PANIMALAR ENGINEERING COLLEGE

Approved by AICTE, New Delhi | Affiliated to Anna University, Chennai

M.E - COMMUNICATION SYSTEMS

REGULATION 2021

CURRICULUM & SYLLABUS

PANIMALAR ENGINEERING COLLEGE

(An Autonomous Institution, Affiliated to Anna University, Chennai)
Bangalore Trunk Road, Varadharajapuram,
Poonamallee, Chennai – 600 123.

Department of Electronics and Communication Engineering

M.E- COMMUNICATION SYSTEMS

CURRICULUM AND SYLLABUS

REGULATION-2021

PROGRAMME EDUCATIONAL OBJECTIVES (PEO)

- To prepare students to analyze, design and implement electronic circuits and systems using the knowledge acquired from basic science and mathematics.
- To train students with good scientific and engineering knowledge so as to comprehend, analyze, design and create novel products and solutions for real life problems.
- To introduce the research world to the graduates not only in their own domain but also in multidisciplinary domain, so that they feel motivated for higher studies.
- To prepare graduates to exhibit professionalism, ethical attitude, communication skills, team work and leadership qualities in their profession and adapt to current trends by engaging in lifelong learning.
- To practice professionalism in a collaborative, team-oriented manner that embraces the multicultural environment of today's business world.

PROGRAM OUTCOMES (PO)

PO1 (Engineering knowledge): Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO2 (Problem Analysis): Identify, formulate, research literature, and analyze complex engineering problem reaching substantiated conclusions using first principles of mathematics,natural sciences, and engineering sciences.

PO3(Design/development of solutions): Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO4 (Conduct investigations of complex problems): Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO5(Modern tool usage): Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

PO6(The engineer and society): Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the Professional engineering practice.

PO7 (Environment and sustainability): Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO8 (Ethics): Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice

PO9 (Individual and team work): Function effectively as an individual, and as a memberor leader in diverse teams, and in multidisciplinary settings

PO10(Communication): Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO11 (Project management and finance): Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO12 (Life-long learning): Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

PROGRAMME SPECIFIC OUTCOMES (PSO)

PSO1: Graduates should demonstrate an understanding of the basic concepts in the primary area of Electronics and Communication Engineering, including: analysis of circuits containing both active and passive components, electronic systems, control systems, electromagnetic systems, digital systems, computer applications and communications.

PSO2: Graduates should demonstrate the ability to utilize the mathematics and the fundamental knowledge of Electronics and Communication Engineering to design complex systems which may contain both software and hardware components to meet the desired needs.

PSO3: The graduates are capable of excelling in Electronics and Communication Engineering industry/Academic /Software companies through professional careers.

M.E - COMMUNICATION SYSTEMS

REGULATIONS – 2021

CHOICE BASED CREDIT SYSTEM

I - IV SEMESTER CURRICULUM AND SYLLABUS

SEMESTER I

SL. NO	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	CONTACT PERIODS	CREDITS
THEORY								
1.	21MA2102	Applied Mathematics for Communication Engineers	FC	4	0	0	4	4
2.	21EC2101	Advanced Radiation Systems	PCC	3	0	0	3	3
3.	21EC2102	Advanced Digital Communication Techniques	PCC	3	0	0	3	3
4.	21EC2103	Advanced Digital Signal Processing	PCC	4	0	0	4	4
5.	21RM2101	Research Methodology and IPR	RMC	2	0	0	2	2
6.		Audit Course I*	AC	2	0	0	2	0
PRACTICAL								
7.	21EC2111	Signal Processing and Communication Laboratory	PCC	0	0	4	4	2
8.	21EC2112	Antenna Design Laboratory	PCC	0	0	4	4	2
			TOTAL	**18**	**0**	**8**	**22**	**20**

* Audit Course is optional

SEMESTER II

SL. NO	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	CONTACT PERIODS	CREDITS
THEORY								
1.	21EC2201	Advanced Wireless Communication Systems	PCC	3	0	0	3	3
2.	21EC2202	MIC and RF System Design	PCC	4	0	0	4	4
3.	21EC2203	Optical Communication and Networking	PCC	3	0	0	3	3
4.		Program Elective I	PE	3	0	0	3	3
5.		Program Elective II	PE	3	0	0	3	3
6.		Audit Course II*	AC	2	0	0	2	0
PRACTICAL								
7.	21EC2211	RF System Design Laboratory	PCC	0	0	4	4	2
8.	21EC2212	Mini Project	EEC	0	0	4	4	2
			TOTAL	**18**	**0**	**8**	**22**	**20**

* Audit Course is optional

SEMESTER III

SL. NO	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	CONTACT PERIODS	CREDITS
THEORY								
1.	21EC2301	Millimeter Wave Communication	PC	3	0	0	3	3
2.		Program Elective III	PEC	3	0	0	3	3
3.		Program Elective IV	PEC	3	0	0	3	3
4.		Open Elective	OE	3	0	0	3	3
PRACTICAL								
5.	21EC2311	Project Work Phase – I	EEC	0	0	12	12	6
			TOTAL	**12**	**0**	**12**	**24**	**18**

* Audit Course is optional

SEMESTER IV

SL. NO	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	CONTACT PERIODS	CREDITS
PRACTICAL								
1.	21EC2411	Project Work Phase – II	EEC	0	0	24	24	12
			TOTAL	**0**	**0**	**24**	**24**	**12**

TOTAL NO. OFCREDITS: 70

FOUNDATIONAL COURSE (FC)

SL. NO	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	CONTACT PERIODS	CREDITS
1.	21MA2102	Applied Mathematics for Communication Engineers	FC	4	0	0	4	4

PROGRAM CORE COURSES (PCC)

SL. NO	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	CONTACT PERIODS	CREDITS
1.	21EC2101	Advanced Radiation Systems	PCC	3	0	0	3	3
2.	21EC2102	Advanced Digital Communication Techniques	PCC	3	0	0	3	3
3.	21EC2103	Advanced Digital Signal Processing	PCC	4	0	0	4	4
4.	21EC2111	Signal Processing and Communication Laboratory	PCC	0	0	4	4	2
5.	21EC2112	Antenna Design Laboratory	PCC	0	0	4	4	2
6.	21EC2201	Advanced Wireless Communication Systems	PCC	3	0	0	3	3
7.	21EC2202	MIC and RF System Design	PCC	4	0	0	4	4
8.	21EC2203	Optical Communication andNetworking	PCC	3	0	0	3	3
9.	21EC2211	RF System Design Laboratory	PCC	0	0	4	4	2
10.	21EC2301	Millimeter Wave Communication	PCC	3	0	0	3	3

PROGRAM ELECTIVE COURSE (PEC)

SL. NO	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	CONTACT PERIODS	CREDITS
1.	21EC2901	Advanced Satellite Communication and Navigation Systems	PEC	3	0	0	3	3
2.	21EC2902	Cognitive RadioNetworks	PEC	3	0	0	3	3
3.	21EC2903	Advanced Wireless Networks	PEC	3	0	0	3	3
4.	21EC2904	Software Defined Radio	PEC	3	0	0	3	3
5.	21EC2905	Communication Network Security	PEC	3	0	0	3	3
6.	21EC2906	Analog and Mixed Mode VLSI Design	PEC	3	0	0	3	3
7.	21EC2907	VLSI for Wireless Communication	PEC	3	0	0	3	3
8.	21EC2908	Radar Signal Processing	PEC	3	0	0	3	3
9.	21EC2909	Pattern Recognition and Machine Learning	PEC	3	0	0	3	3
10.	21EC2910	Wireless Adhoc and Sensor Networks	PEC	3	0	0	3	3
11.	21EC2911	Internet of Things	PEC	3	0	0	3	3
12.	21EC2912	Network Routing Algorithms	PEC	3	0	0	3	3
13.	21EC2913	Wireless Communication Networks	PEC	3	0	0	3	3
14.	21EC2914	Multimedia Communications	PEC	3	0	0	3	3
15.	21EC2915	Digital Audio and Video Broadcasting Technology	PEC	3	0	0	3	3
16.	21EC2916	Image Analysis and	PEC	3	0	0	3	3
17.	21EC2917	Cooperative communications	PEC	3	0	0	3	3
18.	21EC2918	Machine Learning in Communication Networks	PEC	3	0	0	3	3
19.	21EC2919	Signal Integrity for HighSpeed Design	PEC	3	0	0	3	3
20.	21EC2920	Communication Network Design	PEC	3	0	0	3	3
21.	21EC2921	Electromagnetic Interference andCompatibility	PEC	3	0	0	3	3
22.	21EC2922	Spread Spectrum Techniques andApplications	PEC	3	0	0	3	3

DOMAIN WISE GROUPING OF ELECTIVES

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

OPEN ELECTIVE COURSES (OEC)

*(out of 6 courses one course must be selected)

SL. NO	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			CONTACT PERIODS	CREDITS
				L	T	P		
1.	21OE2001	Business Data Analytics	OEC	3	0	0	3	3
2.	21OE2002	Industrial Safety	OEC	3	0	0	3	3
3.	21OE2003	Operations Research	OEC	3	0	0	3	3
4.	21OE2004	Cost Management of Engineering Projects	OEC	3	0	0	3	3
5.	21OE2005	Composite Materials	OEC	3	0	0	3	3
6.	21OE2006	Waste to Energy	OEC	3	0	0	3	3
7.	21OE2007	Security Practices	OEC	3	0	0	3	3
8.	21OE2008	Network Technologies	OEC	3	0	0	3	3

AUDIT COURSES (AC)

*(Registration for any of these courses is optional to students)

SL.NO	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS
			L	T	P	
1.	21AC2101	English for Research Paper Writing	2	0	0	0
2.	21AC2102	Disaster Management	2	0	0	0
3.	21AC2103	Sanskrit for Technical Knowledge	2	0	0	0
4.	21AC2104	Value Education	2	0	0	0
5.	21AC2201	Constitution of India	2	0	0	0
6.	21AC2202	Pedagogy Studies	2	0	0	0
7.	21AC2203	Stress Management by Yoga	2	0	0	0
8.	21AC2204	Personality Development Through Life Enlightenment Skills	2	0	0	0
9.	21AC2205	Unnat Bharat Abhiyan	2	0	0	0
					TOTAL CREDITS	**0**

EMPLOYABILITY ENHANCEMENT COURSES (EEC)

SL. NO	COURSE CODE	COURSE TITLE	CATEGORY	L	T	P	CONTACT PERIODS	CREDITS
1.	21EC2112	Mini Project	EEC	0	0	4	4	2
2.	21EC2311	Project Work Phase – I	EEC	0	0	12	12	6
3.	21EC2411	Project Work Phase – II	EEC	0	0	24	24	12

CREDIT DISTRIBUTION

SL.NO	SUBJECT AREA	CREDITS PERSEMESTER				CREDITS TOTAL	PERCENTAGE %
	SEMESTER	I	II	III	IV		
1.	Foundational courses (FC)	4				4	5.7
2.	Research Methodology and IPR (RMC)	2				2	2.9
3.	Professional Core (PCC)	14	12	3		29	41.4
4.	Professional Electives (PEC)		6	6		12	17.1
5.	Open Electives (OE)			3		3	4.3
6.	Employability Enhancement Courses (EEC)		2	6	12	20	28.6
7.	Non-Credit / (Optional)	0	0			0	0
	TOTAL	**20**	**20**	**18**	**12**	**70**	**100**

21MA2102	APPLIED MATHEMATICS FOR COMMUNICATION ENGINEERS	L	T	P	C
		4	0	0	4

OBJECTIVES:

- The primary objective of this course is to demonstrate various analytical skills in applied mathematics and extensive experience with the tactics of problem solving and logical thinking applicable in communication engineering. This course also will help the students to identify, formulate, abstract, and solve problems in electrical engineering using mathematical tools from a variety of mathematical areas, including linear algebra, matrix linear programming, probability, numerical solution of ordinary differential equations and queuing models.

