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.

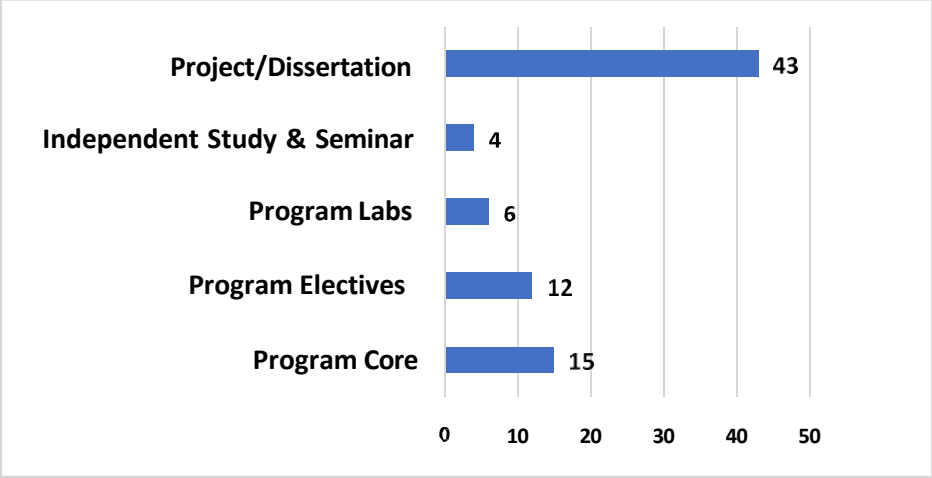
2.5 Program Outcomes (POs)

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

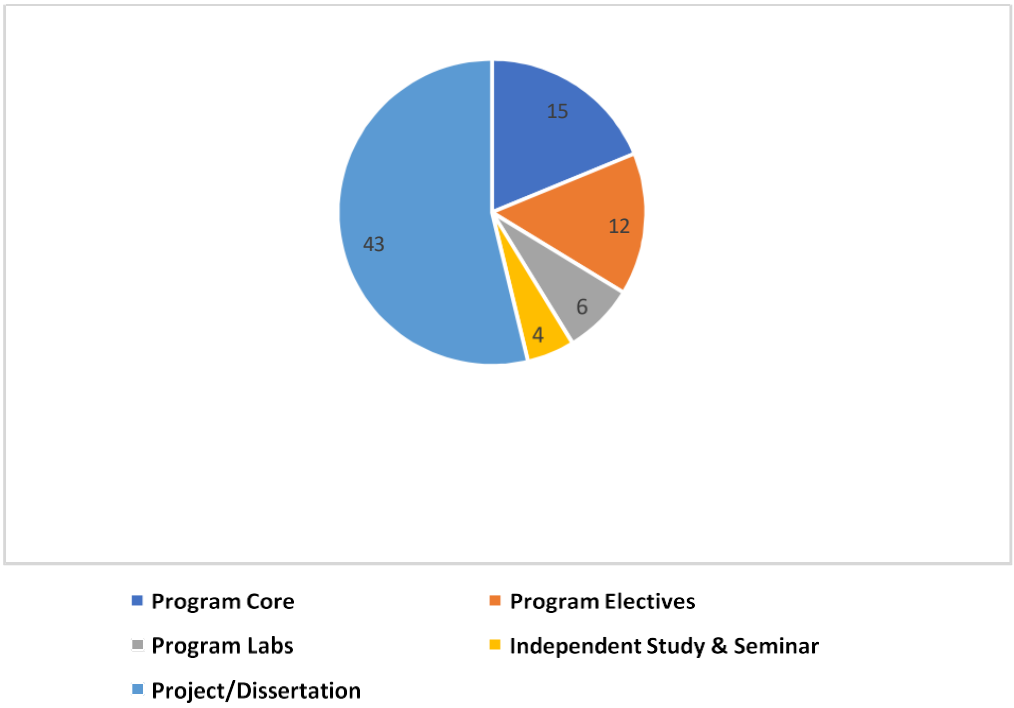


3.2 Semester wise Credit Structure

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 604	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 654	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 512	Nano Electronics & Nano Photonics	3	0	0	3	
13.	ECEM 513	Image and Video Compression	3	0	0	3	
14.	ECEM 514	Video Processing and Communications	3	0	0	3	
15.	ECEM 519	Data Communication and Networking					
16.	ECEM 551	Advanced Photonic Devices	3	0	0	3	Core IV + Core V
17.	ECEM 552	Embedded Core Design	3	0	0	3	
18.	ECEM 553	Advanced Wireless Communication Networks	3	0	0	3	
19.	ECEM 554	Solid State Microwave Devices	3	0	0	3	
20.	ECEM 555	Statistical Signal Analysis	3	0	0	3	
21.	ECEM 556	Modelling and Simulation	3	0	0	3	
22.	ECEM 557	Advanced Numerical Analysis	3	0	0	3	
23.	ECEM 558	Advanced Mathematics	3	0	0	3	
24.	ECEM 559	Organic Electronics	3	0	0	3	
25.	ECEM 560	Nano Materials	3	0	0	3	
26.	ECEM 561	Advanced Image Processing	3	0	0	3	
27.	ECEM 562	Lasers and Opto-electronics	3	0	0	3	
28.	ECEM 563	Bio-Imaging and Bio-Signal Processing	3	0	0	3	
29.	ECEM 564	Mathematical Methods for signal processing	3	0	0	3	
30.	ECEM 567	Visual Signal Processing	3	0	0	3	
31.	ECEM 568	Wireless and Adhoc Networks	3	0	0	3	
32.	ECEM 569	Optical Signal 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 531	Introduction to Plasmonics and Meta-materials	3	0	0	3	
12.	ECEM 532	Optical, electronic & photonic Properties of Nanostructures	3	0	0	3	
13.	ECEM 533	Computer Vision for Signal Processing	3	0	0	3	
14.	ECEM 534	Deep Learning and AI for Signal Processing	3	0	0	3	
15.	ECEM 570	Testing and Verification of VLSI Circuits	3	0	0	3	Elective III + Elective IV
16.	ECEM 571	Nano magnetism and Spintronics	3	0	0	3	
17.	ECEM 572	Computer Aided Design of VLSI Circuits	3	0	0	3	
18.	ECEM 573	Artificial Neural Networks	3	0	0	3	
19.	ECEM 574	Computational Electromagnetics	3	0	0	3	
20.	ECEM 575	Wavelets	3	0	0	3	
21.	ECEM 576	Microelectronics Chip Design	3	0	0	3	
22.	ECEM 577	Telematics	3	0	0	3	
23.	ECEM 578	Free Space Optical Networks	3	0	0	3	
24.	ECEM 579	Semiconductor Optoelectronics	3	0	0	3	
25.	ECEM 580	Low Power VLSI Design	3	0	0	3	
26.	ECEM 581	OFDM for Wireless Communication	3	0	0	3	
27.	ECEM 582	Carbon Nanotubes and Carbon Nano Structures	3	0	0	3	
28.	ECEM 583	Deep Learning and Computer Vision	3	0	0	3	
29.	ECEM 584	Photonics Materials & Devices for Communications	3	0	0	3	
30.	ECEM 585	Biomedical Signal Analysis	3	0	0	3	
31.	ECEM 586	Deep Learning for Computer Vision	3	0	0	3	
32.	ECEM 587	Deep Learning for Imaging	3	0	0	3	
33.	ECEM 588	Machine Learning for Computer Vision	3	0	0	3	

Curriculum in Detail (Core Subjects)

Course Code: ECEM 501	**Open Elective Course: (Y/N)**	**HM Course: (Y/N)**	**DC Course: (Y/N)**	**DE Course: (Y/N)**
	No	No	Yes	No
Type of Course	Theory Course			
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.			
Course Outcomes				**Cognitive Levels**
CO1	To describe the basic building blocks of a digital communication system and understand the concept of sampling and bandwidth. Revision of Communication channels, their characteristics and mathematical modeling. Uniform & Non-uniform Quantization, Error probability calculations			Remembering (Level 1) Understanding (Level II)
CO2	To analyze binary and multi-level digital modulation techniques, their comparison, design of optimum receivers for AWGN Channels, carrier and symbol synchronization. Design and analysis of Match Filter			Analyzing (Level IV) Creating (Level VI)
CO3	To implement the concept of equalizers in the communication system and analyze the performance of receivers in presence of equalizers, Linear and Adaptive equalization, decision feedback equalizer, ISI			Applying (Level III) Analyzing (Level IV)
CO4	To explain and discuss Spread spectrum communication systems, characterization of fading multipath channels, Channel coding, Channel capacity theorems, determine the performance using linear codes.			Understanding (Level II) Evaluating (Level V)
Semester	**1st**		**Autumn**	
Contact Hours	**Lecture**	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
	3	0	0	3	36
Prerequisite course codes with course names	Signal and Systems, Communication Systems, Digital Communication			
Equivalent course codes as per proposed course and old course	-			

Text Books		
1.	Title	Digital Communication
	Author	John G. Proakis and Masoud Salehi
	Publisher	Mc Graw-Hill Education
	Edition	5th Edition, 2007.
2.	Title	Digital Communication: Fundamental and applications
	Author	Bernard Sklar and Pabitra Kumar Ray
	Publisher	Pearson Education

	Edition	3rd Edition, 2021	
3.	Title	Fundamentals of digital Communication	
	Author	Upamanyu Madhow,	
	Publisher	Cambridge University Press	
	Edition	2008	
Reference Books			
1.	Title	Communication Systems	
	Author	Simon Haykins	
	Publisher	John Wiley & Sons	
	Edition	4th Edition, 2006	
2.	Title	Electronic Communication Systems	
	Author	Wayne Tomasi	
	Publisher	Pearson Education	
	Edition	4th Edition	
Course Contents	**UNIT I:** Waveform and Line Coding Techniques: Elements of Digital Communication System; Review of Communication Channels, their characteristics, Linear quantizer, Quantization SNR calculations, non-uniform quantizer, PCM, DPCM, DM, Error probability calculations, baseband shaping for data and mathematical modelling.		**07**
	UNIT II: Digital Modulation Techniques and Optimum Receivers: Digital binary level and multi-level Modulation schemes, Bits vs. Symbol error probability and bandwidth efficiency, Comparison of QPSK, MSK techniques, Probability of error calculation for M-ary systems, Optimum receivers for AWGN channels, Carrier and symbol synchronization, Matched Filter		**07**
	UNIT III: Equalization and Diversity: Sampling of band pass signals with problem solving sessions, Characterization of band limited channels, Inter symbol Interference, Concept of Equalization, Types of equalizers, Linear equalization, adaptive linear equalization, adaptive decision feedback equalizer. Types of Diversity, receiver and transmitter diversity, Diversity-Interference trade-off		**07**
	UNIT IV: Spread Spectrum Modulation and Channel Coding: Model of Spread spectrum communication systems, direct sequence spread spectrum, Frequency hopped spread spectrum, Channel coding concept and channel capacity theorems, types of channel coding, Liner Block codes, cyclic codes, Huffman Coding		**07**
Course Assessment	Theory: Continuous Evaluation 25% Mid Semester 25% End Semester Examination 50% Laboratory: Continuous Evaluation 50% End Semester Examination 50%		
Laboratory	Experiments based on All Theory Topics. Study and Analysis of Sampling; Waveform coding techniques; Modulation Techniques; Spread Spectrum Techniques.		

