KERALA TECHNOLOGICAL UNIVERSITY

ERNAKULAM – WEST CLUSTER

DRAFT

SCHEME AND SYLLABI

FOR

M. Tech. DEGREE PROGRAMME

IN

WIRELESS TECHNOLOGY

(2015 ADMISSION ONWARDS)

SCHEME AND SYLLABI FOR M. Tech. DEGREE PROGRAMME IN

WIRELESS TECHNOLOGY

SEMESTER-1

Exam Slot	Course No:	Name	L-T-P	Internal Marks	End Semester Exam		Credits
					Marks	Duration (hrs)	
A	06EC6017/ 06EC6011	Analytical Foundations for Communication Engineering*	4-0-0	40	60	3	4
B	06EC6027	Wireless Communication Engineering	4-0-0	40	60	3	4
C	06EC6037	Antenna Theory and Design	4-0-0	40	60	3	4
D	06EC6047	Network Routing Algorithms	3-0-0	40	60	3	3
E	06EC6X57	Elective I	3-0-0	40	60	3	3
F	06EC6067/ 06EC6061	Research Methodology*	0-2-0	100	0	0	2
G	06EC6077/ 06EC6071	Seminar I*	0-0-2	100	0	0	2
H	06EC6087	Wireless Communication Lab I	0-0-3	100	0	0	1

Credits: 23

	Elective I (06EC6X57)
06EC6157	Optical Networks
06EC6257	Image and Video processing
06EC6357	Communication Networks
06EC6457	Digital Communication Techniques

*- Common to Communication Engineering/Wireless Technology

SEMESTER-II

Exam Slot	Course No:	Name	L-T-P	Internal Marks	End Semester Exam		Credits
					Marks	Duration (hrs)	
A	06EC6018/ 06EC6012	Communication System Design*	4-0-0	40	60	3	4
B	06EC6028	Mobile Cellular Communication	3-0-0	40	60	3	3
C	06EC6038	Smart Antennas	3-0-0	40	60	3	3
D	06EC6X48	Elective II	3-0-0	40	60	3	3
E	06EC6Y58	Elective III	3-0-0	40	60	3	3
F	06EC6068/ 06EC6062	Mini Project*	0-0-4	100	0	0	2
G	06EC6078	Wireless Communication Lab II	0-0-3	100	0	0	1

Credits: 19

Elective II - (06EC6X48)		Elective III - (06EC6Y58)	
06EC6148	AdHoc and Sensor Networks	06EC6158	Principles of Secure Communication
06EC6248	Spectral Analysis & Methods	06EC6258	Speech and Audio Signal Processing
06EC6348	Embedded System Design	06EC6358	EMI/EMC based system design
06EC6448	RF Circuit Design		

SEMESTER-III

Exam Slot	Course No:	Name	L-T-P	Internal Marks	End Semester Exam		Credits
					Marks	Duration (hrs)	
A	06EC7X17	Elective IV	3-0-0	40	60	3	3
B	06EC7Y27	Elective V	3-0-0	40	60	3	3
C	06EC7037/ 06EC7031	Seminar II*	0-0-2	100	0	0	2
D	06EC7047/ 06EC7041	Project (Phase 1)*	0-0-12	50	0	0	6

Credits: 14

Elective-IV (06EC7X17)		Elective-V (06EC7Y27)	
06EC7117	Linear and Nonlinear Optimization	06EC7127	RF MEMS
06EC7217	Advanced Communications	06EC7227	Coding Theory
06EC7317	MIMO and Multi Carrier Communications	06EC7327	Multi rate and Multi dimensional signal processing
06EC7417	Adaptive Signal Processing	06EC7427	Estimation and Detection Theory

SEMESTER-IV

Exam Slot	Course No:	Name	L-T-P	Internal Marks	End Semester Exam		Credits
					Marks	Duration (hrs)	
A	06EC7018/ 06EC7012	Project (Phase 2)*	0-0-21	70	30	0	12

Credits: 12

Total Credits for all semesters: 68

SEMESTER I

Course No	Course Title	Credits	Year
06EC6017/ 06EC6012	**Analytical Foundations for Communication Engineering**	**4-0-0: 4**	**2015**

Pre-requisites: A basic course in Probability and Linear Algebra

Course Objectives:

- To introduce the concepts of random processes and their properties
- To analyse the effect on random signals over linear systems.
- To analyse the fundamental concepts of vector spaces in the concrete setting of R^n.
- To introduce the concept of inner- product spaces and orthogonal projections and its applications.

Syllabus:

Review of random variables, Distributions and properties, Random processes, Power spectrum, Matrix Algebra and Linear systems , Vector spaces, Subspaces, Linear independence, Span, Basis, Dimension, Matrix representation of linear transform, Inner product spaces.

Course Outcome:

The student will be able to apply the concepts of

- random processes to communication engineering problems.
- signal & noise subspaces in detection & estimation problems encountered in communication engineering
- linear transformations and the principles of orthogonality& least squares.

Text Books:

1. *Monson H. Hayes, "Statistical Signal Processing and Modeling", John Wiley & Sons Inc, Reprint, 2013.*
2. *David C Lay, "Linear Algebra and its Applications", Pearson Education Asia, New Delhi, 2003.*

References :

3. *H. Stark, J.W Woods, "Probability and Random Processes", Pearson Education, 2002.*
4. *Alberto Leon Garcia, "Probability and Random Process for Electrical Engineers", (Second Edition), Pearson Education, 1997.*
5. *R D Yates, D J Goodman, "Probability and Stochastic Processes", John Wiley and Sons, 2005.*
6. *Richard A. Johnson, "Miller and Freund's Probability and Statistics for Engineers, 7th Edition, PHI, 2004.*
7. *Huffman, R. Kunze, "Linear Algebra", Prentice Hall of India, 1998.*
8. *Gilbert Strang, "Linear Algebra and its Applications", Brooks/Cole Ltd., New Delhi, Third Edition, 2003.*
9. *Seymour Lipschutz and Marc Lipson, "Schaum's Outline of Linear Algebra", McGraw Hill Trade; New Delhi, Third Edition, 2000.*
10. *Howard A Anton "Elementary Linear Algebra", John Wiley & Sons, Singapore, Eighth Edition, 2000.*

COURSE PLAN			
Course No **06EC 6017/** **06EC 6012**	Course Title **Analytical Foundations for Communication Engineering**	Credits **4-0-0: 4**	Year **2015**
Module		Hours	End Sem Exam Marks (%)
1	Random Processes Review of random variables (RV) - (3.2.1 to 3.2.5 [1]) distributions and properties – joint pdf -characteristic functions–functions of RVs, Random processes (3.3.1 to 3.3.6 [1]) – stationarity, WSS and ergodic RP – properties –Autocorrelation matrix of random signals, RP and linear systems – (3.3.8, 3.4 ,3.5 [1]), Power spectrum – Weiner-Khinchin theorem, Gaussian and White processes-- (3.3.3, 3.3.7 [1]), Filtered noise processes (3.6 to 3.4 [1]).	**16**	**25**
2	Matrix Algebra and Linear systems System of linear equations - (1.1 to 1.5 [2]) The Matrix equation Ax=b - Solution sets of linear systems Matrix operations (2.1 to 2.3, 2.9 [2]) Dimension and rank - Inverse of a matrix - Characteristics of invertible matrices, Eigenvectors & Eigen values - (5.1 to 5.4 [2]) Characteristic equation - Eigenvectors & linear transformations - Singular value decomposition- Diagonalization, Quadratic forms.	**16**	**25**
FIRST INTERNAL TEST			

3	Vector Space and Linear Transformation (4.1 to 4.7 [2]) Vector spaces - Subspaces, Linear independence, Span, basis, dimension, finite dimensional vector spaces, direct sum- Examples of finite dimensional vector spaces –$\mathbf{R}^N$, $\mathbf{C}^N$, vector space of matrices - Dimensionality of Row and Column space - Non-singular, Hermitian and Unitary matrices, Linear Transformation- range and null space - rank nullity theorem - Matrix representation of linear transform - Change of basis.	**12**	**25**
SECOND INTERNAL TEST			
4	Inner product spaces Inner Product spaces - (6.1 to 6.3, 6.5, 6.7 [2]) norm, orthogonality, Hilbert spaces, orthogonal complements, projection theorem- orthogonal projections, orthogonality and least squares- orthogonal expansion of discrete random processes using KL transform	**12**	**25**
END SEMESTER EXAM			

Course No	Course Title	Credits	Year
06EC6027	**Wireless Communication Engineering**	**4-0-0: 4**	**2015**

Pre-requisites : A basic course in Wireless Communication

Objectives:

- To introduce the concepts of wireless communication
- To familiarise the students with the various propagation methods, Channel models, Traffic & capacity calculations,
- To introduce students to multiple antennas and multiple user techniques used in modern wireless systems

Syllabus:

Wireless Channel Propagation and Model ; Tele Traffic Engineering & System Capacity Calculations ; Diversity & Wireless signalling methods ; Wireless Technologies & Systems

Course Outcome:

The student will be able to analyze and apply the concepts of

- Wireless Propagation Models
- System engineering and capacity estimations and performance of digital modulation across wireless channels
- Various diversity techniques under different channel conditions
- Various wireless systems presently used including Personal Communications Systems.

