KUMARAGURU COLLEGE OF TECHNOLOGY

(Autonomous Institution Affiliated to Anna University, Chennai)

COIMBATORE – 641049

CURRICULUM & SYLLABUS

CHOICE BASED CREDIT SYSTEM

(REGULATIONS 2015)

I to IV Semester

M.E. Communication Systems

Department of Electronics and Communication Engineering

Department of Electronics and Communication Engineering

Vision

To be a centre of repute for learning and research with internationally accredited curriculum, state-of-the-art infrastructure and laboratories to enable the students to succeed in globally competitive environments in academics and industry

Mission

The Department is committed to set standards of excellence in its academic delivery aimed to imbibe right attitude and leadership quality in students to apply the acquired knowledge and skills to meet the challenges of evolving global and local needs adhering to professional ethics.

Kumaraguru College of Technology
Coimbatore – 641 049
Regulations 2015

CBCS – PG Curriculum

Name of the PG Programme: M.E. Communication Systems

Foundation Courses (FC)

S. No.	Course Code	Course Title	Hours/Wk & Credits L	T	P	C	Preferred Semester
1.	P15MAT108	Applied Algebra	3	1	0	4	I
2.	P15COT103	Advanced Signal Processing	3	1	0	4	I

Professional Core (PC)

S. No.	Course Code	Course Title	Hours/Wk & Credits L	T	P	C	Preferred Semester
Specilisation 1: Communication							
1.	P15COT102	Advanced Digital Communication Techniques	3	1	0	4	I
2.	P15COT201	Wireless Communication Engineering	3	0	0	3	II
3.	P15COT202	Data Compression Techniques	3	1	0	4	II
4.	P15COP101	Communication Systems laboratory	0	0	3	1	I
5.	P15COP201	Advanced Communication laboratory	0	0	3	1	II
Specilisation 2: Microwave Engineering							
1.	P15COT101	Microwave Integrated Circuits	3	0	0	3	I
2.	P15COT203	Advanced Radiation systems	3	0	0	3	II
Specilisation 3: Networks							
1.	P15COT104	Optical Communication Networks	3	0	0	3	I

Professional Electives (PE)

S. No.	Course Code	Course Title	Hours /Wk & Credits				Preferred Semester
			L	T	P	C	
1.	P15COTE01	Advanced Digital Image Processing	3	0	0	3	II
2.	P15COTE02	Soft Computing	3	0	0	3	II
3.	P15COTE03	Optimization techniques	3	0	0	3	II
4.	P15COTE04	Non linear signal Processing	3	0	0	3	II
5.	P15COTE05	Underwater Acoustic signal processing	3	0	0	3	III
6.	P15COTE06	Wavelets and Multi-resolution Processing	3	0	0	3	III
7.	P15COTE07	Sparse theory and applications	3	0	0	3	III
8.	P15COTE08	Wireless Networks	3	0	0	3	II
9.	P15COTE09	Detection and Estimation Theory	3	0	0	3	I
10.	P15COTE10	Communication Network Security	3	0	0	3	I
11.	P15COTE11	High Speed Switching Architecture	3	0	0	3	I
12.	P15COTE12	Network Routing Algorithms	3	0	0	3	II
13.	P15COTE13	Speech and Audio Signal Processing	3	0	0	3	I
14.	P15COTE14	RF System Design	3	0	0	3	I
15.	P15COTE15	Advanced Optical Communication	3	0	0	3	II
16.	P15COTE16	Ultra Wideband Communication	3	0	0	3	II
17.	P15COTE17	OFDM / OFDMA Communication	3	0	0	3	II
18.	P15COTE18	Advanced Microwave Systems	3	0	0	3	II

19.	P15COTE19	Satellite Communication	3	0	0	3	III
20.	P15COTE20	Global Positioning Systems	3	0	0	3	II
21.	P15COTE21	Radar Signal Processing	3	0	0	3	III
22.	P15COTE22	Electromagnetic Interference and Compatibility in System Design	3	0	0	3	II
23.	P15COTE23	Communication Protocol Engineering	3	0	0	3	III
24.	P15COTE24	Simulation of Communication Systems and Networks	3	0	0	3	III
25.	P15COTE25	Space Time Wireless Communication Systems	3	0	0	3	II
26.	P15COTE26	Cognitive Radio	3	0	0	3	II
27.	P15COTE27	Advanced Wireless Communication Techniques	3	0	0	3	III
28.	P15COTE28	Mobile Communication Systems and Standards	3	0	0	3	III
29.	P15COTE29	Multiuser Detection	3	0	0	3	III
30.	P15COTE30	Wireless Sensor Networks	3	0	0	3	III
31.	P15COTE31	RF MEMS	3	0	0	3	II
32.	P15COTE32	Internetworking Multimedia	3	0	0	3	I
Special Electives							
33.	P15COSE01	Research Methodology	0	0	0	3	III
34.	P15COSE02	Multirate Signal Processing	0	0	0	3	III

Employability Enhancement Courses (EEC)

S. No.	Course Code	Course Title	Hours/Wk & Credits				Preferred Semester
			L	T	P	C	
1.	P15COP301	Project Work Phase I	0	0	12	6	III
2.	P15COP401	Project Work Phase II	0	0	24	12	IV

One Credit Course *

S. No.	Course Code	Course Title	Name of the Company
1.	P15COIN01	Network Routing	Brocade Communications, Bangalore.
2.	P15COIN02	Wireless System Design	STEPS Knowledge Services P Ltd, Coimbatore
3.	P15COIN03	Telematics	STEPS Knowledge Services P Ltd, Coimbatore
4.	P15COIN04	Automotive Communication Systems	Robert Bosch Engineering and Business Solutions Limited CHIL-SEZ, Keeranatham Village, Coimbatore – 641 035.

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1. Overall CGPA will not include the credits scored in these courses.
2. One credit courses can be opted only during 1st to 3rd semester and is restricted to one course per semester.

SEMESTER – I

	Course Code	Course Title	Category	Contact Hours	L	T	P	C
Theory								
1.	P15MAT108	Applied Algebra	FC	60	3	1	0	4
2.	P15COT101	Microwave Integrated Circuits	PC	45	3	0	0	3

3.	P15COT102	Advanced Digital Communication Techniques	PC	60	3	1	0	4
4.	P15COT103	Advanced Signal Processing	FC	60	3	1	0	4
5.	P15COT104	Optical Communication Networks	PC	45	3	0	0	3
6.	E1	Elective I	PE	45	3	0	0	3
Practicals								
7.	P15COP101	Communication Systems laboratory	PC	30	0	0	2	1
Total credits								22
			SEMESTER – II					
	Course Code	**Course Title**	**Category**	**Contact Hours**	**L**	**T**	**P**	**C**
Theory								
1.	P15COT201	Wireless Communication Engineering	PC	45	3	0	0	3
2.	P15COT202	Data Compression Techniques	PC	60	3	1	0	4
3.	P15COT203	Advanced Radiation Systems	PC	45	3	0	0	3
4.	E2	Elective II	PE	45	3	0	0	3
5.	E3	Elective III	PE	45	3	0	0	3
6.	E4	Elective IV	PE	45	3	0	0	3
Practicals								
7.	P15COP201	Advanced Communication laboratory	PC	30	0	0	2	1
Total credits								**20**
			SEMESTER – III					
	Course Code	**Course Title**	**Category**	**Contact Hours**	**L**	**T**	**P**	**C**
Theory								
1.	E5	Elective V	PE	45	3	0	0	3
2.	E6	Elective VI .	PE	45	3	0	0	3

3.	E7	Elective VII	PE	45	3	0	0	3
4.	E8	Self study course	PE	--	0	0	0	3
Practicals								
5.	P15COP301	Project Work (Phase I)	EEC	--	0	0	12	6
Total credits								**18**
SEMESTER – IV								
	Course Code	**Course Title**	**Category**	**Contact Hours**	**L**	**T**	**P**	**C**
Practicals								
1.	P15COP401	Project Work (Phase II)	EEC	--	0	0	24	12
Total credits								**12**
Total Credit for the programme								**72**

SEMESTER I

DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING
M.E. COMMUNICATION SYSTEMS
REGULATIONS 2015
SYLLABUS

P15MAT108 APPLIED ALGEBRA
(Common to both Applied Electronics and Communication Systems)

L	T	P	C
3	1	0	4

Course Outcomes (COs):
Upon completion of the course the student should be able to:

CO1: Solve linear equations and apply it to real-time problems.
CO2: Apply matrix algebra and determinants to solve problems.
CO3: Compute Eigen values, Eigen vectors and use linear transformations.
CO4: Apply Gram-Schmidt orthogonalization procedure to compute orthogonal bases.
CO5: Develop probabilistic models for observed phenomena

Pre-requisites:
1. Engineering Mathematics

Hrs

LINEAR EQUATIONS **09+03**
System of linear equations - Row reduction & Echelon forms -Vector equations - Matrix equation Ax=b - Solution sets of linear systems: Direct and Iterative methods - Application of linear systems - Linear Independence

MATRIX ALGEBRA **09+03**
Matrix operations - Inverse of a matrix - Characteristics of invertible matrices - Partitioned matrices - Matrix factorizations - Subspaces of Rn - Dimension & rank - Introduction to determinants - Properties of determinants - Cramer's rule.

VECTOR SPACES **09+03**
Vector spaces & subspaces - Null spaces, column spaces & linear transformations - Linearly independent sets; Bases - Coordinate systems - Dimension of a vector space – Rank - Change of basis- Eigen values & Eigen vectors - Characteristic equation –Diagonalization of symmetric matrices - Eigenvectors & linear transformations - Complex Eigen values - Applications to differential equations.

ORTHOGONALITY AND LEAST SQUARES **09+03**
Inner product, Length and Orthogonality - Orthogonal sets - Orthogonal projections –Gram - Schmidt process - Inner product spaces - Applications of inner product spaces - Quadratic forms - Singular value decomposition - Applications to image processing

RANDOM VARIABLES **09+03**
One-dimensional Random Variables – Moments and MGF – Binomial, Poisson, Geometric, Exponential and Normal distributions – Two-dimensional Random Variables – Marginal and

Conditional distribution – Covariance and Correlation coefficient.

Theory 45 Hrs **Tutorial 15 Hrs** **Total 60 Hrs.**

REFERENCES:

1. David C. Lay, Steven R Lay and Judy J McDonald "**Linear Algebra and its Applications**",Global Edition Pearson Education Ltd , 2015
2. Gilbert Strang, "**Linear Algebra and its Applications**",Cencage Learning (RS), Fouth edition, 2007
3. Seymour Lipschutz , Marc Lipson, "**Schaum's Outline of Linear Algebra**", McGraw Hill , Fifth Edition, 2013
4. Howard A. Anton , "**Elementary Linear Algebra**", John Wiley & Sons, Ninth Edition, 2008
5. Veerarajan. T., " **Probability and Random Process**", Tata McGraw Hill,2008

P15COT101 MICROWAVE INTEGRATED CIRCUITS

L	T	P	C
3	0	0	3

Course Outcomes (COs):
Upon completion of the course, the student should be able to:

CO1: Describe the various types of microstrip line components.
CO2: Compare the Hybrid microwave integrated circuits and monolithic microwave integrated circuits.
CO3: Analyze the performance of microstrip lines using different methods.
CO4: Design of microstrip lines for a given set of parameters.
CO5: Design lumped elements for a given set of parameters

Pre-requisites:
1. Microwave Engineering
2. Transmission lines and wave guides

Hrs

TECHNOLOGY OF HYBRID MICS **09**
Microwave integrated circuits, an overview- Rationale for (MICs)-Types of MICs and their Technology-Dielectric substrates - thick film technology and materials - thin film technology and Materials – methods of testing – encapsulation of devices for MICs – mounting of active Devices.

TECHNOLOGY OF MONOLITHIC MICS **09**
Processes involved in fabrication – epitaxial growth of semiconductor layer – growth of Dielectric layer – diffusion-ion implantation – Range versus energy relationship- Lattice damage and annealing.

ANALYSIS OF MICROSTRIP LINE **09**
Methods of conformal transformation – numerical method for analysis – hybrid mode Analysis – coupled mode analysis- method of images – losses in microstrips.

COUPLED MICROSTRIPS, SLOT LINE AND COPLANAR WAVEGUIDE **09**
Coupled microstrips – even and odd mode analysis – microstrip directional couplers – Branch line couplers – periodic branch line couplers – synchronous branch line couplers- Introduction to Slot line and Coplanar Wave guides.

LUMPED ELEMENTS AND NON-RECIPROCAL COMPONENTS **09**
Design and fabrication using Micro strip – flat resistors – flat inductors – interdigital Capacitors – sandwich capacitors – ferromagnetic substrates for non-reciprocal devices – Micro strip circulators – latching circulators – isolators – phase shifters.

Theory 45 Hrs **Tutorial -- Hrs** **Total 45 Hrs.**

REFERENCES:

1. Gupta,K.C, and Amarjit Singh, **"Microwave Integrated Circuits",** John Wiley and sons – Wiley Eastern Reprint, 1978.
2. Hoffmann, R.K, **"Handbook of Microwave Integrated Circuits",** Artech House, 1987.

P14COT102 ADVANCED DIGITAL COMMUNICATION TECHNIQUES

L	T	P	C
3	1	0	4

Course Outcomes (COs):
After successful completion of this course, the student should be able to:

CO1: Formulate a mathematical model for digital modulation schemes.
CO2: Design optimum coherent and non coherent receiver for digital modulation schemes
CO3: Apply mathematical modeling for BER analysis and Band width calculation of digital modulation schemes
CO4: Compare the performance of linear block codes
CO5: Design channel encoder and decoder based on the given specification using the channel coding algorithms.

Pre-requisites:
1. Digital Communication
2. Digital Signal Processing

Hrs

DIGITAL MODULATION TECHNIQUES **09+03**
Representation of Digitally Modulated signals, Memory less Modulation Methods, Signaling Schemes with Memory –CPFSK, CPM, Power Spectrum of Digitally Modulated Signals-PSD of a digitally modulated signal with memory, PSD of a linear modulated signal, PSD of a digitally modulated signal with Finite memory, PSD of a digitally modulation scheme with a Markov Structure.

OPTIMUM RECEIVERS FOR AWGN CHANNEL **09+03**
Waveform and vector channel Models, Waveform and vector AWGN channel, Optimal Detection and Error Probability for band limited Signaling, Optimal Detection and Error Probability for power limited signaling. Non-coherent detection of carrier modulated signals, Optimal Noncoherent detection of FSK modulated signals, Error probability of Orthogonal signaling with Noncoherent detection, Differential PSK (DPSK).

CHANNEL CODING
BCH codes, Reed – Solomon Codes, Low Density Parity Check codes, Coding for channels with burst errors-Interleavers, Combining Codes.
Convolutional codes- Decoding of Convolutional codes- Distance properties of Convolutional codes, Turbo codes and iterative decoding, Trellis Coded Modulation.

SPREAD SPECTRUM COMMUNICATION
Model of Spread Spectrum Digital Communication System, Direct Sequence Spread Spectrum Signals, Frequency-Hopped Spread Spectrum Signals, CDMA- Multi user detection in CDMA- Synchronization of SS systems.

COMMUNICATION THROUGH BAND LIMITED CHANNELS **09+03**
Band Limited Channels- ISI – Nyquist Criterion- Controlled ISI-Partial Response signals-Optimum receiver for channels with ISI and AWGN. Equalization algorithms – Linear equalizer – Decision feedback equalization – Adaptive Equalization algorithms. Reduced complexity ML detectors, Iterative equalization and decoding-Turbo equalization.

