PANIMALAR ENGINEERING COLLEGE

An Autonomous Institution, Affiliated to Anna University, Chennai

(JAISAKTHI EDUCATIONAL TRUST)

Bangalore Trunk Road, Varadharajapuram,
Poonamallee, Chennai – 600 123.

Department of Electronics and Communication Engineering
M.E. Communication Systems

Curriculum and Syllabus
Regulation 2023

VISION

The Department of ECE shall strive continuously to create highly motivated, technologically competent engineers, be a benchmark and a trend setter in Electronics and Communication Engineering by imparting quality education with interwoven input from academic institutions, research organizations and industries, keeping in phase with rapidly changing technologies imbibing ethical values.

MISSION

- Imparting quality technical education through flexible student centric curriculum evolved continuously for students of ECE with diverse backgrounds.
- Providing good academic ambience by adopting best teaching and learning practices.
- Providing congenial ambience in inculcating critical thinking with a quest for creativity, innovation, research and development activities.
- Enhancing collaborative activities with academia, research institutions and industries by nurturing ethical entrepreneurship and leadership qualities.
- Nurturing continuous learning in the state-of-the-art technologies and global outreach programmes resulting in competent world class engineers.

PROGRAMME EDUCATIONAL OBJECTIVES: (PEOs):

- Apply technical knowledge and skills to have successful career in industry, Government and academia as communication engineers.
- Pursue multidisciplinary scientific research in communication and related areas.
- Make use of various state-of art systems and cutting-edge technologies to solve various complex engineering problems.
- Inculcate leadership skills, teamwork, effective communication and lifelong learning to the success of their organization and nation.
- Practice ethics and exhibit commitment in profession to empower/enable rural Communication infrastructure.

PROGRAMME OUTCOMES (POs):

1. An ability to independently carry out research/investigation and development work to solve practical problems.
2. An ability to write and present a substantial technical report/document.
3. 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.
4. Design and analyze RF, Signal processing, Networking, Adaptive and modern Communication systems.
5. Develop the knowledge in 5G communications and beyond techniques, Mmwave communication, smart antennas, Massive MIMO and Wireless sensor networks.
6. Apply various software tools and cutting edge engineering hardware to provide solutions for complex communication engineering problems.

PROGRAMME SPECIFIC OUTCOMES (PSOs):

PSO1: Foundation on Communication System basics : To enable the student to understand the basic principles involved in the design and operation of communication systems based on a solid foundation in signal processing, baseband and band pass communication signal design, radiation systems, electromagnetic, wireless and optical media challenges for transmission and networking and high frequency processing circuits.

PSO2: Foundation on Mathematical concepts : To impart the ability to apply mathematical knowledge to develop new baseband and bandpass techniques, design baseband and bandpass communication circuits and networking protocols, and design and analyse algorithms and circuits for secure communication systems.

PSO3: Foundation on Research Methodology: To facilitate the students to engage with industry and other organizations, to solve engineering problems and to address the technological challenges of the future communication needs.

PANIMALAR ENGINEERING COLLEGE, CHENNAI

(An Autonomous Institution, Affiliated to Anna University, Chennai)

M.E- COMMUNICATION SYSTEMS

CHOICE BASED CREDIT SYSTEM (CBCS)

I - IV SEMESTERS CURRICULUM AND SYLLABI (REGUALTION 2023)

Semester I							
S. No	**COURSE CODE**	**COURSE TITLE**	**Category**	**L/T/P**	**Contact Hours**	**Credit**	**Ext / Int Weightage**
Theory Courses							
1.	23MA2102	Linear Algebra and Probability Techniques	FC	4/0/0	4	4	60/40
2.	23EC2101	Advanced Radiation Systems	PCC	3/0/0	3	3	60/40
3.	23EC2102	Advanced Digital Communication Techniques	PCC	3/0/0	3	3	60/40
4.	23EC2103	Advanced Digital Signal Processing	PCC	3/0/0	3	3	60/40
5.	23RM2101	Research Methodology and IPR	RMC	2/0/0	3	3	60/40
Audit Courses							
6.		Audit Course I	AC	2/0/0	2	0	0/100
Laboratory Courses							
7.	23EC2111	Signal Processing and Communication Laboratory	PCC	0/0/3	3	2	40/60
8.	23EC2112	Antenna Design Laboratory	PCC	0/0/3	3	2	40/60
			TOTAL		**24**	**20**	

Semester II							
S. No	**COURSE CODE**	**COURSE TITLE**	**Category**	**L/T/P**	**Contact Hours**	**Credit**	**Ext / Int Weightage**
Theory Courses							
1.	23EC2201	Advanced Wireless Communication Systems	PCC	3/0/0	3	3	60/40
2.	23EC2202	MIC and RF SystemDesign	PCC	3/0/0	3	3	60/40
3.	23EC2203	Optical Communication and Networking	PCC	3/0/0	3	3	60/40
4.	23EC2204	Wireless Communication Networks	PCC	3/0/0	3	3	60/40
5.		Program Elective I	PEC	3/0/0	3	3	60/40
6.		Program Elective II	PEC	3/0/0	3	3	60/40
Audit Courses							
7.		Audit Course II	AC	2/0/0	2	0	0/100
Laboratory Courses							
8.	23EC2211	RF System Design Laboratory	PCC	0/0/3	3	2	40/60
9.	23EC2212	Advanced Wireless Communication and Networks Laboratory	PCC	0/0/3	3	2	40/60
			TOTAL		**26**	**22**	

Semester III							
S. No	**COURSE CODE**	**COURSE TITLE**	**Category**	**L/T/P**	**Contact Hours**	**Credit**	**Ext / Int Weightage**
Theory Courses							
1.	23EC2301	Millimeter Wave Communication	PCC	3/0/0	3	3	60/40
2.		Program Elective III	PEC	3/0/0	3	3	60/40
3.		Program Elective IV	PEC	3/0/0	3	3	60/40
4.		Program Elective V	PEC	3/0/0	3	3	60/40
5.		Open Elective	OEC	3/0/0	3	3	60/40
Laboratory Courses							
6.	23EC2311	Project Work Phase – I	EEC	0/0/12	12	6	40/60
			TOTAL		**27**	**21**	

Semester IV							
S. No	**COURSE CODE**	**COURSE TITLE**	**Category**	**L/T/P**	**Contact Hours**	**Credit**	**Ext / Int Weightage**
Laboratory Courses							
1.	23EC2411	Project Work Phase – II	EEC	0/0/24	24	12	40/60
			TOTAL		**24**	**12**	

TOTAL NO. OF CREDITS: 75

PROGRAM ELECTIVE COURSE (PEC)

S. No	COURSE CODE	COURSE TITLE	Category	L/T/P	Contact Hours	Credit	Ext / Int Weightage
1.	23EC2901	Advanced Satellite Communication and Navigation Systems	PEC	3/0/0	3	3	60/40
2.	23EC2902	Cognitive Radio Communication & Networks	PEC	3/0/0	3	3	60/40
3.	23EC2903	Advanced Wireless Networks	PEC	3/0/0	3	3	60/40
4.	23EC2904	Software Defined Radio	PEC	3/0/0	3	3	60/40
5.	23EC2905	Communication Network Security	PEC	3/0/0	3	3	60/40
6.	23EC2906	Analog and Mixed Mode VLSI Design	PEC	3/0/0	3	3	60/40
7.	23EC2907	VLSI for Wireless Communication	PEC	3/0/0	3	3	60/40
8.	23EC2908	Radar Signal Processing	PEC	3/0/0	3	3	60/40
9.	23EC2909	Pattern Recognition and Machine Learning	PEC	3/0/0	3	3	60/40
10.	23EC2910	Wireless Adhoc and Sensor Networks	PEC	3/0/0	3	3	60/40
11.	23EC2911	Internet of Things	PEC	3/0/0	3	3	60/40
12.	23EC2912	Network Routing Algorithms	PEC	3/0/0	3	3	60/40
13.	23EC2913	Next Generation Wireless Networks	PEC	3/0/0	3	3	60/40
14.	23EC2914	Multimedia Communications	PEC	3/0/0	3	3	60/40
15.	23EC2915	Digital Audio and Video Broadcasting Technology	PEC	3/0/0	3	3	60/40
16.	23EC2916	Image Analysis and Computer Vision	PEC	3/0/0	3	3	60/40
17.	23EC2917	Cooperative Communications	PEC	3/0/0	3	3	60/40
18.	23EC2918	Machine Learning in Communication Networks	PEC	3/0/0	3	3	60/40
19.	23EC2919	Signal Integrity for High Speed Design	PEC	3/0/0	3	3	60/40
20.	23EC2920	Communication Network Design	PEC	3/0/0	3	3	60/40

21.	23EC2921	Electromagnetic Interference and Compatibility in System Design	PEC	3/0/0	3	3	60/40
22.	23EC2922	Spread Spectrum Techniques and Applications	PEC	3/0/0	3	3	60/40
23.	23EC2923	Multimedia Coding Techniques	PEC	3/0/0	3	3	60/40
24.	23EC2924	Video Processing and Analytics	PEC	3/0/0	3	3	60/40

OPEN ELECTIVE COURSES (OEC)

*(out of 4 courses one course must be selected)

S. No	COURSE CODE	COURSE TITLE	Category	L/T/P	Contact Hours	Credit	Ext / Int Weightage
1.	23OE2001	Security Practices	OEC	3/0/0	3	3	60/40
2.	23OE2002	Network Technologies	OEC	3/0/0	3	3	60/40
3.	23OE2003	Cloud Computing Technologies	OEC	3/0/0	3	3	60/40
4.	23OE2004	Deep Learning	OEC	3/0/0	3	3	60/40

AUDIT COURSES (AC)

S. No	COURSE CODE	COURSE TITLE	Category	L/T/P	Contact Hours	Credit	Ext / Int Weightage
1.	23AC2101	English for Research Paper Writing	AC	2/0/0	2	0	0/100
2.	23AC2102	Disaster Management	AC	2/0/0	2	0	0/100
3.	23AC2201	Value Education	AC	2/0/0	2	0	0/100
4.	23AC2202	Stress Management by Yoga	AC	2/0/0	2	0	0/100

DOMAIN WISE GROUPING OF ELECTIVES

SL. NO	MEDIA PROCESSING	VLSI & RF SIGNAL PROCESSING	COMMUNICATION NETWORKS	ADVANCED WIRELESS TECHNOLOGY
1.	Pattern Recognition and Machine Learning	Analog and Mixed Mode VLSI Design	Next Generation Wireless Networks	Wireless Adhoc and Sensor Networks
2.	Multimedia Communications	VLSI for Wireless Communication	Advanced Wireless Networks	Cooperative communications
3.	Digital Audio and Video Broadcasting Technology	Advanced Satellite Communication and Navigation Systems	Communication Network Security	Communication Network Design
4.	Image Analysis and Computer Vision	Signal Integrity for High Speed Design	Network Routing Algorithms	Software Defined Radio
5.	Multimedia Coding Techniques	Electromagnetic Interference and Compatibility in System design	Machine Learning in Communication Networks	Spread Spectrum Techniques and Applications
6.	Video Processing and Analytics	Radar Signal Processing	Cognitive Radio Communication & Networks	Internet of Things

CREDIT DISTRIBUTION

SL. NO	SUBJECT AREA	CREDITS PER SEMESTER				CREDITS TOTAL	PERCENTAGE
	SEMESTER	I	II	III	IV		%
1	Foundational courses (FC)	4	-	-	-	4	5.33
2	Research Methodology and IPR (RMC)	3	-	-	-	3	4.0
3	Professional Core (PCC)	13	16	3	-	32	42.66
4	Professional Electives (PEC)	-	6	9	-	15	20.0
5	Open Electives (OEC)	-	-	3	-	3	4.0
6	Employability Enhancement Courses (EEC)	-	-	6	12	18	24.0
8	Non-Credit / (Optional)	0	0	-	-	0	0.00
	TOTAL	**20**	**22**	**21**	**12**	**75**	**100**

23MA2102	LINEAR ALGEBRA AND PROBABILITY TECHNIQUES	L	T	P	C
		4	0	0	4

COURSE OBJECTIVES:

- To discuss the concepts on vector spaces, linear transformation, inner product spaces, eigen values and generalized eigenvectors. Apply various methods in linear algebra to solve system of linear equations.
- To develop a fundamental understanding of linear programming models, able to develop a linear programming model from problem description, apply the simplex method for solving linear programming problems
- To apply in computation of probability and random variables in digital process. To concepts of random processes and correlation applied in signals and systems.
- To find the Numerical solution of differential equations, IVP and FVP.
- To expose the basic characteristic features of a queuing system and acquire skills in analyzing queuing models. Using discrete time Markov chains to model computer systems.

UNIT I LINEAR ALGEBRA 12

Vector spaces – Norms – Inner products – Eigen values using QR transformations – QR factorization - Generalized eigenvectors – Singular value decomposition and applications - Pseudo inverse – Least square approximations –Toeplitz matrices and some applications.

UNIT II LINEAR PROGRAMMING 12

Formulation – Graphical solution – Simplex method - Two phase method - Transportation problems - Assignment models - Travelling sales man problem.

UNIT III PROBABILITY AND RANDOM PROCESSES 12

Probability –Random variables - Probability function - Two dimensional random variables - Joint distributions – Marginal and conditional distributions. Random Processes: Classification- Stationary random process- Markov process-Auto correlation- Cross correlation.

UNIT IV NUMERICAL SOLUTION 12

Runge - Kutta method of fourth order for system of IVPs - Numerical stability of Runge - Kutta method – Shooting method, BVP : Finite difference techniques for solution of two dimensional Laplace's and Poisson's equations on rectangular domain and collocation method.

UNIT V QUEUEING MODELS 12

Markovian queues – Single and multi - server models – Little's formula - Steady state analysis – Self -service queue.

TOTAL :60 PERIODS

COURSE OUTCOMES:

Upon completion of the course, students will be able to:

CO1	Conceptualise on vector spaces, linear transformation, inner product spaces, eigenvalues and generalized eigenvectors. Apply various methods in linear algebra to solve system of linear equations.
CO2	Develop a fundamental understanding of linear programming models, able to develop a linear programming model from problem description, apply the simplex method for solving linear programming problems
CO3	Understand Computation of probability and random variables, concepts of random processes and correlation.
CO4	Solve Numerical solution of differential equations, IVP and FVP.
CO5	Conceptualize the principle of optimality and sub-optimization, formulation and computational procedure of dynamic programming. Exposing the basic characteristic features of a queuing system and acquire skills in analyzing queuing models. Using discrete time Markov chains to model computer systems

REFERENCE BOOKS:

1. Bronson, R. and Costa, G. B., “Linear Algebra”, 2nd Edition, Academic Press, 2007.
2. Burden, R. C. and Faires, J. D., "Numerical Analysis ", 9th Edition, Cengage Learning,2016.
3. Gross, D., Shortle, J.F., Thompson, J. M. and Harris, C. M., Fundamentals of Queueing Theory, 4th Edition, Wiley, 2014.
4. Johnson, R.A., Miller, I and Freund J., "Miller and Freund"s Probability and Statistics for Engineers", Pearson Education, Asia, 8th Edition, 2015.
5. Sastry, S. S., "Introductory Methods of Numerical Analysis ",5th Edition, PHI Learning, 2015.
6. Taha H.A., “Operations Research: An Introduction”, 9th Edition, Pearson Education Asia, New Delhi, 2016.
7. T. Veerarajan, “Probability, Statistics and Random Process with Queuing Theory and Queuing Network”, Tata McGraw Hill, 4th Edition, 2017

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3		3	2	2	2
CO2	3		3	2	2	2
CO3	3		3	2	2	2
CO4	3		3	2	2	2
CO5	3		3	2	2	2

23EC2101	ADVANCED RADIATION SYSTEMS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand antenna radiation and its parameters.
- To enhance the student knowledge in the area of various antenna design.
- To design mono pole, dipole and patch antenna
- To impart knowledge about modern antennas.
- To impart knowledge on next generation antennas

UNIT I ANTENNA FUNDAMENTALS & WIRE ANTENNAS 9

Introduction – Types of Antennas – Radiation Mechanism - Current distribution on wire antennas – Maxwell‘s equations – Antenna fundamental parameters – Radiation integrals – Radiation from surface and line current distributions – dipole, monopole, loop antenna.

UNIT II ANTENNA ARRAYS 9

Linear array –uniform array, end fire and broad side array, gain, beam width, side lobe level; Linear array synthesis techniques – Binomial and Chebyshev distributions; Two dimensional uniform arrays; phased array antennas, and adaptive arrays.

UNIT III APERTURES ANTENNAS 9

Field equivalence principle, Radiation from Rectangular and Circular apertures, Babinets principle, Slot antenna; Horn antenna; Reflector antenna, aperture blockage, and design consideration. Microstrip antenna - Radiation Mechanism and Excitation techniques, Rectangular patch – Microstrip array and feed network.

UNIT IV MODERN ANTENNAS & MEASUREMENT TECHNIQUES 9

Smart Antenna, Base station antennas, PIFA – Antennas for WBAN – RFID Antennas – Automotive antennas, MIMO Antennas, Diversity techniques – Antenna impedance and radiation measurements.

UNIT V NEXT GENERATION ANTENNA DESIGN 9

UWB antenna, Vivaldi antenna, Antennas in medicine, Plasma antennas, Wearable Antennas – Conformal, Liquid Crystal Polymer (LCP), Textile and Cloth, Antenna miniaturization for IoT application.

TOTAL :45 PERIODS

COURSE OUTCOMES:

Upon completion of the course, students will be able to:

CO1 Interpret the fundamentals of antenna and design wire antennas
CO2 Understand the design significance of an array antenna
CO3 Understand and design aperture antenna and microstrip patch antenna
CO4 Understand the importance of modern antennas and antennas measurement
CO5 Understand the importance of next generation antennas

REFERENCE BOOKS:

1. Balanis.A, "Antenna Theory Analysis and Design", 4th edition John Wiley and Sons, New York,1982.
2. Hubregt.J.Visser "Antenna Theory and Applications" 1st Edition, John Wiley & Sons Ltd,New York,2012.
3. S.Drabowitch et.al., "Modern Antennas", 2nd Edition Springer science business Media,Inc.2005
4. Xavier Begaud, "Ultra Wide Band Antennas", 1st Edition, ISTE Ltd and John Wiley &Sons Ltd, New York,2013.
5. Prashant Ranjan, "Next-Generation Antennas: Advances and Challenges", 1st edition, Wiley-Scrivener; 2021

WEB REFERENCES:

1. https://www.electronicdesign.com/technologies/passives/article/21769333/welcome-to-antennas 101
2. https://www.tutorialspoint.com/antenna_theory/antenna_theory_fundamentals.htm
3. https://www.microwavejournal.com/articles/29437-antenna-design-analysis-and-simulation
4. https://www.microwaves101.com/encyclopedias/antenna-design

ONLINE COURSES / RESOURCES:

1. https://onlinecourses.nptel.ac.in/noc20_ee20/preview
2. https://www.udemy.com/courses/search/?src=ukw&q=Antennas+for+Wireless+Communications
3. https://www.coursera.org/learn/microwave-antenna
4. https://engineering.purdue.edu/online/courses/antennas-design-application

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1		2	2		
CO2			1	1		
CO3	1		2	2		
CO4	1		3	3	2	
CO5	2		2	3		

23EC2102	ADVANCED DIGITAL COMMUNICATION TECHNIQUES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand the various Bandpass Modulation Techniques
- To understand the different block coded digital communication systems
- To understand the convolutional coded digital communication systems.
- To know the trade-offs involved in the design of basic and advanced coding and modulation techniques.
- To understand the basics of Multicarrier and Multiuser Communications

UNIT I BANDPASS MODULATION AND DETECTION 9

Review of Digital Bandpass Modulation Techniques – PSK, FSK, ASK, QAM, Coherent Detection of PSK and M-PSK, FSK, Non-Coherent detection of DPSK and FSK, Ideal Probability of Bit Error performance, BER for BPSK, MPSK, BFSK, MFSK, BFSK, DPSK, MPSK.