UNIT - I LINEAR ALGEBRA 12

Vector spaces – Norms – Inner products – Eigen values using QR transformations – QR factorization - Generalized eigenvectors – Canonical forms – 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 – Big M method - Two phase method - Transportation problems - Assignment models.

UNIT - III NUMERICAL SOLUTION OF ORDINARY DIFFERENTIAL EQUATIONS 12

Runge - Kutta method of fourth order for system of IVPs - Numerical stability of Runge - Kutta method - Adams - Bashforth multistep method - Shooting method, BVP : Finite difference method and collocation method and orthogonal collocation method.

UNIT - IV PROBABILITY AND RANDOM VARIABLES 12

Probability – Axioms of probability – Conditional probability – Baye's theorem - Random variables - Probability function - Two dimensional random variables - Joint distributions – Marginal and conditional distributions – Functions of two dimensional random variables – Regression curve – Correlation.

UNIT - V QUEUEING MODELS 12

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

TOTAL: 60 PERIODS

OUTCOMES:

After completing this course, students should demonstrate competency in the following skills:

1. Concepts on vector spaces, linear transformation, inner product spaces, Eigen values and generalized Eigenvectors.
2. Apply various methods in linear algebra to solve system of linear equations
3. Could 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.
4. Numerical solution of differential equations by single and multistep methods.
5. Computation of probability, random variables and their associated distributions, correlations and regression.
6. Conceptualize the principle of optimality and sub-optimization, formulation and computational procedure of dynamic programming.
7. Exposing the basic characteristic features of a queuing system and acquire skills in Analyzing queuing models.
8. Using discrete time Markov chains to model computer systems.

REFERENCES:

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.

21EC2101	ADVANCED RADIATION SYSTEMS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To enhance the students knowledge in the area of various antenna design and to make them understand their radiation mechanism.
- To impart knowledge about the state of art in antenna technology.

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, smart antennas, switched beam and adaptive arrays, Mutual Coupling in Finite 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. Radiation Mechanism and Excitation techniques, Microstrip dipole; Patch, Rectangular patch, Circular patch – Microstrip array and feed network; Lens Antennas

UNIT - IV MODERN ANTENNAS & MEASUREMENT TECHNIQUES 9

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

UNIT - V NEXT GENERATION ANTENNA DESIGN 9

UWB antenna arrays – Vivaldi antenna arrays – Artificial magnetic conductors/High impedance surfaces – Antennas in medicine – Plasma antennas – Antennas for millimeter wave communication - optimization techniques – Numerical methods

TOTAL: 45 PERIODS

OUTCOMES:

At the end of the course, the student should be able to:

1. Understand the fundamentals behind the different techniques in antenna technology.
2. Understand the challenges associated in designing antennas based on different technologies
3. Understand the capability and assess the performance of various antennas.
4. Identify the antennas specific to the applications, design and characterize.
5. Understand the need for optimizing in antenna design and the methodologies for the same.

REFERENCES:

1. Balanis.A, “Antenna Theory Analysis and Design”, John Wiley and Sons, New York, 3rd Edition,1982.
2. Frank B. Gross, “Frontiers in Antennas”, Mc Graw Hill, 2011.
3. S. Drabowitch, A. Papiernik, H.D.Griffiths, J.Encinas, B.L.Smith, “Modern Antennas”, Springer Publications, 2nd Edition, 2007.
4. Krauss.J.D, “Antennas”, John Wiley and sons, New York, 2nd Edition, 1997.
5. I.J. Bahl and P. Bhartia, “Microstrip Antennas”, Artech House,Inc.,1980
6. W.L.Stutzman and G.A.Thiele, “Antenna Theory and Design”, John Wiley& Sons Inc., 2nd Edition, 1998.
7. Jim R. James,P.S.Hall ,”Handbook of Microstrip Antennas” IEE Electromagnetic waveseries 28, Volume 2,1989

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+Commun ications
3. https://www.coursera.org/learn/microwave-antenna
4. https://engineering.purdue.edu/online/courses/antennas-design-application

21EC2102	ADVANCED DIGITAL COMMUNICATION TECHNIQUES	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the coherent and non coherent receivers and its impact on different channel characteristics.
- To understand the different block coded digital communication systems.
- To understand the convolutional coded digital communication systems.
- To know the trade-offs involved in the design of basic and advanced coding and modulation techniques.
- To understand the basics of Multicarrier and Multiuser Communications.

UNIT - I COHERENT AND NON-COHERENT COMMUNICATION 9

Review of Coherent receivers – Optimum receivers in WGN – IQ modulation & demodulation Noncoherent receivers in random phase channels; MFSK receivers – Rayleigh and Rician channels – Partially coherent receivers – DPSK; M-PSK; M-DPSK- BER Performance Analysis- Carrier Synchronization- Bit synchronization.

UNIT - II BLOCK CODED DIGITAL COMMUNICATION 9

Architecture and performance – Binary block codes; 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 codesusing Polynomial, State diagram, Tree diagram, and Trellis diagram-Decoding techniques using Maximum likelihood, Viterbi algorithm, Sequential and Threshold methods - Error probability performance for BPSK and Viterbi algorithm.

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, LDPC Codes

UNIT - V **MULTICARRIER AND MULTIUSER COMMUNICATIONS** **9**

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

TOTAL: 45 PERIODS

OUTCOMES:

At the end of the course, the student will be able to:

1. Develop the ability to understand the concepts of signal space analysis for coherent and non- coherent receivers.
2. Possess knowledge on the performance of block codes with modulation.CO3: Understand the issues involved in the design of multi-carrier modulation signals
3. Know the working and implementation of Convolution codes
4. Ability to design Advanced coded modulation as per the bandwidth and power efficiency requirements
5. Comprehend the generation of OFDM signals and the techniques of multiuser detection.

REFERENCES:

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

WEB REFERENCES

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

ONLINE COURSES / RESOURCES:

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

21EC2103 ADVANCED DIGITAL SIGNAL PROCESSING

L	T	P	C
4	0	0	4

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 12

Discrete random processes – Ensemble averages – 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 12

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

UNIT - III SPECTRUM ESTIMATION 12

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

UNIT - IV OPTIMUM FILTERS 12

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

UNIT - V ADAPTIVE FILTERS 12

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: 60 PERIODS

OUTCOMES:

At the end of the course, the student will be able to:

1. Formulate time domain and frequency domain description of Wide Sense Stationary process in terms of matrix algebra and relate to linear algebra concepts. State W-K theorem, spectral factorization theorem
2. Signal Modeling
3. Spectrum estimation, bias and consistency of estimators.
4. Wiener filtering, LMS algorithms, Levinson recursion algorithm
5. Applications of adaptive filters

REFERENCES:

1. Monson H. Hayes, “Statistical Digital Signal Processing and Modeling”, John Wiley and Sons, Inc, Singapore, 2002.
2. John J. Proakis, Dimitris G. Manolakis, “Digital Signal Processing”, Pearson Education, 2002.
3. P. P. Vaidyanathan, “Multirate Systems and Filter Banks”, Prentice Hall, 1992.
4. S. Kay,” Modern spectrum Estimation theory and application”, Prentice Hall, Englehood Cliffs, NJ1988.
5. Simon Haykin, “Adaptive Filter Theory”, Prentice Hall, Englehood Cliffs, NJ1986.
6. Sophoncles J. Orfanidis, “Optimum Signal Processing “, McGraw-Hill, 2000.

21RM2101	RESEARCH METHODOLOGY AND IPR	L	T	P	C
		2	0	0	2

OBJECTIVES:

To impart knowledge and skills required for research and IPR:

- Problem formulation, analysis and solutions.
- Technical paper writing / presentation without violating professional ethics
- Patent drafting and filing patents.

UNIT - I RESEARCH PROBLEM FORMULATION 6

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

UNIT - II LITERATURE REVIEW 6

Effective literature studies approaches, analysis, plagiarism, and research ethics

UNIT - III TECHNICALWRITING / PRESENTATION 6

Effective technical writing, how to write report, paper, developing a research proposal, format of research proposal, a presentation and assessment by a review committee.

UNIT - IV INTRODUCTION TO INTELLECTUAL PROPERTY RIGHTS (IPR) 6

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

UNIT - V INTELLECTUAL PROPERTY RIGHTS (IPR) 6

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

TOTAL : 30 PERIODS

OUTCOMES:

1. Ability to formulate research problem
2. Ability to carry out research analysis
3. Ability to follow research ethics
4. Ability to understand that today's world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity
5. Ability to understand about IPR and filing patents in R & D.

REFERENCES:

1. Asimov, “Introduction to Design”, Prentice Hall, 1962.
2. Halbert, “Resisting Intellectual Property”, Taylor & Francis Ltd ,2007.
3. Mayall, “Industrial Design”, McGraw Hill, 1992.
4. Niebel, “Product Design”, McGraw Hill, 1974.
5. Ranjit Kumar,“Research Methodology: A Step by Step Guide for beginners” 2nd Edition, 2010.