Text Books:

1. *Andrea Goldsmith, " Wireless Communications ", Cambridge University Press ,2008.*
2. *T.S Rappaport, " Wireless Communication, Principles & Practice", Pearson Education, 2010.*
3. *Vijay K Garg, "Wireless Communications and Networking", Morgan Kaufman publishers, 2013.*

References

4. *Dr. Kamilo Feher, "Wireless Digital Communications," PHI Learning Pvt Ltd, New Delhi, 2009.*
5. *TL Singal - "Wireless Communications", Tata Mc Graw Hill Education Pvt. Ltd, New Delhi, 2010.*
6. *Jeffrey H Read," Software Radio- A Modern Approach to Radio Engineering", Prentice Hall , 2002.*
7. *Roy, Blake, "Wireless Communication Technology ", Congage, 2001.*

COURSE PLAN

Course No **06EC 6027**	Course Title **Wireless Communication Engineering**	Credits **4-0-0: 4**	Year **2015**
Module		Hours	End Sem Exam Marks (%)
1	**WIRELESS CHANNEL PROPAGATION AND MODEL** Overview of Wireless Communications (1.1[1]) Wireless vision (1.2 [1]) Technical issues on wireless media (1.3	**14**	**25**

	[1])Propagation of EM SIGNALS. (4.1 [2]) Free space propagation model(4.2 [2]) Propagation mechanisms (4.4[2]) Reflection (4.5 [2]) Diffraction (4.7 [2]) Scattering (4.8 [2]) Practical link Budget Design using path loss model(4.9 [2]) Outdoor propagation models (4.10[2]) Indoor propagations (4.11[2]) Signal penetrations into buildings(4.12 [2]) Ray tracing and site specific modelling (4.13 [2])		
2	**TELE TRAFFIC ENGINEERING & SYSTEM CAPACITY CALCULATIONS** Capacity in AWGN (4.1[1]), capacity of flat fading channel, (4.2 [1]) capacity of frequency selective fading channels (4.3[1])) service level (2.2 [3]) Traffic usage (2.3 [3]) Traffic measurement of units (2.4[3]) Call capacity (2.5[3]) Engineering considerations (2.8 [3]) Traffic Types (2.9 [3]) Blocking formulas (2.10[3]) Er lang B, C, (2.10 [3]) Poisson's Binominal formulas and comparison(2.10[3]) Service management (QoS) (15.11[3]) Industry standards for propagation models (3.8[3]) Frequency management(6.1[5]) Wireless systems and standards 911.12 [2])	**14**	**25**
FIRST INTERNAL TEST			
3	**DIVERSITY & WIRELESS SIGNALLING METHODS** Diversity Techniques(7.10 [2]) Selection Diversity(7.10	**14**	**25**

	[2]) Practical space Diversity considerations (7.10.3 [2]) Selection diversity (7.10.3 [2]) Feedback or scanning diversity (7.10.3.2 [2]) maximum ratio combining (7.10.3.3 [2]) Equal gain combining (7.10.3.3 [2]) Polarization diversity (7.10.4 [2]) Theoretical model for polarization Diversity,(7.40.4[2] Frequency Diversity (7.10.5 [2]) Time Diversity (7.10. 6 [2]) Rake Receiver (7.11[2]) Link Budget ((10.9 [3]) Security in wireless systems (13.2 [3])Wireless and Fixed Networks (10.2[2]) Traffic routing in Wireless Networks (10.5[2])Common Channel Signalling(10.7[2]) Integrated Digital Service Network(13 DN 10.2 [2]) Signalling Systems(10.9[2]) Channel Assignments (10.2[1])		
SECOND INTERNAL TEST			
4	**WIRELESS TECHNOLOGIES & SYSTEMS** Wireless Local Area Networks (21.2.[3]) Wireless wide area interconnections between wireless LANs and 3G systems (22.3 [3]) Cordless phones (10.2[1])W LAN Topologies (27.3[3]) WLAN Technologies (2.4[3])paging systems,(13.2[7] WLL (14.2 [7]) OFDM-MIMO Systems (23.5.3 [3]), Cognitive Radio (23.5.7 [3] Multiple Access Techniques for wireless communications (9.1 [3]) Frequency Division Multiple Access FDMA (9.2 [3], Time Division TDMA (9.3 [3]), Spread spectrum Multiple Access (9.4 [3])Space	**14**	**25**

	Division Multiple Access (SDMA) (9.5 [3]) GSM System (11.3 [2] CDMA 1S-95 (11.5[2] IMT 2000 (16.6 [3]) W- CDMA (13.8[5]) Requirements of PCS (10.11[2]) Personal mobile & Satellite networks,(8.2(4)) Bluetooth (19.3 [3] wireless sensor systems,(20 .2 [1]) Software Defining Radio,(1.2 [6] Design Principles of Software Radio,(1.4[6]) Characteristics and benefits of Software Radio (1.3 [6]) Receiver Design challenges (2.2 [6])		
END SEMESTER EXAM			

CourseNo	Course Title	Credits	Year
06EC6037	**Antenna Theory and Design**	4-0-0: 4	**2015**

Pre-requisites: A basic course in Electromagnetic Theory

Course Objectives:

To give the Student: - A comprehensive exposure starting from basic theory, design and configuration, meeting the application requirements in terms of performance & size. Introduction to modern method of design& validation using software design tools.

Syllabus:

Fundamentals of radiation and field behavior. Important Antenna parameters and their dependence. Commonly used antennas starting from the basic Hertzian dipole(small),half wave dipole ,monopole ,loop ,slot, horn, & apertures. Low profile Microstrip (patch) antennas, Array theory, design and application. Antenna parameter measurements required for design validation. Design and validation using CEM.

Course Outcome:

Students who successfully complete this course will have the required foundation and knowledge of antenna & their function. They would be capable of interpreting the antenna specification and design the antenna meeting the requirements of performance.

Text Books:

1. Balanis A, “Antenna Theory ,Analysis and Design” , John Wiley & Sons, New York, 1982.
2. Krauss J D, “Antennas” , 2nd edition, John Wiley & Sons, New York ,1997.

References:

3. J.D Kraus, R.J.Marhejka, A.S.Khan "Antenna and wave propagation", Tata McGraw Hill, 4th edition,2010.
4. Simon Ramo, John R Whinnery & Theodore Van Duzer "Fields and Waves in Communication Electronics" , John Wiley & Sons, 1994.
5. W.L.Stutzman & G.A Thiele "Antenna Theory & Design" John Wiley & Sons, 3rd edition,2012

COURSE PLAN

Course No **06EC6037**	Course Title **Antenna Theory and Design**	Credits **3-0-0: 3**	Year **2015**
Module		Hours	End Sem Exam Marks (%)
1	Using Maxwells equations derive the field equations and interpret their behaviour[3.2, 3.3(1)]. Starting from Hertzian Dipole(small),the theory is extended to half wave dipole[12.04,12.05(4)],monopole and larger linear antennas.Image theory Important parameters of antenna: Field pattern, Radiation resistance, Radiation efficiency ,Effective aperture, Directivity, gain & polarisation. Reciprocity theorem.[2.8,2.9,2.12,2.13(1)]/[2.3,2.4,2.8,2.12,2.13(2)]	**13**	**25**
2	Small loop antenna as a magnetic source [5.21,5.22,5.23,5.27(1)], low profile antenna using	**15**	**25**

	microstrip technology(patch)[14.1-14.5(1)].Array antenna theory,design and application. Pattern multiplication,grating lobes,sidelobe level reduction.Array synthesis—Binomial and Tchebychev distributions. Microstrip arrays[6.1-6.8(1)]		
FIRST INTERNAL TEST			
3	Aperture antenna,Field equivalence principle and application[12.1-12.7(1)]. Reflectors—plane, corner and parabolic. Design & advantages of Parabolic antenna[15.2-15.4(1)].Horn antenna[13.1-13.7(1)],slot and its complimentary nature[12.8(1)].Antennas for EMI/EMC measurements . Antenna factor. Mobile communication antenna systems for hand set and the base stations[9.2,11.4.2(1), 13.2(2)]	**15**	**25**
SECOND INTERNAL TEST			
4	Antenna measurements—Field pattern, Gain and impedance (including Smith chart). Antenna factor measurements .CEM based simulation of antenna design and validation using FDTD. Basics of FDTD. Modern design tools like HFSS[17.1-17.5(1)]	**13**	**25**
END SEMESTER EXAM			

Course No	Course Title	Credits	Year
06EC6047	**Network Routing Algorithms**	**3-0-0:3**	**2015**

Pre-requisites: A basic course in Computer Communication Networks

Course Objectives:

- To gain knowledge about the layered architecture of communication networks and the specific functions of the network layer.
- To understand the basic principles of routing and the different routing algorithms based on Internetworking requirements, optical backbone and the wireless access part of the network.