UNIT II BLOCK CODED DIGITAL COMMUNICATION 9

Architecture and performance Binary block codes; Waveform Coding – Antipodal, Orthogonal; Biorthogonal; Transorthogonal - Concepts of Spread spectrum communication - Coded BPSK and DPSK demodulators, Review of Linear block codes; Hamming; Golay codes.

UNIT III CONVOLUTIONAL CODED DIGITAL COMMUNICATION 9

Representation of codes using Polynomial, State diagram, Tree diagram, and Trellis diagram -Decoding techniques using Maximum likelihood - Channel Models: Hard versus Soft Decisions, Viterbi Convolutional Decoding Algorithm, Sequential and Feedback decoding methods.

UNIT IV TRELLIS CODED MODULATION AND TURBO CODE 9

Coded Modulation for bandwidth-constrained channels-Trellis coded modulation; Set Partitioning, Four –state Trellis-coded modulation with 8-PSK signal constellation, Eight- state Trellis code for coded 8-PSK modulation, Eight-state Trellis for rectangular QAM signal constellations; Turbo coding Introduction-Turbo Encoder, Turbo Decoder, Iterative Turbo Decoding.

UNIT V MULTICARRIER AND MULTIUSER COMMUNICATIONS 9

Single Vs multicarrier modulation, orthogonal frequency division multiplexing (OFDM), An FFT algorithmic implementation of an OFDM system, Bit and power allocation in multicarrier modulation, Peak-to-average ratio in multicarrier modulation, Overview of GFDM, FBMC, UFMC. Introduction to CDMA systems, multiuser detection in CDMA systems, optimum multiuser receiver, suboptimum detectors, successive interference cancellation.

TOTAL :45 PERIODS

COURSE OUTCOMES:

Upon completion of the course, students will be able to:

CO1 Develop the ability to understand the concepts of Bandpass Modulation Techniques.
CO2 Possess knowledge on the performance of block codes with modulation.
CO3 Know the working and implementation of Convolution codes
CO4 Design Advanced coded modulation such as Turbo and Trellis Coded Modulation
CO5 Comprehend the generation of OFDM signals and the techniques of multiuser detection.

REFERENCE BOOKS:

1. Bernard Sklar., "Digital Communications", Pearson Education, 2nd Edition, 2001.
2. John G. Proakis., "Digital Communication", Mc Graw Hill Publication, 4th Edition, 2001
3. M.K.Simon, S.M.Hinedi and W.C.Lindsey, "Digital communication techniques; Signal Design and Detection", Prentice Hall of India, New Delhi, 1995.
4. Richard Van Nee & Ramjee Prasad, "OFDM for Multimedia Communications" Artech House Publication, 2001.
5. Simon Haykin, "Digital communications", John Wiley and sons, 1998.
6. Stephen G. Wilson, "Digital Modulation and Coding", First Indian Reprint, Pearson

WEB REFERENCES:

1. https://jwcn-eurasipjournals.springeropen.com/articles/10.1186/s13638-016-0792-0
2. R. Gerzaguet et al., ''The 5G candidate waveform race: A comparison of complexity and performance,'' EURASIP J. Wireless Comm. Netw., vol. 2017, no. 1, p. 13, 2017.

ONLINE COURSES / RESOURCES:

1. Modern digital communication techniques – Swayam Online Learning by Prof. Suvra Sekhar Das, IIT Kharagpur

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2		2	2		
CO2	1		2	2		
CO3	2		3	3		
CO4	2		3	3		
CO5	2		2	2	1	

23EC2103	ADVANCED DIGITAL SIGNAL PROCESSING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- The student comprehends mathematical description and modelling of discrete time random signals.
- The student is conversant with important theorems and random signal processing algorithms.
- The student learns relevant figures of merit such as power, energy, bias and consistency.
- The student is familiar with estimation, prediction, filtering concepts and techniques

UNIT I DISCRETE RANDOM SIGNAL PROCESSING 9

Wide sense stationary process – Properties, Ergodic process – Sample mean & variance - Auto-correlation and Auto-correlation matrices- Properties – White noise process – Weiner Khitchine relation - Power spectral density – Filtering random process – Spectral Factorization Theorem.

UNIT II SIGNAL MODELING 9

Special types of Random Processes – AR, MA, ARMA Processes – Yule-Walker equations. Least square method – Pade approximation – Prony's method.

UNIT III SPECTRUM ESTIMATION 9

Bias and Consistency of estimators - Non-Parametric methods – Periodogram – Modified Periodogram – Barlett's method – Welch's method - Parametric methods – AR, MA and ARMA spectrum estimation - Performance analysis of estimators.

UNIT IV OPTIMUM FILTERS 9

Levinson Recursion – Lattice filter - FIR Wiener filter – Filtering – Linear Prediction – Non Causal and Causal IIR Weiner Filter -– Mean square error.

UNIT V ADAPTIVE FILTERS 9

FIR Adaptive filters - Newton's steepest descent method – Widrow Hoff LMS Adaptive algorithm – Convergence – Normalized LMS – Applications – Noise cancellation - channel equalization – echo canceller – Adaptive Recursive Filters - RLS adaptive algorithm – Exponentially weighted RLS- sliding window RLS.

TOTAL :45 PERIODS

COURSE OUTCOMES:

Upon completion of the course, students will be able to:

CO1 Formulate time domain and frequency domain description of Wide Sense Stationary process in terms of matrix algebra and relate to linear algebra concepts. State W-K theorem, spectral factorization theorem
CO2 Understand and Apply Signal Modeling
CO3 Determine Spectrum estimation, bias and consistency of estimators.
CO4 Apply Levinson recursion algorithm, Design Wiener filtering,
CO5 Develop LMS, RLS algorithms and Know the applications of adaptive filters

REFERENCE BOOKS:

1. Monson H. Hayes, “Statistical Digital Signal Processing and Modeling”, John Wiley and Sons, Inc, Singapore, 2002.
2. John J. Proakis, Dimitris G. Manolakis, “Digital Signal Processing”, Pearson Education, 2002.
3. P. P. Vaidyanathan, “Multirate Systems and Filter Banks”, Prentice Hall, 1992.
4. S. Kay,” Modern spectrum Estimation theory and application”, Prentice Hall, Englehood Cliffs, NJ1988.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1		1	2		
CO2	1		1	1		
CO3	1		3	3		
CO4	1		3	3		
CO5	1		3	3		

23RM2101	RESEARCH METHODOLOGY AND IPR	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To impart knowledge and skills required for research and IPR
- Problem formulation, analysis and solutions.
- Technical paper writing / presentation without violating professional ethics
- Patent drafting and filing patents.

UNIT - I RESEARCH PROBLEM FORMULATION 9

Meaning of research problem- Sources of research problem, criteria characteristics of a good research problem, errors in selecting a research problem, scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, necessary instrumentations

UNIT - II LITERATURE REVIEW 9

Effective literature studies approaches, analysis, Primary and secondary sources – reviews, treatise, monographs-patents – web as a source – searching the web - Critical literature review – Identifying gap areas from literature review - Development of working hypothesis-plagiarism, and research ethics

UNIT - III TECHNICALWRITING 9

Structure and components of scientific reports - Types of report – Technical reports and thesis – Significance – Different steps in the preparation – Layout, structure and Language of typical reports – Illustrations and tables - Bibliography, referencing and footnotes- Plagiarism - Citation and acknowledgement - Reproducibility and accountability.

UNIT - IV INTRODUCTION TO INTELLECTUAL PROPERTY RIGHTS (IPR) 9

Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

UNIT - V INTELLECTUAL PROPERTY RIGHTS (IPR) 9

Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications. New Developments in IPR: Administration of Patent System, IPR of Biological Systems, Computer Software etc. Traditional knowledge.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

Upon completion of the course, students will be able to:

CO1 Formulate research problem

CO2 Carry out research analysis

CO3 Follow research ethics

CO4 Understand that the future belongs to those who evolve by ideas, concept, and creativity along with technology

CO5 Understand about IPR and filing patents in R & D.

REFERENCE BOOKS:

1. Asimov, “Introduction to Design”, Prentice Hall, 1962.
2. Halbert, “Resisting Intellectual Property”, Taylor & Francis Ltd ,2007.
3. Mayall, “Industrial Design”, McGraw Hill, 1992.
4. Niebel, “Product Design”, McGraw Hill, 1974.
5. Ranjit Kumar,“Research Methodology: A Step by Step Guide for beginners” 2nd Edition, 2010.
6. Research Methodology A Practical and Scientific Approach, Vinayak Bairagi, Mousami V. Munot 2019.
7. Research Methodology and Scientific Writing By C. George Thomas · 2021

WEB REFERENCES:

1. https://www.wipo.int/patents/en/
2. https://ipindia.gov.in/patents.htm

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	2			2
CO2	3	3	2			2
CO3	3	3	2			2
CO4	3	3	2			2
CO5	3	3	2			2

23EC2211	SIGNAL PROCESSING AND COMMUNICATION LABORATORY	L	T	P	C
		0	0	3	2

COURSE OBJECTIVES:

- To enable the student to verify the basic principles of random signal processing, spectral estimation methods, and additive white Gaussian noise (AWGN) channel characterization, coding and modulation design, synchronization aspects, and the overall baseband system design.
- To design and conduct experiments, as well as to analyse and interpret data to produce meaningful conclusions and match with theoretical concepts.
- To enable the student to appreciate the practical aspects of baseband system design and understand the associated challenges.
- To study & measure the performance of digital communication systems.

LIST OF EXPERIMENTS

1. Design of adaptive filter using LMS algorithm
2. Design of adaptive filter using RLS algorithm
3. Estimation of power spectrum of the given random sequence using Nonparametric methods (Bartlett, Welch and Blackman Tukey)
4. Generation & detection of binary digital modulation techniques: (a) BASK (b) BPSK (c) BFSK (d) DPSK.
5. Performance comparison of hard decision and soft decision using Viterbi decoding algorithms. Assume BPSK modulation and AWGN channel.
6. Generation of Pseudo random binary sequence for Baseband DSSS.
7. Design of transceiver chain for the following modulation schemes. Observe signals at different points of the communication system.
   (a) M-PAM, (b) M-PSK (c) M-QAM
8. Mini Project

TOTAL :60 PERIODS

COURSE OUTCOMES:

Upon completion of the course, students will be able to:

CO1 Design and conduct experiments to demonstrate the trade-offs involved in the design of basic and advanced coding and modulation techniques and the advanced baseband signal conditioning methods.

CO2 Design and analyse the frequency response of Adaptive filters for the given specifications.

CO3 Apply communication engineering principles and design tools and will be well-practiced in design skills.

CO4 Comprehensively record and report the measured data, write reports, communicate research ideas, and do oral presentations effectively.

CO5 Capable of analysing and interpreting the experimental measurement data and producing meaningful conclusions.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1		1	2		
CO2	1		2	2		
CO3	1	3	1	1		
CO4	1		3	3		
CO5	1		3	3		

23EC2112	ANTENNA DESIGN LABORATORY	L	T	P	C
		0	0	3	2

COURSE OBJECTIVES:

- To enable the students to verify the basic principles and design aspects involved in high frequency antennas
- To know the performance parameters antennas.
- To design and develop an antenna using microstrip technology
- To expose the student to different high frequency antennas and conduct the experiments to analyze and interpret data to produce meaningful conclusion and match with theoretical concepts

LIST OF EXPERIMENTS

1. Design of Microstrip patch antenna
2. Antenna Radiation Pattern measurement
3. Measurement of transmission line parameters.
4. S-parameter measurement of antenna using VNA.
5. Design of Microstrip Antenna (Mini Project)

TOTAL :60 PERIODS

COURSE OUTCOMES:

Upon completion of the course, students will be able to:

CO1 Apply the knowledge to identify a suitable architecture and systematically design an antenna, Given the user requirements and the type of channel over which the system has to function.

CO2 Design and conduct experiments to demonstrate the trade- offs involved in the design of high frequency antennas.

CO3 Capable of applying communication engineering principles and design tools and will be well practiced in design skills.

CO4 Comprehensively record and report the measured data, write reports, communicate research ideas, and do oral presentations effectively.

CO5 Capable of analyzing and interpreting the experimental measurement data and produce meaningful conclusions.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	2	3	3	3
CO2	2	2	2	3	3	3
CO3	3	2	3	3	3	3
CO4	2	2	2	3	3	2
CO5	2	2	2	3	3	3

23EC2201	ADVANCED WIRELESS COMMUNICATION SYSTEMS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To learn the concepts of wireless communication.
- To know about the various propagation methods, Channel models, capacity calculations multiple antennas and multiple user techniques used in the mobile communication

UNIT I WIRELESS CHANNEL PROPAGATION AND MODEL 9

Radio wave propagation – Transmit and receive signal models - Free space path loss, Two ray model Empirical Path-loss models: Okumura model - COST -231 Hata model, Longley-Rice Model, NLOS Multipath Fading Models: Rayleigh, Rician, Nakagami, Shadowing Distributions, Statistical Multipath channel models: Discrete-time model, Space-time channel models.

UNIT II CAPACITY OF WIRELESS CHANNELS 9

AWGN channel capacity, capacity of flat fading channels, channel distribution Information known at transmitter or receiver and both capacity comparisons, Capacity of frequency selective fading channels-time invariant- time variant, Capacity of MISO, SIMO systems.

UNIT III DIVERSITY 9

Receiver diversity: Selection combining (SC), Threshold combining, Maximal ratio combining (MRC), Equal gain combining (EGC), Transmitter diversity: Channel known at the transmitter, Channel unknown at the transmitter - Alamouti scheme.

UNIT IV MIMO COMMUNICATIONS 9

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 V MULTI USER SYSTEMS 9

Multiuser channels, Multiple Access, Random access, Scheduling, Power control, Uplink and Downlink channel capacity, Uplink – Downlink duality, Multiuser diversity, MIMO-MU systems

TOTAL :45 PERIODS

COURSE OUTCOMES:

Upon completion of the course, students will be able to:

CO1 Analyze the wireless channel characteristics and identify appropriate channel models

CO2 Understand the mathematics behind the capacity calculation for different types of wireless channels

CO3 Understand the implication of diversity techniques at transmitter and receiver

CO4 Understand the concepts in MIMO Communications

CO5 Understand mulitiple access techniques and their use in different multi-user scenarios.

REFERENCE BOOKS:

1. Andrea Goldsmith, Wireless Communications, Cambridge University Press, 2007.
2. Harry R. Anderson, Fixed Broadband Wireless System Design, John Wiley, India, 2003.
3. Andreas.F. Molisch, Wireless Communications, John Wiley, India, 2006.
4. Rappaport. T.S., Wireless communications, Pearson Education, 2003.
5. Gordon L. Stuber, Principles of Mobile Communication, Springer International Ltd., 2001.
6. Upena Dalal, Wireless Communication, Oxford Higher Education, 2009.
7. David Tse and Pramod Viswanath, Fundamentals of wireless communications, Cambridge University Press, First Edition, 2012

WEB REFERENCES:

1. https://nptel.ac.in/courses/117/102/117102062/
2. http://www.nptelvideos.in/2012/11/advanced-3g-and-4g-wireless-mobile.html

ONLINE COURSES / RESOURCES:

1. Advanced 3G and 4G Wireless Mobile Communications by Prof. Aditya K. Jagannatham, Department of Electrical Engineering, IIT Kanpur.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1		2	2		
CO2	1		2	2		
CO3	1		2	2		
CO4	1		2	3		
CO5	1		3	3	1	1

23EC2202	MIC AND RF SYSTEM DESIGN	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand the fundamentals of RF design and Microwave integrated circuits.
- To understand the various components of RF system for Wireless Communications.
- To know the basic techniques needed for analysis of RF systems.

UNIT I TRANSCEIVER SPECIFICATIONS AND ARCHITECTURES 9

Noise: Thermal, shot, flicker, popcorn noise transceiver Specifications: Two port Noise theory, Noise Figure, THD, IP2, IP3, Sensitivity, SFDR, Phase noise. Transceiver Architectures: Receiver: Homodyne, Heterodyne, Image reject, Low IF Architectures, Transmitter: Direct up conversion, Two step up conversion schemes.

UNIT II IMPEDANCE MATCHING AND AMPLIFIERS 9

Review of S-parameters and Smith chart, Impedance matching networks, OC Time constants in bandwidth estimation and enhancement, High frequency amplifier design, Low Noise Amplifiers: Power match and Noise match, Single ended and Differential schemes.

UNIT III FEEDBACK SYSTEMS AND POWER AMPLIFIERS 9

Feedback Systems: Stability of feedback systems: Gain and phase margin, Compensation, Power Amplifiers: General model – Class A, AB, B, C, D, E and F amplifiers, Linearization Techniques.

UNIT IV RF FILTER, OSILLATOR, MIXER 9

Overview-basic resonator and filter configuration, special filter realizations, filter implementation. Basic oscillator model, high frequency oscillator configuration, basic characteristics of mixers – Types of mixers.

UNIT V MIC COMPONENTS 9

Introduction to MICs, Fabrication Technology, Advantages and applications, MIC components- Passive components: Resistors, Capacitors, Inductors, - Microstrip components: Microstrip couplers and power splitters, Coplanar circuits: Active Power Dividers, Combiners and Switches.

TOTAL :45 PERIODS

COURSE OUTCOMES:

Upon completion of the course, students will be able to:

CO1 Design and analyze the performance of different types of Transceivers.
CO2 Design and analyze the performance of High frequency amplifiers and Low noise amplifiers
CO3 Design and analyze the performance of Feedback systems and Power amplifiers
CO4 Design and analyze the performance of RF Filters, Oscillators and Mixers
CO5 Design MIC components

REFERENCE BOOKS:

1. B.Razavi, “RF Microelectronics”, Pearson Education, 1997.
2. Ingo Wolff,” Coplanar Microwave Integrated circuits”, John Wiley and sons, New Jersey, 2006.
3. T. Lee,”Design of CMOS RF Integrated Circuits”, Cambridge, 2004.Xavier Begaud, “Ultra Wide Band Antennas” , 1st Edition, ISTE Ltd and John Wiley &Sons Ltd, New York,2013.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	2	3	3	3
CO2	2	2	2	3	3	3
CO3	3	2	3	3	3	3
CO4	2	2	2	3	3	2
CO5	2	2	2	3	3	3

23EC2203	OPTICAL COMMUNICATION AND NETWORKING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To enable the student to understand the basic principles of operation of optical system components, the different network architectures and issues associated with network design.
- To enable the student to understand the differences in the design of data plane and the control plane and the routing, switching and the resource allocation methods and the network management and protection methods in vogue.