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, 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.			

Course Outcomes		Cognitive Levels
CO1	Attain the knowledge of basic optical fiber communication systems and learn the latest trends in optical communications	Remembering (Level 1) Understanding (Level II)
CO2	Recognize and classify the structures, types and channel impairments like losses and dispersion in optical fibers	Analyzing (Level IV) Creating (Level VI)
CO3	Classify optical sources and detectors and analyze various coupling losses	Applying (Level III) Analyzing (Level IV)
CO4	Understand the design issues in deploying an optical communication system	Understanding (Level II) Evaluating (Level V)

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:** **05** 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:** **05** 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:** **05** Optical Components: Couplers, isolators, multiplexers and filters, optical amplifiers, wavelength converters, optical Transmitters and Detectors, LEDs, lasers, Tunable lasers, photo detectors, switch **Unit IV:** **05** 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:** **05** 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 Examination 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 introduce the concepts in analog circuit design relevant to CMOS IC design and to equip students with skills to design and analyze CMOS-based circuits and performance trade-offs.			

Course Outcomes		**Cognitive Levels**
CO1	Understanding the MOS Operation and small signal models	Remembering (Level 1) Understanding (Level II)
CO2	To analyze single-stage amplifiers with different loads.	Analyzing (Level IV) Creating (Level VI)
CO3	To design one, two-stage operational amplifiers and VCO Circuits	Applying (Level III) Analyzing (Level IV)
CO4	Understanding the role of feedback in amplifiers.	Understanding (Level II) Evaluating (Level V)

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	Behzad Razavi			
	Publisher	Tata McGraw Hill			
	Edition	2005.			
3.	Title	CMOS Mixed Signal Circuit Design			
	Author	Jacob Baker			
	Publisher	Wiley India Pvt. Limited			
	Edition	2008			
Reference Books:					
1.	Title	Design of Analog Integrated Circuits and Systems			
	Author	Kenneth R. Laker, Willy M.C. Sansen			
	Publisher	Tata McGraw-Hill Companies			
	Edition	1994.			

Content	**Unit I:** **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. **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, VCO Circuit design, phase-locked loop (PLL), delay-locked loop (DLL).
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%

Course Code	Course Name	Periods			Credits	Hours
		L	T	P		
ECEM 507	**ADVANCED DIGITAL SIGNAL PROCESSING**	3	0	0	3	**36**
Pre-Requisite Courses:	Digital Signal Processing					
Course Objective	To equip students with a comprehensive understanding of digital signal processing (DSP) concepts, including discrete Fourier transform, filter design, multirate processing, and spectrum estimation, enabling them to analyze and design efficient DSP systems for real-world applications.					

Course Outcomes		**Cognitive Levels**
CO1	To introduce efficient computation method of discrete Fourier, transform for a wide range of applications.	Level-IV (Analyzing)
CO2	To study about the designing techniques of digital filters and their structures with applications.	Level-VI (Creating)
CO3	Acquire the basics of multirate digital signal processing and their applications.	Level-II (Understanding)
CO4	To study the optimum filtering and power spectrum estimation techniques and apply them for signal processing applications.	Level-III (Applying)

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 Books:		
1.	Title	Theory and Application of Digital Signal Processing
	Author	L.R. Rabiner and B. Gold
	Publisher	Phi Learning
	Edition	First edition, 2008

Course Contents

Unit I: **09**

Introduction to DSP and Discrete Fourier Transform: Review of Discrete time signals and systems, Sampling, z-transform, 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 II: **09**

Design of FIR and IIR filters: Design of digital IIR filters, Design of digital FIR filters, Filter Structures, frequency transformations.

Unit III: **09**

	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 IV:** **09** **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)**	**3DC (Y/N)**	**DE (Y/N)**
	No	**No**	**No**	**Yes**
Type of Course	Theory			
Course Title	**VLSI TECHNOLOGY AND DESIGN**			
Course Coordinator				

Course objectives:	The course helps the students to understand the fabrication steps and design concepts of VLSI.				
Course Outcomes				**Cognitive Levels**	
CO1	To understand the various techniques involved in the VLSI fabrication process.			Level-IV (Analyzing)	
CO2	To understand the mechanism of diffusion and oxidation process.			Level-VI (Creating)	
CO3	To understand the different lithography methods and etching process.			Level-II (Understanding)	
CO4	To analyzes and design the CMOS based circuits.			Level-III (Applying)	
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:** **9** 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:** **9** Lithography: Basic steps in lithography; lithography techniques lithography, electron beam lithography, x-ray lithography, ion beam lithography; resists and mask preparation of respective lithographies, printing techniques, proximity printing and projection printing; merits and demerits of lithographies; 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:** **9** Diffusion and Ion Implantation: Diffusion mechanisms; diffusion reactor; diffusion profile; diffusion kinetics; parameters affecting diffusion profile; Dopants and their behavior, choice of dopants; Ion Implantation, channeling 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:** **9** 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	**Course Name**	**Periods**			**Credits**	**Hours**
		L	**T**	**P**		
ECEM 512	**NANO-ELECTRONICS & NANO-PHOTONICS**	3	0	0	3	36
Pre-Requisite Courses:	Solid State Devices and Applications, Optical Fibre Communication					
Course Objective	This course is intended to cover basics of electronics, transistor, band structure models, nanocapacitors, coulomb blockade, single electron transistor and nanophotonic					
Course Outcomes						Cognitive Levels
CO1	To know nanoelectronics holds the capacity for mass production of high-quality nanodevices with an enormous variety of applications from computers to biosensors, from cell phone to space shuttles and from large display screens to small electronic toys.					Remembering (Level - I)
CO2	To know the scaling of transistors and other devices to smaller and smaller sizes, which has provided the basis for this exponential growth, has limits, physical (size of the atoms), technological (lithography) and economic, which will be reached					Understanding (Level - II)

	by nanoelectronics in the next coming decade.	
CO3	In the near future from photonics, molecular electronics or revolutionary engineering solutions, such as departure from two-dimensional ICs on the surface of silicon wafers to three-dimensional structures. All these gigantic challenges and potential nanotechnology solutions are actively debated	Analyzing (Level-IV)
CO4	To apply and simulate various nano-electronic and nano-photonic structures and to study their behaviors.	Applying (Level - III)
Course Content	**Unit I:** **09** Free Electron Theory & The New Ohm's Law: Why Electrons flow, Classical free electron theory, Sommerfeld's theory, The quantum of conductance, Coulomb blockade, Towards Ohm's law. The Elastic Resistor: Conductance of an Elastic Resistor, Elastic Resistor- Heat dissipation. **Unit II:** **09** Materials for nanoelectronics: Semiconductors, Crystal lattices: bonding in crystals, Electron energy bands, Semiconductor heterostructures, Lattice-matched and paedomorphic heterostructures, Inorganic nanowires, Organic semiconductors, Carbon nanomaterials: nanotubes and fullerenes. **Unit III:** **09** Ballistic and Diffusive Transport: Ballistic and Diffusive Transfer Times, Channels for Conduction Conductivity, Conductivity: E(p) or E(k) Relations, Counting States, Drude Formula, Quantized Conductance, Electron Density -Conductivity **Unit IV:** **06** Electron transport in semiconductors and nanostructures: Time and length scales of the electrons in solids, Statistics of the electrons in solids and nanostructures, Fermi statistics for electrons, the density of states of electrons in nanostructures, Electron transport in nanostructures. **Unit V:** **03** Electrons in traditional low-dimensional structures: Electrons in quantum wells: Single modulation-doped heterojunctions, Numerical analysis of a single heterojunction, Control of charge transfer, Electrons in quantum wires, Electron transport in quantum wires, Electrons in quantum dots.	
Book	Introduction to Nano Science and Technology by S.M. Lindsay. Supriyo Dutta -Lessons from Nanoscience: A Lecture Note Series, World Scientific (2012). Supriyo Dutta --Quantum Transport- Atom to Transistor, Cambridge University Press (2005). Introduction to Nanoelectronics: Science, Nanotechnology, Engineering & Applications by Vladimir.V. Mitin.	
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%	

Course Code: ECEM 513	Open Elective Course: (Y/N)	HM Course: (Y/N)	DC Course: (Y/N)	DE Course: (Y/N)
	N	Y	N	N
Type of Course	Theory Course/ Lab Course			
Course Title	**IMAGE AND VIDEO COMPRESSION**			
Course Coordinator				
Course Objectives	To study the advanced video coding and compression techniques for efficient representation and processing of video signals.			

