PANIMALAR ENGINEERING COLLEGE

(An Autonomous Institution, Affiliated to Anna University, Chennai)
Bangalore Trunk Road, Varadharajapuram,
Poonamallee, Chennai – 600123

Master of Engineering

Communication Systems

Curriculum & Syllabus

DEPARTMENT OF
ELECTRONICS AND COMMUNICATION ENGINEERING

REGULATION 2025

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 2025

VISION

To provide world class quality education and excelling research activities in Electronics and Communication Engineering with strong ethical values and social challenges.

MISSION

M1: To impart high quality technical education by investing in faculty development and resources.

M2: To adapt best teaching and learning process with strong state of art facilities for academic and research activities.

M3: To enhance national and international collaborative activities for evolving indigenous technological solutions to meet social needs, nurture leadership and entrepreneurship qualities with ethical means.

M4: To facilitate partnership with leading core industries and R&Ds for global outreach.

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 Communication Systems.
4. An ability to design effective solutions to address complex and diverse real world problems.
5. An ability to develop new ideas and approaches by integrating emerging knowledge to meet current industry trends.
6. An ability to 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 2025)

Semester I							
S. No	**COURSE CODE**	**COURSE TITLE**	**Category**	**L/T/P**	**Contact Hours**	**Credit**	**Ext / Int Weightage**
Theory Courses							
1.	25MA2102	Linear Algebra and Probability Techniques	FC	3/1/0	4	4	60/40
2.	25EC2101	Radiating Systems and Modern Antennas	PCC	3/0/0	3	3	60/40
3.	25EC2102	Advanced Digital Communication Techniques	PCC	3/0/0	3	3	60/40
4.	25EC2103	Advanced Digital Signal Processing	PCC	2/1/0	3	3	60/40
5.	25RM2101	Research Methodology and IPR	RMC	2/1/0	3	3	60/40
Audit Courses							
6.		Audit Course I	AC	2/0/0	2	0	0/100
Laboratory Courses							
7.	25EC2111	Signal Processing and Communication Laboratory	PCC	0/0/3	3	2	40/60
8.	25EC2112	Antenna Design Laboratory	PCC	0/0/3	3	2	40/60
9.	25EC2113	Qualitative Skills Practice	EEC	0/0/2	2	0	0/100
			TOTAL		**24**	**20**	

Semester II							
S. No	**COURSE CODE**	**COURSE TITLE**	**Category**	**L/T/P**	**Contact Hours**	**Credit**	**Ext / Int Weightage**
Theory Courses							
1.	25EC2201	Advanced Wireless Communication Systems	PCC	3/0/0	3	3	60/40
2.	25EC2202	RF System Design and MIC	PCC	3/0/0	3	3	60/40
3.	25EC2203	Advanced Optical Communication and Network Design	PCC	3/0/0	3	3	60/40
4.	25EC2204	Intelligent 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.	25EC2211	RF System Design Laboratory	PCC	0/0/3	3	2	40/60
9.	25EC2212	Intelligent Communication Networks Laboratory	PCC	0/0/3	3	2	40/60
10.	25EC2213	Quantitative Skills Practice	EEC	0/0/2	2	0	0/100
			TOTAL		**26**	**22**	

Semester III							
S. No	**COURSE CODE**	**COURSE TITLE**	**Category**	**L/T/P**	**Contact Hours**	**Credit**	**Ext / Int Weightage**
Theory Courses							
1.	25EC2301	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.	25EC2311	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.	25EC2411	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.	25EC2901	Cognitive Radio Communication and Networks	PEC	3/0/0	3	3	60/40
2.	25EC2902	Communication Network Security	PEC	3/0/0	3	3	60/40
3.	25EC2903	Analog and Mixed Signal VLSI Design	PEC	3/0/0	3	3	60/40
4.	25EC2904	Radar Signal Processing	PEC	3/0/0	3	3	60/40
5.	25EC2905	Pattern Recognition and Machine Learning	PEC	3/0/0	3	3	60/40
6.	25EC2906	Next Generation Wireless Networks	PEC	3/0/0	3	3	60/40
7.	25EC2907	Multimedia Communications	PEC	3/0/0	3	3	60/40
8.	25EC2908	Image Analysis and Computer Vision	PEC	3/0/0	3	3	60/40
9.	25EC2909	Cooperative Communications	PEC	3/0/0	3	3	60/40
10.	25EC2910	Signal Integrity for High Speed Design	PEC	3/0/0	3	3	60/40
11.	25EC2911	Communication Network Design	PEC	3/0/0	3	3	60/40
12.	25EC2912	Electromagnetic Interference and Compatibility in System Design	PEC	3/0/0	3	3	60/40
13.	25EC2913	Spread Spectrum Techniques and Applications	PEC	3/0/0	3	3	60/40
14.	25EC2914	Video Processing and Analytics	PEC	3/0/0	3	3	60/40
15.	25EC2915	Transformative Wireless Communication for 5G and Beyond	PEC	3/0/0	3	3	60/40
16.	25EC2916	Satellite Communication Systems	PEC	3/0/0	3	3	60/40
17.	25EC2917	Artificial Intelligence and Optimization Techniques	PEC	3/0/0	3	3	60/40
18.	25EC2918	Artificial Intelligence and Internet of Things	PEC	3/0/0	3	3	60/40
19.	25EC2919	Antenna for 5G and 6G Communication	PEC	3/0/0	3	3	60/40

20.	25EC2920	Classical and Quantum Information Theory	PEC	3/0/0	3	3	60/40
21	25EC2921	Wearable Body Area Networks	PEC	3/0/0	3	3	60/40
22.	25EC2922	Semiconductor Device Modeling	PEC	3/0/0	3	3	60/40
23	25EC2923	Signal Processing In VLSI Design	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.	25OE2007	Security Practices	OEC	3/0/0	3	3	60/40
2.	25OE2008	Network Technologies	OEC	3/0/0	3	3	60/40
3.	25OE2009	Cloud Computing Technologies	OEC	3/0/0	3	3	60/40
4.	25OE2010	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.	25AC2101	English for Research Paper Writing	AC	2/0/0	2	0	0/100
2.	25AC2102	Disaster Management	AC	2/0/0	2	0	0/100
3.	25AC2201	Value Education	AC	2/0/0	2	0	0/100
4.	25AC2202	Stress Management by Yoga	AC	2/0/0	2	0	0/100

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**

25MA2102	LINEAR ALGEBRA AND PROBABILITY TECHNIQUES	L	T	P	C
		3	1	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, eigen values 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	PSO1	PSO2	PSO3
CO1	3		3	2			3	2	2
CO2	3		3	2			3	2	2
CO3	3		3	2			3	2	2
CO4	3		3	2			3	2	2
CO5	3		3	2			3	2	2

25EC2101	RADIATING SYSTEMS AND MODERN ANTENNAS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand the fundamental concepts of antenna radiation and its parameters.
- To interpret various antenna arrays to optimize antenna parameters.
- To summarize the principles of aperture antenna design
- To utilize the knowledge of modern antennas to measure impedance and radiation patterns.
- 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 – Reconfigurable Antenna-Metamaterial,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 of wire antennas
CO2 Illustrate the design significance of an array antenna
CO3 Identify the performance of aperture antenna and microstrip patch antenna
CO4 Examine the importance of modern antennas and antennas measurement
CO5 Analyze next-generation antennas for emerging applications

REFERENCE BOOKS:

1. Balanis.A, "Antenna Theory Analysis and Design", 4th edition John Wiley and Sons, New York,2016.
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
6. Frank B. Gross."Frontiers in Antennas: Next Generation Design and Engineering, McGraw-Hill

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	PSO1	PSO2	PSO3
CO1	1		2	2		1	3	3	2
CO2			1	1			3	3	2
CO3	1		2	2		1	3	3	3
CO4	1		3	3	2	1	3	3	3
CO5	2		2	3	2	2	3	3	3

25EC2102	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 modulation techniques

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 MODULATION SYSTEMS 9

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, OTFS Introduction, OTFS Signal Generation, Receivers for OTFS, Performance in AWGN and Time Varying Wireless Channels.

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 and operation of multicarrier modulation systems.