UNIT - I OPTICAL SYSTEM COMPONENTS AND NETWORK DESIGN 9

Optical System Components – MZIM, Multiplexers; filters; switches; wavelength converters; optical amplifiers – EDFA, Raman Amplifiers and hybrid; Transmission system Engineering -System Model, Aimer penalty – transmitter, receiver, cross talk, dispersion compensation, wavelength stabilization, FWM.

UNIT - II COHERENT SYSTEMS 9

Basic principles of Coherent detections – Practical constraints – Injection laser line width state of polarization, local oscillator power, fiber limitations; Modulation formats – ASK, FSK, PSK, DPSK and polarization shift keying (POL SK); Demodulation schemes – Homodyne, Heterodyne – Synchronous and Non synchronous detection; Comparison; Carrier recovery in Coherent detection.

UNIT - III OPTICAL NETWORK ARCHITECTURES 9

Introduction to Optical Networks; First Generation optical networks –SONET / SDH Network, Second Generation (WDM) Optical Networks, Need for Multilayered Architecture-, Layers and Sub-layers, Spectrum partitioning, Optical Network Nodes, Network Access Stations, Overlay Processor, Logical network overlays.

UNIT - IV NETWORK CONNECTIONS 9

Connection Management and Control; Static Networks, Wavelength Routed Networks; Linear Light wave networks; Logically Routed Networks; Routing and Wavelength Assignment, Traffic Grooming in Optical Networks.

UNIT - V OPTICAL NETWORK SURVIVABILITY 9

Protection and Restoration Objectives, Fault Protection and Restoration Techniques in the Logical Layer – Point-to-Point Systems, SONET Self-Healing Rings, Interconnection Techniques, Architectures with Arbitrary Mesh Topologies, Optical-Layer Protection: Point- to-Point and Ring Architectures, Mesh Architectures

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of the course, students will be able to:

CO1 Demonstrate an understanding of the differences and challenges involved in the design of optical systems and networks.

CO2 Apply his knowledge for designing a fiber optic system addressing the channel impairments.

CO3 Familiarize with the architectures and the protocol stack in use.in optical networks and would be able to identify a suitable backbone infrastructure for our present and future communication needs.

CO4 Understand how connections are managed in the network and the pros and cons of the different approaches

CO5 Appreciate the need for network survivability and the methodologies used.

REFERENCE BOOKS:

1. Max Ming-Kang Liu, ―Principles and Applications of Optical Communication‖, Tata McGraw Hill Education Pvt., Ltd., New Delhi.
2. Thomas E. Stern, Georgios Ellinas, Krishna Bala, ―Multiwavelength Optical Networks –Architecture, Design and control ―, Cambridge University Press, 2nd Edition, 2009.
3. Rajiv Ramaswami and Kumar N. Sivarajan, ―Optical Networks: A Practical Perspective‖, Harcourt Asia Pte Ltd., Second Edition 2006.
4. P.E. Green, Jr., ―Fiber Optic Networks‖, Prentice Hall, NJ, 1993.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	3	3	2		1
CO2	3	3	3	2	3	3
CO3	3	3	3	2	2	1
CO4	3	3	3	2	2	2
CO5	3	3	3	2	3	3

23EC2204	WIRELESS COMMUNICATION NETWORKS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To introduce students with concepts, design issues in 5G and beyond networks.
- To study about architectures and protocols and the state-of-the–art developments in next generation wireless network technologies.

UNIT I CHANNEL MODELS 9

Modeling requirements and scenarios, Channel model requirements and Measurements, Propagation scenarios, METIS channel models, Map-based model, stochastic model, Comparison of Models.

UNIT II MULTI- CARRIER WAVEFORMS 9

Filter-bank based multi-carrier (FBMC)- Principles, Transceiver block diagram, Frame structure, Resource structure, allocation, mapping. Universal filtered multi carrier (UFMC)- Principles, Transceiver structure, Frame and Resource structure, allocation, mapping. Generalized frequency division multicarrier (GFDM) – Principles, Transceiver Block diagram, Frame structure, Resource structure, allocation, mapping, MIMO-GFDM.

UNIT III MULTIPLE ACCESS TECHNIQUES 9

Challenges in OFDM- NOMA – Principle- Superposition Coding, Successive Interference Cancellation, Power Domain NOMA, Sparse Code NOMA- types, Power Domain Sparse Code NOMA, Cooperative NOMA- Benefits and Challenges.

UNIT IV MASSIVE MIMO 9

Introduction-pilot design and channel estimation- uplink data transmission and downlink data transmission for Single cell systems and multi cell systems – capacity analysis.

UNIT V COOPERATIVE COMMUNICATION 9

Machine Type Communication (MTC), Device to Device Communication (D2D), 5G and beyond Narrowband IoT, Cloud Computing architecture and Protocols, Relaying: Cooperative NOMA- Benefits and Challenges, Half duplex relaying, Full duplex relaying, Amplify and forward relaying, Decode and forward relaying, Decode and forward relaying with PLNC, BER Analysis, Capacity Analysis.

TOTAL :45 PERIODS

COURSE OUTCOMES:

Upon completion of the course, students will be able to:

CO1 Analyze the performance of different channel models adopted in wireless Systems
CO2 Design a transceiver for Multicarrier waveforms.
CO3 Analyze multiple access techniques.
CO4 Design a pilot, estimate channels and analyze capacity for single cell and multi cell Massive MIMO.
CO5 Analyze different types of cooperative communications.

REFERENCE BOOKS:

1. Afif Osseiran, Jose.F.Monserrat and Patrick Marsch, “5G Mobile and Wireless Communications Technology”, Cambridge University Press, 2016.
2. Robert W. Heath Jr., Nuria González-Prelcic, SundeepRangan, WonilRoh,and Akbar M. Sayeed, “An Overview of Signal Processing Techniques for Millimeter Wave MIMO Systems”, IEEE Journal of Selected Topics in Signal Processing, Vol. 10, No. 3, April 2016.
3. MinChulJu and Il-Min Kim, “Error Performance Analysis of BPSK Modulation in Physical- Layer Network-Coded Bidirectional Relay Networks”, IEEE Transactions on Communications, Vol. 58, No. 10, October 2010.
4. Shengli Zhang, Soung-Chang Liew, Patrick P.Lam, “Physical Layer Network Coding”, Mobicom ‗06, Proceeding of the 12th International Conference on Mobile Computing and Networking, pp.358-365, Los Angeles, CA, USA, Sep.23-29,2006.
5. Thomas L. Marzetta, Erik G. Larsson, Hong Yang, HienQuoc Ngo, “Fundamentals of Massive MIMO”, Cambridge University Press, 1st Edition, 2016.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1		2	2		1
CO2	1		2	2		1
CO3	1		1	1		1
CO4	1		3	3		1
CO5	1		1	1	1	1

23EC2211	RF SYSTEM DESIGN LABORATORY	L	T	P	C
		0	0	3	2

COURSE OBJECTIVES:

- To enable the students to verify the basic principles and design aspects involved in high frequency communication systems components
- To know the performance parameters for the components and the overall system.
- To design and develop RF components using microstrip technology
- To expose the student to different high frequency components and conduct the experiments to analyze and interpret data to produce meaningful conclusion and match with theoretical concepts

LIST OF EXPERIMENTS

1. S parameter estimation of microwave devices using VNA
2. Design of λ/2, λ/4 micro strip transmission line
3. Design of microstrip inductor and capacitor
4. Design of impedance matching network
5. Design of Filters
6. Design of Couplers and Power dividers
7. Mini project

TOTAL :60 PERIODS

COURSE OUTCOMES:

Upon completion of the course:

CO1	Given the user requirements and the type of channel over which the system has to function the student would be in a position to apply the knowledge to identify a suitable architecture and systematically design an RF system.
CO2	The student would be able to design and conduct experiments to demonstrate the trade- offs involved in the design of bandpass systems.
CO3	The student would be capable of applying communication engineering principles and design tools and will be well practiced in design skills.
CO4	The student would be able to comprehensively record and report the measured data, write reports, communicate research ideas, and do oral presentations effectively.
CO5	The student would be capable of analyzing and interpreting the experimental measurement data and produce meaningful conclusions.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	2	2	3	3	3
CO2	2	2	2	3	3	3
CO3	3	2	3	3	3	3
CO4	2	2	2	3	3	2
CO5	2	2	2	3	3	3

23EC2212	ADVANCED WIRELESS COMMUNICATION AND NETWORKS LABORATORY	L	T	P	C
		0	0	3	2

COURSE OBJECTIVES:

- To enable the student to verify the basic principles of outdoor propagation models, multipath channels, wireless and AWGN channel characterization, and congestion control in wireless networks.
- To design and conduct experiments, as well as to analyze and interpret data to produce meaningful conclusions and match with theoretical concepts.
- To enable the student to appreciate the practical aspects of baseband system design and understand the associated challenges.
- To study and analyze the performance of LTE networks for various traffics and scenarios.

LIST OF EXPERIMENTS

1. Design of transmitter and receiver blocks of OFDM for better transmission through a multipath channel.
2. Analysis of outdoor propagation model - HATA model, and OKUMURA model.
3. Implementation of congestion control using the traffic shaping algorithm.
4. Analysis of AWGN & interference of WLAN in voice signal transmission.
5. Implementation of any two scheduling methods in LTE networks for various traffics and scenarios. Also, propose improved scheduling from any one of those scheduling methods.
6. Mini project

TOTAL :60 PERIODS

COURSE OUTCOMES:

Upon completion of the course, students will be able to:

CO1	Design and conduct experiments to demonstrate the trade-offs involved in the design of basic and advanced coding and modulation techniques and the advanced baseband signal conditioning methods.
CO2	Apply communication engineering principles and design tools and will be well-practiced in design skills.
CO3	Implement scheduling algorithms and congestion control for advanced wireless networks.
CO4	Comprehensively record and report the measured data, write reports, communicate research ideas, and do oral presentations effectively.
CO5	Analyze and interpret the experimental measurement data and produce meaningful conclusions.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3	1	1	1	1	1
CO2	3	1	1	1		2
CO3	1	2	2			
CO4	1	3	2			
CO5	1	2	2			2

23EC2301	MILLIMETER WAVE COMMUNICATION	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand the fundamentals of Millimeter wave devices and circuits.
- To understand the various components of Millimeter wave Communications system.
- To know the antenna design at Millimeter wave frequencies.

UNIT I INTRODUCTION 9

Millimeter wave characteristics- millimeter wave wireless, implementation challenges, Radio wave propagation for mm wave: Large scale propagation channel effects, small scale channel effects, Outdoor and Indoor channel models, Emerging applications of millimeter wave communications.

UNIT II MM WAVE DEVICES AND CIRCUITS 9

Models for mm wave Transistors, transistor configurations, Analog mm wave components: Amplifiers, Mixers, VCO, PLL. Metrics for analog mm wave devices, Trends and architectures for mm wave wireless, ADC's and DAC's

UNIT III MM WAVE COMMUNICATION SYSTEMS 9

Modulations for millimeter wave communications: OOK, PSK, FSK, QAM, OFDM, Millimeter wave link budget, Transceiver architecture, Transceiver without mixer, Receiver without Oscillator, Millimeter wave calibration, production and manufacture, Millimeter wave design considerations

UNIT IV MM WAVE MIMO SYSTEMS 9

Massive MIMO Communications, Spatial diversity of Antenna Arrays, Multiple Antennas, Multiple Transceivers, Noise coupling in MIMO system, Potential benefits for mm wave systems, Spatial, Temporal and Frequency diversity, Dynamic spatial, frequency and modulation allocation.

UNIT V ANTENNAS FOR MM WAVE SYSTEMS 9

Antenna beamwidth, polarization, advanced beam steering and beam forming, On-chip and In package mm wave antennas, Techniques to improve gain of on-chip antennas, Implementation for mm wave in adaptive antenna arrays

TOTAL :45 PERIODS

COURSE OUTCOMES:

Upon completion of the course, students will be able to:

CO1	Understand the fundamentals of Millimeter wave
CO2	Understand Millimeter devices and circuits
CO3	Understand the various components of Millimeter wave communication systems
CO4	Understand millimeter wave MIMO system
CO5	Design antenna for Millimeter wave system

REFERENCE BOOKS:

1. K.C. Huang, Z. Wang, "Millimeter Wave Communication Systems", Wiley-IEEE Press, March 2011.
2. Robert W. Heath, Robert C. Daniel, James N. Theodore S. Rappaport, Murdock, "Millimeter Wave Wireless Communication", Prentice Hall, 2014.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	2	3	3	2	3
CO2		2	3		3	3
CO3		2	3		3	3
CO4	2	3	3	3	2	2
CO5	3	3	3	2	3	3

23EC2901	ADVANCED SATELLITE COMMUNICATION AND NAVIGATION SYSTEMS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- Learn M2M developments and satellite applications
- Understand Satellite Communication In IPv6 Environment

UNIT I OVERVIEW OF SATELLITE COMMUNICATION **9**

Overview of satellite communication and orbital mechanics Link budget Parameters, Link budget calculations, Auxiliary Equations, Performance Calculations.

UNIT II M2 M DEVELOPMENTS AND SATELLITE APPLICATIONS **9**

Overview of the Internet of Things and M2M- M2M Applications Examples and Satellite Support- Satellite Roles Context and Applications- Antennas for Satellite M2M Applications- M2M Market Opportunities for Satellite Operators- Ultra HD Video/TV and Satellite Implications- High Throughput Satellites (HTS) and Ka/Ku Spot Beam Technologies- Aeronautical, Maritime and other Mobility Services.

UNIT III SATELLITE COMMUNICATION IN IPV6 ENVIRONMENT **9**

Overview of IPv6 and its benefits for Satellite Networks - Migration and Coexistence- - Implementation scenarios and support- Preparations for IPv6 in Satellite communication- Satellite specific Protocol issues in IPv6 – Impact of IPv6 on Satellite Network architecture and services-Detailed transitional plan- IPv6 demonstration over satellites - Key results and recommendations.

UNIT IV SATELLITE NAVIGATION AND GLOBAL POSITIONING SYSTEM **9**

Over view of Radio and Satellite Navigation, GPS Principles, Signal model and Codes, Satellite Signal Acquisition, Mathematical model of GPS observables, Methods of processing GPS data, GPS Receiver Operation and Differential GPS. IRNSS, GAGAN, GLONASS andGalileo

UNIT V DEEP SPACE NETWORKS AND INTER PLANETARY MISSIONS **9**

Introduction – Functional description - Design procedure and performance criterion-Mars exploration Rover- Mission and space craft summary-Telecommunication subsystem overview-Ground Subsystem-Telecom subsystem and Link performance Telecom subsystem Hardware and software Chandrayaan-1 Mission - Mission and space craft summary- Telecommunication subsystem overview- Ground Subsystem-Telecom subsystem and Link performance. Mangalyaan Mission - Mission and space craft summary-Telecommunication subsystem overview- Ground Subsystem-Telecom subsystem and Link performance.

TOTAL :45 PERIODS

COURSE OUTCOMES:

Upon completion of the course, students will be able to:

CO1 Understand the overview of Satellite Communication
CO2 Outline M2M developments and satellite applications
CO3 Understand Satellite Communication in IPV6 Environment
CO4 Discuss satellite navigation and global positioning system
CO5 Outline deep space networks and inter planetary missions

REFERENCE BOOKS:

1. Adimurthy.V," Concept design and planning of India's first interplanetary mission" Current Science, VOL. 109, NO. 6, 1054 25 SEPTEMBER 2015.
2. Anil K. Maini, Varsha Agrawal, 'Satellite Technology: Principles and Applications', Third Edition, Wiley, 2014.
3. Daniel Minoli' "Innovations in Satellite Communication and Satellite Technology" Wiley, 2015.
4. Daniel Minoli, "Satellite Systems Engineering in an IPv6 Environment", CRC Press, First Edition, 2009.
5. Hofmann-Wellenhof B., Lichtenegger H., and Elmar Wasle, "Global Navigational Satellite Systems" Springer-Verlag, 2008.
6. Jim Taylor, "Deep Space Communications" John Wiley & Sons, 2016.
7. Louis J. Ippolito, Jr. "Satellite Communications Systems Engineering: Atmospheric Effects, Satellite Link Design and System Performance", Second Edition, 2017.

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1. http://www.isro.gov.in/pslv-c25-mars-orbiter-mission.
2. https://en.wikipedia.org/wiki/Mars_Orbiter_Mission.
3. https://en.wikipedia.org/wiki/Chandrayaan-1.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1			1			
CO2	1		3	2		
CO3	1		2	2		
CO4			2			
CO5			2	2	1	1

23EC2902	COGNITIVE RADIO COMMUNICATION & NETWORKS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand the fundamental concepts of cognitive radio communication and its policies.
- To explain the cognitive radio communication techniques, as well as networking concepts.
- To apply Spectrum Sensing techniques to Detect Primary System.
- To access the spectrum dynamically through centralized and distributed manner in current wireless application standards.
- To study Cognitive radio in recent applications

UNIT I INTRODUCTION TO COGNITIVE RADIO 9

Cognitive Radio: Techniques and signal processing History and background, Communication policy and Spectrum Management, Cognitive radio cycle, Cognitive radio architecture, SDR architecture for cognitive radio, Spectrum sensing Single node sensing: energy detection, cyclo stationary and wavelet-based sensing-problem formulation and performance analysis based on probability of detection Vs SNR. Cooperative sensing: different fusion rules, wideband spectrum.

UNIT II COGNITIVE RADIO NETWORKING 9

Cognitive Radios and Dynamic Spectrum Access, the Capability of Cognitive Radios, Fundamental Limits of Cognitive Radios. Network Coding for Cognitive Radio Relay Networks , System Model , Network Capacity Analysis on Fundamental CRRN Topologies , Cognitive Radio Networks Architecture, IP Mobility Management in CRN , Terminal Architecture of CRN , Cognitive Radio Device Architecture , Radio Access Network Selection, QoS Provisional Diversity Radio Access Networks, cooperative/Collaborative Diversity and Efficient Protocols , Statistical QoS Guarantees over Wireless Asymmetry, Collaborative Relay Networks , Scaling Laws of Ad-hoc and Cognitive Radio Networks , Network and Channel Models.

