Scheme and Syllabus
of
M. Tech.
Electronics and Communication Engineering
(2024-2025 onwards)

Offered by:

Department of Electronics & Communication Engineering

NATIONAL INSTITUTE OF TECHNOLOGY DELHI

Delhi-110036

(An autonomous Institute under the aegis of Ministry of Education, Govt. of India)

*Approved in the 3rd Meeting of Board of Studies of the Dept. of ECE, held on February 23, 2024 and in line with the recommendation of the Honourable Senate in the 17th Senate Meeting held on May 30, 2024.

Department of Electronics and Communications Engineering
National Institute of Technology Delhi

1. About the Department

Welcome to the Department of Electronic and Communication Engineering (ECE), National Institute of Technology Delhi. It was established in 2010, immediately with the beginning of the Institute under the aegis of the Ministry of Human Resource and Development (MHRD), Govt. of India. Currently, Department is offering one Undergraduate Program as B. Tech (ECE) and two Postgraduate programs as M. Tech. ECE and M. Tech. ECE (VLSI). The Department also offers Ph.D. and Post-Doctoral Fellowship (PDF) Programme in relevant areas. It has excellent laboratories and research facilities in electronic devices and circuits, electronic measurement and instrumentation, microprocessor and microcontroller, microwave and antenna design, optical fiber communication and optical device, multimedia, and advanced communication and VLSI design automation and simulation laboratory. The Department has received projects, grants, and fellowships from the Ministry of Electronics and Information Technology (MeitY), the Department of Science and Technology (DST)-SERB, and other funding agencies. The Department has active collaborations with academic & research institutes in India and abroad.

The Department of ECE has a blend of young as well as experienced dynamic faculty members and is committed to providing quality education and research in the field. Faculty members of the department have excellent academic & research credentials and published numerous peer-reviewed journal articles/ papers, Books, Book Chapters, etc. in the diversified field and have adequate experience in advanced research. The department of ECE provides a creative learning environment to the students for excellence in technical education. Here the students learn to face the challenges related to emerging technologies in electronics and communication engineering. The department of ECE promotes a self-learning attitude, entrepreneurial skills, and professional ethics. The department hopes to achieve the national goals and objectives of industrialization and self-reliance. As a result, it hopes to produce post graduates with strong academic and practical backgrounds so that they can fit into the academia, research and industry.

1.2 Vision

Create an educational environment to prepare the students to meet the challenges of the modern electronics and communication industry through state of art technical knowledge and innovative approaches beneficial to society.

1.3 Mission:

- To promote teaching and learning by engaging in innovative research and by offering state-of-the-art undergraduate, postgraduate, and doctoral programs.
- To cultivate an entrepreneurial environment and industry interaction, leading to the emergence of creators, innovators, and leaders.
- To promote co-curricular and extra-curricular activities for the overall personality development of the students.
- Building of responsible citizens through awareness and acceptance of ethical values.

M. Tech. in Electronics and Communication Engineering

2.1 Preamble:

M. Tech. ECE offered at NIT Delhi is designed to equip the students with a unique blend of skill sets that include:

- Strong theoretical and experimental foundation.
- Predominantly experiment oriented approach with access to well-equipped and specialized laboratories, and supervised internship/ Thesis work.
- Hands-on technical training on advanced experimental facilities.
- Life skills orientation.
- Hard and soft skills.
- Business perspective, along with emphasis on innovation and entrepreneurship.

2.2 Salient Features:

- Minimum Credits requirements for completion of M. Tech ECE program is 80.
- The Curriculum is based on the guidelines of National Education Policy (NEP) – 2020.
- The curriculum has embedded the multi exit/ multi entry in the M. Tech program.
- The curriculum is designed to meet the prevailing and ongoing industrial requirements.
- The curriculum includes project-based education with adequate exposure for Thesis work.
- The curriculum is flexible and offers adequate choice of electives (Program Elective Courses).
- The curriculum inherits the value-based education aims the holistic development of the students.
- The curriculum offers digital p pedagogy & flipped learning with adequate motivation for entrepreneurship/ start-ups.

2.3 Cardinal Mention:

Students exiting after completing 1st Year will be awarded Post Graduate Diploma in Electronics and Communication Engineering (ECE). A minimum Credit requirement for Post Graduate Diploma is 40 Credits.

2.4 Program Educational Objectives (PEOs)

PEO-1	To acquire advanced knowledge and to be technically competent in the design, development, and implementation of electronics and communication circuits/ systems and to solve complex problems in the wide domain of electronics and communication.
PEO-2	Students shall be competent in adapting to new technologies as well as lead research in order to achieve excellence in their professional career.
PEO-3	Enfold the capability to expand horizons beyond engineering for creativity, innovation and entrepreneurship.
PEO-4	Acquire competence and ethics for social and environmental sustainability with a focus on the welfare of humankind.

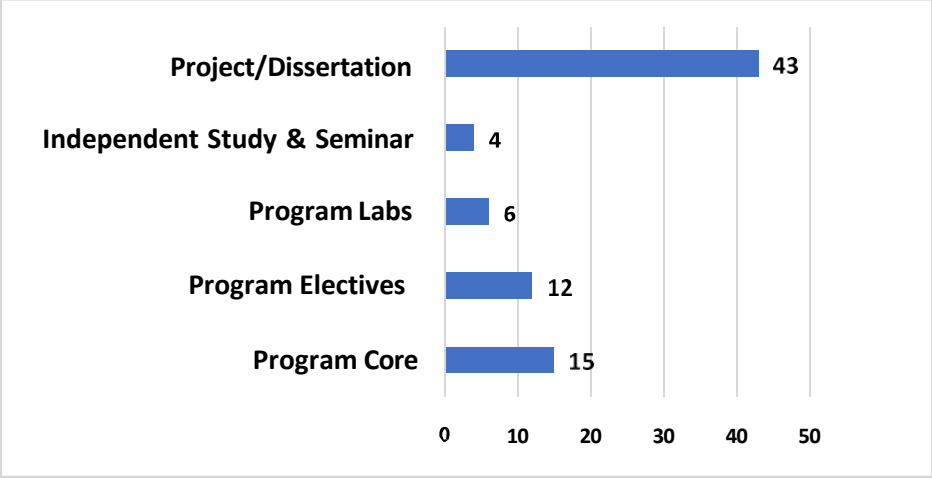
2.5 Program Outcomes (POs)

PO-1	Apply the knowledge of science, mathematics, and engineering principles for a problem-solving attitude and to acquire sound knowledge in the wide area of electronics and communication domain.
PO-2	To design and analyse complex electronic and communication circuits, using appropriate analytical methods as well as front-end and backend tools including prediction and modeling with an understanding of the limitations.
PO-3	An ability to independently carry out research/investigation and development work to solve practical problems towards the benefit of the society and have the preparedness for lifelong learning.
PO-4	Ability to design and conduct experiments, as well as to analyse and interpret data, and synthesis of information.
PO-5	To comprehend and write effective reports and design documentation by adhering to appropriate standards, and making effective presentations.
PO-6	Students will have a clear understanding of professional and ethical responsibility.

