DHANALAKSHMI SRINIVASAN ENGINEERING COLLEGE (AUTONOMOUS)
PERAMBALUR – 621 212.

PROPOSAL FOR M.E COMMUNICATION SYSTEMS

REGULATIONS – 2020

CHOICE BASED CREDIT SYSTEM

SEMESTER I

SL. NO	COURSE CODE	COURSETITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1	P20MA102	Functional Mathematics for Communication Engineers	FC	4	4	0	0	4
2	P20CU102	Antenna and Radiating Systems	PC	3	3	0	0	3
3	P20CU103	Advanced Digital Communication Techniques	PC	3	3	0	0	3
4	P20CU104	Advanced Statistical Signal Processing	PC	4	3	1	0	4
5	P20CU105	Advanced Communication Networks	PC	3	3	0	0	3
6		**Professional Elective I**	PE	3	3	0	0	3
PRACTICALS								
7	P20CU106	Advanced Communication Systems Laboratory	PC	4	0	0	4	2
			TOTAL	**24**	**19**	**1**	**4**	**22**

SEMESTER II

SL. NO	COURSE CODE	COURSETITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1	P20CU201	Advanced Broadband Wireless Communication	PC	3	3	0	0	3
2	P20CU202	Microwave Integrated Circuits and Design	PC	3	3	0	0	3
3	P20CU203	Spectrum Sharing and Interference Management	PC	3	3	0	0	3
4		**Professional Elective II**	PE	3	3	0	0	3
5		**Professional Elective III**	PE	3	3	0	0	3
6		**Professional Elective IV**	PE	3	3	0	0	3
PRACTICALS								
7	P20CU204	Communication System Design Laboratory	PC	4	0	0	4	2
8	P20CU205	Research Methodology and IPR	EEC	2	0	0	2	1
			TOTAL	**24**	**18**	**0**	**6**	**21**

SEMESTER III

SL. NO	COURSE CODE	COURSETITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1	P20CU301	Millimetre Wave Communication	PC	3	3	0	0	3
2		**Professional Elective V**	PE	3	3	0	0	3
3		**Professional Elective VI**	PE	3	3	0	0	3
PRACTICALS								
4	P20CU302	Project Phase I	EEC	12	0	0	12	6
			TOTAL	**21**	**9**	**0**	**12**	**15**

SEMESTER IV

SL. NO	COURSE CODE	COURSETITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
PRACTICALS								
1	P20CU401	Project Phase II	EEC		0	0	24	12
			TOTAL		**0**	**0**	**24**	**12**

SUMMARY

M.E., Communication Systems							
S. No	**Subject Area**	**Credits per Semester**				**Credits Total**	**Percentage %**
		I	**II**	**III**	**IV**		
1	Foundation Courses	4	-	-	-	4	**5.71**
2	Professional Cores	15	11	3	-	29	**41.42**
3	Professional Electives	3	9	6	-	18	**25.71**
4	Employability Enhancement Courses	-	1	6	12	19	**27.14**
Total		**22**	**21**	**15**	**12**	**70**	**100**

PROFESSIONAL ELECTIVE I

SL. NO	COURSE CODE	COURSETITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1	P20EC101	Audio Video Broad Casting Systems	PE	3	3	0	0	3
2	P20EC102	Wireless Security	PE	3	3	0	0	3
3	P20EC103	DSP Processor Architecture and Programming	PE	3	3	0	0	3
4	P20EC104	Advanced Satellite Communication and Navigation Systems	PE	3	3	0	0	3
5	P20EC105	Analog and Mixed Mode VLSI Design	PE	3	3	0	0	3

PROFESSIONAL ELECTIVE II

SL. NO	COURSE CODE	COURSETITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1	P20EC201	Digital Communication Receivers	PE	3	3	0	0	3
2	P20EC202	Communication Network Security	PE	3	3	0	0	3
3	P20EC203	IOT and Applications	PE	3	3	0	0	3
4	P20EC204	Cognitive Radio Networks	PE	3	3	0	0	3
5	P20EC205	Broadband Access Technologies	PE	3	3	0	0	3

PROFESSIONAL ELECTIVE III

SL. NO	COURSE CODE	COURSETITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1	P20EC206	Biomedical Signal Processing	PE	3	3	0	0	3
2	P20EC207	Network Routing Algorithm	PE	3	3	0	0	3
3	P20EC208	VLSI for Wireless Communication	PE	3	3	0	0	3
4	P20EC209	RF IC Design	PE	3	3	0	0	3
5	P20EC210	Artificial Intelligence	PE	3	3	0	0	3

PROFESSIONAL ELECTIVE IV

SL. NO	COURSE CODE	COURSETITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1	P20EC211	Space Time Wireless Communication	PE	3	3	0	0	3
2	P20EC212	Pattern Recognition and Machine Learning	PE	3	3	0	0	3
3	P20EC213	Detection and Estimation Theory	PE	3	3	0	0	3
4	P20EC214	Radar Signal Processing	PE	3	3	0	0	3
5	P20EC215	Network Processors	PE	3	3	0	0	3

PROFESSIONAL ELECTIVE V

SL. NO	COURSE CODE	COURSETITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1	P20EC301	Ultra Wide Band Communication	PE	3	3	0	0	3
2	P20EC302	Speech processing and synthesis	PE	3	3	0	0	3
3	P20EC303	High Performance Networks	PE	3	3	0	0	3
4	P20EC304	Optimization Techniques	PE	3	3	0	0	3
5	P20EC305	Soft Computing Techniques	PE	3	3	0	0	3

PROFESSIONAL ELECTIVE VI

SL. NO	COURSE CODE	COURSETITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
THEORY								
1	P20EC306	Wavelet Transforms and its Applications	PE	3	3	0	0	3
2	P20EC307	Nano Materials and Nanotechnology	PE	3	3	0	0	3
3	P20EC308	Optical Networks	PE	3	3	0	0	3
4	P20EC309	Network Management	PE	3	3	0	0	3
5	P20EC310	Advanced Wireless Networks	PE	3	3	0	0	3

P20CU101	FUNCTIONAL MATHEMATICS FOR COMMUNICATION ENGINEERS	L	T	P	C
		4	0	0	4

Objectives:

- To develop the ability to use the concepts of Linear algebra and Special functions for Solving problems related to Networks.
- To formulate and construct a mathematical model for a linear programming problem in real Life situation.
- To expose the students to solve ordinary differential equations by various techniques.

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 – Two phase method - Transportation and Assignment Models

Unit III: ORDINARY DIFFERENTIAL EQUATIONS (12)

Runge Kutta Methods for system of IVPs, numerical stability, Adams-Bashforth multistep methop, solution of stiff ODEs, shooting method, BVP: Finite difference method, orthogonal collocation Method, orthogonal collocation with finite element method, Galerkin finite element method.

Unit IV: TWO DIMENSIONAL RANDOM VARIABLES (12)

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:

Upon completion of this course the student will have:

1. To achieve an understanding of the basic concepts of algebraic equations and method of Solving them.
2. 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.
3. To familiarize the students with special functions and solve problems associated with
4. Conceptualize the principle of optimality and sub-optimization, formulation and computational procedure of dynamic programming

REFERENCES:

1. Richard Bronson, Gabriel B.Costa, "Linear Algebra", Academic Press, Second Edition, 2007.
2. Richard Johnson, Miller & Freund, "Probability and Statistics for Engineers", 7th Edition, Prentice – Hall of India, Private Ltd., New Delhi (2007).
3. Taha H.A., "Operations Research: An introduction", Pearson Education Asia, New Delhi, Ninth Edition, 2012.
4. Donald Gross and Carl M. Harris, "Fundamentals of Queueing Theory", 2nd edition, John Wiley and Sons, New York (1985).
5. Moon, T.K., Sterling, W.C., Mathematical methods and algorithms for signal processing, Pearson Education, 2000.

P20CU102	ANTENNA AND RADIATING SYSTEMS	L	T	P	C
		3	0	0	3

Objectives:

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

Unit I: ANTENNA FUNDAMENTALS (9)

Wave equations, radiation pattern, HPBW,FNBW, gain and directivity, polarization, equivalent circuit, radiation resistance, Radiation integrals, Radiation from surface and line current distributions – dipole, monopole, loop antenna, Antenna parameters, Image theory; Induction, reciprocity theorem, Balance to unbalance transformer, Introduction to numerical techniques.

Unit II: RADIATION FROM APERTURES (9)

Field equivalence principle, Radiation from Rectangular and Circular apertures, Uniform aperture, distribution on an infinite ground plane; Slot antenna; Horn antenna; Reflector antenna, aperture blockage, design considerations.

Unit III: ARRAYS (9)

Introduction-General structure of phased array, linear array theory, variation of gain as a function of pointing direction, effects of phase quantization, frequency scanned arrays, analog beamforming matrices-Active modules, digital beam forming, MEMS technology in phased arrays-Retrodirective and self phased arrays.

Unit IV: MICRO STRIP ANTENNA (9)

Radiation mechanism from patch; Excitation techniques; Microstrip dipole; Rectangular patch, Circular patch, and Ring antenna – radiation analysis from transmission line model, cavity model; input impedance of rectangular and circular patch antenna; Microstrip array and feed network; Applications of microstrip array antenna.

Unit V: SPECIAL ANTENNAS AND MEASUREMENTS (9)

Mobile phone antenna, base station, hand set antenna, UWB antenna, PIFA, Vivaldi antenna, Antenna for automobiles, Broadband antenna, antenna factor, Gain, impedance and radiation pattern measurements, Test sites and anechoic chamber.

TOTAL : 45 Periods

Outcomes:

Upon completion of this course the student will have:

1. Ability to understand antenna concepts.
2. Ability to design antenna for various applications.
3. Knowledge of modern antenna design.

REFERENCES:

1. Balanis.A, “Antenna Theory Analysis and Design”, John Wiley and Sons, New York, 1982.
2. Hubregt.J.Visser “Antenna Theory and Applications” 1st Edition, John Wiley & Sons Ltd, New York, 2012.
3. S.Drabowitch et.al., ”Modern Antennas”, 2nd Edition Springer science business Media,Inc.2005
4. Xavier Begaud, “Ultra Wide Band Antennas” , 1st Edition, ISTE Ltd and John Wiley & Sons Ltd, New York,2013.
5. Zhijun Zhang” Antenna Design for Mobile Devices” 1st Edition, John Wiley & Sons (Asia) Ltd, New York, 2011.

P20CU103	ADVANCED DIGITAL COMMUNICATION TECHNIQUES	L	T	P	C

3 0 0 3

Objectives:

- To understand the basics of signal-space analysis and digital transmission.
- To understand the coherent and noncoherent receivers and its impact on different channel characteristics.
- To understand the different Equalizers
- To understand the different block coded and convolutional coded digital communication systems.
- To understand the basics of Multicarrier and Multiuser Communications.

Unit I: COHERENT AND NON-COHERENT COMMUNICATION (9)

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: EQUALIZATION TECHNIQUES (9)

Band Limited Channels- ISI – Nyquist Criterion- Controlled ISI-Partial Response signals- Equalization algorithms – Viterbi Algorithm – Linear equalizer – Decision feedback equalization – Adaptive Equalization algorithms.

Unit III: BLOCK CODED DIGITAL COMMUNICATION (9)

Architecture and performance – Binary block codes; Orthogonal; Biorthogonal; Transorthogonal – Shannon's channel coding theorem; Channel capacity; Matched filter; Concepts of Spread spectrum communication – Coded BPSK and DPSK demodulators– Linear block codes; Hamming; Golay; Cyclic; BCH ; Reed – Solomon codes. Space time block codes.

Unit IV: CONVOLUTIONAL CODED DIGITAL COMMUNICATION (9)

Representation of codes using 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, Turbo Coding.

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. Introduction to CDMA systems, multiuser detection in CDMA systems – optimum multiuser receiver, suboptimum detectors, successive interference cancellation.

TOTAL : 45 Periods

Outcomes:

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

1. Develop the ability to understand the concepts of signal space analysis coherent and non-coherent receivers.
2. Comprehend the generation of OFDM signals and the processing of the signals.
3. Possess knowledge on different block codes and convolutional codes.
4. Conceptually appreciate different Equalization techniques.

REFERENCES:

1. Bernard Sklar, "Digital Communications", second edition, Pearson Education, 2001.
2. John G. Proakis, "Digital Communication", Fifth Edition, Mc Graw Hill Publication, 2008.
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. Stephen G. Wilson, "Digital Modulation and Coding", First Indian Reprint, Pearson Education, 2003.
6. Simon Haykin, "Digital communications", John Wiley and sons, 1998.

