PG CURRICULUM

2022 Onwards

PROPOSED SYLLABI

For

M.TECH

(Communication Engineering and Signal Processing)

Electronics & Communication Engineering Department

PEC (Deemed to be University)

Chandigarh-160012

Vision of the Department:

The Department aims to be recognized as centre of excellence in Electronics and Communication Engineering by continuously striving to achieve excellence in providing Education, Research, and Innovation.

Mission of the Department:

1. To provide our graduates with state of art facilities, experienced engineering education that balances both theoretical and practical knowledge for the design, analysis and operation of electronic systems in order to meet the needs of the relevant industry and research organization.
2. To conduct research in the field of Electronics and Communication Engineering focusing in the emerging research areas such as advanced communication systems, VLSI, Photonics systems, embedded systems etc.
3. To promote the overall development of graduates by encouraging them to participate in co-curricular and extra-curricular activities & providing awareness of ethical values in order to prepare them to face the challenges of the changing world.
4. To build relationship with Alumni to create a network and support for the department.
5. To design the curriculum through a continuous process in consultation with stakeholders so that the students graduating from the department have top rating in placement.

PEOs of M.Tech (Communication Engineering and Signal Processing)

The MTech (Communication Engineering and Signal Processing) programme prepares graduates to

1. Be technically competent in design, development and implementation of Communication Engineering and signal processing techniques in different thrust areas that allow them to be successfully employed in industry/ research organization and to have entrepreneurial skill.
2. Possess suitable knowledge for analysing, modelling, and evaluating the research problems in major thrust areas of Communication Engineering and signal processing and pursue doctoral studies in their areas of interests.
3. Develop Effective Technical Communication/Writing skills.

Programme Outcome in Mtech(Communication Engineering and Signal Processing)

PO1:An ability to independently carry out research /investigation and development work to solve practical problems.

PO2: An ability to write and present a substantial technical report/document.

PO3: Students should be able to demonstrate a degree of mastery over the area as per the specialization of the program. The mastery should be at a level higher than the requirements in the appropriate bachelor program.

Proposed Semester wise PG Scheme to be implemented w.e.f. 2022-23 session

Semester I

Sr. No.	Course Stream	Course Name/course code	Credits	L-T-P
1.	Program Core Course (DCC-I)	Signal Theory/ ECR1101	3	3-0-0
2.	Program Core Course (DCC-II)	Advanced Data Communication/ ECR1102	3	2-0-2
3.	Program Core Course (DCC-III)	Advanced Optical Communication/ ECR1103	3	2-0-2
4.	Deptt. Elective Course (DEC-I)	• Advanced Digital Image Processing/ECR1201 • Antenna Theory and Design//ECR1202 • Micro and Nano Technology//ECR1203 • Analog and Digital VLSI Design//ECR1204 • Photonic devices and Circuits//ECR1205	3	2-0-2 2-0-2 3-0-0 2-0-2 2-0-2
5.	Design of experiments and research methodology (CB)	Design of experiments and research methodology/ ECR1001	3	2-0-2
6.	Soft Computing/Soft Skills & Management		3	
		Total Credits	**18**	

Semester II

Sr. No.	Course Stream	Course Name/Course code	Credits	L-T-P
1.	Program Core Course (DCC-IV)	Advanced Digital Communication/ECR1104	3	2-0-2
2.	Program Core Course (DCC-V)	Advanced Wireless Communication//ECR1105	3	2-0-2
3.	Program Core Course (DCC-VI)	Advanced Digital Signal Processing//ECR1106	3	3-0-0

4.	Deptt. Elective Course (DEC-II)	• Information Theory and Coding//ECR1251 • Advanced Embedded System Design//ECR1252 • Microwave Theory and Techniques//ECR1253 • VLSI Architecture for DSP/ECR1254 • Computer vision//ECR1255	3	3-0-0 3-0-0 2-0-2 3-0-0 3-0-0
5.	Open Elective-1	• Neural Networks and Its Applications/ECR3001 • Fundamentals of Signal Processing/ECR3002 • Latest Trends in Communication Technologies/ECR3003	3	3-0-0 3-0-0 3-0-0
6.	Engineering Mathematics (CB)		3	
7.	Industrial Tour		0	
		Total Credits	**18**	

Semester III

Sr. No.	**Course Name/ Course Code**	**Credits**
1.	Seminar and Report Writing/ECR5001	2
2.	Research and Publication Ethics/RPR6001	2
3.	Dissertation-I/ECR7001	14
	Total	**18**

Semester IV

Sr. No.	**Course Name/ Course Code**	**Credits**
1.	Dissertation-II/ ECR8001	18
	Total	**18**

Programme Core Courses- Semester I

Course Name	**:**	**Signal Theory**
Course Code	**:**	**ECR1101**
Credits	**:**	**3.0**
L T P	**:**	**3 0 0**

Total No. Lectures: 42

Course Objectives:

The main objectives of this course are:

- To introduce the students to some advanced aspects of signals and random processes in communication systems
- To familiarize the students with the classical statistical inference techniques such as detection and estimation techniques
- To familiarize the students with the applications of detection and estimation techniques to Communication and Signal Processing problems.

Course Contents:

Sr. No.	**Course contents**	**No. of Lectures**
1.	**Module -1: Introduction** Deterministic and Random Signals, Discrete random variables and their properties, Continuous random variables and their properties like PDF, CDF, and MGF. Stochastic convergence, law of large numbers, central limit theorem	9
2.	**Module -2: Random processes** Stationarity, mean, correlation, and covariance functions, WSS random process; autocorrelation and cross-correlation functions; transmission of a random process through a linear filter; power spectral density; white random process; Gaussian process; Poisson process	9
3.	**Module -3: Classical Decision Theory** Binary hypothesis testing: Bayes criterion, Neyman-Pearson criterion, min-max test; M-ary hypothesis testing: General rule, minimum probability of error decision rule, Gaussian case and associated geometric concepts, Erasure decision problem, Detection of known and un-known signals in AWGN, Detection of signals in coloured noise.	11
4.	**Module–4: Classical Estimation Theory** Random parameter estimation, Non-random parameter estimation, Linear minimum variance estimation, Least squares methods, CRLB (Cramer-Rao Lower Bound) for random parameter estimation, condition for statistical efficiency, estimation with Gaussian density function: Linear and non-linear observation, sequential estimation. Multiple parameter estimation, Linear estimation: Wiener filters and solution of Wiener Hopf Equations, Kalman-Bucy filters	13

Course Outcomes:

At the completion of this course, students will be able to:	
1.	Understand the concept of discrete and continuous random variables and get comfortable with their statistical characteristics.

2.	Apply the concepts of random signals and random processes in communication engineering and signal processing related problems
3.	Analyze the communication system performance with the basic techniques of classical decision/detection theory
4.	Understand the basic techniques of classical estimation theory
5.	Apply the statistical signal processing techniques in the communication engineering problems.

Suggested Books:

Sr. No.	**Authors/Name of Book/ Publisher**	**Year of Publication/ Reprint**
1	A. Papoulis and S. U. Pillai, "Probability, Random Variables, and Stochastic Processes," 4th edition, New York, NY: McGraw-Hill	2002
2	Robert G. Gallager, "Stochastic Processes: Theory for Applications", CUP, 1st edition	2013
3	H. L. Van Trees, Detection, Estimation and Modulation Theory, Part I	
4	S.M. Kay, Fundamentals of Statistical Signal Processing, Volume I: Estimation Theory; Prentice Hall	1993
5	S.M. Kay, Fundamentals of Statistical Signal Processing, Volume II: Detection Theory; Prentice Hall	1993
6	Recently Published Papers	

	PO1	**PO2**	**PO3**
CO1	3	-	3
CO2	3	2	3
CO3	3	-	3
CO4	3	-	3
CO5	3	2	3

Course Name	**:**	**Advanced Data Communication**
Course Code	**:**	**ECR1102**
Credits	**:**	**3.0**
L T P	**:**	**2 0 2**

Total No. Lectures: 28
No. of Lab Hours: 28

Course Objectives:

By the end of this course, the students should be able to

- define the basic concepts/protocols of data communication networks with different models
- understand the access, edge, and core networks
- to describe the BISDN architecture and analyze its QoS metrics
- summarize the Queueing concept for performance modelling of communication networks and explore the design and development of recent networking technologies.

Course Contents:

Sr. No.	**Course contents**	**No. of Lectures**
1.	**Module -1: Introduction** OSI and TCP/IP model layering architecture and their protocols, evolution of BISDN(broadband integrated service digital networks) model; **Access networks** – copper, fiber and wireless access networks, xPON; **Edge and Metro networks** – BISDN, Carrier Ethernet; **Core Networks**– SDH and optical networks; Operation Support Subsystem (OSS) and telecommunication management Networks (TMN)	8
2.	**Module–2: Broadband services and QOS issues:** Quality of Service issues in networks, Integrated service architecture, Queuing Disciplines, Weighted Fair Queuing, Random Early Detection, Differentiated Services, Protocols for QOS support, Resource reservation-RSVP- Multi protocol Label switching (MPLS), Real Time transport protocol.	6
3.	**Module–3: Performance analysis:** Introduction to Queuing theory, Markov chain, Discrete time and continuous time Markov chains, Poisson process, Queueing models for Datagram networks, Little's theorem- M/M/1 queuing systems, M/M/m/m queuing models, M/G/1 queue, Mean value analysis, Time reversibility, Closed queuing networks, Jackson's Networks. Networks of transmission lines, Networks of queues	6
4.	**Module-4 Selected Topics in communication Networks** Software defined Networking (SDN), Network function Virtualization (NFV), Open- Radio Access Networks (O-RAN), Software Defined Radio/ Cognitive Radio Networks: Introduction, need of cognitive radio, Challenges, requirements, Network Architectures, Spectrum Sensing Techniques	8

List of Simulations & Experiments:		No. of Hours
1	Hands on experiment of software defined radio	2*2
2	Experiment related to software defined networking	2*2
3	Experiment on Network function virtualization	2*2
4	Design and analyze weighted fair queueing	2*2
5	Design and analyze M/M/1 queueing model	2*2
6	Implement spectrum sensing techniques	2*2
7	Implementing discrete time and continuous time Markov Chain	2*2

Course Outcomes:

At the completion of this course, students will be able to:	
1.	Understand the basic building blocks of a computer network and evolution of BISDN
2.	Explain the architecture of access, edge, and core networks
3.	Analyze the quality -of -service (QoS) metrics of broadband integrated services digital networks
4.	Apply the strong theoretical foundation of performance analysis of various queueing models on different applications to Internet
5.	Create the ability to explore the design and development of recent networking technologies through lab experiments

Suggested Books:

Sr. No.	Authors/Name of Book/ Publisher	Year of Publication/ Reprint
1	Peterson L.L. and Davie B.S., Computer Networks: A System Approach, Elsevier, 5th edition	2012
2	James. F. Kurose and Keith.W. Ross, Computer Networks, A top-down approach featuring the Internet, Pearson Education, 5th edition	2015
3	D. Bertsekas and R. Gallager, Data Networks, PHI, 2ndedition	2000
4	S. Keshav, An Engineering Approach to Computer Networking, Pearson Education	2005
5	William Stallings, "Data and Computer Communication", PHI, 10th Ed.	2017
6	Recent Publications in relevant field	

	PO1	PO2	PO3
CO1	2	-	3
CO2	2	-	3
CO3	3	2	3
CO4	3	2	3
CO5	3	2	3

Course Name	**:**	**Advanced Optical Communication**
Course Code	**:**	**ECR1103**
Credits	**:**	**3**
L T P	**:**	**2 0 2**

Total No. Lectures: 28
Total No. of Lab hrs: 28

Course Objectives:

The main objectives of this course are:

- Describe the building blocks of an optical fiber system and shall be familiarized with basic laws and phenomena of optoelectronics, LASERs, LED diodes, fibers and detectors used in optoelectronic systems.
- Summarize the various causes of signal degradation in optical fibers, loss and dispersion management and optical multiplexing schemes.
- Explain the working of optical amplifiers, transmitter as well as at the receiver and various measuring instruments etc.
- Keep in touch with the recent trends of fiber optics such as soliton communication, sensing applications etc.

Course Contents:

Sr. No.	Course contents	No. of Lectures
1.	**Signal Degradation and Management** in Optical Communication Systems Attenuation, Intrinsic &extrinsic losses, Linear & nonlinear effects, Dispersion Losses in singe and multimode fibers, Dispersion induced limitations, Dispersion compensation methods: DCF, dispersion shifted and dispersion flattened fibers etc., Amplified Spontaneous Emission (ASE) System Impact of ASE, Optical amplifiers: SOA, EDFA, Raman & hybrid amplifiers.	7
2.	**Optical Transmitters and Receivers** Semiconductor lasers, Laser Rate Equations, Optical Modulators and optical realization of Modulation Schemes, Multilevel Signalling, transmitter design. Optical Receivers-Photodetector Performance Characteristics, Direct detection and Coherent Receivers, Receiver Noise, Optimum Binary Receiver for Coherent Systems	10
3.	**Advanced lightwave systems** WDM lightwave systems: broadcast-and-select WDM networks, DWDM, wavelength-routed networks, FTTH networks, Subcarrier multiplexing, Soliton based communication, OCDMA, OFDM Transmitter and Receiver, Polarization Division Multiplexing	6
4.	**Components of fiber optic networks** Passive components, Switches and functional modules of fiber optic networks, Test and measuring instruments: OTDR, Optical spectrum analyser (OSA), Fiber optic sensors and their applications in various fields: Measurement of pressure, temperature, current and voltage, liquid level and strain.	5

List of Experiments

Sr. No.	Lab contents	No. of Hours
1.	Characterization of DFB Lasers, Optical Add drop multiplexer and 4 channel DWDM devices.	2*2

2.	To simulate and analyze the performance of various optical amplifiers in an optical communication system.	2*1
3.	To compensate the effect of various channel impairments in an optical communication system and investigate the performance in terms of BER and eye diagram.	2*2
4.	To simulate and analyze different 2D and 3D optical waveguides, couplers, bent waveguides, splitters etc. and study their mode profiles.	2*2
5.	To simulate and analyze the performance of optical communication systems using advanced multiplexing techniques	2*2
6.	To investigate the different optical network components such as circulator, wavelength converter, ring resonators etc. and analyze their applications/usage in an optical communication system.	2*2
7.	To study optical fiber based sensor (strain, temperature, refractive index) and investigate in terms of sensitivity.	2*2
8.	To study the effect of solitons on optical system using different data formats and analyze its performance in terms of BER and Q-factor.	2*1

Course Outcomes:

At the completion of this course, students will be able to:	
1.	Understand the various causes of signal degradation in optical communication systems and techniques used for managing signal degradation
2.	Apply the knowledge of design, working, Classification and analysis of Semiconductor Lasers, LEDs, and modulators in practical problems
3.	Explain the design aspects of advanced lightwave systems and evaluate different WDM network topologies including broadcast-and-select and wavelength routing networks.
4.	Analyse the performance of various enabling technologies used in modern optical networks
5.	Design an optical communication system so as to meet desired specifications using the various software and hardware tools available in the lab.

Suggested Books:

Sr. No.	**Authors/Name of Book/ Publisher**	**Year of Publication**
1.	Mynbaev,"Fiber-optics communication Technology", 1st edition, Pearson Education India.	2002
2.	G.P. Aggarwal, "Fiber optic Communication systems, 3rd edition, John Wiley and sons.	2002
3.	Keiser, "Optical fibre communication", 5th edition, Tata McGraw Hill.	2013
4.	John M Senior, "Optical fiber communication", 3rd edition, Pearson Education India.	2010
5.	Joseph C.Palais, "Fiber optic Communication", 5th edition, Pearson Education India.	2011

	PO1	**PO2**	**PO3**
CO1	3	-	3
CO2	3	-	3
CO3	3	-	3
CO4	3	-	3
CO5	3	3	3

Programme Core Courses- Semester II

Course Name	**:**	**Advanced Digital Communications**
Course Code	**:**	**ECR1104**
Credits	**:**	**3.0**
L T P	**:**	**2 0 2**

No. Lectures: 28
No. of Lab hrs: 28

Course Objectives:

The main objectives of this course are:

- to introduce the students to advanced topics in digital communications.
- to provide the students with strong theoretical foundation in digital communications
- to enable the students to do analysis/evaluation of receiver/link performance that are used in the design and implementation of current communication systems and also useful in the development of the communication systems of the future.

Course Contents:

Sr. No.	Course contents	No. of Lectures
1.	**Module -1: Digital Modulation Scheme and Optimum Receivers** Representation of digitally modulated signals and their power spectral densities, Optimal receiver for AWGN Channel (Matched Filter), The Nyquist criterion for ISI avoidance: relating bandwidth to the symbol rate; Optimal detection and error probability of band-limited and power limited signaling, Coherent and non-coherent receivers and their performance (evaluating BER performance); Comparison of digital signaling methods	11
2.	**Module–2 Carrier and Symbol Synchronization** Receiver design requirements, Signal Parameter estimation: Carrier recovery and symbol synchronization in signal demodulation, Carrier Phase estimation, Symbol timing estimation, Joint estimation of Carrier Phase and Symbol timing, Performance characteristics of ML estimators.	5
3.	**Module–3 Channel Equalization** The channel model, Receiver front end, Eye diagram, Maximum Likelihood sequence estimation, Geometrical model for suboptimal equalizer design, Linear equalization, adaptive implementations, Decision feedback equalization, Performance analysis of MLSE, iterative equalization and Decoding-Turbo equalization.	6
4..	**Module–4 Latest Digital Communication Techniques** Physical modelling for wireless channels, Fading and diversity, OFDM, CDMA, MIMO- linear array, Beam-steering, MIMO-OFDM, Spatial Multiplexing, Space-time coding, mmWave Communication, 4G, 5G standard.	6

Lab Work: Projects and case study with the latest tools (Experimental and simulation tools facilities) available in the respective Lab.

List of Simulations & Experiments:		**No. of Hours**
1	Design the optimal receiver for AWGN Channel	2*2
2	Evaluate BER performance for coherent and non-coherent receivers	2*2
3	Design carrier phase estimation in signal demodulation	2*2
4	Design Symbol time estimation in signal demodulation	2*2
5	Implementing maximum likelihood sequence estimation	2*2
6	Implement iterative equalization and decoding-Turbo equalization.	2*2
7	Design and analysis of MIMO-OFDM system	2*2

Course Outcomes:

At the completion of this course, students will be able to:	
1.	Understand the principle behind the designing of optimal receivers for AWGN and bandlimited channels.
2.	Analyze and compare the performance of different digital signaling techniques and judge their applicability and performance in different application scenarios.
3.	Apply the techniques used for carrier and symbol synchronization for receiver design
4.	Understand the different channel Equalization Techniques to reduce ISI and Noise effects
5.	Analyze the performance of emerging wireless communication standards like 4G, 5G and different WLAN that include MIMO, mmWave communication,

Suggested Books:

Sr. No.	**Authors/Name of Book/ Publisher**	**Year of Publication**
1.	Proakis, J.G. and Saheli, M., “Digital Communications”, 5thEd., McGraw-Hill	2008
2.	Barry, J.R., Lee, E.A. and Messerschmitt, D.G., “Digital Communication”, 3rd Ed., Kluwer	2004
3	R. G. Gallager, Principles of Digital Communication, Cambridge Univ. Press	2008
4	A. R. S. Bahai, B. R. Saltzberg, M.Ergen Multi-carrier Digital Communications: Theory and Applications of OFDM (2nd Edition), Springer	2004
5	Simon Haykin and Michael Moher , Modern Wireless Communications, Pearson Prentice Hall	2005

	PO1	**PO2**	**PO3**
CO1	3	-	3
CO2	3	-	3
CO3	3	-	3
CO4	3	-	3
CO5	3	3	3

Course Name	**:**	**Advanced Wireless Communications**
Course Code	**:**	**ECR1105**
Credits	**:**	**3.0**
L T P	**:**	**2 0 2**

Total No. Lectures: 28
No. of Lab Hours:28

Course Objectives:

- To learn the different channel models, modulation and multiple access techniques in wireless communications and analyse the capacity of different wireless channels.
- To acquaint the students with the concepts and the issues involved in the design of wireless sensor networks and latest wireless communication technologies.