2.6 Program Specific Objectives (PSOs)

PSO -1	Enable students to get deep knowledge in the electronics and communication engineering and be able to solve complex problems in the field of Electronics and Communication Engineering.
PSO -2	Enable students to carry out research work in emerging technologies and to pursue career in higher studies and research.

3.1 Credit Distribution

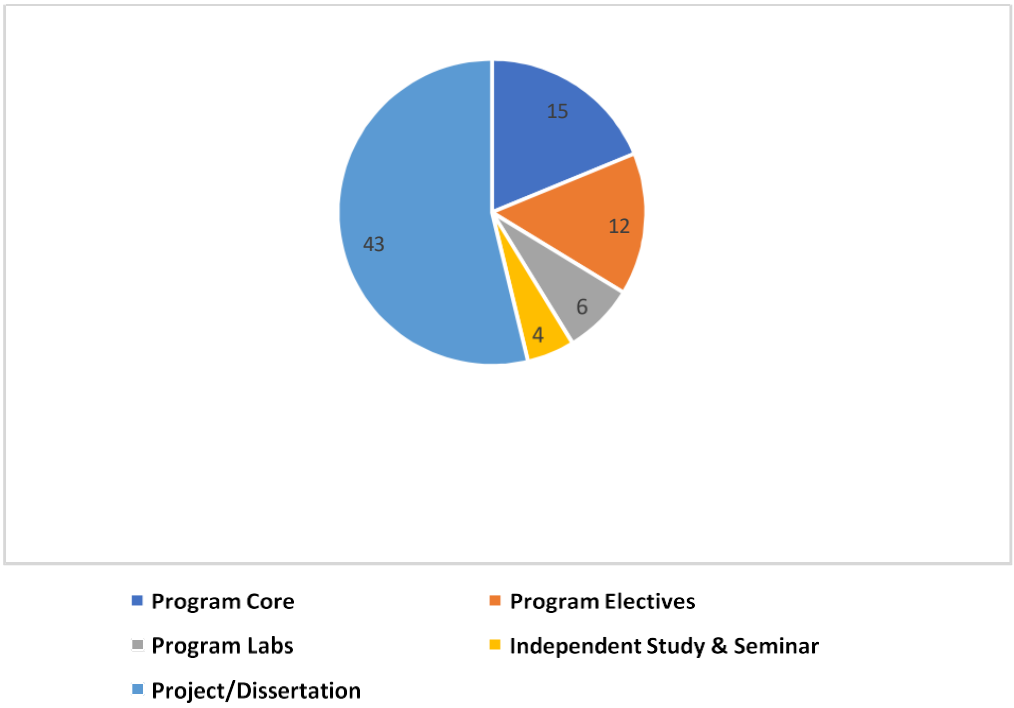


3.2 Semester wise Credit Structure

Credits						
Sl. No.	**Category of Courses**	**1st Year**		**2nd Year**		**Total**
		Semester I	**Semester II**	**Semester III**	**Semester IV**	
1.	Program Core	9	6	-	-	**15**
2.	Program Electives	6	6	-	-	**12**
3.	Program Labs	3	3	-	-	**6**
4.	Independent Study & Seminar	2	2	-	-	**4**
5.	Project/Dissertation	-	3	20	20	**43**
Total		**20**	**20**	**20**	**20**	**80**

Minimum Credits Required for Award of Degree = 80

3.3 Credit Distribution (in %)



Course Coding Pattern		
Semester	**M. Tech ECE**	**M. Tech ECE (VLSI)**
Departmental Core Courses (Theory)		
Autumn Semester	ECEM (5/6)0x (onwards)	ECVM (5/6)0x (onwards)
Spring Semester	ECEM (5/6)5x (onwards)	ECVM (5/6)5x (onwards)
Departmental Elective Courses (Theory)		
Autumn Semester	ECEM (5/6)2x (onwards)	ECVM (5/6)2x (onwards)
Spring Semester	ECEM (5/6)7x (onwards)	ECVM (5/6)7x (onwards)

Numeric for 1st year = 5; Numeric for 2nd year = 6;

Teaching Scheme for
M. Tech in Electronics and Communication Engineering

Semester I

Course Code	Course Title	L	T	P	Credits
ECEM 5xx	Core I	3	0	0	3
ECEM 5xx	Core II	3	0	0	3
ECEM 5xx	Core III	3	0	0	3
ECEM 5xx	Elective I	3	0	0	3
ECEM 5xx	Elective II	3	0	0	3
ECEM 5xx	Laboratory I	0	0	6	3
ECEM 518	Independent Study and Seminar	0	0	4	2
Total Credits		**15**	**0**	**10**	**20**

Semester II

Course Code	Course Title	L	T	P	Credits
ECEM 5xx	Core IV	3	0	0	3
ECEM 5xx	Core V	3	0	0	3
ECEM 5xx	Elective III	3	0	0	3
ECEM 5xx	Elective IV	3	0	0	3
ECEM 5xx	Laboratory II	0	0	6	3
ECEM 569	Core IV	0	0	6	3
ECEM 570	Independent Study and Seminar	0	0	4	2
Total Credits		**12**	**0**	**16**	**20**

Semester III

Course Code	Course Title	L	T	P	Credits
ECEM 601	Dissertation I	0	0	32	16
ECEM 602	MOOCS Course – I/ Independent Study Course - I	3	0	0	3
ECEM 603	Seminar - I	0	0	2	1
Total Credits		3	0	34	**20**

Semester IV

Course Code	Course Title	L	T	P	Credits
ECEM 651	Dissertation II	0	0	32	16
ECEM 652	MOOCS Course – II/ Independent Study Course - II	3	0	0	3
ECEM 653	Seminar - II	0	0	2	1
Total Credits		**3**	**0**	**34**	**20**

Special Note for Selection of Massive Open Online Courses (MOOCs)/ Independent Study Courses

- Students are encouraged to take the above-mentioned MOOCs courses in their 3rd and 4th semesters preferably. The MOOCs courses can only be decided by the students in consultation with the Convener, DPGC (ECE) and HoD (ECE) and should be in allied/ relevant area of ECE or related to the list of elective courses provided in the scheme.

- However, students willing to take those above MOOCs courses during their 1st and 2nd semester are also allowed but their evaluation and marks to be credited during their 3rd and 4th semesters respectively as indicated above.

- If a student completes a MOOC course and submits the evaluation result by the end of 3rd and 4th semester respectively, the they will be exempted from appearing for the Institute examination in the respective Independent Study Course – I (in the 3rd semester) and Independent Study Course – II (in the 4th semester).