Theory 45 Hrs **Tutorial 15 Hrs** **Total 60 Hrs.**

REFERENCES:

1. John G. Proakis., and Masoud Salehi. **“Digital Communication”** , McGraw- Hill, International Edition 2008
2. M.K.Simon, S.M.Hinedi and W.C.Lindsey, **“Digital communication techniques; Signaling and detection”**, prentice Hall India, New Delhi.1995.
3. Simon Haykin, **“Digital communications”**, John Wiley and sons, 2006.
4. B.P.Lathi **“Modern digital and analog communication systems”**, 3rd Edition, Oxford University press 1998.
5. Andrew J. Viterbi, “**CDMA: Principles of Spread Spectrum Communications,**”Prentice Hall, USA, 1995.

P15AET103/P15COT103 ADVANCED SIGNAL PROCESSING
(Common to Applied Electronics and Communication Systems)

L	T	P	C
3	1	0	4

Course Outcomes (COs):
Upon completion of the course, the student should be able to:

CO1: Employ the concepts of discrete random processes and parameter estimation.
CO2: Distinguish between parametric and nonparametric methods of power spectrum estimation.
CO3: Relate concepts of linear prediction and Wiener filtering.
CO4: Analyze concepts of adaptive filtering.
CO5: Apply the concepts of multi-rate signal processing to real time problems.

Pre-requisites:
1. Digital Signal Processing
2. Random Processes

Hrs

DISCRETE RANDOM SIGNAL PROCESSING **09+03**
Discrete Random Processes- Ensemble averages, stationary processes, Autocorrelation and Auto covariance matrices- Parameter estimation: Bias and consistency - Parseval's Theorem, White Noise, Power spectrum, Wiener-Khintchine Relation, Filtering random Processes, Spectral Factorization

SPECTRUM ESTIMATION **09+03**
Non-Parametric Methods - Periodogram Estimator, Performance Analysis of Estimators -Unbiased, Consistent Estimators- Modified Periodogram, Bartlett and Welch methods, Blackman –Tukey method. AR, MA, ARMA processes - Yule-Walker equations - Parametric methods of Spectral Estimation

LINEAR ESTIMATION AND PREDICTION **09+03**
Linear prediction- Forward and backward predictions, Lattice filter realization, Prony’s all pole modeling, Solutions of the Normal equations- Levinson-Durbin recursion - Levinson recursion. Optimum filters- FIR Wiener filter –Causal and Non-causal IIR Wiener filter-Discrete Kalman filter

ADAPTIVE FILTERS **09+03**
FIR adaptive filters -adaptive filter based on steepest descent method- LMS adaptive algorithm, Normalized LMS. Adaptive channel equalization-Adaptive echo cancellation-Adaptive noise cancellation- Adaptive recursive filters (IIR). RLS adaptive filters-Exponentially weighted RLS-sliding window RLS.

MULTIRATE DIGITAL SIGNAL PROCESSING **09+03**
Mathematical description of change of sampling rate - Interpolation and Decimation, Decimation by an integer factor - Interpolation by an integer factor, Sampling rate conversion by a rational factor, Multistage implementation of multirate system, Direct form FIR filter structures, Polyphase filter structures, Subband Coding, Quadrature Mirror Filters – Condition for perfect reconstruction, Applications of Multirate systems

Theory 45 Hrs **Tutorial 15 Hrs** **Total 60 Hrs.**

REFERENCES:

1. Monson H.Hayes, **“Statistical Digital Signal Processing and Modeling”**, John Wiley and Sons, Inc., 2008
2. John G. Proakis, Dimitris G.Manolakis, **“ Digital Signal Processing’** Pearson Education**,** 2013.
3. John G. Proakis et.al., **“Algorithms for Statistical Signal Processing’,** Pearson Education, 2002.
4. Dimitris G.Manolakis et.al., **“Statistical and adaptive signal Processing”,** McGraw Hill, New York, 2005.

P15COT104 OPTICAL COMMUNICATION NETWORKS

L	T	P	C
3	0	0	3

Course Outcomes (COs):
Upon completion of the course, the student should be able to:

CO1: Interpret functions of various optical network components.
CO2: Analyze broadcast-and-select and wavelength routing networks
CO3: Compare different optical network architectures.
CO4: Explain photonic packet switching concepts and access networks.
CO5: Analyze different network management functions.

Pre-requisites:
1. Optical Communication
2. Computer Networks

Hrs

OPTICAL SYSTEM COMPONENTS **09**
Light propagation in optical fibers – Loss & bandwidth, System limitations, Non-Linear effects; Solitons; Optical Network Components – Couplers, Isolators & Circulators, Multiplexers & Filters, Optical Amplifiers, Switches, Wavelength Converters.

OPTICAL NETWORK ARCHITECTURES **09**
Introduction to Optical Networks; SONET / SDH, Metropoliton-Area Networks, Layered Architecture ; Broadcast and Select Networks – Topologies for Broadcast Networks, Media-Access Control Protocols, Testbeds for Broadcast & Select WDM; Wavelength Routing Architecture.

WAVELENGTH ROUTING NETWORKS **09**
The optical layer, Node Designs, Optical layer cost tradeoff, Routing and wavelength assignment,Virtual topology design, Wavelength Routing Testbeds, Architectural variations.

PACKET SWITCHING AND ACCESS NETWORKS **09**
Photonic Packet Switching – OTDM, Multiplexing and Demultiplexing, Synchronisation, Broadcast OTDM networks, Switch-based networks; Access Networks – Network Architecture overview, Future Access Networks, Optical Access Network Architectures; and OTDM networks.

NETWORK DESIGN AND MANAGEMENT **09**
Transmission System Engineering – System model, Power penalty - transmitter, receiver, Optical amplifiers, crosstalk, dispersion; Wavelength stabilization ; Overall design considerations; Control and Management – Network management functions, Configuration management, Performance management, Fault management, Optical safety, Service interface.

Theory 45 Hrs **Tutorial -- Hrs** **Total 45 Hrs.**

REFERENCES:

1. Rajiv Ramaswami and Kumar N. Sivarajan, **“Optical Networks : A Practical Perspective”**, Harcourt Asia Pte Ltd., Second Edition 2004.
2. C. Siva Ram Moorthy and Mohan Gurusamy, **“WDM Optical Networks : Concept, Design and Algorithms”**, Prentice Hall of India, Ist Edition, 2002.
3. Vivek Alwayn, **“Optical Network Design and Implementation”,** Pearson Education,2004.
4. Hussein T.Mouftab and Pin-Han Ho, **“Optical Networks: Architecture and Survivability”,** Kluwer Academic Publishers, 2002.
5. Biswanath Mukherjee, **“Optical Communication Networks”,** McGraw Hill, 1997.
6. P.E. Green, Jr., **“Fiber Optic Networks”,** Prentice Hall, NJ, 1993

P15COP101 COMMUNICATION SYSTEMS LABORATORY

L	T	P	C
0	0	2	1

Course Outcomes (COs):

Upon completion of the course, the student should be able to:

CO1: Analyze the performance of different modulation schemes, channel coding techniques and optical communication systems by simulation over AWGN channel.

CO2: Measure the parameter of microstrip line and components

CO3: Design and implement signal processing algorithms using simulation software.

CO4: Implement channel coding techniques

Pre-requisites:

1. Digital Communication
2. Microwave Engineering

LIST OF EXPERIMENTS

1. Measurement of microstrip line parameters.
2 Simulation of Modulation techniques in AWGN Communication Channel.
3. Simulation of Channel Coding in AWGN Communication Channel.
4. Implementation of Linear and Cyclic Codes.
5. Implementation of Adaptive Filters.
6. Simulation of power spectral estimation methods.
7. Analysis of multistage multirate system using Simulation Packages.
8. Performance evaluation of Digital Data Transmission through Fiber Optic Link.
9. Simulation of QMF.
10. Characteristics Measurement of micro strip directional coupler parameters.

TOTAL 30 Hrs

Software Requirement: MATLAB, CAD FEKO, OPTSIM

SEMESTER-II

P15COT201 WIRELESS COMMUNICATION ENGINEERING

L	T	P	C
3	0	0	3

Course Outcomes (COs):
Upon completion of the course, the student should be able to:

CO1: Explain various wireless channel models.
CO2: Analyze the performance of digital modulation schemes over wireless channel
CO3: Compare different diversity and combining techniques
CO4: Explain and analyze multicarrier modulation technique
CO5: Compare spread spectrum techniques.
CO6: Describe various standards for wireless systems.

Pre-requisites:
1. Digital Communication
2. Communication Theory
3. Digital Signal Processing

Hrs

WIRELESS CHANNEL MODELS **09**
Overview of wireless systems – path loss model for wireless channels – Time and Frequency coherence – Statistical multipath channel models – Capacity of wireless Channel -Capacity of Flat Fading Channel –– Channel Distribution Information known – Channel Side Information at Receiver – Channel Side Information at Transmitter and Receiver –Capacity with Receiver diversity – Capacity comparisons – Capacity of Frequency Selective Fading channels

DIGITAL MODULATION AND DIVERSITY TECHNIQUES **09**
Performance of Digital Modulation over Wireless Channel-Fading– Outage Probability– Average Probability of Error –– Combined Outage and Average Error Probability – Doppler Spread – Intersymbol Interference.
Realization of Independent Fading Paths – Receiver Diversity – Selection Combining – Threshold Combining – Maximal-Ratio Combining – Equal - Gain Combining – Transmitter Diversity – Channel known at Transmitter – Channel unknown at Transmitter – The Alamouti Scheme.

MULTICARRIER MODULATION **09**
Data Transmission using Multiple Carriers – Multicarrier Modulation with Overlapping Subchannels – Mitigation of Subcarrier Fading – Discrete Implementation of Multicarrier Modulation – Peak to average Power Ratio- Frequency and Timing offset – Case study IEEE 802.11a,OFDM,MC CDMA.

MIMO COMMUNICATIONS **09**
Narrowband MIMO model, Parallel decomposition of the MIMO channel, MIMO channel capacity, MIMO Diversity Gain:Beamforming, Diversity-Multiplexing trade-offs, Space time Modulation and coding : STBC,STTC, Spacial Multiplexing and BLAST Architectures

WIRELESS SYSTEMS AND STANDARDS **09**

Multiple Access – FDMA – TDMA – CDMA – SDMA – Hybrid Techniques, Random Access, Power Control, Downlink (Broadcast) Channel Capacity, Uplink (multiple Access) Channel Capacity, Uplink–Downlink Duality, Multiuser Diversity, MIMO Multiuser Systems.

Theory 45 Hrs **Tutorial -- Hrs** **Total 45 Hrs.**

REFERENCES:

1. Andrea Goldsmith, **"Wireless Communications",** Cambridge University Press, 2005.
2. T.S. Rappaport, **"Wireless Communications",** Pearson Education, 2003.
3. David Tse and Pramod Viswanath, **"Fundamentals of Wireless Communication",** Cambridge University Press, 2005.
4. W.C.Y.Lee, **"Mobile Communication Engineering",** Mc Graw Hill, 2000.
5. A.Paulraj, R.Nabar, D.Gore, **"Introduction to Space-Time Wireless Communication",**Cambridge University Press, 2003.

P15COT202 DATA COMPRESSION TECHNIQUES

L	T	P	C
3	1	0	4

Course Outcomes (COs):
Upon completion of the course, the student should be able to:

CO1: Explain the various compression and quantization techniques.
CO2: Discuss various data compression algorithms and compare their efficiency in terms of speed and compression ratio.
CO3: Analyze different compression techniques and standards for image and video
CO4: Compare various video compression standards.
CO5: Apply knowledge for identifying a suitable strategy for compression of text, image, audio and video

Pre-requisites:
1. Statistical theory of communication

Hrs

INTRODUCTION **09+03**
Multimedia data - features — Storage requirements for multimedia - Need for Compression - Taxonomy of compression – Metrics – Quantitative and Qualitative techniques - Overview of source coding – Scalar quantization - Adaptive - Vector quantization.

TEXT COMPRESSION **09+03**
Characteristics of text data – RLE, Huffmann coding – Adaptive Huffmann Coding – Arithmetic coding — Dictionary techniques – static and adaptive- digram coding – LZW algorithm - GIF, TIF, JBIG, JBIG2.

AUDIO COMPRESSION **09+03**
Fundamental concepts of digital audio - Audio compression techniques –μ Law and A- Law companding - PCM, DPCM, DM, ADM - sub-band coding – Application to speech coding – G.722 – MPEG audio – MP3 - Model based coding – Channel Vocoders – LPC - Formant and CELP coders.

IMAGE COMPRESSION **09+03**
Image data representation - Predictive techniques – DPCM: Optimal Predictors and Optimal Quantizers –Transform Coding – JPEG Standard – Sub-band coding – QMF Filters - Wavelet based compression – EZW, SPIHT coders – JPEG 2000 standard – File formats.

VIDEO COMPRESSION **09+03**
Fundamental concepts of video – digital video signal - video formats – AVI, FLV, MP4, Real media - Motion estimation and compensation Techniques, Full search motion estimation methods – MPEG Video Compression standards: MPEG – 1, 2, 4, 7 and 21 — H.26X Standard - Packet Video.

Theory 45 Hrs **Tutorial 15 Hrs** **Total 60 Hrs.**

REFERENCES:

1. Khalid Sayood, **" Introduction to Data Compression",** Morgan Kauffman Harcourt India, 4^{th} Edition, 2012.
2. David Salomon, **" Data Compression – The Complete Reference",** Springer Verlag New York Inc., 2nd Edition, 2012.
3. Mark S. Drew, Ze-Nian Li, Jiangchuan Liu , **" Fundamentals of Multimedia",** Prentice Hall of India, 1st Edition, 2014.
4. Yun Q.Shi, Huifang Sun, **" Image and Video Compression for Multimedia Engineering - Fundamentals, Algorithms & Standards"**, CRC press, 2003
5. Peter Symes , **"Digital Video Compression",** McGraw Hill Pub., 2004.
6. Mark Nelson , **"Data compression"**, BPB Publishers, New Delhi,1998.

P15COT203 ADVANCED RADIATION SYSTEMS

L	T	P	C
3	0	0	3

Course Outcomes (COs):
Upon completion of the course, the student should be able to:

CO1: Describe the various types of microwave antennas.
CO2: Compare the various types of antenna arrays.
CO3: Design of patch antennas for given set of parameters.
CO4: Analyze and compare various types of antennas
CO5: Compare various polarisation of Electro-magnetic fields emitted by the antennas.

Pre-requisites:
1. Antennas and wave propagation
2. Electromagnetic Fields
3. Transmission lines and wave guides

Hrs

CONCEPTS OF RADIATION **09**
Retarded vector potentials – Heuristic approach and Maxwell's equation approach. The Lorentz gauge condition. Vector potential in Phasor form. , Antenna parameters,Alternating current element. . Radiation from Half wave dipole . Electric vector potential F for a magnetic current source M. Far zone fields due to magnetic source M.planar antenna,planar arrays,array factor,planar spiral antennas

ANTENNA ARRAYS **09**
N element linear arrays – uniform amplitude and spacing. Phased arrays. Directivity of Broadside and End fire arrays. Three dimensional characteristics. Binomial arrays and Dolph-Tchebycheff arrays. Circular array. Antenna Synthesis- Line source and Discretization of continuous sources. Schelkunoff polynomial method. Fourier Transform method.

APERTURE ANTENNAS **09**
Magnetic current – Duality. Electric and Magnetic current sheets as sources. Huyghens Source. Radiation through an aperture in an absorbing screen. Fraunhoffer and Fresnel diffraction. Cornu Spiral. Complimentary screens and slot antennas. Slot and dipoles as Dual antennas. Babinets principle. Fourier transform in aperture antenna theory.

HORN, MICROSTRIP, REFLECTOR ANTENNAS **09**
E and H plane sectoral Horns. Pyramidal horns. Conical and corrugated Horns. Microstrip antennas – feeding methods. Rectangular patch- Transmission line model. Parabolic Reflector antennas – Prime focus and Cassegrain reflectors. Equivalent focal Length of Cassegrain antennas. Spillover and taper efficiencies. Optimum illumination.