P20CU104 ADVANCED STATISTICAL SIGNAL PROCESSING L T P C

3 1 0 4

Objectives:

The purpose of this course is to provide in-depth treatment on methods and techniques in

- Discrete-time signal transforms, digital filter design, optimal filtering
- Power spectrum estimation, multi-rate digital signal processing
- DSP architectures which are of importance in the areas of signal processing, control and Communications

Unit I: DISCRETE RANDOM SIGNAL PROCESSING (12)

Weiner Khitchine relation - Power spectral density – filtering random process, Spectral Factorization Theorem, special types of random process – Signal modeling-Least Squares method, Pade approximation, Prony's method, iterative Prefiltering, Finite Data records, Stochastic Models.

Unit II: SPECTRUM ESTIMATION (12)

Non-Parametric methods - Correlation method - Co-variance estimator - Performance analysis of estimators – Unbiased consistent estimators - Periodogram estimator - Barlett spectrum estimation - Welch estimation - Model based approach - AR, MA, ARMA Signal modeling – Parameter estimation using Yule-Walker method.

Unit III: LINEAR ESTIMATION AND PREDICTION (12)

Maximum likelihood criterion - Efficiency of estimator - Least mean squared error criterion - Wiener filter - Discrete Wiener Hoff equations - Recursive estimators - Kalman filter – Linear prediction, Prediction error - Whitening filter, Inverse filter - Levinson recursion, Lattice realization, Levinson recursion algorithm for solving Toeplitz system of equations.

Unit IV: ADAPTIVE FILTERS (12)

FIR Adaptive filters - Newton's steepest descent method - Adaptive filters based on steepest descent method - Widrow Hoff LMS Adaptive algorithm - Adaptive channel equalization – Adaptive echo canceller - Adaptive noise cancellation - RLS Adaptive filters - Exponentially weighted RLS - Sliding window RLS - Simplified IIR LMS Adaptive filter.

Unit V: MULTIRATE DIGITAL SIGNAL PROCESSING (12)

Mathematical description of change of sampling rate - Interpolation and Decimation – Continuous time model - Direct digital domain approach - Decimation by integer factor - Interpolation by an integer factor - Single and multistage realization - Poly phase realization - Applications to sub band coding - Wavelet transform and filter bank implementation of wavelet expansion of signals..

TOTAL : 60 Periods

Outcomes:

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

1. To design adaptive filters for a given application.
2. Calculate mean, variance, auto-correlation and PSD for stochastic processes and derive prediction error criterion also.
3. To design multirate DSP systems.
4. Simulate spectral estimation algorithms and basic models on computing platform.

REFERENCES:

1. Monson H. Hayes, "Statistical Digital Signal Processing and Modeling", John Wiley and Sons Inc., New York, 2006.
2. Sophoncles J. Orfanidis, "Optimum Signal Processing ", McGraw-Hill, 2000.
3. John G. Proakis, Dimitris G. Manolakis, "Digital Signal Processing", Prentice Hall of India, New Delhi, 2005.
4. Simon Haykin, "Adaptive Filter Theory", Prentice Hall, Englehood Cliffs, NJ1986.
5. S. Kay," Modern spectrum Estimation theory and application", Prentice Hall, Englehood Cliffs, NJ1988.
6. P. P. Vaidyanathan, "Multirate Systems and Filter Banks", Prentice Hall, 1992.

P20CU105 ADVANCED COMMUNICATION NETWORKS L T P C

3 0 0 3

Objectives:

The students should be made to be

- Learn modeling and simulation
- Understand Monte Carlo simulation
- Study channel modeling and mobility modeling

Unit I: INTRODUCTION TO MODELING AND SIMULATION (9)

Introduction, Discrete-event Simulation, Modeling for Computer Simulation, Tools and Methods for Network Simulation, The Simulation Platform, Simulation Framework, Tools and Modeling Approaches for Simulating Hardware.

Unit II: MONTE CARLO SIMULATION (9)

Fundamental concepts, Application to communication systems, Monte Carlo integration, Semianalytic techniques, Case study: Performance estimation of a wireless system.

Unit III: LOWER LAYER & LINK LAYER WIRELESS MODELING (9)

Physical Layer Modeling, Description of the Main Components of the PHY Layer, Accurate Simulation of Physical Layers, Physical Layer Modeling for Network Simulations, Link Layer Modeling, Medium Access Control (MAC) Protocols, Logical Link Control, Forward Error Detection and Correction, Backward Error Detection and Correction, Queuing and Processing Delay.

Unit IV: CHANNEL MODELING & MOBILITY MODELING (9)

Channel Modeling :The Physics of Radiation, The Nature of Electromagnetic Radiation, Classification of Propagation Models, Deterministic Approaches by Classical Field Theory, Deterministic Geometric Optical Approaches, Empirical Path Loss Approaches, Stochastic Shadowing Models, Stochastic Fading Models, MIMO Channel Models. Mobility modeling :Categorization of Mobility Models, Mobility Models, Random Walk Model, Random Waypoint Model, Random Direction Model, Gauss-Markov Model, Manhattan Model, Column Model , Pursue Model, Nomadic Community Model, Selection of Appropriate Mobility Models.

Unit V: HIGHER LAYER MODELING & MODELING THE NETWORK TOPOLOGY (9)

Higher Layer Modeling: Modeling the Network Layer and Routing Protocols, Components of a Routing Protocol, Metrics, Virtual Routing on Overlays, Modeling Transport Layer Protocols, Modeling Application Traffic.

Modeling the Network Topology : Abstraction of Network Topologies by Graphs, Characterizing Graphs, Common Topology Models, Geometric Random Graphs – The Waxman Model, Hierarchical Topologies, Preferential Linking – The Barabasi-Albert Model , Modeling the Internet.

TOTAL : 45 Periods

Outcomes:

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

1. Apply Monte Carlo simulation.
2. Discuss Lower Layer and Link Layer Wireless Modeling.
3. Compare channel modeling and mobility modeling.

REFERENCES:

1. Irene Karzela, “Modeling and Simulating Communications Networks”, Prentice Hall India, 1998.
2. K.Wehrie. Gunes, J.Gross, “Modeling and Tools for Network simulation”, Springer, 2010.
3. M.C. Jeruchim, P.Balaban and K. Sam Shanmugam, “Simulation of Communication Systems: Modeling, Methodology and Techniques”, Plenum Press, New York, 2001.
4. Nejat; Bragg, Arnold, “Recent Advances in Modeling and Simulation Tools for Communication Networks and Services”, Springer, 2007
5. William.H.Tranter, K. Sam Shanmugam, Theodore. S. Rappaport, Kurt L. Kosbar, “Principles of Communication Systems Simulation”, Pearson Education (Singapore) Pvt. Ltd, 2004.

P20CU106 ADVANCED COMMUNICATION SYSTEMS LABORATORY L T P C

0 0 4 2

Objectives:

- To acquire knowledge on Transmission line and S- parameter estimation of microwave devices.
- To introduce the basics of Microstrip Patch Antenna and its analysis .
- To study & measure the performance of digital communication systems.
- To provide a comprehensive knowledge of Wireless Communication.
- To learn about the design of digital filter and its adaptive filtering algorithms.

LIST OF EXPERIMENTS:

USE NETWORK ANALYSER FOR THE FOLLOWING EXPERIMENTS:

1. Measurement of transmission line parameters.
2. S-parameter estimation of Microwave devices.
3. Design and testing of a Microstrip coupler.
4. Characteristics of Microstrip patch antenna.

USE APPROPRIATE SIMULATION TOOLS FOR THE FOLLOWING EXPERIMENTS:

1. Generation & detection of binary digital modulation techniques.
2. Spread Spectrum communication system-Pseudo random binary sequence generation-Baseband DSSS.
3. Digital Filter Design
4. Performance evaluation of simulated CDMA system
5. Channel equalizer design(LMS,RLS)
6. Antenna Radiation Pattern measurement

TOTAL : 60 Periods

OUTCOMES:

Upon the completion of course, students are able to

1. Measure and analyze various transmission line parameters.
2. Design Microstrip patch antennas.
3. Implement the adaptive filtering algorithms
4. To generate and detect digital communication signals of various modulation techniques using MATLAB.
5. Evaluate cellular mobile communication technology and propagation model.

P20CU201	ADVANCED BROADBAND WIRELESS COMMUNICATION	L	T	P	C
		3	0	0	3

Objectives:

The students should be made to:

- Understand Concepts of MIMO diversity and spatial multiplexing.
- Learn Massive MIMO system
- Know millimeter wave communication

Unit I: INFORMATION THEORETIC ASPECTS OF MIMO (9)

Review of SISO fading communication channels, MIMO Channel models, Classical i.i.d. and extended channels, Frequency selective and correlated channels models, Capacity of MIMO channels, Erogodic and outage capacity, capacity bounds and influence of channel properties on the capacity.

Unit II: MIMO DIVERSITY AND SPATIAL MULTIPLEXING (9)

Sources and types of diversity, analysis under Rayleigh fading, Diversity and channel knowledge. Alamouti space time code. MIMO spatial multiplexing: Space time receivers, ML, ZF, MMSE and Sphere decoding, BLAST receivers and Diversity multiplexing trade - off.

Unit III: MASSIVE MIMO SYSTEM (9)

Introduction - MIMO for LTE, capacity of massive MIMO, Pilot Design for massive MIMO, Resource allocation and transceivers design, Base band and RF implementation, Channel Models.

Unit IV: MILLIMETER WAVE COMMUNICATION (9)

Spectrum regulation, Channel propagation, Hardware technology for mmW systems, architecture and mobility, Beam forming techniques, Beam finding, Physical layer techniques - Duplex scheme and Transmission Scheme.

Unit V: SOFTWARE DEFINED RADIO AND COGNITIVE RADIO (9)

SDR - Definition, Origin, key characteristic, hardware and software architecture, waveforms. Cognitive Radio - Definitions, Cognitive theories, architectures, Cognitive radio as self controlling system, Ontology based cognitive radio.

TOTAL : 45 Periods

Outcomes:

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

1. Analyze MIMO system.
2. Discuss millimeter wave communication.
3. Demonstrate software defined radio and cognitive radio.

REFERENCES:

1. David Tse and Pramod Viswanath, "Fundamentals of Wireless Communication", Cambridge University Press 2005.
2. Hamid Jafarkhani, "Space - Time Coding: Theory and Practices", Cambridge University Press 2005.
3. Mischa Dohler, Jose F. Monserrat Afif Osseiran "5G Mobile and Wireless Communication Technology", Cambridge University Press 2016.
4. Mieczyslaw M Kokar, Lezek Lechowicz, "Cognitive Radio Interoperability through Waveform Reconfiguration" ARTECH House 2016.

P20CU202	MICROWAVE INTEGRATED CIRCUITS AND DESIGN	L	T	P	C
		3	0	0	3

Objectives:

The students should be made to:

- To understand the fundamentals of RF radio system design.
- To understand the various components that constitutes an RF radio system for wireless Communications.
- To know the basic analysis techniques needed for evaluating the performance of an RF radio system for Wireless applications.

Unit I: CMOS PHYSICS, TRANSCEIVER ECIFICATIONS AND ARCHITECTURES (9)

CMOS: Introduction to MOSFET Physics – Noise: Thermal, shot, flicker, popcorn noise transceviver Specifications: Two port Noise theory, Noise Figure, THD, IP2, IP3,Sensitivity, SFDR, Phase noise - Specification distribution over a communication link Transceiver Architectures: Receiver: Homodyne, Heterodyne, Image reject, Low IF Architectures – Transmitter: Direct up conversion, Two step up conversion

Unit II: IMPEDANCE MATCHING AND AMPLIFIERS (9)

S-parameters with 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 LNAs – Terminated with Resistors and Source Degeneration LNAs.

Unit III: FEEDBACK SYSTEMS AND POWER AMPLIFIERS (9)

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 –Linearisation Techniques – Efficiency boosting techniques – ACPR metric – Design considerations

Unit IV: RF FILTER DESIGN, OSILLATOR, MIXER (9)

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

Unit V: MIC COMPONENTS, ANTENNAS AND MEASUREMENT TECHNIQUES (9)

Introduction to MICs-Fabrication Technology, Advantages and applications, MIC components- Micro strip components, Coplanar circuits, Integrated antennas, photonic band gap antennas, Measurement techniques-test fixture measurements, probe station measurements, thermal and cryogenic measurements, experimental field probing techniques.

TOTAL : 45 Periods

Outcomes:

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

1. Capability to design RF circuits.
2. Analyze RF circuits.
3. Know the concepts of microstrip line and its interpretation in the analysis and deisgn of microstrip line.
4. Design and analysis of non-reciprocal components, active devices, high power and low power circuits.

REFERENCES:

1. T. Lee, “Design of CMOS RF Integrated Circuits”, Cambridge, 2004.
2. B.Razavi, “RF Microelectronics”, Pearson Education, 1997.
3. Jan Crols, Michiel Steyaert, “CMOS Wireless Transceiver Design”, Kluwer Academic Publications, 1997.

P20CU203	SPECTRUM SHARING AND INTERFERENCE MANAGEMENT	L	T	P	C
		3	0	0	3

Objectives:

The students should be made to:

- train students in the analysis, modelling and design of radio resource management mechanisms for wireless communications systems, with a focus on mobile communications.
- develop the concepts for designing and operating a mobile communication network, including the planning and dimensioning processes.