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. SuvraSekhar Das, Ramjee Prasad, "OTFS : Orthogonal Time Frequency Space Modulation – A Waveform for 6G", River Publishers, 2021
4. M.K.Simon, S.M.Hinedi and W.C.Lindsey, "Digital communication techniques; Signal Design and Detection", Prentice Hall of India, New Delhi, 1995.
5. Richard Van Nee & Ramjee Prasad, "OFDM for Multimedia Communications" Artech House Publication, 2001.
6. Simon Haykin, "Digital communications", John Wiley and sons, 1998.
7. 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	PSO1	PSO2	PSO3
CO1	2		2	2	1		3	2	1
CO2	1		2	2	1		3	2	1
CO3	2		3	3	2		3	2	1
CO4	2		3	3	3		3	2	2
CO5	2		2	3	3		3	2	3

25EC2103	ADVANCED DIGITAL SIGNAL PROCESSING	L	T	P	C
		2	1	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 **Explain** the characteristics of wide sense stationary and ergodic processes, including autocorrelation and power spectral density.
CO2 **Implement** signal models such as AR, MA, and ARMA using parameter estimation techniques.
CO3 **Analyze** spectrum estimation methods to assess signal properties using parametric and non-parametric techniques.
CO4 **Evaluate** optimal filter designs like Wiener and lattice filters for error minimization in signal processing.
CO5 **Develop** adaptive filters using LMS and RLS algorithms for real-time signal processing applications.

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, 2014.
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.
5. Maurice Bellanger "Digital Signal Processing: Theory and Practice" John Wiley & Sons, Ltd. April 2024

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	1		2				3	2	1
CO2	1		2				3	2	2
CO3	2		3	1		2	3	2	3
CO4	2	1	3	2	1	2	3	2	1
CO5	2		3	2	1	3	3	2	2

25RM2101	RESEARCH METHODOLOGY AND IPR	L	T	P	C
		2	1	0	3

COURSE OBJECTIVES:

- To impart knowledge and skills required for formulate research problem
- To identify different types of research design and data collection
- To know Technical paper writing / presentation without violating professional ethics
- To understand Patent drafting and filing patents

UNIT - I RESEARCH PROBLEM FORMULATION 9

Objectives of research, types of research, research process, approaches to research; conducting literature review- information sources, information retrieval, tools for identifying literature, Indexing and abstracting services, Citation indexes, summarizing the review, critical review, identifying research gap, conceptualizing and hypothesizing the research gap

UNIT - II RESEARCH DESIGN AND DATA COLLECTION 9

Statistical design of experiments- types and principles; data types & classification; data collection - methods and tools

UNIT - III DATA ANALYSIS, INTERPRETATION AND REPORTING 9

Sampling, sampling error, measures of central tendency and variation,; test of hypothesis-concepts; data presentation- types of tables and illustrations; guidelines for writing the abstract, introduction, methodology, results and discussion, conclusion sections of a manuscript; guidelines for writing thesis, research proposal; References – Styles and methods, Citation and listing system of documents; plagiarism, ethical considerations in research.

UNIT - IV INTELLECTUAL PROPERTY RIGHTS 9

Concept of IPR, types of IPR – Patent, Designs, Trademarks and Trade secrets, Geographical indications, Copy rights, applicability of these IPR; , IPR & biodiversity; IPR development process, role of WIPO and WTO in IPR establishments, common rules of IPR practices, types and features of IPR agreement, functions of UNESCO in IPR maintenance.

UNIT - V PATENTS 9

Patents – objectives and benefits of patent, concept, features of patent, inventive steps, specifications, types of patent application; patenting process - patent filling, examination of patent, grant of patent, revocation; equitable assignments; Licenses, licensing of patents; patent agents, registration of patent agents.

TOTAL : 45 PERIODS

COURSE OUTCOMES:

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

CO1 Describe different types of research; identify, review and define the research problem

CO2 Select suitable design of experiments; describe types of data and the tools for collection of data

CO3 Explain the process of data analysis; interpret and present the result in suitable form

CO4 Explain about Intellectual property rights, types and procedures

CO5 Execute patent filing and licensing.

REFERENCE BOOKS:

1. Cooper Donald R, Schindler Pamela S and Sharma JK, "Business Research Methods", Tata McGraw Hill Education, 11e (2012)
2. Soumitro Banerjee, "Research methodology for natural sciences", IISc Press, Kolkata, 2022,
3. Catherine J. Holland, "Intellectual property: Patents, Trademarks, Copyrights, Trade Secrets", Entrepreneur Press, 2007.
4. David Hunt, Long Nguyen, Matthew Rodgers, "Patent searching: tools & techniques", Wiley, 2007
5. The Institute of Company Secretaries of India, Statutory body under an Act of parliament, "Professional Programme Intellectual Property Rights, Law and practice", September 2013

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	PSO1	PSO2	PSO3
CO1	3	3	2			2	3	3	3
CO2	3	3	2			2	3	3	3
CO3	3	3	2			2	3	3	3
CO4	3	3	2			2	3	3	3
CO5	3	3	2			2	3	3	3

25EC2111	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	PSO1	PSO2	PSO3
CO1	3	2	1	2	3	3	3	3	3
CO2	3	2	2	2	3	3	3	3	3
CO3	3	2	1	1	3	3	3	3	3
CO4	3	3	3	3	3	3	3	3	3
CO5	3	2	3	3	3	3	3	3	3

25EC2112	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)

COURSE OUTCOMES: **TOTAL :60 PERIODS**

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	PSO1	PSO2	PSO3
CO1	3	2	3	3	3	3	3	3	3
CO2	3	2	3	3	3	3	3	3	3
CO3	3	2	3	3	3	3	3	3	3
CO4	3	3	3	3	3	3	3	3	3
CO5	3	2	3	3	3	3	3	3	3

25EC2113	QUALITATIVE SKILLS PRACTICE	L	T	P	C
		0	0	2	0

COURSE OBJECTIVES:

- Learn essential business etiquette and professional writing skill.
- Develop time management skills.
- Enhance presentation skills by organizing materials.
- Solve problems related to quantitative ability.
- Build a strong vocabulary and verbal reasoning skills.

UNIT I BUSINESS ETIQUETTE 6

Business etiquette, including social customs, netiquette, and effective communication-

Focus on writing company blogs, press releases, and meeting notes with audience-Engagement in mind- Develop skills in planning, crafting catchy headlines, and summarizing content for clarity.

UNIT 2 TIME MANAGEMENT SKILLS 6

Prioritization, Procrastination, Scheduling, Multitasking, Monitoring, Working under pressure and adhering to deadlines

UNIT 3 PRESENTATION SKILLS 6

Preparing PowerPoint presentations, including outlining content and using design elements like font, color, and animation-Understand the importance of visual aids, poster design and handling interruptions during presentations-Develop strategies for managing questions, staying in control, and handling difficult queries.

UNIT 4 QUANTITATIVE ABILITY 6

Study number properties, including factors, factorials, and remainder theorem, along with unit and tens digit positions- Learn about averages, weighted averages, and progressions (arithmetic, geometric, and harmonic)-Understand types of ratios and proportions, and concepts like successive increases and decreases.

UNIT 5 REASONING ABILITY AND VERBAL ABILITY 6

Data Arrangement (Linear and circular & Cross Variable Relationship), Blood RelationsOrdering / ranking / grouping, Puzzle test- Selection Decision table- Synonyms & Antonyms-One word substitutes, Word Pairs, Spellings, Idioms, Sentence completion, Analogies.

TOTAL :30 PERIODS

COURSE OUTCOMES:

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

CO1 Demonstrate knowledge of professional communication

CO2 Effectively manage time by prioritizing tasks.

CO3 Organize and deliver professional presentations using structured materials.

CO4 Apply logical reasoning and quantitative skills to analyze data.

CO5 Develop a robust vocabulary and communication proficiency.

REFERENCE BOOKS:

1. Kerry Patterson, Joseph Grenny, Ron McMillan and Al Switzler, (2017).2nd Edition,Crucial Conversations: Tools for Talking when Stakesare High .McGraw-Hill Contemporary, Bangalore
2. Dale Carnegie,(2016).How to Win Friends and Influence People. Gallery Books, New York.
3. Scott Peck. M, (2003). Road Less Travelled. Bantam Press, New York City..
4. SMART, (2018). Place Mentor, 1st edition. Oxford University Press, Chennai.
5. FACE, (2016). Aptipedia Aptitude Encyclopedia. Wiley publications, Delhi.
6. ETHNUS, (2013).Aptimithra. McGraw-Hill Education Pvt Ltd, Bangalore.

WEB REFERENCES:

1. www.chalkstreet.com
2. www.skillsyouneed.com
3. www.mindtools.com
4. www.thebalance.com
5. www.eguru.com

25EC2201	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
8. Aditya K. Jagannatham, Principles of Modern Wireless Communications Systems, 2015, 1st Edition, McGraw-Hill Education, India
9. Andrea Goldsmith, Wireless Communications, IEEE Press, 2020.