Course Contents:

Sr. No.	Course contents	No. of Lectures
1.	**Module -1: Overview of Wireless channel Modelling and its capacity** The wireless channel: physical modeling, linear time-varying system, discrete-time baseband model, time and frequency coherence; Point-to-Point Communication: detection, diversity, spatial multiplexing; Cellular Systems: multiple access and interference management, Capacity of point-to-point wireless channels: single and multi-antenna; Capacity of single-antenna multiuser channels, Point-to-Point multi-antenna (MIMO) channels and spatial multiplexing, point-to-point MIMO capacity and multiplexing architectures.	10
2.	**Module–2: Modulation Techniques for Wireless Communications** Constant envelope modulation techniques, GMSK; OQPSK and π/4 QPSK; Spread spectrum modulation techniques and RAKE receiver; Multicarrier modulation techniques: Orthogonal frequency division multiplexing (OFDM) and its implementation, Performance in fading and multipath channels., Multiple Access Techniques,	7
3.	**Module–3: Introduction to Wireless Sensor Networks** Design factors, WSN architecture, structure of sensor nodes, mobile sensor networks, clustering in WSN, theory of detection in WSN, types of WSN, WSN coverage and connectivity, Distributed Sensing Nodes, Power saving medium access protocols, WPAN (IEEE 802.15), WSN V/s Ad-hoc networks, Applications of WSNs	5
4.	**Module–4: New Age Wireless Technologies and Security** Overview of GSM-architecture, 3G, 4G (LTE and LTE-A), and 5G wireless standards, Spectrum sharing, Small Cell, Heterogenous cellular network, WLAN (IEEE 802.11), WiMAX (802.16), Bluetooth, Zigbee, DTH, Integrated vehicle systems and UAV assisted wireless communication, Green Communication, Security and routing techniques, Cryptography and network security	6

Lab Work: Projects and case study with the latest tools (Experimental and simulation tools facilities) available in the respective Lab.

List of Simulations & Experiments:		**No. of Hours**
1	Study and simulation of Log-normal distribution model	2*1
2	Simulation of Rayleigh and Ricean fading models	2*1
3	Visualize effects of frequency-selective and time selective fading	2*2
4	Implementing water-filling algorithm for calculating the capacity of a wireless channel	2*1
5	Implementing Alamouti space-time block code.	2*2
6	Implement GMSK and OQPSK modulation techniques	2*1
7	Implementing Direct-sequence spread spectrum (DSSS) and Frequency-hopping spread spectrum (FHSS)	2*1
8	Implementing Orthogonal frequency division multiplexing techniques	2*1
9	Implementing heterogeneous cellular network using stochastic geometry models	2*1
10	Implement UAV assisted Wireless network using air to ground channel modelling	2*2
11	Design wireless sensor networks	2*1

Course Outcomes:

At the completion of this course, students will be able to:	
1.	Understand the wireless channel modelling concepts
2.	Analyze the channel capacity in different scenarios
3.	Explain the latest modulation, multiplexing, multiple access techniques utilized in modern wireless communication system
4.	Understand the concepts used behind the implementation of wireless sensor networks and its applications
5.	Appreciate and differentiate the technologies used in latest wireless communication standards

Suggested Books:

Sr. No.	**Authors/Name of the Book/ Publisher**	**Year of Publication/ Reprint**
1	Andrea Goldsmith, Wireless communications, 1st edition, Cambridge University press	2009
2	David Tse and Pramod Viswanath, ``Fundamentals of Wireless Communication," Cambridge University Press	2005
3	T.S Rappaport, Wireless communication, Principles and Practice, 2nd Edition Pearson	2010
4	Gordon L. Stüber, Principles of Mobile Communication, 4th edition, Springer	2017
5	Selmic, Rastko R., Vir V. Phoha, and Abdul Serwadda, Wireless Sensor Networks: Security, Coverage, and Localization, Springer	2016
6	Recent publications in relevant fields	

	PO1	**PO2**	**PO3**
CO1	3	-	3
CO2	3	-	3
CO3	3	-	3
CO4	3	-	3
CO5	3	3	3

Course Name	**:**	**Advanced Digital Signal Processing**
Course Code	**:**	**ECR1106**
Credits	**:**	**3.0**
L T P	**:**	**3 0 0**

Total No. Lectures: 42

Course Objectives:

At the end of this subject students should be able to

- design and analyze the FIR and IIR filters
- get familiarized with the non-parametric and parametric methods of spectral estimation, multirate signal processing and its applications
- utilize the digital signal processing concepts to the speech and radar signals.

Course Contents:

Sr. No.	Course contents	No. of Lectures
1.	**Module -1: Introduction** Review of DFT, FFT, IIR Filters and FIR Filters: Introduction to filter structures (IIR & FIR). Implementation of Digital Filters, specifically 2nd Order Narrow Band Filter and 1st Order All Pass Filter. Frequency sampling structures of FIR, Lattice structures, Forward prediction error, Back ward prediction error, Reflection coefficients for lattice realization, Implementation of lattice structures for IIR filters, Advantages of lattice structures.	10
2.	**Module -2: Non-Parametric Methods** Estimation of spectra from finite duration observation of signals, Nonparametric Methods: Bartlett, Welch & Blackman-Tukey methods, Comparison of all Non-Parametric methods	7
3.	**Module–3: Parametric Methods** Autocorrelation & Its Properties, Relation between auto correlation & model parameters, AR Models – Yule-Walker & Burg Methods, MA & ARMA models for power spectrum estimation, Finite word length effect in IIR digital Filters – Finite word-length effects in FFT algorithms.	8
4.	**Module–4: Multi Rate Signal Processing:** Introduction, Decimation by a factor D, Interpolation by a factor I, Sampling rate conversion by a rational factor I/D, Multistage Implementation of Sampling Rate Conversion, Filter design & Implementation for sampling rate conversion. Examples of up-sampling using an All Pass Filter.	7
5	**Module–5: Applications of Multi Rate Signal Processing** Design of Phase Shifters, Interfacing of Digital Systems with Different Sampling Rates, Implementation of Narrow Band Low Pass Filters, Implementation of Digital Filter Banks, Subband Coding of Speech Signals, Quadrature Mirror Filters, Transmultiplexers, Over Sampling A/D and D/A Conversion. Application of DSP to speech and radar signal processing.	10

Course Outcomes:

At the completion of this course, students will be able to:	
1.	Design, analyze, and implement the FIR and IIR filters
2.	Understand the Non-parametric and parametric methods for spectral estimation
3.	Analyse the multirate signal processing techniques and its applications
4.	Apply the digital signal processing techniques to speech and radar signals

5.	Design problems in the above to be implemented on MATLAB.

Suggested Books:

Sr. No.	Name of Authors/ book/ Publisher	Year of Publication/ Reprint
1	J. G. Proakis & D. G. Manolakis, "Digital Signal Processing: Principles, Algorithms & Applications", 4th Edition, PHI.	2007
2	Alan V Oppenheim & Ronald W Schaffer, "Discrete Time signal processing ", PHI.	1999
3	Emmanuel C. Ifeacher, Barrie. W. Jervis, "DSP – A Practical Approach", 2nd Edition, Pearson Education	2002
4	P.P.Vaidyanathan, "Multi Rate Systems and Filter Banks", Pearson Education.	2004
5	Kaluri V. Rangarao, Ranjan K. Mallik, "Digital Signal Processing: A Practitioner's Approach", ISBN: 978-0-470-01769-2, John Weley.	2006
6	S.Salivahanan, A.Vallavaraj, C.Gnanapriya, "Digital Signal Processing",TMH	2000
7	S. Mitra, "Digital Signal Processing using MATLAB", 2nd Edition	

	PO1	**PO2**	**PO3**
CO1	3	-	3
CO2	3	-	3
CO3	3	-	3
CO4	3	2	3
CO5	3	2	3

Department Elective Courses- Semester I

Course Name	**:**	**Advanced Digital Image Processing**
Course Code	**:**	**ECR1201**
Credits	**:**	**3**
L T P	**:**	**2 0 2**

Total No. Lectures: 28
Total No. of Lab hrs: 28

Course Objectives:

1. To understand the image fundamentals and mathematical transforms necessary for image processing and to study the image enhancement techniques.
2. To understand the image segmentation and representation techniques.
3. To understand how image are analysed to extract features of interest.
4. To introduce the concepts of image registration and image fusion.
5. To analyse the constraints in image processing when dealing with 3D data sets.

Course Contents:

Sr. No.	Course contents	No. of Lectures
1.	**UNIT-I: Image Fundamentals** Introduction, Steps in image processing systems, Image acquisition, Pixel relationships, Frequency domain transformation techniques and their properties, Gray scale and color images.	6
2.	**UNIT II: Image Processing & Enhancement** Image Point Processing: Gray-level mapping, non-liner gray-level mapping, image histogram, histogram stretching, histogram equalization, thresholding. Neighbourhood Processing: Median filter, mean filter, correlation, template matching, edge detection. Color image processing. Morphology: Dilation & erosion, closing & opening and boundary detection. Spatial Image Enhancements- Transformations: Negative, Log, Power, Histogram, Laplacian. Frequency Domain Image Enhancements: 1D FT, Inverse, 2D FT, Filtering, Use of FT, Fast FT. Multi-resolution Expansions: Pyramidal Multi-resolution analysis	7
3.	**UNIT III: Advanced Processing** Statistics of natural images: Power law, Sparsity of DCT coefficients - Laplacian model, Sparsity of wavelet coefficients, dependencies between wavelet coefficients in different sub-bands, Bayesian models: likelihood and prior probability or probability density with examples. Bayesian models: likelihood and prior probability or probability density with examples, Denoising or deblurring using a Laplacian signal prior; derivation of the ISTA algorithm in detail, Denoising or deblurring using a Gaussian signal prior - leading to the Wiener filter	6
4.	**UNIT IV Applications** Introduction to Biomedical signals: Bio-signal Characteristics of Electro Cardiogram (ECG), Electroencephalogram (EEG), Electromyogram (EMG), Phonocardiogram (PCG), Objectives of Biomedical signal analysis, Computer-aided diagnosis. ECG Signal Processing: ECG data acquisition, ECG lead system, ECG parameters and their estimation, ECG QRS detection techniques: Template matching, differentiation based QRS detection techniques. Compressed Sensing: Conventional sensing versus compressed sensing, Application areas of compressed sensing: MRI, video, CT, hyperspectral images, Shannon's sampling theorem and its limitations, Candes'	9

	puzzling experiment, The role of sparsity, Concept of sensing matrix, representation matrix and incoherence between the two.	