21EC2111	SIGNAL PROCESSING AND COMMUNICATION LABORATORY	L	T	P	C
		0	0	4	2

OBJECTIVES:

- To enable the student to verify the basic principles of random signal processing, spectral estimation methods, wireless and AWGN channel characterization, application of adaptive filter algorithms for communication system design, coding and modulation design, synchronization aspects and the overall baseband system design.
- To design and conduct experiments, as well as to analyze and interpret data to produce meaningful conclusions and match with theoretical concepts.
- To enable the student to appreciate the practical aspects of baseband system design and understand the associated challenges.

LIST OF EXPERIMENT:

1. Generation & detection of binary digital modulation techniques.
2. Design and Analysis of Spectrum Estimators (Bartlett , Welch)
3. Carrier and Symbol timing Synchronization
4. Performance evaluation of simulated CDMA system
5. Design and performance analysis of error control encoder and decoder (Block and Convolutional Codes)
6. OFDM transceiver design
7. Channel equalizer design(LMS, RLS)
8. BER performance Analysis of Binary digital Modulation Techniques in AWGN Environment (Binary Phase Shift Keying, Amplitude Shift Keying, Frequency Shift Keying)
9. Generation of Minimum Shift Keying Signal
10. Spread Spectrum communication system-Pseudo random binary sequence generation- Baseband DSSS.

TOTAL: 60 PERIODS

COURSE OUTCOMES:

1. The student would be able to 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.
2. The student would be capable of applying communication engineering principles and design tools and will be well practiced in design skills.
3. The student would be able to comprehensively record and report the measured data, write reports, communicate research ideas and do oral presentations effectively.
4. The student would be capable of analyzing and interpreting the experimental measurement data and produce meaningful conclusions.

21EC2112 ANTENNA DESIGN LABORATORY

L	T	P	C
0	0	4	2

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 EXPERIMENT:

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

TOTAL: 60 PERIODS

COURSE OUTCOMES:

1. 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 antenna.
2. The student would be able to design and conduct experiments to demonstrate the trade- offs involved in the design of high frequency antennas.
3. The student would be capable of applying communication engineering principles and design tools and will be well practiced in design skills.
4. The student would be able to comprehensively record and report the measured data, and would be capable of analyzing and interpreting the experimental measurement data and produce meaningful conclusions.

21EC2201	ADVANCED WIRELESS COMMUNICATION SYSTEMS	L	T	P	C
		3	0	0	3

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

Propagation of EM signals in wireless channel – Reflection, diffraction and Scattering-free space, two ray. Small scale fading- channel classification- channel models – COST -231 Hata model, Longley-Rice Model, NLOS Multipath Fading Models: Rayleigh, Rician, Nakagami, Composite Fading –shadowing Distributions, Link power budget Analysis.

UNIT - II CAPACITY OF WIRELESS CHANNELS 9

Capacity in AWGN, capacity of flat fading channel, capacity of frequency selective fading channels.

UNIT - III DIVERSITY 9

Realization of independent fading paths, Receiver Diversity: Selection combining, Threshold Combining, Maximum-ratio Combining, Equal gain Combining. Transmitter Diversity: Channel known at transmitter, Channel unknown at the transmitter.

UNIT - 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

Review of Multiple Access Techniques, Scheduling, power control, Uplink and Downlink channel capacity, multiuser diversity, MIMO-MU systems.

TOTAL: 45 PERIODS

OUTCOMES:

At the end of the course, the student will be able to:

1. Analyze the wireless channel characteristics and identify appropriate channel models
2. Understand the mathematics behind the capacity calculation under different channel conditions
3. Understand the implication of diversity combining methods and the knowledge of channel
4. Understand the concepts in MIMO Communications
5. Understand multiple access techniques and their use in different multi-user scenarios.

REFERENCES:

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.

WEB REFERENCES

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

ONLINE COURSES / RESOURCES:

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

21EC2202	MIC AND RF SYSTEM DESIGN	L	T	P	C
		4	0	0	4

OBJECTIVES:

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

UNIT – I **CMOS PHYSICS, TRANSCEIVER SPECIFICATIONS AND ARCHITECTURES** **12**

CMOS: Introduction to MOSFET Physics, 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** **12**

Review of S-parameters and Smith chart, Passive IC components, Impedance matching networks, Amplifiers: Common Gate, Common Source Amplifiers, 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** **12**

Feedback Systems: Stability of feedback systems: Gain and phase margin, Root-locus techniques, Time and Frequency domain considerations , Compensation Power Amplifiers: General model – Class A, AB, B, C, D, E and F amplifiers, Linearization Techniques, Efficiency boosting techniques, ACPR metric, Design considerations

UNIT – IV **RF FILTER, OSILLATOR, MIXER** **12**

Overview-basic resonator and filter configuration, special filter realizations, filter implementation. Basic oscillator model, high frequency oscillator configuration, basic characteristics of mixers, phase locked loops, RF directional couplers, hybrid couplers, detector and demodulator circuits.

UNIT – V **MIC COMPONENTS** **12**

Introduction to MICs, Fabrication Technology, Advantages and applications, MIC components- Micro strip components, Coplanar circuits: Transistors, switches, active filters. Coplanar microwave amplifiers: LNA design and Medium power amplifiers.

TOTAL: 60 PERIODS

OUTCOMES:

1. Capability to design RF circuits.
2. To be able to analyze RF circuits.

REFERENCES:

1. B.Razavi, “RF Microelectronics”, Pearson Education, 1997.
2. Ingo Wolff, “Coplanar Microwave Integrated circuits”, John Wiley and sons, New Jersey, 2006.
3. T. Lee, “Design of CMOS RF Integrated Circuits”, Cambridge, 2004.

21EC2203	OPTICAL COMMUNICATION AND NETWORKING	L	T	P	C
		3	0	0	3

OBJECTIVES:

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

UNIT - I **OPTICAL SYSTEM COMPONENTS AND NETWORK DESIGN** **9**

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

UNIT - II **COHERENT SYSTEMS** **9**

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

UNIT - III **OPTICAL NETWORK ARCHITECTURES** **9**

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

UNIT - IV **NETWORK CONNECTIONS** **9**

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

UNIT - V **OPTICAL NETWORK SURVIVABILITY** **9**

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

TOTAL: 45 PERIODS

OUTCOMES:

At the end of the course the student would be

1. Able to demonstrate an understanding of the differences and challenges involved in the design of optical systems and networks.
2. In a position to apply his knowledge for designing a fiber optic system addressing the channel impairments.
3. Familiar 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.
4. Able to understand how connections are managed in the network and the pros and cons of the different approaches
5. Able to appreciate the need for network survivability and the methodologies used.

REFERENCES:

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.

21EC2211	RF SYSTEM DESIGN LABORATORY	L	T	P	C
		0	0	4	2

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 low pass, high pass filters
6. Design of band pass and band stop filter
7. Design of Couplers and Power dividers
8. Design of Mixer
9. Design of Phase shifter
10. Design of LNA

TOTAL: 60 PERIODS

OUTCOMES:

At the end of the course, the student should be able to::

1. 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.
2. The student would be able to design and conduct experiments to demonstrate the trade- offs involved in the design of bandpass systems.
3. The student would be capable of applying communication engineering principles and design tools and will be well practiced in design skills.
4. The student would be able to comprehensively record and report the measured data, and would be capable of analyzing and interpreting the experimental measurement data and produce meaningful conclusions.

21EC2301	MILLIMETER WAVE COMMUNICATION	L	T	P	C
		3	0	0	3

OBJECTIVES:

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

UNIT - I INTRODUCTION 9

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

UNIT - II MM WAVE DEVICES AND CIRCUITS 9

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

UNIT - III MM WAVE COMMUNICATION SYSTEMS 9

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

UNIT - IV MM WAVE MIMO SYSTEMS 9

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

UNIT - V ANTENNAS FOR MM WAVE SYSTEMS 9

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

TOTAL: 45 PERIODS

OUTCOMES:

On successful completion of the course student will be able to:

1. Able to understand the fundamentals of Millimeter wave
2. Able to understand Millimeter devices and circuits
3. Able to understand the various components of Millimeter wave communication systems
4. Able to understand millimeter wave MIMO system
5. Able to design antenna for Millimeter wave system

REFERENCES:

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.

21EC2901	ADVANCED SATELLITE COMMUNICATION AND NAVIGATION SYSTEMS	L	T	P	C
		3	0	0	3

OBJECTIVES:

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

UNIT - I OVERVIEW OF SATELLITE COMMUNICATION 9

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

UNIT - II M2M DEVELOPMENTS AND SATELLITE APPLICATIONS 9

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

UNIT - III SATELLITE COMMUNICATION IN IPV6 ENVIRONMENT 9

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

UNIT - IV SATELLITE NAVIGATION AND GLOBAL POSITIONING SYSTEM 9

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

UNIT - V DEEP SPACE NETWORKS AND INTER PLANETARY MISSIONS 9

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

TOTAL: 45 PERIODS

OUTCOMES:

At the end of this course, the student should be able to:

1. Discuss satellite navigation and global positioning system
2. Outline deep space networks and inter planetary missions

REFERENCES:

1. Adimurthy.V," Concept design and planning of India's first interplanetary mission" Current Science, VOL. 109, NO. 6, 1054 25 SEPTEMBER 2015.
2. Anil K. Maini, Varsha Agrawal, 'Satellite Technology: Principles and Applications', Third Edition, Wiley, 2014.
3. Daniel Minoli' "Innovations in Satellite Communication and Satellite Technology" Wiley, 2015
4. Daniel Minoli, "Satellite Systems Engineering in an IPv6 Environment", CRC Press, First Edition, 2009.
5. Hofmann-Wellenhof B., Lichtenegger H., and Elmar Wasle, "Global Navigational Satellite Systems" Springer-Verlag, 2008.
6. Jim Taylor, " Deep Space Communications" John Wiley & Sons, 2016.
7. Louis J. Ippolito, Jr. "Satellite Communications Systems Engineering: Atmospheric Effects, Satellite Link Design and System Performance", Second Edition, 2017
8. http://www.isro.gov.in/pslv-c25-mars-orbiter-mission
9. https://en.wikipedia.org/wiki/Mars_Orbiter_Mission
10. https://en.wikipedia.org/wiki/Chandrayaan-1

21EC2902	COGNITIVE RADIO NETWORKS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- Understand concepts of cognitive radio.
- Learn spectrum sensing and dynamic spectrum access.
- Understand the evolving paradigm of cognitive radio communication and the enabling technologies for its implementation.
- To enable the student to understand the essential functionalities and requirements in designing software defined radios and their usage for cognitive communication.