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
3. https://onlinecourses.nptel.ac.in/noc25_ee85/preview

ONLINE COURSES / RESOURCES:

1. Advanced 3G and 4G Wireless Mobile Communications by Prof. Aditya K. Jagannatham, Department of Electrical Engineering, IIT Kanpur.
2. Evolution Of Air Interface Towards 5G by Prof. Suvra Sekhar Das | IIT Kharagpur.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3		2	2			3	3	1
CO2	3		2	2			3	3	2
CO3	3		2	2			3	1	2
CO4	3		2	3			3	2	2
CO5	3		3	3	1	1	3	1	2

25EC2202	RF SYSTEM DESIGN AND MIC	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand the fundamentals and analysis of Transceiver architecture.
- To study High frequency and Low noise amplifiers.
- To know the basic techniques needed for analysis of Feedback system and Power amplifiers.
- To understand the design and analysis of RF Filter, Oscillator and Mixer
- To familiarize design of MIC components

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, Advantages and applications, Fabrication Aspects: HMICs, MMICs, MIC components: Resistors, Capacitors, Inductors - Directional Coupler: Branchline, Ring - Power dividers and power combiners, Switches, Phase shifters.

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”, second edition, Pearson Education, 2012.
2. T. Lee,”Design of CMOS RF Integrated Circuits”, Cambridge, 2004.
3. Leo G. Maloratsky, “Passive RF & Microwave Integrated Circuits”, Elsevier/Newnes, 2004.
4. R.Ludwig, P.Bretchko, “RF circuit Design”, Prentice Hall, Second edition, 2011.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	2	3	3	2	2	3	3	3
CO2	3	2	3	3	2	2	3	3	3
CO3	3	2	3	3	2	2	3	3	3
CO4	3	2	3	3	2	2	3	3	3
CO5	3	2	3	3	2	2	3	3	3

25EC2203	ADVANCED OPTICAL COMMUNICATION AND NETWORK DESIGN	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand the differences and challenges involved in the design of optical systems and networks
- To explore the principles, constraints, and modulation/demodulation techniques in coherent optical communication systems.
- To provide an in-depth understanding of optical network architectures, including first and second-generation networks
- To equip students with knowledge of connection management, routing, and traffic grooming
- To analyze the routing and wavelength assignments dimensioning models in WDM network design

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 WDM NETWORK DESIGN 9

Cost Trade-Offs: A Detailed Ring Network Example, LTD and RWA Problems, Light path Topology Design, Routing and Wavelength Assignment, Wavelength Conversion, Dimensioning Wavelength-Routing Network, Statistical Dimensioning Models-First-Passage Model, Blocking Model, Maximum Load Dimensioning Models-Offline Light path Requests, Online RWA in Rings

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 Analyze the routing and wavelength assignments dimensioning models in WDM network design.

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	PSO1	PSO2	PSO3
CO1	2	1	3	1	1		3	2	1
CO2	2	1	3	1	1		3	2	1
CO3	2	1	3	1	1		3	2	1
CO4	2	1	3	1	1		3	2	1
CO5	2	1	3	2	1		3	2	1

25EC2204	INTELLIGENT COMMUNICATION NETWORKS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand the fundamental concepts and techniques of machine learning, algorithms.
- To explain the structure and functions of various neural networks used in deep learning.
- To apply distributed and reinforcement learning methods to solve real-world problems.
- To analyse the use of machine learning in wireless system design for communication tasks.
- To evaluate machine learning-based solutions for optimizing wireless systems and ensuring security.

UNIT I MACHINE LEARNING BASICS 9

Supervised and Unsupervised learning, Capacity, Over fitting and Under fitting, Cross Validation, Linear regression, Logistic Regression, Regularization, Naive Bayes, Principle Component Analysis, Support Vector Machines (SVM), Decision tree, Random forest, K-Means Clustering, k nearest neighbour.

UNIT II NEURAL NETWORKS 9

Feed forward Networks, Back propagation, Convolutional Neural Networks-LeNet, AlexNet, ZFNet, VGGNet, GoogLeNet, ResNet, Visualizing Convolutional Neural Networks, Guided Back propagation, Recurrent Neural Network (RNN).

UNIT III DISTRIBUTED ML AND REINFORCEMENT LEARNING 9

Distributed optimization in resource-constrained systems, Communication-Efficient Distributed Edge Learning, Federated learning, Decentralized learning, Low-latency and on-device AI; Reinforcement Learning-Markov decision processes, Q-learning and Policy Optimization methods, Deep Reinforcement Learning (DRL), Multi-agent systems.

UNIT IV ML IN WIRELESS PHYSICAL LAYER SYSTEM DESIGN 9

Machine Learning in Channel Estimation, Feedback, and Signal Detection-Compressive sensing and pilot Estimation. Physical layer communications-Use of auto encoders for data transmission, Modulation, Channel coding, Modulation / Signal and Constellation classification, Localization, Spectrum Sensing using Deep Learning.

UNIT V ML IN WIRELESS SYSTEMS AND SECURITY 9

LOS and NLOS channel classification, Water-filling power allocation for 5G systems, Optimization for OFDM and MIMO-OFDM systems. Optimization in beamformer design – Robust receives beam forming, Transmit downlink beam forming. IoT Application: MCU-Net, Radar for target detection, Array Processing, MUSIC, ML in Side channel analysis.

TOTAL :45 PERIODS

COURSE OUTCOMES:

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

CO1 Identify the fundamental concepts, techniques and algorithms of machine learning

CO2 Describe the structure and functions of various neural networks used in deep learning

CO3 Implement distributed and reinforcement learning methods to solve real-world problems.

CO4 Examine the applications of machine learning in wireless system design for communication tasks

CO5 Assess machine learning-based solutions for optimizing wireless systems and ensuring security

REFERENCE BOOKS:

1. Ian Good fellow, YoshuaBengio, and Aaron Courville, “Deep learning”, Cambridge, MA”, MIT Press, 2017.
2. EthemAlpaydın, “Introduction to machine learning”, MIT Press, 3rd Edition, 2014.
3. Jo, Taeho. Machine Learning Foundations: Supervised, Unsupervised, and Advanced Learning. Germany: Springer International Publishing, 2021.
4. Ekman, Magnus. Learning Deep Learning: Theory and Practice of Neural Networks, Computer Vision, Natural Language Processing, and Transformers Using TensorFlow. United Kingdom: Pearson Education, 2021.
5. Richard S. Sutton, Andrew G. Barto, “Reinforcement Learning, An Introduction”, · 2018.
6. Xu Wang , Sen Wang, Xingxing Liang , Dawei Zhao, Jincai Huang, XinXu , Bin Dai , and
7. Qiguang Miao , “Deep Reinforcement Learning: A Survey”, IEEE Transactions On Neural
8. Networks And Learning Systems, 2017.
9. Luo, Fa-Long,” Machine Learning for Future Wireless Communications”, United Kingdom: Wiley, 2020.
10. Machine Learning and Wireless Communications. N.p.: Cambridge University Press, 2022.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	2	1	-	-	-	3	3	3
CO2	3	2	2	2	-	-	3	3	3
CO3	3	2	2	2	2	1	3	3	3
CO4	3	2	2	2	2	1	3	3	3
CO5	3	2	2	2	2	1	3	3	3

25EC2211	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, students will be able to:

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	PSO1	PSO2	PSO3
CO1	3	2	3	3	3	3	3	3	3
CO2	3	2	3	3	3	3	3	3	3
CO3	3	2	3	3	3	3	3	3	3
CO4	3	3	3	3	3	3	3	3	3
CO5	3	2	3	3	3	3	3	3	3

25EC2212	INTELLIGENT COMMUNICATION NETWORKS LABORATORY	L	T	P	C
		0	0	3	2

COURSE OBJECTIVES:

- Recall the basic concepts of machine learning for signal classification in wireless communication systems.
- Understand deep learning algorithms used in MIMO systems.
- Apply machine learning algorithms in wireless communication scenarios.
- Analyze advanced machine learning models in wireless communication scenarios.
- Interpret machine learning solutions for real-world wireless communication problems.