Syllabus:

ISO OSI Layer Architecture, TCP/IP Layer Architecture, Functions of Network layer, General Classification of routing, Interior protocol, Exterior Routing Protocols, Routing and Wavelength Assignment in Optical WDM Networks, Macro mobility Protocols, Micro mobility protocols.

Course Outcome:

At the end of this course students will be able

- To apply the concept of network layered architecture in routing.
- To compare and analyze the performance of various routing algorithms
- To design a new algorithm or modify an existing algorithm to improve the performance of the network.

Text Books & References:

1. William Stallings, " High speed networks and Internets Performance and Quality of Service", II nd edition, Pearson Education Asia. Reprint India, 2002.
2. S. Keshav, "An engineering approach to computer networking" , Addison Wesley 1999.
3. 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.

References:

4. C.Siva Rama Murthy and Mohan Gurusamy, " WDM Optical Networks –Concepts, Design and Algorithms", Prentice Hall of India Pvt. Ltd, New Delhi, 2002.
5. A.T Campbell et al., " Comparison of IP Micro mobility Protocols," IEEE Wireless Communications Feb.2002, pp 72-82.
6. Jyh-Cheng Chen, Tao Zhang, "IP-Based Next-Generation Wireless Networks: Systems, Architectures, and Protocols", John Wiley Publication,2004.

Course Plan

Course No	Course Title	Credits	Year
06EC6047	**Network Routing Algorithms**	**4-0-0:4**	**2015**
Module		**Hours**	**End Sem Exam Marks (%)**
1	**INTRODUCTION** ISO OSI Layer Architecture(2.3[1]), TCP/IP Layer	**14**	**25**

	Architecture(3.1[1]), Functions of Network layer(11.1[2]), General Classification of routing, Routing in telephone, Networks(11.4[2]), Dynamic Non hierarchical Routing (DNHR), Trunk status map routing (TSMR), real-time network routing (RTNR), Distance vector routing,Link state routing, Hierarchical routing.		
2	**INTERNET ROUTING** Overview of Graph Theory and Least cost paths(14.1 to 14.5[1]),Interior protocol(15.1 to 15.5 [1]) : Routing Information Protocol (RIP), Open Shortest Path First (OSPF), Bellman Ford Distance Vector Routing. Exterior Routing Protocols(16.1 to 16.4[1]): 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.	**16**	**25**
FIRST INTERNAL TEST			

3	**ROUTING IN OPTICAL WDM NETWORKS** Classification of RWA algorithms(2.1 to 2.3[4]), RWA algorithms, Fairness and Admission Control(2.4[4]), Distributed Control Protocols, Permanent Routing and Wavelength Requirements, Wavelength Rerouting-Benefits and Issues(4.3[4]), Lightpath Migration(4.4[4]), Rerouting Schemes, Algorithms-AG, MWPG	**14**	**25**
SECOND INTERNAL TEST			
4	**MOBILE -IP NETWORKS** Evolution of Mobile IP networks(1.1[6]),Mobility Management(4.2[6]),Location Management, Hand off Management(4.2.7[6]),Macro-mobility Protocols[3], Micro-mobility protocol: Tunnel based : Hierarchical Mobile IP, Intradomain Mobility Management, Routing based: Cellular IP, Handoff Wireless Access Internet Infrastructure (HAWAII), Comparison of IP Micromobility Protocols[5].	**12**	**25**
END SEMESTER EXAM			

Course No	Course Title	Credits	Year
06EC6157	**Optical Networks**	**3-0-0: 3**	**2015**

Pre-requisites: A basic course in Optical Communication

Course Objectives:

To provide a comprehensive understanding of optical networks. To enable the students to understand

- the infrastructure of an optical networks and its basic mechanisms. Also Synchronous Optical Networks (SONET) will be covered to good extend.
- the different components needed to build an optical network.
- the advances in packet switching in optical domain and associated challenges.
- the survivability of the networks.
- the network design and its related models, also make them familiarize with routing, switching and the resource allocation methods and the network control and management methods in vogue.

Syllabus:

The optical layer, SONET / SDH standards Optical network elements; optical packet switching; Multiplexing and De multiplexing, Optical network survivability; Optical network control and management.

Course Outcome:

Student completing this course gets the knowledge of infrastructure of an optical network and various SONET/SDH standards.

Graduate will able to build an optical network using basic components and with OTDM switching technique, also know how to manage and protect the network.

Text Books:

1. Rajiv Ramaswami, Kumar N. Sivarajan and Galen H Sasaki, "Optical Networks :Practical Perspective", Morgan Kaufmann Publishers ,USA,3rd Edition ,2010.

References:

2. C. Siva Ram Moorthy and Mohan Gurusamy, "WDM Optical Network; concept, Design and Algorithms", Prentice Hall,1st edition,2002.
3. Uyless Black, "Optical Networks: Third generation transport systems", Pearson Education, 2002.
4. Biswanath Mukherjee, "Optical Communication Networks"-Mc Graw Hill, 1st Edition ISBN 0-07-044435-8 , 1997 .
5. P.E. Green, Jr., "Fiber Optic Networks, Prentice Hall, NJ,1993.
6. Rajiv Ramaswami and Kumar N. Sivarajan & Galen Sasaki," Optical Networks : A Practical Perspective", Harcourt Asia Pte Ltd, 1 st edition,2004.

COURSE PLAN

Course No	Course Title	Credits	Year
06EC 6157	**Optical Networks**	**3-0-0: 3**	**2015**
Module		Hours	End Sem Exam Marks (%)
1	Optical Network Architectures Introduction to Optical Networks: Optical Networks (T1- sec 1.3), The optical layer (T1-sec 1.4), Cient	**11**	**25**

	Layers of the Optical Layer (T1-sec 6.1)- SONET / SDH standards (T1- sec 6.1), Multiplexing, SONET/SDH Layers, SONET Frame structure, SONET/SDH Physical Layer, Elements of SONET/SDH Infrastructure, Optical Transport Network(T1-sec 6.2)- Frame structure, Ethernet (T1-sec 6.4)- MAC,LAN, Frame structure, switches, Ethernet physical layer, IP (T1-sec 6.5), Multiprotocol Label Switching(MPL) (T1-sec 6.6), Resilient Packet Ring (T1-sec 6.7), Storage Networks (T1-sec 6.8).		
2	WDM Network Elements WDM network architecture (T1-sec 7), Optical Line Terminals (T1-sec 7.1), Optical line Amplifiers (T1-sec 7.2), Optical Add/Drop Multiplexers (T1-sec 7.3)-OADM Architecture, Reconfigurable OADMs, Optical Cross connects (T1-sec 7.4) - All Optical OXC Configurations, Deployment Considerations (T1-sec 13)-SONET/SDH core Network (T1-sec 13.1.1), Architectural choices of next Generation Networks (T1-sec 13.1.2). Designing the Transmission Layer (T1-sec 13.2).	**11**	**25**
FIRST INTERNAL TEST			
3	Network Survivability, Packet Switching & Access Networks Network survivability- Concepts (T1-9.1), Protection in SONET/SDH (T1-9.2), Protection in	**10**	**25**

	Client Layer (T1-9.3), Optical layer Protection Schemes (T1-9.5). Photonic Packet Switching (T1-12) –OTDM (T1-12.1), Multiplexing and Demultiplexing, Optical AND gates (T1- 12.1.3), Synchronization (T1-12.2), Buffering (T1-12.4), Test beds (T1-12.6), Access Networks (T1-11) –Network Architecture overview (T1-11.1), Enhanced HFC (T1-11.2), FTTC (T1-11.3).		
SECOND INTERNAL TEST			
4	Network Design And Management Design-LTD and RWA problems (T1-10.2), Dimensioning and wavelength Routing Networks (T110.3), Statistical Dimensioning Models (T1-10.4), Maximum load Dimensioning Models (T1-10.5). Control and Management (T1 -8) –Network management functions (T1 -8.1), Optical layer Service interfacing (T1 -8.2), Layers within optical layers (T1 -8.3), Performance and Fault management (T1 -8.5), Configuration management (T1 -8.6), Optical safety (T1 -8.7).	**10**	**25**
END SEMESTER EXAM			

Course No	Course Title	Credits	Year
06EC6257	**Image and Video Processing**	3-0-0:3	**2015**

Pre-requisites: A basic course in image processing

Course Objectives:

- To explore different stages of processing and analysis of a digital image.
- To know how a Digital video signal is represented and processed.