Unit I: DESIGN AND OPERATION OF MOBILE COMMUNICATION NETWORKS (9)

Engineering functions, organisation and processes - Base station radio design - Dimensioning - Integration and operation - Transmission – Optimisation.

Unit II: NETWORK PLANNING AND DIMENSIONING (9)

Introduction: Planning objectives and requirements - Link budget in LTE for Uplink and Downlink: Propagation models; Receiver sensitivity; signal to noise ratio and Interference Margin. Clutter Concept. - Traffic Dimensioning for LTE - LTE network design: Frequency planning options; Dimensioning and planning of Control channels - Backhaul and X2 interface dimensioning

Unit III: NETWORK RESOURCE MANAGEMENT (11)

Context, models and framework for network management (ITU FCAPS, eTOM, BSS/OSS/NMS) - Radio Resource Management strategies (admission control, scheduling, handover, cell selection, eICIC, carrier aggregation, load balancing) - Advanced algorithmic solutions for radio resource management (applicability of machine learning techniques) - Network optimisation and SON (network quality cycle, optimisation methodologies and tools, network monitoring and optimisation)

Unit IV: SPECTRUM MANAGEMENT (7)

Licensing regimes and spectrum management models (LSA, TVWS, etc.) - Coexistence studies.

Unit V: SPECTRUM ACCESS AND MANAGEMENT (9)

Spectrum broker, cognitive radio architectures, centralized dynamic spectrum access, distributed dynamic spectrum access, learning algorithms and protocols.

TOTAL : 45 Periods

Outcomes:

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

1. Understand the fundamental concepts of cognitive radio networks.
2. Develop the cognitive radio, as well as techniques for spectrum holes detection that cognitive radio takes advantages in order to exploit it.
3. Understand technologies to allow an efficient use of TVWS for radio communications based on two spectrum sharing business models/policies.
4. Understand fundamental issues regarding dynamic spectrum access, the radio-resource management and trading, as well as a number of optimisation techniques for better spectrum exploitation.

REFERENCES:

1. Romero Pérez, Jordi. Radio resource management strategies in UMTS. Chichester: John Wiley & Sons, 2005. ISBN 0470022779.
2. Hämäläinen, Seppo; Sanneck, Henning; Sartori, Cinzia. LTE self-organising networks (SON) : network management automation for operational efficiency [on line]. Hoboken, N.J.: Wiley, 2012 [Consultation: 15/09/2015]. Available on: http://onlinelibrary.wiley.com/book/10.1002/9781119961789. ISBN 9781119970675.
3. Dahlman, Erik. 3G evolution : HSPA and LTE for mobile broadband. 2nd ed. Amsterdam: Elsevier, 2008. ISBN 9780123745385.
4. Ekram Hossain, Dusit Niyato, Zhu Han, “Dynamic Spectrum Access and Management in Cognitive Radio Networks”, Cambridge University Press, 2009.
5. Kwang-Cheng Chen, Ramjee Prasad, “Cognitive radio networks”, John Wiley & Sons Ltd., 2009.

P20CU204	COMMUNICATION 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 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.
- To design and develop RF components using microstrip technology

LIST OF EXPERIMENTS:

(ADS/IE3D/HFSS or any similar/ equivalent tool may be used for the design)

1. Measurement of S parameters for a) Inductor b) Capacitor c) impedance matching circuits, filters using network analyzer
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, band pass and band stop filter at RF .
6. Design and characterization of micro strip patch antennas
7. Design and characterization of LNA
8. Design and characterization of Mixer
9. Design and characterization of VCO

TOTAL : 60 Periods

OUTCOMES:

Upon the completion of course, students are able to

1. Apply knowledge to identify a suitable architecture and systematically design an RF system.
2. Comprehensively record and report the measured data, and would be capable of analyzing, interpreting the experimentally measured data and produce the meaningful conclusions.
3. Design and develop microstrip filters.

P20CU205	RESEARCH METHODOLOGY AND IPR	L	T	P	C
		0	0	2	1

Objectives:

- To give an overview of the research methodology and explain the technique of defining a research problem
- To explain the functions of the literature review in research
- To explain carrying out a literature search, its review, developing theoretical and conceptual frameworks and writing a review.
- To explain various research designs and their characteristics.
- To explain various forms of the intellectual property, its relevance and business impact in the changing global business environment.

Unit I: Module-1 **(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: Module-2 (6)

Effective literature studies approaches, analysis Plagiarism, Research ethics

Unit III: Module-3 (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: Module-4 (6)

Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications.

Unit V: Module-5 (6)

New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. - Traditional knowledge Case Studies, IPR.

TOTAL : 30 Periods

Outcomes:

At the end of this course, students will be able to

1. Understand research problem formulation.
2. Analyze research related information.
3. Follow research ethics and understand that today's world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and
4. Understanding that when IPR would take such important place in growth of individuals & nation, it is needless to emphasis the need of information about Intellectual Property Right to be promoted among students in general and
5. Understand that IPR protection provides an incentive to inventors for further research work and investment in R & D, which leads to creation of new and better products, and in turn brings about, economic growth and social

REFERENCES:

1. Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science & engineering students'"
2. Wayne Goddard and Stuart Melville, "Research Methodology: An Introduction"
3. Ranjit Kumar, 2nd Edition, "Research Methodology: A Step by Step Guide for beginners"
4. Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd, 2007.
5. Mayall, "Industrial Design", McGraw Hill, 1992
6. Niebel, "Product Design", McGraw Hill, 1974.
7. Asimov, "Introduction to Design", Prentice Hall, 1962.
8. Robert P. Merges, Peter S. Menell, Mark A. Lemley, " Intellectual Property in New Technological Age", 2016.
9. T. Ramappa, "Intellectual Property Rights Under WTO", S. Chand, 2008

P20CU301	MILLIMETRE WAVE COMMUNICATION	L	T	P	C
		3	0	0	3

Objectives:

The students should be made to:

- 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)

Millimeter wave generation and amplification: Peniotrons, Ubitrons, Gyrotrons and Free electron lasers. HEMT, models for mm wave Transistors, transistor configurations, Analog mm wave components: Amplifiers, Mixers, VCO, PLL. Metrics for analog mm wave devices, Consumption factor theory, 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, mm wave design consideration, On-chip and In package mm wave antennas, Techniques to improve gain of on-chip antennas, Implementation for mm wave in adaptive antenna arrays, Device to Device communications over 5G systems, Design techniques of 5G mobile.

TOTAL : 45 Periods

Outcomes:

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

1. Ability to understand Millimeter devices and circuits.
2. Ability to design antenna for Millimeter wave frequencies.
3. Knowledge of Millimeter wave technology.

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.
3. Xiang, W; Zheng, K; Shen, X.S; "5G Mobile Communications: Springer, 2016.

ELECTIVE PAPERS

P20EC101	AUDIO VIDEO BROAD CASTING SYSTEMS	L	T	P	C
		3	0	0	3

Objectives:

- To gain knowledge about the Standards in the real world service creations.
- To know about new generation set-top boxes, hand-held devices, and PC add-in cards.
- Understand MPEG-2 System Standards.

Unit I: INTRODUCTION TO BROADCASTING (9)

Frequency bands – Propagation and Modulation- Radio and Television Transmission System Transmitting Antennas and Systems - RF System Maintenance – Test Equipments – Audio Test and Measurements – Video Signal Measurement and Analysis.

Unit II: DATA BROADCASTING (9)

Introduction to data Broadcasting- Data Broadcasting system overview and Architecture- Mpeg 2 Transport Basics- Data Categorization- Service Description Frame work – Synchronized Streaming Encapsulation – Data Piping Protocol.

Unit III: DESIGN AND INSTALLATION OF VIDEO AND AUDIO SYSTEMS (9)

Basics Of Television - Analog Video Fundamentals – Digital Video Fundamentals – Analog Audio fundamentals - Digital Audio Fundamentals – Data Multiplexing – Transition to DTD.

Unit IV: AUDIO VIDEO STREAMING (9)

Introduction to streaming media – Video Encoding – Audio Encoding – Preprocessing –Stream Serving – Web Casting –Media Players- Applications for Streaming Media – Content Distribution.

Unit V: ALGORITHMS AND INTERFACES (9)

Color Introduction to Luma and Chroma – Introduction to Component SDTV – Introduction to HDTV – Digital Video Interfaces – Filtering And Sampling – Image Digitization and Reconstructions – Perceptions and Visual Activity – DeInterlacing – DV Compressions – Digital television Standards

TOTAL : 45Periods

Outcomes:

Upon completion of this course the student will have:

1. To Implement the Standards in the real world service creations.
2. To work with new generation set-top boxes, hand-held devices, and PC add-in cards.
3. To design various video streaming techniques.

REFERENCES:

1. David Austerberry,"The technology of video and audio streaming" , Elsevier , 2nd edition, 2005
2. Richards.S Chernock, Regis J.cainon, Micheal A. Dolan, John R.Mick JR," Data Broadcasting – Understanding the ATCS Data Broadcasting Standerds", Tata Mcgraw Hill, 2001
3. Charles Poynton – Morgan Kaufman Publishers, "Digital Video And HDTV Algorithm and Interfaces" Charles Poynton – Morgan Kaufman Publishers, 2007
4. Jerry C. Whitaker,"Standard Handbook of Broadcast Engineering", Mcgraw Hill Publications, 2005
5. Michael Robin and Michel Poulin,"Digital Television Fundamentals - Design and Installation of Video and Audio Systems" Tata Mcgraw Hill, Second Edition, 2000.

P20EC102	WIRELESS SECURITY	L	T	P	C
		3	0	0	3

Objectives:

- To understand the fundamentals of wireless security
- To understand the security issues in bluetooth and Wi-Fi
- To explore the security issues in WiMAX and mobile telecommunication networks.
- To understand the security issues in ad-hoc and wireless sensor networks.
- To study the hacking techniques in IEEE 802.11

Unit I: WIRELESS SECURITY FUNDAMENTALS (9)

Vulnerabilities of Wired and Wireless Networks-Security in the digital age-Threats and risks to telecommunications systems- Vulnerabilities from wirelines to wireless communications-Fundamental Security Mechanisms-Basics on security-Secure communication protocols and VPN implementation Authentication-Access control.

Unit II: SECURITY IN BLUETOOTH AND WI-FI (9)

Bluetooth security- Security mode in Bluetooth-Authentication and pairing- Bluetooth encoding attacks-Wi-Fi Security- Attacks on wireless networks- Security in the IEEE 802.11 standard- Security in 802.1x-Security in 802.11i.

Unit III: SECURITY IN WIMAX AND MOBILE TELECOMMUNICATION NETWORKS (9)

WiMAX low layers- Security in 802.16-2004- Security in IEEE-802.16e standard- Telecommunication Security- Signaling- Security in the GSM- GPRS security- 3G security.

Unit IV: SECURITY IN AD HOC AND WIRELESS SENSOR NETWORKS (9)

Attacks to routing protocols- Security mechanisms- Auto-configuration-Authentication issue within adhoc networks- Group key management within ad hoc networks-Attacks on wireless sensor networks and counter measures- Prevention mechanisms: authentication and traffic protection.

Unit V: HACKING 802.11 WIRELESS TECHNOLOGY (9)

Introduction to 802.11 Hacking- Scanning and Enumerating 802.11 Networks- Attacking 802.11 Wireless Networks- Attacking WPA-Protected 802.11 Networks- Attack 802.11 Wireless Clients.

TOTAL : 45 Periods

Outcomes:

Upon completion of this course the student will have:

1. Identify various possibilities for security threats in wireless networks.
2. Handle the security threats in Bluetooth and Wi-Fi networks.
3. Solve the security attacks in WiMAX and mobile telecommunication networks.
4. Prevent the attacks in ad-hoc and wireless sensor networks.
5. Protect the 802.11 Networks from attacks.

REFERENCES:

1. Alan Holt, Chi-Yu Huang, "802.11 Wireless Networks- Security and Analysis", Springer, 2010.
2. Hakima Chaouchi, Maryline Laurent-Maknavicius, "Wireless and Mobile Network Security, Security Basics, Security in On-the-shelf and Emerging Technologies", John Wiley & Sons Inc, 2009.
3. Johnny Cache, Joshua Wright, Vincent Liu, "Hacking Exposed Wireless: Wireless Security Secrets & Solutions", Second Edition, McGraw-Hill, 2010.
4. Lei Chen, Jiahuang Ji, Zihong Zhang, "Wireless Network Security: Theories and Applications", Higher Education Press, 2013.

P20EC103	DSP PROCESSOR ARCHITECTURE AND PROGRAMMING	L	T	P	C
		3	0	0	3

Objectives:

The objective of this course is to provide in-depth knowledge on

- Digital Signal Processor basics.
- Third generation DSP Architecture and programming skills.
- Advanced DSP architectures and some applications.