UNIT - I INTRODUCTION TO SOFTWARE DEFINED RADIO AND COGNITIVE RADIO 9

Evolution of Software Defined Radio and Cognitive radio: goals, benefits, definitions, architectures, relations with other radios, issues, enabling technologies, radio frequency spectrum and regulations.

UNIT - II COGNITIVE RADIO ARCHITECTURE 9

Cognitive Radio – functions, components and design rules, Cognition cycle – orient, plan, decide and act phases, Inference Hierarchy, Architecture maps, Building the Cognitive Radio Architecture on Software defined Radio Architecture, Overview of IEEE 802.22 standard for broadband wireless access in TV bands.

UNIT - III SPECTRUM SENSING AND DYNAMIC SPECTRUM ACCESS 9

Introduction – Primary user detection techniques – energy detection, feature detection, matched filtering, cooperative detection , Bayesian Approach, Neyman Pearson fusion rule for spectrum sensing, Optimum spectrum sensing - Kullback Leibler Divergence and other approaches, Fundamental Tradeoffs in spectrum sensing, Spectrum Sharing Models of Dynamic Spectrum Access - Unlicensed and Licensed Spectrum Sharing, Fundamental Limits of Cognitive Radio.

UNIT - IV MAC AND NETWORK LAYER DESIGN FOR COGNITIVE RADIO 9

MAC for cognitive radios – Multichannel MAC - slotted ALOHA – CSMA, Network layer design – routing in cognitive radios, flow control and error control techniques.

UNIT - V ADVANCED TOPICS IN COGNITIVE RADIO 9

Cognitive radio for Internet of Things - Features and applications – Enabling technologies and protocols – M2M technologies - Data storage and analysis techniques - Requirement and challenges of IoT – Energy efficiency– MIMO Cognitive Radio – Power allocation algorithms.

TOTAL: 45 PERIODS

OUTCOMES:

At the end of this course, the student should be able to

1. Able to appreciate the motivation and the necessity for cognitive radio communication strategies
2. Demonstrate understanding of the enabling technologies for its implementation
3. Demonstrate understanding of the essential functionalities and requirements in designing software defined radios and their usage for cognitive communication
4. Compare MAC and network layer design for cognitive radio
5. Discuss cognitive radio for Internet of Things and M2M technologies

REFERENCES:

1. Alexander M. Wyglinski,Maziar Nekovee,Thomas Hou,“Cognitive Radio Communications and Networks”, Academic Press, Elsevier, 2010.
2. Bruce Fette, “Cognitive Radio Technology”, Newnes, 2006.
3. Kwang-Cheng Chen, Ramjee Prasad, “Cognitive Radio Networks”, John Wiley and Sons, 2009.
4. Huseyin Arslan (Ed.), “Cognitive Radio, Software Defined Radio, and Adaptive Wireless Systems, Springer, 2007.
5. S.Shanmugavel, M.A.Bhagyaveni, R.Kalidoss, “Cognitive Radio-An Enabler for Internet of things”, River Publishers, 2017.

21EC2903	ADVANCED WIRELESS NETWORKS	L	T	P	C
		3	0	0	3

OBJECTIVES: To impart Knowledge on the following topics:

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

UNIT - I INTRODUCTION 9

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

UNIT - II WIRELESS IP NETWORK ARCHITECTURES 9

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

UNIT - III ADAPTIVE LINK AND NETWORK LAYER 9

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

UNIT - IV MOBILITY MANAGEMENT 9

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

UNIT - V QUALITY OF SERVICE 9

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

TOTAL: 45 PERIODS

OUTCOMES:

On successful completion of the course student will be able to:

1. Familiar with the latest 4G networks and LTE
2. Understand about the wireless IP architecture and LTE network architecture.
3. Familiar with the adaptive link layer and network layer graphs and protocol.
4. Understand about the mobility management and cellular network.
5. Understand about the wireless sensor network architecture and its concept.
6. Outline the concepts of 4G and 5G devices.

REFERENCES:

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

WEB REFERENCES:

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

21EC2904	SOFTWARE DEFINED RADIO	L	T	P	C
		3	0	0	3

OBJECTIVES:

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

UNIT - I INTRODUCTION & CASE STUDIES 9

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

UNIT - II RADIO FREQUENCY IMPLEMENTATION 9

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

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

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

UNIT - IV DATA CONVERTERS AND SMART ANTENNAS 9

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

UNIT - V DIGITAL HARDWARE AND SOFTWARE CHOICES 9

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

TOTAL: 45 PERIODS

OUTCOMES:

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

1. Design data converters
2. Evaluate smart antennas
3. Discuss digital hardware and software choices.

REFERENCES:

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

ONLINE COURSES/RESOURCES:

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

21EC2905	COMMUNICATION NETWORK SECURITY	L	T	P	C
		3	0	0	3

OBJECTIVES:

- Understand the need and concept of security
- 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

OUTCOMES:

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

1. Explain digital signature standards
2. Discuss authentication
3. Explain security at different layers

REFERENCES:

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.

21EC2906	ANALOG AND MIXED MODE VLSI DESIGN	L	T	P	C
		3	0	0	3

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

OUTCOMES:

On successful completion of the course student will be able to:

1. Discuss submicron circuit design
2. Compare data converters
3. Design and analyze switched capacitor circuits.

REFERENCES:

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.

21EC2907	VLSI FOR WIRELESS COMMUNICATION	L	T	P	C
		3	0	0	3

OBJECTIVES:

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

UNIT - I COMMUNICATION CONCEPTS 9

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

UNIT - II RECEIVER ARCHITECTURE & LOW NOISE AMPLIFIERS 9

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

UNIT - III MIXERS 9

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

UNIT - IV FREQUENCY SYNTHESIZERS 9

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

UNIT - V TRANSMITTER ARCHITECTURES & POWER AMPLIFIERS 9

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

TOTAL: 45 PERIODS

OUTCOMES:

On successful completion of the course student will be able to:

1. Design LNA and Mixers
2. Evaluate frequency synthesizers
3. Design and analyze power amplifiers

REFERENCES:

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

21EC2908	RADAR SIGNAL PROCESSING	L	T	P	C
		3	0	0	3

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

OUTCOMES:

On successful completion of the course student will be able to:

1. Explain the principles of elements and functions involved in radar signal processing.
2. Describe different types of radar waveforms.
3. Discuss on Doppler processing and its issues.

REFERENCES:

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

21EC2909	PATTERN RECOGNITION AND MACHINE LEARNING	L	T	P	C
		3	0	0	3

OBJECTIVES:

- 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

OUTCOMES:

On successful completion of the course student will be able to:

1. Classify the data and identify the patterns.
2. Utilize the given data set to extract and select features for Pattern recognition.
3. Describe the decision tree and concept learning.
4. Discuss on recent advances in pattern recognition.

REFERENCES:

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.

21EC2910	WIRELESS ADHOC AND SENSOR NETWORKS	L	T	P	C
		3	0	0	3

OBJECTIVES:

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

UNIT - I MAC & TCP IN AD HOC NETWORKS 9

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

UNIT - II ROUTING IN AD HOC NETWORKS 9

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

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

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

UNIT - IV SENSOR MANAGEMENT 9

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

UNIT - V SECURITY IN AD HOC AND SENSOR NETWORKS 9

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

TOTAL: 45 PERIODS

OUTCOMES:

On successful completion of the course student will be able to:

1. Identify different issues in wireless ad hoc and sensor networks.
2. To analyze protocols developed for ad hoc and sensor networks.
3. To identify and address the security threats in ad hoc and sensor networks.
4. Establish a Sensor network environment for different type of applications.

REFERENCES:

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

21EC2911	INTERNET OF THINGS	L	T	P	C
		3	0	0	3

OBJECTIVES:

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

UNIT - I INTRODUCTION TO IoT 9

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

UNIT - II IoT ARCHITECTURE 9

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

UNIT - III IoT PROTOCOLS 9

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

UNIT - IV BUILDING IoT WITH RASPBERRY PI & ARDUINO 9

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

UNIT - V CASE STUDIES AND REAL-WORLD APPLICATIONS 9

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

TOTAL: 45 PERIODS

OUTCOMES:

On successful completion of the course student will be able to:

1. Analyze various protocols for IoT
2. Develop web services to access/control IoT devices.
3. Design a portable IoT using Rasperry Pi
4. Deploy an IoT application and connect to the cloud.
5. Analyze applications of IoT in real time scenario

REFERENCES:

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

21EC2912	NETWORK ROUTING ALGORITHMS	L	T	P	C
		3	0	0	3

OBJECTIVES:

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

UNIT - I INTRODUCTION 9

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

UNIT - II INTERNET ROUTING 9

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

UNIT - III ROUTING IN OPTICAL WDM NETWORKS 9

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

UNIT - IV MOBILE - IP NETWORKS 9

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

UNIT - V MOBILE AD –HOC NETWORKS 9

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

TOTAL: 45 PERIODS

OUTCOMES:

On successful completion of the course student will be able to:

1. Given the network and user requirements and the type of channel over which the network has to operate, the student would be in a position to apply his knowledge for identifying a suitable routing algorithm, implementing it and analyzing its performance
2. The student would also be able to design a new algorithm or modify an existing algorithm to satisfy the evolving demands in the network and by the user applications.

REFERENCES:

1. A.T Campbell et al., — Comparison of IP Micromobility Protocols, IEEE Wireless Communications Feb.2002, pp 72-82.
2. C.E Perkins, “Ad Hoc Networking”, Addison – Wesley, 2001.
3. C.Siva Rama Murthy and Mohan Gurusamy, “WDM Optical Networks – Concepts,Design and Algorithms”, Prentice Hall of India Pvt. Ltd, New Delhi –2002.
4. Ian F. Akyildiz, Jiang Xie and Shantidev Mohanty, “A Survey of mobility Management in Next generation All IP- Based Wireless Systems”, IEEE Wireless Communications Aug.2004, pp 16-27.
5. M. Steen Strub, “Routing in Communication network”, Prentice Hall International, Newyork,1995.
6. S. Keshav, “An engineering approach to computer networking”, Addison Wesley 1999.
7. William Stallings, “High speed Networks TCP/IP and ATM Design Principles”, Prentice Hall, New York, 1995.
8. William Stallings, “High speed networks and Internets Performance and Quality of Service”, II Edition, Pearson Education Asia. Reprint India 2002.