LIST OF EXPERIMENTS:

1. Design and implementation of supervised and unsupervised machine learning models to classify wireless signals (e.g., LOS, NLOS, and multipath fading).
2. Implementation of Receiver Diversity using Deep Learning techniques in MIMO systems.
3. Application of CNN to detect free and occupied spectrum channels based on spectrograms or power spectral density (PSD) features.
4. Application of water-filling algorithm to optimize power allocation in multi-channel communication system.
5. Implementation of MUSIC algorithm to estimate the Direction of Arrival (DOA) of incoming signals in a multi-antenna wireless communication system
6. Mini Project

TOTAL :60 PERIODS

COURSE OUTCOMES:

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

CO1 Recall the fundamental concepts of machine learning for signal classification in wireless communication systems.

CO2 Apply deep learning algorithms for different receiver diversity techniques in MIMO Systems.

CO3 Analyze the performance of different wireless communication scenarios using CNNs.

CO4 Evaluate advanced machine learning models to solve real-world wireless communication problems.

CO5 Design and optimize machine learning solutions for real-world problems.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	3	1	-	-	-	3	3	3
CO2	3	3	2	2	3	3	3	3	3
CO3	3	3	2	2	3	3	3	3	3
CO4	3	3	2	2	3	3	3	3	3
CO5	3	3	2	2	3	3	3	3	3

25EC2213	QUANTITATIVE SKILLS PRACTICE	L	T	P	C
		0	0	2	0

COURSE OBJECTIVES:

- Learn the structure of a professional resume.
- Practice effective interview techniques.
- Conduct SWOT analysis and psychometric assessments.
- Solve complex problems in quantitative ability and logical.
- To enhance critical thinking and innovative skills.

UNIT I RESUME SKILLS **6**

Structure of a standard resume, including layout, content, color, and font-

Understand power verbs, types of resumes, and how to customize resumes for different companies' requirements- Create a professional resume aligned with industry standards.

UNIT 2 INTERVIEW SKILLS **6**

Types of interviews, including structured, unstructured, remote, and phone interviews- Learn techniques to handle interviewers' questions and prepare for video interviews- Practice mock interviews with recorded feedback and tips to customize preparation for personal interviews.

UNIT 3 EMOTIONAL INTELLIGENCE **6**

Basics of transactional analysis, including ego states, life positions, and contracting- Brainstorming techniques - Individual/group brainstorming, reverse brainstorming, and star bursting- psychometric and personality tests, skill assessments, and conduct a personal SWOT analysis.

UNIT 4 QUANTITATIVE ABILITY **6**

Permutations, combinations, probability, and set theory- geometry, mensuration, trigonometry, and logarithms,focusing on properties, areas, volumes, and functions- quadratic equations, probabilities, and Venn diagrams.

UNIT 5 REASONING AND VERBAL ABILITY **6**

Develop logical reasoning skills through syllogisms, binary logic, and sequential output tracing- problems in data sufficiency, crypto arithmetic, and data interpretation-Analyze complex tables, pie charts, and bar charts - Enhance reading comprehension and tackle para jumbles effectively- Master critical reasoning skills, including identifying premises, conclusions, assumptions, inferences, and evaluating arguments.

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. Michael Farra and JIST Editors,(2011).Quick Resume & Cover Letter Book: Write and Use an Effective Resume in Just One Day. Jist Works, Saint Paul, Minnesota.Flage Daniel E, (2003).The Art of Questioning: An Introduction to Critical
2. Flage Daniel E, (2003).The Art of Questioning: An Introduction to Critical Thinking. Pearson, London.
3. David Allen, (2015).Getting Things done: The Art of Stress-Free productivity. Penguin Books, New York City.
4. SMART, (2018). Place Mentor 1st edition. Oxford University Press, Chennai.
5. FACE, (2016).Aptipedia Aptitude Encyclopedia. Wileypublications, Delhi.
6. ETHNUS, (2013).Aptimithra. McGraw-Hill Education Pvt Ltd, Bangalore.

WEB REFERENCES:

1. www.chalkstreet.com
2. www.skillsyouneed.com
3. www.mindtools.com
4. www.thebalance.com
5. www.eguru.com

25EC2301	MILLIMETER WAVE COMMUNICATION	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand the fundamentals of Millimeter wave.
- To outline the operation of various millimeter wave devices and circuits
- To understand the working of Millimeter wave Communicationssystem.
- To explain the principle of millimeter MIMO 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 Interpret Millimeter devices and circuits
CO3 Outline the various components of Millimeter wave communication systems
CO4 Explain 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	PSO1	PSO2	PSO3
CO1	1	2	3	3	2	2	3	2	2
CO2	1	2	3	3	2	2	3	2	2
CO3	1	2	3	3	2	2	3	2	2
CO4	2	2	3	3	2	2	3	2	2
CO5	3	2	3	3	2	2	3	2	2

25EC2901	COGNITIVE RADIO COMMUNICATION AND 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	PSO1	PSO2	PSO3
CO1	3		3	3	2	3	3	3	3
CO2	3		3	3	2	3	3	3	3
CO3	3		3	3	2	3	3	3	3
CO4	3		3	3	2	3	3	3	3
CO5	3		3	3	2	3	3	3	3

25EC2902	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	PSO1	PSO2	PSO3
CO1	1		1			1	3	2	1
CO2	1		2			1	3	2	1
CO3	2		3	1		2	3	2	1
CO4	1		2		1		3	2	1
CO5	2		3	3		2	3	2	2

25EC2903	ANALOG AND MIXED SIGNAL 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	PSO1	PSO2	PSO3
CO1	2		2	2	2	1	3	2	1
CO2	2		2	2	2	1	3	3	2
CO3	2		2	2	2	1	3	3	3
CO4	2		2	3	3	1	3	2	2
CO5	2		2	3	3	1	3	2	2

25EC2904	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	PSO1	PSO2	PSO3
CO1	1	1	1	1	1	1	3	2	1
CO2	2	2	2	1	2	1	3	2	1
CO3	3	3	2	3	3	3	3	2	1
CO4	3	3	2	3	3	3	3	2	1
CO5	2	2	2	2	2	2	3	2	1

25EC2905	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	PSO1	PSO2	PSO3
CO1	3		3	3	2	2	3	2	1
CO2	3		3	3	2	2	3	2	1
CO3	3		3	3	2	2	3	2	1
CO4	3		3	3	2	2	3	2	2
CO5	3		3	3	2	2	3	2	3

25EC2906	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	PSO1	PSO2	PSO3
CO1	3		3	3	3	2	3	3	3
CO2	3		3	3	3	2	3	3	3
CO3	3		3	3	3	2	3	3	3
CO4	3		3	3	3	2	3	3	3
CO5	3		3	3	3	2	3	3	3

25EC2907	MULTIMEDIA COMMUNICATIONS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To enable the student to understand the basic characteristics of multimedia components
- To understand multimedia information representation
- To familiarize different methods for compressing text and image compression
- To explore different audio & video compression methods
- To know standards for multimedia communications.

UNIT - I BASIC CHARACTERISTICS OF MULTIMEDIA 9

Introduction – Multimedia information representation – Multimedia networks – Telephone, Data, Broadcast Television, Integrated services digital networks- Multimedia applications –Interpersonal communications, Interactive applications over the Internet, Entertainment applications - Application and networking terminology-Media types, Communication modes, Network types, Multipoint conferencing, Network QoS, Application QoS.

UNIT - II MULTIMEDIA INFORMATION REPRESENTATION 9

Introduction – Digitization principles – Analog signals, Encoder and Decoder design- Text- Unformatted text, formatted text, Hypertext – Images- Graphics, Digitized documents, Digitized pictures –Audio – PCM speech, CD-quality audio, Synthesized audio –Video – Broadcast television, Digital, PC, video content.

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 –arithmetic coding - image compression.

UNIT - IV 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 - V STANDARDS FOR MULTIMEDIA COMMUNICATIONS 9

Introduction- Reference models- TCP/IP reference model, Protocol basics – Standards relating to interpersonal communications –circuit-mode networks, Packet switched networks, Electronic mail – Standards relating to interactive applications over the Internet- Information browsing, Electronic commerce, Intermediate systems, Java and JavaScript – Standards for entertainment applications- Movie/video-on-demand, Interactive television.

TOTAL: 45 PERIODS

COURSE OUTCOMES:

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

CO1 To understand the different multimedia components and their characteristics.

CO2 To outline the concept of multimedia information representation

CO3 Infer different types of text and image compression

CO4 Explain different types of audio and video compression.