Lab Work:

Sr. No.	**List of Experiments**	**Lab hours**
1	MATLAB program to extract different Attributes of an Image	**2*1**
2	MATLAB program for Image Negation	**2*1**
3	MATLAB program for Power Law Transformation	**2*1**
4	MATLAB program for Histogram Mapping and Equalization	**2*2**
5	MATLAB program for Image Smoothening and Sharpening	**2*2**
6	MATLAB program for Edge Detection using Sobel, Prewitt and Roberts Operators	**2*2**
7	MATLAB program for Morphological Operations on Binary Images	**2*2**
8	MATLAB program for Pseudo Coloring	**2*1**
9	MATLAB program for Chain Coding	**2*1**
10	MATLAB program for DCT/IDCT Computation	**2*1**

Course Outcomes:

Upon Completion of the course, the students will be able to

1. Understand image formation and the role human visual system plays in perception of gray and color image data.
2. Apply image processing techniques in both the spatial and frequency (Fourier) domains.
3. Design image analysis techniques in the form of image segmentation and to evaluate the methodologies for segmentation.
4. Conduct independent study and analysis of feature extraction techniques.
5. Understand the concepts of image registration and image fusion.
6. Analyse the constraints in image processing when dealing with 3D data sets
7. Apply image processing algorithms in practical applications.

Suggested Books:

Sr. No.	**Authors/ Name of Book/ Publisher**	**Year of Publication/ Reprint**
1	R.C. Gonzalez and R.E. Woods, “Digital Image Processing”, Addison- Wesley	2009
2	D. A. Forsyth , J. Ponce, “Computer Vision: A Modern Approach”, Prentice Hall	2011
3	R.J. Shalkoff “Digital Image Processing and Computer-Vision”,John Wiley and Sons, New York	2000
4	Anil K. Jain, “Fundamentals of Digital Image Processing”. Pearson Education	1989
5	Rangaraj M Rangayyan, “Biomedical Signal Analysis” –, IEEE Press,	2001
6	Aapo Hyvarinen, Jarmo Hurri and Patrick Hoyer , "Natural Image Statistics", Springer Verlag	2009
7	Simon Foucart and Holger Rauhut, Birkhauser , "A Mathematical Introduction to Compressive Sensing"	2013

	PO1	**PO2**	**PO3**
CO1	3	-	3
CO2	3	-	3
CO3	3	-	3
CO4	3	-	3
CO5	3	-	3
CO6	3	-	3
CO7	3	2	3

Course Name	**:**	**Antenna Theory and Design**
Course Code	**:**	**ECR1202**
Credits	**:**	**3.0**
L T P	**:**	**2 0 2**

Total No. Lectures: 28
No. of Lab Hours: 28

Course Objectives:

By the end of this course, the students should be able to:

- understand the radiation phenomenon from antenna
- analyze any given antenna numerically and able to comment on fundamental parameters of the given antenna.
- Through the lab component of the course, the student will learn the design, and characterization of the antenna through latest commercially available software.
- The fabrication and experimental verification of the antenna will build fundamental concepts in practical environment.

Course Contents:

Sr. No.	Course contents	No. of Lectures
1.	**Module -1: Antenna and Antenna Arrays**: Linear Wire Antennas, Loop Antennas, Arrays: Linear , planar and circular, Antenna Synthesis, Horn Antennas: Corrugate Horn, Dielectric loaded Horns, Conical Horns, Circular aperture antennas, Travelling Wave and Broadband Antennas, Smart Antennas	6
2.	**Module–2: Integral equations, Moment Method, Broadband and Matching Techniques:** Integral Equation method, Finite Diameter wires, Moment Method Solution, Self and Mutual Impedance, Mutual Coupling, Biconical Antenna, Cylindrical Dipole, Folded Dipole, Discone and Conical Skirt Monopole , Matching Techniques	8
3.	**Module–3: Micostrip Antennas:** Rectangular Patch, Circular Patch, Quality Factor, Bandwidth, and Efficiency, Input Impedance,Coupling, Circular Polarization, Arrays and Feed Networks	7
4.	**Module-4 Measurement of antenna parameters** Antenna Measurements, Antenna Ranges, Radiation Patterns, Gain Measurements, Directivity Measurements, Radiation, Efficiency, Impedance Measurements, Current Measurements, Polarization Measurements	7

Software simulation (HFSS/CST/ADS), and Testing of the following experiments.

Sr. No.	List of Experiments	Lab hours
1	Design of Dipole Antenna in free space, and reflector backing	**2*2**
2	Design of a Microstrip patch antenna and its array.	**2*2**
3	Design of a Yagi Uda Antenna Array.	**2*2**
4	Design of a circularly polarized microstrip patch antenna.	**2*2**
5	Measurement of the gain of an antenna under test using gain comparison method.	**2*2**

6	Measurement of the radiation pattern of an antenna under test.	**2*2**
7	Axial ratio measurement of a circularly polarized antenna	**2*2**

Course Outcomes:

At the completion of this course, students will be able to:	
1.	Analyse the characterization of any antenna with its fundamental parameters
2.	Understand the analytical and physical process behind the radiation mechanism of different types of antenna and should be able to derive the radiation of antenna.
3.	Design and characterize the antennas with the given specific performance of antenna parameters through software
4.	Develop the understanding of fabrication and measurement of antenna performance parameters experimentally

Suggested Books:

Sr. No.	Authors/Name of Book/ Publisher	Year of Publication/ Reprint
1	J.D. Kraus, R.J. Marhefka and Ahmad S. Khan, Antennas and Wave Propagation, TMH, New Delhi, 4th ed., (Special Indian Edition),	2010
2	E.C. Jordan and K.G. Bahrain, Electromagnetic Waves and Radiating Systems,. PHI, 2nd ed.,	2000
3	C.A. Balanis Antenna Theory, John Wiley & Sons, 3rd ed..	2005
4	Stutzman, W.L. and Thiele, H.A., “Antenna Theory and Design”, 2nd Ed., John Wiley & Sons.	1998
5	Elliot, R.S., “Antenna Theory and Design”, Revised edition, WileyIEEE Press.	2003
6	Recent Publications in relevant field	

	PO1	PO2	PO3
CO1	2	2	3
CO2	1	1	2
CO3	1	1	3
CO4	3	1	2
CO5	3	3	3

Course Name	**:**	**Micro and Nano Technology**
Course Code	**:**	**ECR1203**
Credits	**:**	**3**
L T P	**:**	**3-0-0**

Course Objectives:

1. To impart knowledge of device physics/operation, technologies and problems/issues with micro-nano devices and how to overcome these problems.
2. To make student familiar with the basic concepts of nano electronics and followed by the advanced understanding of the nano-micro fabrication techniques.
3. To make student understand the impact of the physical and chemical processes of integrated circuit fabrication technology on the design of integrated circuits.

Total No. of Lectures – 42

Lecture wise breakup		**Number of Lectures**
1	**REVIEW OF SEMICONDUCTORS AND MOSFETS:** Brief recapitulation- band theory, FD statistics, recombination effects and bipolar junction devices. MOSFETs, MOS device modeling-long channel effects, short channel structures scaled down device models, subthreshold conduction.. High frequency devices-metal semiconductor contacts. MESFETS.	6
2	**EMERGING NANOSCALE DEVICES and INTERCONNECTS** History of semiconductor devices, Moore's law, feature size and minimum feature size trend. Si and hetero-structure nanowire MOSFETs, carbon nanotube MOSFETs, Tunnel FET, quantum wells, quantum wires and quantum dots, Resonant tunneling devices, Single electron transistors, Junctionless transistors, Spintronics devices. Optical interconnects, Superconducting interconnects, Nanotechnology interconnects, Silicon nanowires, Carbon nanotube (CNT) and Graphene nanoribbon (GNR) interconnects, performance comparison of CNTs, GNRs and copper interconnects.	6
3	**CRYSTAL GROWTH, WAFER PREPARATION, EPITAXY AND OXIDATION** Electronic Grade Silicon, Czochralski crystal growing, Silicon Shaping, processing consideration, Vapor Phase Epitaxy, Molecular Beam Epitaxy, Silicon on Insulators, Epitaxial Evaluation, Growth Mechanism And kinetics, Thin Oxides, Oxidation Techniques and Systems, Oxide properties, Redistribution of Dopant At interface, Oxidation of Poly Silicon, Oxidation inducted Defects.	12
4	**NANO-FABRICATION:** **LITHOGRAPHY AND RELATIVE PLASMA ETCHING** Optical Lithography, Electron Lithography, X-Ray Lithography, Ion Lithography, Plasma properties, Feature Size control and Anisotropic Etch mechanism, relative Plasma Etching techniques and Equipment. **DEPOSITION, DIFFUSION, ION IMPLEMENTATION AND METALLIZATION** Epitaxy and Thin Film Deposition, Film growth: PVD Processes Evaporation (Thermal and ebeam), Chemical Growth Fundamentals of CVD growth Processes, Modern variants: MOCVD, PECVD and ALD Spin Coating. Annealing Shallow junction – High energy implantation – Physical vapors Deposition – Patterning	12
5	**CHARACTERISATION TECHNIQUES** Morphological characterisation: Raman, XRD, SEM, AFM; Electrical Characterisation: Electrical measurement techniques, two probe and four probe measurement technique; RF characterisation	4
6	**APPLICATIONS**	2

	Introduction to novel smart materials, Photovoltaic technology and design, Flexible electronics, Emerging Memory technologies (Magnetic, Phase Change, Resistive) Molecular Switches and logic gates and Introduction to electronics and Bio sensors.	

Course Outcomes: By the end of this course, the student will be able to :	
1	Understand physics behind nano-scaled semiconductor devices with the physical insight of their functional characteristics.
2	Analyse thin body MOSFET structure and impacts of substrate on the performance
3	Understand, Define, Explore and Characterize novel materials for futuristic micro-nano devices.
4	Explain how micro-nano devices are fabricated and characterized.
5	Understand the fundamental function of micro-nano materials and devices & describe the various applications of nanotechnology in Communications systems, Energy harvesting, biotechnology & medicine.