21EC2913	WIRELESS COMMUNICATION NETWORKS	L	T	P	C
		3	0	0	3

OBJECTIVES:

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

UNIT - I 5G CHANNEL MODEL 9

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

UNIT - II MULTI- CARRIER WAVEFORMS 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 - III 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 Code NOMA, Cooperative NOMA- Benefits and Challenges

UNIT - IV MASSIVE MIMO 9

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

UNIT - V COOPERATIVE COMMUNICATION 9

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

TOTAL: 45 PERIODS

OUTCOMES:

On successful completion of the course student will be able to:

1. Able to analyze the performance of different channel models adopted in 5G wireless Systems
2. Able to design a transceiver for Multicarrier waveforms.
3. Able to analyze multiple access techniques in 5G networks
4. Able to design a pilot, estimate channels and analyze capacity for single cell and multicellMassive MIMO.
5. Able to analyze different types of cooperative communications.

REFERENCES:

1. Afif Osseiran, Jose.F.Monserrat and Patrick Marsch, “5G Mobile and Wireless Communications Technology”, Cambridge University Press, 2016.
2. Robert W. Heath Jr., Nuria González-Prelcic, SundeepRangan, WonilRoh,and Akbar M. Sayeed, “An Overview of Signal Processing Techniques for Millimeter Wave MIMO Systems”, IEEE Journal of Selected Topics in Signal Processing, Vol. 10, No. 3, April 2016.
3. MinChulJu and Il-Min Kim, “Error Performance Analysis of BPSK Modulation in Physical- Layer Network-Coded Bidirectional Relay Networks”, IEEE Transactions on Communications, Vol. 58, No. 10, October 2010.
4. Shengli Zhang, Soung-Chang Liew, Patrick P.Lam, “Physical Layer Network Coding”, Mobicom _06, Proceeding of the 12th International Conference on Mobile Computing and Networking, pp.358-365, Los Angeles, CA, USA, Sep.23-29,2006.
5. Thomas L. Marzetta, Erik G. Larsson, Hong Yang, HienQuoc Ngo, “Fundamentals of Massive MIMO”, Cambridge University Press, 1st Edition, 2016.

21EC2914	MULTIMEDIA COMMUNICATIONS	L	T	P	C
		3	0	0	3

OBJECTIVES:

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

UNIT - I MULTIMEDIA COMPONENTS 9

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

UNIT - II AUDIO AND VIDEO COMPRESSION 9

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

UNIT - III TEXT AND IMAGE COMPRESSION 9

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

UNIT - IV VoIP TECHNOLOGY 9

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

UNIT - V MULTIMEDIA NETWORKING 9

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

TOTAL: 45 PERIODS

OUTCOMES:

On successful completion of the course student will be able to:

1. Able to demonstrate an understanding of the different multimedia components and their characteristics.
2. Familiar with the challenges involved in multimedia signal processing and the techniques used.
3. Able to demonstrate an understanding of the multimedia transmission technologies.
4. Able to demonstrate an understanding of the multimedia networking aspects.
5. In a position to apply his knowledge for identifying a suitable strategy for compression and communication based on the signal characterization and its needs.

REFERENCES:

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.

21EC2915	DIGITAL AUDIO AND VIDEO BROADCASTING TECHNOLOGY	L	T	P	C
		3	0	0	3

OBJECTIVES:

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

UNIT - I INTRODUCTION 9

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

UNIT - II VIDEO CODING 9

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

UNIT - III AUDIO AND VIDEO COMPRESSION 9

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

UNIT - IV DIGITAL AUDIO BROADCASTING 9

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

UNIT - V DIGITAL TV SIGNAL TRANSMISSION 9

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

TOTAL: 45 PERIODS

OUTCOMES:

On successful completion of the course student will be able to:

1. To be able to design and implement digital compression techniques.
2. To be able to design video coding and audio compression
3. To be able to design digital audio schemes
4. To be able to design digital TV systems
5. To identify issues and provide solutions for digital TV transmission.

REFERENCES:

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

21EC2916	IMAGE ANALYSIS AND COMPUTER VISION	L	T	P	C
		3	0	0	3

OBJECTIVES:

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

UNIT - I IMAGE ENHANCEMENT 9

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

UNIT - II IMAGE TRANSFORMS 9

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

UNIT - III IMAGE RESTORATION AND SEGMENTAT ION 9

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

UNIT - IV IMAGE COMPRESSION 9

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

UNIT - V VIDEO PROCESSING 9

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

TOTAL: 45 PERIODS

OUTCOMES:

On successful completion of the course student will be able to:

1. To be able to implement image enhancement algorithms
2. To be able to apply image transform for different imaging modalities
3. To be able to perform different segmentation and restoration processes
4. To be able to implement different compression techniques
5. To be able to develop algorithms for computer vision problems.

REFERENCES:

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

21EC2917	COOPERATIVE COMMUNICATIONS	L	T	P	C
		3	0	0	3

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 multihop cellular networks; Resource allocation for green communication in relay-based cellular networks; Green Radio Test-Beds and Standardization Activities.

TOTAL: 45 PERIODS

OUTCOMES:

On successful completion of the course student will be able to:

1. Able to appreciate the necessity and the design aspects of cooperative and green wireless communication.
2. Familiar with different techniques used in cooperative cellular networks.
3. Familiar with different techniques used in green radio networks.
4. Able to evolve new techniques and demonstrate their feasibility using mathematical validations and simulation tools.
5. Able to demonstrate the impact of the green engineering solutions in a global, economic, environmental and societal context.

REFERENCES:

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.

21EC2918	MACHINE LEARNING IN COMMUNICATION NETWORKS	L	T	P	C
		3	0	0	3

OBJECTIVES:

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

UNIT - I MATHEMATICAL BACKROUND 9

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

UNIT - II MACHINE LEARNING BASICS 9

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

UNIT - III NEURAL NETWORKS 9

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

UNIT - IV ML IN WIRELESS AND SECURITY 9

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

UNIT - V ML IN BIO- MEDICAL 9

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

TOTAL: 45 PERIODS

OUTCOMES:

On successful completion of the course student will be able to:

1. Demonstrate understanding of the mathematical principles underlying machine learning.
2. Familiar with the different machine learning techniques and their use cases.
3. In a position to formulate machine learning problems corresponding to different applications.
4. Able to recognize the characteristics of machine learning techniques that are useful to solve real-world problems.
5. In a position to read current research papers, understand the issues and the machine learning based solution approaches.

REFERENCES:

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

21EC2919	SIGNAL INTEGRITY FOR HIGH SPEED DESIGN	L	T	P	C
		3	0	0	3

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, canceling parasitic capacitance, Clock jitter.

TOTAL: 45 PERIODS

OUTCOMES:

On successful completion of the course student will be able to:

1. Familiar with transmission line characterization due to high speed signal propagation.
2. Able to understand the impairments, crosstalk and non-ideal effects associated with high speed design
3. Able to identify sources affecting the speed of digital circuits and their analysis.
4. Able to appreciate power and clock related challenges in high speed system design.
5. Able to identify methods to improve the signal transmission characteristics

REFERENCES:

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

TOOLS REQUIRED:

1. SPICE, source - http://www-cad.eecs.berkeley.edu/Software/software.html
2. HSPICE from synopsis, www.synopsys.com/products/ mixedsignal/hspice/hspice.html

21EC2920	COMMUNICATION NETWORK DESIGN	L	T	P	C
		3	0	0	3

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 Modeling 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

OUTCOMES:

On successful completion of the course student will be able to:

1. Familiar with the functional elements and evolution of communication networking
2. Familiar with the multiplexing, switching and routing related issues, solutions and performance metrics
3. Able to understand the wired and wireless network design process.
4. Analyse the various aspects of a protocol and implement it using a network simulation tool.
5. Able to 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.

REFERENCES:

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.

21EC2921	ELECTRO MAGNETIC INTERFERENCE AND COMPATIBILITY	L	T	P	C
		3	0	0	3

OBJECTIVES:

- The basics of EMI, EMI sources, EMI problems
- Solution methods in PCB.
- Measurements techniques for emission.
- Measurement techniques for immunity.

UNIT - I BASIC THEORY 9

Introduction to EMI and EMC, Intra and inter system EMI, Elements of Interference, Sources and Victims of EMI, Conducted and Radiated EMI emission and susceptibility, Case Histories, Radiation hazards to humans, Various issues of EMC, EMC Testing categories EMC Engineering Application.

UNIT - II COUPLING MECHANISM 9

Electromagnetic field sources and Coupling paths, Coupling via the supply network, Common mode coupling, Differential mode coupling, Impedance coupling, Inductive and Capacitive coupling, Radioactive coupling, Ground loop coupling, Cable related emissions and coupling, Transient sources, Automotive transients.

UNIT - III EMI MITIGATION TECHNIQUES 9

Working principle of Shielding and Murphy‟s Law, LF Magnetic shielding, Apertures and shielding effectiveness, Choice of Materials for H, E, and free space fields, Gasketting and sealing, PCB Level shielding, Principle of Grounding, Isolated grounds, Grounding strategies for Large systems, Grounding for mixed signal systems, Filter types and operation, Surge protection devices, Transient Protection.

UNIT - IV STANDARD AND REGULATION 9

Need for Standards, Generic/General Standards for Residential and Industrial environment, Basic Standards, Product Standards, National and International EMI Standardizing Organizations; IEC, ANSI, FCC, AS/NZS, CISPR, BSI, CENELEC, ACEC. Electro Magnetic Emission and susceptibility standards and specifications, MIL461E Standards.

UNIT - V EMI TEST METHODS AND INSTRUMENTATION 9

Fundamental considerations, EMI Shielding effectiveness tests, Open field test, TEM cell for immunity test, Shielded chamber , Shielded anechoic chamber, EMI test receivers, Spectrum analyzer, EMI test wave simulators, EMI coupling networks, Line impedance stabilization networks, Feed through capacitors, Antennas, Current probes, MIL -STD test methods, Civilian STD test methods.