CO5 Explore Standards for multimedia communications

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	PSO1	PSO2	PSO3
CO1	1		3		1		3	2	1
CO2	2		3	3	1		3	2	1
CO3	2		3	3	1		3	2	1
CO4	2		3	3	1		3	2	1
CO5	2		3	3	1		3	2	1

25EC2908	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 interpret to algorithms related to image segmentation and restoration
- To summarize basic concepts and methodologies in image compression
- To explain 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., Fourth Edition, 2018
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”, Third Edition, CL Engineering, 2013.
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
6. Ranjay Krishna, Computer vision: Foundations and Applications, Stanford University, 2017.
7. David A. Forsyth, Jean Ponce, “Computer Vision: A Modern Approach”, 2nd Ed., 2011.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3		3	2	2	2	3	3	2
CO2	3		3	2	2	2	3	3	2
CO3	3		3	2	2	2	3	3	2
CO4	3		3	2	2	2	3	3	3
CO5	3		3	2	2	2	3	3	3

25EC2909	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	PSO1	PSO2	PSO3
CO1	1		2	1			3	3	3
CO2			2	1			3	3	3
CO3			2				3	3	3
CO4	1		2	2			3	3	3
CO5	1		3	1	1	1	3	3	3

25EC2910	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	PSO1	PSO2	PSO3
CO1	1	2	2	2	1		3	2	1
CO2	2	2	2	2	1		3	2	1
CO3	1	1	2	2	1		3	2	1
CO4	2	2	1	2	1		3	2	1
CO5	2	2	2	2	1		3	2	1

25EC2911	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	PSO1	PSO2	PSO3
CO1			2				3	2	2
CO2			2	2			3	2	2
CO3			2	2			3	2	2
CO4			2	2			3	2	2
CO5	1		3	3			3	2	2

25EC2912	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	PSO1	PSO2	PSO3
CO1			2				3	2	1
CO2	1				3	3	3	2	1
CO3			2				3	2	1
CO4			2	3	2	3	3	2	1
CO5				3	3	2	3	2	1

25EC2913	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	PSO1	PSO2	PSO3
CO1	3		3	3	1	1	3	2	1
CO2	3		3	3	1	1	3	2	1
CO3	3		3	3	1	1	3	2	1
CO4	3		3	3	1	1	3	2	1
CO5	3		3	3	1	1	3	2	1

25EC2914	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	PSO1	PSO2	PSO3
CO1	2	1	1	1	2	3	3	3	3
CO2	2	1	1	1	2	3	3	3	3
CO3	2	1	1	1	2	3	3	3	3
CO4	1	2	2	2	2	3	3	3	3
CO5	1	2	2	3	3	3	3	3	3

25EC2915	TRANSFORMATIVE WIRELESS COMMUNICATION FOR 5G AND BEYOND	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To introduce fundamental concepts of 5G and beyond.
- To discuss advanced architectures with various integration features.
- To study multi-carrier waveforms with resource allocation phases.
- To understand the operation of multiple access techniques in 5G.
- To analyze cooperative communication technologies and their applications.

UNIT I INTRODUCTION TO 5G AND BEYOND 9

5G characteristics and requirements – Applications and Case studies - 5G channel models - METIS channel models - Map-based model - Stochastic model - Comparison of Models.

UNIT II 5G ARCHITECTURE 9

Introduction, NFV and SDN - Basics about RAN architecture - High –level requirements for the 5G architecture - Functional architecture and 5G flexibility - Functional split criteria - Functional Split Alternatives - Functional optimization for specific applications - Integration of LTE and new air interface to fulfill 5G requirements - Enhanced Multi-RAT Coordination features - Physical architecture and 5G deployment.

UNIT III MULTI CARRIER WAVEFORMS FOR 5G 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 IV MULTIPLE ACCESS TECHNIQUES IN 5G 9

Challenges in OFDM - NOMA – Principle - Superposition Coding - Successive Interference Cancellation - Power Domain NOMA - Sparse Code NOMA – Types - Power Domain Sparse 19 Code NOMA - Cooperative NOMA – Benefits and Challenges.

UNIT V COOPERATIVECOMMUNICATION 9

Machine Type Communication (MTC) - Device to Device Communication (D2D) - 5G 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 and Capacity Analysis.

TOTAL :45 PERIODS

COURSE OUTCOMES:

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

CO1 Understand the basic requirements of 5G wireless networks and beyond.
CO2 Identify the functional architectures of 5G.
CO3 Classify multicarrier waveforms and resource allocations.
CO4 Analyze multiple access techniques in 5G networks
CO5 Identify various operations 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. ThomasL.Marzetta, ErikG.Larsson,HongYang, HienQuocNgo,"Fundamentals of Massive MIMO", Cambridge University Press, 1stEdition, 2016.

WEB REFERENCES:

1. Robert W. Heath Jr., Nuria González-Prelcic, SundeepRangan, WonilRohand 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.
2. Min ChulJu 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.
3. 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.

ONLINE COURSES / RESOURCES:

1. https://onlinecourses.nptel.ac.in/noc23_ee61/preview
2. https://www.udemy.com/course/from-5g-to-6gnavigating-the-next-wave-of-wireless-evolution/?srsltid=AfmBOorkjh0Q6_a4jd5bXHBWPxJ1dhzDt6EXPhrnM65JU0HMM1pzRI9L
3. https://www.futurelearn.com/courses/5g-and-wireless-communication-for-beginners.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	1		2	2			3	2	1
CO2	1		1	1			3	2	1
CO3	1		2	2			3	2	1
CO4	1		3	3	2		3	2	1
CO5	2		2	3			3	2	1

25EC2916	SATELLITE COMMUNICATION SYSTEMS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand the basic principles of satellite system.
- To gain knowledge on satellite subsystems and satellite links
- To understand the operation of mobile satellite network
- To impart knowledge about modern antennas for satellite communication.
- To impart knowledge on applications of mobile satellites

UNIT I BASIC PRINCIPLES 9

General features- frequency allocation for satellite services- properties of satellite communication systems- Kepler's laws- orbital dynamics- orbital characteristics- satellite spacing and orbital capacity- GSO & LEO Satellites – Launch Vehicle Technology-GSLV.

UNIT II SATELLITE SUBSYSTEMS AND SATELLITE LINKS 9

Attitude and orbit control system- telemetry, tracking and command- power systems communication subsystems- antenna subsystem- equipment reliability and space qualification. Free space loss- Atmospheric effects- Ionospheric scintillation-link design-Power Budget Calculation -system noise temperature – Modulation for satellite communication

UNIT III MOBILE SATELLITE NETWORK 9

GSM signaling and S-PCN signaling protocol architecture, Mobility management-cell location, location management, handover management. Resource Management-Resource allocation strategies, Network operation and procedures

UNIT IV ANTENNAS AND MOBILE TERMINALS 9

Antennas for MSS, Architecture of Hand held, Vehicle mounted, Ship borne, Aeronautical terminals, CODECS for Mobile Satellite Communication.

UNIT V APPLICATIONS 9

GPS, Mobile satellite system for UMTS, GSM/EDGE, MOBILE IP, WLAN, Global Broadband services, ATM, GEO and Non GEO Mobile satellite systems.

TOTAL :45 PERIODS

COURSE OUTCOMES:

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

CO1 Understand the principles of satellite system
CO2 Design satellite subsystems and satellite link.
CO3 Design mobile satellite network
CO4 Design new antenna architecture for satellite system
CO5 Develop new applications in the field of mobile satellite

REFERENCE BOOKS:

1. Wilbur L Pritchard, Henri G Suyderhoud, “Satellite Communication Systems Engineering”, 2nd Edition, Pearson 2013.
2. Tri T.Ha “Digital Satellite Communications”, Tata McGraw Hill, 1st Reprint, 2nd Edition, 2012.
3. Timothy Pratt, Chareless Bostian, “Satellite Communications”, Wiley, 2nd Edition, 2010.
4. Dennis Roddy “Satellite Communication”, Tata McGraw-Hill, 4th Edition, 2009.
5. Ray E. Sheriff and Y. Fun Hu, “Mobile Satellite communication Networks,” John Wiley & Sons, 2008.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	2	1	2	3	2	2	3	2	2
CO2	2	1	3	3	2	2	3	2	2
CO3	3	1	2	2	3	3	3	2	2
CO4	3	1	3	3	2	2	3	2	2
CO5	2	1	2	2	3	3	3	2	2

25EC2917	ARTIFICIAL INTELLIGENCE AND OPTIMIZATION TECHNIQUES	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand the principles of neural networks.
- To gain knowledge on fuzzy logic systems
- To understand the principles of genetic algorithms
- To impart knowledge on ANT colony optimization technique.
- To familiarize on PSO technique

UNIT I NEURAL NETWORKS 9

Neural Networks: Back Propagation Network, generalized delta rule, Radial Basis Function Network, interpolation and approximation RBFNS, comparison between RBFN and BPN, Support Vector Machines: Optimal hyperplane for linearly separable patterns, optimal hyperplane for nonlinearly separable patterns, Inverse Modeling.