Course Outcomes		**Cognitive Levels**
CO1	Discuss video encoding and Waveform-based encoding techniques.	Remembering (Level - I)
CO2	Illustrate distinct image and video encoding approaches.	Understanding (Level - II)
CO3	Analysing and extraction of relevant features of the concerned domain problem.	Analyzing (Level-IV)
CO4	Apply the knowledge in solving high level vision problems like Distributed Video Coding and Stereo and Multiview video processing, etc.	Applying (Level - III)

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	35				

Text Books

1.	Title	Video Processing and Communications
	Author	Yao Wang, Joern Ostermann, and Ya-Qin Zhang
	Publisher	Prentice Hall

	Edition	2002	
2.	Title	Digital Video Processing	
	Author	M. Tekalp	
	Publisher	Prentice Hall, 1995	
	Title	Computer Vision: Algorithms and Applications	
	Author	Richard Szeliski	
	Publisher	Springer	
	Edition	II Edition	
Reference Books			
1.	Title	*The Image Processing Handbook*	
	Author	*J.C. Russ*	
	Publisher	CRC Press; 6th edition	
	Edition	2011	
Course Contents	**UNIT I:** Fundamental of video coding: Coding Systems, Entropy, Lossy and Lossless Coding, Exploiting Statistical Dependence, Binary Encoding (Arithmatic and Huffman), Scalar Quantization, Scalar and Vector Quantization . Waveform-based coding: transform coding, predictive coding. Video coding: motion compensated prediction and interpolation, block-based hybrid video coding.		**07**
	UNIT II: JPEG and JPEG -2000 Standard, 3D Video Coding: 3D Cinema, Stereo Video, Disparity, Autostereoscopic Displays, 3D Video Coding for Stereo Displays, 3D Video Coding for Autostereoscopic Displays.		**07**
	UNIT III: Video compression standards (H.261 and H.263, MPEG1, MPEG2, MPEG4, H.264/AVC, H.264/SVC,H.265/HEVC, AVS), Subband Video Coding: Hybrid video coding with motion-compensated prediction, Temporal DPCM is challenging when aiming for z transmission over lossy channels and z scalable video representations Alternative technique: Subband Video Coding,		**07**
	UNIT IV: Distributed Video Coding: Lossless and lossy compression with receiver side information, Shifting the complexity of video encoding to the decoder, Error-resilient video transmission. Stereo and multiview video processing, Error control in video communications and video streaming over Internet and wireless networks, Video quality assessment.		**07**
Course Assessment	Theory: Continuous Evaluation 25% Mid Semester 25% End Semester Examination 50%		

Course Code: ECEM 514	Open Elective Course: (Y/N)	HM Course: (Y/N)	DC Course: (Y/N)	DE Course: (Y/N)
	N	Y	N	N
Type of Course	Theory Course/ Lab Course			
Course Title	**VIDEO PROCESSING AND COMMUNICATIONS**			
Course Coordinator				
Course Objectives	Overview of fundamental theory and techniques for efficient representation and processing of video signals.			

Course Outcomes		**Cognitive Levels**
CO1	Understand the Basic concepts of Video Processing and its Applications.	Remembering (Level - I)
CO2	Analyzing and extraction of relevant features of the concerned domain problem.	Understanding (Level - II)
CO3	Deduce the distinct compression and encoding techniques.	Analyzing (Level-IV)
CO4	Understand and apply the video compression and its relevance in real time applications	Applying (Level - III)

Semester	**1st, 2nd, 3rd etc**	**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	Video Processing and Communications
	Author	Yao Wang, Joern Ostermann, and Ya-Qin Zhang
	Publisher	Prentice Hall
	Edition	2002
2.	Title	Digital Video Processing
	Author	M. Tekalp
	Publisher	Prentice Hall, 1995
	Title	Computer Vision: Algorithms and Applications
	Author	Richard Szeliski
	Publisher	Springer
	Edition	II Edition
Reference Books		
1.	Title	The Image Processing Handbook
	Author	J.C. Russ
	Publisher	CRC Press; 6th edition

	Edition	2011	
Course Contents	**Unit I:** Basics of analog and digital video, Frequency domain analysis of video signals, spatial and temporal frequency response of the human visual system: Multidimensional Continuous and Discrete -Space Signals and Systems, Frequency Domain Characterization of Video Signals and Response of the Human Visual System. Video sampling: Basics of the Lattice Theory, Sampling over Lattices, Sampling of Video Signals, Filtering Operations in Cameras and Display Devices, Conversion of Signals Sampled on Different Lattices, Sampling Rate Conversion of Video Signals.		**07**
	Unit II: 2D-3D Video Modeling: Camera Model, Illumination Model, Object Model, Scene Model, Two-Dimensional Motion Models, Optical Flow, General Methodologies, Pixel-Based Motion Estimation, Block-Matching Algorithm, Deformable Block-Matching Algorithms and advanced techniques (mesh-based, global motion estimation, multi-resolution approach).		**07**
	Unit III: Basic compression techniques: information bounds for lossless and lossy source coding, binary encoding techniques (LZW, Arithmetic Coding) and scalar and vector quantization. Waveform-based coding: transform coding, predictive coding. Video coding: motion compensated prediction and interpolation, block-based hybrid video coding.		**07**
	Unit IV: Video compression standards (H.261 and H.263, MPEG1, MPEG2, MPEG4, H.264/AVC, H.264/SVC,H.265/HEVC, AVS) , Stereo and multiview video processing, Error control in video communications and video streaming over Internet and wireless networks, Video quality assessment.		**07**
Course Assessment	Theory: Continuous Evaluation 25% Mid Semester 25% End Semester Examination 50%		

Course Code	**ECEM 519**	**Semester - Even**		**Semester -** 2023 **Session** 2022- Month from Jan to June	
Course Name	**DATA COMMUNICATION AND NETWORKING**				
Credits	3		**Contact Hours**	36	
Faculty (Names)	**Coordinator(s)**				
	Teacher(s) (Alphabetically)				

Course no: ECLB 451	**Open course (YES/NO)**	**HM Course (Y/N)**	**DC (Y/N)**	**DE (Y/N)**
	No	No	Yes	No
Type of course	**Core Engineering Course**			
Course Coordinator				
Course objectives:	To Focus on information sharing and networks. • To Introduce flow of data, categories of network, and different topologies. • To Focus on different coding schemes. To build a strong understanding of the fundamental concepts of computer networking. Brief the students regarding protocols and standards. • To give a clear idea of signals, transmission media, errors in data communications and their correction, networks classes and devices ,etc.. Modern routing algorithms are introduced in this course. Deep understanding of Data links, Networks and Transport Layers ECB providing more focus on Internet and network performance.			
Semester	**Autumn: No**		**Spring: Yes**	

	Lecture	**Tutorial**	**Practical**	**Credits**	**Total Teaching Hours**
Contact Hours 48 Hours	3	0	0	3	**36**
Prerequisite course code as per proposed course numbers					
Prerequisite credits					
Equivalent course codes asper proposed course and old course					
Overlap course codes as per proposed course numbers					

Text Books:

1.	Title	Data and Computer Communications
	Author	William Stallings
	Publisher	Pearson
	Edition	TENTH EDITION

<table>
<tr><td rowspan="4">2.</td><td>Title</td><td>Computer Networks</td></tr>
<tr><td>Author</td><td>AS Tanenbaum, DJ Wetherall</td></tr>
<tr><td>Publisher</td><td>Prentice-Hall</td></tr>
<tr><td>Edition</td><td>5th Edition, 2010</td></tr>
<tr><td rowspan="4">3.</td><td>Title</td><td>Data Communication and Network</td></tr>
<tr><td>Author</td><td>Behrouz A. Forouzan</td></tr>
<tr><td>Publisher</td><td>McGraw Hill</td></tr>
<tr><td>Edition</td><td>5th Edition, 2012</td></tr>
<tr><td>Content</td><td colspan="2">UNIT I: 08
Introduction to data communication and networking: Why study data communication? Data Communication, Networks, Protocols and Standards, Standards Organizations. Line Configuration, Topology, Transmission Modes, Categories of Networks Internet works, history and development of computer networks, Basic Network Architectures: OSI reference model, TCP/IP reference model, and Networks topologies, types of networks (LAN, MAN, WAN, circuit-switched, packet-switched, message switched, extranet, intranet, Internet, wired, wireless)
UNIT II: 08
Study of Signals: Analog and Digital, Periodic and Aperiodic Signals, Analog Signals, Time and Frequency Domains , Composite Signals , Digital Signals, Physical layer: line encoding, block encoding, scrambling, and Different types of transmission media. Data Link Layer services: framing, error control, flow control, medium access control. Error & Flow control mechanisms: stop and wait, Go back N and selective repeat. MAC protocols: Aloha, slotted aloha, CSMA, CSMA/CD, CSMA/CA, polling, token passing, scheduling.
UNIT III: 08
Guided Media, Unguided Media, Transmission Impairments, Performance Wavelength , Shannon Capacity , Media Comparison, PSTN , Switching, Local Area Network Technology: Token Ring. Error detection (Parity, CRC), Ethernet, Fast Ethernet, Gigabit Ethernet, Personal Area Network: Bluetooth and Wireless Communications Standard: Wi-Fi (802.11) and WiMAX
UNIT IV: 12
Network layer: Internet Protocol, IPv6, ARP, DHCP, ICMP, Routing algorithms: Distance vector, Link state, Metrics, Inter-domain routing. Subnetting, Supernetting, Classless addressing, Network Address Translation.
UNIT V: 12
Introduction to networks and devices: Network classes,Repeaters, Hub, Bridges , Switches, Routers, Gateways Brouters Routing Algorithms, Distance Vector Routing , Link State Routing, Transport layer: UDP, TCP. Connection establishment and termination, sliding window, flow and congestion control, timers, retransmission, TCP extensions, Queuing theory, Single and multiple server queuing models, Little’s formula. Application Layer. Network Application services and protocols including e-mail, www, DNS, SMTP.</td></tr>
<tr><td>Course Assessment</td><td colspan="2">Continuous Evaluation 25%
Mid Semester 25%
End Semester 50%</td></tr>
</table>

Evaluation Criteria Components	
Midterm	25%
End Semester Examination	50%
continuous Evaluation:	25%

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 propose 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	Course Name	Periods			Credits	Hours
		L	T	P		
ECEM 553	ADVANCED WIRELESS COMMUNICATION NETWORKS	3	0	0	3	36
Pre-Requisite Courses:						
Course Objective	To equip students with foundational and advanced knowledge of wireless communication systems, including channel propagation, diversity techniques, MIMO systems, and next-generation wireless networks.					