TOTAL: 45 PERIODS

OUTCOMES:

On successful completion of the course student will be able to:

1. Identify Standards
2. Compare EMI test methods
3. Discuss EMI mitigation techniques.

REFERENCES:

1. Bemhard Keiser, “Principles of Electromagnetic Compatibility”, 3rd Ed, Artech house, Norwood, 1986.
2. Clayton Paul, “Introduction to Electromagnetic Compatibility”, Wiley Interscience, 2006.
3. Daryl Gerke and William Kimmel, “EDN‟s Designer‟s Guide to Electromagnetic Compatibility”, Elsevier Science & Technology Books, 2002
4. Dr Kenneth L Kaiser, “The Electromagnetic Compatibility Handbook”, CRC Press 2005.
5. Electromagnetic Compatibility by Norman Violette ,Published by Springer, 2013
6. Electromagnetic Interference and Compatibility: Electrical noise and EMI specifications Volume 1 of A Handbook Series on Electromagnetic Interference and Compatibility, Donald R. J. White Publisher-Don white consultants Original from the University of Michigan Digitized 6 Dec 2007.
7. Henry W. Ott, “Electromagnetic Compatibility Engineering”, John Wiley & Sons Inc, Newyork, 2009
8. V Prasad Kodali, “Engineering Electromagnetic Compatibility”, IEEE Press, Newyork, 2001.
9. Scott Bennett, “Control and Measurement of Unintentional Electromagnetic Radiation”, John Wiley & Sons Inc., (Wiley Interscience Series) 1997

21EC2922	SPREAD SPECTRUM TECHNIQUES AND APPLICATIONS	L	T	P	C
		3	0	0	3

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

OUTCOMES:

On successful completion of the course student will be able to:

1. To be able to arrive at detailed specifications of the spread spectrum systems.
2. To be able to realize the generation of PN sequence.
3. To be able to analyze synchronization issues in spread spectrum.
4. To design systems based on spread spectrum to mitigate the jamming.
5. To be able to design GPS system.

REFERENCES:

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.

21OE2001	BUSINESS DATA ANALYTICS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- To understand the basics of business analytics and its life cycle.
- To gain knowledge about fundamental business analytics.
- To learn modeling for uncertainty and statistical inference.
- To understand analytics using Hadoop and Map Reduce frameworks.
- To acquire insight on other analytical frameworks.

UNIT - I OVERVIEW OF BUSINESS ANALYTICS 9

Introduction – Drivers for Business Analytics – Applications of Business Analytics: Marketing and Sales, Human Resource, Healthcare, Product Design, Service Design, Customer Service and Support – Skills Required for a Business Analyst – Framework for Business Analytics LifeCycle for Business Analytics Process.

SUGGESTED ACTIVITIES:

- Case studies on applications involving business analytics.
- Converting real time decision making problems into hypothesis.
- Group discussion on entrepreneurial opportunities in Business Analytics.

SUGGESTED EVALUATION METHODS:

- Assignment on business scenario and business analytical life cycle process.
- Group presentation on big data applications with societal need.
- Quiz on case studies.

UNIT - II ESSENTIALS OF BUSINESS ANALYTICS 9

Descriptive Statistics – Using Data – Types of Data – Data Distribution Metrics: Frequency, Mean, Median, Mode, Range, Variance, Standard Deviation, Percentile, Quartile, z-Score, Covariance, Correlation – Data Visualization: Tables, Charts, Line Charts, Bar and Column Chart, Bubble Chart, Heat Map – Data Dashboards.

SUGGESTED ACTIVITIES:

- Solve numerical problems on basic statistics.
- Explore chart wizard in MS Excel Case using sample real time data for data visualization.
- Use R tool for data visualization.

SUGGESTED EVALUATION METHODS:

- Assignment on descriptive analytics using benchmark data.
- Quiz on data visualization for univariate, bivariate data.

UNIT - III MODELING UNCERTAINTY AND STATISTICAL INFERENCE 9

Modeling Uncertainty: Events and Probabilities – Conditional Probability – Random Variables–Discrete Probability Distributions – Continuous Probability Distribution – Statistical Inference: Data Sampling – Selecting a Sample – Point Estimation – Sampling Distributions – Interval Estimation – Hypothesis Testing.

SUGGESTED ACTIVITIES:

- Solving numerical problems in sampling, probability, probability distributions and hypothesis testing
- Converting real time decision making problems into hypothesis.

SUGGESTED EVALUATION METHODS:

- Assignments on hypothesis testing.
- Group presentation on real time applications involving data sampling and hypothesis testing.
- Quizzes on topics like sampling and probability

UNIT - IV ANALYTICS USING HADOOP AND MAPREDUCE FRAMEWORK 9

Introducing Hadoop – RDBMS versus Hadoop – Hadoop Overview – HDFS (Hadoop Distributed File System) – Processing Data with Hadoop – Introduction to MapReduce – Features of MapReduce – Algorithms Using Map-Reduce: Matrix-Vector Multiplication, Relational Algebra Operations, Grouping and Aggregation – Extensions to MapReduce.

SUGGESTED ACTIVITIES:

- Practical – Install and configure Hadoop.
- Practical – Use web based tools to monitor Hadoop setup.
- Practical – Design and develop MapReduce tasks for word count, searching involving text corpus etc.

SUGGESTED EVALUATION METHODS:

- Evaluation of the practical implementations.
- Quizzes on topics like HDFS and extensions to MapReduce.

UNIT - V OTHER DATA ANALYTICAL FRAMEWORKS 9

Overview of Application development Languages for Hadoop – PigLatin – Hive – Hive Query Language (HQL) – Introduction to Pentaho, JAQL – Introduction to Apache: Sqoop, Drill and Spark, Cloudera Impala – Introduction to NoSQL Databases – Hbase and MongoDB.

SUGGESTED ACTIVITIES:

- Practical – Installation of NoSQL database like MongoDB.
- Practical – Demonstration on Sharding in MongoDB.
- Practical – Install and run Pig
- Practical – Write PigLatin scripts to sort, group, join, project, and filter data.
- Design and develop algorithms to be executed in MapReduce involving numerical methods for analytics.

SUGGESTED EVALUATION METHODS:

- Mini Project (Group) – Real time data collection, saving in NoSQL, implement analytical techniques using Map-Reduce Tasks and Result Projection.

TOTAL: 45 PERIODS

OUTCOMES:

On completion of the course, the student will be able to

1. Identify the real world business problems and model with analytical solutions
2. Solve analytical problem with relevant mathematics background knowledge.
3. Convert any real world decision making problem to hypothesis and apply suitablestatistical testing.
4. Write and Demonstrate simple applications involving analytics using Hadoop and MapReduce
5. Use open source frameworks for modeling and storing data.
6. Apply suitable visualization technique using R for visualizing voluminous data

REFERENCES:

1. Vignesh Prajapati, “Big Data Analytics with R and Hadoop”, Packt Publishing, 2013.
2. Umesh R Hodeghatta, Umesha Nayak, “Business Analytics Using R – A Practical Approach”, Apress, 2017.
3. Anand Rajaraman, Jeffrey David Ullman, “Mining of Massive Datasets”, Cambridge University Press, 2012.
4. Jeffrey D. Camm, James J. Cochran, Michael J. Fry, Jeffrey W. Ohlmann, David R. Anderson, “Essentials of Business Analytics”, Cengage Learning, second Edition, 2016.
5. U. Dinesh Kumar, “Business Analytics: The Science of Data-Driven Decision Making”, Wiley, 2017.
6. A. Ohri, “R for Business Analytics”, Springer, 2012
7. Rui Miguel Forte, “Mastering Predictive Analytics with R”, Packt Publication, 2015.

21OE2002	INDUSTRIAL SAFETY	L	T	P	C
		3	0	0	3

OBJECTIVES:

- Summarize basics of industrial safety
- Describe fundamentals of maintenance engineering
- Explain wear and corrosion
- Illustrate fault tracing
- Identify preventive and periodic maintenance

UNIT - I INTRODUCTION 9

Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act 1948 for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc, Safety color codes. Fire prevention and firefighting, equipment and methods.

UNIT - II FUNDAMENTALS OF MAINTENANCE ENGINEERING 9

Definition and aim of maintenance engineering, Primary and secondary functions and responsibility of maintenance department, Types of maintenance, Types and applications of tools used for maintenance, Maintenance cost & its relation with replacement economy, Service life of equipment.

UNIT - III WEAR AND CORROSION AND THEIR PREVENTION 9

Wear- types, causes, effects, wear reduction methods, lubricants-types and applications,Lubrication methods, general sketch, working and applications, i. Screw down grease cup, ii. Pressure grease gun, iii. Splash lubrication, iv. Gravity lubrication, v. Wick feed lubrication. vi. Side feed lubrication, vii. Ring lubrication, Definition, principle and factors affecting the corrosion. Types of corrosion, corrosion prevention methods.

UNIT - IV FAULT TRACING 9

Fault tracing-concept and importance, decision tree concept, need and applications, sequence of fault finding activities, show as decision tree, draw decision tree for problems in machine tools, hydraulic, pneumatic, automotive, thermal and electrical equipment's like, I. Any one machine tool, ii. Pump iii. Air compressor, iv. Internal combustion engine, v. Boiler, vi. Electrical motors, Types of faults in machine tools and their general causes.

UNIT - V PERIODIC AND PREVENTIVE MAINTENANCE 9

Periodic inspection-concept and need, degreasing, cleaning and repairing schemes, overhauling of mechanical components, overhauling of electrical motor, common troubles and remedies of electric motor, repair complexities and its use, definition, need, steps and advantages of preventive maintenance. Steps/procedure for periodic and preventive maintenance of: I. Machine tools, ii. Pumps, iii. Air compressors, iv. Diesel generating (DG) sets, Program and schedule of preventive maintenance of mechanical and electrical equipment, advantages of preventive maintenance. Repair cycle concept and importance.

TOTAL: 45 PERIODS

OUTCOMES:

Students will be able to:

1. Ability to summarize basics of industrial safety
2. Ability to describe fundamentals of maintenance engineering
3. Ability to explain wear and corrosion
4. Ability to illustrate fault tracing
5. Ability to identify preventive and periodic maintenance.

REFERENCES:

1. Audels, Pump-hydraulic Compressors, Mcgrew Hill Publication, 1978.
2. Garg H P,Maintenance Engineering, S. Chand and Company,1987.
3. Hans F. Winterkorn, Foundation Engineering Handbook, Chapman & Hall London, 2013.