UNIT II FUZZY LOGIC SYSTEMS 9

Fuzzy Logic System: Basic of fuzzy logic theory, crisp and fuzzy sets, Basic set operation like union , interaction , complement, T-norm, T-conorm , composition of fuzzy relations, fuzzy if- then rules , fuzzy reasoning, Neuro-Fuzzy Modeling: Adaptive Neuro-Fuzzy Inference System (ANFIS) , ANFIS architecture , Hybrid Learning Algorithm.

UNIT III EVOLUTIONARY COMPUTATION & GENETIC ALGORITHMS 9

Evolutionary Computation (EC) – Features of EC – Classification of EC – Advantages – Applications. Genetic Algorithms: Introduction – Biological Background – Operators in GA-GA Algorithm – Classification of GA – Applications

UNIT IV ANT COLONY OPTIMIZATION 9

Ant Colony Optimization: Introduction – From real to artificial ants- Theoretical considerations – Convergence proofs – ACO Algorithm – ACO and model based search – Application principles of ACO.

UNIT V PARTICLE SWARM OPTIMIZATION 9

Particle Swarm Optimization: Introduction – Principles of bird flocking and fish schooling – Evolution of PSO – Operating principles – PSO Algorithm – Neighborhood Topologies – Convergence criteria – Applications of PSO, Honey Bee Social Foraging Algorithms, Bacterial Foraging Optimization Algorithm.

TOTAL :45 PERIODS

COURSE OUTCOMES:

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

CO1 Design and train neural networks with different rules.
CO2 Devise fuzzy logic rules.
CO3 Implement genetic algorithms.
CO4 Implement ANT colony optimization technique for various problems.
CO5 Implement PSO technique.

REFERENCE BOOKS:

1. Wolfgang Ertel, “Introduction to Artificial Intelligence”, Springer, 2 Edition, 2017
2. Nello Cristianini, John Shawe-Taylor, "An Introduction to Support Vector Machines and Other Kernel-based Learning Methods”, Cambridge University Press. 2013
3. Christopher M. Bishop, “Neural Networks for Pattern Recognition”, Oxford University Press,1995
4. H.-J. Zimmermann,“Fuzzy Set Theory and its Applications”, Springer Science + Business Media New York, 4th edition, 2001
5. David E. Goldberg, “Genetic Algorithms in search, Optimization & Machine Learning”, Pearson Education, 2006
6. Kenneth A DeJong, “Evolutionary Computation A Unified Approach”, Prentice Hall of India,New Delhi, 2006.
7. Marco Dorigo and Thomas Stutzle, “Ant Colony optimization”, Prentice Hall of India, NewDelhi, 2004.
8. N P Padhy, “Artificial Intelligence and Intelligent Systems”, Oxford University Press, 2005.
9. Engelbrecht, A.P., “Fundamentals of Computational Swarm Intelligence”, Wiley, 2005.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1			2	2	2	1	3	2	1
CO2			3	2	2	1	3	2	1
CO3	1		3	3	2	1	3	2	1
CO4	1		3	2	2	1	3	2	1
CO5			3	3	2	1	3	2	1

25EC2918	ARTIFICIAL INTELLIGENCE AND INTERNET OF THINGS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand the fundamentals of AI.
- To gain knowledge on AI learning models
- To understand the principles of IOT
- To impart knowledge on communication of smart objects.
- To explore IOT application layer

UNIT I ARTIFICIAL INTELLIGENCE 9

Introduction to AI, agent, environment and its Applications; Principles of search, uninformed (“blind”) search, informed (“heuristic”) search, constraint satisfaction problems, adversarial search and games; AI Models: Knowledge representation and reasoning: rule based representations, declarative or logical formalisms, Logic Programming and logic network; Reasoning in uncertain environments: Genetic algorithms, fuzzy logic, soft computing.

UNIT II AI LEARNING MODELS 9

Supervised learning, unsupervised learning, reinforcement learning. Generative discriminative models; Probabilistic models: Bayesian models, probabilistic discriminative models; Optimization methods: gradient descent, multi-objective optimization. Practical cases: natural language processing, computer vision, bioinformatics, etc.

UNIT III INTRODUCTION TO IOT 9

Challenges, IoT network architecture & design: oneM2M, IoTWF, Core functional stack, Data management stack. 'Things' in IoT: Sensors, Actuators, Smart objects, Basics of Sensor Networks.

UNIT IV COMMUNICATING SMART OBJECTS 9

Communication criteria, IoT access technologies- IEEE 802.15.4, IEEE 802.15.4e, IEEE 802.11ah, IEEE 1901.2a, NB-IoT. IoT Network Layer: IP as IoT network layer, 6LoWPAN, 6Lo, 6TiSCH, RPL.

UNIT V IOT APPLICATION LAYER 9

IoT application transport methods, CoAP, MQTT. Data and Analytics for IoT: IoT Middleware, Data analytics for IoT, Big Data analytics tools and technology. IoT application case study: Smart City, Smart Grid, Smart Transportation, Smart Manufacturing, Smart Healthcare.

TOTAL :45 PERIODS

COURSE OUTCOMES:

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

CO1 Understand the basics of Artificial intelligence.
CO2 Understand AI learning models
CO3 Understand the basics of Internet of things.
CO4 Understand the communication of smart objects and their underlying protocols
CO5 Understand the application layer and to work on real time applications

REFERENCE BOOKS:

1. Russell, Norvig, Artificial Intelligence: A MODERN APPROACH, 4th edition , 2022
2. Perry Lea, IoT and Edge Computing for Architects: Implementing edge and IoT systems from sensors to clouds with communication systems, analytics, and security, 2nd Edition, 2020.
3. SudipMisra, Anandarup Mukherjee, Arijit Roy, Introduction to IoT, Cambridge press, 2022
4. Zach Shelby,Carsten Bormann,"6LoWPAN:TheWireless Embedded Internet", John Wiley& Sons, 2009.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	2		2	1	1		3	2	1
CO2	2		3	2			3	2	1
CO3	2		3	2		1	3	2	1
CO4	2		3	2		2	3	2	1
CO5	2		2	2		2	3	2	1

25EC2919	ANTENNA FOR 5G AND 6G COMMUNICATION	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand the principles of 5G antenna design.
- To outline design requirements of 5G antennas for mobile terminal.
- To summarize the principles of aperture antenna for base station.
- To utilize the knowledge of beam forming techniques in antenna array.
- To classify various antenna array techniques for improved performance.

UNIT I INTRODUCTION 9

5G Mobile Communication, spectrum, 5G antenna design considerations, Antenna integration with RFIC, Sub-6GHz 5G antennas, mm wave 5G antennas, Frequency reconfigurable multi band antenna, 6G spectrum, 6G antenna specifications, mm wave antennas, THz antennas, Lens antennas.

UNIT II ANTENNA FOR 5G MOBILE TERMINAL 9

Antenna for cellular communications, antenna for mobile terminal, requirements for mobile antenna, Wide band antenna for 5G mobile terminal, CPW feed antenna, CPW feed antenna with reflector, Wide band high gain antenna for mm wave 5G, Flexible antenna for 5G, Patch antenna, slot antenna and Vivaldi antenna.

UNIT III ANTENNA FOR 5G BASE STATIONS 9

Antenna for 5G base stations, mm wave tapered slot antenna, dielectric and metamaterial loaded tapered slot antenna, diversity antenna with radome, 3D radome for patch antenna, high aperture efficiency antenna, shared aperture antenna for base station, pattern diversity.

UNIT IV ANTENNA ARRAY FOR 5G AND 6G 9

5G requirement of antenna arrays, array characteristics, integration and Antenna-in Package, 6G antenna requirements, digital beamforming, hybrid beam forming, mm wave beam forming networks.

UNIT V ANTENNA ARRAY- TYPES AND TECHNIQUES 9

Decoupling methods- Electromagnetic Band Gap, Defected Ground Surface, neutralization lines, metamaterial, Polarization decoupling. Type of antenna arrays- differential feed, linear and circularly polarized differential antennas, conformal transmit arrays, multi beam transmit array.