Unit I: FUNDAMENTALS OF PROGRAMMABLE DSPs (9)

Multiplier and Multiplier accumulator – Modified Bus Structures and Memory access in PDSPs – Multiple access memory – Multi-port memory – VLIW architecture- Pipelining – Special Addressing modes in P-DSPs – On chip Peripherals.

Unit II: TMS320C5X PROCESSOR (9)

Architecture – Assembly language syntax - Addressing modes – Assembly language Instructions - Pipeline structure, Operation – Block Diagram of DSP starter kit – Application Programs for processing real time signals.

Unit III: TMS320C6X PROCESSOR (9)

Architecture of the C6x Processor - Instruction Set - DSP Development System: Introduction – DSP Starter Kit Support Tools- Code Composer Studio - Support Files - Programming Examples to Test the DSK Tools – Application Programs for processing real time signals.

Unit IV: ADSP PROCESSORS (9)

Architecture of ADSP-21XX and ADSP-210XX series of DSP processors- Addressing modes and assembly language instructions – Application programs –Filter design, FFT calculation.

Unit V: ADVANCED PROCESSORS (9)

Architecture of TMS320C54X: Pipe line operation, Code Composer studio – Architecture of TMS320C6X - Architecture of Motorola DSP563XX – Comparison of the features of DSP family processors.

TOTAL : 45 Periods

Outcomes:

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

1. Become Digital Signal Processor specialized engineer.
2. DSP based System Developer.
3. Recognize the fundamentals of fixed and floating point architecture of various DSPs.
4. Infer about the control instructions, interrupts and pipeline operations.

REFERENCES:

1. B.Venkataramani and M.Bhaskar, “Digital Signal Processors – Architecture, Programming and Applications” – Tata McGraw – Hill Publishing Company Limited. New Delhi, 2003.
2. Avtar Singh and S. Srinivasan, Digital Signal Processing – Implementations using DSP Microprocessors with Examples from TMS320C54xx, cengage Learning India Private Limited, Delhi 2012.
3. User guides Texas Instrumentation, Analog Devices, Motorola.
4. Rulph Chassaing, Digital Signal Processing and Applications with the C6713 and C6416 DSK, a john wiley & sons, inc., publication, 2005.

P20EC104	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 (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:

Upon completion of this course the student will have:

1. Discuss satellite navigation and global positioning system
2. Outline deep space networks and inter planetary mission
3. Knowledge on deep space networks and inter plane 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.

P20EC105	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 design 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 model – small signal model- single stage Amplifier-Source follower- Common gate stage Cascode Stage

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)

Characteristics of Sample and Hold- Digital to Analog Converters- architecture-Differential Non linearity-Integral Non linearity- Voltage Scaling-Cyclic DAC-Pipeline DAC-Analog to Digital Converters-architecture – Flash ADC-Pipeline ADC-Differential Non linearity-Integral Non linearity

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

TOTAL : 45 Periods

Outcomes:

Upon completion of this course the student will have:

1. Study the concepts of MOS large signal model and small signal model
2. Explain the concepts of D/A conversion methods and their architectures.
3. Design filters for ADC.
4. Study about the switched capacitor circuits.

REFERENCES:

1. Vineetha P.Gejji Analog and Mixed Mode Design - Prentice Hall, 1st Edition, 2011
2. JeyaGowri Analog and Mixed Mode Design- Sapna publishing House 2011.

P20EC201	DIGITAL COMMUNICATION RECEIVERS	L	T	P	C
		3	0	0	3

Objectives:

- To understand the basic principles of digital communication techniques.
- To gain knowledge about receivers for AWGN channel and Fading channels.
- To understand the concepts of synchronization and adaptive equalization techniques.

Unit I: REVIEW OF DIGITAL COMMUNICATION TECHNIQUES (9)

Base band communication; signal space representation, linear and nonlinear modulation techniques, Error tracking and Spectral characteristics of digital modulation.

Unit II: OPTIMUM RECEIVERS FOR AWGN CHANNEL (9)

Correlation demodulator, matched filter, maximum likelihood sequence detector, optimum receiver for CPM signals, optimum receivers for signals with random phase in AWGN channel, envelope detection of M-ary orthogonal signals and correlated binary signals.

Unit III: RECEIVERS FOR FADING CHANNELS (9)

Characterization of fading multiple channels, statistical models, flat and frequency selective fading, diversity technique, parameter synchronization for flat fading channels, digital signaling over a frequency selective and slowly fading channel, coded waveform for fading channel.

Unit IV: SYNCHRONIZATION TECHNIQUES (9)

Carrier and signal synchronization, carrier phase estimation-PLL, Decision directed loops, symbol timing estimation, maximum likelihood and non-decision directed timing estimation, joint estimation.

Unit V: ADAPTIVE EQUALIZATION (9)

Zero forcing algorithm, LMS algorithm, adaptive decision-feedback equalizer and Equalization of Trellis-coded signals. Kalman algorithm, blind equalizers and stochastic gradient algorithm.

TOTAL : 45 Periods

Outcomes:

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

1. Apply basic principles of digital communication techniques.
2. Discuss on receivers for AWGN & Fading channel
3. Describe various synchronization techniques.
4. Design adaptive equalization algorithms to satisfy the evolving demands in digital communication.

REFERENCES:

1. Heinrich Meyer, Mare Moeneclacy, Stefan.A.Fechtel, "Digital communication receivers ", Vol I & Vol II, John Wiley, New York, 1997.
2. H.Meyr & G.Ascheid, Synchronization in Digital Communications, John Wiley, 1990
3. John.G.Proakis, “Digital communication “4th Edition, McGraw-Hill, New York, 2001.
4. R.G.Gallager, "Principles of Digital Communication", Newyork, Cambridge University Press, 2008
5. Simon Marvin, “Digital communication over fading channel; An unified approach to Performance Analysis ", John Wiley, New York, 2000.
6. U.Mengali & A.N.D"Andrea, Synchronization Techniques for Digital Receivers, Kluwer, 1997.

P20EC202	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 - DiffieHellman (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 the course, the student 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 "Cryptography and Network Security: Principles and Practice", 3rd Edition, Pearson Education, 2002.
7. William Stallings "Network Security Essentials: Applications and Standards", 2nd Edition, Pearson Education, 2000.

P20EC203	IOT AND APPLICATIONS	L	T	P	C
		3	0	0	3

Objectives:

- To Understand IoT architecture
- To understand M2M to IoT
- To Understand the application of IoT

Unit I: IOT & WEB TECHNOLOGY (9)

The Internet of Things Today, Time for Convergence, Towards the IoT Universe, Internet of Things Vision, IoT Strategic Research and Innovation Directions, IoT Applications, Future Internet Technologies, Infrastructure, Networks and Communication, Processes, Data Management, Security, Privacy & Trust, Device Level Energy Issues, IoT Related Standardization, Recommendations on Research Topics.

Unit II: M2M TO IOT (9)

A Basic Perspective– Introduction, Some Definitions, M2M Value Chains, IoT Value Chains, An emerging industrial structure for IoT, The international driven global value chain and global information monopolies. M2M to IoT-An Architectural Overview– Building an architecture, Main design principles and needed capabilities, An IoT architecture outline, standards considerations.

Unit III: IOT ARCHITECTURE (9)

Introduction, State of the art, Architecture Reference Model- Introduction, Reference Model and architecture, IoT reference Model, IoT Reference Architecture- Introduction, Functional View, Information View, Deployment and Operational View, Other Relevant architectural views.

Unit IV: IOT APPLICATIONS FOR VALUE CREATIONS (9)

Introduction, IoT applications for industry: Future Factory Concepts, Brownfield IoT, Smart Objects, Smart Applications, Four Aspects in your Business to Master IoT, Value, Creation from Big Data and Serialization, IoT for Retailing Industry, IoT For Oil and Gas, Industry, Opinions on IoT Application and Value for Industry, Home Management, eHealth.

Unit V: INTERNET OF THINGS PRIVACY, SECURITY AND GOVERNANCE (9)

Introduction, Overview of Governance, Privacy and Security Issues, Contribution from FP7 Projects, Security, Privacy and Trust in IoTData-Platforms for Smart Cities, First Steps Towards a Secure Platform, Smartie Approach.

TOTAL : 45 Periods

Outcomes:

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

1. Understand the vision of IoT from a global context.
2. Determine the Market perspective of IoT.
3. Use of Devices, Gateways and Data Management in IoT.
4. Building state of the art architecture in IoT.
5. Application of IoT in Industrial and Commercial Building Automation and Real World Design Constraints.

REFERENCES:

1. Vijay Madisetti and Arshdeep Bahga, “Internet of Things (A Hands-on-Approach)”, 1st Edition, VPT, 2014
2. Francis daCosta, “Rethinking the Internet of Things: A Scalable Approach to Connecting Everything”, 1 st Edition, Apress Publications, 2013
3. Cuno Pfister, Getting Started with the Internet of Things, O"Reilly Media, 2011, ISBN: 978-1-4493- 9357-1

P20EC204	COGNITIVE RADIO NETWORKS	L	T	P	C
		3	0	0	3

Objectives:

- Understand the concepts of cognitive radio
- Learn spectrum sensing and dynamic spectrum access

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 IDENTIFICATION (9)

Primary Signal Detection: Energy Detector, Cyclostationary Feature Detector, Matched Filter ,Cooperative Sensing , Definition and Implications of Spectrum Opportunity, Spectrum Opportunity Detection , Fundamental Trade-offs: Performance versus Constraint , MAC Layer Performance Measures, Global Interference Model, Local Interference Model, Fundamental Trade-offs: Sensing Accuracy versus Sensing Overhead.

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 the course, the student should be able to:

1. Compare MAC and network layer design for cognitive radio
2. Discuss cognitive radio for Internet of Things and M2M technologies

REFERENCES:

1. Alexander M. Wyglinski, Maziar Nekovee, And Y. Thomas Hou, “Cognitive Radio Communications And Networks - Principles And Practice”, Elsevier Inc., 2010.
2. Kwang-Cheng Chen and Ramjee Prasad,” Cognitive Radio Networks”, John Wiley & Sons, Ltd, 2009.
3. Khattab, Ahmed, Perkins, Dmitri, Bayoumi, Magdy, “Cognitive Radio Networks - From Theory to Practice”, Springer Series: Analog Circuits and Signal Processing, 2009.
4. J. Mitola, “Cognitive Radio: An Integrated Agent Architecture for software defined radio”, Doctor of Technology thesis, Royal Inst. Technology, Sweden 2000.
5. Simon Haykin, “Cognitive Radio: Brain –empowered wireless communications”, IEEE Journal on selected areas in communications, Feb 2005.
6. Ian F. Akyildiz, Won – Yeol Lee, Mehmet C. Vuran, Shantidev Mohanty, “NeXt generation / dynamic spectrum access / cognitive radio wireless networks: A Survey Elsevier Computer Networks, May 2006.

P20EC205	BROADBAND ACCESS TECHNOLOGIES	L	T	P	C
		3	0	0	3

Objectives:

- To give fundamental concepts related to broadband access technologies.
- To understand the current and emerging wired and wireless access technologies.
- To acquire knowledge about cable modems and fiber access technologies.
- To have an exposure to different systems standards for next generation broadband access networks.

Unit I: REVIEW OF ACCESS TECHNOLOGIES (9)

Phone-Line modem, cable-access, ISDN, Emerging Broad band Technologies, Cable DSL, Fiber and Wireless, Standards for access network.

Unit II: DIGITAL SUBSCRIBER LINES (9)

Asymmetric Digital subscriber lines (ADSL) – Rate Adaptive subscriber line (RADSL)-ISDN Digital subscriber line (IDSL) - High bit rate DSL (HDSL)-Single line DSL (SDSL) - very high bit rate DSL (VDSL) - Standards for XDSL & Comparison.

Unit III: CABLE MODEM (9)

Cable Modem, DOCSIS – Physical Cabling, Dual Modem Operation, Hub Restriction, Upstream Operation – Downstream operation – Access control – framing Security sub layer – Data link layer – LLC & Higher layers – ATM centric VS IP – centric cable modem.

Unit IV: FIBER ACCESS TECHNOLOGIES (9)

Optical Fiber in access networks, Architecture and Technologies- Hybrid fiber – Coax (HFC) system, Switched Digital Video (SDV) – Passive optical networks (PON) – FTTX (FTTH, FTTB, FTTC, FTT cab) comparison.

Unit V: BROAD BAND WIRELESS (9)

Fixed Wireless, Direct Broadcast Satellite (DBS), Multi channel multi point distribution services (MMDS), Local multi point distribution services (LMDS), and Wideband integrated Digital Interactive Services (WIDIS), Mobile Wireless 3G – IMT 2000.

TOTAL : 45 Periods

Outcomes:

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

1. To able to design systems meeting out the requirements of the recent standards.
2. To meet out the industry requirements for man power in next generation networks.
3. To be able to contribute towards the enhancement of the existing wireless technologies.