ANTENNA POLARIZATION **09**
Simple relationship involving, spherical triangles. Linear, Elliptical and circular Polarization. Development of the Poincare sphere. Representation of the state of polarization in the Poincare sphere. Random polarization – Stokes parameters.

Theory 45 Hrs **Tutorial -- Hrs** **Total 45 Hrs.**

REFERENCES:

1. Jordan, E.C and Balmaian, **“Electromagnetic waves and Radiating systems”,** PHI, 2003.
2. Balanis, C.A, **“Antenna Theory”,** Wiley,2003,

3 Krauss, J.D, **“Radio Astronomy”,** McGraw-Hill 1966

4. Krauss, J.D, Fleisch,D.A, **“Electromagnetics”**, McGraw-Hill,1999.

P15COP201 ADVANCED COMMUNICATION LABORATORY

L	T	P	C
0	0	2	1

Course Outcomes (COs):

Upon completion of the course, the student should be able to:

CO1: Analyze the performance of different modulation schemes, channel coding techniques and Spread Spectrum techniques by simulation over fading channel.

CO2: Compare various data compression algorithms

CO3: Analyze the performance of image coding algorithms.

CO4: Design and analyze microstrip devices.

CO5: Design and analyze optical communication system.

Pre-requisites:

1. Digital Communication
2. Multimedia Compression techniques
3. Microwave Engineering
4. Wireless Communication
5. Optical Communication

LIST OF EXPERIMENTS

1. Simulation of Modulation techniques in fading Channel.
2 Simulation of Channel Coding in fading Channel.
3. Simulation of Audio and Speech compression algorithms
4. Simulation of EZW / SPIHT Image coding algorithm.
5. Radiation pattern analysis of Microstrip Antennas.
6. S-parameter estimation of Microstrip devices.
7. Simulation and analysis of Spread Spectrum Techniques: DSSS, OFDM
8. Design and testing of Microstrip Components.
9. Simulation and analysis of optical communication system. (Design the transmitter and receiver modules, use of different types and combinations of fibers, location and number of EDFAs deployed are your choice

TOTAL 30 Hrs

Software Requirement: MATLAB, CAD FEKO, OPTSIM

ELECTIVES

P15AETE01/P15COTE01 ADVANCED DIGITAL IMAGE PROCESSING
(Common to Applied Electronics and Communication Systems)

L	T	P	C
3	0	0	3

Course Outcomes (COs):

After successful completion of this course, the student should be able to:

CO1: Demonstrate knowledge of image acquisition, digitization and spatial filters for enhancement
CO2: Employ color image processing techniques.
CO3: Apply morphological image processing algorithms.
CO4: Apply segmentation algorithms and descriptors for image processing.
CO5: Use neural networks, fuzzy logic and genetic algorithms in object recognition.
CO6: Apply compression, watermarking and steganography algorithms to images.

Pre-requisites:

1. Digital Image Processing

Hrs

FUNDAMENTALS OF DIGITAL IMAGE PROCESSING **09**

Elements of Visual Perception- Image acquisition, digitization- Histogram - Image enhancement – Spatial filters for smoothing and sharpening – Discrete 2D transforms - DFT, DCT, Walsh-Hadamard, Slant, KL, Wavelet Transform – Haar wavelet.

COLOR IMAGE PROCESSSING 09

Color Image Fundamentals-Color Models- RGB, CMY, CMYK and HSI Color Models- Pseudocolor Image Processing - Intensity Slicing- Intensity to Color transformations -Basics of Color Image Processing- Color Transformation - Color Image Smoothing and Sharpening- Color Segmentation - Noise in Color Images.

MORPHOLOGICAL IMAGE PROCESSING **09**

Preliminaries- Basic Concepts from Set Theory-Logic Operations Involving Binary Images -Dilation and Erosion –Opening and Closing - Hit-or-Miss Transformation - Basic Morphological Algorithms -Boundary Extraction- Region Filling- Extraction of Connected Components- Convex Hull- Thinning-Thickening-Skeletons- Pruning- - Gray-Scale Morphology.

SEGMENTATION, REPRESENTATION AND DESCRIPTION **09**

Edge Detection - Edge Linking and Boundary Detection -Thresholding- Segmentation by Morphological Watershed Segmentation Algorithm - Use of Markers- Representation and Boundary Descriptors.

OBJECT RECOGNITION AND IMAGE PROCESSING APPLICATIONS **09**

Patterns and Pattern Classes -Recognition Based on Decision-Theoretic Methods -Matching - Optimum Statistical Classifiers- Neural Networks, Fuzzy Systems - GA. Image compression- JPEG, JPEG2000 JBIG standards - Watermarking - Steganography.

Theory 45 Hrs **Tutorial -- Hrs** **Total 45 Hrs.**

REFERENCES

1. Rafael C. Gonzalez, **"Digital Image Processing",** Pearson Education, Inc., 3rd Edition, 2008.
2. Milman Sonka, Vaclav Hlavac, Roger Boyle, **"Image Processing, Analysis and Machine Vision",** Brooks/Cloe, Vikas Publishing House 2nd Edition, 1999.
3. Khalid Sayood, **"Data Compression",** Morgan Kaufmann Publishers (Elsevier)., 3rd Edition, 2006.
4. Rafael C. Gonzalez, Richards E.Woods, Steven Eddins, "**Digital Image Processing using MATLAB**", Pearson Education, Inc., 2004.
5. Willam K.Pratt, **"Digital Image Processing",** John Wiley, New York, 2002.

P15AETE02 /P15COTE02 SOFT COMPUTING
(**Common to Applied Electronics and Communication Systems)**

L	T	P	C
3	0	0	3

Course Outcomes (COs):
Upon completion of the course, the student should be able to:

CO1: Classify optimization algorithms.
CO2: Explain the concepts of neural network theory.
CO3: Discuss the principles of genetic algorithms.
CO4: Apply neural networks, fuzzy logic and genetic algorithms for optimization problems
CO5: Develop neuro fuzzy models for real-time applications.

Pre-requisites:
Nil

Hrs

ARTIFICIAL NEURAL NETWORKS 09
Supervised learning Neural networks-Introduction, Perception- Adaline, Back propagation- Multi layer perception- Unsupervised learning and other Neural networks-Introduction, Competitive learning networks, Kohenen self organizing networks, Learning vector quantization, Hebbian learning, Hopfield network , Content addressable nature, Binary Hopfield network, Continuous-valued Hopfield network , Travelling Salesperson problem.

FUZZY SET THEORY 09
Fuzzy sets, Basic definitions and terminology, Member function formulation & parameterization, Fuzzy rules , fuzzy reasoning - Extension principle, Fuzzy relation, Fuzzy inference systems: Mamdani model, Sugeno model. Tsukamoto model, Input space partitioning, Fuzzy modeling.

OPTIMIZATION 09
Derivative based optimization-Descent methods, Method of steepest descent, Classical Newtons method, Step-size determination; Derivative free optimization- Genetic algorithm, Simulated annealing, Random search, Downhill search.

ADVANCED NEURO-FUZZY MODELLING 09
Classification and regression trees, decision tress, Cart algorithm – Data clustering algorithms: K-means clustering, Fuzzy C-means clustering, Mountain clustering, Subtractive clustering – rule base structure, Input space partitioning, rule based organization, focus set based rule combination; Neuro-fuzzy control: Feedback Control Systems, Expert Control, Inverse Learning, Specialized Learning, Back propagation through real time Recurrent Learning

GENETIC ALGORITHM 09
Fundamentals of genetic algorithm- Basic concepts - Encoding – Binary, Octal, Hex, Permutation, Value and tree, Reproduction- Roulette-wheel selection, Boltzman selection, Tournament selection, Rank selection, Steady state selection, Crossover single site, Two point, Multi point, Uniform and matrix, Crossover rate, Inversion, Deletion and duplication, Deletion and Regeneration, Segregation, Crossover, Mutation, Generational cycle

Theory 45 Hrs Tutorial -- Hrs Total 45 Hrs.

REFERENCES:

1. Jang J.S.R., Sun C.T and Mizutani E, **"Neuro Fuzzy and Soft computing",** Pearson education (Singapore) 2004.
2. S.Rajasekaran and G.A.Vijayalakshmi Pai, "**Neural networks, Fuzzy logic, and Genetic Algorithms"**, Prentice Hall of India, 2003.
3. David E.Goldberg, **"Genetic Algorithms in Search, Optimization, and Machine Learning",** Pearson Education, Asia,2002
4. Laurene Fauseett, **"Fundamentals of Neural Networks",** Prentice Hall India, New Delhi, 2004.
5. Timothy J.Ross, **"Fuzzy Logic Engineering Applications"**, McGrawHill, NewYork, 2011.

P15AETE03/P15COTE03 OPTIMIZATION TECHNIQUES
(Common to Applied Electronics and Communication Systems)

L	T	P	C
3	0	0	3

Course Outcomes (COs):
Upon completion of the course, the student should be able to:

CO1: Explain the theory of optimization methods and algorithms
CO2: Formulate problems that arise in engineering in terms of optimization problems
CO3: Analyze and apply appropriate optimization algorithms for solving problems.

Pre-requisites:
NIL

Hrs

CLASSICAL OPTIMIZATION TECHNIQUES 09
Single variable optimization, multivariable optimization with no constraints, multivariable optimization with equality constraints, multivariable optimization with inequality constraints, convex programming problem.

LINEAR PROGRAMMING 09
Simplex method, Duality, Non-Simplex Method, Integer Linear Programming

NONLINEAR PROGRAMMING 09
Elimination methods, Interpolation methods, Unconstrained optimization techniques - Direct search methods - Indirect search methods, Constrained Optimization methods – Direct methods, Indirect methods.

DYNAMIC PROGRAMMING 09
Multistage decision process, Concept of suboptimization and principle of optimality, computational procedure in dynamic programming.

MODERN OPTIMIZATION METHODS 09
Simulated annealing, Particle Swarm optimization, Ant colony optimization, Bee colony optimization, Cuckoo Search, Bat Algorithms, Firefly Algorithms.

Theory 45 Hrs **Tutorial -- Hrs** **Total 45 Hrs.**

REFERENCES:

1. Singiresu S Rao, **"Engineering Optimization: Theory and Practice",** 4th Edition, John Wiley and Sons, 2009
2. Xin-Sie Yang, **"Nature Inspired Optimization Techniques",** Elsevier, 2014.
3. Edwin K P Chong and Stanislaw S Zak, **"An Introduction to Optimization",** Fourth Edition, John Wiley and Sons, 2013

P15AETE04/ P15COTE04 NONLINEAR SIGNAL PROCESSING
(**Common to Applied Electronics and Communication Systems)**

L	T	P	C
3	0	0	3

Course Outcomes:
Upon completion of the course the student should be able to:

CO1: Explain the fundamentals of nonlinear filtering
CO2: Design nonlinear filters.
CO3: Analyze and use filters using order statistics
CO4: Explain the basics of Adaptive nonlinear filters
CO5: Understand the algorithms and architectures for nonlinear filtering
CO6: Apply nonlinear filters to image processing problems

Pre-requisite:
1. Advanced Digital Signal Processing

Hrs

INTRODUCTION TO NONLINEAR FILTERS AND STATISTICAL PRELIMINARIES **08**
Nonlinear filters - measure of robustness - M estimators - L estimators - R estimators - order statistics - median filter and their characteristics - impulsive noise filtering by median filters - Recursive and weighted median filters - stock filters.

NON LINEAR DIGITAL SIGNAL PROCESSING BASED ON ORDER STATISTICS **07**
Time ordered nonlinear filters - rank ordered nonlinear filters - max/median filtering - median hybrid filters - characteristics of ranked order filters - L filters - M filters - R filters - comparison.

ADAPTIVE NONLINEAR AND POLYNOMIAL FILTERS **10**
Definition of polynomial filters - Wiener filters - robust estimation of scale - Adaptive filter based on local statistics - Decision directed filters - Adaptive L filters - Comparison of adaptive nonlinear filters - Neural networks for nonlinear filter.

ALGORITHMS AND ARCHITECTURES **10**
Sorting and selection algorithm - running median algorithm - fast structures for median and order statistics filtering - systolic array implementation - Wavefront array implementation - quadratic digital filters implementation

APPLICATIONS OF NONLINEAR FILTERS **10**
Power spectrum analysis - Morphological image processing - nonlinear edge detection impulse noise rejection in image and bio signals - two component image filtering - speech processing

Theory 45 Hrs **Tutorial -- Hrs** **Total 45 Hrs.**

REFERENCES:

1. Loannis Pitas, Anastarios, N.Venetsanopoulos, **"Nonlinear Digital filters - Principles and Applications**", Kluwer Academic Publishers, 1990

2. Jaakko T.Astola, Jaakko Astola Kuosmanen, **"Fundamentals of Nonlinear Digital filtering",** CRC Press LLC, 1997
3. Wing Kuen Ling, **"Nonlinear Digital filters: Analysis and Applications**", Elsevier Science & Tech. 2007
4. Gonzalo R. Arce, **"Nonlinear Signal Processing - A statistical approach"**, Wiley Publishers, 2005

P15AETE05/P15COTE05 UNDERWATER ACOUSTIC SIGNAL PROCESSING
(**Common to Applied Electronics and Communication Systems)**

L	T	P	C
3	0	0	3

Course Outcomes:
Upon completion of the course the student should be able to:

CO1: Explain the procedure of sound propagation in ocean.
CO2: Analyze various noise sources in the ocean.
CO3: Understand the working of Sonar Systems.
CO4: Explain the working of various imaging sonars

Pre-requisite:

1. Advanced Signal Processing

Hrs

FUNDAMENTALS OF UNDERWATER ACOUSTICS 09
The Ocean acoustic environment, measuring sound level, Sources and receivers, relevant units, sound velocity in sea water, typical vertical profiles of sound velocity, Sound propagation in the Ocean- characteristic sound propagation paths-deep water and shallow water, Range dependent environment. Sound attenuation in sea water, Bottom Loss, Surface bottom and volume scattering, Snell's law for range dependent ocean.

AMBIENT NOISE IN THE SEA 09
Sources of ambient noise-introduction, different frequency bands of ambient noise, process of surface noise generation, shallow water, variability of ambient noise, spatial coherence of ambient noise, directional characteristics of ambient noise, intermittent sources of noise- biological & non biological (rain, earthquakes, explosions and valcanos).

SIGNALS, FILTERS AND RANDOM FUNCTIONS 09
Fourier representations, filters and noise, digital filter design techniques, temporal resolution and bandwidth of signals, signal to noise power ratio, Estimates of autocovariance, power spectrum, cross covariance and cross spectrum.

CHARACTERISTICS OF SONAR SYSTEMS 09
Sonar systems, active and passive sonar equations, transducers and their directivities, Sensor array characteristics-array gain, receiving directivity index, beam patterns, shading and super directivity, adaptive beamforming.

IMAGING SONARS 09
Sidescan Sonar, Synthetic Aperture Sonar, Multibeam Sonar – Principle of operation and Image formation.

Theory 45 Hrs **Tutorial -- Hrs** **Total 45 Hrs.**

REFERENCES:

1. Robert J Urick, "**Principles of Underwater Sound**" 3rd Edition Peninsula Publications, 3rd Edition, 2013
2. Robert J Urick, "**Ambient noise in the sea**" Peninsula Publications, 2nd Edition 1986.
3. Clay & Medwin , **" Acoustical Oceanography : Principles and Applications",** Academic Press, 1998
4. L.M.Brekhovskikh & Yu.P.Lysanov, **"Fundamental of ocean acoustics"** Springer, 2002.
5. Richard O.Nielsen, **"Sonar signal processing"**Artech House Acoustic Library 1991
6. A.D Waite, **"Sonar for Practising Engineers**", 3dr edition, Wiley, 20001

P15AETE06/P15COTE06 WAVELETS AND MULTI-RESOLUTION PROCESSING
(Common to Applied Electronics and Communication Systems)

L	T	P	C
3	0	0	3

Course Outcomes (COs):
Upon completion of the course, the student should be able to:

CO1: Illustrate the fundamentals of vectors, signals and their relationships.
CO2: Examine the convergence of signals in Hilbert and Fourier signal spaces.
CO3: Analyze signals using Multi Resolution Analysis
CO4: Assess the different family of wavelets for real-time applications
CO5: Apply wavelet transform for image processing
CO6: Explain the principle of non-linear wavelets.