- A student failing to complete the MOOC courses will have to choose an Independent Study course-I (in the 3rd semester) and Independent Study Course – II (in the 4th semester), (*from the list of elective courses and also which is not running in that semester/ previously not studied by the concern student*), have to complete (as per the Institute's procedure) the self-study and examinations as per the Institute's rules and regulations.

List of Core Subjects

S. No.	Course Code	Course Title	L	T	P	Credits	Core Applicability
1.	ECEM 501	Advanced Digital Communication Systems	3	0	0	3	Core I + Core II + Core III
2.	ECEM 502	Computer Communication	3	0	0	3	
3.	ECEM 503	Advanced Optical Communication Systems	3	0	0	3	
4.	ECEM 504	Growth, Fabrication and Characterization of Semiconductor Devices	3	0	0	3	
5.	ECEM 505	Introduction to Nano electronics and Nano photonics	3	0	0	3	
6.	ECEM 506	Analog IC Design	3	0	0	3	
7.	ECEM 507	Advanced Digital Signal Processing	3	0	0	3	
8.	ECEM 508	Design of Analog and Mixed Mode VLSI Circuits	3	0	0	3	
9.	ECEM 509	Microelectronics	3	0	0	3	
10.	ECEM 510	Physics of MOS Transistors	3	0	0	3	
11.	ECEM 511	VLSI Technology and Design	3	0	0	3	
12.	ECEM 551	Advanced Photonic Devices	3	0	0	3	Core IV + Core V
13.	ECEM 552	Embedded Core Design	3	0	0	3	
14.	ECEM 553	Advanced Wireless Communication Networks	3	0	0	3	
15.	ECEM 554	Solid State Microwave Devices	3	0	0	3	
16.	ECEM 555	Statistical Signal Analysis	3	0	0	3	
17.	ECEM 556	Modelling and Simulation	3	0	0	3	
18.	ECEM 557	Advanced Numerical Analysis	3	0	0	3	
19.	ECEM 558	Advanced Mathematics	3	0	0	3	
20.	ECEM 559	Organic Electronics	3	0	0	3	
21.	ECEM 560	Nano Materials	3	0	0	3	
22.	ECEM 561	Advanced Image Processing	3	0	0	3	

List of Laboratory Subjects

S. No.	Course Code	Course Title	L	T	P	Credits	Lab Applicability
1.	ECEM 515	Communication laboratory I	0	0	6	3	Lab I
2.	ECEM 565	Communication Laboratory II	0	0	6	3	Lab II
3.	ECEM 516	Fibre Optics Laboratory	0	0	6	3	Lab I
4.	ECEM 517	VLSI Design Laboratory	0	0	6	3	Lab I
5.	ECEM 566	VLSI Design with CAD Tools	0	0	6	3	Lab II

List of Elective Subjects

S. No.	Course Code	Course Title	L	T	P	Credits	Elective Applicability
1.	ECEM 520	Advanced Error Control Codes	3	0	0	3	Elective I + Elective II
2.	ECEM 521	Introduction to MEMS	3	0	0	3	
3.	ECEM 522	Information and Network Security	3	0	0	3	
4.	ECEM 523	Photonic Integrated Devices and Systems	3	0	0	3	
5.	ECEM 524	Speech Processing	3	0	0	3	
6.	ECEM 525	Quantum Mechanics and its Applications to Engineering	3	0	0	3	
7.	ECEM 526	Digital CMOS Integrated Circuits	3	0	0	3	
8.	ECEM 527	Wireless Networks	3	0	0	3	
9.	ECEM 529	Digital IC Design	3	0	0	3	
10.	ECEM 530	Advanced Microwave Devices	3	0	0	3	
11.	ECEM 570	Testing and Verification of VLSI Circuits	3	0	0	3	Elective III + Elective IV
12.	ECEM 571	Nano magnetism and Spintronics	3	0	0	3	
13.	ECEM 572	Computer Aided Design of VLSI Circuits	3	0	0	3	
14.	ECEM 573	Artificial Neural Networks	3	0	0	3	
15.	ECEM 574	Computational Electromagnetics	3	0	0	3	
16.	ECEM 575	Wavelets	3	0	0	3	
17.	ECEM 576	Microelectronics Chip Design	3	0	0	3	
18.	ECEM 577	Telematics	3	0	0	3	
19.	ECEM 578	Free Space Optical Networks	3	0	0	3	
20.	ECEM 579	Semiconductor Optoelectronics	3	0	0	3	
21.	ECEM 580	Low Power VLSI Design	3	0	0	3	
22.	ECEM 581	OFDM for Wireless Communication	3	0	0	3	
23.	ECEM 582	Carbon Nanotubes and Carbon Nano Structures	3	0	0	3	
24.	ECEM 583	Deep Learning and Computer Vision	3	0	0	3	

Curriculum in Detail (Core Subjects)

Course Code: ECEM 501	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. Further to have idea on the advances in Multichannel and Multicarrier Systems design.				
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. , 2021.
3.	Title	Fundamentals of digital Communication
	Author	UpamanyuMadhow,
	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 Code: ECEM 502	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.				
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. Queuing Models: M/M/1 queue, M/M/1/N queue, embedded Markov chain, M/G/1 queue, Network layout and reliability consideration.
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%

Course Code: ECEM 503	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:	The proposed course aims to expose the students to the basics of optical fibre communication system including signal propagation through optical fibers, fiber impairments, components, devices and optical fiber communication system design.				
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	3rd Edition, 2010.
2.	Title	Optical Fibre Communications
	Author	G. Keiser,
	Publisher	Tata McGraw Hill,
	Edition	3rd Edition, 2000.
3.	Title	Fibre-Optic Communication Systems
	Author	G. P. Agarwal
	Publisher	John Wiley and Sons
	Edition	3rd Edition

Content	**Unit I:** **08** 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** Optical 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:** **04** 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 Code: ECEM 504	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
	No	No	Yes	No
Type of Course	Theory			
Course Title	GROWTH, FABRICATION AND CHARACTERIZATION OF SEMICONDUCTOR DEVICES			
Course Coordinator				
Course objectives:	To provide in depth foundation in MOS and CMOS fabrication 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	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 alignedsilicides, 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 Code: ECEM 505	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)		DE (Y/N)
	No	**No**	**Yes**		**No**
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.				
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 Code: ECEM 506	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)		DE (Y/N)
	No	No	Yes		No
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. Further to develop the skills to design analog VLSI circuits for a given specification.				
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