Suggested Books:

Sr. No.	**Authors/Name of Book/ Publisher**	**Year of Publication/ Reprint**
1	Yuan Taur & Tak H. Ning, Fundamentals of Modern VLSI Devices, 3rd Edition, Cambridge University Press	2021
2	Risal Singh & Shipra Mital Gupta, Introduction to Nanotechnology, First Edition, Oxford India press	2016
3	Marc Madou, Fundamentals of Microfabrication and Nanotechnology (3rdEdition), (CRC Press)	2011
4	Chang, C.Y. and Sze, S.M., “ULSI Technology”, McGraw-Hill	1996
5	Gandhi, S. K., “VLSI Fabrication Principles: Silicon and Gallium Arsenide”, 2nd Edition, John Wiley and Sons	2008

	PO1	**PO2**	**PO3**
CO1	-	-	2
CO2	-	-	2
CO3	-	-	3
CO4	2	-	3
CO5	2	2	3

Course Name	**:**	**Analog and Digital VLSI Design**
Course Code	**:**	**ECR1204**
Credits	**:**	**3**
L T P	**:**	**2-0-2**

Course Objective: The course on Digital and Analog integrated circuits deals with the key principles of design and analysis of basic VLSI circuits and their fabrication technology.

		Total No. of Lectures - 28
Lecture wise breakup		**No. of Lectures**
DIGITAL VLSI DESIGN		
1.	CMOS Inverter: CMOS Inverter Analysis and Design, Bi-CMOS Inverters, Latch up in CMOS Circuits, Pass Transistor, Transmission Gate, NMOS Inverter, Various Pull-ups, switching characteristics- delay time calculation.	4
2.	Combinational Logic Circuit, Transistor sizing in static CMOS logic gates, static CMOS logic gate sizing considering method of logical effort, dynamic logic, pass-transistor logic, common mode and other cross-coupled logic families. Building Block, Multiplexer, De multiplexer, Decoder, Encoder, Code Converters.	6
3	Layout design rules, Lambda based design rule, CMOS Inverter Layout, Intra-Layer Design Rules, Colour Codes, Designing of Interconnects between poly and diffusion.	4
ANALOG VLSI DESIGN		
4.	Analog MOS Process (Double Poly Process), fabrication of active devices, passive devices and interconnects, capacitors and resistors, substrate coupling, ground bounce. Single stage amplifiers: Common source stage, source follower, common gate stage, cascode, Folded cascode	5
5	Differential Amplifier, General considerations, theory and design, performance parameters, single-stage Op Amps, two-Stage Op Amps, design of 2-stage MOS Operational amplifier, gain boosting, comparison of various topologies, slew rate, offset effects, PSRR. Stability and Frequency Compensation: General Considerations, multi-pole systems, phase margin, frequency compensation, compensation techniques	9

Lab Work: Projects and case study with the latest tools (Experimental and simulation tools facilities) available in the respective Lab.

Sr. No.	Lab contents	No. of Hours
1.	To plot the output characteristics, Transfer characteristics of an n-channel and P-channel MOSFET.	2*1
2.	To design and plot the static (VTC) and dynamic characteristics of a digital CMOS inverter	2*1
3.	To design and plot the output characteristics of a 3-inverter ring oscillator	2*1
4.	To design and plot the dynamic characteristics of 2-input NAND, NOR, XOR and XNOR logic gates using CMOS technology.	2*1

5.	To design and plot the characteristics of a 4x1 digital multiplexer using pass transistor logic.	2*1
6.	To design and plot the characteristics of a positive and negative latch based on multiplexers	2*1
7.	To design and plot the characteristics of a master-slave positive and negative edge triggered registers based on multiplexers.	2*1
8.	Design and simulation of a simple 5 transistor differential amplifier. Measure gain, ICMR, and CMRR.	2*1
9.	To design layout of : a. NMOS and CMOS inverter. b. 2-input NAND, NOR gates	2*1
10.	Analysis of Frequency response of a. Common source amplifiers. b. Common drain amplifiers	2*1
11.	To design layout of NMOS and CMOS inverter.	2*1
12.	Design and Simulation of Single Stage Cascode Amplifier.	2*1
13.	Design and Simulation of Basic Current Mirror, Cascode Current Mirror Amplifier	2*2

Topics for Mini-Projects:

- To perform the case study on design and analysis of A Low Power, Compact Size, Supply Independent Bandgap Reference (https://github.com/vsao/BGR)

Course Outcomes: By the end of this course, the student should be able to:	
1.	Design CMOS inverters with specified noise margin and propagation delay.
2.	Apply efficient techniques at circuit level for improving power and speed of combinational and sequential circuits
3.	Understand the layout of analog and digital VLSI circuits and analyse the parasitic calculation
4.	Apply suitable topologies of the constituent sub systems and corresponding circuits as per the specifications of the system
5.	Design basic building blocks like sources, sinks, mirrors, up to layout level.

Suggested Books:

Suggested books:		
Sr. No.	**Authors/Name of Book/ Publisher**	**Year of Publication/ reprint**
1.	Jan M Rabaey, Digital Integrated Circuits, 2nd Edition, Pearson Education	2003
2.	Sung-Mo Kang, CMOS Digital Integrated Circuits, McGraw-Hill	2002
3.	P R Gray and R G Meyer, Analysis and Design of Analog Integrated Circuits, 5th Edition, Wiley	2009

	PO1	**PO2**	**PO3**
CO1	3	2	3
CO2	3	2	3
CO3	3	-	3
CO4	3	-	3
CO5	3	2	3

Course Name	**:**	**PHOTONIC DEVICES AND CIRCUITS**
Course Code	**:**	**ECR1205**
Credits	**:**	**3**
L T P	**:**	**2-0-2**

Course Objective: The course on photonic integrated circuits (PICs) deals with the key principles underlying the analysis and design of integrated photonic devices and circuits. Various aspects that will be dealt are optical waveguide theory; passive and active devices, dynamic and functional devices; materials and fabrication technology.

Total No. of Lectures - 28

Lecture wise breakup		No. of Lectures
1.	**Introduction:** Distinction between electronic, optoelectronic and photonic devices; Electrical and optical bandwidth, requirement of Photonic Integrated circuits	2
2.	**Advanced On-Chip Waveguides:** Planar slab waveguides, symmetric and asymmetric waveguides; rectangular waveguides, Marcatili's method, Effective index method; graded index waveguides; loss in planar slab waveguide; Silicon-on Insulator waveguide, Silicon plasmonic waveguide, and silicon wire waveguide, Coupled mode theory and applications.	8
3	**Advanced Integrated Photonic Devices:** Couplers, multimode interference based couplers, tapers, bends, y- branch, gratings, switches, filters, resonators, On chip Semiconductor Sources (LDs (Double heterojunction, DFB, Quantum wire & dot), On chip Semiconductor Detectors (various types, their Structure and analysis)	8
4.	**On Chip Photonic Device Fabrication Technology:** Materials-glass, lithium niobate, silicon, compound semiconductors(III-V compounds, SiGe etc.), polymers, metamaterial, graphene and other 2d materials; fabrication techniques - lithography, ion-exchange, deposition, diffusion process, and device characterization, packaging and environmental issues.	7
5.	**Integration Of Photonic Devices:** Major Issues, photonic device integration, photonic-electronic integration, power and power density issues on-chip.	3

List of Experiments:

Sr. No.	Lab contents	No. of Hours
1.	Introduction to photonic integrated circuits and its applications.	2*1
2.	Hands-on to photonic device simulation environment. a. FDTD (FullWave) b. FEM (FemSIM)	2*2
3.	Hands-on to photonic system simulation environment (Optisim / VPI Photonics / Lumerical Interconnect).	2*2
4.	Introduction to Si-photonics design and layout.	2*1
5.	To Design, simulate and characterize a straight waveguide using FEMSIM (or any mode solver).	2*2

6.	To Design, simulate and analyze power transmission, power crossing, insertion loss and S-parameters of a waveguide crossing (coupler) using FDTD and creating an Optisim S-parameter compact model.	2*2
7.	To Design, simulate and analyze the insertion loss and transmission of a Y-branch using FDTD and creating an Optisim S-parameter compact model.	2*2
8.	Design a grating coupler connecting a single-mode fiber on the surface of a photonic chip to an integrated waveguide.	2*2

Course Outcomes: By the end of this course, the student should be able to:	
1.	Illustrate the importance of photonics integration and its applications
2.	Design and analyse optoelectronics and photonics devices such as planar waveguides, high speed laser diodes, tapers, bends and couplers etc.
3.	Describe fabrication technology and select the materials for design of optoelectronic device.

Suggested books:

Sr. No.	Authors/Name of Book/ Publisher	Year of Publication/ reprint
1.	C R Pollock and M Lipson: Integrated photonics, Kluwer Academic Pub,	2003
2.	Govind P Agrawal: Lightwave technology: component and devices, John Wiley ,	2004
3.	.Katsunari Okamoto: Fundamentals of Optical Waveguides Academic Press	2006
4.	Daryl Inniss, Roy Rubenstein, Silicon Photonics: Fueling the Next Information Revolution	Latest edition
5.	Arons, Arnold B., and M. B. Peppard. "Einstein's Proposal of the Photon Concept—a Translation of the Annalen der Physik Paper of 1905." American Journal of Physics 33.5 (1965): 367-374.	
6.	Soref, Richard. "Silicon photonics: a review of recent literature." Silicon 2.1 (2010): 1-6.	