REFERENCES:

1. Niel Ransom and Albert A. Azzam, “Broadband Access Technologies: ADSL, VDSL Cable Modem, Fiber and LMDS", McGraw Hill, 1999.
2. Gilbert Held, “Next Generation Modems: A Professional Guide to DSL and Cable Modems”, John Wiley & Sons, 2000.
3. Walter J Woralski, “ADSL and DSL Technologies”, McGraw Hill Computer Communication Series, Second Edition Oct 2001.
4. William Webb, “Introduction to Wireless Local Loop Broadband and Narrow Band System”, Mobile Communication Series, Artech House Publishers, Second Edition 2000.
5. Martin P. Clarke, “Wireless Access Network: Fixed Wireless Access and WLL Network Design and Operation”, John Wiley & Sons 2000.
6. Dennis J. Rauschmayer, “ADSL/VDSL Principles: A Practical and Precise Study of Asymmetric Digital Subscriber Lines and Very High Speed Digital Subscriber Lines, Macmillan Technology Series, 1998.

P20EC206	BIOMEDICAL SIGNAL PROCESSING	L	T	P	C
		3	0	0	3

Objectives:

- To introduce the characteristics of different biosignals
- To discuss linear and non-linear filtering techniques to extract desired information
- To introduce techniques for automated classification and decision making to aid diagnosis

Unit I: SIGNAL, SYSTEM AND SPECTRUM (9)

Characteristics of some dynamic biomedical signals, Noises- random, structured and physiological noises. Filters- IIR and FIR filters. Spectrum – power spectral density function, cross-spectral density and coherence function, cepstrum and homomorphic filtering. Estimation of mean of finite time signals.

Unit II: TIME SERIES ANALYSIS AND SPECTRAL ESTIMATION (9)

Time series analysis – linear prediction models, process order estimation, lattice representation, non stationary process, fixed segmentation, adaptive segmentation, application in EEG, PCG signals, Time varying analysis of Heart-rate variability, model based ECG simulator. Spectral estimation – Blackman Tukey method, periodogram, and model based estimation. Application in Heart rate variability, PCG signals,

Unit III: ADAPTIVE FILTERING AND WAVELET DETECTION (9)

Filtering – LMS adaptive filter, adaptive noise canceling in ECG, improved adaptive filtering in FECG, Wavelet detection in ECG – structural features, matched filtering, adaptive wavelet detection, detection of overlapping wavelets.

Unit IV: BIOSIGNAL CLASSIFICATION AND RECOGNITION (9)

Signal classification and recognition – Statistical signal classification, linear discriminant function, direct feature selection and ordering, Back propagation neural network based classification. Application in Normal versus Ectopic ECG beats.

Unit V: TIME FREQUENCY AND MULTIVARIATE ANALYSIS (9)

Time frequency representation, spectrogram, Wigner distribution, Time-scale representation, scalogram, wavelet analysis – Data reduction techniques, ECG data compression, ECG characterization, Feature extraction- Wavelet packets, Multivariate component analysis-PCA, ICA

TOTAL : 45 Periods

Outcomes:

Upon completion of this course the student will have:

1. To come across the different types of signals & systems
2. To analyse signals in time series domain & estimate the spectrum
3. To understand the significance of wavelet detection applied in biosignal processing
4. To extract the features using multivariate component analysis

REFERENCES:

1. Arnon Cohen, Bio-Medical Signal Processing Vol I and Vol II, CRC Press Inc., Boca Rato, Florida 1999.
2. Rangaraj M. Rangayyan, 'Biomedical Signal Analysis-A case study approach', Wiley Interscience/IEEE Press, 2002
3. Willis J. Tompkins, Biomedical Digital Signal Processing, Prentice Hall of India, New Delhi, 2003.
4. Emmanuel C. Ifeachor, Barrie W.Jervis, 'Digital Signal processing- A Practical Approach' Pearson education Ltd., 2002
5. Raghuveer M. Rao and Ajith S.Bopardikar, Wavelets transform – Introduction to theory and its applications, Pearson Education, India 2000.

P20EC207	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 (7)

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 (11)

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

Unit III: ROUTING IN OPTICAL WDM NETWORKS (9)

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

Unit IV: MOBILE - IP NETWORKS (9)

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

Unit V: MOBILE AD –HOC NETWORKS (9)

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

TOTAL : 45Periods

Outcomes:

Upon completion of this course the student will have:

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. William Stallings, 'High speed networks and Internets Performance and Quality of Service', IInd Edition, Pearson Education Asia. Reprint India 2002
2. M.Steen Strub, 'Routing in Communication network, Prentice –Hall International, Newyork, 1995.
3. Keshav, 'An engineering approach to computer networking' Addison Wesley 1999.
4. William Stallings, 'High speed Networks TCP/IP and ATM Design Principles, Prentice- Hall, New York, 1995
5. C.E Perkins, 'Ad Hoc Networking', Addison – Wesley, 2001
6. 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.

P20EC208	VLSI FOR WIRELESS COMMUNICATION	L	T	P	C
		3	0	0	3

Objectives:

- To study the design concepts of low noise amplifiers.
- To study the various types of mixers designed for wireless communication.
- To study and design PLL and VCO.
- To understand the concepts of CDMA in wireless communication.

Unit I: COMPONENTS AND DEVICES (9)

Integrated inductors, resistors, MOSFET and BJT AMPLIFIER DESIGN: Low Noise Amplifier Design - Wideband LNA - Design Narrowband LNA - Impedance Matching - Automatic Gain Control Amplifiers – Power Amplifiers.

Unit II: MIXERS (9)

Balancing Mixer - Qualitative Description of the Gilbert Mixer - Conversion Gain – Distortion – Low Frequency Case: Analysis of Gilbert Mixer – Distortion - High-Frequency Case – Noise – A Complete Active Mixer. Switching Mixer - Distortion in Unbalanced Switching Mixer – Conversion Gain in Unbalanced Switching Mixer - Noise in Unbalanced Switching Mixer - A Practical Unbalanced Switching Mixer. Sampling Mixer - Conversion Gain in Single Ended Sampling Mixer - Distortion in Single Ended Sampling Mixer - Intrinsic Noise in Single Ended Sampling Mixer -Extrinsic Noise in Single Ended Sampling Mixer.

Unit III: FREQUENCY SYNTHESIZERS (9)

Phase Locked Loops - Voltage Controlled Oscillators - Phase Detector – Analog Phase Detectors – Digital Phase Detectors - Frequency Dividers - LC Oscillators - Ring Oscillators - Phase Noise – A Complete Synthesizer Design Example (DECT Application).

Unit IV: SUB SYSTEMS (9)

Data converters in communications, adaptive Filters, equalizers and transceivers

Unit V: IMPLEMENTATIONS (9)

VLSI architecture for Multitier Wireless System - Hardware Design Issues for a Next generation CDMA System

TOTAL : 45 Periods

Outcomes:

Upon completion of this course the student will have:

1. Understand the details about implementation of VLSI for wireless communication.
2. Knowledge of design components of Mixer circuits

REFERENCES:

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

P20EC209	RF IC DESIGN	L	T	P	C
		3	0	0	3

Objectives:

- To study the various impedance matching techniques used in RF circuit design.
- To understand the functional design aspects of LNAs, Mixers, PLLs and VCO.
- To understand frequency synthesis.

Unit I: IMPEDANCE MATCHING IN AMPLIFIERS (9)

Definition of “Q", series parallel transformations of lossy circuits, impedance matching using “L", “PI" and T networks, Integrated inductors, resistors, Capacitors, tunable inductors, transformers

Unit II: AMPLIFIER DESIGN (9)

Noise characteristics of MOS devices, Design of CG LNA and inductor degenerated LNAs. Principles of RF Power Amplifiers design.

Unit III: ACTIVE AND PASSIVE MIXERS (9)

Qualitative Description of the Gilbert Mixer - Conversion Gain, and distortion and noise , analysis of Gilbert Mixer – Switching Mixer - Distortion in Unbalanced Switching Mixer -Conversion Gain in Unbalanced Switching Mixer - Noise in Unbalanced Switching Mixer - A Practical Unbalanced Switching Mixer. Sampling Mixer - Conversion Gain in Single Ended Sampling Mixer - Distortion in Single Ended Sampling Mixer - Intrinsic Noise in Single Ended Sampling Mixer - Extrinsic Noise in Single Ended Sampling Mixer

Unit IV: OSCILLATORS (9)

LC Oscillators, Voltage Controlled Oscillators, Ring oscillators, Delay Cells, tuning range in ring oscillators, Tuning in LC oscillators, Tuning sensitivity, Phase Noise in oscillators, sources of phase noise

Unit V: PLL AND FREQUENCY SYNTHESIZERS (9)

Phase Detector/Charge Pump, Analog Phase Detectors, Digital Phase Detectors, Frequency Dividers, Loop Filter Design, Phase Locked Loops, Phase noise in PLL, Loop Bandwidth, Basic Integer-N frequency synthesizer, Basic Fractional-N frequency synthesizer

TOTAL : 45 Periods

Outcomes:

Upon completion of this course the student will have:

1. To understand the principles of operation of an RF receiver front end
2. To design and apply constraints for LNAs, Mixers and Frequency synthesizers

REFERENCES:

1. B.Razavi ,”RF Microelectronics” , Prentice-Hall ,1998
2. Bosco H Leung “VLSI for Wireless Communication”, Pearson Education, 2002
3. Behzad Razavi, “Design of Analog CMOS Integrated Circuits” McGraw-Hill, 1999
4. Jia-sheng Hong, "Microstrip filters for RF/Microwave applications", Wiley, 2001
5. Thomas H.Lee, “The Design of CMOS Radio –Frequency Integrated Circuits", Cambridge University Press ,2003

P20EC210	ARTIFICIAL INTELLIGENCE	L	T	P	C
		3	0	0	3

Objectives:

- To provide in-depth knowledge about
- Searching Techniques
- Knowledge Representation Learning.

Unit I: INTRODUCTION (8)

Intelligent Agents – Agents and environments – Good behaviour – The nature of environments – structure of agents – Problem Solving – problem solving agents – example problems – searching for solutions – uniformed search strategies – avoiding repeated states – searching with partial information

Unit II: SEARCHING TECHNIQUES (10)

Informed search strategies – heuristic function – local search algorithms and optimistic problems – local search in continuous spaces – online search agents and unknown environments **–** Constraint satisfaction problems (CSP) – Backtracking search and Local search – Structure of problems **–** Adversarial Search – Games – Optimal decisions in games – Alpha – Beta Pruning – imperfect real-time decision – games that include an element of chance.

Unit III: KNOWLEDGE REPRESENTATION (10)

First order logic - syntax and semantics – Using first order logic – Knowledge engineering **–** Inference – prepositional versus first order logic – unification and lifting – forward chaining – backward chaining **–** Resolution **–** Knowledge representation **–** Ontological Engineering **–** Categories and objects – Actions **–** Simulation and events **–** Mental events and mental objects.

Unit IV: LEARNING (9)

Learning from observations **–** forms of learning **–** Inductive learning - Learning decision trees **–** Ensemble learning **–** Knowledge in learning – Logical formulation of learning – Explanation based learning – Learning using relevant information – Inductive logic programming - Statistical learning methods **–** Learning with complete data **–** Learning with hidden variable **–** EM algorithm **–** Instance based learning **–** Neural networks **–** Reinforcement learning – Passive reinforcement learning **–** Active reinforcement learning **–** Generalization in reinforcement learning.

Unit V: APPLICATIONS (8)

Communication – Communication as action – Formal grammar for a fragment of English – Syntactic analysis – Augmented grammars – Semantic interpretation – Ambiguity and disambiguation – Discourse understanding – Grammar induction **–** Probabilistic language processing **–** Probabilistic language models – Information retrieval – Information Extraction – Machine translation

TOTAL : 45 Periods

Outcomes:

Upon completion of this course the student will have:

1. Explain Uniform search strategies and searching with partial information
2. Understand Backtracking, Local and Adversarial Search
3. Describe Learning decision trees
4. Explain Probabilistic language processing

REFERENCES:

1. Stuart Russell, Peter Norvig, “Artificial Intelligence – A Modern Approach”, Second Edition, Pearson Education / Prentice Hall of India, 2004.
2. Nils J. Nilsson, “Artificial Intelligence: A new Synthesis”, Harcourt Asia Pvt. Ltd., 2000.
3. Elaine Rich and Kevin Knight, “Artificial Intelligence”, Second Edition, Tata McGraw Hill, 2003.
4. George F. Luger, “Artificial Intelligence-Structures and Strategies for Complex Problem Solving”, Pearson Education / PHI, 2002.

P20EC211	SPACE TIME WIRELESS COMMUNICATION	L	T	P	C
		3	0	0	3

Objectives:

- To understand the important concepts of Space time Wireless Communication, Channel, Multiple Antenna Propagation, Capacity and Space diversity.