Pre-requisites:
1. Digital Image processing
2. Signals and system

Hrs

INTRODUCTION **09**
Vector Spaces - properties - dot product - basis - dimension, orthogonality and orthonormality - relationship between vectors and signals - Signal spaces – concept of Convergence - Hilbert spaces for energy signals - Generalised Fourier Expansion.

MULTI RESOLUTION ANALYSIS **09**
Definition of Multi Resolution Analysis (MRA) – Haar basis - Construction of general orthonormal MRA-Wavelet basis for MRA – Continuous time MRA interpretation for the DTWT – Discrete time MRA- Basis functions for the DTWT – PRQMF filter banks

CONTINUOUS WAVELET TRANSFORM **09**
Wavelet Transform - definition and properties - concept of scale and its relation with frequency - Continuous Wavelet Transform (CWT) - Scaling function and wavelet functions (Daubechies, Coiflet, Mexican Hat, Sinc, Gaussian, Bi-Orthogonal) – Tiling of time -scale plane for CWT.

DISCRETE WAVELET TRANSFORM **09**
Filter Bank and sub band coding principles - Wavelet Filters - Inverse DWT computation by Filter banks -Basic Properties of Filter coefficients - Choice of wavelet function coefficients - Mallat's algorithm for DWT - Lifting Scheme: Wavelet Transform using Polyphase matrix Factorization – Geometrical foundations of lifting scheme - Lifting scheme in Z –domain

APPLICATIONS **09**
Image Compression using DWT – Sequential / Progressive - JPEG 2000 standard - Image denoising - Edge detection and object Isolation and Object Detection - Image Fusion -Wavelet Packets- Multiwavelets - Non linear wavelets – Ridgelets – Curvelets – Contourlets.

Theory 45 Hrs **Tutorial -- Hrs** **Total 45 Hrs.**

REFERENCES:

1. C. Sidney Burvus, Ramesh A.Gopinath haito , "**Introduction to wavelets and wavelet Transform",** Prentice Hall International, 1995.
2. Gilbert Strang, **"Linear Algebra and its Applications**", 3rd edition.
3. J.C. Goswami, A.K. Chan, **"Fundamentels of wavelets",** John wiley and sons, 1999.
4. Strang G, Nguyen T, **"Wavelets and Filter Banks,"** Wellesley Cambridge Press,1996.
5. Vetterli M, Kovacevic J, **"Wavelets and Sub-band Coding,"** Prentice Hall, 1995.
6. Mallat S., **"Wavelet Signal Processing",** Academic Press, 1996.

P15AETE07/ P15COTE07 SPARSE THEORY AND APPLICATIONS
(**Common to Applied Electronics and Communication Systems)**

L	T	P	C
3	0	0	3

Course Outcomes:
Upon completion of the course the student should be able to:

CO1: Analyze nonlinear multiscale transforms
CO2: Apply compressive sensing algorithms in space science
CO3: Identify relevant research problems
CO4: Contribute to the frontier research in the area

Pre-requisite:
1. Multiresolution Signal Processing
2. Wavelets and Multiresolution Processing

Hrs

SPARSITY AND WAVELET **09**
Sparse Representation: Sparsity, Sparsity Terminologies, Underdetermined Linear Systems - Regularization - Convexity - l_1Minimization - Moving to Sparse Solutions - The l_0 Norm and Implications - The P_0 Problem in sparse signal processing. Fourier to STFT, From STFT to Wavelets, From Wavelets to Over complete Representations.

DISCRETE WAVELET TRANSFORMS **09**
Continuous Wavelet transform (CWT), Definition of CWT and Inverse CWT, Discretization of CWT, Approximation of Vectors in nested vector spaces, Multiresolution analysis in $L^2(R)$, Haar scaling function, Haar wavelet, Haar wavelet decomposition, Wavelet Packets, Haar Wavelet Packets.

NONLINEAR MULTISCALE TRANSFORMS **10**
Decimated Nonlinear Transform – Multiresolution Based on the Median Transform - Guided Numerical Experiments - The Ridgelet and Curvelet Transforms: The Continuous Ridgelet Transform - The Rectopolar Ridgelet Transform - The Orthonormal Finite Ridgelet Transform - Sparse Representation by Ridgelets - The First-Generation Curvelet Transform - Sparse Representation by First-Generation Curvelets.

LINEAR INVERSE PROBLEMS **08**
Sparsity-Regularized Linear Inverse Problems - Monotone Operator Splitting Framework - Selected Problems and Algorithms - Sparsity Penalty with Analysis Prior - Other Sparsity Regularized Inverse Problems General Discussion: Sparsity, Inverse Problems and Iterative Thresholding.

COMPRESSIVE SENSING **09**
Incoherence and Sparsity, Sensing Protocol Stable Compressed Sensing Designing Good Matrices: Random Sensing Sensing with Redundant Dictionaries Compressed Sensing in Space Science Guided Numerical Experiments.

Theory 45 Hrs **Tutorial -- Hrs** **Total 45 Hrs.**

REFERENCES:

1. Jean-Luc Starck, Fionn Murtagh and Jalal M. Fadili, "**Sparse image and signal processing Wavelets, Curvelets, Morphological Diversity"**, Cambridge University press, First Edition, 2010.
2. Michael Elad**,"Sparse and Redundant Representations: From Theory to Applications in Signal and image processing"**, Spinger Science, Kindle Edition, 2010.
3. Do, M. N., and Vetterli, M and G. V. Welland (eds.), **"Contourlets Beyond Wavelets"**, in J. Stoeckler, Academic, San Diego, CA, First Edition, 2003.
4. Mallat, S, **"A Wavelet Tour of Signal Processing, The Sparse Way"**, Academic, San Diego, CA, Third Edition, 2008.
5. http://ese.wustl.edu/~nehorai/research/sparse/sparse_ref.html
6. http://en.wikipedia.org/wiki/Sparse approximation

P15COTE08 WIRELESS NETWORKS

L	T	P	C
3	0	0	3

Course Outcomes (COs):

Upon completion of the course, the student should be able to:

CO1: Analyze the design considerations of wireless modem
CO2: Formulate channel allocate techniques and capacity expansion FCA
CO3: Describe various wireless Wide Area Networking standards
CO4: Explain wireless LAN and WPAN standards
CO5: Discuss Geo-location systems

Pre-requisites:

1. Computer networks
2. Wireless communication

Hrs

PHYSICAL AND WIRELESS MAC LAYER ALTERNATIVES 09

Wired transmission techniques- design of wireless modems, power efficiency, out of band radiation, applied wireless transmission techniques, short distance base band transmission, UWB pulse transmission, broad Modems for higher speeds, diversity and smart receiving techniques, random access for data oriented networks, integration of voice and data traffic.

WIRELESS NETWORK PLANNING AND OPERATION 09

Wireless networks topologies, cellular topology, cell fundamentals signal to interference ratio calculation, capacity expansion techniques, cell splitting, use of directional antennas for cell sectoring, micro cell method, overload cells, channels allocation techniques and capacity expansion FCA, channel borrowing techniques, DCA, mobility management, radio resources and power management securities in wireless networks.

WIRELESS WAN 09

Mechanism to support a mobile environment, communication in the infrastructure, IS-95 CDMA forward channel, IS – 95 CDMA reverse channel, pallert and frame formats in IS – 95, IMT – 2000; forward channel in W-CDMA and CDMA 2000, reverse channels in W-CDMA and CDMA-2000, GPRS and higher data rates, short messaging service in GPRS mobile application protocols.

WIRELESS LAN 09

Historical overviews of the LAN industry, evolution of the WLAN industry, wireless home networking, IEEE 802.11.The PHY Layer, MAC Layer, wireless ATM, HYPER LAN, HYPER LAN – 2.

WPAN AND GEOLOCATION SYSTEMS 09

IEEE 802.15 WPAN, Home RF, Bluetooth, interface between Bluetooth and 802.11, wireless geo-location technologies for wireless geo-location, geo-location standards for E.911 service.

Theory 45 Hrs **Tutorial -- Hrs** **Total 45 Hrs.**

REFERENCES:

1. Kaveh Pahlavan, Prashant Krishnamoorthy, "**Principles of Wireless Networks"**, - A united approach - PearsonEducation,2002.
2. Jochen Schiller, "**Mobile Communications"**, Person Education – 2003, 2nd Edn.
3. X.Wang and H.V.Poor, "**Wireless Communication Systems"**, Pearson education, 2004.
4. M.Mallick, "**Mobile and Wireless design essentials"**, Wiley Publishing Inc. 2003.
5. P.Nicopolitidis, M.S.Obaidat, G.I. papadimitria, A.S. Pomportsis, "**Wireless Networks"**, John Wiley & Sons, 2003

P15COTE09 DETECTION AND ESTIMATION THEORY

L	T	P	C
3	0	0	3

Course Outcomes (COs):
Upon completion of the course, the student should be able to:

CO1: To apply the detection theory for system design and analysis.
CO2: To apply the various estimation theory for signal and system design and analysis

Pre-requisites:
1. Digital Signal Processing

Hrs

STATISTICAL DECISION THEORY **08**
Bayesian Hypothesis Testing - Likelihood Ratio Tests - Minimax Hypothesis Testing - Neyman Pearson Hypothesis Testing - Composite Hypothesis Testing - M'ary Hypothesis Testing

SIGNAL DETECTION IN DISCRETE TIME **08**
Deterministic Signals - Stochastic Signals – Models and Detector Structures – Performance Evaluation - Chernoff Bounds - Applications of Detection in Signal Processing

PARAMETER ESTIMATION **10**
Fundamentals of Estimation Theory - Minimum Variance Unbiased Estimation – Cramer Rao Lower bound – Best Linear Unbiased Estimators - Linear Least Squares Estimation – Nonlinear Least Squares Estimation - Maximum Likelihood Estimation

BAYESIAN ESTIMATION **09**
Bayesian philosophy – General Bayesian Estimators - Minimum Mean Square Error Estimators – Maximum A Posteriori Estimators – Linear MMSE Estimation

DISTRIBUTION-FREE ESTIMATION **10**
Orthogonality Principle – Autoregressive Techniques - Discrete Wiener Filter, Continuous Wiener Filter, Generalization of Discrete and Continuous Filter Representations, Kalman Filter, Extended Kalman Filter - Applications of Estimation in Signal Processing.

Theory 45 Hrs **Tutorial -- Hrs** **Total 45 Hrs.**

REFERENCES:

1. Thomas Schonhoff and Arthur A.Giordano, **"Detection and Estimation Theory",** Prentice Hall, 2007.
2. Kay S M, **"Fundamentals of Statistical Signal Processing, Volume 1: Estimation Theory",** Prentice Hall, 1993.
3. Kay S M, **"Fundamentals of Statistical Signal Processing, Volume 2: Detection Theory",** Prentice Hall, 1998.
4. Poor H V, **"An Introduction to Signal Detection and Estimation"**, Springer-Verlang, 1994.
5. Scharf L L, **"Statistical Signal Processing"**, Addison Wesley, 1991.

6. Sam Shanmugam K and Breipohl A M, **“Random Signals: Detection, Estimation and Data Analysis”**, John Wiley, 1988

P15COTE10 COMMUNICATION NETWORK SECURITY

L	T	P	C
3	0	0	3

Course Outcomes (COs):
Upon completion of the course, the student should be able to:

CO1: Classify the symmetric encryption techniques.
CO2: Illustrate various Public key cryptographic techniques.
CO3: Evaluate the authentication and hash algorithms
CO4: Elaborate the network security and web security techniques
CO5: Identify intrusion detection and its solutions to overcome the attacks.

Pre-requisites:
1. Computer Networks

Hrs

BASIC SYMMETRIC CIPHERS **09**
OSI security Architecture- Model for network Security, Classical Encryption Techniques- Symmetric Cipher Model-Substitution Techniques-Transposition Techniques- Stegnography, Block Ciphers and Data Encryption Standard- Block Cipher Design Principles-Data Encryption Standard- Strength of DES

ADVANCED SYMMETRIC CIPHERS **09**
AES Cipher- Multiple Encryption-Triple DES- Block Cipher Modes of Operation -Stream Ciphers and RC4, Confidentiality using Symmetric Encryption-Placement of Encryption Function, Traffic Confidentiality, Key Distribution and Random Number Generation.

PUBLIC-KEY ENCRYPTION AND HASH FUNCTIONS **09**
Public Key Cryptography and RSA- Principles of Public Key Cryptosystems, RSA Algorithm, Key Management - Diffie-Hellman Key Exchange, Elliptic Curve arithmetic, Elliptic Curve Cryptography, Message Authentication and Hash Functions- Authentication Requirements, Authentication Functions, Message Authentication Codes, Hash Functions and MAC algorithms- Secure Hash Algorithm-HMAC, Digital Signatures, Digital Signature Standards..

NETWORK SECURITY AND WEB SECURITY **09**
Authentication Applications- Kerberos, X.509- Authentication Service, Electronic Mail Security - Pretty Good Privacy - S/MIME, IP Security- IP Security Overview - IP Security Architecture - Authentication Header - Encapsulating Security Payload, Web Security- Web Security Considerations, Secure Sockets Layer and Transport Layer Security, Secure Electronic Transaction

SYSTEM SECURITY **09**
Intruders- Intruder Detection- Password Management, Malicious Software- Virus and Related Threats - Virus Counter Measures, Firewalls- Firewall Design Principles

Theory 45 Hrs **Tutorial -- Hrs** **Total 45 Hrs.**

REFERENCES:

1 William Stallings, **“Cryptography and Network Security”**, fourth edition, Prentice Hall of India,New Delhi ,2011

2 Behrouz A. Forouzan , Debdeep Mukhopadhyay **,“ Cryptography and Network security” ,** 2nd edition, Tata McGraw- Hill,2010

3 William Stallings, **“Network Security Essentials”,** 5th edition. Pearson Education, New Delhi, 2013

P15COTE11 HIGH SPEED SWITCHING ARCHITECTURE

L	T	P	C
3	0	0	3

Course Outcomes (COs):
Upon completion of the course, the student should be able to:

CO1: Explain evolution of high speed networks.
CO2: Discuss different LAN Switching techniques.
CO3: Apply switching architecture solutions for different networks
CO4: Analyze performance of queued ATM switches.
CO5: Distinguish between different IP switching solutions

Pre-requisites:
1. Computer Networks

Hrs

HIGH SPEED NETWORK **09**
Introduction- LAN, WAN, Network evolution through ISDN to B-ISDN, Transfer mode and control of B-ISDN, SDH multiplexing structure, ATM standard, ATM adaptation layers.

LAN SWITCHING TECHNOLOGY **09**
Switching Concepts, switch forwarding techniques, switch path control, LAN Switching, cut through forwarding, store and forward, virtual LANs

ATM SWITCHING ARCHITECTURE **09**
Switch model, ATM,QOS, Blocking networks - basic - and- enhanced banyan networks, sorting networks - merge sorting, re-arrangable networks - full-and- partial connection networks, non blocking networks - Recursive network construction, comparison of non-blocking network, Switching with deflection routing - shuffle switch, tandem banyan

QUEUES IN ATM SWITCHES **09**
Internal Queuing -Input, output and shared queuing, multiple queuing networks – Combined Input, output and shared queuing - performance analysis of Queued switches.