Topics for Mini-Projects:

- To perform the case study on design and analysis of MZI-Semiconductor-Based All-Optical Switch With Switching Gain (https://opg.optica.org/DirectPDFAccess/8476A682-4F4D-4F72-93A11D2EF70EA493_294395/jlt-32-13-2433.pdf?da=1&id=294395&seq=0&mobile=no)

Department Elective Courses- Semester II

Course Name	**:**	**Information Theory and Coding**
Course Code	**:**	**ECR1251**
Credits	**:**	**3.0**
L T P	**:**	**3 0 0**

Total No. Lectures: 42

Course Objectives:

The main objectives of this course are:

- To define and apply the basic concepts of information theory (entropy, channel capacity etc.)
- To learn the principles and applications of information theory in communication systems
- To study various data compression methods and describe the most common such methods
- To understand the theoretical framework upon which error-control codes are built

Course Contents:

Sr. No.	Course contents	No. of Lectures
1.	**Module -1: Information theory** Concept of amount of information, information units Entropy: marginal, conditional, joint and relative entropies, relation among entropies Mutual information, information rate, channel capacity, redundancy and efficiency of channels Discrete channels – Symmetric channels, Binary Symmetric Channel, Binary Erasure Channel, Noise-Free Channel, Channel with independent I/O, Cascaded channels, repetition of symbols, Binary asymmetric channel, Shannon theorem.	12
2.	**Module -2: Source Coding Channel Coding** Source coding – Encoding techniques, Purpose of encoding, Instantaneous codes, Construction of instantaneous codes, Kraft's inequality, Coding efficiency and redundancy, Source coding theorem. Construction of basic source codes – Shannon Fano coding, Shannon Fano Elias coding, Huffman coding, Minimum variance Huffman coding, Adaptive Huffman coding, Arithmetic coding, Dictionary coding – LZ77, LZ78, LZW, ZIP coding Channel coding, Channel coding theorem for DMC	10
3.	**Module–3: Codes for error detection and correction** Parity check coding, Linear block codes, Error detecting and correcting capabilities, Generator and Parity check matrices, Standard array and Syndrome decoding, Hamming codes Cyclic codes – Generator polynomial, Generator and Parity check matrices, Encoding of cyclic codes, Syndrome computation and error detection, Decoding of cyclic codes, BCH codes, RS codes, Burst error correction	10
4.	**Module–4: Convolutional codes** Encoding and State, Tree and Trellis diagrams, Maximum likelihood decoding of convolutional codes -Viterbi algorithm, Sequential decoding -Stack algorithm. Interleaving techniques – Block and convolutional interleaving, Coding and interleaving applied to CD digital audio system - CIRC encoding and decoding, interpolation and muting. ARQ – Types of ARQ, Performance of ARQ, Probability of error and throughput	10

Course Outcomes:

At the completion of this course, students will be able to:	
1.	Understand the notion of information in a mathematically sound way
2.	Explain what is the significance of this quantitative measure of information in the communications systems
3.	Analyze entropy, joint entropy, relative entropy, conditional entropy, and channel capacity of a system
4.	Evaluate the differences between lossy and lossless compression techniques
5.	Design an efficient data compression scheme for a given information source
6.	explain the impact of feedback and/or many senders or receivers on the communication systems

Suggested Books:

Sr. No.	Authors/Name of Book/ Publisher	Year of Publication
1.	J. A. Thomas and T. M. Cover: Elements of information theory, Wiley	2006
2.	J. H. van Lint: Introduction to Coding Theory, Third Edition, Springer	1998
3	R. J. McEliece, The Theory of Information and Coding, Cambridge University Press	2004
4	R. Togneri, C.J.S deSilva, Fundamentals of Information Theory and Coding Design, Taylor and Francis.	2003
5	M. Medard and A. Sprintson, (editors): Network Coding – Fundamentals and Applications, Acadamic Press	2012
6	R. Bose, Information Theory Coding and Cryptography, Tata McGraw Hill	2002

	PO1	**PO2**	**PO3**
CO1	3	-	3
CO2	3	-	3
CO3	3	-	3
CO4	3	-	3
CO5	3	2	3
CO6	3	-	3

Course Name	**:**	**Advanced Embedded Systems Design**
Course Code	**:**	**ECR1252**
Credits	**:**	**3**
L T P	**:**	**3-0-0**

Course Objectives:
1. To make students familiar with the basic concepts of embedded systems, applications in which they are used and various aspects of embedded system design from Hardware and Software point of view. 2. To equip students with knowledge and experience of Architecture & Programming concepts of ARM microcontrollers and their supportive devices. 3. To impart an in-depth understanding of different tools and methodologies needed for the development of smart, effective and low-cost embedded system applications.

Total No. of Lectures – 28

Lecture wise breakup		**Number of Lectures**
1	**INTRODUCTION TO EMBEDDED SYSTEMS:** Evolution of microprocessors and embedded systems. General purpose computers vs Embedded systems. Performance and power consumption, Moore's law, Amdahl's law. ARM. Classifications: RISC, CISC, Flynn's Classification, Big and little endian CPI. Computer Architecture: Pipelining stages, Superscalar processing, Throughput and latency.	5
2	**INTRODUCTION TO EMBEDDED SYSTEMS HARDWARE AND SOFTWARE:** Terminology – Gates – Timing diagram – Memory – Microprocessor buses – Direct memory access – Interrupts – Built interrupts – Interrupts basis – Shared data problems – Interrupt latency - Embedded system evolution trends – Interrupt routines in an RTOS environment.	5
3	**EMBEDDED NETWORKING:** Embedded Networking: Introduction, I/O Device Ports and Buses- Serial Bus communication protocols -RS232 standard – RS422 – RS485 – CAN Bus -Serial Peripheral Interface (SPI) – Inter Integrated Circuits (I2C) -need for device drivers.	4
4	**ARM ARCHITECTURE: STM32L15xxx ARM Cortex M3/M4 Microcontroller:** Memory and Bus Architecture, Power Control, Reset and Clock Control. STM32L15xxx Peripherals: GPIOs, System Configuration Controller, NVIC, ADC, Comparators, GP Timers, USART.	8
5	**OVERVIEW OF CORTEX-M3 CORTEX-M3 BASICS:** Registers, general purpose registers, stack pointer, link register, program counter, special registers, operation mode, exceptions and interrupts, vector tables, stack memory operations, reset sequence. **Instruction Sets:** Assembly Basics, Instruction List, Instruction Descriptions. **Cortex-M3 Implementation Overview:** Pipeline, Block Diagram, Bus Interfaces on Cortex-M3, I-Code Bus, D-Code Bus, System Bus, External PPB and DAP Bus.	7
6	**CORTEX-M3/M4 PROGRAMMING:** Typical Development Flow, CMSIS (Cortex Microcontroller Software Interface Standard), Using Assembly. **Exception Programming:** Using Interrupts, Exception/Interrupt Handlers, Software Interrupts, Vector Table Relocation. **Memory**	7

	Protection Unit and other Cortex-M3 features: MPU Registers, Setting Up the MPU, Power Management, Multiprocessor Communication.	
7	**Case Study and Embedded System Application Development:** Embedded system applications in home, infrastructures, buildings, security, Industries, Home appliances etc. Industry 4.0 concepts. Sensors and sensor Node and interfacing using any Embedded target boards (ARM Cortex).	7

Course Outcomes: By the end of this course, the student will be able to	
1	Understand and explore various Embedded Development Strategies, Tools and Techniques available for design and development of embedded system applications. Make and present report on them
2	Substantiate the role of different software modules in the development of an embedded system
3	Understand, Define, Explain and Explore Architecture and Programming of ARM microcontrollers.
4	Incorporate suitable microcontroller along with appropriate interfacing circuits and implement the same for an application with software programs.
5	Design systems based on ARM micro-controller to solve modern day problems.

Suggested Books:

Sr. No.	**Authors/Name of Book/ Publisher**	**Year of Publication**
1.	Rajkamal, Embedded System-Architecture, Programming, Design, Mc Graw Hill,	2013
2.	Peckol, Embedded system Design, John Wiley and Sons,	2010
3	Lyla B Das, Embedded Systems-An Integrated Approach, Pearson,	2013
4	Steve Furber, “ARM System-on-Chip Architecture”, 2nd Edition, Pearson Education	2007
5	STM32L152xx ARM Cortex M3 Microcontroller Reference Manual	

	PO1	**PO2**	**PO3**
CO1	3	3	1
CO2	-	2	3
CO3	-	-	3
CO4	-	-	3
CO5	3	1	3

Course Name	**:**	**MICROWAVE THEORY AND TECHNIQUES**
Course Code	**:**	**ECR1253**
Credits	**:**	**3.0**
L T P	**:**	**2 0 2**

Total No. Lectures: 28
No. of Lab Hours: 28

Course Objectives:

- By the end of this course, the students should be able to familiar with the microwave network characterization parameters. The student should develop understanding to design the microwave passive and active devices with specified performance constraints. To develop the understanding for fabrication and measurement of microwave devices.

Course Contents:

Sr. No.	Course contents	No. of Lectures
1.	**Module -1:Introduction and Microwave Devices**: Scattering Parameters for microwave Circuits. Power, Frequency and impedance, measurement, Network Analyser and measurement of scattering parameters, Smith Chart, Impedance Matching, Power dividers, Combiners, Couplers	5
2.	**Module–2: Microwave Filters:** Periodic structures, Filter design by Image parameter method, Filter design by Insertion loss method, Filter transformations, Filter Implementation, Stepped Impedance low pass filters, coupled line filters, filters using resonators	8
3.	**Module–3: Active Microwave Circuits** Noise in Microwave Circuits, Detectors and Mixers, PIN Diode Phase Shifters, Microwave Integrated circuits, Overview of Microwave sources	7
4.	**Module-4 Design of Microwave Amplifiers and Oscillators** Characteristics of Microwave Transistors, Gain and stability: Two port power gains, Single stage amplifier: design for maximum gain, Constant gain circles and design for specified gain, Broadband Transistor amplifier design, Oscillator Design	8

Software simulation (HFSS/CST/ADS), and Testing of the following experiments.

S.NO.	LIST OF EXPERIMENTS	LAB HOURS
1	Studies on the input impedance characteristics of a terminated transmission line	2
2	Impedance matching of a terminated transmission line	2
3	Design of power divider for equal and unequal power division.	2
4	Design a coupler for equal and unequal power division using numerical software (HFSS/CST/ ADS). Comment on the S-matrix of both the couplers.	2
5	Design a low/bandpass/high pass micostrip filter using maximally flat/binomial/chebyshev techniques.	2
6	Design of an RF amplifier (Power Amplifier, Low Noise Amplifier)	2
7	Design of RF mixer.	2

Course Outcomes:

At the completion of this course, students will be able to:	
1.	Understand the design and characterization of microwave active and passive devices
2.	Design matching sections in microwave networks
3.	Design a microwave active/passive device for a given specific performance parameter.
4.	Design and characterization of microwave passive and active devices using software
5.	Develop the ability to perform microwave measurements

Suggested Books:

Sr. No.	**Authors/Name of Book/ Publisher**	**Year of Publication/ Reprint**
1	Pozar, D.M., "Microwave Engineering", 3rd Ed., John Wiley & Son	2004
2	Collin, R.E., "Foundations for Microwave Engineering", 2nd Ed., John Wiley & Sons.	2000
3	Ludwig, R. and Bretchko, P., "RF Circuit Design", Pearson Education	2000
4	Hunter, I., "Theory and Design of Microwave Filters", IEE Press.	2001
5	Edwards, T.C. and Steer M.B., "Foundations for Interconnects and Microstrip Design", 3rd Ed., John Wiley & Sons.	2001

	PO1	**PO2**	**PO3**
CO1	1	3	3
CO2	1	1	2
CO3	1	2	3
CO4	3	1	2
CO5	3	3	3

Course name	:	**VLSI Architechture For DSP**
Course Code	:	**ECR1254**
Credits	:	**3**
LTP	:	**3-0-0**

Course Objectives:

- In this course, students will be introduced to the fundamentals of VLSI signal processing and its applications.
- Students should be able to design and optimize VLSI architectures for basic DSP algorithms.