Course Outcomes		Cognitive Levels
CO1	Explain wireless channel propagation phenomena, fading models, and link power budget analysis for understanding signal behavior in different environments.	Understanding (Level II)
CO2	Analyze diversity techniques for enhancing the performance of wireless communication systems in the presence of fading and interference.	Analyzing (Level IV)
CO3	Evaluate MIMO system architectures, including capacity, diversity gain, and space-time coding techniques, to improve system reliability and efficiency.	Evaluate – (Level V)
CO4	Examine the evolution of wireless networks, including 3G, 4G, and IEEE 802.11 WLANs, with a focus on their architecture, air interfaces, and key technologies.	Analyzing (Level IV)

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**: **07** 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:** **07** 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:** **07** 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:** **07** 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	Theory: Continuous Evaluation 25% Mid Semester 25% End Semester Examination 50% Laboratory: Continuous Evaluation 50% End Semester Examination 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%

Course Code	Course Name	Periods			Credits	Hours
		L	T	P		
ECEM 562	**LASERS AND OPTO-ELECTRONICS**	3	0	0	3	36
Pre-Requisite Courses:	Solid State Devices and Applications, Optical Fibre Communication					
Course Objective	To bring out the basics of opto-electronic properties and basic theory of LASERS as an application of these studied opto-electronic properties					

Course Outcomes		**Cognitive Levels**
CO1	To familiarize about the various opto-electronic properties.	Remembering (Level - I)
CO2	To bring out the basic principle of operation of semiconductor lasers.	Understanding (Level - II)
CO3	To implement the afore-mentioned opto-electronic properties in designing the structure of semiconductor lasers.	Analyzing (Level-IV)
CO4	To discuss applications and specific properties of semiconductor lasers.	Applying (Level - III)

Course Content

Unit I: **09**

Quantum Theory of Atomic Energy Levels – Radiative and Nonradiative decay of excited state atoms – Emission Broadening and linewidth – Radiation and Thermal equilibrium – Conditions for laser action – Laser Oscillation above threshold - Laser Amplifiers – Requirements for obtaining population inversion – Rate Equations for three and four level systems – Laser pumping requirements – Laser Cavity modes – Stable resonators – Gaussian beams- Special Laser Cavities – Q-switching and Mode locking – Generation of ultra-fast Optical pulses- Pulse compression.

Unit II: **09**

Atomic Gas Lasers – He-Ne, Argon ion, He-Cd — Molecular Gas Lasers – CO2, Excimer, Nitrogen—X-Ray Plasma Laser — Free-Electron Laser — Organic Dye lasers — Solid-state lasers – Ruby, Nd: YAG, Alexandrite, Ti:Sapphire.

Unit III: **09**

Electronic and Optical properties of semiconductors- electron-hole pair formation, PN Junction, diffusion, injection efficiency, quantum efficiency, homojunction and heterojunction, Excitation absorption, donor-acceptor and impurity band absorption, LED, Semiconductor lasers, Heterojunction Lasers, quantum well lasers, VCSEL, DFB and DBR Lasers.

Unit IV: **09**

Detection of Optical radiations – Basic Principle, Thermal detectors, Photo multipliers, photoconductive detectors, Photo diodes, Avalanche photodiodes, CCDs, Image Intensifiers, Arrays, Solar Cells, noise considerations.

Book	Laser Fundamentals – W.T. Silfvast, Second Edition, Cambridge University Press, 2004 Principles of Lasers – O. Svelto, Fourth edition, Springer, 1998 Photonics: Optical Electronics in Modern Communications – A. Yariv and P. Yeh, Sixth Edition, Oxford University Press, 2007 Semiconductor Optoelectronic devices – Pallab Bhattacharya, Prentice Hall of India, 1995 Semiconductor Optoelectronics – Jasprit Singh, Tata Mc Graw Hill, 1995 Optoelectronics - an Introduction – Wilson and Hawkes, Prentice Hall, 1998.
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%

Course Code	Course Name	Periods			Credits	Hours
		L	T	P		
ECEM 563	BIO-IMAGING AND BIO-SIGNAL PROCESSING	3	0	0	3	36
Pre-Requisite Courses:	Digital Signal Processing					
Course Objective	The objective of this course is to provide foundational knowledge and skills for signal and image processing with applications in bio-signal acquisition and medical imaging. Students will gain an understanding of digital filtering, Fourier analysis, and image processing techniques while exploring the practical applications of signal processing in medical diagnostics and imaging modalities.					
Course Outcomes					Cognitive Levels	
CO1	Explain the concepts of data acquisition, including sampling, aliasing, interpolation, and quantization.				Understanding (Level II)	
CO2	Analyze and design digital filters (FIR and IIR) for discrete-time systems.				Analyzing (Level IV)	
CO3	Apply the discrete Fourier transform (DFT) and fast Fourier transform (FFT) for spectral analysis of signals.				Applying (Level - III)	
CO4	Evaluate the effects of sampling and aliasing in time and frequency domains.				Analyzing (Level IV)	
Course Content	**Unit I:** **07** **Fundamentals of Deterministic Signal and Image Processing:** Data Acquisition: Sampling in time, aliasing, interpolation, and quantization. Digital Filtering: FIR and IIR filters, basic properties of discrete-time systems. FIR and IIR filter design. DFT: Sampling in frequency domain, the discrete Fourier transform and its properties, the fast Fourier transform (FFT). **Unit II:** **07** **Bio-Signal acquisition:** Basics of bio-signal acquisition systems like Electrocardiograph ECG: Cardiac electrophysiology, relation of electrocardiogram (ECG) components to cardiac events, clinical applications, Electroencephalograph (EEG), Electrogastrograph (EGG), Speech Signals: The source-filter model of speech production, spectrographic analysis of speech. Speech Coding, Analysis-synthesis systems, linear prediction of speech. **Unit III:** **06** **Image processing for bio-medical imaging:** Basics of image processing, Extension of filtering and Fourier methods to 2-D signals and systems. Interpolation, noise reduction methods, image enhancement, image segmentation, edge detection, homomorphic filtering. **Unit IV:** **07** **Survey of major modalities for medical imaging:** Image acquisition systems like X-ray, CT, MRI, PET, and SPECT. MRI: signal processing for magnetic resonance imaging. Surgical Applications: A survey of surgical applications of medical image processing.					
Books	**Textbooks** 1. Rangayyan, R.M., 2015. Biomedical signal analysis (Vol. 33). John Wiley & Sons. 2. 2. Reddy, D.C., 2005. Biomedical signal processing: principles and techniques. McGraw-Hill 3. Gonzalez, Woods, Eddins, Digital Image Processing using MATLAB, Gatesmark Publishing					

	4. L R Rabiner and RW Schafer, 1978. Digital Processing of Speech Signals, Prentice Hall **Reference Books** 1. Tompkins, W.J., 1993. Biomedical digital signal processing. Editorial Prentice Hall. 2. Sörnmo, L. and Laguna, P., 2005. Bioelectrical signal processing in cardiac and neurological applications (Vol. 8). Academic Press. 3. Anil K Jain, Fundamentals of Digital Image Processing, PHI Publication 4. D O'Shaughnessy, 1987. Speech Communication: Human and Machine, Addison Wesley
Course Assessment	Theory: Continuous Evaluation 25% Mid Semester 25% End Semester Examination 50%

Course Code: ECEM 564	Open Elective Course: (Y/N)	HM Course: (Y/N)	DC Course: (Y/N)	DE Course: (Y/N)
	N	Y	N	N
Type of Course	Theory Course/ Lab Course			
Course Title	**MATHEMATICAL METHODS FOR SIGNAL PROCESSING**			
Course Coordinator	Dr. Mahesh K Singh			
Course Objectives	Preferable in one or two lines in continuation without bullets and numbering			

Course Outcomes		**Cognitive Levels**
CO1	Understand the basic concept of linear algebra.	Understanding (Level II)
CO2	Analyse linear models through linear algebra concept.	Analyzing (Level IV)
CO3	Applying linear algebra concept to distinct data analysis.	Applying (Level - III)
CO4	Applying linear algebra concept to distinct system modelling.	Analyzing (Level IV)

Semester	**1st, 2nd, 3rd etc**	**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	Introductory Algebra: a real-world approach
	Author	Ignacio Bello
	Publisher	McGraw-Hill Higher Education
	Edition	4th
2.	Title	Linear Algebra and its Applications
	Author	Gilbert Strang
	Publisher	Cengage India Private Limited
	Edition	4th.
Reference Books		
1.	Title	Linear Algebra and Its Applications
	Author	David C. Lay
	Publisher	Pearson Education
	Edition	5th

Course Contents		
	Unit I: Vector spaces, subspaces and bases associated with a matrix, Orthogonal bases and orthogonal projections, Gram-Schmidt process, linear transformations, similarity transformations. Solution of linear system of equations, LU and QR decomposition, orthogonal and oblique projections, pseudo-inverse, singular value decomposition.	**12**
	Unit II: Linear models and least-squares problems, Eigenvalues and Eigenvectors, Symmetric and positive definite matrices. Functions on Euclidean space:	**12**

	Subsets of Euclidean space, Norms and inner product, Functions and continuity, Sequences and convergence	
	Unit III: Applications to data analysis: Regression, Principal component analysis, factor analysis, linear discriminant analysis, compressed sensing.	**12**
	Unit IV: Application to modelling: System identification, dimensionality reduction of a system of differential equations, Krylov subspace techniques, data-driven modelling.	**12**
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%	

Course Code: ECEM 567	Open Elective Course: (Y/N)	HM Course: (Y/N)	DC Course: (Y/N)	DE Course: (Y/N)
	N	Y	N	N
Type of Course	Theory Course/ Lab Course			
Course Title	**VISUAL SIGNAL PROCESSING**			
Course Coordinator				
Course Objectives	Preferable in one or two lines in continuation without bullets and numbering			