IP SWITCHING **09**
Addressing model, IP Switching types - flow driven and topology driven solutions, IP Over ATM address and next hop resolution, multicasting, Photonic switching - Photonic switching architectures.

Theory 45 Hrs **Tutorial -- Hrs** **Total 45 Hrs.**

REFERENCES:

1. Achille Pattavina, **"Switching Theory: Architectures and performance in Broadband ATM networks ",** John Wiley & Sons Ltd, New York. 1998.
2. Christopher Y Metz, **" Switching protocols & Architectures",** McGraw – Hill Professional Publishing, NewYork.1998.
3. Rainer Handel, Manfred N Huber, Stefan Schroder, **"ATM Networks – Concepts Protocols, Applications",** III Edition, Addison Wesley, New York. 1999.

4. John A.Chiong, **" Internetworking ATM for the internet and enterprise networks",** McGraw Hill, New York, 1998.
5. S.Kar and T.Srinivas, **"Optical fiber communications, Principles and Practice",** Tata Mc Graw Hill, 2002.

P15COTE12 NETWORK ROUTING ALGORITHMS

L	T	P	C
3	0	0	3

Course Outcomes (COs):
Upon completion of the course, the student should be able to:

CO1: Compare and analyze various network routing algorithm.
CO2: Discuss about Interior and exterior routing protocols.
CO3: Explain routing algorithms for optical WDM Networks
CO4: Elaborate Mobile – IP Network and its protocol..
CO5: Analyze routing algorithm for mobile Adhoc– Network

Pre-requisites:
1. Computer Networks
2. Optical Communication
3. Wireless Communication

Hrs

INTRODUCTION 09
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.

INTERNET ROUTING 09
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.

ROUTING IN OPTICAL WDM NETWORKS 09
Classification of RWA algorithms, RWA algorithms, Fairness and Admission Control, Distributed Control Protocols, Permanent Routing and Wavelength Requirements, Wavelength Rerouting-Benefits and Issues, Lightpath Migration, Rerouting Schemes, Algorithms- AG, MWPG.

MOBILE - IP NETWORKS 09
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)

MOBILE AD –HOC NETWORKS 09
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).

Theory :45 Hrs **Tutorial :-- Hrs** **Total :45Hrs.**

REFERENCES:

1. M. Steen Strub, **" Routing in Communication network"**, Prentice –Hall International, Newyork, 1995.
2. William Stallings, **" High speed networks and Internets Performance and Quality of Service"**, IInd Edition, Pearson Education Asia. Reprint India 2002
3. S. 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.
7. A.T Campbell et al., **" Comparison of IP Micromobility Protocols",** IEEE WirelessCommunications Feb.2002, pp 72-82.
8. C.Siva Rama Murthy and Mohan Gurusamy, **" WDM Optical Networks – Concepts, Design and Algorithms"**, Prentice Hall of India Pvt. Ltd, New Delhi –2002.

P15COTE13 SPEECH AND AUDIO SIGNAL PROCESSING

L	T	P	C
3	0	0	3

Course Outcomes (COs):

Upon completion of the course, the student should be able to:

CO1: Illustrate the mechanism and model of speech production.
CO2: Apply auditory perception techniques.
CO3: Analyze speech signals and extract its features.
CO4: Analyze speech processing methods in time and frequency domain
CO5: Estimate LPC parameters and apply for speech processing.
CO6: Apply various algorithms for speech and audio signal processing

Pre-requisites:

1. Digital Signal Processing
2. Statistical theory of communication

Hrs

MECHANISM OF SPEECH **09**

Speech production mechanism – Nature of Speech signal – Discrete time modelling of Speech production – Representation of Speech signals – Classification of Speech sounds – Phones – Phonemes – Phonetic and Phonemic alphabets – Articulatory features.

Music production – Auditory perception – Anatomical pathways from the ear to the perception of sound – Peripheral auditory system – Psycho acoustics

TIME DOMAIN METHODS FOR SPEECH PROCESSING **09**

Time domain parameters of Speech signal – Methods for extracting the parameters Energy, Average Magnitude – Zero crossing Rate – Silence Discrimination using ZCR and energy – Short Time Auto Correlation Function – Pitch period estimation using Auto Correlation Function

FREQUENCY DOMAIN METHOD FOR SPEECH PROCESSING **09**

Short Time Fourier analysis – Filter bank analysis – Formant extraction – Pitch Extraction – Analysis by Synthesis- Analysis synthesis systems- Phase vocoder – Channel Vocoder. Homomorphic speech analysis: Cepstral analysis of Speech – Formant and Pitch Estimation – Homomorphic Vocoders.

LINEAR PREDICTIVE ANALYSIS OF SPEECH **09**

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.

APPLICATION OF SPEECH & AUDIO SIGNAL PROCESSING **09**

Algorithms: Spectral Estimation, dynamic time warping, hidden Markov model – Music analysis – Pitch Detection – Feature analysis for recognition – Music synthesis – Automatic Speech Recognition

– Feature Extraction for ASR – Deterministic sequence recognition – Statistical Sequence recognition – ASR systems – Speaker identification and verification – Voice response system – Speech Synthesis: Text to speech, voice over IP.

Theory 45 Hrs **Tutorial -- Hrs** **Total 45 Hrs.**

REFERENCES:

1. Ben Gold and Nelson Morgan, **"Speech and Audio Signal Processing",** John Wiley and Sons Inc., Singapore, 2004.
2. L.R.Rabiner and R.W.Schaffer, **"Digital Processing of Speech signals"**, Prentice Hall -1978.
3. Quatieri, **"Discrete-time Speech Signal Processing",** Prentice Hall, 2001.
4. J.L.Flanagan, **"Speech analysis: Synthesis and Perception",** 2nd edition, Berlin, 1972.
5. I.H.Witten, **"Principles of Computer Speech"**, Academic Press, 1982.

P15COTE14 RF SYSTEM DESIGN

L	T	P	C
3	0	0	3

Course Outcomes (COs):
Upon completion of the course, the student should be able to:

CO1: Describe the various passive and active components for radio frequency circuits.
CO2: Analyze microstrip line filters.
CO3: Analyze the biasing methods for RF amplifiers.
CO4: Compare the various RF oscillators for their performance.
CO5: Design matching networks using smith chart

Pre-requisites:
1. Electromagnetic Fields
2. Microwave Engineering
3. Transmission line and wave guides
4. Electronic Circuits

Hrs

INTRODUCTION TO RF DESIGN **09**
Importance of RF design, Electromagnetic Spectrum, RF behavior of passive Components, Chip components and Circuit Board considerations, Scattering Parameters, Smith Chart and applications.

RF FILTER DESIGN **09**
Overview , Basic resonator and filter configuration, Special filter realizations, Filter implementations, Coupled filter.

ACTIVE RF COMPONENTS & APPLICATIONS **09**
RF diodes, BJT, RF FETs, High electron mobility transistors; Matching and Biasing Networks – Impedance matching using discrete components, Microstripline matching networks, Amplifier classes of operation and biasing networks.

RF AMPLIFIER DESIGNS **09**
Characteristics, Amplifier power relations, Stability considerations, Constant gain circles, Constant VSWR circles, Broadband , high power and multistage amplifiers.

OSCILLATORS, MIXERS & APPLICATIONS **09**
Basic Oscillator model, High frequency oscillator configuration, Basic characteristics of Mixers ; Phase Locked Loops ; RF couplers Wilkinson divider and Lange coupler ;
Detector and demodulator circuits.

Theory 45 Hrs **Tutorial -- Hrs** **Total 45 Hrs.**

REFERENCES:

1. Reinhold Ludwig and Powel Bretchko, **"RF Circuit Design – Theory and Applications"**, Pearson Education Asia, First Edition, 2001.
2. Joseph . J. Carr, **"Secrets of RF Circuit Design"** , McGraw Hill Publishers, Third Edition, 2000.

3. Mathew M. Radmanesh, **“Radio Frequency & Microwave Electronics”**, Pearson Education Asia, Second Edition, 2002.
4. Ulrich L. Rohde and David P. NewKirk, **“RF / Microwave Circuit Design”,** John Wiley & Sons USA 2000.
5. Roland E. Best, **“Phase - Locked Loops : Design, simulation and applications”,** McGraw Hill Publishers 5TH edition 2003.

P15COTE15 ADVANCED OPTICAL COMMUNICATION

L	T	P	C
3	0	0	3

Course Outcomes (COs):
Upon completion of the course, the student should be able to:

CO1: Categorize the types of sources and receivers.
CO2: Illustrate components of an optical fiber system.
CO3: Analyze dispersion in optical waveguides and its compensation techniques.
CO4: Compare various optical amplifiers.
CO5: Examine a light wave system.

Pre-requisites:
1. Optical Communication

Hrs

FIBER OPTIC GUIDES 09
Light wave generation systems, system components, optical fibres, SI, GI, fibres, modes, Dispersion in fibres, limitations due to dispersion, Fiber loss, non linear effects. Dispersion shifted and Dispersion flattened fibres.

OPTICAL TRANSMITTERS AND RECEIVERS 09
Basic concepts, LED's structure spectral distribution, semiconductor lasers, gain coefficients, modes, SLM and STM operation, Transmitter design, Receiver PIN and APD diodes design, noise sensitivity and degradation, Receiver amplifier design.

LIGHT WAVE SYSTEM 09
Coherent, homodyne and heterodyne keying formats, BER in synchronous – and asynchronous – receivers, sensitivity degradation, system performance, Multichannel, WDM, multiple access networks, WDM components, TDM, Subcarrier and Code division multiplexing.

AMPLIFIERS 09
Basic concepts, Semiconductor laser amplifiers, Raman – and Brillouin – fiber amplifiers, Erbium doped – fiber amplifiers, pumping phenomenon, LAN and cascaded in-line amplifiers.

DISPERSION COMPENSATION 09
Limitations, Post- and Pre- compensation techniques, Equalizing filters, fiber based gratings, Broad band compensation, soliton communication system, fiber soliton, Soliton based communication system design, High capacity and WDM soliton system.

Theory 45 Hrs **Tutorial -- Hrs** **Total 45Hrs.**

REFERENCES:

1. G.P. Agarwal, **"Fiber optic communication systems",** 2nd Ed, John Wiley & Sons, New York, 1997.

2. Franz & Jain, **“Optical Communication Systems”,** Narosa Publications,NewDelhi,1995.
3. G. Keiser, **“Optical fiber communication systems”,** McGraw-Hill, New York, 2000.
4. Franz & Jain, **“Optical communication, Systems and components”,** Narosa Publications,New Delhi, 2000.

P15COTE16 ULTRAWIDE BAND COMMUNICATION

L	T	P	C
3	0	0	3

Course Outcomes (COs):

Upon completion of the course, the student should be able to:

CO1: Demonstrate the basic concepts of UWB technique.
CO2: Design and analyze antennas for UWB transmission.
CO3: Compare the UWB based standards.

Pre-requisites:

1. Communication theory
2. Antennas and wave propagation

Hrs

UWB SIGNALS AND SYSTEMS WITH UWB WAVEFORMS 09

Introduction – Power spectral density – Pulse shape – Pulse trains – Spectral masks – Multipath – Penetration characteristics – Spatial and spectral capacities – Speed of data transmission – Gaussian waveforms – Designing waveforms for specific spectral masks – Practical constraints and effects of imperfections.

SIGNAL PROCESSING TECHNIQUES FOR UWB SYSTEMS AND UWB CHANNEL MODELING 09

Effects of a lossy medium on a UWB transmitted signal – Time domain analysis – Frequency domain techniques – A simplified UWB multipath channel model – Path loss model – Two-ray UWB propagation model – Frequency domain autoregressive model.

UWB COMMUNICATIONS AND ADVANCED UWB PULSE GENERATION 09

UWB modulation methods – Pulse trains – UWB transmitter/receiver – Multiple access techniques in UWB – Capacity of UWB systems – Comparison of UWB with other wideband communication systems – Interference and coexistence of UWB with other systems – Hermite pulses – Orthogonal prolate spheroidal wave functions – Wavelet packets in UWB PSM – Applications of UWB communication systems.

UWB ANTENNAS AND ARRAYS, POSITION AND LOCATION WITH UWB SIGNALS 09

Antenna fundamentals – Antenna radiation for UWB signals – Conventional antennas and Impulse antennas for UWB systems – Beamforming for UWB signals – Radar UWB array systems – Wireless positioning and location – GPS techniques – Positioning techniques – Time resolution issues – UWB positioning and communications

UWB COMMUNICATION STANDARDS AND ADVANCED TOPICS IN UWB COMMUNICATION SYSTEMS 09

UWB standardization in wireless personal area networks – DS-UWB proposal – MB-OFDM UWB proposal – IEEE proposals for UWB channel models – UWB ad-hoc and sensor networks – MIMO and Space-time coding for UWB systems – Self interference in high data-rate UWB communications – Coexistence of DS-UWB with WIMAX

Theory 45 Hrs **Tutorial -- Hrs** **Total 45 Hrs.**

REFERENCES:

1. M. Ghavami, L. B. Michael and R. Kohno, **"Ultra Wideband signals and systems in Communication Engineering"**, 2nd Edition, John Wiley & Sons, NY, USA, 2007.
2. Jeffrey H. Reed, **"An Introduction to Ultra Wideband Communication systems"**, Prentice Hall Inc., NJ, USA, 2012.

P15COTE17 OFDM/OFDMA COMMUNICATIONS

L	T	P	C
3	0	0	3

Course Outcomes (COs):
Upon completion of the course, the student should be able to:

CO1: Analyze OFDM/OFDMA based systems.
CO2: Design and analyze resource management techniques.
CO3: Apply adaptive modulation techniques for OFDMA system.
CO4: Compare various standards with OFDM/OFDMA.

Pre-requisites:

1. Digital Communication

Hrs

RADIO CHANNEL MODELING, RESOURCE ALLOCATION, AND SPECTRUM EFFICIENCY **09**

Introduction – Statistical characterization – OFDM/OFDMA channel models – OFDMA scheduling and resource allocation – System model – transmit spectra – Egress reduction techniques.

RESOURCE MANAGEMENT AND SYNCHRONIZATION: OFDM VS OFDMA **09**

Resource allocation and Scheduling algorithms – Synchronization in OFDMA downlink and uplink – Synchronization for WIMAX

ADAPTIVE MODULATION AND TRAINING SEQUENCE DESIGN **09**

Adaptive modulation algorithms – Channel feedback – Optimal condition for training sequence – Realization of Optimal training – Differential Space time Block codes – Differential Space frequency block codes

COOPERATIVE OFDMA, PERFORMANCE AND OPTIMIZATION OF RELAY ASSISTED OFDMA NETWORKS **09**

Cooperative OFDMA uplink – Channel capacity – Frequency offset and channel estimation – **Uplink/Downlink optimization** – System performance.

OFDMA SYSTEMS AND APPLICATIONS, AND OFDMA BASED MOBILE WIMAX **09**

Mobile WIMAX – Evolved Universal Terrestrial Radio Access – OFDMA, frame structure and sub channelization – Power saving mode – Handover.

Theory 45 Hrs **Tutorial -- Hrs** **Total 45Hrs.**

REFERENCES:

1. Tao Jiang, Lingyang Song, and Yan Zhang, **"Orthogonal Frequency Division Multiple Access (OFDMA) Fundamentals and Applications"**,Auberbach Publications, Taylor & Francis Group, 2010.
2. Yi (Geoffrey) Li, and Gordon L. Stuber, **"Orthogonal Frequency Division Multiplexing",** Springer Science+Business Media Inc., NY, USA, 2006.

3. Jeffrey G. Andrews, Arunabha Ghosh and Riaz Muhamed, **"Fundamentals of WIMAX: Understanding broadband wireless networking"**, 1st Edition, Prentice Hall Inc., NJ, 2007.
4. Lawrence Harte and Kalai Kalaichelvan, **"WIMAX explained: System fundamentals"**, 1st Edition, Althos Publishing, 2007.