Syllabus:

Introduction To Digital Image Processing & Applications, Image Transforms, Image Segmentation, Wavelets and Multiresolution Processing, Morphological Image Processing, image Representation, Object Recognition, introduction to Video Processing, Representation of Digital Video, Spatial-Temporal Sampling, Video Compression, Standards - MPEG, H.264.

Course Outcome:

At the end of this course students will be able

- to apply transform techniques to processing of digital images
- to apply the concepts in representation and segmentation to analysis of digital images.
- to formulate suitable algorithms for object recognition

Text Books:

1. *R. C. Gonzalez, R. E. Woods, Digital Image Processing, Pearson Education, 2007.*
2. *Anil K. Jain, Fundamentals of Digital Image Processing, Prentice Hall of India, 1989.*
3. *Iain E Richardson, H.264 and MPEG-4 Video Compression, John Wiley & Sons, September 2003.*

References:

4. *M. Tekalp, Digital Video Processing ,Prentice-Hall of India,1995*
5. *Keith Jack,Digital Video and DSP, ,Elsevier inc. ,2008*
6. *A Bovik, Handbook Of Image & Video Processing, Academic Press, 2000*
7. *W. K. Pratt, Digital Image Processing, Prentice Hall of India,1989*
8. *Rosenfeld and A. C. Kak, Digital Image Processing,Vols. 1 & 2, Prentice Hall, 1982.*
9. *K.R.Rao, Zoran.SBojkovic, Dragorad A Milovanovic, Multimedia Communication Systems: Techniques, Standards and Networks, Prentice Hall of India, 2002.*

COURSE PLAN

Course No	Course Title	Credits	Year
06EC6257	**Image and Video Processing**	**3-0-0: 3**	**2015**
Module		Hours	End Sem Exam Marks (%)
1	Introduction To Digital Image Processing & Applications (Ref1, Chapter 1 page no 1-7), Elements Of Visual Perception-Mach Band Effect-, Sampling, Quantization, Basic Relationship Between Pixels (Ref 1 Chapter 2 page no 35-71), Color Image Fundamentals- RGB-HSI Models (Ref 1 chapter 6 page no 394-407), Image Transforms-Two Dimensional Orthogonal And Unitary Transforms, Separable Unitary Transforms -Basis Images, DFT, WHT, KLT, DCT and SVD (Ref 2) .	**11**	**25**
2	Image Segmentation: Pixel Classification, Bi-Level Thresholding, Multilevel Thresholding, Adaptive Thresholding, Spectral &	**11**	**25**

	Spatial Classification, Edge Detection, Hough Transform, Region Growing. (Ref 1 Chapter 10 page no 689-766).Wavelets and Multiresolution Processing:Multiresolution Expansions, Wavelet Transforms in One Dimension, Fast Wavelet Transform, Wavelet Packets (Ref1 Chapter 7 page no 461-510).Morphological Image Processing: Erosion and Dilation, Opening and Closing, orphological Algorithms. (Ref1 Chapter 9 page no 627-664).		
FIRST INTERNAL TEST			
3	Representation- Boundary Representation: Chain Codes- Polygonal Approximation – Boundary Segments – Boundary Descriptors - Regional Descriptors–Relational Descriptors (Ref 1 Chapter 11 page no 795-852) - Object Recognition- Pattern And Pattern Classes- Recognition Based On Decision Theoretic Methods. Structural Methods. (Ref1 Chapter 12 page no 861-904)	**11**	**25**
SECOND INTERNAL TEST			
4	Video Processing : Display Enhancement, Video Mixing, Video Scaling, Scan Rate Conversion (Ref 5, chapter 5), Representation Of Digital Video (Ref 4 chapter 1 page no 1-16), Spatio-Temporal Sampling (Ref 4 chapter 3 page no 36-55), Video Compression-Motion	**9**	**25**

	Estimation, Intra And Inter frame Prediction (Ref 4 chapter 6 page no 419-429) , Perceptual Coding, Standards - MPEG, H.264 (Ref 4 chapter 6 page no 432-455).		
END SEMESTER EXAM			

Course No	Course Title	Credits	Year
06EC6357	**Communication Networks**	3-0-0: 3	**2015**

Pre-requisites: A basic course in Computer networks & Queuing Theory

Course Objectives:

- To introduce the state-of-the-art in communication network architectures, protocols and applications.
- To obtain a working knowledge of a variety of computer communications technologies used in computer network infrastructures.
- To develop the ability to formulate a computer communications problem, analyze it, and communicate the results in written and graphical form.

- To familiarize the network queuing models and to analyse the significance of Markov process in communication network design.

Syllabus:

Introduction to Computer network, Layering, Application layer,Data link layer- Error detection and correction,Multiple access protocols,Transport layer,routing algorithms,Routing in the internet ,Protocols for Real-time interactive applications, Integrated and Differentiated services for multimedia transport Markov Process, Transition Probability Matrices of a Markov Chain, Continuous Time Markov Chains, Modelling and performance analysis of networks, M/M/1, M/M/m, M/M/infinity, M/M/m/m, M/G/1 Queuing systems.

Course Outcome:

The student will be able to apply the concepts of

- network layering,design/performance parameters in designing novel communication network architectures.

- Markov chain and network queuing models in communication networks.
- network routing protocols for interactive multimedia communication networks.

Text Book:

1. *James. F. Kurose and Keith. W. Ross, "Computer Networks: A top-down approach featuring the Internet", Pearson Education, 3/e, 2005. (Modules 1 & 2).*
2. *Bertsekas, D., and Gallager, R., Data Networks, Second Edn, Prentice Hall India, 2002. (Modules 1 & 2) http://web.mit.edu/dimitrib/www/datanets.html.*
3. *Alberto Leon Garcia, "Probability and Random Processes for Electrical Engineering", Pearson Education, 2nd edition, 2007 (Modules 3 & 4).*

References:

4. *S. M. Ross, Introduction to Probability Models, Elsevier, 8th edition, 2002 (Modules 3 &4).*
5. *Papoulis, S. U. Pillai, "Probability, Random Variables and Stochastic Processes"4th Edition Tata-Mc Hill (4/E), 2001. (Module 3).*
6. *Kumar, A., Manjunath, D., and Kuri, J., Communication Networking: An Analytical Approach, Morgan Kaufman Publishers, 2004. (Chapter 14-16 for module 2, module 3 &4).*
7. *S. Karlin& H.M Taylor, A First Course In Stochastic Processes, 2nd Edition, Academic Press, New York, 1975.*
8. *J.Medhi, Stochastic Processes, New Age International, New Delhi, 2009.*

COURSE PLAN			
Course No **06EC6357**	Course Title **Communication Networks**	Credits **3-0-0: 3**	Year **2015**
Module		Hours	End Sem Exam Marks (%)
1	Application and Data link layer: Computer network- a nuts-and-bolts description, services, protocol (1.1.1-1.1.3 ref.[1]), Network edge and core (1.2, 1.3 ref. [1]), Layering (1.3.1- 1.3.7 ref. [2]), Application layer- FTP (2.3 ref. [1]), SMTP (2.4.1 ref. [1]), Data link layer- Error detection and correction (5.2.1-5.2.3 ref. [1]), Multiple access protocols (5.3 ref. [1]), IEEE 802.11 MAC (6.3.2 ref. [1]).	**10**	**25**
2	Transport Layer and Network Layer: Transport layer - TCP and UDP (3.3, 3.5 ref. [1]), TCP congestion control (3.7 ref. [1]), Network layer- IP (4.4 ref. [1]), routing algorithms (4.5 ref. [1]), Routing in the internet (4.6 ref. [1]) - Mobile IP (6.6 ref. [1]), Protocols for Real-time interactive applications (7.4 ref. [1]), Integrated and Differentiated services for multimedia transport (7.8 ref. [1]).	**10**	**25**
FIRST INTERNAL TEST			
3	Markov Process and Markov Chains: Discrete Time Markov Chains- Definition, Examples,	**11**	**25**

	Transition Probability Matrices of a Markov Chain, Classification of States and Chains, Chapman Kolmogorov Equation, Basic Limit Theorem, Limiting Distribution of Markov Chains. Continuous Time Markov Chains: General Pure Birth Processes And Poisson Processes- Properties, Inter Arrival And Waiting Time Distributions, Birth And Death Processes. (Sec. 12.4 [1])		
SECOND INTERNAL TEST			
4	Network Modeling and Performance analysis: Modeling and performance analysis of networks: queuing models: Little's Theorem, M/M/1, M/M/m, M/M/infinity, M/M/m/m, M/G/1 Queuing systems, Priority Queueing-Erlang's B and C formulae	**11**	**25**
END SEMESTER EXAM			

Course No	Course Title	Credits	Year
06EC6457	**Digital Communication Techniques**	3-0-0:3	**2015**

Pre-requisites: A basic course in Probability and Linear Algebra

Course Objectives:

- To analyze binary and M-ary digital modulation techniques and their performance in AWGN baseband channels.
- To introduce the concepts of amplitude, phase and quadrature- amplitude modulation and detection schemes.
- To study the design and detection of digital signals for transmission on bandlimited channels
- To introduce the need of synchronisation and equalization in communication systems.