Course Outcomes		**Cognitive Levels**
CO1	Understanding the basic of the imaging system.	Understanding (Level II)
CO2	Illustrate distinct image transformation approaches.	Analyzing (Level IV)
CO3	Analyzing and extraction of relevant features of the concerned domain problem.	Applying (Level - III)
CO4	Apply the knowledge in solving high level Imaging problems like Image restoration and edge detection, etc.	Analyzing (Level IV)

Semester	**1st, 2nd, 3rd etc**	**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	Fundamentals of Digital Image Processing
	Author	A.K. Jain
	Publisher	Pearson Education India
	Edition	2015
2.	Title	Digital Image Processing And Analysis Computer Vision And Image Analysis
	Author	Scott E Umbaugh
	Publisher	CRC Press
	Edition	4 edt.
Reference Books		
1.	Title	Introduction to Video and Image Processing: Building Real Systems
	Author	Thomas B. Moeslund
	Publisher	Springer-Verlag New York Inc
	Edition	2012

Course Contents	**Unit I:** Basics: Applications of image processing. notion of pixel, resolution, quantization, photon noise, Geometric transformations, source-to-target and target-to-source mapping, planar and rotational homography, RANSAC for homography estimation, image registration, change detection, and image mosaicing. Motion blur: Exposure time, weighted frame integration, depth aware warping, spatio-temporal averaging, dynamic scenes.	**10**

	Unit II: Image Formation in Lens:Pin-hole versus real aperture lens model, lens as a 2D LSI system, blur circle, Doubly block circulant system matrix, pill box and Gaussian blur models, space invariant and space variant blurring.3D Shape from Focus: Depth of field, focal stack, focus operators, focus measure curve, Gaussian interpolation, 3D recovery, focused image recovery. Image Transforms: Data dependent and independent transforms, 1D Orthogonal transforms, Kronecker product, 2D orthogonal transforms from 1D, 2D DFT, 2D DFT for image matching, 2D DCT, Walsh-Haddamard transform, Karhunen-Loeve transform, eigen filters, PCA for face recognition, singular value decomposition, image denoising using SVD.	**14**
	Unit III: Photometric stereo: Normal estimation, depth reconstruction, uncalibrated PS, Generalized bas relief ambiguity. Image Enhancement: Thresholding methods (peak-valley, Otsu, Chow-Kaneko), histogram equalization and modification, Noise models, mean, weighted mean, median, weighted median, non-local means filter, BM3D, frequency domain filtering, illumination compensation by homomorphic filtering, segmentation by k-means clustering, higher-order statistics-based clustering.	**8**
	Unit IV: Image Restoration: Well-posed and ill-posed problems, Fredholm-integral equation, condition number of matrix, conditional mean, Inverse filter, Wiener filter, ML and MAP restoration, image super-resolution. Edge Detection: Gradient operators, Prewitt, Sobel, Roberts, compass operators, LOG, DOG, Canny edge detectors, non-maxima suppression, hysteresis thresholding.	**8**
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%	

Course Code: ECEM 568	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
	No	No	Yes	No
Type of Course	Theory			Elective Engineering Course
Course Title	**WIRELESS AND ADHOC NETWORKS**			
Course Coordinator				
Course objectives:	To familiarize the fundamentals of end to end and security aspects of Network and MAC layer in modern wireless Adhoc network. To design the protocols of different layers for given QoS.			

Course Outcomes		**Cognitive Levels**
CO1	To understand the challenges and constraints of wireless sensor network and its subsystems	Understanding (Level-II)
CO2	To examine the physical layer specification, modulation and transceiver design considerations	Analyzing (Level-IV)
CO3	To adapt and analyse the protocols used at the MAC layer and scheduling mechanisms	Application/Analysis (Level-III/Level-IV)
CO4	To evaluate and synthesize the application areas and practical implementation issues.	Evaluation/Synthesis (Level-V/Level-VI)

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					
Equivalent course codes as per proposed course and old course					
Overlap course codes as per proposedcourse numbers					

Text Books:		
1.	Title	Ad hoc Networking
	Author	Charles E. Perkins
	Publisher	Pearson Education. 2007
	Edition	Wesley, 2000nd Edition
2.	Title	Adhoc Wireless Networks Architectures and Protocols
	Author	C.Siva Ram Murthy and B.S. Manoj
Reference Books:		
3.	Title	Mobile Adhoc Networking
	Author	Stefano Basagni, Marco Conti, Silvia Giordano and Ivan Stojmenovic
	Publisher	Wiley-IEEE press

	Edition	2004
4.	Title	Cross Layer Design Optimization in Wireless Protocol Stacks
	Author	V.T. Raisinhani and S. Iyer
	Publisher	Comp. Communication
	Edition	Vol. 27 no. 8, 2004

Content	**Unit I:** **06** Introduction to adhoc networks – definition, characteristics features, applications. Characteristics of Wireless channel, Adhoc Mobility Models: - Indoor and outdoor models. **Unit II:** **09** MAC Protocols: design issues, goals and classification. Contention based protocols-with reservation, scheduling algorithms, protocols using directional antennas. IEEE standards: 802.11a, 802.11b, 802.11g, 802.15. HIPERLAN. **Unit III:** **09** Routing Protocols: Design issues, goals and classification. Proactive Vs reactive routing, Unicast routing algorithms, Multicast routing algorithms, hybrid routing algorithm, Energy aware routing algorithm, Hierarchical Routing, QoS aware routing. **Unit IV:** **09** Transport layer: Issues in designing- Transport layer classification, adhoc transport protocols. Security issues in adhoc networks: issues and challenges, network security attacks, secure routing protocols. **Unit V:** **09** Cross layer Design: Need for cross layer design, cross layer optimization, parameter optimization techniques, Cross layer cautionary prespective. Integration of adhoc with Mobile IP networks.
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%

Course Code: ECEM 569	Open course (YES/NO)	HM Course (Y/N)	DC (Y/N)	DE (Y/N)
	No	No	Yes	No

Type of course	Theory; Core Engineering Course
Course Title	**OPTICAL SIGNAL PROCESSING**
Course Coordinator	
Course objectives:	To introduce the basic principles required for the understanding of optical signal processing techniques.

Course Outcomes		**Cognitive Levels**
CO1	Understand basic concepts of light propagation, spatial frequency and Spectral analysis.	Remembering (Level-I)
CO2	To study and design different domain filtering techniques.	Understanding (Level - II)
CO3	Apply the transform domain approach for study of light behaviors.	Applying (Level –III)
CO4	Ability to develop optical filters, modulators and detectors for various applications of light processing	Analyzing (Level –IV)

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					
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 signal processing
	Author	Anthony Vanderlugt
	Publisher	Wiley-Interscience
	Edition	First Edition
2.	Title	Ultrafast All-Optical Signal Processing Devices
	Author	Hiroshi Ishikawa
	Publisher	Wiley
	Edition	First Edition, 2008
Reference Book:		
1.	Title	Optical data Processing-Applications
	Author	D. Casasent
	Publisher	Springer-Verlag, Berlin
	Edition	First Edition

2.	Title	Optical Signal Processing, Computing, and Neural Networks
	Author	Francis T. S. Yu, SugandaJutamulia
	Publisher	Krieger Publishing Company
	Edition	2nd Edition

Content	**Unit I:** **05** Characterization of a General signal, examples of signals, Spatial signal. Basic laws of geometrical optics, Refractions by mirrors, the lens formulas, General Imaging conditions, the optical invariant, Optical Aberrations. **Unit II:** **07** Physical optics: The Fresnel Transforms, the Fourier transform, Examples of Fourier transforms, the inverse Fourier transform Extended Fourier transform analysis, Maximum information capacity and optimum packing density, System coherence. **Unit III:** **08** Spectrum Analysis and Spatial Filtering: Light sources, spatial light modulators, The detection process in Fourier domain, System performance parameters, and Dynamic range. Some fundamentals of signal processing, Spatial Filters. **Unit IV:** **08** Binary spatial filters: Magnitude Spatial Filters, Phase Spatial Filters, Real valued Spatial Filters, Interferometry techniques for constructing Spatial Filters. Optical signal processor and filter generator, Applications for optical signal processing. Acousto-optic cell spatial light modulators: Applications of acousto-optic devices. Basic Acousto-optic power spectrum analyzer. Heterodyne systems: Interference between two waves, the optical Radio. Lab based on the topics in Theory.
Course Assessment	Theory: Continuous Evaluation 25% Mid Semester 25% End Semester Examination 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	Course Name	Periods			Credits	Hours
		L	T	P		
ECEM 524	SPEECH PROCESSING	3	0	0	3	36
Pre-Requisite Courses:	Digital Signal Processing					
Course Objective	To provide foundational knowledge and technical skills in speech processing, including analysis, synthesis, and applications, enabling learners to design and implement speech-based technologies effectively.					

Course Outcomes		Cognitive Levels
CO1	Explain the fundamentals of speech production, articulatory and acoustic phonetics, and digital signal processing concepts for speech.	Understanding (Level II)
CO2	Analyze speech signals using time and frequency domain techniques, and evaluate pitch, formant, cepstral, and LPC analysis methods.	Analyzing (Level IV)
CO3	Develop basic speech synthesis systems using articulatory, formant, and LPC-based approaches for text-to-speech applications.	Creating (Level - VI)
CO4	Apply speech processing techniques in practical applications like speech enhancement, recognition, and assistive technologies for speech and hearing impairments.	Applying (Level - III)

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: **07**

Basic Concepts: Speech Fundamentals: Articulatory Phonetics – Production and Classification of Speech Sounds; Acoustic Phonetics – acoustics of speech production; Review of Digital Signal Processing concepts; Short-Time Fourier Transform, Filter-Bank and LPC Methods.

Unit II: **07**

Speech analysis: time and frequency domain techniques for Speech analysis, pitch and formant estimation, cepstral and LPC analysis.

Unit III: **07**

Speech synthesis: articulatory, formant, and LPC synthesis, voice response and text-to-speech systems.

Unit IV: **07**

Applications: data compression, vocoders, speech enhancement, speech

	recognition, speaker recognition, aids for the speech and hearing impairments.
Course Assessment	Theory: Continuous Evaluation 25% Mid Semester 25% End Semester Examination 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:

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:** 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:** 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:** 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:** 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 quips students with the knowledge to design and analyze CMOS-based digital circuits, focusing on performance, power, and scalability.			