TOTAL :45 PERIODS

COURSE OUTCOMES:

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

CO1 Understand the principles of 5G antenna design
CO2 Interpret the design requirements of 5G antenna for mobile terminal
CO3 Explain the design requirements of 5G antenna for base station
CO4 Classify the beamforming technique
CO5 Analyze the characteristics of antenna array for 5G and 6G

REFERENCE BOOKS:

1. Shiban Kishen Koul and G S Karthikaya, Millimater Wave antennas for 5G mobile terminals and base stations, CRC Press, 2021.
2. Yingjie Jay Guo, Richard W. Ziolkowski, Advanced Antenna Array Engineering for 6G and Beyond Wireless Communications, Wiley-IEEE press, 2022.
3. Qammer H. Abbasi, Syeda Fizzah Jilani,Akram Alomainy, Muhammad Ali Imran, Antenna and Propagation for 5G and beyond, IET,2020.
4. Paul RP Hoole, Smart Antennas and Electromagnetic Signal Processing in Advanced Wireless Technology, River Publishers,2020.
5. Mohammed Ali, Reconfigurable Antenna Design and Analysis, Artech House, 2021

WEB REFERENCES

1. https://ieeexplore.ieee.org/document/10421039
2. https://www.microwavejournal.com/articles/42866-toward-6g-selecting-the-antenna-type-that-meets-future-design-challenges .
3. https://www.ibwave.com/storage/app/media/pdf/white-papers/5g-design-best-practices_white-paper.pdf

ONLINE COURSES / RESOURCES:

1. https://www.keysight.com/us/en/assets/6123-2471/webinars/218-How-to-Design-a-5G-and-6G-mmWave-Beamforming .
2. https://extendedstudies.ucsd.edu/courses/advanced-antennas-design-modeling-and-simulation-ee -40183

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	1	3	1	1	1	3	2	2
CO2	3	1	3	1	1	1	3	2	2
CO3	3	1	3	2	3	1	3	2	2
CO4	3	1	3	2	3	1	3	2	2
CO5	3	1	3	2	3	1	3	2	2

25EC2920	CLASSICAL AND QUANTUM INFORMATION THEORY	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To Introduce Classical and Quantum Information Theory fundamentals.
- To Explore mathematical techniques for classical and quantum information and entropy.
- To Study quantum states, entanglement, and error correction.
- To Understand information transmission over noisy classical and quantum channels.
- To Develop insights into the practical implications of quantum information systems.

UNIT I INTRODUCTION 9

Classical Shannon theory - Brief history of quantum computing and quantum information – Quantum Computation – Qubit Gates – Quantum Circuits - The Noiseless quantum theory - The Noisy quantum theory – Quantum Parallelism - Prospects for practical quantum information processing.

UNIT II CLASSICAL INFORMATION AND ENTROPY 9

Basic properties of entropy – The binary Entropy - Conditional entropy and mutual information - Von Neumann entropy – Quantum relative entropy - Subadditivity - Concavity of the entropy - The entropy of a mixture of quantum states – Strong Subadditivity - Proof of strong subadditivity.

UNIT III QUANTUM ERROR CORRECTION 9

The three qubit bit flip code - Three qubit phase flip code - The Shor code - Theory of quantum error-correction - Discretization of the errors - Independent error models - Degenerate codes - The quantum Hamming bound - Fault-tolerant quantum computation - Fault-tolerant quantum logic.

UNIT IV QUANTUM INFORMATION THEORY-I 9

Distinguishing quantum states and the accessible information - The Holevo bound - Example applications of the Holevo bound - Classical information over noisy quantum channels - Communication over noisy classical and quantum noisy channels - Quantum cryptography - Quantum key distribution.

UNIT V QUANTUM INFORMATION THEORY-II 9

Quantum information over noisy quantum channels - Entropy exchange and the quantum Fano inequality - Quantum Singleton bound - Quantum refrigeration and Maxwell's demon - Entanglement as a physical resource: Entanglement distillation and dilution, Entanglement distillation and quantum error-correction.

TOTAL :45 PERIODS

COURSE OUTCOMES:

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

CO1 Understand the principles of quantum computing and information.

CO2 Distinguish between classical and quantum computational models.

CO3 Analyze and implement error correction techniques.

CO4 Evaluate the implications of accessible information in communication

CO5 Apply theoretical concepts to practical problems in quantum computing and information

REFERENCE BOOKS:

1. M. A. Nielsen and I. L. Chuang, "Quantum Computation and Quantum Information";Cambridge University.
2. M. M. Wilde, "From Classical to Quantum Shannon Theory", Cambridge University Press, 2019. CUP
3. The mathematical language of quantum theory: from uncertainty to entanglement, T. Hienosaari & M.Ziman, Cambridge University Press (2011)
4. Quantum systems, channels, information, A.S. Holevo, de Gruyter Studies in Mathematical Physics (2012)

WEB REFERENCES:

1. https://www.sciencedirect.com/science/article/pii/S2666603022000240
2. https://www.mdpi.com/2227-7390/11/15/3423
3. https://www.ericsson.com/en/reports-and-papers/further-insights/impact-of-quantum-computing-on-5g-6g-security
4. https://www.telecomgurukul.com/post/5g-protocol-testing-integrating-quantum-computing-for-enhanced-performance-in-2024table-of-contents

ONLINE COURSES / RESOURCES:

1. https://www.coursera.org/courses?query=quantum%20computing
2. https://azure.microsoft.com/en-in/resources/training-and-certifications/quantum-computing
3. https://www.quantech.org.in/courses

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	1		2	2			3	2	1
CO2			1	1			3	2	1
CO3	1		2	2			3	2	1
CO4	1		3	3	2		3	2	1
CO5	2		2	3	2		3	2	1

25EC2921	WEARABLE BODY AREA NETWORKS	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand the fundamentals of WBAN.
- To gain knowledge on hardware required for BAN
- To understand the principles of wearable sensors
- To identify the signal processing techniques for BAN.
- To understand applications of wearable systems

UNIT I INTRODUCTION 9

Definition, BAN and Healthcare, Technical Challenges- Sensor design, biocompatibility, Energy Supply, optimal node placement, number of nodes, System security and reliability, BSN Architecture – Introduction.

UNIT II HARDWARE FOR BAN 9

Processor-Low Power MCUs, Mobile Computing MCUs, Integrated processor with radio transceiver, Memory, Antenna-PCB antenna, Wire antenna, Ceramic antenna, External antenna, Sensor Interface, Power sources- Batteries and fuel cells for sensor nodes.

UNIT III WEARABLE SENSORS 9

Need for wearable systems, Sensors for wearable Systems-Inertia movement sensors, Respiration activity sensor, Inductive plethysmography, Impedance plethysmography, pneumography, Wearable ground reaction force sensor, GSR, Radiant thermal sensor, Wearable motion sensors, CMOS –Based Biosensors, E-Textiles, Bio compatibility.

UNIT IV SIGNAL PROCESSING 9

Wearability issues -physical shape and placement of sensor, Technical challenges - sensor design, signal acquisition, Constraint on sampling frequency for reduced energy consumption, light weight signal processing, Rejection of irrelevant information, Data mining, case studies on optimal signal processing techniques for wearables.

UNIT V APPLICATIONS 9

Monitoring patients with chronic disease, Hospital patients, Elderly patients, Cardiac arrhymia monitoring, Multi patient monitoring systems, Multichannel Neural recording, Gait analysis, Sports Medicine, Electronic pill. case studies on wearables for sports applications.

TOTAL :45 PERIODS

COURSE OUTCOMES:

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

CO1 Understand the need for WBAN and the challenges involved in the design

CO2 Analyze the wireless Body Area Network and the hardware required for the implementation

CO3 Select the type of wearable sensor required for specific BAN application.

CO4 Implement the suitable signal processing technique for optimal power consumption.