Syllabus:

Basic digital communication system. Performance analysis of wire line and radio communication channels. Geometric representation. Binary pulse modulation. M-ary pulse modulation. Amplitude modulated digital signals. Phase modulated digital signals. Probability of error. Quadrature Amplitude modulated signals. Digital transmission through band limited channels. Signal design for band limited channels. Nyquist criterion. Symbol by symbol detection of data with zero ISI and probability of error. Equalization- Signal design. Different types of equalizers. Symbol synchronisation- different methods.

Course outcome:

The student will be able to:

- Evaluate the performance of binary and M-ary digital modulation schemes in AWGN baseband channels.
- Calculate the probability of error and compare the performance of amplitude, phase and quadrature –amplitude modulation methods.
- Design band limited signals with zero and controlled ISI and calculate their probability of error.
- Apply the concept of equalization and synchronisation to communication systems.

Text book:

1. *John G Proakis and MasoudSalehi, "Fundamentals of Communication Systems" , Pearson Education, 2007.*

References:

2. *J.G. Proakis, M. Salehi, "Digital Communication", MGH, 5th edition, 2008.*
3. *T.T Ha, "Theory and design of Digital Communication Systems", Cambridge university press, 2011.*
4. *John B. Anderson, "Digital Transmission Engineering", Wiley India Reprint, 2012.*
5. *Edward. A. Lee and David. G. Messerschmitt, "Digital Communication", Allied Publishers (second edition), 1994.*
6. *J Marvin.K.Simon, Sami. M. Hinedi and William. C. Lindsey, "Digital Communication Techniques", PHI, 1994.*

COURSE PLAN			
Course No **06EC 6457**	Course Title **Digital Communication Techniques**	Credits **3-0-0: 3**	Year **2015**
Module		Hours	End Sem Exam Marks (%)
1	Elements of an Electrical communication system [1-1.2]-Digital Communication system, [1-1.2.1], Mathematical models for communication channels [1 – 1.4] Performance Analysis for wire line and radio communication channels- regenerative repeaters, link budget analysis for radio channels [1-11.5]. Digital Modulation in an Additive White Gaussian Noise Baseband Channel Geometric representation of Signal waveforms [1-8.1], Binary Pulse Modulation- Binary Pulse Amplitude Modulation, Binary Pulse Position Modulation [1-8.2]. Optimum receivers for binary modulated signals in AWGN – correlation type demodulator, matched filter type demodulator. Performance of optimum detector for binary signals [1-8.3]. M-ary Pulse modulation [1-8.4]– M-ary pulse amplitude modulation[1-8.4.1], M-ary orthogonal signals[[1-8.4.2], Optimum receiver for M-ary signals in AWGN[1-8.4.6].	**10**	**25**

	Probability of error for M-ary pulse modulation[1-8.5]–Probability of error for M-ary pulse amplitude modulation[1-8.5.1], Probability of error for M-ary orthogonal signals[1-8.5.2], Union bound on the probability of error[1-8.5.3]		
2	Transmission of Digital Information via Carrier Modulation: Amplitude modulated digital signals – Demodulation and detection of Amplitude Modulated Signals[1-10.1],Phase modulated digital signals –Demodulation and detection of phase modulated signals. Differential phase modulation and demodulation, Probability of error for Phase coherent PSK modulation, Probability of error for DPSK[1-10.2], Quadrature Amplitude modulated digital signals – Demodulation and detection of Quadrature Amplitude modulated signals- probability of error for QAM[1-10.3].Comparison of modulation schemes[1-10.5].	**10**	**25**
FIRST INTERNAL TEST			
3	Digital transmission through band limited AWGN channels: Digital transmission through band limited channels – digital PAM transmission through band limited channels[1-9.1], Signal design for band limited	**12**	**25**

	channels- Design of band limited signals for zero ISI – the Nyquist criterion, design of band limited signals with controlled ISI – partial response signals [1-9.2], Probability of error for detection of digital PAM with zero ISI, Symbol by symbol detection of data with controlled ISI, Probability of error for symbol by symbol detection of partial response signals, Maximum likelihood sequence detection of partial response signals [1-9.3].		
SECOND INTERNAL TEST			
4	Equalization: System design in the presence of channel distortion-design of transmitting and receiving filters for a known channel, Channel equalization-maximum likelihood sequence detection, Linear equalizers, Adaptive equalizers, Decision feedback equalizer [1-9.4]. Synchronization: Symbol synchronization –early late gate synchronizers, minimum mean square error method, Maximum likelihood method, spectral line method [1-8.6]. Symbol synchronisation for carrier modulated signals [1-10.6]	**10**	**25**
END SEMESTER EXAM			

Course No	Course Title	Credits	Year
06EC6067/ 06EC6061	**Research Methodology**	**0-2-0:2**	**2015**

Pre-requisites: Nil

Course Objectives:

- To familiarize with the methodologies needed to follow in technical research.
- To familiarize with the scientific methods to do experiments and data analysis.

Syllabus:

Meaning of research, objectives, type of research approaches, Understanding the language of research,Ethical issues,Intellectual property rights and patent law,Reproducibility and accountability, Graphic & diagrammatic representation data,Processing and analysis of data, Interpretation and report writing,Techniques of developing measurement tools.Control &.randomization and their objectives & advantages,Experimental Designs,Defining research problem,Sampling fundamentals,Sampling,Distribution of mean- sampling distribution of proportion Testing of hypotheses,Soft wares for statistical testing.

Course Outcome:

At the end of this course students will be able

- to pursue systematic technical research.
- develop the necessary skill for technical reporting, presentations and hypothesis testing mechanisms

Text Books:

1. *Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, "An introduction to Research Methodology", RBSA Publishers, U.K., 2002.*
2. *Kothari, C.R., "Research Methodology: Methods and Techniques". New Age International. 418p. 1990.*
3. *Deepak Chawla and Neena Sondhi, "Research Methodology concepts and cases" Vikas Publishing house pvt Ltd ,2011.*

References

4. *R. Paneerselvam , "Research Methodolog"y, PHI Learning , 2014*
5. *Sinha, S.C. and Dhiman, A.K., "Research Methodology", Ess Ess Publications. 2 volumes. 2002.*
6. *Trochim, W.M.K., "Research Methods: the concise knowledge base", Atomic Dog Publishing. 270p. , 2005.*
7. *Wadehra, B.L." Law relating to patents, trademarks, copyright designs and geographical indication". Universal Law Publishing. 2000.*
8. *Day, R.A., "How to Write and Publish a Scientific Paper", Cambridge University Press. 1992.*
9. *Fink, A., "Conducting Research Literature Reviews: From the Internet to Pape"r. Sage Publications. 2009.*
10. *Leedy, P.D. and Ormrod, J.E., "Practical Research: Planning and Design", Prentice Hall. 2004*

COURSE PLAN			
Course No **06EC6067/** **06EC6061**	Course Title **Research Methodology**	Credits **0-2-0: 2**	Year **2015**
Module		Hours	End Sem Exam Marks (%)
1	Research methodology: Meaning of research, objectives, type of research approaches, research process, and criteria for good research. Concept of theory, empiricism, deductive and inductive theory. Characteristics of scientific method – Understanding the language of research – Concept, Construct, Definition, Variable. Research Process Application of results and ethics - Environmental impacts - Ethical issues - ethical committees -Commercialization – Copy right – royalty - Intellectual property rights and patent law – Trade Related aspects of Intellectual Property Rights – Reproduction of published material – Plagiarism -Citation and acknowledgement - Reproducibility and accountability	**7**	**25**
2	Techniques of developing measurement tools – scaling – important scaling techniques. Methods ofdatacollection–collection of primary data– observation method questionnaires –other methods ofdata collection. Processing and analysis of data –	**7**	**25**

	processing operations – editing – coding – classification – tabulation. Interpretation and report writing-techniques of interpretation – steps in report writing. Graphic & diagrammatic representation data - Purpose of Diagrams & Graphs, Bar diagrams (Simple, Component & Percentage), Pie Charts, Line Square Diagrams, Interpretations & Comparisons, Graphical Representation of Frequency Distribution, Histograms, Frequency Polygon, Frequency Curve.		
FIRST INTERNAL TEST			
3	Defining research problem – research design, features of good design - different research designs basic principle of experimental design developing a research plan. Experimental Designs - purpose of designing experiments, methods of increasing accuracy of experiments, replication, control & randomization and their objectives & advantages - basic ideas of completely randomized , randomized block, Factorial and Latin square designs.	**7**	**25**
SECOND INTERNAL TEST			
4	Sampling fundamentals – need for sampling – important sampling distribution: Sampling	**7**	**25**

