Hours
Contact Hours	3	0	0	3	36
Prerequisite course code as per proposed course numbers	NIL				
Prerequisite Credits	NIL				
Equivalent course codes as per proposed course and old course	NIL				
Overlap course codes as per proposed course numbers	NIL				

Text Books:		
1.	Title	Carbon Nanotubes
	Author	M. Endo, S. Iijima, M. S. Dresselhaus
	Publisher	Pergamon
	Edition	
2.	Title	Carbon Nanotubes: Advanced Topics in the Synthesis, Structure, Properties and Applications
	Author	Ado Jorio, Mildred S. Dresselhaus, and Gene Dresselhaus
	Publisher	Springer
	Edition	
3.	Title	Physics of Carbon Nanostructures
	Author	Stefano Bellucci, Alexander Malesevic
	Publisher	Springer
	Edition	
Content	**Unit I:** **07** Introduction to Carbon Nanostructure: Carbon molecule, carbon small clusters, carbon big clusters, fullerenes, discovery of C60, synthesis of C60, properties of C60, other buckeyballs, CNT. **Unit II:** **07** CNT Morphology: From a graphene sheet to a nanotube, structure - archiral and chiral nanotubes, singlewall, multiwall and bundled nanotubes, zigzag and armchair nanotubes, Euler's Theorem in cylindrical and defective nanotubes.	

	Unit III: **08** Production Techniques of Nanotubes: Growth of single-wall/multiwall nanotubes, carbon arc bulk synthesis in presence and absence of catalysts, high purity material (bucky paper) production using pulsed laser vaporization (PLV) of pure and doped graphite, high-pressure co-conversion (HIPCO), nanotube synthesis based on Boudoir reaction-chemical vapor deposition (CVD), laser ablation, synthesis of aligned nanotube films. **Unit IV:** **08** Structural, Electronic Properties: Structural changes in free standing and interacting nanotubes – librations, rotations, twistons, effect of inter tube interactions on the electronic structure, electronic structure of graphite as building block of nanotubes, effect of chirality and discrete atoms, conducting versus insulating nanotubes, band structure of metallic carbon nanotubes, effect of doping on conductivity, electrical properties, vibrational properties, chemical properties, mechanical properties, physical properties, optical properties. **Unit V:** **06** Applications of Nanotubes Harnessing field enhancement, flat panel displays, Hydrogen storage, carbon nanotubes & drug delivery, structural application of CNTs, CNT nanocomposites.
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%