UNIT III SPECTRUM SENSING AND AWARENESS 9

Spectrum Sensing to Detect Specific Primary System, Conventional Spectrum Sensing, Power efficiency and energy/battery awareness, Device capability awareness, RF Awareness Interference/noise temperature awareness, channel (medium, radio channel) awareness. Location Awareness, Power Control, Power-Scaling Power Control, Cooperative Spectrum Sensing, Spectrum Sensing for Cognitive OFDMA Systems, Cognitive Cycle, Discrimination of States of the Primary System, Spectrum Sensing Procedure, Spectrum Sensing for Cognitive Multi-Radio Networks, Multiple System Sensing, Radio Resource Sensing

UNIT IV DYNAMIC SPECTRUM ACCESS 9

Centralized dynamic spectrum access - Distributed dynamic spectrum access - Coexistence of dissimilar secondary radio systems-impact of QoS & interference-codes for dynamic spectrum access- coexistence & access problems in Cognitive radios- spectrum sensing in current wireless standards Cognitive OFDM standards and technologies.

UNIT V COGNITIVE RADIO IN RECENT APPLICATIONS AND CASE STUDY 9

Medium access control for CR, Applications of cognitive radio, Cognitive features in the standards (like 802.16m, LTE advanced, 802.11n, adaptive frequency hopping in Bluetooth), Femto-cells and relation to cognitive radio, UWB and Cognitive radio (underlay and overlay) systems. Security issues in CRN. CR based Internet of Things (IoT). Case study: IEEE 802.22 WRAN standard

TOTAL :45 PERIODS

COURSE OUTCOMES:

Upon completion of the course, students will be able to:

CO1 Understand the fundamental concepts of cognitive radio communication and its policies.
CO2 Interpret the cognitive radio communication techniques and networking concepts.
CO3 Analyze the Spectrum Sensing techniques to Detect Primary System in Cognitive Radio networks
CO4 Understand the concepts and principles of dynamic spectrum access and its mechanisms.
CO5 Apply the concepts of cognitive radio in various applications and evaluate its real time scenario.

REFERENCE BOOKS:

1. Cognitive Radio, Software Defined Radio and Adaptive Wireless Systems", Hüseyin Arslan, Springer, ISBN 978-1-4020-5541-6 (HB), 2007.
2. Bruce Fette, "Cognitive Radio Technology", Elsevier, Second Edition,2009.
3. Linda Doyle, "Essentials of Cognitive Radio", Cambridge University Press, 2009.
4. Kwang-Cheng Chen, Ramjee Prasad, "Cognitive radio networks", John Wiley & Sons Ltd., 2009.
5. Ekram Hossain, Dusit Niyato, Zhu Han, "Dynamic Spectrum Access and Management in Cognitive Radio Networks", Cambridge University Press, First Edition, 2009.
6. Alexander M. Wyglinski, Maziar Nekovee, and Y. Thomas Hou, "Cognitive Radio Communications and Networks - Principles and Practice", Elsevier Inc., 2010.
7. Francisco Rodrigo Porto Cavalcanti, Soren Andersson "Optimizing Wireless Communication Systems" Springer, First Edition, 2009.
8. Linda Doyle, "Essentials of Cognitive Radio", Cambridge University Press, First Edition, 2009

WEB REFERENCES:

1. http://www.springer.com/engineering/signals/book/978-1-4020-5541-6
2. http://www.cept.org/ecc/topics/cognitive-radio-systems-and-software-defined-radio.
3. http://ieeexplore.ieee.org/xpl/freeabs_all.jsp?arnumber=4410972&abstractAccess=no&userType=inst

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3		3	3	2	3
CO2	3		3	3	2	3
CO3	3		3	3	2	3
CO4	3		3	3	2	3
CO5	3		3	3	2	3

23EC2903	ADVANCED WIRELESS NETWORKS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To study about advanced wireless network, LTE, 4G and Evolutions from LTE to LTE.
- To study about wireless IP architecture, Packet Data Protocol and LTE network architecture
- To study about adaptive link layer, hybrid ARQ and graphs routing protocol.
- To study about mobility management, cellular network, and micro cellular networks

UNIT I INTRODUCTION 9

Introduction to 1G/2G/3G/4G Terminology. Evolution of Public Mobile Services - Motivation for IP Based Wireless Networks -Requirements and Targets for Long Term Evolution (LTE) - Technologies for LTE- 4G Advanced Features and Roadmap Evolutions from LTE to LTEA - Wireless Standards.

UNIT II WIRELESS IP NETWORK ARCHITECTURES 9

3GPP Packet Data Networks - Network Architecture - Packet Data Protocol (PDP) Context - Configuring PDP Addresses on Mobile Stations - Accessing IP Networks through PS Domain LTE network Architecture - Roaming Architecture- Protocol Architecture- Bearer Establishment Procedure -Inter-Working with other RATs. 43

UNIT III ADAPTIVE LINK AND NETWORK LAYER 9

Link Layer Capacity of Adaptive Air Interfaces-Adaptive Transmission in Ad Hoc Networks Adaptive Hybrid ARQ Schemes for Wireless Links-Stochastic Learning Link Layer Protocol Infrared Link Access Protocol-Graphs and Routing Protocols-Graph Theory-Routing with Topology Aggregation-Network and Aggregation Models

UNIT IV MOBILITY MANAGEMENT 9

Cellular Networks-Cellular Systems with Prioritized Handoff-Cell Residing Time Distribution Mobility Prediction in Pico- and Micro-Cellular Networks.

UNIT V QUALITY OF SERVICE 9

QoS Challenges in Wireless IP Networks - QoS in 3GPP - QoS Architecture, Management and Classes -QoS Attributes - Management of End-to-End IP QoS - EPS Bearers and QoS in LTE networks.

TOTAL :45 PERIODS

COURSE OUTCOMES:

Upon completion of the course, students will be able to:

CO1 Familiar with the latest 4G networks and LTE
CO2 Understand about the wireless IP architecture and LTE network architecture.
CO3 Familiar with the adaptive link layer and network layer graphs and protocol.
CO4 Understand about the mobility management and cellular network.
CO5 Understand about the wireless sensor network architecture and its concept.

REFERENCE BOOKS:

1. Ayman ElNashar, Mohamed El-saidny, Mahmoud Sherif, "Design, Deployment and Performance of 4G-LTE Networks: A Practical Approach", John Wiley & Sons, 2014.
2. Cross point Boulevard, "Wireless and Mobile All-IP Networks", Wiley Publication, 2005.
3. Jyh-Cheng Chen and Tao Zhang, "IP-Based Next-Generation Wireless Networks Systems, Architectures, and Protocols", John Wiley & Sons, Inc. Publication, 2006.
4. Minoru Etoh, "Next Generation Mobile Systems3G and Beyond," Wiley Publications, 2005.
5. Savo Glisic," advanced wireless networks-technology and business models", Third Edition, John Wiley & Sons, Ltd, 2016.
6. Savo Glisic,"Advanced Wireless Networks-4G Technologies", John Wiley & Sons, Ltd, 2006.
7. StefaniaSesia, IssamToufik and Matthew Baker, "LTE – The UMTS Long Term Evolution From Theory to Practice", John Wiley & Sons, Inc. Publication, Second Edition, 2011.

WEB REFERENCES:

1. https://www.artizanetworks.com/resources/tutorials/what_lte.html
2. https://www.3gpp.org/technologies/keywords-acronyms/98-lte
3. http://www.sis.pitt.edu/prashk/inf1072/Fall16/Arch.pdf
4. https://onlinelibrary.wiley.com/doi/pdf/10.1002/0471478253.fmatter

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3		3	3	2	2
CO2	3		3	3	2	2
CO3	3		3	3	2	2
CO4	3		3	3	2	2
CO5	3		3	3	2	2

23EC2904	SOFTWARE DEFINED RADIO	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To Understand radio frequency implementation.
- To Learn multi rate signal processing and digital generation of signals.

UNIT I INTRODUCTION & CASE STUDIES **9**

Introduction to software Radio concepts: Need for software Radios, Definition of software Radio, Characteristics and Benefits. Design Principles. Case studies: SPEAK easy, JTRS, SDR-3000.

UNIT II RADIO FREQUENCY IMPLEMENTATION **9**

The purpose of the RF Front End, Dynamic Range, RF receivers front end Topologies, Importance of the components to Overall performance, Transmitter Architecture, Noise and Distortion in the RF Chain, ADC and DAC Distortion, Flexible RF systems using MEMS.

UNIT III MULTI RATE SIGNAL PROCESSING AND DIGITAL GENERATION OF SIGNALS. **9**

Sample rate conversion principles. Digital filter Banks. Timing recovery in Digital Receivers using Multi rate Digital filters. Approaches to Direct Digital Synthesis. Analysis of spurious signal Band pass signal generation, Generation of Random sequences.

UNIT IV DATA CONVERTERS AND SMART ANTENNAS **9**

Parameters of Ideal and practical Data Converters, Techniques to Improve Data Converter performance, Common ADC and DAC Architectures. Smart Antennas- Hardware implementation of Smart Antennas.

UNIT V DIGITAL HARDWARE AND SOFTWARE CHOICES **9**

DSP Processors, FPGA, ASIC s. Trade offs, Object oriented programming, Object Brokers, GNU Radio-USRP.

TOTAL :45 PERIODS

COURSE OUTCOMES:

Upon completion of the course, students will be able to:

CO1 Understand SDR & its applications
CO2 Understand RF Implementation
CO3 Design data converters
CO4 Evaluate smart antennas
CO5 Discuss digital hardware and software choices.

REFERENCE BOOKS:

1. Jeffrey H.Reed, "Software Radio: A Modern Approach to Radio Engineering, Prentice Hall,2002
2. Joseph Mitola, "Software Radio Architecture: Object Oriented Approaches to Wireless System Engineering", Wiley-Inter science; I Edition 2000,ISBN:0471384925
3. Radio, G. N. U. "The gnu software radio." Available from World Wide Web: https://gnuradio. org (2007).
4. S.Shanmugavel, M.A.Bhagyaveni, R.Kalidoss, “Cognitive Radio-An Enabler for Internet of things”, River Publishers, 2017.

ONLINE RESOURCES:

1. https://onlinecourses.nptel.ac.in/noc20_ee87/preview
2. https://www.udemy.com/courses/search/?q=software+define+radio&src=sac&kw=software+defined+radio
3. https://pe.gatech.edu/courses/software-defined-radio-development-gnu-radio-theory-and- application
4. https://www.mooc-list.com/tags/software-defined-radio
5. https://shortcourses.uclaextension.edu/881-275/

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3		3	3	2	3
CO2	3		3	3	2	3
CO3	3		3	3	2	3
CO4	3		3	3	2	3
CO5	3		3	3	2	3

23EC2905	COMMUNICATION NETWORK SECURITY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand the need and concept of security.
- To Learn cryptosystems.

UNIT I INTRODUCTION AND NUMBER THEORY 9

Introduction to Information Security, Computer Security & Network Security. Need For Security. Security – Goals, Attacks, Security Services and Mechanisms, and Techniques. Number Theory and Mathematics for Symmetric Cryptography- Finite Arithmetic, Congruence Arithmetic-Linear Congruence and Quadratic Congruence. Mathematics for Asymmetric-Key Cryptography: Fermat‟s Theorem and Euler‟s Theorem, Primes, Primality Testing, Factorization, CRT, Exponentiation. Classical Symmetric-Key Ciphers – Substitution Ciphers, Transposition Ciphers.

UNIT II SYMMETRIC AND ASYMMETRIC CRYPTOSYSTEMS 9

Modern Symmetric-Key Cipher - Block Ciphers (DES, 3DES, AES and its mode of operations), Stream Ciphers, Asymmetric-Key Cryptosystem- RSA, ElGamal, ECC, Key Management - Diffie- Hellman (DH) Mechanism, Kerberos – Needham Schroeder Protocol.

UNIT III AUTHENTICATION, DIGITAL SIGNATURES AND CERTIFICATES 9

Message Integrity & Message Authentication - Message Authentication Code (MAC), Cryptographic Hash Functions – Birthday Attacks, Digital Signatures - Digital Signature Standards (FIPS 186-2), DSA (ANSI X9.30), RSA (ANSI X9.31) – Public Key Distribution- RSA schemes, Digital Certificates - PKI Certificates, PKI Life Cycle Management.

UNIT IV TRUSTED IDENTITY 9

Entity Authentication: Password System- Fixed and One time Passwords (S/Key) RFC 2289-Callback Systems, Zero Knowledge, Challenge and Response Systems – RADIUS – – ITU- T X.509.

UNIT V SECURITY AT LAYERS 9

Network Layer Security - IPSec, Transport Layer Security- SSL/TLS, SSH, Application Layer Security –PGP, S/MIME, Firewall - Concepts, Architecture, Packet Filtering, Proxy Services and Bastion Hosts.

TOTAL :45 PERIODS

COURSE OUTCOMES:

Upon completion of the course, students will be able to:

CO1 Understand Number theory Concepts
CO2 Understand Symmetric and Asymmetric Cryptosystems
CO3 Explain digital signature standards
CO4 Discuss authentication
CO5 Explain security at different layers

REFERENCE BOOKS:

1. Behrouz A.Forouzan, “Cryptography and Network Security”, Special Edition, Tata McGraw Hill, 2007.
2. Bruce Scheneier, “Applied Cryptography”, John Wiley & Sons, 1994.
3. Charlie Kaufmann, Radia Perlman, Mike Speciner, "Network Security", Second Edition, Prentice Hall, 2002
4. Douglas R.Stinson, “Cryptography: Theory and Practice”, CRC Press Series on Discrete Mathematics and its Applications, 1995.
5. David M. Durton, “Elementary Number Theory”, Tata Mcgraw Hill, Sixth Edition, 2009.
6. William Stallings “Network Security Essentials: Applications and Standards”, 2nd Edition, Pearson Education, 2000.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1		1			
CO2	1		2			
CO3	2		3	1		
CO4			2		1	
CO5	2		3	3		

23EC2906	ANALOG AND MIXED MODE VLSI DESIGN	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To study the concepts of MOS large signal model and small signal model
- To understand the concepts of D/A conversion methods and their architectures.
- To learn filters for ADC.
- To study about the switched capacitor circuits.

UNIT I INTRODUCTION AND BASIC MOS DEVICES 9

Challenges in analog design-Mixed signal layout issues- MOS FET structures and characteristics- large signal and small signal model of single stage Amplifier-Source follower- Common gate stage – Cascode Stage – large and small signal analysis of differential amplifier with active load, pole-zero estimation, zero value time constant method,frequency response of CS, cascade and cascade amplifiers

UNIT II SUBMICRON CIRCUIT DESIGN 9

Submicron CMOS process flow, Capacitors and resistors, Current mirrors, Digital Circuit Design, Delay Elements – Adders- OP Amp parameters and Design

UNIT III DATA CONVERTERS 9

Static and dynamic errors in DAC and ADC – Architectures & Characteristics of Sample and Hold- Digital to Analog Converters- DAC- R-2R, weighted DAC, multiplying DAC, segmented DAC and sigma delta DAC. ADC – Flash ADC, pipelined ADC, successive approximation ADC, sigma delta ADC.

UNIT IV SNR IN DATA CONVERTERS 9

Overview of SNR of Data Converters- Clock Jitters- Improving Using Averaging – Decimating Filters for ADC- Band pass and High Pass Sinc Filters- Interpolating Filters for DAC

UNIT V SWITCHED CAPACITOR CIRCUITS 9

Resistors, First order low pass Circuit, Switched capacitor Amplifier, Switched Capacitor Integrator – Design of flip around sample and hold circuit – pipelined ADC.

TOTAL :45 PERIODS

COURSE OUTCOMES:

Upon completion of the course, students will be able to:

CO1 Understand Basic MOS devices

CO2 Discuss submicron circuit design

CO3 Compare data converters

CO4 Compute SNR in Data Converters

CO5 Design and analyze switched capacitor circuits.

REFERENCE BOOKS:

1. J.Jacob Wikner, Mikael Gustavsson, Nianxiong Tan “CMOS Data Converters for Communications” Springer, 2000.
2. Van de Plassche, Rudy J., “CMOS Integrated Analog-to-Digital and Digital-to-Analog Converters” Springer, 2003.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2		2	3	3	1
CO2	2		2	3	3	1
CO3	2		2	3	3	1
CO4	2		2	3	3	1
CO5	2		2	3	3	1

23EC2907	VLSI FOR WIRELESS COMMUNICATION	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand the concepts of basic wireless communication concepts.
- To study the parameters in receiver and low noise amplifier design.
- To study the various types of mixers designed for wireless communication.
- To study and design PLL and VCO.
- To understand the concepts of transmitters and power amplifiers in wireless communication.

UNIT I COMMUNICATION CONCEPTS 9

Introduction – Overview of Wireless systems – Standards – Access Methods – Modulation schemes – Classical channel – Wireless channel description – Path loss – Multipath fading – Standard Translation.

UNIT II RECEIVER ARCHITECTURE & LOW NOISE AMPLIFIERS 9

Receiver front end – Filter design – Non-idealities – Design parameters – Noise figure & Input intercept point. LNA Introduction – Wideband LNA design – Narrow band LNA design: Impedance matching & Core amplifier.

UNIT III MIXERS 9

Balancing Mixer - Qualitative Description of the Gilbert Mixer - Conversion Gain – Distortion Noise - A Complete Active Mixer. Switching Mixer – Distortion, Conversion Gain & Noise in Unbalanced Switching Mixer - A Practical Unbalanced Switching Mixer. Sampling Mixer Conversion Gain, Distortion, Intrinsic & Extrinsic Noise in Single Ended Sampling Mixer.

UNIT IV FREQUENCY SYNTHESIZERS 9

PLL – Phase detector – Dividers – Voltage Controlled Oscillators – LC oscillators – Ring Oscillators – Phase noise – Loop filters & design approaches – A complete synthesizer design example (DECT) – Frequency synthesizer with fractional divider

UNIT V TRANSMITTER ARCHITECTURES & POWER AMPLIFIERS 9

Transmitter back end design – Quadrature LO generator – Power amplifier design.

TOTAL :45 PERIODS

COURSE OUTCOMES:

Upon completion of the course, students will be able to:

CO1 Understand Communication concepts

CO2 Design LNA

CO3 Design Mixers

CO4 Evaluate frequency synthesizers

CO5 Design and analyze power amplifiers.

REFERENCE BOOKS:

1. Bosco H Leung “VLSI for Wireless Communication”, Pearson Education, 2002.
2. B.Razavi ,”RF Microelectronics” , Prentice-Hall ,1998.
3. Behzad Razavi, “Design of Analog CMOS Integrated Circuits” McGraw-Hill, 1999.
4. Emad N Farag and Mohamed I Elmasry, “Mixed Signal VLSI wireless design – Circuits & Systems”, Kluwer Academic Publishers, 2000.
5. J. Crols and M. Steyaert, “CMOS Wireless Transceiver Design,” Boston, Kluwer Academic Pub., 1997.
6. Thomas H.Lee, “The Design of CMOS Radio – Frequency Integrated Circuits”, Cambridge University Press ,2003.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	1	1			
CO2	1		2	3		
CO3	2		2	1	1	1
CO4	1		2	2	1	1
CO5	2		2	1	1	1

23EC2908	RADAR SIGNAL PROCESSING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand the basic concepts of Radar systems and Signal models
- To illustrate the concepts of Sampling and Quantization of pulsed radar signals.
- To provide in-depth knowledge in Radar waveforms and Doppler processing.