	Distribution of mean- sampling distribution of proportion – student's 't' distribution – F distribution–Chi-square distribution – concept of standard error - – sample size and its determination. Testing of hypotheses – procedure for testing hypotheses - important parametric tests: Z test, t-test, chi- square test, F test and ANOVA. Softwares for statistical testing.		
END SEMESTER EXAM			

Course No	Course Title	Credits	Year
06EC6077/ 06EC6071	**Seminar 1**	0-0-2: 2	**2015**

Course Objectives:

- To introduce the students to cutting edge technology in the area of communication engineering.
- To develop the acumen of reading & comprehending technical papers and implementing the methods as mentioned them

Syllabus:

Each student shall present a seminar on any topic of interest related to Communication Engineering topics. He/she shall select the topic based on the references from recent international journals of repute, preferably IEEE journals. They should get the paper approved by the Programme Co-ordinator/ Faculty member in charge of the seminar and shall present it in the class. Every student shall participate in the seminar. The students should undertake a detailed study on the topic and submit a report at the end of the semester. Marks will be awarded based on the topic, presentation, participation in the seminar and the report submitted.

Course Outcome:

- This course will prepare the student to comprehend technical papers in their selected areas.
- This will eventually improve the quality of their main project.
- Their ability to write and report technical results will be improved.

Course No	Course Title	Credits	Year
06EC6087	**Wireless Communication Lab I**	3-0-0:3	**2015**

Pre-requisites: A basic course in Digital Communication, Wireless Communication

Course Objectives:

To understand and analyse the concepts of Wireless Communication, Communication Networks, and Basics of Digital Communication Techniques.

Syllabus:

Tools:

Computing and Simulation Environments **–** GNU Octave / MATLAB/ Lab View/NS 2 or any other equivalent tool.

Suitable Hardware Tools like Network Analyser, Microwave Test Bench Communication TX, Rx kit or similar equipments

Suggested flow of experiments: (These are minimum requirements; Topics could be added in concurrence with the syllabus of core and elective subjects)

- Familiarisation of Vector Network Analyzer and calibration
- Various characteristics measurement of communication system using vector network analyser
- Measurement of Antenna Parameters
- Familiarisation of free space propagation
- Comparison of Antenna Characteristics
- Generation and simulation of Various Signals
- Implementation of Analog Modulation Schemes
- Implementation of Digital Modulation Schemes
- Implementation of different type Filters
- Simulation of BER curves for the various schemes, comparison with analytical results.
- Modelling and Simulation of Networks using NS2 /similar tools.

Course Outcome:

On successful completion of this course students will be able to analyse the Concepts of Wireless Communication, Communication Networks and Basics of Digital Communication Techniques.

Text Books & References:

1. Balanis A, "Antenna Theory ,Analysis and Design" , John Wiley & Sons, New York, 1982.
2. *J.G. Proakis, and M. Salehi, "Contemporary Communication Systems using MATLAB", Bookware Companion Series, 2006.*
3. *E. Aboelela, "Network Simulation Experiments Manual," The Morgan Kaufmann Series in Networking", 2007.*

SEMESTER II

Course No	Course Title	Credits	Year
06EC6018/ 06EC6012	**Communication System Design**	**4-0-0:4**	**2015**

Pre-requisites: A basic course in Communication, Wireless Communication

Course Objectives:

To address the various designs and architectures of communication system in the context of modern multimode and multi standard devices

To expose the students to

- noise in wireless receivers and how it manifests itself in circuits and components, including phase noise.
- system nonlinearity and its impact on receiver performance and design
- quantization noise, sampling clock jitter, impact of phase noise on the sampling clock, signal overloading and clipping
- ADC architectures, ΔΣ Modulators, AGCs, PLLs, and receiver architectures

Syllabus:

Transmitter & Receiver Design Fundamentals, Noise Fundamentals, Phase Noise, Non Ideal Transfer Functions & Compensation, Sampling, Distortion & Jitter, Data Conversion, Frequency Synthesizers , AGCs, PLLs, Receiver Architectures

Course Outcome:

The students will be able to

- understand transmitter & receiver design from analog front ends to mixed signal design and frequency synthesis with equal emphasis on theory and practical design.

- design futuristic wireless radios and modems, capable of supporting multiple standards and modes, is drastically different from traditional designs supporting a single standard.

Text Books:

1. *Scott R. Bullock, "Transceiver and System Design for Digital Communications", SciTech Publishing, Inc. Raleigh, NC, Third Edition, 2009.*
2. *Kevin McClaning, "Wireless Receiver Design for Digital Communications", SciTech Publishing, Inc. Raleigh, NC, Second Edition, 2012.*

References:

3. *Tony J Rouphael, "Wireless Receiver Architectures and Design: Antennas, RF, Synthesizers, Mixed Signal and Digital Signal Processing", Elsevier, 2014.*
4. *Ariel Luzzatto and Gadi Shirazi, "Wireless Transceiver Design-Mastering the Design of Modern Wireless Equipment and Systems", John Wiley & Sons, 2007.*

COURSE PLAN

Course No **06EC6018/ 06EC 6012**	Course Title **Communication System Design**	Credits **4-0-0: 4**	Year **2015**
Module		Hours	End Sem Exam Marks (%)
1	Transmitter & Receiver Design Fundamentals Transmitter Design Fundamentals (Chap 2 [1]), Receiver Design Fundamentals(Chap 3 [1]), Noise Fundamentals: Amplifier Noise Model, Signal-to-Noise Ratio, Noise Factor/Noise Figure, Cascade Performance, Minimum Detectable Signal (Chap 6 [2]), Phase Noise (Chap 9.3 [2]).	**13**	**25**

2	Non Ideal Transfer Functions & Compensation Amplifier Transfer Curve, Polynomial Approximations, Distortion Summary, Pre-selection, Narrowband and Wideband Systems, Gain Compression/Output Saturation, Compression Point, Nonlinearities and Modulated Signals (Chap 7 [2]). Sampling, Distortion & Jitter Sampling and reconstruction of low pass and band pass signals, Signal distortion due to sampling and conversion imperfections: Quantization noise, Signal to quantization noise ratio, Effect of clock jitter on sampling, Impact of phase noise on clock jitter, Overloading and clipping, Anti-aliasing filtering requirements (Chap 5 [3]).	**15**	**25**
FIRST INTERNAL TEST			
3	Data Conversion Track-and-Hold and Sample-and–hold amplifiers, Comparators, Nyquist convertors: The FLASH architecture, Pipelined and subranging ADC architectures, Folding ADC architectures, Δ∑ Modulators: The basic loop dynamics, Continuous time vs discrete time Δ∑ Modulators (Chap 6 [3]). AGC The purpose of AGC in the receiver, AGC architecture and strategies, Types of AGC algorithms (Chap 7.1 [3]).	**15**	**25**

SECOND INTERNAL TEST			
4	Frequency Synthesizers PLLs: The linear PLL model, Error convergence, order and type of PLL, PLL stability and operating range parameters, the phase detector; Fractional N frequency synthesis, programmable digital counter, spurs in fractional N frequency synthesizers, Δ∑ fractional N frequency synthesizers (Chap 7.2 [3]). Receiver Architectures Direct Conversion receivers: architecture and performance; Super heterodyne receiver: architecture and performance; Low IF receivers: architecture and performance, Typical driving requirements: Sensitivity, selectivity, Image rejection, Frequency planning & generation, Linearity (Chap 8 [3]).	**13**	**25**
END SEMESTER EXAM			

Course No	Course Title	Credits	Year
06EC6028	**Mobile Cellular Communications**	**3-0-0: 3**	**2015**

Pre-requisites : A Basic course in wireless Communication

Objectives

- To introduce students to fundamentals of Mobile cellular Communications and major cellular standards
- To Familiarise students with elements of mobile cellular system and Wireless interference avoidance and capacity creation in mobile cellular networks
- To make students conversant with modern digital modulation Techniques and multiple
- To highlight Mobility management issues and mobile cellular network infrastructure