P15COTE18 ADVANCED MICROWAVE SYSTEMS

L	T	P	C
3	0	0	3

Course Outcomes (COs):

Upon completion of the course, the student should be able to:

CO1: Evaluate the parameters of microstrip lines and coupled microstrip lines.
CO2: Analyze and derive the parameters of linear current elements and current loops.
CO3: Analyze periodic structure in microwave filter and derive the impedance and phase characteristics.
CO4: Design RF amplifier for constant VSWR, constant noise figure and constant gain for wide range of RF frequencies.
CO5: Analyze Gaussian beams in homogeneous medium.

Pre-requisites:

1. Transmission Lines and Wave guides
2. Microwave Engineering

Hrs

FIELD ANALYSIS OF PLANAR TRANSMISSION LINES 09

Microstrip Transmission Lines – Attenuation – High frequency properties of Microstrip lines. Coupled Microstrip lines – even and odd modes. Strip transmission lines – Coupled strip lines – Fin lines.

CIRCUIT THEORY FOR WAVE GUIDE SYSTEMS 09

Equivalent voltages and currents – Impedance description of waveguide elements and circuits – one port circuit. Foster's reactance theorem. N-port circuits. Two port junctions.
Excitation of waveguides. Probe coupling in rectangular waveguide. Radiation from linear current elements and current loops. Waveguide coupling by apertures.

PERIODIC STRUCTURES AND FILTERS 09

Wave analysis of periodic structures. Periodic structures composed of Unsymmetrical two port networks. Terminated Periodic structures. Matching of Periodic structures. Floquet's theorem and spatial Harmonics. Microwave Filters – Image parameter method. Filter design by insertion loss method. Low pass filter design. Microstrip parallel coupled filter.

MICROWAVE SOLID STATE AMPLIFIERS 09

S-parameters - Unilateral design of amplifiers – simultaneous conjugate match. Bilateral design of amplifiers. Amplifier stability. Conditional and unconditional stability criteria.
Amplifier power gain. Constant gain circles. Noise temperature concept. Noise factor and noise figure. Noise temperature for cascaded stages. Constant noise figure circles. Design of single stage microwave amplifiers.

MICROWAVES AND OPTICS 09

Geometrical optics as a limiting case of wave optics. Ray matrices for paraxial ray optics.
Gaussian beams. Generation of Gaussian beams at microwave frequencies. The beam waist. Propagation of Gaussian beams in Homogeneous medium. Transformation of Gaussian beams with lenses.

Theory 45 Hrs **Tutorial -- Hrs** **Total 45 Hrs.**

REFERENCES

1. R.E.Collin, **“ Foundations for Microwave Engineering”,** McGraw-Hill, 1992.
2. Ramo, Whinnery and Van Duzer , **“Fields and Waves in communication electronics”,** 3rd Edition., Wiley, 1997.

P15COTE19 SATELLITE COMMUNICATION

L	T	P	C
3	0	0	3

Course Outcomes (COs):
Upon completion of the course, the student should be able to:

CO1: Explain the fundamental concepts of satellite and satellite launch vehicles.
CO2: Discuss the various earth station equipment & spacecraft subsystems.
CO3: Design the satellite links for a specified carrier to noise ratio.
CO4: Compare various multiple access techniques for digital satellite signals.
CO5: Explain the various satellite services for mobile, multimedia, navigation and remote sensing applications.

Pre-requisites:
1. Communication Theory
2. Wireless Communication
3. Digital Communication

Hrs

ORBITAL MECHANICS **09**
Kepler's laws of motion, Orbits, Orbit Equations, Orbit Description, Locating the Satellite in the Orbit and with Respect to Earth, Orbital Elements-Look Angle Determination and Visibility - Orbital Perturbations, Orbit Determination, Launch Vehicles, Orbital Effects in Communication System - Performance Attitude control; Satellite launch vehicles. Spectrum allocations for satellite systems.

SPACECRAFT SUB SYSTEMS AND EARTH STATION **09**
Spacecraft Subsystems, Altitude and Orbit Control, Telemetry and Tracking, Power Systems, Communication Subsystems, Transponders, Antennas, Equipment Reliability, Earth Stations, Example of payloads of operating and planned systems.

SPACE LINKS **09**
The Space Link, Satellite Link Design - Satellite uplink -down link power Budget, Basic Transmission Theory, System Noise Temp, G/T Ratio, Noise Figure, Downlink Design, Design of Satellite Links for Specified C/N - Microwave Propagation on Satellite-Earth Paths. Interference between satellite circuits, Energy Dispersal, propagation characteristics of fixed and mobile satellite links.

MULTIPLE ACCESS TECHNIQUES AND NETWORK ASPECTS **09**
Single access vs. multiple access (MA). Classical MA techniques: FDMA, TDMA. Single channel per carrier (SCPC) access - Code division multiple access (CDMA).Demand assignment techniques. Examples of MA techniques for existing and planned systems (e.g. the satellite component of UMTS).Mobile satellite network design, ATM via satellite. TCP/IP via satellite - Call control, handover and call set up procedures, Hybrid satellite-terrestrial networks

SERVICES AND APPLICATIONS **09**

Mixed and mobile services - Multimedia satellite services - Advanced applications based on satellite platforms - INTELSAT series - INSAT, VSAT, Remote Sensing - Mobile satellite service: GSM. GPS, INMARSAT, Navigation System, Direct to Home service (DTH), Special services, E-mail, Video conferencing and Internet connectivity

Theory 45 Hrs **Tutorial -- Hrs** **Total 45 Hrs.**

REFERENCES:

1. Dennis Roddy, **“Satellite Communications”,** Third Edition, Mc Graw Hill International Editions, 2001.
2. Bruce R.Elbert, **"The Satellite Communication Applications Hand Book”,** Artech House Boston,1997.
3. Wilbur L.Pritchard, Hendri G.Suyderhood, Robert A.Nelson, **"Satellite Communication Systems Engineering",** II Edition, Prentice Hall, New Jersey,1993.
4. Tri T.Ha, **"Digital Satellite Communication",** 2nd Edition, McGraw Hill, New York, 1990.
5. Timothy Pratt and Charles W Bostian, **"Satellite Communications",** John Wiley and Sons, 1986.
6. Emauel Fthenakis, **" Manual of Satllite Communications",** McGraw Hill , 1984.
7. Ha.W.A, **"Digital Satellite Communications",** PHI, 1999.
8. Coolen.M, **" Satellite Communication",** IEEE Publication, 1999.
9. Robert M.Gagliardi , **"Satellite Communication",** CBS Publishers, 1991.

P15COTE20 GLOBAL POSITIONING SYSTEMS

L	T	P	C
3	0	0	3

Course Outcomes (COs):

Upon completion of the course, the student should be able to:

CO1: Explain the basic principles of satellite navigation.
CO2: Analyze and compare various coordinate systems used in GPS.
CO3: Discuss and compare the various pseudo codes used in GPS transmission
CO4: Analyze the ionospheric and tropospheric effects on GPS signals.
CO5: Compare the features of ground GPS, air borne GPS and space borne GPS.

Pre-requisites:

1. Satellite Communication
2. Wireless Communication

Hrs

INTRODUCTION TO GPS AND DIFFERENTIAL GPS 09

History of GPS – BC-4 System – HIRAN – NNSS – NAVSTAR GLONASS and GNSS Systems – GPS Constellation – Space Segment – Control Segment – User Segment – Single and Dual Frequency – Point – Relative – Differential GPS – Static and Kinematic Positioning – 2D and 3D – reporting Anti Spoofing (AS); Selective Availability (SA) – DOP Factors.

GPS COORDINATE AND TIME SYSTEM 09

Coordinate Systems – Geo Centric Coordinate System – Conventional Terrestrial Reference System – Orbit Description – Keplerian Orbit – Kepler Elements – Satellite Visibility – Topocentric Motion – Disturbed Satellite Motion – Perturbed Motion – Disturbing Accelerations - Perturbed Orbit – Time Systems – Astronomical Time System – Atomic Time – GPS Time – Need for Coordination – Link to Earth Rotation – Time and Earth Motion Services

GPS SIGNAL STRUCTURE AND THEORY 09

C/A code; P-code; Y-code; L1, L2 Carrier frequencies – Code Pseudo Ranges – Carries Phases – Pseudo Ranges – Satellite Signal Signature – Navigation Messages and Formats – Undifferenced and Differenced Range Models – Delta Ranges – Signal Processing and Processing Techniques – Tracking Networks – Ephemerides – Data Combination: Narrow Lane; Wide Lane – OTF Ambiguity.

ATMOSPHERIC EFFECTS ON GPS SIGNAL 09

Propagation Media – Multipath – Antenna Phase Centre – Atmosphere in brief – Elements of Wave Propagation – Ionospheric Effects on GPS Observations – Code Delay – Phase Advances – Integer Bias – Clock Error – Cycle Slip – Noise-Bias – Blunders – Tropospheric Effects on GPS Oberservables – Multipath Effect – Antenna Phase Centre Problems and Correction.

APPLICATIONS OF GPS 09

Inter Disciplinary Applications – Crystal Dynamics – Gravity Field Mapping – Atmospheric

Occulation – Surveying – Geophysics – Air borne GPS – Ground Transportation – Space borne GPS – Metrological and Climate Research using GPS.

Theory 45 Hrs **Tutorial -- Hrs** **Total 45 Hrs.**

REFERENCES

1. B.Hoffman - Wellenhof, H.Lichtenegger and J.Collins, **"GPS: Theory and Practice",** 4th revised edition, Springer, Wein, New york,1997.
2. A.Leick, **"GPS Satellites Surveying",** 2nd edition, John Wiley & Sons,NewYork,1995.
3. B.Parkinson, J.Spilker, Jr.(Eds), **"GPS: Theory and Applications",** Vol.I & Vol.II, AIAA, 370 L'Enfant Promenade SW, Washington, DC 20024, 1996.
4. A.Kleusberg and P.Teunisen(Eds), **"GPS for Geodesy",** Springer-Verlag, Berlin,1996.
5. L.Adams, **"The GPS - A Shared National Asset",** Chair, National Academy Press,Washington, DC, 1995.

OTHER REFERENCES

1. http://www.auslig.gov.au
2. http://igscb.jpl.nasa.gov
3. http://gibs.leipzig.ifag.de
4. http://www.navcen.uscg.mil

P15COTE21 RADAR SIGNAL PROCESSING

L	T	P	C
3	0	0	3

Course Outcomes (COs):

Upon completion of the course, the student should be able to:

CO1: Demonstrate the basic operation of Radar concepts.
CO2: Classify the various types of Radars.
CO3: Design and analyze the radar signals and processing.

Pre-requisites:

1. Engineering Physics
2. Digital Signal Processing

Hrs

INTRODUCTION TO RADAR SYSTEMS **09**

History and application of radar, 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

SIGNAL MODELS **09**

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

SAMPLING AND QUANTIZATION OF PULSED RADAR SIGNALS **09**

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

RADAR WAVEFORMS **09**

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.

DOPPLER PROCESSING **09**

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

Theory 45 Hrs **Tutorial -- Hrs** **Total 45Hrs.**

REFERENCES:

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

2. Francois Le Chevalier, **"Principles of Radar and Sonar Signal Processing",** Artech House
3. Michael O Kolawole, " **Radar systems, Peak Detection and Tracking**",Elseveir, 2010.
4. Skolnik, **"Introduction To Radar Systems**" 3rd edition, McGraw Hill.
5. Peyton Z. Peebles, **" Radar Principles",** Wiley India, 2009
6. Fred E. Nathanson, " **Radar Design Principles-Signal Processing and the environment**", PHI

P15COTE22 ELECTROMAGNETIC INTERFERENCE AND COMPATIBILITY IN SYSTEM DESIGN

L	T	P	C
3	0	0	3

Course Outcomes (COs):

Upon completion of the course, the student should be able to:

CO1: Explain the basic principles of EMI/EMC.
CO2: Discuss various EMI coupling methods.
CO3: Compare various EMI/EMC standards.
CO4: Explain various isolation, grounding and shielding techniques to minimize EMI effects.
CO5: Design the printed circuit board traces and layouts with minimum crosstalk.

Pre-requisites:

1. Electromagnetic fields

Hrs

EMI ENVIRONMENT **09**

EMI/EMC concepts and definitions, Sources of EMI, conducted and radiated EMI, Transient EMI, Time domain Vs Frequency domain EMI, Units of measurement parameters, Emission and immunity concepts, ESD.

EMI COUPLING PRINCIPLES **09**

Conducted, Radiated and Transient Coupling, Common Impedance Ground Coupling, Radiated Common Mode and Ground Loop Coupling, Radiated Differential Mode Coupling, Near Field Cable to Cable Coupling, Power Mains and Power Supply

EMI/EMC STANDARDS AND MEASUREMENTS **09**

Civilian standards - FCC, CISPR,IEC, EN, Military standards - MIL STD 461D/462, EMI Test Instruments /Systems, EMI Shielded Chamber, Open Area Test Site, TEM Cell, Sensors/Injectors/Couplers, Test beds for ESD and EFT, Military Test Method and Procedures (462).

EMI CONTROL TECHNIQUES **09**

Shielding, Filtering, Grounding, Bonding, Isolation Transformer, Transient Suppressors, Cable Routing, Signal Control, Component Selection and Mounting.

EMC DESIGN OF PCBs **09**

PCB Traces Cross Talk, Impedance Control, Power Distribution Decoupling, Controlling differential mode radiation-Board Layout, Multilayer boards.

Theory 45 Hrs **Tutorial - Hrs** **Total 45Hrs.**

REFERENCES:

1. Henry W.Ott, **"Noise Reduction Techniques in Electronic Systems",** John Wiley and Sons, NewYork. 1988.
2. C.R.Paul, **"Introduction to Electromagnetic Compatibility",** John Wiley and Sons, Inc, 1992

3. V.P.Kodali, **"Engineering EMC Principles, Measurements and Technologies",** IEEE Press, 1996.
4. Bernhard Keiser, **"Principles of Electromagnetic Compatibility",** Artech house, 3rd Ed, 1986.

P15COTE23 COMMUNICATION PROTOCOL ENGINEERING

L	T	P	C
3	0	0	3

Course Outcomes (COs):

Upon completion of the course, the student should be able to:

CO1: Explain layered architecture and its protocol.
CO2: Formulate protocol specifications.
CO3: Analyze protocol used in any particular application.
CO4: Design the performance testing methodology for the designed protocol.
CO5: Explain various protocol synthesis algorithms and its implementation.

Pre-requisites:

1. Computer Networks

Hrs

NETWORK REFERENCE MODEL **09**

Communication model-software, subsystems, protocol, protocol development methods, Protocol engineering process, Layered architecture, Network services and Interfaces, Protocol functions, OSI model ,TCP/IP protocol suite

PROTOCOL SPECIFICATIONS **09**

Components of protocol, Specifications of Communication service, Protocol entity, Interface, Interactions, Multimedia protocol, Internet protocol, SDL, SDL based protocolother. protocol specification languages.

PROTOCOL VERIFICATION/VALIDATION **09**

Protocol verification, Verification of a protocol using finite state machines, Protocol validation, protocol design errors, Protocol validation approaches, SDL based protocol verification and validation.

PROTOCOL CONFORMANCE/PERFORMANCE TESTING **09**

Conformance testing methodology and frame work, Conformance test architectures, Test sequence generation methods, Distributed architecture by local methods, Conformance testing with TTCN, systems with semi controllable interfaces - RIP,SDL based tools for conformance testing, SDL based conformance testing of MPLS Performance testing, SDL based performance testing of TCP and OSPF, Interoperability testing, SDL based interoperability testing of CSMA/CD and CSMA/CA protocol using Bridge, Scalability testing.