UNIT I INTRODUCTION TO RADAR SYSTEMS 9

Basic radar function, elements of pulsed radar, review of signal processing concepts and operations, A preview of basic radar signal processing, radar system components, advanced radar signal processing

UNIT II SIGNAL MODELS 9

Components of a radar signal, amplitude models, types of clutters, noise model and signal-to noise ratio, jamming, frequency models: the doppler shift, spatial models, spectral model

UNIT III SAMPLING AND QUANTIZATION OF PULSED RADAR SIGNALS 9

Domains and criteria for sampling radar signals, Sampling in the fast time dimension, Sampling in slow time: selecting the pulse repetition interval, sampling the doppler spectrum, Sampling in the spatial and angle dimension, Quantization, I/Q Imbalance and Digital I/Q

UNIT IV RADAR WAVEFORMS 9

Introduction, The waveform matched filter, Matched filtering of moving targets, The ambiguity function, The pulse burst waveform, frequency-modulated pulse compression waveforms, Range sidelobe control for FM waveforms, the stepped frequency waveform, Phase-modulated pulse compression waveforms, COSTAS Frequency codes.

UNIT V DOPPLER PROCESSING 9

Alternate forms of the Doppler spectrum, Moving target indication (MTI), Pulse Doppler processing, dwell-to-dwell stagger, Pulse pair processing, additional Doppler processing issues, clutter mapping and the moving target detector, MTI for moving platforms: adaptive displaced phase center antenna processing.

TOTAL :45 PERIODS

COURSE OUTCOMES:

Upon completion of the course, students will be able to:

CO1 Investigate various Radar Signal models

CO2 Analyze the sampling and quantization of pulse radar signals

CO3 Explain the principles of elements and functions involved in radar signal processing.

CO4 Describe different types of radar waveforms.

CO5 Discuss on Doppler processing and its issues.

REFERENCE BOOKS:

1. Francois Le Chevalier, "Principles of Radar and Sonar Signal Processing", Artech House

2. Fred E. Nathanson, "Radar Design Principles-Signal Processing and the Environment", PHI

3. Mark A. Richards, "Fundamentals of Radar Signal Processing", McGraw-Hill, New York, 2005.

4. Michael O Kolawole, Radar systems, Peak Detection and Tracking, 2010, Elseveir Introduction to Radar Systems 3rd Edition, Skolnik, McGraw Hill.

5. Peyton Z. Peebles, "Radar Principles", 2009 Wiley India

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	1	1	1	1	1
CO2	2	2	2	1	2	1
CO3	3	3	2	3	3	3
CO4	3	3	2	3	3	3
CO5	2	2	2	2	2	2

23EC2909	PATTERN RECOGNITION AND MACHINE LEARNING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To Study the fundamental of pattern classifier.
- To know about various clustering concepts.
- To originate the various structural pattern recognition and feature extraction.
- To understand the basic of concept learning and decision trees
- To explore recent advances in pattern recognition.

UNIT I PATTERN CLASSIFIER 9

Overview of Pattern recognition – Discriminant functions – Supervised learning – Parametric estimation – Maximum Likelihood Estimation – Bayesian parameter Estimation – Problems with Bayes approach– Pattern classification by distance functions –Minimum distance pattern classifier.

UNIT II CLUSTERING 9

Clustering for unsupervised learning and classification -Clustering concept – C-means algorithm – Hierarchical clustering procedures -Graph theoretic approach to pattern clustering-Validity of clusters.

UNIT III FEATURE EXTRACTION AND STRUCTURAL PATTERN RECOGNITION 9

KL Transforms – Feature selection through functional approximation – Binary selection - Elements of formal grammars - Syntactic description - Stochastic grammars –Structural representation

UNIT IV INTRODUCTION, CONCEPT LEARNING AND DECISION TREES 9

Learning Problems – Designing Learning systems, Perspectives and Issues – Concept Learning-Version Spaces and Candidate Elimination Algorithm – Inductive bias – DecisionTree learning – Representation – Algorithm – Heuristic Space Search

UNIT V RECENT ADVANCES 9

Neural network structures for pattern recognition -Neural network based pattern associators – Unsupervised learning in neural pattern recognition -Self organizing networks -Fuzzy logic - Fuzzy pattern classifiers -Pattern classification using Genetic Algorithms.

TOTAL :45 PERIODS

COURSE OUTCOMES:

Upon completion of the course, students will be able to:

CO1 Classify the data and identify the patterns.

CO2 Utilize the given data set to extract and select features for Pattern recognition.

CO3 Describe the decision tree and concept learning.

CO4 Discuss on recent advances in pattern recognition.

CO5 Explore the recent advancement in Neural Networks & Fuzzy logic

REFERENCE BOOKS:

1. Duda R.O., and Hart.P.E., Pattern Classification and Scene Analysis, Wiley, New York, 1973.
2. Morton Nadier and Eric Smith P., Pattern Recognition Engineering, John Wiley & Sons, New York, 1993.
3. Narasimha Murty M and Susheela Devi V, “Pattern Recognition – An Algorithmic Approach”, Springer, Universities Press, 2011
4. Robert J.Schalkoff, Pattern Recognition : Statistical, Structural and Neural Approaches, John Wiley &Sons Inc., New York, 2007.
5. Tom M. Mitchell, “Machine Learning”, McGraw-Hill Education (Indian Edition), 2013.
6. Tou and Gonzalez, Pattern Recognition Principles, Wesley Publication Company, London, 1974.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3		3	3	2	2
CO2	3		3	3	2	2
CO3	3		3	3	2	2
CO4	3		3	3	2	2
CO5	3		3	3	2	2

23EC2910	WIRELESS ADHOC AND SENSOR NETWORKS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand the basics of Ad-hoc & Sensor Networks.
- To learn various fundamental and emerging protocols of all layers.
- To study about the issues pertaining to major obstacles in establishment and efficient management of Ad-hoc and sensor networks.
- To understand the nature and applications of Ad-hoc and sensor networks.
- To understand various security practices and protocols of Ad-hoc and Sensor Networks.

UNIT I MAC & TCP IN AD HOC NETWORKS 9

Fundamentals of WLANs – IEEE 802.11 Architecture - Self configuration and Auto configuration-Issues in Ad-Hoc Wireless Networks – MAC Protocols for Ad-Hoc Wireless Networks – Contention Based Protocols - TCP over Ad-Hoc networks-TCP protocol overview-TCP and MANETs – Solutions for TCP over Ad-Hoc Networks.

UNIT II ROUTING IN AD HOC NETWORKS 9

Routing in Ad-Hoc Networks- Introduction-Topology based versus Position based Approaches-Proactive, Reactive, Hybrid Routing Approach-Principles and issues – Location services - DREAM – Quorums based location service – Grid – Forwarding strategies – Greedy packet forwarding – Restricted directional flooding- Hierarchical Routing- Issues and Challenges in providing QoS.

UNIT III MAC, ROUTING & QOS IN WIRELESS SENSOR NETWORKS 9

Introduction – Architecture - Single node architecture – Sensor network design considerations-Energy Efficient Design principles for WSNs – Protocols for WSN – Physical Layer: Transceiver Design considerations – MAC Layer Protocols – IEEE 802.15.4 Zigbee – Link Layer and Error Control issues - Routing Protocols – Mobile Nodes and Mobile Robots - Data Centric & Contention Based Networking – Transport Protocols & QOS – Congestion Control issues – Application Layer support.

UNIT IV SENSOR MANAGEMENT 9

Sensor Management - Topology Control Protocols and Sensing Mode Selection Protocols - Time synchronization - Localization and positioning – Operating systems and Sensor Network programming – Sensor Network Simulators.

UNIT V SECURITY IN AD HOC AND SENSOR NETWORKS 9

Security in Ad-Hoc and Sensor networks – Key Distribution and Management – Software based Anti-tamper techniques – water marking techniques – Defense against routing attacks - Secure Adhoc routing protocols – Broadcast authentication WSN protocols –TESLA – Biba-Sensor Network Security Protocols – SPINS.

TOTAL :45 PERIODS

COURSE OUTCOMES:

Upon completion of the course, students will be able to:

CO1 Identify different issues in wireless ad hoc and sensor networks.

CO2 Analyze protocols developed for ad hoc and sensor networks.

CO3 Identify and address the security threats in ad hoc and sensor networks.

CO4 Establish a Sensor network environment for different type of applications.

CO5 Investigate the process involved in Sensor Management

REFERENCE BOOKS:

1. Adrian Perrig, J. D. Tygar, "Secure Broadcast Communication: In Wired and Wireless Networks", Springer, 2006.
2. Carlos De Morais Cordeiro, Dharma Prakash Agrawal “Ad Hoc and Sensor Networks: Theory and Applications (2nd Edition), World Scientific Publishing, 2011.
3. C.Siva Ram Murthy and B.S.Manoj, “Ad Hoc Wireless Networks – Architectures and Protocols”, Pearson Education, 2004.
4. C.K.Toh, “Ad Hoc Mobile Wireless Networks”, Pearson Education, 2002.
5. Erdal Çayırcı, Chunming Rong, “Security in Wireless Ad Hoc and Sensor Networks”, John Wiley and Sons, 2009.
6. Holger Karl, Andreas willig, Protocols and Architectures for Wireless Sensor Networks, John Wiley & Sons, Inc .2005.
7. Subir Kumar Sarkar, T G Basavaraju, C Puttamadappa, “Ad Hoc Mobile Wireless Networks”, Auerbach Publications, 2008.
8. Waltenegus Dargie, Christian Poellabauer, “Fundamentals of Wireless Sensor Networks Theory and Practice”, John Wiley and Sons, 2010.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1			1	2		
CO2			2	2		
CO3	1		3	3	1	1
CO4	1		2	2		
CO5	1		2	3	1	1

23EC2911	INTERNET OF THINGS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand the fundamentals of Internet of Things
- To learn about the basics of IOT protocols
- To build a small low cost embedded system using Raspberry Pi.
- To apply the concept of Internet of Things in the real world scenario.

UNIT I INTRODUCTION TO IoT **9**

Internet of Things - Physical Design- Logical Design- IoT Enabling Technologies - IoT Levels & Deployment Templates - Domain Specific IoTs - IoT and M2M - IoT System Management with NETCONF-YANG- IoT Platforms Design Methodology

UNIT II IoT ARCHITECTURE **9**

M2M high-level ETSI architecture - IETF architecture for IoT - OGC architecture - IoT reference model - Domain model - information model - functional model - communication model - IoT reference architecture.

UNIT III IoT PROTOCOLS **9**

Protocol Standardization for IoT – Efforts – M2M and WSN Protocols – SCADA and RFID Protocols – Unified Data Standards – Protocols – IEEE 802.15.4 – BACNet Protocol – Modbus– Zigbee Architecture – Network layer – 6LowPAN - CoAP - Security

UNIT IV BUILDING IoT WITH RASPBERRY PI & ARDUINO **9**

Building IOT with RASPERRY PI- IoT Systems - Logical Design using Python – IoT Physical Devices & Endpoints - IoT Device -Building blocks -Raspberry Pi -Board - Linux on Raspberry Pi - Raspberry Pi Interfaces -Programming Raspberry Pi with Python - Other IoT Platforms - Arduino.

UNIT V CASE STUDIES AND REAL-WORLD APPLICATIONS **9**

Real world design constraints - Applications - Asset management, Industrial automation, smart grid, Commercial building automation, Smart cities - participatory sensing - Data Analytics for IoT – Software & Management Tools for IoT Cloud Storage Models & Communication APIs - Cloud for IoT -Amazon Web Services for IoT.

TOTAL :45 PERIODS

COURSE OUTCOMES:

Upon completion of the course, students will be able to:

CO1 Analyze various protocols for IoT

CO2 Develop web services to access/control IoT devices.

CO3 Design a portable IoT using Rasperry Pi

CO4 Deploy an IoT application and connect to the cloud.

CO5 Analyze applications of IoT in real time scenario

REFERENCE BOOKS:

1. Arshdeep Bahga, Vijay Madisetti, “Internet of Things – A hands-on approach”, Universities Press, 2015
2. Dieter Uckelmann, Mark Harrison, Michahelles, Florian (Eds), “Architecting the Internet of Things”, Springer, 2011.
3. Honbo Zhou, “The Internet of Things in the Cloud: A Middleware Perspective”, CRC Press, 2012.
4. Jan Ho¨ ller, Vlasios Tsiatsis , Catherine Mulligan, Stamatis , Karnouskos, Stefan Avesand. David Boyle, "From Machine-to-Machine to the Internet of Things - Introduction to a New Age of Intelligence", Elsevier, 2014.
5. Olivier Hersent, David Boswarthick, Omar Elloumi , “The Internet of Things – Key applications and Protocols”, Wiley, 2012.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3		3	3	2	2
CO2	3		3	3	2	2
CO3	3		3	3	2	2
CO4	3		3	3	2	2
CO5	3		3	3	2	2

23EC2912	NETWORK ROUTING ALGORITHMS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To expose the students to the layered architecture for communication networks and the specific functionality of the network layer.
- To enable the student to understand the basic principles of routing and the manner this is implemented in conventional networks and the evolving routing algorithms based on internetworking requirements, optical backbone and the wireless access part of the network.
- To enable the student to understand the different routing algorithms existing and their performance characteristics.

UNIT I INTRODUCTION 9

ISO OSI Layer Architecture, TCP/IP Layer Architecture, Functions of Network layer, General Classification of routing, Routing in telephone networks, Dynamic Non-hierarchical Routing (DNHR), Trunk status map routing (TSMR), real-time network routing (RTNR), Distance vector routing, Link state routing, Hierarchical routing.

UNIT II INTERNET ROUTING 9

Interior protocol: Routing Information Protocol (RIP), Open Shortest Path First (OSPF), Bellman Ford Distance Vector Routing. Exterior Routing Protocols: Exterior Gateway Protocol (EGP) and Border Gateway Protocol (BGP). Multicast Routing: Pros and cons of Multicast and Multiple Unicast Routing, Distance Vector Multicast Routing Protocol (DVMRP), Multicast Open Shortest Path First (MOSPF), MBONE, Core Based Tree Routing.

UNIT III ROUTING IN OPTICAL WDM NETWORKS 9

Classification of RWA algorithms, RWA algorithms, Fairness and Admission Control, Distributed Control Protocols, Permanent Routing and Wavelength Requirements, Wavelength Rerouting- Benefits and Issues, Light path Migration, Rerouting Schemes, Algorithms- AG, MWPG.

UNIT IV MOBILE - IP NETWORKS 9

Macro-mobility Protocols, Micro-mobility protocol: Tunnel based: Hierarchical Mobile IP, Intra domain Mobility Management, Routing based: Cellular IP, Handoff Wireless Access Internet Infrastructure (HAWAII).

UNIT V MOBILE AD –HOC NETWORKS 9

Internet-based mobile ad-hoc networking communication strategies, Routing algorithms – Proactive routing: destination sequenced Distance Vector Routing (DSDV), Reactive routing: Dynamic Source Routing (DSR), Ad hoc On-Demand Distance Vector Routing (AODV), Hybrid Routing: Zone Based Routing (ZRP).

TOTAL :45 PERIODS

COURSE OUTCOMES:

Upon completion of the course, students will be able to:

CO1 Explain basic network routing concepts.

CO2 Compare different internet routing protocols.

CO3 Understand the routing schemes used in optical WDM networks.

CO4 Describe the developments in mobile IP networks.

CO5 Explain the concepts of mobile Ad hoc networks.

REFERENCE BOOKS:

1. A.T Campbell et al., — Comparison of IP Micromobility Protocols, IEEE Wireless Communications Feb.2002, pp 72-82.Dieter Uckelmann, Mark Harrison, Michahelles, Florian (Eds), “Architecting the Internet of Things”, Springer, 2011.
2. C.E Perkins, “Ad Hoc Networking”, Addison – Wesley, 2001.Jan Ho¨ ller, Vlasios Tsiatsis , Catherine Mulligan, Stamatis , Karnouskos, Stefan Avesand. David Boyle, "From Machine-to-Machine to the Internet of Things - Introduction to a New Age of Intelligence", Elsevier, 2014.
3. C.Siva Rama Murthy and Mohan Gurusamy, “WDM Optical Networks – Concepts,Design and Algorithms”, Prentice Hall of India Pvt. Ltd, New Delhi – 2002.
4. Ian F. Akyildiz, Jiang Xie and Shantidev Mohanty, “A Survey of mobility Management in Next generation All IP- Based Wireless Systems”, IEEE Wireless Communications Aug.2004, pp 16-27.
5. M. Steen Strub, “Routing in Communication network”, Prentice Hall International, Newyork,1995.
6. S. Keshav, “An engineering approach to computer networking”, Addison Wesley 1999.
7. William Stallings, “High speed Networks TCP/IP and ATM Design Principles”, Prentice Hall, New York, 1995.
8. William Stallings, “High speed networks and Internets Performance and Quality of Service”, II Edition, Pearson Education Asia. Reprint India 2002.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3		3	3	2	2
CO2	3		3	3	2	2
CO3	3		3	3	2	2
CO4	3		3	3	2	2
CO5	3		3	3	2	2

23EC2913	NEXT GENERATION WIRELESS NETWORKS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To learn the fundamentals of 5G and beyond internet.
- To understand the concept of small cells in 5G and beyond mobile networks.
- To learn the mobile clouds in 5G and beyond network context.
- To understand the role of cognitive radios in 5G and beyond networks.
- To learn the security issues in 5G and beyond networks.

UNIT I PERVASIVE CONNECTED WORLD AND 5G AND BEYOND INTERNET 9

Historical Trend of Wireless Communications – Evolution of LTE Technology to Beyond 4G. 5G and beyond Roadmap – Ten Pillars of 5G and beyond – Internet of Things and Context Awareness – Networking Reconfiguration and Virtualization Support – Mobility – Quality of Service Control. Emerging Approach for Resource Over-provisioning

UNIT II SMALL CELLS FOR 5G AND BEYOND MOBILE NETWORKS 9

Introduction to Small Cells – Capacity Limits and Achievable Gains with Densification – Mobile Data Demand – Demand vs. Capacity – Small Cell Challenges

UNIT III COOPERATION FOR NEXT GENERATION WIRELESS NETWORKS 9

Introduction – Cooperative Diversity and Relaying Strategies: Cooperation and Network Coding, Cooperative ARQ MAC Protocols – PHY Layer Impact on MAC Protocol Analysis: Impact of Fast Fading and Shadowing on Packet Reception for QoS Guarantee, Impact of Shadowing Spatial Correlation– Study: NCCARQ, PHY Layer Impact.

UNIT IV MOBILE CLOUDS AND COGNITIVE RADIO 9

Introduction – The Mobile Cloud – Mobile Cloud Enablers – Network Coding – Overview of Cognitive Radio Technology in 5G and beyond Wireless –Spectrum Optimization using Cognitive Radio. Relevant Spectrum Optimization Literature in 5G and beyond – Cognitive Radio and Carrier Aggregation – Energy Efficient Cognitive Radio Technology.