<table>
<tr><td colspan="3">Reference Books:</td></tr>
<tr><td rowspan="4">1.</td><td>Title</td><td>Design of Analog Integrated Circuits and Systems</td></tr>
<tr><td>Author</td><td>Kenneth R. Laker, Willy M.C. Sansen</td></tr>
<tr><td>Publisher</td><td>Tata McGraw-Hill Companies</td></tr>
<tr><td>Edition</td><td>1994.</td></tr>
<tr><td>Content</td><td colspan="2">Unit I: 09
Basic MOS Device Physics: Device Structure and Operation, General Considerations, MOS I/V Characteristics, Finite Output Resistance in Saturation, Transconductance, Second Order effects: body effect, Channel length modulation, Subthreshold conduction, MOS small signal models, SPICE, Short Channel Effects: DIBL, velocity saturation, hot carrier, impact ionization, surface scattering.
Unit II: 09
Amplifiers: Basic concepts, Single Stage Amplifiers: Basic Concepts, Common Source Stage: resistive load, diode connected load, current source load, triode load, source degeneration. Source Follower, Common Gate Stage, Cascode Stage. Folded cascode.
Differential Amplifiers: Single Ended and Differential Operation, Basic Differential Pair, Common Mode Response, Differential Pair with MOS loads, Gilbert Cell.
Unit III: 09
Passive and Active Current Mirrors: Basic Current Mirrors, Cascode Current Mirrors, Active Current Mirrors.
Frequency Response of Amplifiers: Amplifier transfer function, General Considerations, Miller Effect, Common Source Stage, Source Followers, Common Gate Stage, Cascode Stage, Differential Pair.
Unit IV: 09
Feedback Amplifiers: General Considerations, Feedback Topologies, Effect of Loading. Operational Amplifiers: General Considerations, One Stage Op Amps, Two Stage Op Amps, Gain Boosting, Common Mode Feedback, Input Range limitations, Slew Rate, Power Supply Rejection, VCO Circuit design, phase-locked loop (PLL), delay-locked loop (DLL).</td></tr>
<tr><td>Course Assessment</td><td colspan="2">Continuous Evaluation 25%
Mid Semester 25%
End Semester 50%</td></tr>
</table>

Course Code: ECEM 507	Open Course (Yes/No)	HM Course (Yes/No)	DC (Y/N)	DE (Y/N)	
	No	**No**	**Yes**	**No**	
Type of Course	Theory				
Course Title	**ADVANCED DIGITAL SIGNAL PROCESSING**				
Course Coordinator					
Course Objectives:	To provide the overview of signal processing techniques. To introduce efficient computation method of discrete Fourier transform. To study the advanced signal processing techniques and application and then to apply the signal processing algorithms for a wide range of 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				
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 Signal Processing: A Computer-Based Approach
	Author	S. K. Mitra
	Publisher	McGraw-Hill
	Edition	Third edition, 2006
2.	Title	Discrete-Time Signal Processing
	Author	A.Oppenheim and R. Schafer
	Publisher	Prentice Hall
	Edition	Second edition, 1999
3.	Title	Digital Signal Processing: Principles, Algorithms and Applications
	Author	J. Proakis, D. Manolakis
	Publisher	Prentice-Hall
	Edition	Fourth edition, 2006
Reference Book		
1.	Title	Theory and Application of Digital Signal Processing
	Author	L.R. Rabiner and B. Gold
	Publisher	Phi Learning
	Edition	First edition, 2008

Contents	**Unit I:** **08** **Introduction to DSP:** Review of Discrete time signals and systems. Convolution and correlation of discrete time systems, linear time-invariant systems, Sampling, z-transform **Unit II:** **07** **The Discrete and fast Fourier Transforms:** Discrete Fourier transform, properties of DFT. Frequency domain sampling, linear filtering methods based on DFT, Frequency analysis of signals using the DFT, Decimation in time domain and decimation in frequency domain algorithms. **Unit III:** **07** **Design of FIR and IIR filters:** Design of digital IIR filters, Design of digital FIR filters, frequency transformations. **Unit IV:** **07** **Multirate DSP:** Decimation and Interpolation, Multistage design of interpolators and decimators; Poly-phase decomposition and FIR structures, Implementation of multirate conversion. Applications of multirate DSP. **Unit V:** **07** **Optimum filtering and spectrum estimation:** Wiener filters, least mean square filters, Recursive least square filters, Power spectrum estimation techniques.
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%

Course Code: ECEM 508	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
	No	No	Yes	No
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.			
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 Code: ECEM 509	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
	No	**No**	**Yes**	**No**
Type of Course	Theory			
Course Title	**MICROELECTRONICS**			
Course Coordinator				
Course objectives:	To analyze semiconductor devices, through numerical problems, using fundamental characteristics of semiconductor materials, such as carrier densities, transport, lifetime, generation and recombination. Further to analyze main characteristics of electronic and optoelectronic devices such as BJTs, MOSFETs and LEDs.			
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	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 Code: ECEM 510	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
	No	**No**	**Yes**	**No**
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.			
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 Code: ECEM 511	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
	No	**No**	**Yes**	**No**
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.			
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	McGraw Hill Education (India) Private Limited
	Edition	2nd Edition
2.	Title	VLSI Fabrication Principles: Silicon and Gallium Arsenide
	Author	Sorab Khushro Ghandhi
	Publisher	Wiley Publisher
	Edition	Second edition (January 2008)
3.	Title	CMOS Digital Integrated Circuits: Analysis and Design
	Author	Sung-Mo Kang, Yusuf Leblebici
	Publisher	McGraw-Hill Higher Education; 41st edition (1 December 2002)
	Edition	2002

Content	**Unit I:** **09** Crystal growth: Source of silicon; Single crystalline and Poly crystalline; Requirement of purity for electronics industry; Electronics grade silicon production; Crystal growth Czocharalski method, Silicon Wafer Preparation & Crystal Defects; Epitaxial Process: Need of epitaxial layer; vapors phase epitaxy, chemistry of epitaxial process, transport mechanism, doping & auto doping; selective epitaxy, epitaxial process induced defects, molecular beam epitaxy, merits and demerits among epitaxial processes; recent trends in Epitaxy. Oxidation: Importance of oxidation; types of oxidation techniques; growth mechanism & kinetics; factors affecting the growth mechanisms; silicon oxidation model, dry & wet oxidation; recent trends in oxidation. **Unit II:** **09** Lithography: Basic steps in lithography; lithography techniques-optical lithography, electron beam lithography, x-ray lithography, ion beam lithography; resists and mask preparation of respective lithography's, printing techniques-contact, proximity printing and projection printing; merits and demerits of lithography's; recent trends in lithography at nano regime; Etching: Performance metrics of etching; types of etching- wet and dry etching; dry etching techniques-ion beam or ion-milling, sputter ion plasma etching and reactive ion etching (RIE); merits and demerits of etching; etching induced defects; recent trends in etching. **Unit III:** **09** Diffusion and Ion Implantation: Diffusion mechanisms; diffusion reactor; diffusion profile; diffusion kinetics; parameters affecting diffusion profile; Dopants and their behaviour, choice of dopants; Ion Implantation, channelling effect, Metallization: Desired properties of metallization for VLSI; metallization choices; metallization techniques vacuum evaporation, sputtering; Introduction to packaging; packaging process; package design considerations, various package types. **Unit IV:** **09** Review of Microelectronics and Introduction to MOS Technologies: MOS, CMOS, BiCMOS Technology. Basic Electrical Properties of MOS, Ids – Vds relationships, Threshold Voltage VT, body effect, MOS Transistor circuit model, CMOS inverter characteristics, Bi CMOS Inverters, Latch-up in CMOS circuits. Scaling of MOS devices and design rules, Design Styles, concept of hierarchy, regularity, modularity and locality. Gate design using CMOS, Transistor sizing, Pass Transistor and transmission gates.
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%