PROTOCOL SYNTHESIS AND IMPLEMENTATION **09**

Protocol synthesis, Interactive synthesis algorithm, Automatic synthesis algorithm, Automatic synthesis of SDL from MSC, Protocol Re-synthesis; Requirements of protocol implementation, Object based approach to protocol implementation, Protocol compilers, Tool for protocol engineering.

Theory 45 Hrs **Tutorial -- Hrs** **Total 45Hrs.**

REFERENCES:

1. Pallapa Venkataram and Sunilkumar S.Manvi, **"Communication protocol Engineering"**, Eastern Economy edition, 2004.
2. Richard Lai and Jirachiefpattana, **"Communication Protocol Specification and Verification"**, Kluwer Publishers, Boston, 1998.
3. Tarnay, K., **"Protocol Specification and Testing"**, Plenum, New York, 1991.
4. Mohamed G. Gouda, **"Elements of Network Protocol Design"**, John Wiley & Sons, Inc. New York, USA, 1998.
5. V.Ahuja, **"Design and Analysis of Computer Communication networks"**, McGraw- Hill, London, 1982.

P15COTE24 SIMULATION OF COMMUNICATION SYSTEMS AND NETWORKS

L	T	P	C
3	0	0	3

Course Outcomes (COs):
Upon completion of the course, the student should be able to:

CO1: Interpret and analyze mathematical models for sources and channels
CO2: Apply random number generation algorithms and analyze the properties using simulation tools
CO3: Develop simulation models for the digital communication systems and analyze with suitable parameters
CO4: Analyze various queuing models
CO5: Analyze the networking problems by conducting suitable simulation experiments using appropriate tools.

Pre-requisites:
1. Digital Communication
2. Random Signal Processing
3. Computer Networks.

Hrs

MODELLING OF COMMUNICATION SYSTEM **09**
Model of speech and picture signals, Pseudo noise sequences, Non-linear sequences, Analog channel model- Noise and fading, Digital channel model-Gilbert model of bursty channels, HF, Troposcatter and satellite channels, Switched telephone channels, Analog and Digital communication system models, Light wave system models.

SIMULATION OF RANDOM VARIABLES AND RANDOM PROCESS **09**
Univariate and multivariate models, Transformation of random variables, Bounds and approximation, Random process models-Markov and ARMA Sequences, Sampling rate for simulation, Computer generation and testing of random numbers.

ESTIMATION OF PERFORMANCE MEASURES **09**
Quality of an estimator, estimator for SNR, Probability density functions of analog communication system, BER of digital communication systems, Monte Carlo method and Importance of sampling method, estimation of power spectral density.

COMMUNICATION NETWORKS **09**
Queuing models, M/M/I and M/M/I/N queues, Little formula, Burke's theorem ,M/G/I queue, Embedded Markov chain analysis of TDM systems, Polling, Random access systems.

NETWORK OF QUEUES **09**
Queues in tandem, store and forward communication networks, capacity allocation, Congestion and flow chart, Routing model, Network layout and Reliability.

Theory 45 Hrs **Tutorial -- Hrs** **Total 45Hrs.**

REFERENCES:

1. M.C.Jeruchim, Philip Balaban and K.Sam Shanmugam, **"Simulation Of Communication Systems",** Plenum Press, New York,1992.
2. A.M.Law and W.David Kelton, **"Simulation Modelling And Analysis",** Mc Graw Hill Inc., New York ,1991.
3. J.F.Hayes, **"Modelling and Analysis of Computer Communication networks",** Plenum Press, New York,1984.
4. Jerry Banks and John S.Carson, **"Discrete-event System Simulation",** Prentice Hall Inc., New Jersey,1984.

P15COTE25 SPACE TIME WIRELESS COMMUNICATION SYSTEMS:

L	T	P	C
3	0	0	3

Course Outcomes (COs):

Upon completion of the course, the student should be able to:

CO1: Describe and categorize various wireless MIMO channel models.
CO2: Analyze the performance of various MIMO channel models.
CO3: Prioritize different spatial diversity techniques.
CO4: Explain various ST coding techniques and design optimum receivers for MIMO systems.
CO5: Analyze and evaluate advanced signal processing techniques for wireless communications.

Pre-requisites:

1. Wireless Communication
2. Digital Signal Processing

Hrs

MULTIPLE ANTENNA PROPAGATION AND ST CHANNEL CHARACTERIZATION **09**

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

CAPACITY OF MULTIPLE ANTENNA CHANNELS AND SPATIAL DIVERSITY **09**

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, 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.

MULTIPLE ANTENNA CODING AND RECEIVERS **09**

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.

ST OFDM, SPREAD SPECTRUM AND MIMO MULTIUSER DETECTION 09

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

ST CO-CHANNEL INTERFERENCE MITIGATION AND PERFORMANCE LIMITS IN MIMO CHANNELS 09

CCI characteristics, Signal models, CCI mitigation on receive for SIMO,CCI mitigating receivers for MIMO,CCI mitigation on transmit for MISO, Joint encoding and decoding, SS modulation, OFDM modulation, Interference diversity and multiple antennas, Error performance in fading channels, Signaling rate vs PER vs SNR, Spectral efficiency of ST doing/receiver techniques, System Design, Comments on capacity

Theory 45 Hrs **Tutorial -- Hrs** **Total 45Hrs.**

REFERENCES:

1. A. Paulraj, Rohit Nabar, Dhananjay Gore., "**Introduction to Space Time WirelessCommunication 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

P15COTE26 COGNITIVE RADIO

L	T	P	C
3	0	0	3

Course Outcomes (COs):

Upon completion of the course, the student should be able to:

CO1: Appreciate the motivation and the necessity for cognitive radio communication.
CO2: Demonstrate Software Defined Radio techniques.
CO3: Demonstrate the impact of the evolved solutions in future wireless network design.

Pre-requisites:

1. Communication theory
2. Signal processing

Hrs

INTRODUCTION TO SDR **09**

Definitions and potential benefits, software radio architecture evolution – foundations, technology tradeoffs and architecture implications, Antenna for Cognitive Radio.

SDR ARCHITECTURE **09**

Essential functions of the software radio, architecture goals, quantifying degrees of programmability, top level component topology, computational properties of functional components, interface topologies among plug and play modules, architecture partitions

INTRODUCTION TO COGNITIVE RADIOS **09**

Marking radio self-aware, the cognition cycle, organization of congnition tasks, structuring knowledge for cognition tasks, Enabling location and environment awareness in cognitive radios –concepts, architecture, design considerations.

COGNITIVE RADIO ARCHITECTURE **09**

Primary Cognitive Radio functions, Behaviors, Components, A–Priori Knowledge taxonomy, observe – phase data structures, Radio procedure knowledge encapsulation, components of orient, plan, decide phases, act phase knowledge representation, design rules.

NEXT GENERATION WIRELESS NETWORKS **09**

The XG Network architecture, spectrum sensing, spectrum management, spectrum mobility, spectrum sharing, upper layer issues, cross – layer design.

Theory 45 Hrs **Tutorial -- Hrs** **Total 45Hrs.**

REFERENCES:

1. Alexander M. Wyglinski, Maziar Nekovee, And Y. Thomas Hou, **" Cognitive Radio Communications And Networks - Principles And Practice"**, Elsevier Inc. , 2010.
2. E. Biglieri, A.J. Goldsmith., L.J. Greenstein, N.B. Mandayam, H.V. Poor, **"Principles of Cognitive Radio"**, Cambridge University Press, 2013.
3. Kwang-Cheng Chen and Ramjee Prasad, **" Cognitive Radio Networks"** , John Wiley & Sons, Ltd, 2009.

4 Khattab, Ahmed, Perkins, Dmitri, Bayoumi, Magdy, **"Cognitive Radio Networks - From Theory to Practice"**, Springer Series: Analog Circuits and Signal Processing, 2009.
5 J. Mitola, **" Cognitive Radio: An Integrated Agent Architecture for software defined radio"**, Doctor of Technology thesis, Royal Inst. Technology, Sweden 2000.
6 Simon Haykin, **"Cognitive Radio: Brain –empowered wireless communications",** IEEE Journal on selected areas in communications, Feb 2005.
7 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

P15COTE 27 ADVANCED WIRELESS COMMUNICATION TECHNIQUES

L	T	P	C
3	0	0	3

Course Outcomes (COs):

Upon completion of this course, the student should be able to:

CO1: Appreciate the need and design of cooperative and green wireless communication.

CO2: Apply the energy saving techniques to develop green technology .

CO3: Demonstrate the impact of the green engineering solutions in a global, economic, environmental and societal context.

Pre-requisites:

1. Wireless Communication

Hrs

COOPERATIVE COMMUNICATIONS AND GREEN CONCEPTS 09

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

COOPERATIVE BASE STATION TECHNIQUES 09

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

RELAY-BASED COOPERATIVE CELLULAR NETWORKS 09

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

GREEN RADIO NETWORKS 09

Base Station Power-Management Techniques- Opportunistic spectrum and load management, Energy-saving techniques in cellular wireless base stations , Power-management for base stations in smart grid environment , Cooperative multicell processing techniques for energy-efficient cellular wireless communications , Green communications in cellular networks with fixed relay nodes.

ACCESS TECHNIQUES FOR GREEN RADIO NETWORKS 09

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

Theory 45 Hrs **Tutorial -- Hrs** **Total 45Hrs.**

REFERENCES:

1. Ekram Hossain, Dong In Kim, Vijay K. Bhargava , **"Cooperative Cellular Wireless Networks"**, Cambridge University Press, 2011. 2.
2. Ekram Hossain, Vijay K. Bhargava(Editor), Gerhard P. Fettweis (Editor), **"Green Radio Communication Networks",** Cambridge University Press, 2012.

P15COTE28 MOBILE COMMUNICATION SYSTEMS & STANDARDS

L	T	P	C
3	0	0	3

Course Outcomes (COs):

Upon completion of this course, the student should be able to:

CO1: Explain the basic cellular communication concepts.
CO2: Appreciate different channel models
CO3: Compare and analyze different cellular standards
CO4: Analyze various access techniques used in wireless communication networks

Pre-requisites:

1.Mobile Communication

Hrs

INTRODUCTION TO MOBILE COMMUNICATION SYSTEMS **09**

Evolution of Mobile radio communications – Mobile radio systems in the U.S. and around the world – Examples of Mobile radio systems.

CELLULAR CONCEPT **09**

Cellular concept – Frequency reuse – Channel Assignment strategies – Handoff strategies – Interference and System capacity – Trunking and Grade of service – Improving capacity in cellular systems.

MOBILE RADIO PROPAGATION **09**

Small-scale multipath propagation – Impulse response of a multipath channel – Parameters of mobile multipath channel – Types of small-scale fading – Rayleigh and Rician distributions – Statistical models for multipath fading channels

GSM, GPRS, 3G STANDARDS **09**

GSM services and features – GSM system architecture – GSM radio subsystem – Frame structure for GSM – Signal processing in GSM – GPRS network architecture – GPRS services and features – 3G UMTS network architecture – UMTS services and features.

MULTIPLE ACCESS TECHNIQUES AND WIRELESS NETWORKING **09**

Multiple access techniques – FDMA, TDMA, TDMA/FDD, CDMA, SDMA and OFDMA/MIMO/SC-FDMA, MIMO/SOFDMA, OFDM/MIMO, HCSDMA/ TDD/MIMO – Wireless networking – Design issues in personal wireless systems – Cordless systems and Wireless Local Loop (WLL) – IEEE 802.16 Fixed Broadband Wireless Access standard, WIMAX, HSPA, LTE and LTE Advanced standards – Mobile IP and Wireless Application Protocol.

Theory 45 Hrs **Tutorial -- Hrs** **Total 45Hrs.**

REFERENCES:

1. Rappaport, T.S., “Wireless Communications, Principles and Practice”, 2nd Edition, Prentice Hall, NJ, 2002.
2. William Stallings, “Wireless Communications and Networks”, 2nd Edition, Pearson Education, 2005.
3. Siegmund M. Redl, Mathias K. Weber, Malcolm W. Oliphant, “An Introduction to GSM”, Artech House Publishers,1998.

P15COTE29 MULTI USER DETECTION

L	T	P	C
3	0	0	3

Course Outcomes (COs):

Upon completion of the course, the student should be able to:

CO1: Demonstrate different multiple access techniques used in multiuser environment
CO2: Design and analyze optimum receiver for multiuser detection
CO3: Compare correlation and non-correlating based multiuser detection algorithms.
CO4: Analyze decision driven detection algorithms.

Pre-requisites:

1. Communication Theory

Hrs

MULTIACCESS COMMUNICATION **09**

The multi-access channel - FDMA and TDMA - Random Multiaccess- CDMA - CDMA channel - Basic synchronous and asynchronous CDMA model - signature waveform- data streams- modulation-fading-antenna arrays- Discrete time synchronous and asynchronous models.

SINGLE USER MATCHED FILTER **09**

Hypothesis testing - Optimal receiver for single user channel - Q functionmatched filter in the CDMA function- Asymptotic multiuser efficiency and related measures- coherent single user matched filter in Reyleigh fading - differentially coherent demodulation- non coherent demodulation.

OPTIMUM MULTIUSER DETECTION **09**

Optimum Detection and error probability for synchronous and asynchronous - channels - Reyleigh fading- optimum noncoherent multiuser detection - decorrelating detector in synchronous and asynchronous channel.

NONDECORRELATING LINEAR MULTIUSER DETECTION **09**

Optimum linear multiuser detection- Minimum mean square linear multiuser detection- performance of MMSE linear multiuser detection- Adaptive MMSE linear multiuser detection-canonical representation of linear multiuser detectors-blind MMSE multiuser detection

DECISION – DRIVEN MULTIUSER DETECTORS **09**

Successive cancellation - performance analysis of successive cancellation - multistage detection - CT tentative decisions - decision feedback multiuser detection.

Theory 45 Hrs **Tutorial -- Hrs** **Total 45 Hrs.**

REFERENCES:

1. Sergio Verdo **"Multiuser Detection"**, Cambridge University Press, 1998.
2. IEEE Transaction of communication **"Special Issue on Multiuser detection",** November, 1997

P15COTE30 WIRELESS SENSOR NETWORKS

L	T	P	C
3	0	0	3

Course Outcomes (COs):

Upon completion of the course, the student should be able to:

CO1: Demonstrate the fundamentals of sensor networks
CO2: Design and analyze energy efficient sensor nodes and protocols
CO3: Analyze MAC and routing algorithms.
CO4: Demonstrate synchronization, Localization techniques
CO5: Compare data management and security algorithms.

Pre-requisites:

1. Wireless Communication

Hrs

OVERVIEW OF WIRELESS SENSOR NETWORKS 09

Challenges for Wireless Sensor Networks-Characteristics requirements-required mechanisms, Difference between mobile ad-hoc and sensor networks, Applications of sensor networks- case study, Enabling Technologies for Wireless Sensor Networks.

ARCHITECTURES 09

Single-Node Architecture - Hardware Components, Energy Consumption of Sensor Nodes, Operating Systems and Execution Environments, Network Architecture - Sensor Network Scenarios, Optimization Goals and Figures of Merit, Gateway Concepts. Physical Layer and Transceiver Design Considerations

MAC AND ROUTING 09

MAC Protocols for Wireless Sensor Networks, IEEE 802.15.4, Zigbee, Low Duty Cycle Protocols And Wakeup Concepts - S-MAC , The Mediation Device Protocol, Wakeup Radio Concepts, Address and Name Management, Assignment of MAC Addresses, Routing Protocols- Energy-Efficient Routing, Geographic Routing.

INFRASTRUCTURE ESTABLISHMENT 09

Topology Control, Clustering, Time Synchronization, Localization and Positioning, Sensor Tasking and Control.

DATA MANAGEMENT and SECIRUTY 09

Data management in WSN, Storage and indexing in sensor networks, Query processing in sensor, Data aggregation, Directed diffusion, Tiny aggregation, greedy aggregation, security in WSN.