Number of Lectures 42

S.No	Content	Lectures
1	**Multirate Signal Processing-** Decimation and Interpolation, Spectrum of Decimated and Interpolated Signals, Polyphase Decomposition of FIR Filters and Its Applications to Multirate DSP. Sampling Rate Converters, Sub-Band Encoder. Filter Banks-Uniform Filter Bank. Direct and DFT Approaches.	**5**
2	**Pipelining of FIR digital filters -**Parallel processing for FIR systems -combined pipelining and parallel processing of FIR filters for low power -Pipelining in IIR filters –parallel processing for IIR filters -combined pipelining and parallel processing of FIR filters. Retiming: Introduction, Definition and Properties, Solving System of Inequalities, Retiming Techniques. **Parallel FIR filters -**Discrete time cosine transform -implementation of DCT based on algorithm -architecture transformations -parallel architectures for rank order filters. Scaling and round off noise -round off noise in pipelined IIR filters -round off noise in lattice filters -pipelining of lattice IIR digital filters -low power CMOS lattice IIR filters.	**12**
3	**Unfolding:** Introduction an Algorithms for Unfolding, Properties of Unfolding, Critical Path, Unfolding and Retiming Application of Unfolding. Folding: Introduction to Folding Transformation, Register Minimization Techniques, Register Minimization in Folded Architectures, Folding in Multirate Systems.	**6**
4	**Systolic Architecture Design:** Introduction, Systolic Array Design Methodology, FIR Systolic Arrays, Selection of Scheduling Vector, Matrix Multiplication and 2D Systolic Array Design, Systolic Design for Space Representations Containing Delays.	**10**
5	**Evolution of programmable DSP processors -**DSP processors for mobile and wireless communications -processors for multimedia signal processing -FPGA implementation of DSP processors.	**9**

Couse Outcomes:

At the completion of this course, students will be able to:

1. Apply the mutirate signal processing techniques for different applications of DSP
2. Understand VLSI design methodology for signal processing systems
3. Understand VLSI algorithms and architectures for DSP.
4. Design the basic architectures for DSP using CAD tools.

Suggested Books:

Sr. No.	**Authors/Name of Book/ Publisher**	**Year of Publication**
1.	Keshab K. Parhi, VLSI Digital signal processing Systems: Design and Implementation, John Wiley & Sons,	1999
2.	Uwemeyer- Baes, DSP with Field programmable gate arrays, Springer	2001
3	Digital Signal Processors: Architectures , Implementations and applications, Sen M Kuo, Woon-Seng S. Gan, Prentice Hall	2004
4	DECS integrated circuits, Lars Wanhammar, Academic Press	1999
5	Mohammed Ismail, Terri, Fiez, Analog VLSI Signal and Information Processing, McGraw Hill	1994
6	Kung. S.Y., H.J. While house T.Kailath, VLSI and Modern singal processing, Prentice Hall	1985

	PO1	**PO2**	**PO3**
CO1	3	-	3
CO2	3	-	3
CO3	3	-	3
CO4	3	2	3

Course name	:	**Computer Vision**
Course Code	:	**ECR1255**
Credits	:	**3**
LTP	:	**3-0-0**

Course Objectives:

- To introduce the student to computer vision algorithms, methods and concepts
- To enable the student to implement computer vision systems with emphasis on applications and problem solving.

Number of Lectures 42

S.No	Content	No. of Lectures
1	**Digital Image Formation and low-level processing:** Overview and State-of-the-art, Fundamentals of Image Formation, Transformation: Orthogonal, Euclidean, Affine, Projective, etc; Fourier Transform, Convolution and Filtering, Image Enhancement, Restoration, Histogram Processing. **Introduction to computer vision:** Image classification and clustering, Linear classification, Higher-level representations, Object detection, Bag of words, Object recognition/categorization, Segmentation.	8
2	**Depth estimation and Multi-camera views** Perspective, Binocular Stereopsis: Camera and Epipolar Geometry; Homography, Rectification, DLT, RANSAC, 3-D reconstruction framework; Auto-calibration.	4
3	**Image Segmentation** Region Growing, Edge Based approaches to segmentation, Graph-Cut, Mean-Shift, MRFs, Texture Segmentation; Object detection	4
4	**Feature Extraction** Edges - Canny, LOG, DOG; Line detectors (Hough Transform), Corners - Harris and Hessian Affine, Orientation Histogram, SIFT, SURF, HOG, GLOH, Scale-Space Analysis- Image Pyramids and Gaussian derivative filters, Gabor Filters and DWT.	10
5	**Pattern Analysis** Clustering: K-Means, K-Medoids, Mixture of Gaussians, Classification: Discriminant Function, Supervised, Un-supervised, Semi-supervised; Classifiers: Bayes, KNN, ANN models; Dimensionality Reduction: PCA, LDA, ICA; Non-parametric methods. **Introduction to Neural Networks**: Linear regression, Backpropagation, Cross-validation process, Optimization, Debugging, Convolutional Neural Networks architectures	12
6	**Motion Analysis** Background Subtraction and Modelling, Optical Flow, KLT, Spatio-Temporal Analysis, Dynamic Stereo; Motion parameter estimation.	4

Course Outcomes:

By the end of this course, students will be able to:

1. Design, analyze, and implement algorithms for multidimensional signal processing
2. Understand the Image formation, processing and classifications concepts
3. Apply the learned techniques of feature extraction, and pattern analysis.

4. Apply the learned concept in various applications ranging from biometrics, medical diagnosis, document processing etc.

Suggested Books:

Sr. No.	Authors/Name of Book/ Publisher	Year of Publication
1.	Zohra Saidane, Image and video text recognition using convolutional neural networks: Study of new CNNs architectures for binarization, segmentation and recognition of text images, Publisher: LAP LAMBERT Academic Publishing	2011
2.	Stefan Duffner, Face Image Analysis with Convolutional Neural Networks, Publisher: GRIN Verlag	2013
3	Nikhil Buduma, Fundamentals of Deep Learning, Designing Next-Generation Artificial Intelligence Algorithms, Publisher: O'Reilly Media	2015
4	Michael Nielsen, Neural Networks and Deep Learning, Online Book: http://neuralnetworksanddeeplearning.com	
5	Alex Krizhevsky, Ilya Sutskever, Geoffrey E Hinton , ImageNet Classification with Deep Convolutional Neural Networks, NIPS	2012

	PO1	**PO2**	**PO3**
CO1	3	2	3
CO2	3	-	3
CO3	3	-	3
CO4	3	2	3

Open Elective-I

Course Name	**:**	**Neural Networks and Its Applications**
Course Code	**:**	**ECR3001**
Credits	**:**	**3**
L T P	**:**	**3-0-0**

Course Objectives:
The goals of this course are

- To introduce some of the fundamental techniques and principles of neural computation.
- Basic neural network models, single and multilayer perceptron.
- To investigate some associative Networks
- To introduce some of neural networks based on competition.
- To introduce adaptive neural network models.
- To investigate networks based on gradient descent rules.
- To investigate some special networks and their applications

		Total No. of Lectures: 42
Course Contents		**No. of Lectures**
1.	**Introduction to neural networks**: Introduction to artificial neural networks, biological neural networks, comparison between biological and artificial Neural Networks, terminology and various architectures of Neural Networks, History of Neural Networks.	3
2.	**Fundamental concepts:** MC Culloch-Pitt Neuron model, various Activation functions, Hebbnet, Biases and threshold, Linear separability.	4
3.	**Pattern Classification:** Perceptron, Adaline and Madaline. Architecture, training algorithms and application algorithms of these networks, practical implementation using matlab.	7
4.	**Pattern Association:** Architecture, Training and application Algorithms for Pattern Association networks, Heteroassociative Memory Neural Network, Auto associative Net, Iterative Auto associative Net, Bidirectional Associative Memory, Discrete Hopfield Network, practical implementation of these networks using matlab.	7
5.	**Competitive Nets:** Maxnet, Mexican Hat, Hamming Net, Kohonen Self Organizing Maps, Learning Vector Quantization, Full and Forward Counterpropagation. Application based on these networks. Use of Counterpropagation net for a mathematical function, practical implementation using matlab.	7
6.	**Adaptive and Backpropagation networks:** Adaptive Resonance Theory: Introduction, architecture, algorithm and application of ART1. Backpropagation neural net, architecture, algorithm, variations, applications, derivation of learning rules. Applications based on backpropagation neural net.	7
7.	**Fixed Weight Networks**: Fixed-Weight Nets for Constrained Optimization, Neural Net approach to Constrained Optimization, Boltzmann Machine: architecture, algorithm, Travelling Salesman Problem. Examples based on Boltzmann Machine.	7

Course Outcomes: Upon successful completion of this course, the enrolled students will be able to	
1.	Implement neural networks for pattern classification.
2.	Adequate knowledge about activation functions used for neural networks.
3.	Design a fault tolerant neural network for character recognition.
4.	Application of neural networks to generate functions.
5.	Design multi-layered neural networks to solve complex problems.

6.	Solve complex problems using fixed weight neural networks like Travelling Salesman Problem.

Suggested Books:

S. No.	Name of the book/authors/ publisher	Year of publication/reprint
1.	Laurence Fausett, Fundamentals of Neural Networks, , Pearson Education	2006
2.	K Vinod Kumar, R. Saravana Kumar, Neural networks and Fuzzy Logic, Katson Books	2012
3.	Haykin, Neural Networks and machine learning, Pearson Education	2008
4.	Satish Kumar , Neural Networks, TMH	2001
5.	Introduction to Neural Networks using MATLAB 6.0	2006

	PO1	**PO2**	**PO3**
CO1	2	1	2
CO2	3	1	2
CO3	3	1	3
CO4	3	1	2
CO5	3	1	3
CO6	2	1	3

Course Name	**:**	**Fundamentals of Signal Processing**
Course Code	**:**	**ECR3002**
Credits	**:**	**4**
L T P	**:**	**3-0-0**

Total No. Lectures: 42

Course Objectives:

By the end of this course, the students will

- understand the continuous and digital signals and processing done to retrieve information from these signals.
- identify the challenges in signal processing applications and also learn various transforms, algorithms which will be beneficial to designing and analyzing a signal processor.
- learn processing of signal in different domains of image, speech, bio-medical, and video.