Course Outcomes		Cognitive Levels
CO1	To develop a comprehensive understanding of MOSFET technology	Understanding (Level II)
CO2	To implement combinational circuits with various CMOS logic styles such as static CMOS, pass transistor logic, and dynamic logic.	Analyzing (Level IV)
CO3	To analyze and design sequential MOS logic circuits.	Creating (Level - VI)
CO4	To Explore clock distribution schemes and memory design.	Applying (Level - III)

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 circuits, 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, and advanced 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 Mobile 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 Elective Course: (Y/N)	HM Course: (Y/N)	DC Course: (Y/N)	DE Course: (Y/N)
	N	Y	N	N
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.			

Course Outcomes		**Cognitive Levels**
CO1	Explain different types of waveguides and their respective modes of propagation	
CO2	Analyze typical microwave networks using impedance, admittance, transmission and scattering matrix representations	
CO3	Describe and explain working of microwave tubes and solid-state devices	
CO4	Explain the operation of RADAR systems and recite their applications.	

Semester	**1st, 2nd, 3rd etc**	**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	Title
	Author	Author
	Publisher	Publisher
	Edition	
2.	Title	Microwave Engineering
	Author	David M. Pozar
	Publisher	John Willey & Sons
	Edition	

Reference Books		
1.	Title	Microwave Engineering
	Author	David M. Pozar
	Publisher	John Willey & Sons
	Edition	

Course Contents		
	Unit I: 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.	**12**
	Unit II: 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	**12**

	microwave applications, Circulators, Isolators, Microwave Filters, Microwave attenuators and loads, Co-axial to wave guide transitions, Slotted line, iris, tuners.	
	Unit III: 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.	**12**
	Unit IV: 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.	**12**
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%	

Course Code	Course Name	Periods			Credits	Hours
		L	T	P		
ECEM 531	INTRODUCTION TO PLAMONICS AND META-MATERIALS	3	0	0	3	36
Pre-Requisite Courses:	Solid State Devices and Applications, Optical Fibre Communication					
Course Objective	To expose the students to the basics of plasmonic and related concept of meta-materials.					
Course Outcomes						Cognitive Levels
CO1	The course provides a detailed introduction to the three cornerstones of the future photonic technologies, viz., nanophotonic, plasmonic, and metamaterials, covering their fundamentals and latest advancements					Remembering (Level - I)
CO2	The basics and applied aspects of nanophotonic i.e. controlling, guiding, and manipulating electromagnetic radiation at the nanoscale will be discussed. The course will first cover the principles of photonic crystals, metal optics, surface plasmon resonance and their applications					Understanding (Level - II)
CO3	Later on, the course will focus on metamaterials and meta surfaces, covering their fundamentals and various applications such as tunable devices, absorbers, hyper lens, super lens, beam steering, and in cloaking and transformation optics.					Analyzing (Level-IV)
CO4	The course will also introduce new alternative materials for nanophotonic and summarize different techniques for fabrication of these nanophotonic devices.					Applying (Level - III)
Course Content	**Unit I:** 09 Motivation, brief introduction to nanophotonic, plasmonic and metamaterials; Overview of current status of research in academia and industry in the fields of nanophotonic, plasmonic, and metamaterials. **Unit II:** 09 Electromagnetic theory of light; Electromagnetic properties of material; Constitutive relationships and material parameters; Electromagnetic waves in dielectric media. Polarization of light; Reflection and refraction; Fresnel equations; Absorption, dispersion, and scattering of electromagnetic waves. **Unit III:** 09 Matrix theory of dielectric layered media; Fabry–Perot Etalon; Bragg Grating; 1D Photonic crystals — Bloch modes, Dispersion relation and photonic band structure. Real and reciprocal lattices; 2D and 3D Photonic crystals; Bandgap engineering; Devices based on photonic crystals; Emerging Applications of Photonic Crystals. **Unit IV:** 06 Metamaterials concept; Effective medium theories: Maxwell–Garnett theory, Bruggeman theory, Anisotropic mixtures: multilayers and wire media; Negative-permittivity and negative-permeability metamaterials; Double-Negative Materials. Perfect absorbers; Super lens, Hyperbolic metamaterials and application in high-resolution imaging: Hyper lens; Tunable photonic metamaterial-based devices. **Unit V:** 03 Nanofabrication: Thin films —Physical methods: Evaporation, Sputtering, Pulsed laser deposition; Chemical methods: chemical vapor deposition (CVD), Atomic layer deposition; Epitaxy: Metal organic CVD, Molecular beam epitaxy; Lithography — photolithography, Non-optical lithography; Pattern transfer; Nanophotonic characterization: brief overview of near-field microscopy and other related methods.					

Book	Plasmonics: Fundamentals and Applications, S. Maier, Springer (2007) Fundamentals of Photonics, 3rd Edition. by Bahaa E. A. Saleh, Malvin Carl Teich. (2019) Fundamentals and Applications of Nanophotonics. by Joseph W. Haus (2016) Optical Metamaterials: Fundamentals and Applications, W. Cai and V. Shalaev Springer (2010)
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%

Course Code	Course Name	Periods			Credits	Hours
		L	T	P		
ECEM 532	OPTICAL, ELECTRONIC & PHOTONIC PROPERTIES OF NANOSTRUCTURES	3	0	0	3	36
Pre-Requisite Courses:	Solid State Devices and Applications, Optical Fibre Communication					
Course Objective	To bring out the distinct properties like electronic, optical, and photonic properties of nanostructures					
Course Outcomes						Cognitive Levels
CO1	To familiarize about the various properties of nanostructures.					Remembering (Level - I)
CO2	To bring out the differences between nano and macro structures.					Understanding (Level - II)
CO3	To discuss applications and specific properties of nanomaterials.					Analyzing (Level-IV)
CO4	To apply and simulate various properties like electronic, optical, and photonic properties of nanostructures					Applying (Level - III)
Course Content	**Unit-I:** 09 Optical properties, Photonic crystals, optical properties of semiconductors, band edge energy, band gap, dependence on nanocrystalline size, Quantum dots, optical transitions, absorptions, Interbrand transitions, quantum confinements. **Unit-II:** 09 Fluorescence/luminescence, photoluminescence/fluorescence, optically excited emission, electroluminescence, Laser emission of quantum dot, Photo fragmentation and columbic explosion, phonons in nanostructures, luminescent quantum dots for biological labeling. **Unit-III:** 09 Electronic properties, Energy bands and gaps in semiconductors, Fermi surfaces, localized particle, donors, acceptors, deep traps, excitons, mobility, size dependent effects, conduction electrons and dimensionality Fermi gas and density of states, semiconducting nanoparticles. **Unit-IV:** 06 Electronic Properties of Copper and Silicon (NM): Direct and reciprocal lattices of the fcc structure, Brillouin zone for the fcc structure, Copper and alloy formation, Silicon. Silicon band structure. **Unit V:** 03 Nanophononics: Photonic crystals, Photonic Bandgap, Defects in Photonic Crystals: Localization of Light, Control of Dispersion and the Slowing and Storage of Light, High-Efficiency Optical Sources, Photonic Crystal Waveguides and Fibers.					
Book	1. Introduction to Nano Technology by Charles. P. Poole Jr& Frank J. Owens. Wiley India Pvt. Ltd. 2. Solid State physics by Pillai, Wiley Eastern Ltd. 3. Introduction to solid state physics 7th edition by Kittel. John Wiley & sons (Asia) Pvt Ltd. 4. Nano Technology and Nano Electronics – Materials, devices and measurement 5. Encyclopedia of Nano Technology by M.Balakrishna Rao and K.Krishna Reddy, Vol I to X Campus books					

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

Course Code: ECEM 533	Open Elective Course: (Y/N)	HM Course: (Y/N)	DC Course: (Y/N)	DE Course: (Y/N)
	N	Y	N	N
Type of Course	Theory Course/ Lab Course			
Course Title	**COMPUTER VISION FOR SIGNAL PROCESSING**			
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.			

Course Outcomes		**Cognitive Levels**
CO1	Learn fundamentals of computer vision and its applications	Remembering (Level - I)
CO2	Understand the basic image processing operations to enhance, segment the images.	Understanding (Level - II)
CO3	Analyzing and extraction of relevant features of the concerned domain problem.	Analyzing (Level-IV)
CO4	Understand and apply the motion concepts and its relevance in real time applications	Applying (Level - III)

Semester	**2nd, 3rd etc**	**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	Computer vision – A modern approach
	Author	D. Forsyth and J. Ponce
	Publisher	Pearson,
	Edition	Second edition, 2012.
2.	Title	Computer Vision: Algorithms and Applications
	Author	R. Szeliski
	Publisher	Springer,
	Edition	2011.
Reference Books		
1.	Title	Computer vision – Models, learning and inference
	Author	S. Prince
	Publisher	Cambridge univ. press,
	Edition	2012.