21OE2003	OPERATIONS RESEARCH	L	T	P	C
		3	0	0	3

OBJECTIVES:

- Solve linear programming problem and solve using graphical method.
- Solve LPP using simplex method
- Solve transportation, assignment problems
- Solve project management problems
- Solve scheduling problems

UNIT - I LINEAR PROGRAMMING 9

Introduction to Operations Research – assumptions of linear programming problems -Formulations of linear programming problem – Graphical method

UNIT - II ADVANCES IN LINEAR PROGRAMMING 9

Solutions to LPP using simplex algorithm- Revised simplex method - primal dual relationships – Dual simplex algorithm - Sensitivity analysis

UNIT - III NETWORK ANALYSIS – I 9

Transportation problems -Northwest corner rule, least cost method, Voges's approximationmethod - Assignment problem -Hungarian algorithm

UNIT - IV NETWORK ANALYSIS – II 9

Shortest path problem: Dijkstra's algorithms, Floyds algorithm, systematic method -CPM/PERT

UNIT - V NETWORK ANALYSIS – III 9

Scheduling and sequencing - single server and multiple server models - deterministicinventory models - Probabilistic inventory control models

TOTAL: 45 PERIODS

OUTCOMES:

Students will be able to:

1. To formulate linear programming problem and solve using graphical method.
2. To solve LPP using simplex method
3. To formulate and solve transportation, assignment problems
4. To solve project management problems
5. To solve scheduling problems.

REFERENCES:

1. Harvey M Wagner, Principles of Operations Research: Prentice Hall of India 2010
2. Hitler Libermann, Operations Research: McGraw Hill Pub. 2009
3. Pant J C, Introduction to Optimisation: Operations Research, Jain Brothers, Delhi, 2008
4. Pannerselvam, Operations Research: Prentice Hall of India 2010
5. Taha H A, Operations Research, An Introduction, PHI, 2008

21OE2004	COST MANAGEMENT OF ENGINEERING PROJECTS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- Summarize the costing concepts and their role in decision making
- Infer the project management concepts and their various aspects in selection
- Interpret costing concepts with project execution
- Develop knowledge of costing techniques in service sector and various budgetary controltechniques
- Illustrate with quantitative techniques in cost management

UNIT - I INTRODUCTION TO COSTING CONCEPTS 9

Objectives of a Costing System; Cost concepts in decision-making; Relevant cost, Differential cost, Incremental cost and Opportunity cost; Creation of a Database for operational control.

UNIT - II INTRODUCTION TO PROJECT MANAGEMENT 9

Project: meaning, Different types, why to manage, cost overruns centres, various stages of project execution: conception to commissioning. Project execution as conglomeration of technical and nontechnical activities, Detailed Engineering activities, Pre project execution main clearances and documents, Project team: Role of each member, Importance Project site: Data required with significance, Project contracts.

UNIT - III PROJECT EXECUTION AND COSTING CONCEPTS 9

Project execution Project cost control, Bar charts and Network diagram, Project commissioning: mechanical and process, Cost Behavior and Profit Planning Marginal Costing; Distinction between Marginal Costing and Absorption Costing; Break-even Analysis, Cost- Volume-Profit Analysis, Various decision-making problems, Pricing strategies: Pareto Analysis, Target costing, Life Cycle Costing.

UNIT - IV COSTING OF SERVICE SECTOR AND BUDGETERY CONTROL 9

Just-in-time approach, Material Requirement Planning, Enterprise Resource Planning, Activity- Based Cost Management, Bench Marking; Balanced Score Card and Value-Chain Analysis, Budgetary Control: Flexible Budgets; Performance budgets; Zero-based budgets.

UNIT - V QUANTITATIVE TECHNIQUES FOR COST MANAGEMENT 9

Linear Programming, PERT/CPM, Transportation problems, Assignment problems, LearningCurve Theory.

TOTAL: 45 PERIODS

OUTCOMES:

Students will be able to:

1. Understand the costing concepts and their role in decision making
2. Understand the project management concepts and their various aspects in selection
3. Interpret costing concepts with project execution
4. Gain knowledge of costing techniques in service sector and various budgetary controltechniques
5. Become familiar with quantitative techniques in cost management.

REFERENCES:

1. Ashish K. Bhattacharya, Principles & Practices of Cost Accounting A. H. Wheelerpublisher, 1991
2. Charles T. Horngren and George Foster, Advanced Management Accounting, 1988
3. Charles T. Horngren et al Cost Accounting A Managerial Emphasis, Prentice Hall ofIndia, New Delhi, 2011
4. Robert S Kaplan Anthony A. Alkinson, Management & Cost Accounting, 2003
5. Vohra N.D., Quantitative Techniques in Management,McGraw Hill Book Co. Ltd,2007.

21OE2005	COMPOSITE MATERIALS	L	T	P	C
		3	0	0	3

OBJECTIVES:

- Summarize the characteristics of composite materials and effect of reinforcement incomposite materials.
- Identify the various reinforcements used in composite materials.
- Compare the manufacturing process of metal matrix composites.
- Understand the manufacturing processes of polymer matrix composites.
- Analyze the strength of composite materials.

UNIT - I INTRODUCTION 9

Definition – Classification and characteristics of Composite materials - Advantages and application of composites - Functional requirements of reinforcement and matrix - Effect of reinforcement (size, shape, distribution, volume fraction) on overall composite performance.

UNIT - II REINFORCEMENTS 9

Preparation-layup, curing, properties and applications of glass fibers, carbon fibers, Kevlar fibers and Boron fibers - Properties and applications of whiskers, particle reinforcements - Mechanical Behavior of composites: Rule of mixtures, Inverse rule of mixtures - Isostrain andIsostress conditions.

UNIT - III MANUFACTURING OF METAL MATRIX COMPOSITES 9

Casting – Solid State diffusion technique - Cladding – Hot isostatic pressing - Properties and applications. Manufacturing of Ceramic Matrix Composites: Liquid Metal Infiltration –Liquid phase sintering. Manufacturing of Carbon – Carbon composites: Knitting, Braiding, Weaving-Properties and applications.

UNIT - IV MANUFACTURING OF POLYMER MATRIX COMPOSITES 9

Preparation of Moulding compounds and prepregs – hand layup method – Autoclave method– Filament winding method – Compression moulding – Reaction injection moulding -Properties and applications.

UNIT - V STRENGTH 9

Laminar Failure Criteria-strength ratio, maximum stress criteria, maximum strain criteria, interacting failure criteria, hygrothermal failure. Laminate first play failure-insight strength; Laminate strength-ply discount truncated maximum strain criterion; strength design using caplet plots; stress concentrations.

TOTAL: 45 PERIODS

OUTCOMES:

Students will be able to:

1. Know the characteristics of composite materials and effect of reinforcement incomposite materials.
2. Know the various reinforcements used in composite materials.
3. Understand the manufacturing processes of metal matrix composites.
4. Understand the manufacturing processes of polymer matrix composites.
5. Analyze the strength of composite materials.

REFERENCES:

1. Cahn R.W. - Material Science and Technology – Vol 13 – Composites, VCH, WestGermany.
2. Callister, W.D Jr., Adapted by Balasubramaniam R, Materials Science and Engineering, An introduction, John Wiley & Sons, NY, Indian edition, 2007
3. Chawla K.K., Composite Materials, 2013.
4. Lubin.G, Hand Book of Composite Materials, 2013.

21OE2006	WASTE TO ENERGY	L	T	P	C
		3	0	0	3

OBJECTIVES:

- Interpret the various types of wastes from which energy can be generated
- Develop knowledge on biomass pyrolysis process and its applications
- Develop knowledge on various types of biomass gasifiers and their operations
- Invent knowledge on biomass combustors and its applications on generating energy
- Summarize the principles of bio-energy systems and their features

UNIT - I INTRODUCTION TO EXTRACTION OF ENERGY FROM WASTE 9

Classification of waste as fuel – Agro based, Forest residue, Industrial waste - MSW – Conversion devices – Incinerators, gasifiers, digestors

UNIT - II BIOMASS PYROLYSIS 9

Pyrolysis – Types, slow fast – Manufacture of charcoal – Methods - Yields and application – Manufacture of pyrolytic oils and gases, yields and applications.

UNIT - III BIOMASS GASIFICATION 9

Gasifiers – Fixed bed system – Downdraft and updraft gasifiers – Fluidized bed gasifiers – Design, construction and operation – Gasifier burner arrangement for thermal heating – Gasifier engine arrangement and electrical power – Equilibrium and kinetic consideration in gasifier operation.

UNIT - IV BIOMASS COMBUSTION 9

Biomass stoves – Improved chullahs, types, some exotic designs, Fixed bed combustors, Types, inclined grate combustors, Fluidized bed combustors, Design, construction and operation - Operation of all the above biomass combustors.

UNIT - V BIO ENERGY 9

Properties of biogas (Calorific value and composition), Biogas plant technology and status - Bio energy system - Design and constructional features - Biomass resources and their classification - Biomass conversion processes - Thermo chemical conversion - Direct combustion - biomass gasification - pyrolysis and liquefaction - biochemical conversion - anaerobic digestion - Types of biogas Plants – Applications - Alcohol production from biomass-Bio diesel production -Urban waste to energy conversion - Biomass energy programme in India.

TOTAL: 45 PERIODS

OUTCOMES:

Students will be able to:

1. Understand the various types of wastes from which energy can be generated.
2. Gain knowledge on biomass pyrolysis process and its applications
3. Develop knowledge on various types of biomass gasifiers and their operations.
4. Gain knowledge on biomass combustors and its applications on generating energy.
5. Understand the principles of bio-energy systems and their features

REFERENCES:

1. Biogas Technology - A Practical Hand Book - Khandelwal, K. C. and Mahdi, S. S., Vol. I& II, Tata McGraw Hill Publishing Co. Ltd., 1983.
2. Biomass Conversion and Technology, C. Y. WereKo-Brobby and E. B. Hagan, John Wiley & Sons, 1996
3. Food, Feed and Fuel from Biomass, Challal, D. S., IBH Publishing Co. Pvt. Ltd., 1991.
4. Non Conventional Energy, Desai, Ashok V., Wiley Eastern Ltd., 1990.

21OE2007	SECURITY PRACTICES	L	T	P	C
		3	0	0	3

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

OUTCOMES:

Students will be able to:

1. Understand the core fundamentals of system security
2. Apply the security concepts to wired and wireless networks
3. Implement and Manage the security essentials in IT Sector
4. Explain the concepts of Cyber Security and Cyber forensics
5. Be aware of Privacy and Storage security Issues.