UNIT V SECURITY & SELF ORGANISING NETWORKS 9

Overview of Potential 5G and beyond Communications System Architecture – Security Issues and Challenges in 5G and beyond Communications Systems – Self Organising Networks: Introduction, Self Organising Networks in UMTS and LTE, The Need for Self Organising Networks in 5G and beyond, Evolution towards Small Cell Dominant HetNets

TOTAL :45 PERIODS

COURSE OUTCOMES:

Upon completion of the course, students will be able to:

CO1 Compare the 5G and beyond network with older generations of networks.
CO2 Identify suitable small cells for different applications in 5G and beyond networks.
CO3 Simulate 5G and beyond network scenarios.
CO4 Connect applications to mobile cloud.
CO5 Analyze the security risks in 5G and beyond networks.

REFERENCE BOOKS:

1. Jonathan Rodriguez, “Fundamentals of 5G Mobile Networks”, Wiley, 2015.
2. Yin Zhang, Min Chen, “Cloud Based 5G Wireless Networks”, Springer Briefs in Computer Science, Springer, 2016.
3. Athanasios G. Kanatas, Konstantina S. Nikita, Panagiotis Takis Mathiopoulos, “New Directions in Wireless Communications Systems: From Mobile to 5G”, CRC Press, 2017.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3		3	3	3	2
CO2	3		3	3	3	2
CO3	3		3	3	3	2
CO4	3		3	3	3	2
CO5	3		3	3	3	2

23EC2914	MULTIMEDIA COMMUNICATIONS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To enable the student to understand the basic characteristics of multimedia components and the different methods for compressing audio, video, text and images.
- To expose the students to the challenges of IP based transport and the solution approaches considering the example case of VoIP technology.
- To enable the student to understand the different networking aspects with reference to multimedia transmission.

UNIT - I MULTIMEDIA COMPONENTS **9**

Introduction – Multimedia skills – Multimedia components and their characteristics – Text, sound, images, graphics, animation, video, hardware.

UNIT - II AUDIO AND VIDEO COMPRESSION **9**

Audio compression–DPCM-Adaptive PCM –adaptive predictive coding-linear Predictive coding- code excited LPC-perpetual coding Video compression – principles-H.261-H.263- MPEG 1, 2, 4, Watermarking

UNIT - III TEXT AND IMAGE COMPRESSION **9**

Compression principles-source encoders and destination encoders-lossless and lossy compression-entropy encoding –source encoding –text compression –static Huffman coding dynamic coding –arithmetic coding –Lempel ziv-welsh Compression-image compression.

UNIT - IV VoIP TECHNOLOGY **9**

Basics of IP transport, VoIP challenges, H.323/ SIP –Network Architecture, Protocols, Call establishment and release, VoIP and SS7, Quality of Service-CODEC Methods-VOIP applicability.

UNIT - V MULTIMEDIA NETWORKING **9**

Multimedia networking –Applications-streamed stored and audio-making the best Effort service- protocols for real time interactive Applications-distributing multimedia-beyond best effort service- secluding and policing Mechanisms-integrated services-differentiated Services- RSVP, Encryption and Decryption.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of the course, students will be able to:

- **CO1** Able to demonstrate an understanding of the different multimedia components and their characteristics.
- **CO2** Familiar with the challenges involved in multimedia signal processing and the techniques used.
- **CO3** Able to demonstrate an understanding of the multimedia transmission technologies.
- **CO4** Able to demonstrate an understanding of the multimedia networking aspects.
- **CO5** In a position to apply his knowledge for identifying a suitable strategy for compression and communication based on the signal characterization and its needs.

REFERENCE BOOKS:

1. Fred Halshall, "Multimedia communication – applications, networks, protocols and standards", Pearson education, 2007.
2. Tay Vaughan, —Multimedia: making it work‖, TMH, 7th Edition, 2007.
3. Kurose and W.Ross, "Computer Networking —a Top down approach", Pearson education, 3rd Edition, 2005.
4. Marcus goncalves, "Voice over IP Networks", McGraw Hill,
5. K R. Rao,Z S Bojkovic, D A Milovanovic, "Multimedia Communication Systems: Techniques, Standards, and Networks", Pearson Education, 2007.
6. R. Steimnetz, K. Nahrstedt, "Multimedia Computing, Communications and Applications‖, Pearson Education", 1st Edition, 1995.
7. Ranjan Parekh, "Principles of Multimedia", TMH, 2006.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1			2			
CO2	2		3	3		
CO3			2	1		
CO4			2	1		
CO5	2		2	3	1	

23EC2915	DIGITAL AUDIO AND VIDEO BROADCASTING TECHNOLOGY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand the basics of audio broadcasting technology
- To understand the basics of video broadcasting technology
- To learn the principle of audio and video coding methods.
- To understand the technology of digital TV transmission.
- To understand digital audio broadcasting.

UNIT - I INTRODUCTION **9**

Basic television, analog and digital TV, standards for analog and digital TV, scanning on original black and white picture, synchronization, horizontal and vertical synchronization, adding colour information, transmission methods, distortion and interference, measurements on analog video standards.

UNIT - II VIDEO CODING **9**

Video compression, MPEG-2 data stream, coding, modulation of moving pictures, DPCM of moving pictures, DCT and quantization, Huffman coding, structure of video elementary system, recent compression methods, MPEG-4 –H.263-advanced video coding. HDTV.

UNIT - III AUDIO AND VIDEO COMPRESSION **9**

Digital audio signal, MPEG and Dolby digital, subband coding, transform coding for MPEG, multi channel sound, Comparison digital video signal, MPEG- 1, MPEG-- 2, VCD, DVD, MPEG 3, MPEG-4, MPEG- 7 and MPEG- 21, measurement of MPEG-2 transport system, picture quality analysis.

UNIT - IV DIGITAL AUDIO BROADCASTING **9**

Digital audio broadcasting (DAB), comparing DAB and DVB, physical layer of DAB, forward error correction of DAB, modulator and transmitter for DAB, single frequency networks, DAB data broadcasting.

UNIT - V DIGITAL TV SIGNAL TRANSMISSION **9**

Digital TV signal transmission by satellite, DVB-S/S2, parameters, modulator, signal processing in satellite, receiver, satellite transmission link, DVB-S measurement of CNR, SNR and Eb/No, noise power, broadcast cable transmission, DVB-C, modulator and receiver, DVB-T and DVB-H standards.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of the course, students will be able to:

CO1 Design and implement digital compression techniques.

CO2 Analyze video coding and audio compression techniques.

CO3 Investigate digital audio signals and schemes

CO4 Construct digital broadcast and TV systems

CO5 Identify issues and provide solutions for digital TV transmission.

REFERENCE BOOKS:

1. W.Fischer, "Digital Video and Audio Broadcasting Technology, A Practical Engineering Guide", 2nd Edition, Springer, 2010.
2. W.Fischer,"Digital Television,A Practical Engineering Guide",2nd Edition, Springer,2004.
3. Ken C Pohlmann, “Principles of Digital Audio”, 6th Edition, McGraw Hill, 2010.
4. Herve Benoit, “Digital Television, MPEG-1, MPEG-2 and Principles of DVB Systems”, Focal Press, Elsevier Science Imprint, 2002.
5. Jerry Whitaker,Blair Benson, “Standard Handbook of Audio Engineering” Second Edition.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3		3	3	2	2
CO2	3		3	3	2	2
CO3	3		3	3	2	2
CO4	3		3	3	2	2
CO5	3		3	3	2	2

23EC2916	IMAGE ANALYSIS AND COMPUTER VISION	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand the general process of image acquisition and enhancement
- To study the different image transform techniques
- To get exposed to algorithms related to image segmentation and restoration
- To learn basic concepts and methodologies in image compression
- To understand the basics of video processing for computer vision applications

UNIT - I IMAGE ENHANCEMENT 9

Digital image fundamentals - Image sampling - Quantization - Spatial domain filtering - intensity transformations - Contrast stretching - Histogram equalization - Smoothing filters, Sharpening filters-Noise distributions - Mean filters - Order statistics filters

UNIT - II IMAGE TRANSFORMS 9

1D DFT- 2D Transforms - DFT- DCT- Walsh - Hadamard - Slant - Haar - KLT- SVD- Wavelet transform.

UNIT - III IMAGE RESTORATION AND SEGMENTAT ION 9

Image restoration - degradation model - Unconstrained and Constrained restoration - Inverse filtering - Wiener filtering - Image segmentation - Thresholding - Edge detection, Edge linking - Region based methods.

UNIT - IV IMAGE COMPRESSION 9

Need for data compression - Huffman - Arithmetic coding - LZW technique - Vector Quantization - JPEG – MPEG.

UNIT - V VIDEO PROCESSING 9

Back ground Subtraction - Video analytics - Video object Segmentation - Object Detection - Face Recognition - Motion Estimation.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of the course, students will be able to:

CO1 Implement image enhancement algorithms
CO2 Apply image transform for different imaging modalities
CO3 Perform different segmentation and restoration processes
CO4 Implement different compression techniques
CO5 Develop algorithms for computer vision problems.

REFERENCE BOOKS:

1. Rafael C. Gonzalez, Richard E. Woods, “Digital Image Processing”, Pearson Education, Inc., Third Edition, 2007
2. Anil K. Jain, "Fundamentals of Digital Image Processing”, Prentice Hall of India, 2004.
3. Milan Sonka, Vaclav Hlavac and Roger Boyle, “Image Processing, Analysis and Machine Vision”, Brookes/ Cole, Vikas Publishing House, 2nd edition,1999.
4. Sid Ahmed, M.A., “Image Processing Theory, Algorithms and Architectures”, Mc Graw Hill, 1995
5. Richard Szeliski, "Computer Vision - Algorithms and Applications", Springer Verlag London Limited, 2001

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3		3	2		3
CO2	3		3	2		3
CO3	3		3	2		3
CO4	3		3	2		3
CO5	3		3	2		3

23EC2917	COOPERATIVE COMMUNICATIONS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To enable the student to appreciate the necessity of co-operative wireless communication.
- To expose the student would to new techniques and understand their feasibility.

UNIT - I COOPERATIVE COMMUNICATIONS AND GREEN CONCEPTS 9

Network architectures and research issues in cooperative cellular wireless networks; Cooperative communications in OFDM and MIMO cellular relay networks: issues and approaches; Fundamental trade-offs on the design of green radio networks, Green modulation and coding schemes.

UNIT - II COOPERATIVE TECHNIQUES 9

Cooperative techniques for energy efficiency, Cooperative base station techniques for cellular wireless networks; Turbo base stations; Antenna architectures for cooperation; Cooperative communications in 3GPP LTE-Advanced, Partial information relaying and Coordinated multi- point transmission in LTE-Advanced.

UNIT - III RELAY-BASED COOPERATIVE CELLULAR NETWORKS 9

Distributed space-time block codes; Collaborative relaying in downlink cellular systems; Radio resource optimization; Adaptive resource allocation; Cross-layer scheduling design for cooperative wireless two-way relay networks; Network coding in relay-based networks.

UNIT - IV GREEN RADIO NETWORKS 9

Base station Power-Management Techniques - Opportunistic spectrum and load management, Energy-saving techniques in cellular wireless base stations, Power-management for base stations in smart grid environment, Cooperative multicell processing techniques for energy-efficient cellular wireless communications.

UNIT - V ACCESS TECHNIQUES FOR GREEN RADIO NETWORKS 9

Cross-layer design of adaptive packet scheduling for green radio networks; Energy-efficient relaying for cooperative cellular wireless networks; Energy performance in TDD-CDMA multi-hop cellular networks; Resource allocation for green communication in relay-based cellular networks; Green Radio Test-Beds and Standardization Activities.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of the course, students will be able to:

CO1	Appreciate the necessity and the design aspects of cooperative and green wireless communication.
CO2	Familiar with different techniques used in cooperative cellular networks.
CO3	Familiar with different techniques used in green radio networks.
CO4	Evolve new techniques and demonstrate their feasibility using mathematical validations and simulation tools.
CO5	Demonstrate the impact of the green engineering solutions in a global, economic, environmental and societal context.

REFERENCE BOOKS:

1. Ekram Hossain, Dong In Kim, Vijay K. Bhargava, “Cooperative Cellular Wireless Networks”, Cambridge University Press, 2011.
2. Ekram Hossain, Vijay K. Bhargava(Editor), Gerhard P. Fettweis (Editor), “Green Radio Communication Networks”, Cambridge University Press, 2012.
3. F. Richard Yu, Yu, Zhang and Victor C. M. Leung, “Green Communications and Networking”, CRC press, 2012.
4. Mazin Al Noor, “Green Radio Communication Networks Applying Radio-Over-Fibre Technology for Wireless Access”, GRIN Verlag, 2012.
5. Mohammad S. Obaidat, Alagan Anpalagan and Isaac Woungang, “Handbook of Green Information and Communication Systems”, Academic Press, 2012.
6. Ramjee Prasad and Shingo Ohmori, Dina Simunic, “Towards Green ICT”, River Publishers, 2010.
7. Jinsong Wu, Sundeep Rangan and Honggang Zhang, “Green Communications: Theoretical Fundamentals, Algorithms and Applications”, CRC Press, 2012.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1		2	1		
CO2			2	1		
CO3			2			
CO4	1		2	2		
CO5	1		3	1	1	1

23EC2918	MACHINE LEARNING IN COMMUNICATION NETWORKS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To enable the student to understand the concept of machine learning and its application in wireless communication and bio-medical.
- To expose the student to be familiar with a set of well-known supervised, semi- supervised and unsupervised learning algorithms.

UNIT - I MATHEMATICAL BACKROUND 9

Linear Algebra – Arithmetic of matrices, Norms, Eigen decomposition, Singular value decomposition, Pseudo inverse, Principal Component analysis. Probability theory – probability distribution, conditional probability, Chain rule, Bayes rule, Information theory, Structured Probabilistic models.

UNIT - II MACHINE LEARNING BASICS 9

Supervised and Unsupervised learning, Capacity, Overfitting and Underfitting, Cross Validation, Linear regression, Logistic Regression, Regularization, Naive Bayes, Support Vector Machines (SVM), Decision tree, Random forest, K-Means Clustering, k nearest neighbor.

UNIT - III NEURAL NETWORKS 9

Feedforward Networks, Backpropagation, Convolutional Neural Networks-LeNet, AlexNet, ZF- Net, VGGNet, GoogLeNet, ResNet, Visualizing Convolutional Neural Networks, Guided Backpropagation, Deep Dream, Deep Art, Fooling Convolutional Neural Networks. Recurrent Neural Network(RNN) – Backpropagation through time (BPTT), Vanishing and Exploding Gradients.

UNIT - IV ML IN WIRELESS AND SECURITY 9

Water-filling power allocation, Optimization for MIMO Systems, OFDM Systems and MIMO- OFDM systems. Optimization in beamformer design – Robust receive beamforming, Transmit downlink beamforming. Application: Radar for target detection, Array Processing, MUSIC, ML in Side channel analysis.

UNIT - V ML IN BIO- MEDICAL 9

Machine Learning in Medical Imaging. Deep Learning for Health Informatics. Deep Learning Automated ECG Noise Detection and Classification System for Unsupervised Healthcare Monitoring. Techniques for Electronic Health Record (EHR) Analysis.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of the course, students will be able to:

CO1 Demonstrate understanding of the mathematical principles underlying machine learning.

CO2 Familiar with the different machine learning techniques and their use cases.

CO3 Formulate machine learning problems corresponding to different applications.

CO4 Recognize the characteristics of machine learning techniques that are useful to solve real-world problems.

CO5 Read current research papers, understand the issues and the machine learning based solution approaches.

REFERENCE BOOKS:

1. Ian Goodfellow, Yoshua Bengio, and Aaron Courville, "Deep learning",Cambridge,MA", MIT Press, 2017.
2. Tom M. Mitchell, "Machine Learning", McGraw Hill, 1997.
3. Ethem Alpaydın, "Introduction to machine learning", MIT Press, 3rd Edition, 2014.
4. M. N. Wernick, Y. Yang, J. G. Brankov, G. Yourganov and S. C. Strother, "Machine Learning in Medical Imaging", IEEE Signal Processing Magazine, vol. 27, no. 4, pp. 25- 38, July 2010.
5. Ravì et al., "Deep Learning for Health Informatics," IEEE Journal of Biomedical and Health Informatics, vol. 21, no. 1, pp. 4-21, Jan. 2017.
6. U. Satija, B. Ramkumar and M. S. Manikandan, "Automated ECG Noise Detection and Classification", IEEE Journal of Biomedical and Health Informatics PP(99), March 2017
7. "System for Unsupervised Healthcare Monitoring," IEEE Journal of Biomedical and Health Informatics, vol. 22, no. 3, pp. 722-732, May 2018.
8. B. Shickel, P. J. Tighe, A. Bihorac and P. Rashidi, "Deep EHR: A Survey of Recent Advances in Deep Learning Techniques for Electronic Health Record (EHR) Analysis," IEEE Journal of Biomedical and Health Informatics, vol. 22, no. 5, pp. 1589-1604, Sept. 2018.
9. A. Heuser, S. Picek, S. Guilley and N. Mentens, "Lightweight Ciphers and their Side- channel Resilience," IEEE Transactions on Computers, DOI 10.1109/TC.2017.2757921.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1		1			
CO2	1		2			
CO3			3	3	1	
CO4	1		3	3		1
CO5			2		1	

23EC2919	SIGNAL INTEGRITY FOR HIGH SPEED DESIGN	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To identify sources affecting the speed of digital circuits.
- To introduce methods to improve the signal transmission characteristics

UNIT - I SIGNAL PROPAGATION ON TRANSMISSION LINES 9

Transmission line equations, wave solution, wave vs. circuits, initial wave, delay time, Characteristic impedance , wave propagation, reflection, and bounce diagrams Reactive terminations – L, C , static field maps of micro strip and strip line cross-sections, per unit length parameters, PCB layer stackups and layer/Cu thicknesses, cross-sectional analysis tools, Zo and Td equations for microstrip and stripline Reflection and terminations for logic gates, fan- out, logic switching , input impedance into a transmission-line section, reflection coefficient, skin-effect, dispersion.

UNIT - II MULTI- CONDUCTOR TRANSMISSION LINES AND CROSS -TALK 9

Multi-conductor transmission-lines, coupling physics, per unit length parameters, Near and far-end cross-talk, minimizing cross-talk (stripline and microstrip) Differential signalling, termination, balanced circuits, S-parameters, Lossy and Lossless models.

UNIT - III NON-IDEAL EFFECTS 9

Non-ideal signal return paths – gaps, BGA fields, via transitions, Parasitic inductance and capacitance, Transmission line losses – Rs, tanδ, routing parasitic, Common-mode current, differential-mode current , Connectors.

UNIT - IV POWER CONSIDERATIONS AND SYSTEM DESIGN 9

SSN/SSO, DC power bus design, layer stack up, SMT decoupling, Logic families, power consumption, and system power delivery, Logic families and speed Package types and parasitic, SPICE, IBIS models, Bit streams, PRBS and filtering functions of link-path components, Eye diagrams, jitter, inter-symbol interference Bit-error rate, Timing analysis.