Unit I: MULTIPLE ANTENNA PROPAGATION AND ST CHANNEL CHARACTERIZATION (9)

Wireless channel, Scattering model in macrocells, Channel as a ST random field, Scattering functions, Polarization and field diverse channels, Antenna array topology, Degenerate channels, reciprocity and its implications, Channel definitions, Physical scattering model, Extended channel models, Channel measurements, sampled signal model, ST multiuser and ST interference channels, ST channel estimation.

Unit II: CAPACITY OF MULTIPLE ANTENNA CHANNELS (9)

Capacity of frequency flat deterministic MIMO channel: Channel unknown to the transmitter, Channel known to the transmitter, capacity of random MIMO channels, Influence of ricean fading, fading correlation, XPD and degeneracy on MIMO capacity, Capacity of frequency selective MIMO channels.

Unit III: SPATIAL DIVERSITY (9)

Diversity gain, Receive antenna diversity, Transmit antenna diversity, Diversity order and channel variability, Diversity performance in extended channels, Combined space and path diversity, Indirect transmit diversity, Diversity of a space-time- frequency selective fading channel.

Unit IV: MULTIPLE ANTENNA CODING AND RECEIVERS (9)

Coding and interleaving architecture, ST coding for frequency flat channels, ST coding for frequency selective channels, Receivers (SISO, SIMO, MIMO), Iterative MIMO receivers, Exploiting channel knowledge at the transmitter: linear pre-filtering, optimal pre-filtering for maximum rate, optimal pre-filtering for error rate minimization, selection at the transmitter, Exploiting imperfect channel knowledge.

Unit V: OFDM, SPREAD SPECTRUM AND MIMO MULTIUSER DETECTION (9)

SISO-OFDM modulation, MIMO-OFDM modulation, Signaling and receivers for MIMO- OFDM,SISO-SS modulation, MIMO-SS modulation, Signaling and receivers for MIMO- S.MIMO-MAC,MIMO-BC, Outage performance for MIMO-MU,MIMO-MU with OFDM,CDMA and multiple antennas.

TOTAL : 45 Periods

Outcomes:

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

1. Understand Space Time Channel Characterization
2. Explain Capacity of Multiple Antenna Channels
3. Learn ST OFDM, Spread Spectrum

REFERENCES:

1. Paulraj, Rohit Nabar, Dhananjay Gore, “Introduction to Space Time Wireless Communication Systems”, Cambridge University Press, 2003.
2. Sergio Verdu, Multi User Detection, Cambridge University Press, 1998.
3. Andre Viterbi, Principles of Spread Spectrum Techniques, Addison Wesley 1995.

P20EC212	PATTERN RECOGNITION AND MACHINE LEARNING	L	T	P	C
		3	0	0	3

Objectives:

- To know about Supervised and unsupervised Learning.
- To study about feature extraction and structural pattern recognition.
- To explore different classification models.
- To understand Fuzzy Pattern Classifiers and Perception.

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 – 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: HIDDEN MARKOV MODELS AND SUPPORT VECTOR MACHINE (9)

State Machines – Hidden Markov Models – Training – Classification – Support vector Machine – Feature Selection.

Unit V: RECENT ADVANCES (9)

Fuzzy logic – Fuzzy Pattern Classifiers – Pattern Classification using Genetic Algorithms – Case Study Using Fuzzy Pattern Classifiers and Perception.

TOTAL : 45 Periods

Outcomes:

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

1. Classify the data and identify the patterns.
2. Extract feature set and select the features from given data set.

REFERENCES:

1. M. Narasimha Murthy and V. Susheela Devi, “Pattern Recognition”, Springer 2011.
2. S.Theodoridis and K.Koutroumbas, “Pattern Recognition”, 4th Ed., Academic Press, 2009.
3. Robert J.Schalkoff, “Pattern Recognition Statistical, Structural and Neural Approaches”, John Wiley & Sons Inc., New York, 1992.
4. C.M.Bishop, “Pattern Recognition and Machine Learning”, Springer, 2006.
5. R.O.Duda, P.E.Hart and D.G.Stork, “Pattern Classification”, John Wiley, 2001
6. Andrew Webb, “Stastical Pattern Recognition”, Arnold publishers, London,1999.

P20EC213	DETECTION AND ESTIMATION THEORY	L	T	P	C
		3	0	0	3

Objectives:

- To understand the concepts of detection and estimation.
- To learn the basics of multi-user detection theory
- To understand the theory behind various estimation techniques.
- To understand Wiener filter and Kalman filter in detail.

Unit I: REVEIW OF PROBABILITY AND STOCHASTIC PROCESS (9)

Conditional Probability, Bayes' Theorem , Random Variables, Conditional Distributions and Densities, moments and distribution of random variables., Stationary Processes Cyclostationary Processes Averages and Ergodicity Autocorrelation Function Power Spectral Density Discrete Time Stochastic Processes, Spatial Stochastic Processes, Random Signals, Relationship of Power Spectral Density and Autocorrelation Function.

Unit II: SINGLE AND MULTIPLE SAMPLE DETECTION (9)

Hypothesis Testing and the MAP Criterion, Bayes Criterion, Minimax Criterion, Neyman-Pearson Criterion, Sequential Detection, The Optimum Digital Detector in Additive Gaussian Noise , Performance of Binary Receivers in AWGN.

Unit III: FUNDAMENTALS OF ESTIMATION THEORY (9)

Formulation of the General Parameter Estimation Problem, Relationship between Detection and Estimation Theory, Types of Estimation Problems, Properties of Estimators, Bayes estimation, Minimax Estimation, Maximum-Likelihood Estimation, Comparison of Estimators of Parameters.

Unit IV: WIENER AND KALMAN FILTERS (9)

Orthogonality Principle, Autoregressive Techniques, Discrete Wiener Filter, Continuous Wiener Filter, Generalization of Discrete and Continuous Filter Representations , Linear Least-Squares Methods, Minimum-Variance Weighted Least-Squares Methods, Minimum-Variance, LeastSquares, Kalman Algorithm - Computational Considerations, Signal Estimation, Continuous Kalman Filter, Extended Kalman Filter.

Unit V: APPLICATIONS (9)

Detector Structures in Non-Gaussian Noise , Examples of Noise Models, Receiver Structures, and Error-Rate Performance, Estimation of Non-Gaussian Noise Parameters Fading Multipath Channel Models, Receiver Structures with Known Channel Parameters, Receiver Structures without Knowledge of Phase, Receiver Structures without Knowledge of Amplitude or Phase, Receiver Structures and Performance with No Channel Knowledge

TOTAL : 45 Periods

Outcomes:

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

1. To be able to apply detection and estimation theory to solve communication problems.
2. To apply probability and stochastic process concepts in detection and estimation.
3. To design Wiener and Kalman filters to solve linear estimation problems.

REFERENCES:

1. Harry L. Van Trees, "Detection, Estimation and Modulation Theory", Part I John Wiley and Sons, New York, 2004.
2. Ludeman, Lonnie C. Random processes: filtering, estimation, and detection. John Wiley & Sons, Inc., 2003.
3. Steven M. Kay, "Fundamentals of Statistical Processing, Volume I: Estimation Theory", Prentice Hall Signal Processing Series, Prentice Hall, PTR, NewJersy, 1993.
4. Sergio Verdu " Multi User Detection" Cambridge University Press, 1998
5. Thomas Schonhoff, "Detection and Estimation Theory", Prentice Hall, New Jersy, 2007.

P20EC214	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-tonoise 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:

At the end of the course, the student should 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,
4. Michael O Kolawole, "Radar systems, Peak Detection and Tracking", Elsevier 2010.
5. Peyton Z. Peebles, "Radar Principles", Wiley India 2009 6. Skolnik, "Introduction To Radar Systems" 3rd Edition McGraw Hill.

P20EC215	NETWORK PROCESSORS	L	T	P	C
		3	0	0	3

Objectives:

- Learn network processors
- Study commercial network processors
- Understand network processor architecture

Unit I: INTRODUCTION (9)

Traditional protocol processing Systems – Network processing Hardware – Basic Packet Processing Algorithms and data Structures - Packet processing functions – Protocol Software – Hardware Architectures for Protocol processing – Classification and Forwarding – Switching Fabrics.

Unit II: NETWORK PROCESSOR TECHNOLOGY (9)

Network Processors: Motivation and purpose - Complexity of Network Processor Design – Network Processor Architectures architectural variety, architectural characteristics Peripheral Chips supporting Network Processors: Storage processors, Classification Processors, Search Engines, Switch Fabrics, Traffic Managers.

Unit III: COMMERCIAL NETWORK PROCESSORS (9)

Multi-Chip Pipeline, Augmented RISC processor, Embedded Processor plus Coprocessors, Pipelilne of Flomogeneous processors. Configurable Instruction set processors – Pipeline of Electrogeneous processors – Extensive and Diverse processors – Flexible RISC plus Coprocessors – Scalability issues – Design Tradeoffs and consequences.

Unit IV: NETWORK PROCESSOR: ARCHITECTURE AND PROGRAMMING (9)

Architecture: Intel Network Processor: Multi headed Architecture Overview – Features- Embedded EISC processor - Packet Processor Hardware – Memory interfaces – System and Control Interface Components – Bus Interface. Programming Software Development Kit-IXP Instruction set – register formats – Micro Engine Programming – Intra thread and Inter-thread communication– thread synchronization – developing sample applications – control plane – ARM programming.

Unit V: IOS TECHNOLOGIES (9)

CISCO COS – Connectivity and scalability – high availability – IP routing – IP services – IPV6 –Mobile IP – MPLS – IP Multicast 0 Manageability – QoS – Security – Switching – Layer VPN2.

TOTAL : 45 Periods

Outcomes:

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

1. Discuss network processor architecture
2. Compare different programming
3. Explain IOS technologies

REFERENCES:

1. Douglas E.Comer “Networks Systems Design using Network Processors” Prentice Hall JaN. 2003.
2. Erik, J.Johnson and Aaron R.Kunze, “IXP2400/2806 Programming: The Microengine Coding Grade” Intel Press.
3. Hill Carlson, “Intel Internet Exchange Architecture & Applications a Practical Guide to Intel‟s network Processors” Intel press. www.cisco.com
4. Panas C. Lekkas, “Network Processors: Architectgures, Protocols and Paradigms Telecom Engineering)”, McGraw Hill, Professional, 2003.
5. Patrick Crowley, M aEranklin, H. Hadminglu, PZ Onfryk, “Network Processor Design, Issues and Practices Vol-1” Morgan Kaufman, 2002.
6. Patrick Crowley, M a Frankliln, H. Hadimioglyum PZ Onufryk, Network Processor Design, Issues and Prentices vol.II, Morgan Kaufman, 2003.
7. Ran Giladi, Network Processors: Architecture, Programming, and Implementation, Morgan Kauffmann, 2008.

P20EC301	ULTRA WIDEBAND COMMUNICATION	L	T	P	C
		3	0	0	3

Objectives:

- To give fundamental concepts related to Ultra wide band
- To understand the channel model and signal processing for UWB.
- To acquire knowledge about UWB antennas and regulations.

Unit I: INTRODUCTION TO UWB (9)

History, Definition, FCC Mask, UWB features, UWB Interference: IEEE 802.11.a Interference, Signal to Interference ratio calculation, Interference with other wireless services.

Unit II: UWB TECHNOLOGIES AND CHANNEL MODELS (9)

Impulse Radio, Pulsed Multiband, Multiband OFDM, features : Complexity, Power Consumption, Security and achievable data rate. MIMO Multiband OFDM, Differential multiband OFDM, Performance characterization, Ultra Wide Band Wireless Channels Channel model: Impulse Response Modeling of UWB Wireless Channels, IEEE UWB channel model, Path loss, Delay profiles, Time and frequency modeling

Unit III: UWB SIGNAL PROCESSING (9)

Data Modulation schemes, UWB Multiple Access Modulation, BER, Rake Receiver, Transmit- Reference (T-R) Technique, UWB Range- Data Rate Performance, UWB Channel Capacity, UWB Wireless Locationing: Position Locationing Methods, Time of Arrival Estimation, NLOS Location Error , Locationing with OFDM

Unit IV: UWB ANTENNAS (9)

Antenna Requirements, Radiation Mechanism of the UWB Antennas, Types of Broad band antennas, Parameters, Analysis of UWB Antennas, Link Budget for UWB System. Design examples of broad band UWB antennas

Unit V: UWB APPLICATIONS AND REGULATIONS (9)

Wireless Ad hoc Networking, UWB Wireless Sensor, RFID, Consumer Electronics and Personal, Asset Location, Medical applications, UWB Regulation and standards in various countries , UWB Regulation in ITU, IEEE Standardization

TOTAL : 45 Periods

Outcomes:

Upon completion of this course the student will have:

1. Ability to assess the performance of UWB channels.
2. The student would be able to design UWB antenna for various applications.