CO5 Design wearable systems for wireless healthcare system applications

REFERENCE BOOKS:

1. Annalisa Bonfiglio, Danilo De Rossi, "Wearable Monitoring Systems", Springer,2011.
2. Sandeep K. S. Gupta, Tridib Mukherjee, Krishna Kumar Venkata Subramanian, “Body Area Networks Safety, Security and Sustainability”, Cambridge University Press,2013.
3. Zhang, Yuan-Ting, “Wearable Medical Sensors and Systems”, Springer, 2021.
4. Guang - Zhong Yang, “Body Sensor Networks”, Springer, 2016.
5. Mehmet R. Yuce, Jamil Y. Khan, “Wireless Body Area Networks Technology, Implementation and Applications, Pan Stanford Publishing, 1st Edition, 2011
6. Jamil Khan , Mehmet R. Yuce, “Wireless Body Area Networks: Technology,Implementation and Applications”, Pan Stanford Publishing, 1st Edition, 2011.
7. Kasun Maduranga Silva Thotahewa , Jean-Michel Redouté, “Ultra-wideband Wireless Body Area Networks”, Springer, 2016.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1			3	3	2		3	2	2
CO2			3	3	2		3	2	2
CO3			3	3	2		3	2	2
CO4	3	3	3	3	2		3	2	2
CO5	3	3	3	3	2		3	2	2

25EC2922	SEMICONDUCTOR DEVICE MODELING	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To explain the fundamental concepts of semiconductors.
- To describe the physics of key semiconductor devices.
- To design MOSFET devices considering non-idealities.
- To develop compact models for SPICE simulations.
- To analyze process variability and device reliability.

UNIT I BASIC THEORY OF SEMICONDUCTORS 9

Introduction, - direct and indirect semiconductors – Fermi-Dirac statistics - Quasi-Fermi Levels - Poisson's Equation, conduction in semiconductor, effect of temperature, doping, and high electric field on carrier mobility, PN junction at equilibrium - current-voltage characteristics-diode current model and its limitations.

UNIT II MOSFET DEVICE PHYSICS 9

MOS capacitor – potential balance and charge balance, the effect of gate-body voltage – MOSFET structures - qualitative description of MOS transistor operation – MOS transistor characteristics – Transistor regions of operations – CMOS fabrication process. Characteristics (IDS vs VGS) of MOSFET using Simulation Tool.

UNIT III MOSFET STATIC MODELS 9

Static drain current model – simple charge control model - Pao-Sah model - Pierret-Shields's model – charge sheet model – strong inversion model – weak inversion model – SPICE model, short channel effects, Quantum mechanical effects, modeling of lightly doped drain MOSFET and SOI MOSFET. Drain characteristics (IDS vs VDS) of MOSFET using Simulation Tool.

UNIT IV MODELING FOR CIRCUIT SIMULATORS 9

Introduction, types of models, attributes for good compact models, model formulation, model implementation in circuit simulators, model testing, parameter extraction, simulation, and extraction for RF applications, compact models – BSIM models - EKV models – PSP models. Extraction of threshold voltage, transconductance, device ON and OFF current, and subthreshold slope of MOSFET using Open-Source Simulation tool.

UNIT V DEVICE SCALING AND VARIABILITY EFFECTS 9

Introduction, classical scaling laws, process variability- global and local process variability, characterization of parametric variability in MOSFETs, Reliability of MOSFETs - high-field effects, hot carrier degradation, bias temperature instability, MOSFET breakdown, high-k dielectrics.

TOTAL :45 PERIODS

COURSE OUTCOMES:

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

CO1 Apply the semiconductor concepts of drift, diffusion, donors and acceptors, majority and minority carriers, and carrier mobility

CO2 Illustrate the physics and principles of operation of p-n junction diodes, MOS capacitors, and MOSFETs

CO3 Design and simulate MOSFET devices, taking into consideration of non-ideal and short- channel effects

CO4 Develop compact models for short-channel MOSFETs suitable for SPICE simulators

CO5 Analyze the process variability and reliability effects of the nano-scaled MOSFETs and simulate the device lifetime.

REFERENCE BOOKS:

1. K. Saha, "Compact models for integrated circuit design: Conventional transistors and beyond", Taylor & Francis, 2015**.**
2. Tsividis, Y. & McAndrew, C. Operation, and modeling of the MOS transistor. Third edition, Oxford University Press, USA: 2011.
3. AB Bhattacharyya, "Compact MOSFET models for VLSI design", Wiley, New York, 2009.
4. J.J. Liou, A. Ortiz-Conde, F. Garcia-Sanchez, "Analysis and Design of MOSFETs: Modeling, Simulation, and Parameter Extraction", Springer Science & Business Media, 1998.
5. T. Ytterdal, Y. Cheng, T. A. Fjeldly, "Device Modeling for Analog and RF CMOS Circuit Design", John Wiley & Sons, New York 2003.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3	1	3	2	1		3	2	1
CO2	3	1	3	3	1		3	3	1
CO3	3	1	3	3	2		3	2	3
CO4	3	1	3	3	2		3	3	2
CO5	3	1	3	3	1		3	2	2

25EC2923	SIGNAL PROCESSING IN VLSI DESIGN	L	T	P	C
		3	0	0	3

COURSE OBJECTIVES:

- To understand the architecture of DSP systems.
- To gain knowledge on design equations for efficient DSP architecture
- To interpret convolution process and develop fast and area efficient IIR structures
- To learn fast and area efficient multiplier architectures.
- To impart knowledge on fast hardware for synchronous digital systems

UNIT I INTRODUCTION TO DSP SYSTEMS, PIPELINING AND PARALLEL PROCESSING OF FIR FILTERS 9

Introduction to DSP systems – Typical DSP algorithms, Data flow and Dependence graphs - critical path, Loop bound, iteration bound, Longest path matrix algorithm, Pipelining and Parallel processing of FIR filters, Pipelining and Parallel processing for low power.

UNIT II RETIMING, ALGORITHMIC STRENGTH REDUCTION 9

Retiming – definitions and properties, Unfolding – an algorithm for unfolding, properties of unfolding, sample period reduction and parallel processing application, Algorithmic strength reduction in filters and transforms – 2-parallel FIR filter, 2-parallel fast FIR filter, DCT architecture, rank-order filters, Odd-Even merge-sort architecture, parallel rank- order filters.

UNIT III FAST CONVOLUTION, PIPELINING AND PARALLEL PROCESSING OF IIR FILTERS 9

Fast convolution – Cook-Toom algorithm, modified Cook-Toom algorithm, Pipelined and parallel recursive filters – Look-Ahead pipelining in first-order IIR filters, Look-Ahead pipelining with power- of-2 decomposition, Clustered look-ahead pipelining, Parallel processing of IIR filters, combined pipelining and parallel processing of IIR filters.

UNIT IV BIT-LEVEL ARITHMETIC ARCHITECTURES 9

Bit-level arithmetic architectures – parallel multipliers with sign extension, parallel carry ripple and carry-save multipliers, Design of Lyon‟s bit-serial multipliers using Horner‟s rule, bit-serial FIR filter, CSD representation, CSD multiplication using Horner‟s rule for precision improvement, Distributed Arithmetic fundamentals and FIR filters.

UNIT V NUMERICAL STRENGTH REDUCTION, SYNCHRONOUS, WAVE AND ASYNCHRONOUS PIPELINING 9

Numerical strength reduction – sub expression elimination, multiple constant multiplication, iterative matching, synchronous pipelining and clocking styles, clock skew in edge-triggered single phase clocking, two-phase clocking, wave pipelining. Asynchronous pipelining bundled data versus dual rail protocol.

TOTAL :45 PERIODS

COURSE OUTCOMES:

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

CO1 Determine the parameters influencing the efficiency of DSP architectures and apply pipelining and parallel processing techniques to alter FIR structures for efficiency

CO2 Apply and modify the design equations leading to efficient DSP architectures for transforms

CO3 Analyze convolution process and develop fast and area efficient IIR structures

CO4 Develop fast and area efficient multiplier architectures

CO5 Build fast hardware for synchronous digital systems

REFERENCE BOOKS:

1. Keshab K. Parhi, " VLSI Digital Signal Processing Systems, Design and implementation ", Wiley, Interscience, 2007.
2. U. Meyer – Baese, " Digital Signal Processing with Field Programmable Gate Arrays", Springer, 4th Edition, June 2014.

CO-PO MAPPING

	PO1	PO2	PO3	PO4	PO5	PO6	PSO1	PSO2	PSO3
CO1	3		2	2	2		3	2	1
CO2	3		2	2	2		3	3	1
CO3	3		2	3	2		3	3	2
CO4	3		2	3	2		3	2	3
CO5	3		2	3	2		2	3	3

25OE2007	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.

25OE2008	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

25OE2009	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.

25OE2010	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.

25AC2101	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

25AC2102	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. Nishitha Rai, Singh AK, "Disaster Management in India: Perspectives, issues and strategies", New Royal book Company,2007.
3. Sahni, PardeepEt.Al. ," Disaster Mitigation Experiences And Reflections", Prentice Hall OfIndia, New Delhi, 2001.

25AC2201	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

25AC2202	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