Theory 45 Hrs **Tutorial -- Hrs** **Total 45Hrs.**

REFERENCES:

1. Ian F. Akyildiz, Mehmet Can Vuran, “ **Wireless Sensor Networks**” John Wiley, 2010

2. Yingshu Li, My T. Thai,Weili Wu, **“ Wireless Sensor Networks and Applications”** Springer 2008
3. Holger Karl & Andreas Willig, **" Protocols And Architectures for Wireless Sensor Networks"** , John Wiley, 2005.
4. Feng Zhao & Leonidas J. Guibas, **“Wireless Sensor Networks- An Information Processing Approach"**, Elsevier, 2007.
5. Kazem Sohraby, Daniel Minoli, & Taieb Znati, **“Wireless Sensor Networks-s Technology, Protocols, And Applications”**, John Wiley, 2007..
6. Anna Hac, **“Wireless Sensor Network Designs”,** John Wiley, 2003.
7. Bhaskar Krishnamachari**, ”Networking Wireless Sensors”,** Cambridge Press,2005
8. Mohammad Ilyas And Imad Mahgaob**,”Handbook Of Sensor Networks: Compact Wireless And Wired Sensing Systems”**, CRC Press,2005.
9. Wayne Tomasi, **“Introduction To Data Communication And Networking”**, Pearson Education, 2007

P15COTE31 RF MEMS

L	T	P	C
3	0	0	3

Course Outcomes (COs):

Upon completion of the course, the student should be able to:

CO1: Describe various switching operations
CO2: State the design issues and performance of RF capacitors and inductors
CO3: State the design issues and performance of RF Phase shifter
CO4: Explain the MEMS based microwave components.
CO5: Describe the RF antennas (micro strip) and its characteristics

Pre-requisites:

1. RF System Design

Hrs

INTRODUCTION **09**

Micromachining Processes - methods, RF MEMS relays and switches. Switch parameters Actuation mechanisms. Bistable micro relays and micro actuators. Dynamics of switching operation.

MEMS INDUCTORS AND CAPACITORS **09**

MEMS Inductor : Effect of inductor layout. Modeling and design issues of planar inductor. MEMS Capacitor: Gap-tuning and area-tuning capacitors. Dielectric tunable capacitors.

MEMS PHASE SHIFTERS **09**

Types of phase shifters and their limitations, MEMS Phase Shifter: Switched delay line phase shifter, Distributed MEMS phase shifter, Polymer based phase shifters, Fundamentals of RF MEMS Filters.

MICROMACHINED TRANSMISSION LINES **09**

Losses in transmission lines, Coplanar lines, Micromachined waveguide components, Micromachined directional coupler and mixer.

MICROMACHINED ANTENNAS **09**

Microstrip antennas, Micromachining techniques to improve antenna performance, Micromachinining as a fabrication process for small antennae, Reconfigurable antennas.

Theory 45 Hrs **Tutorial -- Hrs** **Total 45Hrs.**

REFERENCES:

1. Vijay.K.Varadan et al, **"RF MEMS and their Applications**", Wiley-India, 2011.
2. H.J.D.Santos, **"RF MEMS Circuit Design for Wireless Communications**", Artech House, 2002.
3. G.M.Rebeiz, **"RF MEMS Theory, Design, and Technology**", Wiley, 2003.

P15COTE32 INTERNETWORKING MULTIMEDIA

L	T	P	C
3	0	0	3

Course Outcomes (COs):

Upon completion of the course, the student should be able to:

CO1: Describe the characteristics of multimedia signals.
CO2: Explain the different broadband networking services suitable for multimedia.
CO3: Illustrate transport of multimedia through networks
CO4: Explain different multimedia communication standards.
CO5: Use different networks for transport of audio / video

Pre-requisites:

NIL

Hrs

INTRODUCTION TO MULTIMEDIA **09**

Digital sound, video and graphics, basic multimedia networking, multimedia characteristics, evolution of Internet services model, network requirements for audio/video transform, multimedia coding and compression for text, image, audio and video.

SUBNETWORK TECHNOLOGY **09**

Broadband services, ATM and IP, IPV6, High speed switching, resource reservation, Buffer management, traffic shaping, caching, scheduling, and policing, throughput, delay and jitter performance.

MULTIMEDIA NETWORKING APPLICATIONS **09**

MIME, Peer- to-Peer computing, shared application, video conferencing, centralized and distributed conference control, distributed virtual reality, light weight session philosophy.

MULTIMEDIA COMMUNICATION STANDARDS **09**

Objective of MPEG- 7 standard, Functionalities and systems of MPEG-7, MPEG-21 Multimedia Framework Architecture, - Content representation, Content Management and usage, Intellectual property management, Audio visual system- H322: Guaranteed QOS LAN systems; MPEG_4 video Transport across internet.

MULTIMEDIA COMMUNICATION ACROSS NETWORKS **09**

Packet Audio/video in the network environment, video transport across Generic networks- Layered video coding, error Resilient video coding techniques, Scalable Rate control, Streaming video across Internet, Multimedia transport across ATM networks and IP network, Multimedia across wireless networks.

Theory 45 Hrs **Tutorial -- Hrs** **Total 45Hrs.**

REFERENCES:

1. Jon Crowcroft, Mark Handley, Ian Wakeman, **"Internetworking Multimedia",** Harcourt Asia Pvt. Ltd. Singapore, 1998.
2. B.O. Szuprowicz, **"Multimedia Networking",** McGraw Hill, Newyork, 1995.
3. Tay Vaughan, **"Multimedia - Making it to work",** 4ed, Tata McGraw Hill , NewDelhi, 2000.
4. K.R.Rao, Zoran S. Bojkovic and Dragorad A. Milovanovic, **"Multimedia Communication Systems"**, PHI , 2003.

SPECIAL ELECTIVES

P14AESE01/P14COSE01 RESEARCH METHODOLOGY
(Common to Applied Electronics and Communication Systems)

L	T	P	C
3	0	0	3

Course Outcomes (COs):
Upon completion of the course, the student should be able to:

CO1: Recognize the importance of literature review.
CO2: Identify the different types of research.
CO3: Develop mathematical models for different problems.
CO4: Formulate models for experimental analysis.
CO5: Analyze the results using statistical methods
CO6: Prepare technical reports.

Pre-requisites: Nil

Hrs

RESEARCH CONCEPTS **09**
Concepts, meaning, objectives, motivation, types of research, approaches, research (Descriptive research, Conceptual, Theoretical, Applied & Experimental). Formulation of Research Task – Literature Review, Importance & Methods, Sources, quantification of Cause Effect Relations, Discussions, Field Study, Critical Analysis of Generated Facts, Hypothetical proposals for future development and testing, selection of Research task.

MATHEMATICAL MODELING AND SIMULATION **09**
Concepts of modeling, Classification of Mathematical Models, Modeling with Ordinary differential Equations, Difference Equations, Partial Differential equations, Graphs, Simulation, Process of formulation of Model based on Simulation.

EXPERIMENTAL MODELING **09**
Definition of Experimental Design, Examples, Single factor Experiments, Guidelines for designing experiments. Process Optimization and Designed experiments, Methods for study of response surface, determining optimum combination of factors, Taguchi approach to parameter design.

ANALYSIS OF RESULTS **09**
Parametric and Non-parametric, descriptive and Inferential data, types of data, collection of data (normal distribution, calculation of correlation coefficient), processing, analysis, error analysis, different methods, analysis of variance, significance of variance, analysis of covariance, multiple regression, testing linearity and non-linearity of model.

REPORT WRITING **09**
Types of reports, layout of research report, interpretation of results, style manual, layout and format, style of writing, typing, references, tables, figures, conclusion, appendices.

Theory 45 Hrs **Tutorial -- Hrs** **Total 45Hrs.**

REFERENCES:

1. R. Panneerselvam, **“Research Methodology”**, PHI 2004.
2. Douglas Montgomary, **“Design of Experiments, Statistical Consulting Services”,** 1990.
3. Douglas H. W. Allan, **“Statistical Quality Control: An Introduction for Management”,** Reinhold Pub Corp, 1959.
4. Cochran and Cox, **“Experimental Design”,** John Willy & Sons, 2^{nd} Edition , May 1992
5. S. S. Rao, **“Optimization Theory and Application”,** Wiley Eastern Ltd., New Delhi, 1996.
6. C. R. Kothari, **“Research Methodology”,** New Age Publishers, 2005.

P15COSE02 MULTIRATE SIGNAL PROCESSING

L	T	P	C
3	0	0	3

Course Outcomes (COs):
Upon completion of the course, the student should be able to:

CO1: Discuss the fundamental concepts of multirate systems.
CO2: Design QMF filter banks.
CO3: Design perfect reconstruction filter banks and analyze their properties
CO4: Implement filters using polyphase structures.
CO5: Design filters banks using cosine modulation techniques.
CO6: Apply the concepts of multirate signal processing to real time signals

Pre-requisites:

1. Digital signal Processing

Hrs

FUNDAMENTALS OF MULTIRATE SYSTEMS **09**

Sampling theorem - sampling at sub Nyquist rate - Basic Formulations and schemes-Multirate operations- Decimation and Interpolation - Digital Filter Banks –Interconnection of Building Blocks- Decimation with transversal filters – Interpolation with transversal filters – **Polyphase representation -**Decimation with Polyphase filters – Interpolation with polyphase filters – Decimation and Interpolation with Rational sampling factors

MAXIMALLY DECIMATED FILTER BANKS **09**

Quadrature mirror filter banks -Errors in the QMF bank- Perfect reconstruction (PR) QMF Bank - Design of an alias free QMF Bank - Biorthogonal and linear phase filter banks – Transmuliplexer filter banks

PERFECT RECONSTRUCTION FILTER BANKS **09**

Paraunitary PR Filter Banks- Filter Bank Properties induced by paraunitarity - Two channel FIR paraunitary QMF Bank- Linear phase PR Filter banks- Necessary conditions for Linear phase property- Quantization Effects: -Types of quantization effects in filter banks. - coefficient sensitivity effects, dynamic range and scaling.

FILTER BANKS WITH POLYPHASE STRUCTURE **09**

Fundamental polyphase structures – polyphase QMF banks – General two channel polyphase filter banks – General M-channel polyphase filter banks – Paraunitary polyphase filter banks – DFT polyphase filter banks. Application: Digital audio.

COSINE MODULATED FILTER BANKS **09**

Cosine Modulated pseudo QMF Bank- Alias cancellation- Elimination of Phase distortion- Closed form expression- Cosine modulated PR Systems-Sub band coding of speech and Image signals

Theory 45 Hrs **Tutorial -- Hrs** **Total 45Hrs.**

REFERENCES:

1. Vaidyyanathan P P, **"Multirate Systems and Filter Banks",** Prentice Hall Inc., 2011
2. Fliege N J, **"Multirate Digital Signal Processing",** John Wiley and sons, 1994
3. J.G. Proakis. D.G. Manolakis. **"Digital Signal Processing: Principles. Algorithms and Applications",** 3rd Edn.Prentice Hall India, 1999
4. Sanjit K Mitra, **"Digital Signal Processing-A Computer Based Approach",** Tata McGraw Hill, 2003
5. R.E. Crochiere. L. R. **"Multirate Digital Signal Processing",** Prentice Hall. Inc.1983.

ONE CREDIT COURSES

P15COIN01 Network Routing
Name of the Industry : Brocade Communications, Bangalore.

L	T	P	C
0	0	0	1

Pre-requisites:

1. Computer Networks

Basics of OSI Layers
Understanding Linux to use as Networking Element
Layer 2 and Layer 3 Addressing
Basic Switching
Basic Routing (will cover how internally routing is done by the system)
Hands-on Switching and Routing (Switching and routing the packets)
Unicast routing protocols
PIM
Demo on the routing with 1 unicast and 1 multicast protocol
Software Defined Networks
Overview of MPLS

TOTAL: 15Hrs

P15COIN02 Wireless System Design
Name of the Industry : STEPS Knowledge Services P Ltd, Coimbatore

L	T	P	C
0	0	0	1

Pre-requisites:

1. Wireless Communication

OVERVIEW

Overview of Wireless Connectivity, Comparison of Wireless Technologies – WiFi, Zigbee, Bluetooth, LoWPAN, Sub 1GHz band. Frequency bands and Worldwide regulations, Unlicensed bands, Network Topology and Range, Different Ranges and Applications of Personal, Local, Neighborhood and wide area networks.

EMERGING TECHNOLOGIES

Protocols - Standard and Proprietary Protocols, Network Topology and Size, Overheads and Throughput. Internet of Things (IoT) and its applications. TI IoT Cloud EcoSystem

Applications of Wireless Networks using MSP430 And SimpliciTI Protocol
Peer to Peer Networking with TIVA ARM Launchpad
Mesh Networking For Smart Sensors

TOTAL: 15Hrs

P15COIN03 Telematics
Name of the Industry : STEPS Knowledge Services P Ltd, Coimbatore

L	T	P	C
0	0	0	1

Pre-requisites:
1. Analog and Digital Integrated Circuits
2. Microprocessors & Microcontrollers
3. Mobile Communications

Hrs

OVERVIEW **03**

Introduction to 16Bit Ultra Low Power Microcontroller - CPU Architecture, Basic Block Diagram, Clock Module Overview, clock module configuration, various frequency settings, Introduction to IDE, compiler and linker file configuration, Interfacing the IDE and HW development board

PERIPHERALS INTERFACING **03**

Introduction to digital peripherals - Introduction to Input / Output Ports - Configuration of Digital ports as Input and Output - Introduction to Low Power Modes - Various Low power mode of operations and settings Introduction to ADC, Modes Of operations, Timing for data conversion, ADC Conversion calculation, Configuration of ADC, DMA Transfer for results Communication Peripherals – Universal Asynchronous Serial Transmission (UART) – Baud rate – Register Configuration – Transmission and Reception of Data between MCU and PC

TELEMATICS APPLICATIONS **03**

Overview of Global System for Mobile Communication – Operation – Introduction to AT commands – Send Message using Serial Terminal Overview of Global Positioning System – Introduction to NMEA Protocol – GPS Coordinates – Monitoring GPS Data over Serial Terminal

INTERFACING GSM WITH LOW POWER MCU **03**

MCU – Configuration of UART - Hardware Interfacing of GSM with MCU – Send Message using AT commands – Temperature Sensor Monitoring Using GSM

INTERFACING GPS WITH LOW POWER MCU **03**

MCU – Configuration of UART – Hardware Interfacing of GPS with MCU – Led Indication of GPS Position Fix – Send Alert SMS with the Change in GPS Position Change.

TOTAL: 15 Hrs

P15COIN04 Automotive Communication System
Name of the Industry : Robert Bosch

L	T	P	C
0	0	0	1

Hrs

Basics Automotive Electronics **06**

Automotive Embedded System, Sensors, Actuators, Power train Management System (Gasoline, Diesel, Hybrid), Active Safety System -- Electronic Stability Program (Antilock Braking System, Antislip Regulation), Passive Safety Systems -- Air Bags, Seatbelt Tensioners, Steering System, Night vision, Park Assistance, Cruise Control, Speed Limiter & System Testing. Vehicle Network Architecture

OSEK – Communication Structure **03**

INTRODUCTION - Message Transmission, Message Reception, Deadline Monitoring, Notification, Communication System Management, Functional Model of the interaction Layer, Network Management (Direct and Indirect). Impacts upon OS, COM and the data link layer

CAN Basics: **03**

CAN BUS: Overview , CAN Bus Overview , The Development of CAN , CANBUS and the OSI Model , CANBUS Physical Layer , Message Oriented Transmission Protocol , Message Format , Bus Arbitration , Basic Bit Encoding & CAN Frames

On Vehicle and Off Vehicle **03**

Introduction to On Vehicle Communication and Off Vehicle Communications, Need for Services, Introduction to Universal Diagnostic Services, In depth understanding of Diagnostic Services.

TOTAL: 15 Hrs