REFERENCES:

1. Homayoun Nikookar and Ramjee Prasad, “Introduction to Ultra Wideband for Wireless Communications”1st Edition, Springer Science & Business Media B.V. 2010.
2. Thomas Kaiser, Feng Zheng “Ultra Wideband Systems with MIMO”, 1st Edition, John Wiley & Sons Ltd, New York, 2010
3. W. Pam Siriwongpairat and K. J. Ray Liu, “Ultra-Wideband Communications Systems: Multiband OFDM approach” John Wiley and IEEE press, New York 2008.

P20EC302	SPEECH PROCESSING AND SYNTHESIS	L	T	P	C
		3	0	0	3

Objectives:

- To study the basic concepts of speech and audio.
- To study the analysis of various M-band filter banks for audio coding
- To learn various transform coders for audio coding.
- To study the speech processing methods in time and frequency domain

Unit I: MECHANICS OF SPEECH AND AUDIO (9)

Introduction - Review Of Signal Processing Theory-Speech production mechanism – Nature of Speech signal – Discrete time modelling of Speech production – Classification of Speech sounds – Phones – Phonemes – Phonetic and Phonemic alphabets – Articulatory features. Absolute Threshold of Hearing - Critical Bands- Simultaneous Masking, Masking-Asymmetry, and the Spread of Masking- Nonsimultaneous Masking - Perceptual Entropy - Basic measuring philosophy -Subjective versus objective perceptual testing - The perceptual audio quality measure (PAQM) - Cognitive effects in judging audio quality.

Unit II: TIME-FREQUENCY ANALYSIS: FILTER BANKS AND TRANSFORMS (9)

Introduction -Analysis-Synthesis Framework for M-band Filter Banks- Filter Banks for Audio Coding: Design Considerations - Quadrature Mirror and Conjugate Quadrature Filters- Tree- Structured QMF and CQF M-band Banks - Cosine Modulated “Pseudo QMF” M-band Banks - Cosine Modulated Perfect Reconstruction (PR) M-band Banksand the Modified Discrete Cosine Transform (MDCT) – Discrete Fourier and Discrete Cosine Transform - Pre-echo Distortion- Preecho Control Strategies.

Unit III: AUDIO CODING AND TRANSFORM CODERS (9)

Lossless Audio Coding-LossyAudioCoding- ISO-MPEG-1A,2A,2A Advaned , 4A AudioCoding - Optimum Coding in the Frequency Domain - Perceptual Transform Coder -Brandenburg-Johnston Hybrid Coder - CNET Coders - Adaptive Spectral Entropy Coding -Differential Perceptual Audio Coder - DFT Noise Substitution -DCT with Vector Quantization -MDCT with Vector Quantization

Unit IV: TIME AND FREQUENCY DOMAIN METHODS FOR SPEECH PROCESSING (9)

Time domain parameters of Speech signal – Methods for extracting the parameters :Energy, Average Magnitude – Zero crossing Rate – Silence Discrimination using ZCRand energy Short Time Fourier analysis – Formant extraction – Pitch Extraction using time and frequency domain methods

Unit V: LINEAR PREDICTIVE ANALYSIS OF SPEECH (9)

Formulation of Linear Prediction problem in Time Domain – Basic Principle – Auto correlation method – Covariance method – Solution of LPC equations – Cholesky method – Durbin’s Recursive algorithm – lattice formation and solutions – Comparison of different methods – Application of LPC parameters – Pitch detection using LPC parameters – Formant analysis – VELP – CELP.

TOTAL : 45 Periods

Outcomes:

Upon completion of this course the student will have:

1. Analysed the speech and audio signal
2. Record, analyze, characterize, modify and synthesize speech signals.
3. Locate, interpret and synthesize scientific literature.

REFERENCES:

1. 1.Digital Audio Signal Processing, Second Edition, Udo Zölzer**,** A John Wiley& sons Ltd Publicatioons
2. Applications of Digital Signal Processing to Audio And Acoustics
3. Mark Kahrs, Karlheinz Brandenburg, Kluwer Academic Publishers New York, Boston, Dordrecht, London, Moscow
4. Digital Processing of Speech signals – L.R.Rabiner and R.W.Schaffer - Prentice Hall --1978

P20EC303	HIGH PERFORMANCE NETWORKS	L	T	P	C
		3	0	0	3

Objectives:

- To develop a comprehensive understanding of multimedia networking.
- To study the types of VPN and tunneling protocols for security.
- To learn about network security in many layers and network management.

Unit I: INTRODUCTION (9)

Review of OSI, TCP/IP; Multiplexing, Modes of Communication, Switching, Routing. SONET – DWDM – DSL – ISDN – BISDN,ATM.

Unit II: MULTIMEDIA NETWORKING APPLICATIONS (9)

Streaming stored Audio and Video – Best effort service – protocols for real time interactive applications – Beyond best effort – scheduling and policing mechanism – integrated services – RSVP- differentiated services.

Unit III: ADVANCED NETWORKS CONCEPTS (9)

VPN-Remote-Access VPN, site-to-site VPN, Tunneling to PPP, Security in VPN.MPLS-operation, Routing, Tunneling and use of FEC, Traffic Engineering, MPLS based VPN, overlay networks-P2P Connections

Unit IV: TRAFFIC MODELLING (9)

Little's theorem, Need for modeling, Poisson modeling and its failure, Non - poisson models, Network performance evaluation.

Unit V: NETWORK SECURITY AND MANAGEMENT (9)

Principles of cryptography – Authentication – integrity – key distribution and certification – Access control and: fire walls – attacks and counter measures – security in many layers. Infrastructure for network management – The internet standard management framework – SMI, MIB, SNMP, Security and administration – ASN.1

TOTAL : 45 Periods

Outcomes:

Upon completion of this course the student will have:

1. Knowledge about security mechanism and network management in layers.
2. Understand how the ATM protocol works
3. Understand how ATM enables data transfer at high speeds.

REFERENCES:

1. J.F. Kurose & K.W. Ross, "Computer Networking- A top down approach featuring the internet",Pearson, 2nd edition, 2003.
2. Walrand .J. Varatya, High performance communication network, Morgan Kauffman – Harcourt Asia Pvt. Ltd. 2nd Edition, 2000.
3. LEOM-GarCIA, WIDJAJA, "Communication networks", TMH seventh reprint 2002.
4. Aunurag kumar, D. MAnjunath, Joy kuri, "Communication Networking", Morgan Kaufmann Publishers, 1ed 2004.
5. Hersent Gurle & petit, "IP Telephony, packet Pored Multimedia communication Systems", Pearson education 2003.
6. Fred Halsall and Lingana Gouda Kulkarni, "Computer Networking and the Internet" fifth edition, Pearson education

P20EC304	OPTIMIZATION TECHNIQUES	L	T	P	C
		3	0	0	3

Objectives:

- To learn various Soft computing frameworks.
- To familiarizes with the design of various neural networks.
- To understand the concept of fuzzy logic.
- To gain insight onto Neuro Fuzzy modeling and control.
- To gain knowledge in conventional optimization techniques.
- To understand the various evolutionary optimization techniques

Unit I: NEURAL NETWORKS (9)

Machine Learning using Neural Network, Learning algorithms, Supervised Learning Neural Networks – Feed Forward Networks, Radial Basis Function, Unsupervised Learning Neural Networks – Self Organizing map , Adaptive Resonance Architectures, Hopfield network

Unit II: FUZZY LOGIC (9)

Fuzzy Sets – Operations on Fuzzy Sets – Fuzzy Relations – Membership Functions-Fuzzy Rules and Fuzzy Reasoning – Fuzzy Inference Systems – Fuzzy Expert Systems – Fuzzy Decision Making

Unit III: NEURO-FUZZY MODELING (9)

Adaptive Neuro-Fuzzy Inference Systems – Coactive Neuro-Fuzzy Modeling – Classification and Regression Trees – Data Clustering Algorithms – Rule base Structure Identification –Neuro-Fuzzy Control – Case Studies

Unit IV: CONVENTIONAL OPTIMIZATION TECHNIQUES (9)

Introduction to optimization techniques, Statement of an optimization problem, classification, Unconstrained optimization-gradient search method-Gradient of a function, steepest gradient-conjugate gradient, Newton‟s Method, Marquardt Method, Constrained optimization –sequential linear programming, Interior penalty function method, external penalty function method.

Unit V: EVOLUTIONARY OPTIMIZATION TECHNIQUES (9)

Genetic algorithm - working principle, Basic operators and Terminologies, Building block hypothesis, Travelling Salesman Problem, Particle swam optimization, Ant colony optimization.

TOTAL : 45 Periods

Outcomes:
Upon completion of this course the student will have:

1. Implement machine learning through neural networks.
2. Develop a Fuzzy expert system.
3. Model Neuro Fuzzy system for clustering and classification.
4. Able to use the optimization techniques to solve the real world problems

REFERENCES:

1. David E. Goldberg, Genetic Algorithms in Search, Optimization and Machine Learning, Addison wesley, 2009.
2. George J. Klir and Bo Yuan, Fuzzy Sets and Fuzzy Logic-Theory and Applications,Prentice Hall, 1995.
3. James A. Freeman and David M. Skapura, Neural Networks Algorithms, Applications, and Programming Techniques, Pearson Edn., 2003.
4. Jyh-Shing Roger Jang, Chuen-Tsai Sun, Eiji Mizutani, Neuro-Fuzzy and Soft Computing, Prentice-Hall of India, 2003
5. Mitchell Melanie, An Introduction to Genetic Algorithm, Prentice Hall, 1998

P20EC305	SOFT COMPUTING TECHNIQUES	L	T	P	C
		3	0	0	3

Objectives:

- To know the basics of artificial neural networks
- To provide adequate knowledge about feed forward /feedback neural networks
- To apply the concept of fuzzy logic in various systems.
- To have the idea about genetic algorithm
- To provide adequate knowledge about the applications of Soft Computing.

Unit I: ARTIFICIAL NEURAL NETWORK (9)

Introduction-Basic concepts of Neural Network-Model of an Artificial Neuron-Characteristics of Neural Network-Learning Methods-Backpropagation Network Architecture-Backpropagation Learning-Counter Propagation Network-Hopfield/Recurrent Network-Adaptive Resonance Theory.

Unit II: FUZZY LOGIC (9)

Fuzzy Sets – Operations on Fuzzy Sets – Fuzzy Relations – Membership Functions-Fuzzy Rules and Fuzzy Reasoning – Fuzzy Inference Systems – Fuzzy Expert Systems – Fuzzy Decision Making

Unit III: NEURO-FUZZY MODELING (9)

Adaptive Neuro-Fuzzy Inference Systems – Coactive Neuro-Fuzzy Modeling – Classification and Regression Trees – Data Clustering Algorithms – Rule base Structure Identification –Neuro-Fuzzy Control – Case Studies

Unit IV: GENETIC ALGORITHMS (9)

Basic concepts-Working Principle-Inheritance Operators-Cross Over-Inversion & Deletion-Mutation Operator-Generation Cycle.

Unit V: APPLICATIONS OF SOFTCOMPUTING (9)

Genetic Algorithm Application- Bagley and Adaptive Game-Playing Program- Greg Viols Fuzzy Cruise Controller-Air Conditioner Controller-Application of Back Propagation Neural Network.

TOTAL : 45 Periods

Outcomes:

Upon completion of this course the student will have:

1. Knowledge on concepts of soft computational techniques.
2. Able to apply soft computational techniques to solve various problems.
3. Motivate to solve research oriented problems.

REFERENCES:

1. George J. Klir and Bo Yuan, „Fuzzy Sets and Fuzzy Logic Theory and Applications", Printice Hall of India, 2002.
2. J.S.R.Jang, C.T.Sun and E.Mizutani,"Neuro-Fuzzy and Soft Computing", PHI, 2004, Pearson Education 2004.
3. Laurene Fausett, “Fundamentals of Neural Networks: Architectures, Algorithms and Applications”, Pearson Education India, 2006.
4. S.Rajasekaran and G.A.V.Pai."Neural Networks, Fuzzy Logic and Genetic Algorithms", PHI, 2010.
5. Timothy J Ross, “Fuzzy logic with Engineering Applications”, John Wiley and Sons, 2009.
6. Zimmermann H.J."Fuzzy Set Theory and Its Application" Springer International Edition, 2011.

P20EC306	WAVELET TRANSFORMS AND ITS APPLICATIONS	L	T	P	C
		3	0	0	3

Objectives:

- To introduce the fundamentals concepts of wavelet transforms.
- To study system design using Wavelets
- To learn the different wavelet families & their applications

Unit I: INTRODUCTION TO WAVELETS (9)

Introduction to Multirate signal processing- Decimation and Interpolation, Quadrature Mirror Filters, Subband coding, Limitations of Fourier transform, Short time Fourier transform and its drawbacks, Continuous Wavelet transform, Time frequency representation, Wavelet System and its characteristics, Orthogonal and Orthonormal functions and function space

Unit II: MULTIRESOLUTION CONCEPT AND DISCRETE WAVELET TRANSFORM (9)

Multiresolution formulation of wavelet systems- signal spaces, scaling function, wavelet function and its properties, Multiresolution analysis, Haar scaling and wavelet function, Filter banksAnalysis and Synthesis, 1D and 2D Discrete wavelet transform, Wavelet Packets, Tree structured filter bank, Multichannel filter bank, Undecimated wavelet transform.