Course Contents	**Unit I:** Essential mathematical tools: Least squares, RANSAC, Eigen-analysis, PCA, SVD, clustering, gradient-based optimization methods Image Formation: Geometric image formation, Photometric image formation - Camera Calibration: camera models; intrinsic and extrinsic parameters; radial lens distortion; direct parameter calibration; Camera Projection Models –	**07**

	Orthographic, Affine, Perspective, Projective models. Geometry, Camera models, Epipolar geometry, Stratified reconstruction, Applications: large scale reconstruction, single-view metrology Camera calibration: camera models; intrinsic and extrinsic parameters; radial lens distortion; direct parameter calibration; camera parameters from projection matrices; orthographic, weak perspective, affine, and perspective camera models.	
	Unit II: Image Processing: Pixel transforms, color transforms, histogram processing, histogram equalization, filtering, convolution, Fourier transformation and its applications in sharpening, blurring and noise removal. Feature detection: edge detection, corner detection, line and curve detection, active contours, SIFT and HOG descriptors, shape context descriptors, Morphological operations	**07**
	Unit III: Segmentation: Low-level segmentation, energy minimization and clustering based methods, semantic segmentation, Active contours, split & merge, watershed, region splitting, region merging, graph-based segmentation, mean shift and model finding, Normalized cut. Stereo disparity estimation, Optical flow (Lucas Kanade and Horn Schunk approaches, contemporary energy minimization methods). Motion representation: the motion field of rigid objects; motion parallax; optical flow, the image brightness constancy equation, affine flow; differential techniques; feature-based techniques; regularization and robust estimation	**07**
	Unit IV: Features detection and tracking: Harris corner detector, KL tracking, SIFT, Overview of other contemporary descriptors. Motion representation: the motion field of rigid objects; motion parallax; optical flow, the image brightness constancy equation, affine flow; differential techniques; feature-based techniques; regularization and robust estimation. Motion tracking: statistical filtering; iterated estimation; observability and linear systems; the Kalman filter. Object recognition and shape representation: alignment, appearance-based methods, invariants, image eigenspaces.	**07**
Course Assessment	Theory: Continuous Evaluation 25% Mid Semester 25% End Semester Examination 50% Laboratory: Continuous Evaluation 50% End Semester Examination 50%	

Course Code: ECEM 534	Open Elective Course: (Y/N)	HM Course: (Y/N)	DC Course: (Y/N)	DE Course: (Y/N)
	N	Y	N	N
Type of Course	Theory Course/ Lab Course			
Course Title	**DEEP LEARNING AND AI FOR SIGNAL PROCESSING**			
Course Coordinator				
Course Objectives	Preferable in one or two lines in continuation without bullets and numbering			

Course Outcomes		**Cognitive Levels**
CO1	Understand the modern CNN-based architectures.	II
CO2	Describe relative merits of various deep learning architectures	III
CO3	Applying deep learning model in distinct applications.	IV
CO4	Understand advanced deep learning model and its applications	IV

Semester	**1st, 2nd, 3rd etc**	**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 for AI
	Author	Ian Goodfellow and Yoshua Bengio and Aaron Courville
	Publisher	MIT Press
	Edition	2016
2.	Title	Dive into Deep Learning
	Author	Aston Zhang, Zachary C. Lipton, Mu Li, Alexander J. Smola
	Publisher	Cambridge Univ Press
	Edition	2023

Reference Books

1.	Title	Understanding Deep Learning
	Author	Simon J. D. Prince
	Publisher	MIT Press
	Edition	2023

Course Contents		
	Unit I: Deep feedforward neural networks (DFNNs), Optimization methods: Generalized delta rule, AdaGrad, RMSProp, Adadelta, AdaM, Second order methods; Regularization methods: Dropout, Dropconnect; Batch normalization. Autoencoders: Auto associative neural network, stacked autoencoder, Greedy layer-wise training, Pre-training of a DFNN using a stacked autoencoder, Fine tuning a DFNN, Regularization in autoencoders, Denoising autoencoder, Variational autoencoder	**12**
	Unit II: CNN: Basic CNN architecture, Rectilinear Unit (ReLU), 2-D Deep CNNs:	**12**

	LeNet, AlexNet, VGGNet, GoogLeNet, ResNet; Image classification using 2-D CNNs; 3-D CNN for video classification; 1-D CNN for text and audio processing; Vector of Linearly Aggregated Descriptors (VLAD) method for aggregation – NetVLAD. Recurrent neural networks (RNNs): Architecture of an RNN, Unfolding an RNN, Backpropagation through time, Vanishing and exploding gradient problems in RNNs, Long short term memory (LSTM) units, Gated recurrent units, Bidirectional RNNs, Deep RNNs.	
	Unit III: Encoder-decoder paradigm, Image and video captioning models, Machine translation, Text processing models, Representation of words: Word2Vec, GloVe. Transformer models: Attention based models, Scaled dot product attention, Multi-head attention (MHA), Self-attention MHA, Cross-attention MHA, Position encoding, Encoder and Decoder modules in a transformer, Sequence to sequence mapping using transformer, Machine translation using transformer model, Vision transformer for image classification, Video captioning using transformer model, Bidirectional encoder representations from transformers (BERT) model for text processing, Pre-training a BERT model, Fine tuning a BERT model for text processing tasks, Vision-and-Language BERT (ViLBERT) for image and video processing tasks, Text and Visual question answering and reasoning using transformer models.	**12**
	Unit IV: Generative adversarial networks (GANs): mage generation models, Architecture and training of a GAN, Deep convolutional GAN, Cyclic GAN, Conditional GAN, Super-resolution GAN, Applications of GANs for image processing. Reinforcement Learning: Introduction to reinforcement learning, Markov decision processes, Policy gradients, Temporal difference learning, Q-learning, Deep reinforcement learning - Deep policy gradient, Deep Q learning; Text processing using deep reinforcement learning - Text classification, Text summarization.	**12**
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 Elective Course: (Y/N)	HM Course: (Y/N)	DC Course: (Y/N)	DE Course: (Y/N)
	N	Y	N	N
Type of Course	Theory Course			
Course Title	**COMPUTATIONAL ELECTROMAGNETICS**			
Course Coordinator				
Course Objectives	To give idea about Numerical methods for solving complex Electromagnetic problems			

Course Outcomes		**Cognitive Levels**
CO1	To provide advance level of understanding of electromagnetic field theory	
CO2	To provide comprehensive knowledge on various computational techniques such as FDM, FDTD, FEM, MoM.	
CO3	To provide the application of computational techniques to solve Maxwell's equations, wave propagation in bounded and unbounded media, radiation, scattering and other fundamental electromagnetic problems.	
CO4	Understanding of advance Microwaves Waveguides, MMIC	

Semester	**1st, 2nd, 3rd etc**	**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	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	

Reference Books		
1.	Title	Numerical Methods in Engineering with Python,
	Author	JaanKiusalaas,
	Publisher	Cambridge
	Edition	

Course Contents		
	Unit I: 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.	**12**
	Unit II: Review of Basic Electromagnetics Electrostatics. Magnetostatics. Wave	**12**

	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: 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.	**12**
	Unit IV: Microwaves. Waveguides. MMICs. Antennas. Scattering Optics. Fibre optics. Integrated optics. Plasmonics. Micro magnetics. Hysteresis. Non-volatile memory, Spin waves Effects of EM radiation	**12**
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 Networks 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

<table>
<tr><td colspan="3">Reference Books:</td></tr>
<tr><td rowspan="4">1.</td><td>Title</td><td>Computational Electronics</td></tr>
<tr><td>Author</td><td>DragicaVasileska and Stephen M. Goodnick</td></tr>
<tr><td>Publisher</td><td>CRC Press</td></tr>
<tr><td>Edition</td><td></td></tr>
<tr><td rowspan="4">2.</td><td>Title</td><td>Semiconductor Optoelectronics Devices: .</td></tr>
<tr><td>Author</td><td>Pallab Bhattacharya</td></tr>
<tr><td>Publisher</td><td>Pearson Education</td></tr>
<tr><td>Edition</td><td></td></tr>
<tr><td>Content</td><td colspan="2">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.</td></tr>
</table>

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:	The Low Power VLSI Design course focuses on understanding power dissipation sources in digital circuits and applying low-power techniques at the device, circuit, logic, and system levels.			

Course Outcomes		Cognitive Levels
CO1	To understand the importance of low power in VLSI circuits.	Knowledge (Level I)
CO2	Understanding of various sources of power dissipation in CMOS circuits	Understanding (Level II)
CO3	Analyse the power dissipation at the circuit and gate level	Analysis (Level IV)
CO4	Understand the power dissipation problem in the clock distribution of VLSI circuits	Understanding (Level II)

	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: **09**

Introduction: Low-power VLSI chips are needed. 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, Monte Carlo simulation.

Unit II: **09**

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: **09**

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: **09**

Low power Clock Distribution: Power dissipation in clock distribution, single driver Vs. distributed buffers, Zero skew Vs tolerable skew, 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%

Course Code	Course Name	Periods			Credits	Hours
		L	T	P		
ECEM 584	**PHOTONIC MATERIALS AND DEVICES COMMUNICATION**	3	0	0	3	36
Pre-Requisite Courses:	Solid State Devices and Applications, Analog Electronics					
Course Objective	To expose the students to the basics of signal propagation through optical fibers, fiber impairments, components and devices and system design.					
Course Outcomes					**Cognitive Levels**	
CO1	To Develop an understanding of photonic components and optical fiber technology.				Remembering and Understanding (Level – I & II)	
CO2	To Classify the material system/technologies along with their fabrication processes to design efficient photonic devices for communication.				Analyzing (Level-IV)	
CO3	To Design and analyze different types of Photonic/Nano-photonic devices and components.				Applying (Level - III)	
CO4	Analytically evaluate the various photonic devices.				Evaluating (Level V)	

Course Content

Unit I: **09**

Basics of Photonics, Optical fibers and Communication: Photonics, integrated photonics and their brief history, Basic photonic technologies and components, Brief introduction to Maxwell's equations, wave equation, Electromagnetic waves at different dielectric interfaces. Overview of Optical fibers, types (step-index and graded index), single-mode and multimode along with their condition, birefringent fiber, numerical aperture, Optical fiber communications, Dispersion and scattering losses in fiber, budget analysis.

Unit II: **09**

Optical waveguides and Photonic Devices: Optical waveguides classification, Guided modes in optical waveguides, Dispersion of guided modes, Single-mode 3-D optical waveguides. Basic integrated-optic devices: Optical power splitter, Directional coupler, thermo-optic switches, Mach-Zehnder interferometer, Arrayed Waveguide Grating (AWG)-based MUX/DEMUX, Add-drop multiplexer, Design of photonic devices: Beam Propagation Method and Marcatili's Method.

Unit III: **09**

Fundamental of Nano-Photonic Devices and Components: Nano-photonics: Photonic crystal (PhC) technology, PhC waveguide, PhC resonator, PhC MUX/DEMUX, PhC Filters, PhC fibers, Nano-wires, Packaging of photonic devices. Recent studies on PhC based devices for communication applications.