SYLLABUS

Introduction to Cellular Mobile Systems ;Elements Of Cellular Mobile Radio System ; Digital Modulation And Multiple Access Techniques For Cellular System ; Mobility Management and Cellular Infra Structure

Course Outcome :

The student will be able to apply the concepts of

- Mobile cellular Networks and mobile standards
- interference reduction and capacity enhancement of mobile cellular networks
- various diversity techniques and wireless access technologies
- Mobility management and Cell site infrastructure requirements

Text Books :

1. *William C.Y . Lee " Mobile Cellular Telecommunications" Tata Mc Graw hill Edition ,1995*
2. *Vijay K Garg "Wireless Communications and Networking", , Morgan Kaufman publishers, 2013*
3. *T. S. Rappaport, "Wireless Communication, Principles & Practice", Pearson Education, 2010.*

References :

4. *Andrzo Jajszczyk , " A Guide to the Wireless Engineering Body of Knowledge (WEBOK)" Wiey- IEEE Press , II edition, 2012.*
5. *Jinson Wu, Sundeep Rangan & Honggang Zhang, " Green Communications " CRC Press, Taylor & Francis Group ,2012.*
6. *T L Singal , " Wireless Communications" Megeaio Hill, 2011.*
7. *Huan Hua Chang, David William, Julie Schulman , "Near Field communication Explained" Iverday NFC Publishers MEDS Magazine, 2013.*
8. *Florain Harrmann , " Medical Electronics Device Solutions" MEDS Magazine, 2013*
9. *Lorenzi .C, Brthommiar. F, " Effects of Envelope expansions on speech Recognition" US National library of Medicine , Elsevier, 1999.*
10. *IEEE communication standard 802.11 wireless access in Vehicular environment (WAVE)*

COURSE PLAN

Course No **06EC 6028**	Course Title **Mobile Cellular Communications**	Credits **3-0-0: 3**	Year **2015**
Module	**Introduction To Cellular Mobile Systems**	Hours	End Sem Exam Marks (%)
1	Mobile Radio environment (1.6 [1]) Basic Propagation Methods (4.4 [3] Outdoor propagation models (4.10 [3]) Indoor Propagation Models (4.11 [3]) Signal penetration	**14**	**25**

	into buildings (4.12 [3]) Small scale multipath Propagation (5.1 [2]) Small scale multipath measurements (5.3 [2]) Limitations of Analogue Mobile System (1.1 [1]) Trunking efficiency (1.3 [1], Performance criteria (1.5 [1]) Architecture of a mobile cellular system (10.3 [2], Design fundamentals (1.3[4]) Different generations of Mobile systems, (1.2 [3]), Cellular communications from IG to 3 G (1.3 [3]) Road map for 3 G Data rate capability and Different Migration paths (1.4 [3]), Wireless 4G systems (1.5 [3]) Wireless access Technologies Road map, Vision of future GSM –LTE- 5G **(** 1.5 [4]) 3G PP2 Radio Access standards evolution (1.6[4])		
2	**Elements Of Cellular Mobile Radio System** Channel planning for wireless systems (2.1[1]) concept of frequency reuse (2.2 [1]) Interference and system capacity (3.5[2]) Co channel interference (3.5.1[2]) Adjacent channel interference (3.5.3[2]) power control for reducing interference (3.5.4 [3]) Trunking & grade of service,(3 6.[3]) improving coverage and capacity in cellular systems (3.7[2]),cell splitting (3.7.1[2]), sectoring (3.7.2 [2]), Repeaters' (3.7.3 [2]), Microcell concept (3.7.4 [2]), Quality of service , QoS(15.12[2]), QoS classes 15.12.1 [1]), QoS attributes (15.12.2[2])	**14**	**25**
FIRST INTERNAL TEST			
3	**Digital Modulation And Multiple Access Techniques For Cellular System** Factors influencing the choice of digital modulation	**14**	**25**

	(6.4.1[2]) Gaussian Techniques filter(6.6[2]) BPSK (6.6.1[2]) DPSK 96.6.2[2]) QPSK (6.6.3[2]) Offset QPSK (6.6.4[2]) BFSK (6.9.1 [2]) MSK (6.9.2[2]) GMSK (6.9.3 [2]) Spread Spectrum Modulation Techniques (6.11[2]) Direct sequence, Spread spectrum- Frequency hopped spread spectrum, Narrow Band systems (6.2[3]) Frequency Division Duplex and Time Division Duplex Systems (6.2.1 [3]) , Frequency Division Multiple Access (6.2.2[3]), Time division multiple access (6.2.3.[3]) , Spectral efficiency (6.3 [3]), Wideband systems (6.4[3]) Code Division multiple access, OFDM (6.9 [3]), IS-95 CDMA (11.4[3]) IMT- 2000 (16.6 [2]), UMIS (13.7.2[6] W -CDMA (13.8 [6]), IEEE and other access technologies (1.7[4]) , Cognitive Radio and M2M (235.7[2]), NFC Technology(2,[7]), Bluetooth health device protocol (8), Expansion in speech recognition (9)), W-i Max(21.15 [2])Vehicle communication (10)		
SECOND INTERNAL TEST			
4	**Mobility Management and Cellular Infra Structure** Mobility Management Functions (12.2 [3]) Mobile Location Management (12.3 [3]) Mobile Registration (12.4 [3]) GSM Token based registration (12.4.1[3]) IMSI Attach and IMSI Detach in GSM, Paging in GSM (12.4.2 [3]) Hand off strategies (3.4 [2]) Hand off Techniques (12.5.1 [3]) Hand off types (12.5.2.[3]) Prioritising Hand off (3.4.1[2]) Practical Hand off considerations (3.4.2[2]) Tower considerations, Cell site	**14**	**25**

	Antennas(6.4 [1]) Minimum separation of cell site receiving antennas (58.5.2[1]) Choosing an antenna site (5.5.4[1])Mobile antennas (5.6[1]). Facilities infrastructure – cell site power supply (4.2[4]) electrical protection heating & ventilation (4.3 [4]) Rake mounting (4.4 [4]) wave guide and transmission lines(4.5[4]),Distributed antenna systems(4.6[4]), Surveillance and alarm systems (4.7 [4])Green Cell site systems [6]		
END SEMESTER EXAM			

Course No	Course Title	Credits	Year
06EC6038	**Smart Antennas**	**3-0-0: 3**	**2015**

Pre-requisites: A basic course in digital signal processing and mobile communication

Course Objectives:

- To introduce the need for smart antennas for increasing the capacity in a mobile communication scenario
- To study the required signal processing algorithms for DOA estimation and adaptive beam forming on both the base stations and mobile stations.

Syllabus:

Role of smart antennas in a mobile communication scenario, need for interference cancellation, various configurations, transmitter and receiver blocks, received signal model, autocorrelation matrix of received signal, DOA estimation both conventional, MVDR and subspace based methods, conventional beam former(BF), multiple side lobe canceller, Linearly constrained beamformer (LCMV), statistically optimum weight vector, LMS and RLS algorithms for real time BF realisation, Use of a second antenna in mobile stations, effects of antenna spacing and correlation, methods of combining, RAKE receiver, doubling of capacity in a cell.

Course Outcome:

The student will learn

- to link the importance of various adaptive signal processing algorithms based on interference cancellation techniques

- about the usage of second antenna for the performance improvement of the whole mobile cell communications.