UNIT - V CLOCK DISTRIBUTION AND CLOCK OSCILLATORS 9

Timing margin, Clock slew, low impedance drivers, terminations, Delay Adjustments, cancelling parasitic capacitance, Clock jitter.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of the course, students will be able to:

CO1 Familiar with transmission line characterization due to high speed signal propagation.

CO2 Understand the impairments, crosstalk and non-ideal effects associated with high speed design

CO3 Identify sources affecting the speed of digital circuits and their analysis.

CO4 Appreciate power and clock related challenges in high speed system design.

CO5 Identify methods to improve the signal transmission characteristics

REFERENCE BOOKS:

1. H. W. Johnson and M. Graham, “High-Speed Digital Design: A Handbook of Black Magic”, Prentice Hall, 1993.
2. Douglas Brooks, “Signal Integrity Issues and Printed Circuit Board Design”, Prentice Hall PTR, 2003.
3. S. Hall, G. Hall, and J. McCall, “High-Speed Digital System Design: A Handbook of Interconnect Theory and Design Practices”, Wiley-Interscience, 2000.
4. Eric Bogatin, “Signal Integrity – Simplified”, Prentice Hall PTR, 2003

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	2	2	3	3	2
CO2	2	2	2	3	3	2
CO3	1	1	2	3	3	3
CO4	2	2	1	3	3	2
CO5	2	2	2	3	3	2

23EC2920	COMMUNICATION NETWORK DESIGN	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To expose the student to the functional elements and evolution of networking, the multiplexing, switching and routing related issues and some case studies of wired and wireless network design process.
- To enable the student to analyse the various aspects of a protocol and implement it using a network simulation tool.

UNIT - I INTRODUCTION **9**

Importance of Quantitative Modelling in Engineering of Telecommunication Networks, The Functional Elements of Networking, Evolution of Networking in the Wired and Wireless Domain.

UNIT - II MULTIPLEXING **9**

Performance Measures and Engineering Issues Network characterization, Circuit multiplexed Networks, packet Multiplexing over wireless networks, Events and processes in packet multiplexer models, Deterministic traffic Models and network calculus, stochastic traffic models, LRD traffic, Link Scheduling and network capacity in wireless networks.

UNIT - III SWITCHING **9**

Performance Measures of packet switches and circuit switches, queuing in packet switches, delay Analysis in Output Queued Switch, Input Queued Switch and CIOQ Switch with Parallelism, Blocking in Switching Networks, Closed Networks.

UNIT - IV ROUTING **9**

Algorithms for Shortest Path Routing - Dijkstra‘s Algorithm, Bellman Ford Algorithm, Generalized Dijkstra‘s Algorithm, Optimal Routing, Routing Protocols-Distance Vector, Link State and Exterior gateway protocols, Formulations of the Routing Problem-minimum interference Routing, MPLS, QoS Routing, Nonadditive and Additive metrics.

UNIT - V CASE STUDIES **9**

Design of a wireless network and a wired network, prototype implementation to be simulated in a network simulator.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of the course, students will be able to:

CO1 Familiar with the functional elements and evolution of communication networking

CO2 Familiar with the multiplexing, switching and routing related issues, solutions and performance metrics

CO3 Understand the wired and wireless network design process.

CO4 Analyse the various aspects of a protocol and implement it using a network simulation tool.

CO5 Breakup the communication network design problem into a number of sub-problems, identify suitable protocol solutions, implement using any simulator tool and carry out performance characterization.

REFERENCE BOOKS:

1. Anurag Kumar, D. Manjunath and Joy, “Communication Networking”, Morgan Kaufan Publishers, 2005.
2. A.Lean Garica and Indra Widjaja, “Communications Networks”, Tata Mc Graw Hill,2004.
3. Thomas G.Robertazzi, “Computer Networks and Systems”, Springer, 3rd Edition, 2006.
4. Keshav.S., “An Engineering Approach to Computer Networking”, Addison – Wesley, 1999.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1			2			
CO2			2	2		
CO3			2	2		
CO4			2	2		
CO5	1		3	3		

23EC2921	ELECTRO MAGNETIC INTERFERENCE AND COMPATIBILITY IN SYSTEM DESIGN	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To gain broad conceptual understanding of the various aspects of electromagnetic (EM) interference and compatibility
- To develop a theoretical understanding of electromagnetic shielding effectiveness
- To understand ways of mitigating EMI by using shielding, grounding and filtering
- To understand the need for standards and to appreciate measurement methods
- To understand how EMI impacts wireless and broadband technologies

UNIT I INTRODUCTION & SOURCES OF EM INTERFERENCE 9

Introduction - Classification of sources - Natural sources - Man-made sources - Survey of the electromagnetic environment.

UNIT II EM SHIELDING 9

Introduction - Shielding effectiveness - Far-field sources - Near-field sources - Low-frequency, magnetic field shielding - Effects of apertures.

UNIT III INTERFERENCE CONTROL TECHNIQUES 9

Equipment screening - Cable screening - grounding - Bonding -Power-line filters - Isolation - Balancing - Signal-line filters - Nonlinear protective devices.

UNIT IV EMC STANDARDS, MEASUREMENTS AND TESTING 9

Need for standards - The international framework - - Civilian EMC Standards - Military Standards - Human exposure limits to EM fields -EMC measurement techniques - Measurement tools - Test environments.

UNIT V EMC CONSIDERATIONS IN WIRELESS AND BROADBAND TECHNOLOGIES 9

Efficient use of frequency spectrum - EMC, interoperability and coexistence - Specifications and alliances - Transmission of high-frequency signals over telephone and power networks – EMC and digital subscriber lines - EMC and power line telecommunications.

TOTAL :45 PERIODS

COURSE OUTCOMES:

Upon completion of the course, students will be able to:

CO1 Demonstrate knowledge of the various sources of electromagnetic interference
CO2 Display an understanding of the effect of how electromagnetic fields couple through apertures, and solve simple problems based on that understanding
CO3 Explain the EMI mitigation techniques of shielding and grounding
CO4 Explain the need for standards and EMC measurement methods
CO5 Discuss the impact of EMC on wireless and broadband technologies

REFERENCE BOOKS:

1. Christopoulos C, Principles and Techniques of Electromagnetic Compatibility, CRC Press, Second Edition, Indian Edition, 2013.
2. Paul C R, Introduction to Electromagnetic Compatibility, Wiley India, Second Edition,2008.
3. Kodali V P, Engineering Electromagnetic Compatibility, Wiley India, Second Edition,2010.
4. Henry W Ott, Electromagnetic Compatibility Engineering, John Wiley & Sons Inc, Newyork,2009.
5. Scott Bennett W, Control and Measurement of Unintentional Electromagnetic Radiation, John Wiley& Sons Inc., Wiley Interscience Series, 1997.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1			2			
CO2	1				3	3
CO3			2			
CO4			2	3	2	3
CO5				3	3	2

23EC2922	SPREAD SPECTRUM TECHNIQUES AND APPLICATIONS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To introduce the concept of spread spectrum modulation.
- To understand the generation of PN sequence and their properties.
- To understand the performance of spread spectrum in jamming environment.
- To understand the way in which spread spectrum is applied to CDMA and GPS systems.
- To get expose to the applications of spread spectrum.

UNIT - I SPREADING CODES 9

Finite-Field Arithmetic- Sequence Generator Fundamentals-State - Machine Representation of Shift-Register Generators-Generation &Properties of m-Sequences Gold Codes - Kasami Sequences (Small Set) - Quaternary Sequences - Complementary Code Keying - Walsh– Hadamard Sequences.

UNIT - II SPREAD SPECTRUM SYSTEMS 9

Direct Sequence Spread Spectrum (DSSS)- Processing Gain- Frequency Hop Spread Spectrum (FHSS)- Coherent & Noncoherent Slow FHSS – Coherent & Noncoherent Fast FHSS- Hybrid DS/FH Spread Spectrum.

UNIT - III SYNCHRONIZATION IN SPREAD SPECTRUM 9

Sources of synchronization Uncertainty, Carrier Synchronization - Code Synchronization & Acquisition - Matched Filter Acquisition, Serial Search Acquisition, Sequential Acquisition, Code Tracking- Delay Lock Tracking loop, Noncoherent Tracking loop.

UNIT - IV SPREAD SPECTRUM IN CELLULAR COMMUNICATION 9

Cellular Network and Power Control- DS-CDMA Cellular Networks, FH-CDMA Cellular Networks, Performance in Jamming Environment – Low Probability of Intercept methods- Optimum Intercept Receives for Spread - Spectrum Signals.

UNIT - V APPLICATIONS OF SPREAD SPECTRUM METHODS 9

Space Systems, Avionics Systems, Test Systems and equipment, Message Protection, GPS System-Principles-Differential GPS.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of the course, students will be able to:

CO1 Explain specifications of the spread spectrum systems.

CO2 Realize the generation of spread spectrum sequence.

CO3 Analyze synchronization issues in spread spectrum.

CO4 Design systems based on spread spectrum to mitigate the jamming.

CO5 Study the characteristics and performance of GPS system.

REFERENCE BOOKS:

1. Rodger E. Ziemer, "Fundamentals of Spread Spectrum Modulation", Morgan & Claypool, Publishers series, 2007.
2. Robert C. Dixon, "Spread Spectrum Systems with Commercial Applications", 3rd Edition, John Wiley & Sons, Ins, 1994.
3. R. L. Peterson, R. E. Ziemer, and D. E. Borth, "Introduction to Spread Spectrum Communications", Upper Saddle River, NJ: Prentice Hall, 1995.
4. M.K.Simon, J.K.Omura, R.A.Scholtz and B.K.Levit,"Spread Spectrum Communications Handbook", Electronic Edition, McGraw-Hill, 2002.
5. Don Torrieri, "Principles of Spread-Spectrum Communication Systems", Springer Science, Business Media, Inc Boston, 2005.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	3		3	3	2	2
CO2	3		3	3	2	2
CO3	3		3	3	2	2
CO4	3		3	3	2	2
CO5	3		3	3	2	2

23EC2923	MULTIMEDIA CODING TECHNIQUES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To enrich student learning in fundamentals of multimedia coding and standards.
- To train the students to acquire knowledge in text coding.
- To acquire knowledge behind theory of image and video coding & decoding with standards.
- To learn principles of audio coding and standards.
- To get comprehensive learning in multimedia standard content description and formats.

UNIT I LOSSLESS AND LOSSY CODING 9

Components of Multimedia – Basics of Information Theory – Entropy – Lossless Compression – Text Compression – Run Length Coding – Variable Length Coding – Shannon Fano Coding – Huffman and Adaptive Huffman Coding – Dictionary Based Coding

Arithmetic Coding – Lossy Compression Algorithms – Rate Distortion Theory – Quantization – Transform Coding – Wavelet Based Coding.

UNIT II IMAGE PROCESSING AND CODING 9

Image Formation – CIE Chromaticity Diagram – Color Models: RGB, CMY, LMS, HSV, HSL

Color Balancing – Gamma Correction – Image Coding and Decoding Standards: JPEG, JPEG-2000, JPEG-LS, GIF, PNG, TIFF, EXIF, BMP.

UNIT III VIDEO PROCESSING AND CODING 9

Video Color Transform: YUV, YIQ, YcbCr – Chroma Subsampling – Standard Digital Video Formats – CIF – QCIF – HDTV – UHDTV – Resolutions – 4K, 8K, 16K – Video Compression Based on Motion Compensation – Search for Motion Vectors – H.261 – H.264 – Motion Compensation in MPEG – MPEG–1, MPEG–2 – MPEG–4.

UNIT IV AUDIO PROCESSING AND CODING 9

Digitization of Audio: PCM, ADPCM – Waveform Audio File Format – Synthetic Sounds – Musical Instrument Digital Interface – Vocoders – MPEG Audio – MP3 – Advance Audio Coding – High-Efficiency Advanced Audio Coding – MPEG4 – Home Theatre Systems.

UNIT V MULTIMEDIA CONTENT DESCRIPTION AND FRAMEWORK 9

Hypermedia Coding – Multimedia and Hypermedia Expert Group – Multimedia Content Description Interface – MPEG-7 – Multimedia Framework – MPEG-21 – High Efficiency Coding and Media Delivery in Heterogeneous Environments – MPEG-H – Dynamic Adaptive Streaming over HTTP – MPEG-DASH.

TOTAL :45 PERIODS

COURSE OUTCOMES:

Upon completion of the course, students will be able to:

CO1 Articulate the concepts and techniques used in multimedia basics and standard coding techniques.
CO2 Develop competence in implementing text coding.
CO3 Design and implement algorithms for image and video coding.
CO4 Choose and analyze suitable audio coding for a given multimedia application.
CO5 Design and develop multimedia projects with standard content formats and frameworks.

REFERENCE BOOKS:

1. Mark S. Drew, Zee Nian Li, “Fundamentals of multimedia”, Prentice Hall, 2014.
2. Ralf Steinmetz, Klara Nahrstedt, “Multimedia Computing, Communications and Applications”, Innovative Technology Series, Prentice Hall, 1995.
3. Jerry D. Gibson, Toby Berger, Tom Lookabaugh, Dave Lindergh, Richard L. Baker, “Digital Compression for Multimedia: Principles and Standards”, Elsevier, 2006.
4. Ranjan Parekh, “Principles of Multimedia”, McGraw-Hill, Second Edition, 2017.
5. Fred Halsall, “Multimedia Communications: Applications, Networks, Protocols and Standards”, Pearson Education, 2002.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	2	1	1	1	1
CO2	2	1	1	1	1	1
CO3	2	1	2	2	1	2
CO4	2	1	2	1	1	3
CO5	2	1	1	1	1	1

23EC2924	VIDEO PROCESSING AND ANALYTICS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To have a better knowledge about videos representation and its formats
- To know the fundamental concepts of data science and analytics
- To enrich students with video processing for analytics
- To understand the data analytics for processing video content
- To expose the student to emerging trends in video analytics

UNIT I VIDEO FUNDAMENTALS 9

Basic Concepts and Terminology – Analog Video Standards – Digital Video Basics – Analog-to Digital Conversion – Color Representation and Chroma Sub Sampling – Video Sampling Rate and Standards Conversion – Digital Video Formats –Video Features – Colour, Shape and Textural Features.

UNIT II MOTION ESTIMATION AND VIDEO SEGMENTATION 9

Fundamentals of Motion Estimation – Optical Flow – 2D and 3D Motion Estimation – Block Based Point Correspondences – Gradient Based Intensity Matching – Feature Matching – Frequency Domain Motion Estimation – Video Segmentation

UNIT III FUNDAMENTAL DATA ANALYSIS 9

Exploratory Data Analysis – Collection of Data – Graphical Presentation of Data – Classification of Data – Storage and Retrieval of Data – Big Data – Challenges of Conventional Systems – Web Data – Evolution of Analytic Scalability – Analytic Processes and Tools – Analysis vs. Reporting.

UNIT IV MINING DATA STREAMS AND VIDEO ANALYTICS 9

Introduction To Streams Concepts – Sampling Data in a Stream – Filtering Streams – Counting Distinct Elements in a Stream – Analytic Processes and Tools – Video shot boundary detection – Model Based Annotation and Video Mining – Video Database – Video Categorization – Video Query Categorization.

UNIT V EMERGING TRENDS 9

Affective Video Content Analysis – Parsing a Video Into Semantic Segments – Video Indexing and Abstraction for Retrievals – Automatic Video Trailer Generation – Video In painting – Forensic Video Analysis.

TOTAL :45 PERIODS

COURSE OUTCOMES:

Upon completion of the course, students will be able to:

CO1 Discuss video processing fundamentals
CO2 Analyze video features for segmentation purpose
CO3 Derive numeric problems related to motion estimation
CO4 Process video streams for analytics purpose
CO5 Parse and index video segments and design applications for video analytics in current trend

REFERENCE BOOKS:

1. Roy, A., Dixit, R., Naskar, R., Chakraborty, R.S., "Digital Image Forensics: Theory and Implementation", Springer, 2018.
2. Paul Kinley, "Data Analytics for Beginners: Basic Guide to Master Data Analytics", CreateSpace Independent Publishing Platform, 2016.
3. Henrique C. M. Andrade, Bugra Gedik, Deepak S. Turaga, "Fundamentals of Stream Processing: Application Design, Systems, and Analytics", Cambridge University Press, 2014.
4. Murat Tekalp, "Digital Video Processing" Second Edition, Prentice Hall, 2015.
5. Bart Baesens, "Analytics in a Big Data World: The Essential Guide to Data Science and its Applications", Wiley, 2014.
6. Oges Marques, "Practical Image and Video Processing Using MATLAB", Wiley-IEEE Press, 2011.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2	1	1	1	2	3
CO2	2	1	1	1	2	3
CO3	2	1	1	1	2	3
CO4	1	2	2	2	2	3
CO5	1	2	2	3	3	3

23OE2001	SECURITY PRACTICES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To learn the core fundamentals of system and web security concepts
- To have through understanding in the security concepts related to networks
- To deploy the security essentials in IT Sector
- To be exposed to the concepts of Cyber Security and cloud security
- To perform a detailed study of Privacy and Storage security and related Issues

UNIT - I SYSTEM SECURITY 9

Model of network security – Security attacks, services and mechanisms – OSI security architecture - A Cryptography primer- Intrusion detection system- Intrusion Prevention system - Security web applications- Case study: OWASP - Top 10 Web Application Security Risks.

UNIT - II NETWORK SECURITY 9

Internet Security - Intranet security- Local Area Network Security - Wireless Network Security - Wireless Sensor Network Security- Cellular Network Security - Mobile security - IOT security - Case Study - Kali Linux.

UNIT - III SECURITY MANAGEMENT 9

Information security essentials for IT Managers- Security Management System - Policy Driven System Management- IT Security - Online Identity and User Management System. Case study: Metasploit

UNIT - IV CYBER SECURITY AND CLOUD SECURITY 9

Cyber Forensics- Disk Forensics – Network Forensics – Wireless Forensics – Database Forensics – Malware Forensics – Mobile Forensics – Email Forensics- Best security practices for automate Cloud infrastructure management – Establishing trust in IaaS, PaaS, and SaaS Cloud types. Case study: DVWA.