REFERENCES:

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.

21OE2008	NETWORK TECHNOLOGIES	L	T	P	C
		3	0	0	3

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

OUTCOMES:

Students will be able to

1. Explain basic networking concepts
2. Compare different wireless networking protocols
3. Describe the developments in each generation of mobile data networks
4. Explain and develop SDN based applications
5. Explain the concepts of network function virtualization

REFERENCES:

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

21AC2101 ENGLISH FOR RESEARCH PAPER WRITING	L	T	P	C
	2	0	0	0

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

OUTCOMES:

1. Understand that how to improve your writing skills and level of readability
2. Learn about what to write in each section
3. Understand the skills needed when writing a Title
4. Understand the skills needed when writing the Conclusion.
5. Ensure the good quality of paper at very first-time submission.

REFERENCES:

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

21AC2102	DISASTER MANAGEMENT	L	T	P	C
		2	0	0	0

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

OUTCOMES:

1. Ability to summarize basics of disaster
2. Ability to explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.
3. Ability to illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
4. Ability to describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
5. Ability to develop the strengths and weaknesses of disaster management approaches

REFERENCES:

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

21AC2103	SANSKRIT FOR TECHNICAL KNOWLEDGE	L	T	P	C
		2	0	0	0

OBJECTIVES:

- Illustrate the basic sanskrit language.
- Recognize sanskrit, the scientific language in the world.
- Appraise learning of sanskrit to improve brain functioning.
- Relate sanskrit to develop the logic in mathematics, science & other subjects enhancing the memory power.
- Extract huge knowledge from ancient literature.

UNIT - I ALPHABETS 6

Alphabets in Sanskrit

UNIT - II TENSES AND SENTENCES 6

Past/Present/Future Tense - Simple Sentences

UNIT - III ORDER AND ROOTS 6

Order - Introduction of roots

UNIT - IV SANSKRIT LITERATURE 6

Technical information about Sanskrit Literature

UNIT - V TECHNICAL CONCEPTS OF ENGINEERING 6

Technical concepts of Engineering-Electrical, Mechanical, Architecture, Mathematics

TOTAL: 30 PERIODS

OUTCOMES:

1. Understanding basic Sanskrit language.
2. Write sentences.
3. Know the order and roots of Sanskrit.
4. Know about technical information about Sanskrit literature.
5. Understand the technical concepts of Engineering.

REFERENCES:

1. “Abhyaspustakam” – Dr. Vishwas, Samskrita-Bharti Publication, New Delhi
2. “Teach Yourself Sanskrit” Prathama Deeksha-Vempati Kutumbshastri, Rashtriya Sanskrit Sansthanam, New Delhi Publication
3. “India’s Glorious Scientific Tradition” Suresh Soni, Ocean books (P) Ltd., New Delhi, 2017.

21AC2104	VALUE EDUCATION	L	T	P	C
		2	0	0	0

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

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

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

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

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

OUTCOMES:

Students will be able to

1. Knowledge of self-development.
2. Learn the importance of Human values.
3. Developing the overall personality.

SUGGESTED READING

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

21AC2201	CONSTITUTION OF INDIA	L	T	P	C
		2	0	0	0

OBJECTIVES:

- Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.
- To address the growth of Indian opinion regarding modern Indian intellectuals' constitutional
- Role and entitlement to civil and economic rights as well as the emergence nation hood in the early years of Indian nationalism.
- To address the role of socialism in India after the commencement of the Bolshevik Revolutionin1917and its impact on the initial drafting of the Indian Constitution.

UNIT - I HISTORY OF MAKING OF THE INDIAN CONSTITUTION 5

History, Drafting Committee, (Composition & Working)

UNIT - II PHILOSOPHY OF THE INDIAN CONSTITUTION 5

Preamble, Salient Features

UNIT - III CONTOURS OF CONSTITUTIONAL RIGHTS AND DUTIES 5

Fundamental Rights, Right to Equality, Right to Freedom, Right against Exploitation, Right to Freedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies, Directive Principles of State Policy, Fundamental Duties.

UNIT - IV ORGANS OF GOVERNANCE 5

Parliament, Composition, Qualifications and Disqualifications, Powers and Functions, Executive, President, Governor, Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualifications, Powers and Functions.

UNIT - V LOCAL ADMINISTRATION 5

District's Administration head: Role and Importance Municipalities: Introduction, Mayor and role of Elected Representative, CEO, Municipal Corporation. Pachayati raj: Introduction,PRI: Zila Pachayat. Elected officials and their roles, CEO Zila Pachayat: Position and role. Block level: Organizational Hierarchy (Different departments), Village level: Role of Elected and Appointed officials, Importance of grass root democracy.

UNIT - VI ELECTION COMMISSION 5

Election Commission: Role and Functioning. Chief Election Commissioner and Election Commissioners - Institute and Bodies for the welfare of SC/ST/OBC and women.

TOTAL: 30 PERIODS

OUTCOMES:

Students will be able to:

1. Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.
2. Discuss the intellectual origins of the framework of argument that informed the conceptualization of social reforms leading to revolution in India.
3. Discuss the circumstances surrounding the foundation of the Congress Socialist Party [CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution.
4. Discuss the passage of the Hindu Code Bill of 1956.

SUGGESTED READING:

1. The Constitution of India, 1950(Bare Act),Government Publication.
2. Dr.S.N.Busi, Dr.B. R.Ambedkar framing of Indian Constitution, 1st Edition, 2015.
3. M.P. Jain, Indian Constitution Law, 7th Edn., Lexis Nexis,2014.
4. D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.

21AC2202	PEDAGOGY STUDIES	L	T	P	C
		2	0	0	0

OBJECTIVES:

- Review existing evidence on there view topic to inform programme design and policy
- Making under taken by the DfID, other agencies and researchers.
- Identify critical evidence gaps to guide the development.

UNIT - I INTRODUCTION AND METHODOLOGY 6

Aims and rationale, Policy background, Conceptual framework and terminology - Theories of learning, Curriculum, Teacher education - Conceptual framework, Research questions - Overview of methodology and Searching

UNIT - II THEMATIC OVERVIEW

Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries - Curriculum, Teacher education.

UNIT – III EVIDENCE ON THE EFFECTIVENESS OF PEDAGOGICAL PRACTICES 6

Methodology for the in depth stage: quality assessment of included studies - How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy? - Theory of change - Strength and nature of the body of evidence for effective pedagogical practices - Pedagogic theory and pedagogical approaches-Teachers' attitudes and beliefs and Pedagogic strategies.

UNIT - IV PROFESSIONAL DEVELOPMENT 6

Professional development: alignment with classroom practices and follow up support - Peer support - Support from the head teacher and the community - Curriculum and assessment - Barriers to learning: limited resources and large class sizes.

UNIT - V RESEARCH GAPS AND FUTURE DIRECTIONS 6

Research design – Contexts – Pedagogy - Teacher education - Curriculum and assessment - Dissemination and research impact.

TOTAL: 30 PERIODS

OUTCOMES:

Students will be able to:

1. What pedagogical practices are being used by teachers informal and informal classrooms in developing countries?
2. What is the evidence on the effectiveness of these pedagogical practices, in what conditions, and with what population of learners?
3. How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy?

SUGGESTED READING:

1. Ackers J, HardmanF (2001) Classroom interaction in Kenyan primary schools, Compare, 31(2): 245-261.
2. Agrawal M (2004) Curricular reform in schools: The importance of evaluation, Journal of Curriculum Studies, 36(3):361-379.
3. Akyeampong K (2003) Teacher training in Ghana-does it count? Multi-site teacher education research project (MUSTER) country report 1.London:DFID.
4. Akyeampong K, Lussier K, Pryor J, Westbrook J (2013) Improving teaching and learning of basic maths and reading in Africa: Does teacher preparation count? International Journal Educational Development, 33(3): 272–282.
5. Alexander RJ(2001) Culture and pedagogy: International comparisons in primary education. Oxford and Boston: Blackwell.
6. Chavan M(2003) Read India: Amass scale, rapid, 'learning to read' campaign.
7. www.pratham.org/images/resource%20working%20paper%202.pdf

21AC2203 STRESS MANAGEMENT BY YOGA

L	T	P	C
2	0	0	0

OBJECTIVES:

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

UNIT - I

Definitions of Eight parts of yoga.(Ashtanga)

UNIT - II

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

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

OUTCOMES:

Students will be able to:

1. Develop healthy mind in a healthy body thus improving social health also
2. Improve efficiency

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

21AC2204	PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTENMENT SKILLS	L	T	P	C
		2	0	0	0

OBJECTIVES:

- To learn to achieve the highest goal happily
- To become a person with stable mind, pleasing personality and determination
- To awaken wisdom in students

UNIT - I

Neetisatakam-holistic development of personality - Verses- 19,20,21,22 (wisdom) - Verses- 29,31,32 (pride & heroism) – Verses- 26,28,63,65 (virtue) - Verses- 52,53,59 (dont's) - Verses- 71,73,75,78 (do's)

UNIT - II

Approach to day to day work and duties - Shrimad Bhagwad Geeta: Chapter 2- Verses 41, 47,48-Chapter 3-Verses 13, 21, 27, 35 Chapter 6-Verses 5,13,17,23, 35 - Chapter 18-Verses 45, 46, 48.

UNIT - III

Statements of basic knowledge - Shrimad Bhagwad Geeta: Chapter2-Verses 56, 62, 68 Chapter 12 -Verses 13, 14, 15, 16,17, 18 - Personality of role model - shrimad bhagwad geeta-Chapter2-Verses 17, Chapter 3-Verses 36,37,42 Chapter 4-Verses 18, 38,39 Chapter18 – Verses 37,38,63.

TOTAL: 30 PERIODS

OUTCOMES:

Students will be able to:

1. Study of Shrimad-Bhagwad-Geeta will help the student in developing his personality and achieve the highest goal in life
2. The person who has studied Geeta will lead the nation and mankind to peace and prosperity
3. Study of Neet is hatakam will help in developing versatile personality of students.

SUGGESTED READING:

1. Gopinath, Rashtriya Sanskrit Sansthanam P, Bhartrihari's Three Satakam, Niti-sringar- vairagya, New Delhi,2010
2. Swami Swarupan and a,Srimad Bhagavad Gita,Advaita Ashram, Publication Department, Kolkata, 2016.