Course Contents:

Sr. No.	**Course contents**	**No. of Lectures**
1.	**Module -1 Introduction**: Fourier methods, Laplace transform, convolution, frequency/time domain processing. Passive and active continuous filters. Linear filter implementation using op-amps, Data converters (A/D, D/A), machine architecture, Sampling and Reconstruction	5
3.	**Module–2: Image processing** Introduction, Image sampling, Quantization, Resolution, Image file formats, Elements of image processing system, Image Transforms, Image Enhancement, Image Restoration, Image Segmentation, Image Compression, Recent applications of image processing	6
4.	**Module-3 Speech processing:** Speech Fundamentals, Signal Processing concepts; Short-Time Fourier Transform, Filter-Bank and LPC Methods., Speech Analysis, Speech Modeling, Speech Recognition, Speech Synthesis	10
5.	**Module-4 Bio-medical processing:** The nature of Biomedical Signals, Examples of Biomedical Signals, Objectives and difficulties in Biomedical analysis, Basic electrocardiography, ECG lead systems, ECG signal characteristics, Signal Conversion, signal averaging, Adaptive Noise Cancelling, Data Compression Techniques, Neurological signal processing, Analysis of EEG channels	11
6	**Module-5 Video Processing:** Analog Video, Digital Video. Time-Varying Image Formation models: Three-Dimensional Motion Models, Geometric Image Formation, Photometric Image Formation, Sampling of Videosignals, Filtering operations.	10

Course Outcomes:

At the completion of this course, students will be able to:	
1.	To understand and distinguish the representations of continuous and discrete time signals.
2.	Understand the production of speech and analyze the coding and speech enhancement techniques.
3.	Understand the challenges and processing of signals for Bio-medical applications.
4.	Understand the representation of digital images in transform domain and applications of image transforms

5	Develop an understanding of sampling, filtering and coding operations in video processing signal.

Suggested Books:

Sr. No.	Name of Book/ Authors/ Publisher	Year of Publication/ Reprint
1	J. Proakis, D. Manolakis , “Digital Signal Processing: Principles, Algorithms and Applications” Prentice-Hall,	2010
2	B. Porat, “A Course in Digital Signal Processing”, J. Wiley and Sons	2000
3	Rafael C. Gonzalez, Richard E. Woods, ‗Digital Image Processing‘, Pearson, Third Edition	2010
4	S. Orfandis “Introduction to Signal Processing,”, Prentice Hall	1995
5	Y. Wang, J. Ostermann and Y. Quin Zhang, Video Processing and Communication, .1st Ed., PH Int	2001
6	L.R. Rabiner and S. W. Schafer, Digital Processing of Speech Signals , Pearson Education	2008

	PO1	**PO2**	**PO3**
CO1	3	-	3
CO2	3	-	3
CO3	3	-	3
CO4	3	-	3
CO5	3	-	3

Course Name	**:**	**Latest Trends in Communication Technologies**
Course Code	**:**	**ECR3003**
Credits	**:**	**4**
L T P	**:**	**3-0-0**

Total No. Lectures: 42
No. of Lab Hours: 42

Course Objectives:

By the end of this course, the students should be able to

- familiar with the latest techniques used in communication systems
- develop understanding to various trends, and problems associated with communication technologies
- develop analytical knowledge to implement it in the research models of the ever changing communication needs.

Course Contents:

Sr. No.	Course contents	No. of Lectures
1.	**Module -1: Introduction to communication**: Cellular Communication. First to Second Generation, Third Generation System, Fourth Generation System, Future Cellular System, Wireless Channels, Multiple Access techniques – FDMA, TDMA, CDMA – Capacity calculations–Cellular concept- Frequency reuse – channel assignment- hand off- interference & system capacity, Fading, Recent applications in wireless communications.	7
2.	**Module–2: Optical Communication:** Introduction to optical fibers, system optical components, Optical communication system and networks, Transmission characteristic of optical fiber, losses, dispersion, bandwidth, Optical sources and detectors, Optical Sensors, Multiplexing techniques, Optical receiver, measurements and coupling, Recent applications in Optical communications.	11
3.	**Module–3: Telecommunication and computer networks:** Data communication and its components: Transmitter, Receiver, Medium, Message, Protocol, Protocols, Standards, Standard organizations, Bandwidth, Data Transmission Rate, Baud Rate and Bits per second, Modes of Communication (Simplex, Half duplex, Full Duplex). Fundamental of Computer Network: Definition and Need of Computer Network, Applications, Network Benefits. Classification of Network: LAN, WAN, MAN Network Architecture: Peer To Peer, Client Server Network	12
4.	**Module-4: Satellite communication** Basics of satellite orbits, Space segment and satellite link design, Modulation and Multiplexing: Voice, Data, Video, Analog – digital transmission system, Digital video Broadcast, multiple access: FDMA, TDMA, CDMA, DAMA Assignment Methods, compression – encryption, Satellite Navigational System. GPS Position Location Principles, Differential GPS, Direct Broadcast satellites (DBS/DTH), Applications in Television, DTH Broadcasting, DSNG and VSAT to exploit the unique capabilities in terms of coverage and outreach recent case studies.	12

Course Outcomes:

At the completion of this course, students will be able to:	
1.	To understand the in-depth knowledge of advances in communication systems
2.	Understand the propagation of the signal through optical fibers, and system design.
3.	Analyze fundamental capacity limits of wireless channels and the characteristics of the capacity-achieving transmission strategies.

4.	Develop the understanding of analyzing the data communication and computer architecture.
5	Understand the methods of satellite access and understand the different applications of satellite communication.

Suggested Books:

Sr. No.	Name of Book/ Authors/ Publisher	Year of Publication/ Reprint
1	Bruce R. Elbert, The Satellite Communication Applications‖, Hand Book, Artech House Bostan London.	1997
2	M.Richharia, Satellite Communication Systems-Design Principles‖, Macmillan	2003
3	A. Goldsmith, Wireless Communications. Cambridge: Cambridge University Press.	2005
4	Gerd Keiser , Optical Fiber Communication 4th Ed., MGH	2008
5	Bhusan Trivedi, Data communication and Networks, Oxford university press	2016

	PO1	PO2	PO3
CO1	3	-	3
CO2	3	-	3
CO3	3	-	3
CO4	3	-	3
CO5	3	-	3

Course Name	**:**	**Design of experiments and research methodology**
Course Code	**:**	**ECR1001**
Credits	**:**	**3**
L T P	**:**	**2-0-2**

Course Objectives:

This course provides a basic introduction to the principles, methods, and techniques of empirical social research

1. Learn the fundamentals of the scientific method and scientific inquiry
2. Develop a grasp of different ethical considerations in research, basic methods of quantitative and qualitative data collection.
3. Acquire knowledge to formulate a coherent research proposal, with well delimited research questions, connected to theory and operationalized into a coherent methodological design.

		Total number of Lectures-28
	Lecture wise breakup	**No. of Lecture**
1	Introduction to Research Methods: Meaning, Objectives, Motivation, Utility. Concept of theory, empiricism, deductive and inductive theory. Characteristics of scientific method – Understanding the language of research – Concept, Construct, Definition, Variable. Research Process. Problem Identification & Formulation – Research Question – Investigation Question – Measurement Issues – Hypothesis – Qualities of a good Hypothesis –Null Hypothesis & Alternative Hypothesis. Hypothesis Testing – Logic & Importance.	**6**
2	Research Design: Concept and Importance in Research – Features of a good research design – Exploratory Research Design – concept, types and uses, Descriptive Research Designs – concept, types and uses. Experimental Design: Concept of Independent & Dependent variables. Qualitative and Quantitative Research: Qualitative research – Quantitative research – Concept of measurement, causality, generalization, replication. Merging the two approaches	**6**
3	Data Collection and Analysis: Techniques of method validation, observation and collection of data, methods of data collection, sampling methods, data processing and analysis strategies and tools, data analysis with statically package (Sigma STAT,SPSS for student t-test, ANOVA, etc.), hypothesis testing.	**5**
4	Interpretation of Data and Paper Writing – Layout of a Research Paper, Journals in Computer Science, Impact factor of Journals, When and where to publish ?, Ethical issues related to publishing, Plagiarism and Self-Plagiarism. Use of tools / techniques for Research: methods to search required information effectively, Reference Management Software like Zotero/Mendeley, Software for paper formatting like LaTeX/MS Office, Software for detection of Plagiarism	**6**
5	Research Ethics, IPR And Scholary Publishing: Ethics-ethical issues, ethical committees (human & animal); IPR- intellectual property rights and patent law, commercialization, copy right, royalty, trade related aspects of intellectual lproperty rights (TRIPS); scholarly publishing-	**5**

	IMRAD concept and design of research paper, citation and acknowledgement, plagiarism, reproducibility and accountability	

Course Outcome: As a result of taking this course students will
1. Develop strong capabilities in the following areas: o Writing a proposal o Conducting a literature review o Constructing a database o Managing, coding, and cleaning data o Describing data
2. Understand and differentiate between qualitative and quantitative methods and the kind of knowledge they produce, including the limitations attached to various methods.
3. Formulate a coherent research proposal, with well delimited research questions, connected to theory and operationalized into a coherent methodological design
4. Understand how to construct different types of research designs, and the strengths and limitations of each approach
5. Create and conduct their own research projects for a thesis, consulting effort, or peer-review publication.

Suggested Books:
1. Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K., 2002. An introduction to Research Methodology, RBSA Publishers
2. Business Research Methods – Alan Bryman & Emma Bell, Oxford University Press.
3. Trochim, W.M.K., 2005. Research Methods: the concise knowledge base, Atomic Dog Publishing.
4. Wadehra, B.L. 2000. Law relating to patents, trademarks, copyright designs and geographical indications. Universal Law Publishing.

CO-PO Mapping:

CO	PO1	PO2	PO3
CO1	**1**	**3**	**-**
CO2	**1**	**3**	**-**
CO3	**-**	**3**	**-**
CO4	**-**	**3**	**-**
CO5	**-**	**3**	**-**