UNIT - V PRIVACY AND STORAGE SECURITY 9

Privacy on the Internet - Privacy Enhancing Technologies - Personal privacy Policies - Detection of Conflicts in security policies- privacy and security in environment monitoring systems. Storage Area Network Security - Storage Area Network Security Devices - Risk management - Physical Security Essentials.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of the course, students will be able to:

- **CO1** Understand the core fundamentals of system security
- **CO2** Apply the security concepts to wired and wireless networks
- **CO3** Implement and Manage the security essentials in IT Sector
- **CO4** Explain the concepts of Cyber Security and Cyber forensics
- **CO5** Be aware of Privacy and Storage security Issues

REFERENCE BOOKS:

1. John R. Vacca, Computer and Information Security Handbook, Third Edition, Elsevier 2017
2. Michael E. Whitman, Herbert J. Mattord, Principles of Information Security, Seventh Edition, Cengage Learning, 2022
3. Richard E. Smith, Elementary Information Security, Third Edition, Jones and Bartlett Learning, 2019
4. Mayor, K.K.Mookhey, Jacopo Cervini, Fairuzan Roslan, Kevin Beaver, Metasploit Toolkit for Penetration Testing, Exploit Development and Vulnerability Research, Syngress publications, Elsevier, 2007. ISBN: 978-1-59749-074-0
5. John Sammons, “The Basics of Digital Forensics- The Primer for Getting Started in Digital Forensics”, Syngress, 2012
6. Cory Altheide and Harlan Carvey, “Digital Forensics with Open Source Tools”,2011 Syngress, ISBN: 9781597495875.
7. Siani Pearson, George Yee "Privacy and Security for Cloud Computing" Computer Communications and Networks, Springer, 2013.

23OE2002	NETWORK TECHNOLOGIES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand the basic concepts of networks
- To explore various technologies in the wireless domain
- To study about 4G and 5G cellular networks
- To learn about Network Function Virtualization
- To understand the paradigm of Software defined networks

UNIT - I NETWORKING CONCEPTS 9

Peer To Peer Vs Client-Server Networks. Network Devices. Network Terminology. Network Speeds. Network throughput, delay. Osi Model. Packets, Frames, And Headers. Collision And Broadcast Domains. LAN Vs WAN. Network Adapter. Hub. Switch. Router. Firewall, IP addressing

UNIT - II WIRELESS NETWORKS 9

Wireless access techniques- IEEE 802.11a, 802.11g, 802.11e, 802.11n/ac/ax/ay/ba/be, QoS – Bluetooth – Protocol Stack – Security – Profiles – zigbee.

UNIT - III MOBILE DATA NETWORKS 9

4G Networks and Composite Radio Environment – Protocol Boosters – Hybrid 4G Wireless. Networks Protocols – Green Wireless Networks – Physical Layer and Multiple Access – Channel Modelling for 4G – Concepts of 5G – channel access –air interface -Cognitive Radio- spectrum management – C-RAN architecture - Vehicular communications-protocol – Network slicing – MIMO, mmWave, Introduction to 6G

UNIT - IV SOFTWARE DEFINED NETWORKS 9

SDN Architecture. Characteristics of Software-Defined Networking. SDN- and NFV-Related Standards. SDN Data Plane. Data Plane Functions. Data Plane Protocols. OpenFlow Logical Network Device. Flow Table Structure. Flow Table Pipeline. The Use of Multiple Tables. Group Table. OpenFlow Protocol. SDN Control Plane Architecture. Control Plane Functions. Southbound Interface. Northbound Interface. Routing. ITU-T Model. OpenDaylight. OpenDaylight Architecture. OpenDaylight Helium. SDN Application Plane Architecture. Northbound Interface. Network Services Abstraction Layer. Network Applications. User Interface.

UNIT - V NETWORK FUNCTIONS VIRTUALIZATION 9

Motivation-Virtual Machines –NFV benefits-requirements — architecture- NFV Infrastructure - Virtualized Network Functions - NFV Management and Orchestration- NFV Use Cases- NFV and SDN –Network virtualization — VLAN and VPN

TOTAL: 45 PERIODS

COURSE OUTCOMES:

Upon completion of the course, students will be able to:

CO1 Explain basic networking concepts

CO2 Compare different wireless networking protocols

CO3 Describe the developments in each generation of mobile data networks

CO4 Explain and develop SDN based applications

CO5 Explain the concepts of network function virtualization

REFERENCE BOOKS:

1. James Bernstein, “Networking made Easy”, 2018.
2. HoudaLabiod, Costantino de Santis, HossamAfifi –“Wi-Fi, Bluetooth, Zigbee and WiMax”, Springer 2007
3. Erik Dahlman, Stefan Parkvall, Johan Skold, —4G: LTE/LTE-Advanced for Mobile Broadband, Academic Press, 2013
4. Saad Z. Asif – “5G Mobile Communications Concepts and Technologies” CRC press – 2019
5. William Stallings –“Foundations of Modern Networking: SDN, NFV, QoE, IoT, and Cloud” 1st Edition, Pearson Education, 2016.
6. Thomas D.Nadeau and Ken Gray, “SDN — Software Defined Networks”,O‟Reilly Publishers, 2013.
7. Guy Pujolle, “Software Networks”, Second Edition, Wiley-ISTE, 2020

23OE2003	CLOUD COMPUTING TECHNOLOGIES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To gain expertise in Virtualization, Virtual Machines and deploy practical virtualization solution
- To understand the architecture, infrastructure and delivery models of cloud computing.
- To explore the roster of AWS services and illustrate the way to make applications in AWS
- To gain knowledge in the working of Windows Azure and Storage services offered by Windows Azure
- To develop the cloud application using various programming model of Hadoop and Aneka

UNIT I VIRTUALIZATION AND VIRTUALIZATION INFRASTRUCTURE 9

Basics of Virtual Machines - Process Virtual Machines – System Virtual Machines – Emulation – Interpretation – Binary Translation - Taxonomy of Virtual Machines. Virtualization –Management Virtualization –– Hardware Maximization – Architectures – Virtualization Management – Storage Virtualization – Network Virtualization- Implementation levels of virtualization – virtualization structure – virtualization of CPU, Memory and I/O devices – virtual clusters and Resource Management – Virtualization for data center automation.

UNIT II CLOUD PLATFORM ARCHITECTURE 9

Cloud Computing: Definition, Characteristics - Cloud deployment models: public, private, hybrid, community – Categories of cloud computing: Everything as a service: Infrastructure, platform, software- A Generic Cloud Architecture Design – Layered cloud Architectural Development – Architectural Design Challenges

UNIT III AWS CLOUD PLATFORM - IAAS 9

Amazon Web Services: AWS Infrastructure- AWS API- AWS Management Console - Setting up AWS Storage - Stretching out with Elastic Compute Cloud - Elastic Container Service for Kubernetes- AWS Developer Tools: AWS Code Commit, AWS Code Build, AWS Code Deploy, AWS Code Pipeline, AWS code Star - AWS Management Tools: Cloud Watch, AWS Auto Scaling, AWS control Tower, Cloud Formation, Cloud Trail, AWS License Manager.

UNIT IV PAAS CLOUD PLATFORM 9

Windows Azure: Origin of Windows Azure, Features, The Fabric Controller – First Cloud APP in Windows Azure- Service Model and Managing Services: Definition and Configuration, Service runtime API- Windows Azure Developer Portal- Service Management API- Windows Azure Storage Characteristics-Storage Services- REST API- Blops.

UNIT V PROGRAMMING MODEL **9**

Introduction to Hadoop Framework - Mapreduce, Input splitting, map and reduce functions, specifying input and output parameters, configuring and running a job – Developing Map Reduce Applications - Design of Hadoop file system –Setting up Hadoop Cluster- Aneka: Cloud Application Platform, Thread Programming, Task Programming and Map-Reduce Programming in Aneka.

TOTAL :45 PERIODS

COURSE OUTCOMES:

Upon completion of the course, students will be able to:

CO1 Employ the concepts of virtualization in the cloud computing
CO2 Identify the architecture, infrastructure and delivery models of cloud computing
CO3 Develop the Cloud Application in AWS platform
CO4 Apply the concepts of Windows Azure to design Cloud Application
CO5 Develop services using various Cloud computing programming models.

REFERENCE BOOKS:

1. Bernard Golden, Amazon Web Service for Dummies, John Wiley & Sons, 2013.
2. Raoul Alongi, AWS: The Most Complete Guide to Amazon Web Service from Beginner to Advanced Level, Amazon Asia- Pacific Holdings Private Limited, 2019.
3. Sriram Krishnan, Programming: Windows Azure, O'Reilly,2010.
4. Rajkumar Buyya, Christian Vacchiola, S.Thamarai Selvi, Mastering Cloud Computing , MCGraw Hill Education (India) Pvt. Ltd., 2013.
5. Danielle Ruest, Nelson Ruest, —Virtualization: A Beginner‟s Guide‖, McGraw-Hill Osborne Media, 2009.
6. Jim Smith, Ravi Nair , "Virtual Machines: Versatile Platforms for Systems and Processes", Elsevier/Morgan Kaufmann, 2005.
7. John W.Rittinghouse and James F.Ransome, "Cloud Computing: Implementation, Management, and Security", CRC Press, 2010.
8. Toby Velte, Anthony Velte, Robert Elsenpeter, "Cloud Computing, A Practical Approach", McGraw-Hill Osborne Media, 2009.
9. Tom White, "Hadoop: The Definitive Guide", Yahoo Press, 2012.

23OE2004	DEEP LEARNING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- Develop and Train Deep Neural Networks.
- Develop a CNN, R-CNN, Fast R-CNN, Faster-R-CNN, Mask-RCNN for detection and recognition
- Build and train RNNs, work with NLP and Word Embeddings
- The internal structure of LSTM and GRU and the differences between them
- The Auto Encoders for Image Processing

UNIT I DEEP LEARNING CONCEPTS 9

Fundamentals about Deep Learning. Perception Learning Algorithms. Probabilistic modelling. Early Neural Networks. How Deep Learning different from Machine Learning. Scalars. Vectors. Matrixes, Higher Dimensional Tensors. Manipulating Tensors. Vector Data. Time Series Data. Image Data. Video Data

UNIT II NEURAL NETWORKS 9

About Neural Network. Building Blocks of Neural Network. Optimizers. Activation Functions. Loss Functions. Data Pre-processing for neural networks, Feature Engineering. Overfitting and Underfitting. Hyperparameters.

UNIT III CONVOLUTIONAL NEURAL NETWORK 9

About CNN. Linear Time Invariant. Image Processing Filtering. Building a convolutional neural network. Input Layers, Convolution Layers. Pooling Layers. Dense Layers. Backpropagation Through the Convolutional Layer. Filters and Feature Maps. Backpropagation Through the Pooling Layers. Dropout Layers and Regularization. Batch Normalization. Various Activation Functions. Various Optimizers. LeNet, AlexNet, VGG16, ResNet. Transfer Learning with Image Data. Transfer Learning using Inception Oxford VGG Model, Google Inception Model, Microsoft ResNet Model. R- CNN, Fast R-CNN, Faster R-CNN, Mask-RCNN, YOLO

UNIT IV NATURAL LANGUAGE PROCESSING USING RNN 9

About NLP & its Toolkits. Language Modeling. Vector Space Model (VSM). Continuous Bag of Words (CBOW). Skip-Gram Model for Word Embedding. Part of Speech (PoS) Global Co- occurrence Statistics–based Word Vectors. Transfer Learning. Word2Vec. Global Vectors for Word Representation GloVe. Backpropagation Through Time. Bidirectional RNNs (BRNN). Long Short Term Memory (LSTM). Bi-directional LSTM. Sequence-to-Sequence Models (Seq2Seq). Gated recurrent unit GRU.

UNIT V DEEP REINFORCEMENT & UNSUPERVISED LEARNING 9

About Deep Reinforcement Learning. Q-Learning. Deep Q-Network (DQN). Policy Gradient Methods. Actor-Critic Algorithm. About Auto encoding. Convolutional Auto Encoding. Variational Auto Encoding. Generative Adversarial Networks. Auto encoders for Feature Extraction. Auto Encoders for Classification. Denoising Auto encoders. Sparse Auto encoders.

TOTAL :45 PERIODS

COURSE OUTCOMES:

Upon completion of the course, students will be able to:

CO1 Feature Extraction from Image and Video Data
CO2 Implement Image Segmentation and Instance Segmentation in Images
CO3 Implement image recognition and image classification using a pretrained network (Transfer Learning)
CO4 Traffic Information analysis using Twitter Data
CO5 Auto encoder for Classification & Feature Extraction

REFERENCE BOOKS:

1. Deep Learning A Practitioner's Approach Josh Patterson and Adam Gibson O'Reilly Media, Inc.2017
2. Learn Keras for Deep Neural Networks, Jojo Moolayil, Apress,2018
3. Deep Learning Projects Using TensorFlow 2, Vinita Silaparasetty, Apress, 2020
4. Deep Learning with Python, FRANÇOIS CHOLLET, MANNING SHELTER ISLAND,2017
5. Pro Deep Learning with TensorFlow, Santanu Pattanayak, Apress,2017.

23AC2101	ENGLISH FOR RESEARCH PAPER WRITING	L	T	P	C
		2	0	0	0

COURSE OBJECTIVES:

- Teach how to improve writing skills and level of readability
- Tell about what to write in each section
- Summarize the skills needed when writing a Title
- Infer the skills needed when writing the Conclusion
- Ensure the quality of paper at very first-time submission

UNIT I INTRODUCTION TO RESEARCH PAPER WRITING 6

Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness.

UNIT II PRESENTATION SKILLS 6

Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticizing, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts, Introduction

UNIT III TITLE WRITING SKILLS 6

Key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check

UNIT IV RESULT WRITING SKILLS 6

Skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions.

UNIT V VERIFICATION SKILLS 6

Useful phrases, checking Plagiarism, how to ensure paper is as good as it could possibly be the first- time submission.

TOTAL: 30 PERIODS

COURSE OUTCOMES:

Upon completion of the course, students will be able to:

CO1 Understand that how to improve your writing skills and level of readability

CO2 Learn about what to write in each section

CO3 Understand the skills needed when writing a Title

CO4 Understand the skills needed when writing the Conclusion.

CO5 Ensure the good quality of paper at very first-time submission.

REFERENCE BOOKS:

1. Adrian Wallwork, English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011
2. Day R How to Write and Publish a Scientific Paper, Cambridge University Press 2006
3. Goldbort R Writing for Science, Yale University Press (available on Google Books) 2006
4. Highman N, Handbook of Writing for the Mathematical Sciences, SIAM. Highman's book 1998

23AC2102	DISASTER MANAGEMENT	L	T	P	C
		2	0	0	0

COURSE OBJECTIVES:

- Summarize basics of disaster
- Explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.
- Illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
- Describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
- Develop the strengths and weaknesses of disaster management approaches

UNIT I INTRODUCTION 6

Disaster: Definition, Factors and Significance; Difference between Hazard And Disaster; Natural and Manmade Disasters: Difference, Nature, Types and Magnitude.

UNIT II REPERCUSSIONS OF DISASTERS AND HAZARDS 6

Economic Damage, Loss of Human and Animal Life, Destruction Of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts And Famines, Landslides And Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks And Spills, Outbreaks Of Disease And Epidemics, War And Conflicts.

UNIT – III DISASTER PRONE AREAS IN INDIA 6

Study of Seismic Zones; Areas Prone To Floods and Droughts, Landslides And Avalanches; Areas Prone To Cyclonic and Coastal Hazards with Special Reference To Tsunami; Post- Disaster Diseases and Epidemics

UNIT – IV DISASTER PREPAREDNESS AND MANAGEMENT 6

Preparedness: Monitoring of Phenomena Triggering a Disaster or Hazard; Evaluation of Risk: Application of Remote Sensing, Data from Meteorological And Other Agencies, Media Reports: Governmental and Community Preparedness.

UNIT – V RISK ASSESSMENT 6

Disaster Risk: Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques of Risk Assessment, Global Co-Operation in Risk Assessment and Warning, People's Participation in Risk Assessment. Strategies for Survival

TOTAL: 30 PERIODS

COURSE OUTCOMES:

Upon completion of the course, students will be able to:

CO1 Summarize basics of disaster

CO2 Explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.

CO3 Illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.

CO4 Describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.

CO5 Develop the strengths and weaknesses of disaster management approaches

REFERENCE BOOKS:

1. Goel S. L., Disaster Administration And Management Text And Case Studies",Deep & Deep Publication Pvt. Ltd., New Delhi,2009.
2. NishithaRai, Singh AK, "Disaster Management in India: Perspectives, issues and strategies "'NewRoyal book Company,2007.
3. Sahni, PardeepEt.Al. ," Disaster Mitigation Experiences And Reflections", Prentice Hall OfIndia, New Delhi,2001.

23AC2201	VALUE EDUCATION	L	T	P	C
		2	0	0	0

COURSE OBJECTIVES:

- Understand value of education and self-development
- Imbibe good values in students
- Let the students should know about the importance of character.

UNIT – I **8**

Values and self-development–Social values and individual attitudes. Work ethics, Indian vision of humanism. Moral and non-moral valuation. Standards and principles. Value judgements.

UNIT - II **8**

Importance of cultivation of values. Sense of duty. Devotion, Self-reliance. Confidence, Concentration. Truthfulness, Cleanliness. Honesty, Humanity. Power of faith, National Unity. Patriotism. Love for nature, Discipline

UNIT - III **7**

Personality and Behavior Development-Soul and Scientific attitude. Positive Thinking. Integrity and discipline. Punctuality, Love and Kindness. Avoid fault Thinking. Free from anger, Dignity of labour. Universal brother hood and religious tolerance. True friendship. Happiness Vs suffering, love for truth. Aware of self-destructive habits. Association and Cooperation. Doing best for saving nature

UNIT - IV **7**

Character and Competence–Holy books vs Blind faith. Self-management and Good health. Science of reincarnation. Equality, Nonviolence, Humility, Role of Women. All religions and same message. Mind your Mind, Self-control. Honesty, Studying effectively.

TOTAL: 30 PERIODS

COURSE OUTCOMES:

Upon completion of the course, students will be able to:

CO1 Know about self-development.

CO2 Learn the importance of Human values.

CO3 Develop the overall personality.

CO4 Understand Social Values and values on Judgments

CO5 Interpret Holistic value system on Character and Competence

SUGGESTED READING:

1. Chakroborty, S.K.“Values and Ethics for organizations Theory and practice”, Oxford University Press, New Delhi

23AC2202	STRESS MANAGEMENT BY YOGA	L	T	P	C
		2	0	0	0

COURSE OBJECTIVES:

- To achieve overall health of body and mind
- To overcome stress.

UNIT - I **10**

Definitions of Eight parts of yoga.(Ashtanga)

UNIT - II **10**

Yam and Niyam - Do`s and Don't's in life - i) Ahinsa, satya, astheya, bramhacharya and aparigraha, ii) Ahinsa, satya, astheya, bramhacharya and aparigraha.

UNIT – III **10**

Asan and Pranayam - Various yog poses and their benefits for mind & body - Regularization of breathing techniques and its effects-Types of pranayam

TOTAL: 30 PERIODS

COURSE OUTCOMES:

Upon completion of the course, students will be able to:

CO1 Develop healthy mind in a healthy body thus improving social health also

CO2 Improve efficiency

CO3 Inculcate Lifelong Practices on Asan and Pranayam

SUGGESTED READING:

1. 'Yogic Asanas for Group Tarining-Part-I":Janardan Swami Yoga bhyasi Mandal, Nagpur
2. "Rajayoga or conquering the Internal Nature" by Swami Vivekananda, Advaita Ashrama (Publication Department), Kolkata