Unit IV: **09**

Photonic Materials and Fabrication Technologies: Photonic materials, selection of materials like silicon, silica, Lithium Niobate, Compound Semiconductor and Polymers. Fabrication and process techniques like Lithography, Deposition, and Diffusion etc. Parameter measurement and techniques, recent studies on photonic materials.

Book	Gerd Keiser, Optical Fiber Communications, 3rd Edition, McGraw-Hill International edition, 2000. John M. Senior, Optical Fiber Communications, 2nd Edition, PHI, 2002. H Nishihara, M Haruna and T Suhara, Optical integrated Circuits, McGraw-hill, 1989. C. R. Pollock and M. Lip Son, Integrated Photonics, Kluwer Pub., 2003. D.K. Mynbaev, S.C. Gupta and Lowell L. Scheiner, Fiber Optic Communications, Pearson Education, 2005.
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%

Course Code	Course Name	Periods			Credits	Hours
		L	T	P		
ECEM 585	**BIOMEDICAL SIGNAL ANALYSIS**	3	0	0	3	**36**
Pre-Requisite Courses:	Digital Signal Processing					
Course Objective	To understand the fundamentals of biomedical signals, their characteristics, and the techniques used for their processing, analysis, and noise removal to enable accurate diagnosis and interpretation.					
Course Outcomes					**Cognitive Levels**	
CO1	Explain the principles of human physiology and the generation and propagation of bioelectric signals.				Understanding (Level II)	
CO2	Analyze the origin, characteristics, and challenges in the interpretation of various biomedical signals such as ECG, EEG, and EMG.				Analyzing (Level IV)	
CO3	Apply filtering techniques to remove noise and artifacts from biomedical signals in time and frequency domains.				Applying (Level - III)	
CO4	Utilize advanced analytical methods for event detection, feature extraction, and signal interpretation in applications like ECG and EEG analysis.				Applying (Level - III)	
Course Content	**Unit I:** **06** **Introduction to Biomedical Signals:** Introduction to human physiology, Basic components of Biomedical signal processing, bioelectric signals. Action Potential and Its Generation, propagation of action potentials in nerves. **Unit II:** **07** **Biomedical Signals and Characteristics:** Origin and Waveform Characteristics of Basic Biomedical Signals Like: Electrocardiogram (ECG), Electroencephalogram (EEG), Electromyogram (EMG), Phonocardiogram (PCG), Electroneurogram (ENG), Event-Related Potentials (ERPS), Electrogastrogram (EGG), Biomedical Signal Analysis, Difficulties in Biomedical Signal Analysis, Computer-Aided Diagnosis. **Unit III:** **07** **Removal of Noise and Artifacts from Biomedical Signal**: Noise, Physiological Interference, Noises and Artifacts Present in ECG and EEG Time and Frequency Domain Filtering. **Unit III:** **07** **EEG and ECG Signal Analysis and Event Detection in Biomedical Signals**: EEG signal Analysis, Linear Prediction Theory, Autoregressive Method, Sleep EEG, Application of Adaptive Filter for Noise Cancellation in ECG and EEG Signals; Detection of P, Q, R, S and T Waves in ECG, EEG Rhythms, Waves and Transients, Detection of Waves and Transients, Correlation Analysis Ad Coherence Analysis of EEG Channels.					
Books	**Textbooks** 5. Rangayyan, R.M., 2015. Biomedical signal analysis (Vol. 33). John Wiley & Sons. 6. 2. Reddy, D.C., 2005. Biomedical signal processing: principles and techniques. McGraw-Hill **Reference Books** 1. Tompkins, W.J., 1993. Biomedical digital signal processing. Editorial Prentice Hall. 2. Sörnmo, L. and Laguna, P., 2005. Bioelectrical signal processing in cardiac and neurological applications (Vol. 8). Academic Press.					
Course Assessment	Theory: Continuous Evaluation 25% Mid Semester 25% and End Semester Examination 50%					

Course Code: ECEM 586	Open Elective Course: (Y/N)	HM Course: (Y/N)	DC Course: (Y/N)	DE Course: (Y/N)
	N	Y	N	N
Type of Course	Theory Course/ Lab 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.			

Course Outcomes		**Cognitive Levels**
CO1	Understand the modern CNN-based architectures.	Remembering (Level - I)
CO2	Describe relative merits of various deep learning architectures	Understanding (Level - II)
CO3	Analyzing and extraction of relevant features of the concerned domain problem.	Analyzing (Level-IV)
CO4	Understand and apply the computer vision concepts and its relevance in real time applications	Applying (Level - III)

Semester	**2nd, 3rd etc**	**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.		**10**
	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		**10**
	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.		**08**
	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		**10**
Course Assessment	Theory: Continuous Evaluation 25% Mid Semester 25% End Semester Examination 50%		

Course Code: ECEM 587	Open Elective Course: (Y/N)	HM Course: (Y/N)	DC Course: (Y/N)	DE Course: (Y/N)
	N	Y	N	N
Type of Course	Theory Course/ Lab Course			
Course Title	**DEEP LEARNING FOR IMAGING**			
Course Coordinator				
Course Objectives	Preferable in one or two lines in continuation without bullets and numbering			

Course Outcomes		**Cognitive Levels**
CO1	Understand the basic NN-based architectures.	Remembering (Level - I)
CO2	Describe relative merits of various NN based architectures	Understanding (Level - II)
CO3	Analyzing and extraction of relevant features of the advanced deep learning architectures.	Analyzing (Level-IV)
CO4	Applying various deep learning models to the real applications	Applying (Level - III)

Semester	**1st, 2nd, 3rd etc**	**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	Understanding Deep Learning
	Author	Simon J.D. Prince
	Publisher	MIT Press
	Edition	2023
2.	Title	Deep Learning
	Author	Ian Goodfellow and Yoshua Bengio and Aaron Courville
	Publisher	MIT Press
	Edition	2016.

Reference Books		
1.	Title	Deep learning with PyTorch
	Author	Eli Stevens, Luca Antiga, and Thomas Viehmann
	Publisher	Manning
	Edition	2020

Course Contents		
	Unit I: Basic Neural Network: Perceptron; Multi-layer Perceptron; Back propagation; Stochastic gradient descent; Universal approximation theorem; Applications in imaging such as for denoising. Convolutional Neural Networks (CNN): CNN Architecture (Convolutional layer, Pooling layer, ReLu layer, fully connected layer, loss layer); Regularization methods such as dropout; Fine-tuning; Understanding and Visualizing CNN; Applications of CNN in imaging such as object/scene recognition.	**12**
	Unit II: Autoencoders: Autoencoder; Denoising auto-encoder; Sparse auto-encoder;	**12**

	Variational autoencoder; Applications in imaging such as segnet and image generation. Recurrent Neural Network (RNN): Basic RNN; Long Short-Term Memory (LSTM) and GRUs; Encoder-Decoder models; Applications in imaging such as activity recognition, image captioning.	
	Unit III: Deep Generative Models: Restricted Boltzmann machine; Deep Boltzmann machine; Recurrent Image Density Estimators (RIDE); Pixel RNN and Pixel CNN; Plug-and-Play generative networks. Generative Adversarial Network (GAN): GAN; Deep Convolutional GAN; Conditional GAN; Applications.	**12**
	Unit IV: Deep Learning for Image Processing and Computational Imaging Denoising; Deblurring; Super-resolution; Color Filter Array design.	**12**
Course Assessment	Continuous Evaluation 25% Mid Semester 25% End Semester 50%	

Course Code:	Open Elective Course: (Y/N)	HM Course: (Y/N)	DC Course: (Y/N)	DE Course: (Y/N)
ECEM 588	N	Y	N	N
Type of Course	Theory Course/ Lab Course			
Course Title	**MACHINE LEARNING FOR COMPUTER VISION**			
Course Coordinator				
Course Objectives	Preferable in one or two lines in continuation without bullets and numbering			

Course Outcomes		**Cognitive Levels**
CO1	Understand the Basic concepts of Machine Learning Approaches to Computer Vision Task.	Remembering (Level - I)
CO2	Analyzing and extraction of relevant features of the concerned domain problem.	Understanding (Level - II)
CO3	Deduce the distinct represent and representation Learning.	Analyzing (Level-IV)
CO4	Understand and apply the computer vision domain for real life applications	Applying (Level - III)

Semester	**1st, 2nd, 3rd etc**	**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	Understanding Deep Learning
	Author	Simon J.D. Prince
	Publisher	MIT Press
	Edition	2023
2.	Title	Deep Learning
	Author	Ian Goodfellow and Yoshua Bengio and Aaron Courville
	Publisher	
	Edition	2016

Reference Books		
1.	Title	Deep Learning for Coders with fastai and PyTorch
	Author	Jeremy Howard and Sylvain Gugger
	Publisher	
	Edition	2020

Course Contents	**Unit I:** Practical aspects of model training. Regularization, optimizers, training recipes. Attention and vision transformers. Image classification architectures based on Transformers (ViT, SWiN). ConvNeXt. Object detection. Introduction to ensemble learning via boosting. The Viola-Jones detector and its applications. Specialized NN architectures for object detection. Two-stages, one-stage, and anchor-free detectors. RoI Pooling operator, Feature Pyramid Networks. Imbalanced learning and the focal loss. Hands-on session on object	**12**

	detection.	
	Unit II: Dense prediction problems: semantic/instance segmentation and depth from mono/stereo. Ensemble learning via bagging and random forests. The algorithm behind the Kinect body part segmentation. Fully Convolutional Networks. Transposed and dilated convolutions. RoI Align operator. Specialized NN architectures for semantic, instance, and panoptic segmentation. Deep networks for depth estimation: DispNet, GCNet, RAFT Stereo, Mono depth.	**12**
	Unit III: **Metric and representation learning**. Deep metric learning and its applications to face recognition/identification and beyond. Locally connected layers. Contrastive and triplet loss. Unsupervised representation learning. Hands-on session on face recognition.	**12**
	Unit IV: **3D computer vision:** data structures (point clouds, mesh, voxel grids). Specialized neural networks for point clouds and voxels. Hands-on session on point cloud classification. **Image generation with diffusion models:** denoising diffusion probabilistic models and score-matching models. Stable diffusion and text-guided image generation. Hands-on session on textual inversion.	**12**
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%				