Course Code: ECEM 551	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:	This course will give an in-depth understanding of the principle of operation, design, and performance analysis of advanced photonic devices for a variety of applications, including optical-fibre communications and solar power generation and it's material-based study.			
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	Ben G Streetman and S. K. Banerjee,
	Publisher	Global edition, Pearson
	Edition	2018.

4.	Title	Semiconductor Physics and Devices
	Author	D. A. Neamen and D. Biswas
	Publisher	Mcgraw Hill Education (India) Pvt. Ltd, Special Indian Edition
	Edition	4th Edition, 2007
5.	Title	Semiconductor Nanophotonics,
	Author	P. K. Basu, B. Mukhopadhyay and R. Basu
	Publisher	Oxford Science Publications, Oxford University Press
	Edition	2022
6.	Title	Semiconductor Laser Theory
	Author	P. K. Basu, B. Mukhopadhyay and R. Basu
	Publisher	CRC Press, Taylor and Francis Group
	Edition	2016
Content	**Unit I:** **08** Basic Electronics and 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:** **04** Theory of Band Structures: 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:** **04** 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:** **04** 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:** **04** Electronic Transport: 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:** **04** Optical Properties: Basics of EM field, Photons, Scattering mechanisms, phonons, absorptions, spontaneous and stimulated emissions, Interband and intraband transitions, excitons, Franz-Keldysh effect, Exciton effect, Quantum confined Stark effect. **Unit VII:** **04** Advanced Optical 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: **04** Advanced Material 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 Code: ECEM 552	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
	No	No	Yes	No
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.			
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 — Modelingwith 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 Code: ECEM 553	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.			
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 Code: ECEM 554	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)		DE (Y/N)
	No	No	Yes		No
Type of Course	Theory				
Course Title	SOLID STATE MICROWAVE DEVICES				
Course Coordinator					
Course objectives:	To have advanced knowledge and applications of recently trend microwave devices applicable for the various applications of communications.				
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 Code: ECEM 555	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
	No	No	Yes	No
Type of Course	Theory			
Course Title	STATISTICAL SIGNAL ANALYSIS			
Course Coordinator				
Course objectives:	To introduce the various techniques used to predict the outcomes of a random process and to ability to appreciate the various filters, their inherent assumptions and the statistics they require.			

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 Code: ECEM 556	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
	No	**No**	**Yes**	**No**
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.			
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	BehzadRazavi
	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 Code: ECEM 557	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 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 Eigensystem 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	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 Code: ECEM 558	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 MATHEMATICS			
Course Coordinator				
Course objectives:	Understanding of fundamental mathematics and to solve problems of algebraic and differential equations, simultaneous equation, partial differential equations and to provide an overview of discovering the experimental aspect of modern applied mathematics			

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 Code: ECEM 559	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
	No	**No**	**Yes**	**No**
Type of Course	Theory			
Course Title	**ORGANIC ELECTRONICS**			
Course Coordinator				
Course objectives:	This course will cover the design and synthetic methods of organic materials for electronic, optical, and electrochemical applications such a s organic light-emitting diodes (OLED), organic thin-film transistors (OTFT), and organic solar cell (OSC).			
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 Code: ECEM 560	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
	No	No	Yes	No
Type of Course	Theory			
Course Title	NANO MATERIALS			
Course Coordinator				
Course objectives:	To learn and appreciate by the students regarding different material preparation methods. To identify the various methods of material growth and deposition and to understand the equipment used in characterization of nanomaterials			
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 Code: ECEM 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 IMAGE PROCESSING			
Course Coordinator				
Course objectives:	To understand the various steps in digital image processing. To get a thorough understanding of digital image representation and processing techniques and to learn the ability to process the image in spatial and transform domain for better enhancement.			
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	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%	

Curriculum in Detail (Elective Subjects)

Course Code: ECEM 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	**ADVANCED ERROR CONTROL CODES**			
Course Coordinator				
Course objectives:	To explain the importance of modern coding techniques in the design of digital 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 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:** **05** 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: **05** 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:** **05** 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:** **05** 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:** **05** **Convolution codes:** Encoding of convolutional codes, Distance properties, Viterbi decoding algorithm for decoding Extended and Modified State Diagram, Error Probability Analysis for Convolutional codes. Hard and soft Decisions. **Unit VI:** **05** Turbo codes: Introduction to Turbo coding and their distance properties, design of Turbo codes, Decoding of Turbo codes. **Unit VII:** **03** LDPC Codes**:** Introduction to Low Density Parity Check Codes, Regular and Irregular LDPC Codes, Decoding of LDPC Codes using Tannar Graph. **Unit VIII:** **03** Space-Time Block Codes: The Alalouti Code Coding and Decoding.
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%

Course Code: ECEM 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	INTRODUCTION TO MEMS				
Course Coordinator					
Course objectives:	The course is designed to familiarize the student with the functions and applications of MEMS.				
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	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 Code: ECEM 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	INFORMATION AND NETWORK SECURITY				
Course Coordinator					
Course objectives:	To study the various security attacks, data security and network security algorithms and wireless security mechanism.				
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 Code: ECEM 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	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.				
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 Code: ECEM 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	SPEECH PROCESSING			
Course Coordinator				
Course objectives:	To familiarize the basic mechanism of speech production and get an overview of articulatory and acoustic Phonetics. To learn the basic concepts of methods for speech analysis and parametric representation of speech andthen to get an overall picture about 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 Code: ECEM 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	**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.			
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 Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%