Unit III: WAVELET SYSTEM DESIGN (9)

Refinement relation for orthogonal wavelet systems, Restrictions on filter coefficients, Design of Daubechies orthogonal wavelet system coefficients, Design of Coiflet and Symlet wavelets.

Unit IV: WAVELET FAMILIES (9)

Continuous Wavelets- Properties of Mexican hat wavelet, Morlet, Gaussian and Meyer wavelets. Orthogonal wavelets- Properties of Haar wavelets, Daubechies wavelets, Symlets, Coiflets and Discrete Meyer wavelets. Properties of Biorthogonal wavelets, Applications of wavelet families.

Unit V: WAVELET APPLICATIONS (9)

Denoising of Signals and Images, Image enhancement, Edge detection, Image Fusion, Image compression, Wavelet based feature extraction, Analysis of phonocardiogram signals, Analysis of EEG signals, Speech enhancement for hearing aids

TOTAL : 45 Periods

Outcomes:

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

1. Apprehend the detailed knowledge about the Wavelet transforms & its applications
2. Understand the concepts on system design using Wavelets
3. Learn the different wavelet families & their applications

REFERENCES:

1. C.Sidney Burrus, Ramesh Gopinath & Haito Guo, Introduction to wavelets and wavelet transform, Prentice Hall, 1998.
2. G.Strang and T.Nguyen, Wavelet and filter banks, Wesley and Cambridge Press.
3. Metin Akay, Time frequency and wavelets in biomedical signal processing, Wiley-IEEE Press, October 1997
4. M.Vetterli and J. Kovacevic, Wavelets and sub band coding, Prentice Hall, 1995.
5. P.P.Vaidyanathan, Multi rate systems and filter banks, Prentice Hall 1993
6. Raguveer m Rao & Ajith S. Bopardikar, Wavelet transforms – Introduction to theory and applications, Addison Wesley, 1998
7. S.Mallet, A Wavelet tour of signal processing, Academic Press 1998

P20EC307	NANO MATERIALS AND NANOTECHNOLOGY	L	T	P	C
		3	0	0	3

Objectives:

- To recognize the surface modification of nanoparticles by surface fictionalization and their application.
- To understand the different type of nanostructures and analyze the top down and bottom up approach for nano-scale device preparation and differentiate the different properties of nanomaterials.

Unit I: NANOSTRUCTURED FILMS (9)

Synthesis - physical vapour deposition (PVD) – molecular beam epitaxy (MBE) - DC/RF magnetron sputtering - chemical vapour deposition (CVD) – progress and challenges of photovoltaic applications of silicon nanocrystalline materials - sol-gel technique – sol-gel films – properties and applications of sol-gel derived nanostructured thin films. Electrodeposition of semiconductor quantum dot films – electrodeposition of thick films of semiconductors from DMSO – ultrathin films and isolated nanocrystal deposition – electronic characterization of electrodeposited semiconductor nanparticle films.

Unit II: NANOLITHOGRAPHY (9)

Nanostructures fabricated by physical techniques – lithography – photo, electron beam, X-ray, ion beam, and AFM and STM based lithography – nanolithography – soft lithography – microcontact printing – dip-pen nanolithography – assembly of nanostructures.

Unit III: PHOTOCHEMISTRYAND ELECTROCHEMISTRY OF NANO-ASSEMBLIES (9)

Photoinduced charge transfer processes in semiconductor nanoparticles systems – photoinduced transformations of metal nanoparticles – electrochemistry of semiconductor nanostructures – nanostructured metal oxide films – nanostructured oxide films modified with dyes and redox chromophores - electrochemistry of metal nanostructures – semiconductor-metal nanocomposites – nanoelectrode ensembles – charge transport in nanostructured thin film electrodes - intensity modulated photocurrent and photovoltage spectroscopy.

Unit IV: DYE SENSITIZED SOLAR CELLS (9)

Introduction to Photovoltaic (PV) systems - the PV cell - the PV module - the PV array - photoelectrochemical conversion of solar enegy – photoredox reactions of colloidal semiconductors and particulates – dye sensitization of semiconductors – sequence of electron transfer steps of a dyesensitized solar cell (DSSC) – key efficiency parameters of a DSSC – key components of DSSC – improvement in efficiency through nanostructuring of materials – dye solar cells based on nanorods/ nanotubes and nanowires – sensitization using quantum dots - pervoskite solar cells.

Unit V: PHOTOLUMINESCENCE OF NANOCRYSTALS (9)

Principles of photoluminescence – photoluminescence in solid systems – radiative transitions in pure semiconductors – radiative transitions across the band gap – nonradiatives processes – quantum dots and nanophosphors – weak and strong confinement regimes – photoluminescence of quantum dots prepared by wet chemical precipitation – photoluminescence from doped quantum dots – nanoscale particles for molecular imaging – photoluminescence in undoped and doped nanocrystals of ZnO and TiO2 .

TOTAL : 45 Periods

Outcomes:

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

1. Recognize the history, background and the nature of the Nanoscience and technology.
2. Distinguish the functionality of nanostructures and their characteristic evaluation, self assembly and its application towards controlling the structure.
3. Appraise the different smart materials like thermos-responsive, piezoelectric electrostrictive and biometric materials, smart gel, shape memory and their application towards product formation.

REFERENCES:

1. Challa S.S.R. Kumar (Ed) - Nanomaterials for Biosensors, Wiley-VCH, Verlag, Weinheim, 2007.
2. Challa S.S.R. Kumar (Ed) - Nanosystem Characterization Tools in the Life Science, Wiley-VCH, Verlag, Weinheim, 2006.
3. Arben Merkoci - Biosensing using Nanomaterials. Wiley Publication, New Jersey, 2009.
4. Challa Kumar(Ed) - Semiconductor Nanomaterials, Wiley-VCH, 2010.

P20EC308	OPTICAL NETWORKS	L	T	P	C
		3	0	0	3

Objectives:

- Optical system components like optical amplifiers, wavelength converters.
- Up-to-date survey of development in Optical Network Architectures.
- Packet switching.
- Network design perspectives.
- Different Optical Network management techniques and functions.

Unit I: INTRODUCTION TO OPTICAL NETWORKS (9)

Telecommunications Networks Architecture, Services, circuit switching and packet switching, Optical Networks: Multiplexing Techniques, Second generation Optical Networks, Optical Packet Switching, Transmission Basics: Wavelength, frequencies, and channel spacing, Wavelength standards, Optical power and loss, Network Evolution, Nonlinear Effects: Self-phase Modulation, Cross-phase Modulation, Four Wave mixing, Solitons. Components: Couplers, Isolators and Circulators, Multiplexers and Filters, Optical Amplifiers, Transmitters, Detectors, Switches, Wavelength Converters.

Unit II: TRANSMISSION SYSTEM ENGINEERING (9)

System Model, Power Penalty, Transmitter, Receiver, Optical Amplifiers, Crosstalk, Dispersion, Wavelength Stabilization, Overall Design Considerations. Optical Internets: Migration to IP optical networking, IP and Optical backbone, IP Routing table, MPLS and optical cross connect table, Protocol stack Alternatives, Internetworking SS7 and Legacy Transport, Internet transport network protocol stack.

Unit III: SONET, SDH AND OPTICAL TRANSPORT NETWORKS (OTNS) (9)

SONET and SDH: SONET multiplexing hierarchy, Frame structure, Functional Component, problem detection, concatenation. Architecture of Optical Transport Networks (OTNs): Digital wrapper, in-band and out-of band control signalling, Importance of Multiplexing and multiplexing hierarchies, SONET multiplexing hierarchies, SDH multiplexing hierarchies, New Optical Transport, OTN layered Model, Generic Framing Procedure (GFP)

Unit IV: WDM, NETWORK TOPOLOGIES, MPLS AND OPTICAL NETWORKS (9)

WDM: WDM operation, Dense Wavelength Division Multiplexing (DWDM), Erbium-doped Fiber (EDF), WDM amplifiers, Add-Drop Multiplexers, Wavelength Continuity Property, Higher dispersion for DWDM, Tunable DWDM Lasers.

Unit V: NETWORK TOPOLOGIES AND PROTECTION SCHEMES (9)

Robust networks, Line and path protection switching, Types of topology, Point to point topology, bi-directional line-switched ring (BLSR), meshed topology, Passive optical networks, Metro optical networks 28 MPLS and Optical Networks: IS label switching, Forwarding equivalence class (FEC), Types of MPLS nodes, Label distribution and binding, label swapping and traffic forwarding, MPLS support of Virtual Private Networks (VPN), MPLS traffic engineering, Multi protocol Lambda switching (MPIS).

TOTAL : 45 Periods

Outcomes:

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

1. Design and Analyze Network Components
2. Assess and Evaluate optical networks

REFERENCES:

1. Rajiv Ramaswami and Kumar Sivarajan, "Optical Networks – Practical Perspective", 3rd Edition, Morgan - Kaufmann Publishers, 2009.
2. Optical Networks, Third Generation Transport Systems, Uyless Black, Pearson Education, 2002.

P20EC309	NETWORK MANAGEMENT	L	T	P	C
		3	0	0	3

Objectives:

- To appreciate the need for interoperable network management as a typical distributed application
- To familiarize concepts and terminology associated with SNMP
- To be aware of current trends in network management technologies

Unit I: OSI NETWORK MANAGEMENT (9)

OSI Network management model - Organizational model - Information model, Communication model. Abstract Syntax Notation - Encoding Structure, Macros Functional Model CMIP/CMIS.

Unit II: BROADBAND NETWORK MANAGEMENT (9)

Broadband networks and services, ATM Technology - VP, VC, ATM Packet, Integrated service, ATM LAN emulation, Virtual LAN, ATM Network Management - ATM Network reference model, Integrated local Management Interface. ATM Management Information base, Role of SNMP and ILMI in ATM Management, M1, M2, M3, M4 interface. ATM Digital Exchange Interface Management.

Unit III: SIMPLE NETWORK MANAGEMENT PROTOCOL (9)

SNMPv1 Network Management: Communication and Functional Models. The SNMP Communication Model, Functional model. SNMP Management SNMPv2: Major Changes in SNMPv2, SNMPv2 System Architecture, SNMPv2 Structure of Management Information, The SNMPv2 Management Information Base,SNMPv2 Protocol, Compatibility With SNMPv1.Configuration management, Fault management, Performance management, Event Correlation Techniques 168 security management, Accounting management, Report Management, Policy Based Management, Services Level Management.

Unit IV: NETWORK MANAGEMENT SYSTEMS (9)

Network Management Tools, Network Statistics Measurement Systems, History of Enterprise Management, Commercial Network management Systems, System Management and Enterprise Management Solutions.

Unit V: WEB-BASED MANAGEMENT (9)

NMS with Web Interface and Web-Based Management, Web Interface to SNMP Management, Embedded Web-Based Management, Desktop management Interface, Web-Based Enterprise Management, WBEM: Windows Management Instrumentation, Java management Extensions, Management of a Storage Area Network.

TOTAL : 45 Periods

Outcomes:

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

1. Diagnose problems and make minor repairs to computer networks using appropriate diagnostics software b
2. Demonstrate how to correctly maintain LAN computer systems
3. Maintain the network by performing routine maintenance tasks
4. Apply network management tools

REFERENCES:

1. Lakshmi G Raman, "Fundamentals of Telecommunication Network Management", Eastern Economy Edition IEEE Press, New Delhi, 1999.
2. Mani Subramanian, "Network Management - Principles and Practice", Pearson Education, Second edition, 2010.
3. Mani Subramanian, "Network Management Principles and Practice", Addison Wesley, Second edition, 2010.
4. Mark Burges, "Principles of Network System Administration", Wiley, 2000.
5. Salah Aiidarons and Thomas Plevayk, "Telecommunications Network Technologies and Implementations", Eastern Economy Edition IEEE press, New Delhi, 1998.

P20EC310	ADVANCED WIRELESS NETWORKS	L	T	P	C
		3	0	0	3

Objectives:

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

Unit I: INTRODUCTION (9)

Introduction to 1G/2G/3G/4G Terminology. Evolution of Public Mobile Services -Motivation for IP Based Wireless Networks -Requirements and Targets for Long Term Evolution (LTE) - Technologies for LTE-4G Advanced Features and Roadmap Evolutions from LTE to LTE-A - Wireless Standards. Network Model-Network Connectivity-Wireless Network Design with Small World Properties

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.

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:

At the end of the course, the student should 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.

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. Crosspoint Boulevard, “Wireless and Mobile All-IP Networks”, Wiley Publication, 2005.
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