Course Code: ECEM 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	**DIGITAL CMOS INTEGRATED CIRCUITS**			
Course Coordinator				
Course objectives:	To get Fundamental idea of analog circuits, like, basic amplifiers, current mirrors, differential amplifiers etc. Then to get an idea of static and switching characteristics of the CMOS Inverter, operation of pass transistor logic and transmission gates, different types of Memory and its decoder 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 Digital Integrated Circuits: Analysis and Design
	Author	Sung-Mo Kang , Yusuf Leblebici
	Publisher	McGraw-Hill Higher Education; 41st edition (1 December 2002)
	Edition	2002
2.	Title	Digital system design- A design perspective.
	Author	Rabaey, Chandrakasan and Milokic.
	Publisher	Pearson education, India.
	Edition	
3.	Title	Principles of CMOS VLSI Design, A System Perspective,
	Author	Neil H.E.Weste and Kamran Eshraghian
	Publisher	Pearson Education, India
	Edition	

Reference Books:		
1.	Title	CMOS Circuit Design, Layout and simulation
	Author	J. Baker, D.E. Boyce.,
	Publisher	wiely
	Edition	2009
Content	**Unit I:** **09** Introduction to MOSFETs technology: Process flow and masking steps for MOS, Electrical behaviour of MOS transistors and CMOS fabrication technologies (well process, SOI and scaling), Latch up in CMOS technology. CMOS Inverter: Design, analysis of NMOS inverter (resistive, enhancement and depletion load, CMOS inverters; transfer characteristics, Noise margins, , rationing of transistor size, logic voltage levels, rise and fall of delays, Propagation Delay, Power Consumption. **Unit II:** **09** Layout and stick diagram: Layout Design Rules: Lambda and micron based design rules- stick diagram, Layer properties of various conducting layers in MOS and CMOS technology (diffusion, poly-silicon and metal), Layout design of different CMOS circuit, area estimation. Design styles, design issues. Combinational Circuits: Design of basic gates in NMOS technology; CMOS logic design styles: static CMOS logic (NAND, NOR gates), complex gates, Pass Transistor logic, Transmission gate, Dynamic MOS design: pseudo NMOS logic, (Half and Full adder), Multiplexer, XOR, XNOR. **Unit III:** **09** Sequential MOS Logic and Memory Design: Static latches; Flip flops & Registers, Dynamic Latches & Registers, CMOS Schmitt trigger, Monostable sequential Circuits, Astable Circuits. clocked CMOS (C2 MOS) logic, domino logic, NORA, TSPC, advance dynamic logic circuits. **Unit IV:** **09** Clock distribution and clock schemes in VLSI chips, Memory Design: ROM & RAM cells. Energy recovery and adiabatic logic circuits Logical Effort: Logical Effort of Different Digital Circuit Design, Input capacitance, Logical and Electrical effort, parasitic delay, Single stage and Multistage with and without branch network. Design of minimum delay and optimization of best stages.	
Course Assessment	Continuous Evaluation 25% Mid Semester 25%; End Semester 50%	

Course Code: ECEM 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	WIRELESS 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 and to impart design principles of wireless 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 Code: ECEM 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	DIGITAL IC DESIGN				
Course Coordinator					
Course objectives:	To develop expertise in full custom, digital integrated 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	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 Code: ECEM 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	ADVANCED MICROWAVE DEVICES			
Course Coordinator				
Course objectives:	To study passive microwave components and their S- parameters, microwave semiconductor devices & applications, microwave sources and 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	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 Code: ECEM 570	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.				
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 Code: ECEM 571	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:	To understand the basics of magnetic materials and building blocks of a magnetic devices, to know the basic properties of magnetic nanostructures.			
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

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 Code: ECEM 572	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:	To understand new theoretical or practical developments and techniques in VLSI design and CAD algorithms.				
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 Code: ECEM 573	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, basics of artificial Neural Network, applications of ANN and different pattern recognition task using ANN.			
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	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 Code: ECEM 574	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (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.			
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 Code: ECEM 575	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 and to study the theory and construction of wavelets and its practical implementations.			
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 Code: ECEM 576	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:	To introduce the basic and hands on knowledge of chip designing by reviving the concept of microelectronics, VLSI circuits and advanced CMOS knowledge's.			
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 Code: ECEM 577	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:	To develop the basic knowledge and applications of telematics.			

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: 09
	Basics of Telephony: Telephone Network overview; Subscriber Loop; Signaling in the Telephone Network; Overview of ISDN, BISDN and ATM Technologies.

	Unit II: **09** 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:** **09** 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 toenhance input queued switches; Concentrators super concentrators and Copy networks, **Unit IV:** **09** 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 Code: ECEM 578	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.				
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,ChristianBoisrobert 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 Code: ECEM 579	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 hetero-structures and super-lattices. Applications of these properties will also be discussed.			
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	DragicaVasileska 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, interdiffusion 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 Code: ECEM 580	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 DESIGN**			
Course Coordinator				
Course objectives:	To spread awareness regarding the importance of low power design and the possibilities and to provide students design optimizations with special focus on circuit level. To make aware students the class of art techniques in VLSI design with power and delay trade-offs.			
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 Code: ECEM 581	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 objectives:	To impart OFDM modulation and receiver synchronization techniques.			

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 Code: ECEM 582	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 NANOTUBES AND CARBON NANO STRUCTURES			
Course Coordinator				
Course objectives:	To introduce the basic knowledge of graphene's and then to introduce the knowledge and applications of carbon based devices/ carbon based advance nano-structured 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	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%	

Course Code: ECEM 583	Open Elective Course: (Y/N)	HM Course: (Y/N)	DC Course: (Y/N)	DE Course: (Y/N)
	N	N	N	Y
Type of Course	Theory Course			
Course Title	Deep Learning for Computer Vision			
Course Coordinator				
Course Objectives	The course emphasizes the core vision tasks of scene understanding and recognition. Applications to object recognition, image analysis, image retrieval and object tracking will be discussed.			
Semester			**Autumn /Spring (Write only one)**	

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

Prerequisite course codes with course names	
Equivalent course codes as per proposed course and old course	

Text Books		
1.	Title	Deep Learning
	Author	Ian Goodfellow and Yoshua Bengio and Aaron Courville
	Publisher	MIT Press
	Edition	2016.
2.	Title	Computer Vision: Algorithms and Applications
	Author	R. Szeliski
	Publisher	Springer,
	Edition	2011.
3	Title	Neural Networks and Deep Learning
	Author	Michael Nielsen
	Publisher	Determination Press
	Edition	2016
Reference Books		
1.	Title	Computer vision – Models, learning and inference
	Author	S. Prince
	Publisher	Cambridge univ. press,

	Edition	2012.	
	Title	Computer Vision: Models, Learning, and Inference	
	Author	Simon Prince	
	Publisher	Cambridge Univ. Press	
	Edition	2012	
Course Contents	**UNIT I:** Neural Network Review- Neural Network model, Multi-layer Perceptrons, Backpropagation. Convolutional Neural Networks (CNNs)- Introduction to CNNs; Evolution of CNN Architectures: AlexNet, ZFNet, VGG, InceptionNets, ResNets, DenseNets. Imaging system: Image Formation, Capture and Representation; Linear Filtering, Correlation, Convolution. Visual Features and Representations: Edge, Blobs, Corner Detection; Scale Space and Scale Selection; SIFT, SURF; HoG, LBP, etc. Visual Matching: Bag-of-words, VLAD; RANSAC, Hough transform; Pyramid Matching; Optical Flow.		**9**
	UNIT II: Visualization and Understanding CNNs: Visualization of Kernels; Backprop-to-image/Deconvolution Methods; Deep Dream, Hallucination, Neural Style Transfer; CAM,Grad-CAM, Grad-CAM++; Recent Methods (IG, Segment-IG, SmoothGrad), CNNs for Recognition, Verification, Detection, Segmentation: CNNs for Recognition and Verification (Siamese Networks, Triplet Loss, Contrastive Loss, Ranking Loss); CNNs for Detection: Background of Object Detection, R-CNN, Fast R-CNN, Faster R-CNN, YOLO, SSD, RetinaNet; CNNs for Segmentation: FCN, SegNet, U-Net, Mask-RCNN		**9**
	UNIT III: CNN + RNN Models for Video Understanding: Spatio-temporal Models, Action/Activity Recognition. Attention Models: Introduction to Attention Models in Vision; Vision and Language: Image Captioning, Visual QA, Visual Dialog; Spatial Transformers; Transformer Networks.		**9**
	UNIT IV: Deep Generative Models: Review of (Popular) Deep Generative Models: GANs, VAEs; Other Generative Models: PixelRNNs, NADE, Normalizing Flows, etc Variants and Applications of Generative Models in Vision: Applications: Image Editing, Inpainting, Superresolution, 3D Object Generation, Security; Variants: CycleGANs, Progressive GANs, StackGANs, Pix2Pix, etc, Recent Trends: Zero-shot, One-shot, Few-shot Learning; Self-supervised Learning; Reinforcement Learning in Vision; Other Recent Topics and Applications		**9**

Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%

Curriculum in Detail (Laboratory Subjects)

Course Code: ECEM 515	**Open course (YES/NO)**	**HM Course (Y/N)**	**DC (Y/N)**	**DE (Y/N)**	
	No	No	Yes	No	
Type of course	Lab		Core Engineering Course		
Course Title	**COMMUNICATION LABORATORY -I**				
Course Coordinator					
Course objectives:	Represent discrete-time signals analytically and visualize them in the time domain. Understand the Transform domain and its significance and problems related to computational complexity. Be able to specify and design any digital filters using MATLAB, implement the digital modulation using DSP/FPGA kits. Able to analyze speech and bio signals.				
Semester	**Autumn: No**		**Spring: Yes**		
	Lecture	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours	0	0	6	3	**36**
Prerequisite course code as per proposed course numbers					
Prerequisite credits					
Equivalent course codes as per proposed course and old course					
Overlap course codes as per proposed course numbers					
Text Books:					
1.	Title	Digital Signal Processing: A Computer-Based Approach			
	Author	S. K. Mitra			
	Publisher	McGraw-Hill			
	Edition	Third edition, 2006			
2.	Title	Discrete-Time Signal Processing			
	Author	A. Oppenheim and R. Schafer			
	Publisher	Prentice Hall			
	Edition	Second edition, 1999			
3	Title	Digital Signal Processing and Applications with the TMS320C6713 and TMS320C6416 DSK			
	Author	RulphChassaing			
	Publisher	Wiley			
	Edition	2nd			

4.	Title	Digital Signal Processing: Principles, Algorithms and Applications
	Author	J. Proakis, D. Manolakis
	Publisher	Prentice-Hall
	Edition	4th edition, 2006
5.	Title	Computer-Based Exercises for Signal Processing Using MATLAB 5
	Author	J. McClellan (Ed.)
	Publisher	Prentice Hall
	Edition	1997
6.	Title	Understanding Digital Signal Processing
	Author	R. Lyons
	Publisher	Prentice-Hall
	Edition	1996
Reference Book:		
1.	Title	Theory and Application of Digital Signal Processing
	Author	L.R. Rabiner and B. Gold
	Publisher	Phi Learning
	Edition	1st Edition, 2008
Content	**Tentative List of experiments for Digital Signal Processing Laboratory:** • Basics of MATLAB-Realisation of Unit Impulse, Unit Step & Unit Ramp signals. • To create user function for performing signal operation: folding, Shifting, signal addition and continuous and discrete time scaling. Response of LTI Systems • Linear & Circular Convolution of two Sequences, Correlation of two sequences. • Study of Floating-Point Digital Signal Processor &Fixed-Point Digital Signal Processor. • Realisation of Circular & Linear Convolution and Correlation of two sequences. • DFT & IDFT Computation. • Computation of DFT & IDFT of a given Sequence using DSP Processors. • Radix-2 & Radix-4 algorithm FFT Calculation using DSP Processors. • FIR & IIR Filter Implementation using the DSP Processors. • Implementation of Digital modulation techniques using DSK/FPGA kits. • Experiments on pitch detection schemes, speech analysis • To remove various artifacts and noises in EEG signals using Discrete Wavelet thresholding techniques. • Classification of EEG signals	
Course Assessment	Lab: Continuous Evaluation 50% Lab: End Semester Lab Exam 50%	

Course Code: ECEM 565	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)	
	No	No	Yes	No	
Type of course	Lab		Core Engineering Course		
Course Title	**COMMUNICATION LABORATORY -II**				
Course Coordinator					
Course objectives:	To understand the Transform domain and its significance and problems related to computational complexity. Be able to specify and design any digital filters using MATLAB, implement the digital modulation using DSP processors. Able to deal with the bio signals and processing of those signals.				
Semester	**Autumn: No**		**Spring: Yes**		
	Lecture	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours	0	0	6	3	**36**
Prerequisite course code as per proposed course numbers					
Prerequisite credits					
Equivalent course codes as per proposed course and old course					
Overlap course codes as per proposed course numbers					

Text Books:		
1.	Title	Digital Signal Processing: A Computer-Based Approach
	Author	S. K. Mitra
	Publisher	McGraw-Hill
	Edition	Third edition, 2006
2.	Title	Discrete-Time Signal Processing
	Author	A. Oppenheim and R. Schafer
	Publisher	Prentice Hall
	Edition	Second edition, 1999
3.	Title	Schaum's Outline of Digital Signal Processing
	Author	M. Hays
	Publisher	McGraw-Hill
	Edition	1999
4.	Title	Digital Signal Processing: Principles, Algorithms and Applications
	Author	J. Proakis, D. Manolakis
	Publisher	Prentice-Hall

	Edition	4th edition, 2006
5.	Title	A Course in Digital Signal Processing
	Author	B. Porat
	Publisher	J. Wiley and Sons
	Edition	1996
6.	Title	Computer-Based Exercises for Signal Processing Using MATLAB 5
	Author	J. McClellan (Ed.)
	Publisher	Prentice Hall
	Edition	1997
7.	Title	Understanding Digital Signal Processing
	Author	R. Lyons
	Publisher	Prentice-Hall
	Edition	1996
8	Title	Digital Signal Processing and Applications with the TMS320C6713 and TMS320C6416 DSK
	Author	RulphChassaing
	Publisher	Wiley
	Edition	2nd
Reference Book:		
1.	Title	Theory and Application of Digital Signal Processing
	Author	L.R. Rabiner and B. Gold
	Publisher	Phi Learning
	Edition	1st Edition, 2008
Content	**Tentative List of experiments for Digital Signal Processing Laboratory:** • Basics of MATLAB-Realization of Unit Impulse, Unit Step & Unit Ramp signals. • To create user function for performing signal operations for communication. • Denoising of speech signals. • Study of Floating-Point Digital Signal Processor & Fixed-Point Digital Signal Processor. • Efficient computation of DFT &IDFT . • FIR & IIR Filter Implementation using the using TMS320C6713 DSK. • Implementation of Digital modulation techniques using TMS320C6713 DSK. • Experiments on image enhancement, edge detection. • Bio signal processing-based experiments. • To extract various time domain features like sum, energy, standard deviation, and variance of EEG signals. • To extract various hybrid time-frequency domain features of EEG signal using wavelet transform. • To classify the EEG signals using various Machine learning classifiers like SVM, Logistic regression, Decision Trees, Random Forest and plot the performance metrics like Accuracy, Precision, Recall, Specificity, Sensitivity. • To classify the EEG signals using Recurrent Neural Networks like long short term memory (LSTM), and gated recurrent unit (GRU) and plot the performance metrics like Accuracy, Precision, Recall, Specificity, Sensitivity. ▪ RRM/BPM/HRM/Pulse Oximeter based experiments ▪ RRM,BIA based experiments ▪ Ultra sound HRM based experiments	
Course Assessment	Lab: Continuous Evaluation 50% Lab: End Semester Lab Exam 50%	

Course Code: ECEM 516	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)	
	No	No	Yes	No	
Type of course	Lab		Core Engineering Course		
Course Title	**FIBRE OPTICS LABORATORY**				
Course Coordinator					
Course objectives:	To expose the students to the basics of signal propagation through optical fibers, fiber impairments, components, devices and systems design.				
Semester	**Autumn: No**		**Spring: Yes**		
	Lecture	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours	0	0	6	3	**36**
Prerequisite course code as per proposed course numbers					
Prerequisite credits					
Equivalent course codes as per proposed course and old course					
Overlap course codes as per proposed course numbers					
Text Books:					
1.	Title	Optical fiber communications: principles and practice			
	Author	John. M. Senior			
	Publisher	Prentice Hall			
	Edition	Third edition, 2006			
2.	Title	Optical fiber communications			
	Author	Gerd Keiser			
	Publisher	McGrawHill			
	Edition	Third edition,			
3.	Title	Fiber Optic Communication Systems			
	Author	G.PAgrawal			
	Publisher	Johannian and Sons			
	Edition	1999			
	Publisher	Phi Learning			
	Edition	1st Edition, 2008			

Content	**Tentative List of experiments for Fibre Optics Laboratory:** • To study the basic structure and types of the optical fiber • To measure the numerical aperture (NA) of the different cables provided • To measure the optical power emitted by the LED. • To observe the attenuation & coupling loss in optical fiber. • Describe the operational characteristics and parameters of Photo diode used as photo detector in fiber optics ystem. • To check the transmission characteristic of LED & laser source. • To carry out measurement on digital communication systems. • To become familiar with different types of multiplexing techniques. • To carry out an audio +video communication system consisting of: audio and video source; audio video multiplexer and de-multiplexer; analog transmitter and receiver on optical fiber.
Course Assessment	Lab: Continuous Evaluation 50% Lab: End Semester Lab Exam 50%

Course Code: ECEM 517	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)	
	No	No	Yes	No	
Type of course	Lab		Core Engineering Course		
Course Title	**VLSI DESIGN LABORATORY**				
Course Coordinator					
Course objectives:	To introduce the relevance of this course to the existing technology through demonstrations, case studies, simulations, contributions of scientist, national/international policies with a futuristic vision along with socio-economic impact and issues. To learn the fundamental principles of VLSI circuit design in digital and analog domain, Digital circuit design suing VHDL/Verilog and Design using FPGAs.				
Semester	**Autumn: No**		**Spring: Yes**		
	Lecture	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours	0	0	6	3	**36**
Prerequisite course code as per proposed course numbers					
Prerequisite credits					
Equivalent course codes as per proposed course and old course					
Overlap course codes as per proposed course numbers					
Text Books:					
1.	Title	SPICE manual, IRSIM manual, MAGIC manual			
	Author				
	Publisher				
	Edition				
2.	Title	Xilinx Corporation, "FPGA Technology for Nineties" Xilinx Handbook, 1992.			
	Author				
	Publisher				
	Edition				
Content	• Combinational and Sequential logic circuit design implementation. • Frequency Response of CE, CB, CC and CS amplifiers, Darlington Amplifier, Differential Amplifiers - Transfer characteristic, CMRR Measurement, Cascode / Cascade amplifier. • Two case studies and one minor proj				

Course Assessment	Lab: Continuous Evaluation 50% Lab: End Semester Lab Exam 50%

Course Code: ECEM 566	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)	
	No	No	Yes	No	
Type of course	Lab		Core Engineering Course		
Course Title	**VLSI DESIGN WITH CAD TOOLS**				
Course Coordinator					
Course objectives:	To introduce the relevance of this course to the existing technology through demonstrations, case studies, simulations, contributions of scientist, national/international policies with a futuristic vision along with socio-economic impact and issues. To learn the fundamental principles of VLSI circuit design in digital and analog domain, Digital circuit design using Cadence virtuoso tool.				
Semester	**Autumn: No**		**Spring: Yes**		
	Lecture	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours	0	0	6	3	**36**
Prerequisite course code as per proposed course numbers					
Prerequisite credits					
Equivalent course codes as per proposed course and old course					
Overlap course codes as per proposed course numbers					
Text Books:					
1.	Title	Cadence virtuoso manual			
2.	Title	CMOS Digital Integrated Circuits: S. M. Kang			
Content	• CMOS-inverter implementation. • Half adder, full adder, half subtractor, and full subtractor implementation. • Current mirror, differential amplifier, CE, CB, and CC amplifier circuit implementation				
Course Assessment	Lab: Continuous Evaluation 50% Lab: End Semester Lab Exam 50%				