Text Books:

1. *Constantine A Balanis, Panayiotis I Ioannids, 'Introduction to Smart Antennas', Morgan & Claypool publishers.2007*
2. *Ahmed EI Zoogby, 'Smart Antenna Engineering' Artech House Publishers, 2007.*
3. *Monson H. Hayes, Statistical Signal Processing and Modeling, John Wiley & Sons Inc, Reprint 2013.*

References:

4. *MJ Bronzel ,' Smart Antennas ' John Wiley, 2004.*
5. *TS Rappaport & JC Liberty,' Smart Antennas for Wireless Communication', Prentice Hall, 1996.*
6. *RJanaswamy,' Radiowave propagation and Smart Antennas for Wireless Communication' Kluwer, 2000*

COURSE PLAN

Course No **06EC6038**	Course Title **Smart Antennas**	Credits **3-0-0: 3**	Year **2015**
Module		Hours	End Sem Exam Marks (%)
1	Introduction to smart antennas (4.1-4.9[1]) Need for smart antennas, Smart Antenna Configurations, Switched beam antennas, Adaptive antenna approach, Space Division Multiple Access (SDMA), Architecture of a smart antenna System, Transmitter, Receiver, Benefits and Drawbacks, Basic	**8**	**25**

	principles of interference suppression in ULA, Mutual coupling Effects.		
2	DOA Estimation (5.1-5.8[1]) Introduction to array response vector, Received signal Model, Subspace Based data model, Signal Auto Covariance Matrices (ACM), Conventional Beamforming method, Capon's minimum variance method (MVDL), Subspace approach to DOA Estimation, MUSIC Algorithm, ESPRIT Algorithm, Uniqueness of DOA Estimates.	**12**	**25**
FIRST INTERNAL TEST			
3	Beamforming (6.1, 6.2, 6.3.1, 6.3.2, 6.3.4 [1]) The Classical beamformer, Statistically Optimum Beamforming Weight Vectors, The maximum SNR Beamformer, The multiple Sidelobe canceller, Maximum SINR Beam former, Minimum Mean Square Error (MMSE), Direct Matrix Inversion, Linearly constrained beamformer (LCMV), Adaptive Algorithms for beamforming, (9.1,9.2,9.2.1,9.2.2,9.2.4 [3])the Least Mean Square Algorithm(LMS), Normalised LMS, (9.4,9.4.1[3]) Recursive Least Squares Algorithm (RLS) ([3]).	**14**	**25**
SECOND INTERNAL TEST			

4	Mobile station's smart antennas (Chapter 9 [2]) Introduction, Multiple antenna MS Design, combining techniques, Selection (switched) diversity, Maximal Ratio combining, Adaptive beamforming or Optimum combining, RAKE Receivers, Mutual coupling effects, Dual antenna Performance Improvements on MS, Downlink capacity gains.	**8**	**25**
END SEMESTER EXAM			

Course No	Course Title	Credits	Year
06EC6148	AdHoc and Sensor Networks	3-0-0: 3	2015

Pre-requisites: A basic course in Communication networks

Course Objectives:

- This course will provide students with an understanding of wireless ad-hoc and sensor networks, and provide them with an understanding of the major design issues, including topics such as protocol mechanisms and resource constraints.
- To enable the student to understand the different approaches of routing mechanisms like proactive, on-demand and hybrid and Knowledge of Multicast routing.
- To enable the students to understand various security threats to ad hoc networks and describe proposed solutions.
- To enable the student to understand the Energy efficient communication in adhoc network.
- To understand the basic principles of sensor network, its architecture and MAC protocol for sensor networks. This includes the sensor data dissemination and tracking.

Syllabus:

All important design issues –medium access control, routing, multicasting, security, quality of service provisioning, energy management - in ad-hoc wireless networking in considerable depth. It includes wireless sensor networks and the Canonical problem.

Course Outcome:

- Students who successfully complete this course will have an understanding of the principles of mobile ad hoc networks (MANETs) and what distinguishes them from infrastructure-based networks. Students will be able to describe the unique issues in ad-hoc/ sensor networks.
- Students will be able to describe how proactive, reactive and hybrid routing protocols function and their implications on data transmission delay and bandwidth consumption.

- Students will be familiar with the mechanisms for implementing security and trust mechanisms in MANETs.
- Students will have an understanding of the principles and characteristics of wireless sensor networks (WSNs). Students will be able to discuss the challenges in designing MAC protocol for sensor networks.

Text Books:

1. *1 C.S. Murthy & B.S. Manoj, "AdHoc Wireless Network"s, Pearson, 2004.*

References:

2. *S.Basagni & M.Conti, "Mobile Ad Hoc Networking", Wiley, 2004*
3. *Feng ZHAO & Leonidas GUIBAS, "Wireless Sensor Networks-An Information Processing Approach", Morgan Kaufmann, 2004.*
4. *C.Perkins, "Ad Hoc Networking", Addison Wesley, 2000.*
5. *Ozan K. Tonguz & Gianluigi, "Adhoc Wireless Networks", Wiley, 2006.*
6. *Kazem Sohraby, Daniel Minoli &Taieb Znati, "Wireless sensor networks: Technology, Protocols, and applications", John Wiley & Sons, 2007.*

COURSE PLAN

Course No	Course Title	Credits	Year
06EC 6148	**AdHoc and Sensor Networks**	**3-0-0: 3**	**2015**
Module		Hours	End Sem Exam Marks (%)
1	Ad-hoc wireless Networks Introduction : Cellular and Adhoc wireless networks (T1-5.1.1), Application of Adhoc wireless networks (T1-	**11**	**25**

	5.1.2), Issues in Adhoc wireless networks (T1-5.2), MAC Protocols for Adhoc wireless networks: Issues in Designing MAC protocol(T1-6.2), Design goals of MAC protocol(T1-6.3),Classification of MAC Protocols (T1-6.4 to 6.7): Contention based, Contention based with reservation mechanisms, Contention based with scheduling mechanisms, other protocols(T1-6.9).		
2	Routing Protocols for Ad-hoc wireless networks Issues in designing routing protocols(T1-7.2) Classifications of routing protocols (T1-7.2), Routing approaches: Table driven(T1-7.4) On demand Routing Protocols(T1-7.5), Hybrid Routing (T1-7.6), Routing protocols with efficient flooding mechanisms (T1-7.7) Hierarchical (T1-7.8),Power aware routing Protocols(T1-7.9). Multicast Routing in adhoc wireless networks: Issues in designing Multicast Routing Protocol (T1-8.2), peration of Multicast routing Protocols: Source-Initiated, Receiver-Initiated (T1-8.3), Classifications of Multicast routing Protocols (T1-8.5), Tree based Multicast routing Protocols (T1-8.6). Mesh based Multicast routing Protocols (T1-8.7).	**11**	**25**
FIRST INTERNAL TEST			
3	Network security & Energy efficient communication Network security requirements (T1-9.8), Issues and	**10**	**25**

	challenges in security (T1-9.9) Network security attacks (T1-9.10), Key Management (T1-9.11), Secure routing in ad-hoc wireless networks (T1-9.12). Energy efficient communication in ad hoc networks. Measuring energy consumption (R2-11.3). Power save protocols (R2-11.4), Power control techniques (R2-11.5). Maximum life time routing. Secure routing protocols (R2-11.6).		
SECOND INTERNAL TEST			
4	Wireless Sensor Networks Introduction (T1 -12.1), Sensor Network Architecture (T1-12.2) Data Dissemination (T1- 12.3), Data gathering (T1 -12.4), MAC protocol for Sensor Networks (T1 – 12.5), Location Discovery (T1- 12.6), Quality of a sensor networks (T1 12.7), Other issues (T1 -12.9). Canonical problem: Localization and Tracking-Tracking scenario (R3-2.1), Problem formulation (R3-2.2), Distributed representation and Inference of states (R3-3.3), Tracking Multiple objects (R3 -2.4), Sensor models (R3 -2.5).	**10**	**25**
END SEMESTER EXAM			

Course No	Course Title	Credits	Year
06EC6248	**RF Circuit Design**	**3-0-0:3**	**2015**

Pre-requisites:A basic course in Analogue Integrated Circuits

Course Objectives:

- To present the concepts of RF design and analysis of RF circuits used in modern wireless communication integrated circuits.
- To analyse the effect of various MOS devices in circuit designs.
- To analyse the fundamental concepts of High frequency and power amplifiers in RF transceivers.
- To analyse the radio transceiver architectures that we are coming across in day today life.

Syllabus:

Basic Concepts in RF Design, Passive RLC networks, Passive IC Components, MOS device review, Distributed systems, High frequency amplifier design, Low noise amplifier design, RF Power amplifiers and mixers, Phased Lock Loops and Voltage controlled oscillators, Frequency synthesis, Radio architectures.

Course Outcome:

The student will be able to apply the concepts of

- parameters for various RF Circuits for transceivers.
- amplifiers and mixers used in various circuits.
- radio architectures and WLAN Transceivers.

Text Books:

1. *Thomas H.Lee, "The Design of CMOS Radio-Frequency Integrated Circuits", 2nd Edition, by Cambridge University Press, 2003.*
2. *BehzadRazavi, "RF Microelectronics", 2nd Edition, by Prentice Hall, 2011.*

References:

3. *R.Ludwig, P. Bretchko, "RF Circuit Design", Pearson Asia Education, New Delhi, 2004.*
4. *Ulrich L. Rohde & David P. NewKirk, "RF / Microwave Circuit Design", John Wiley & Sons, 2000.*
5. *Davis W. Alan, "Radio Frequency Circuit Design", Wiley India, 2009.*
6. *Hoffman R.K, "Handbook of Microwave Integrated Circuits", Artech House, Boston, 1987.*

COURSE PLAN

Course No	Course Title	Credits	Year
06EC6248	**RF Circuit Design**	**3-0-0: 3**	**2015**
Module		Hours	End Sem Exam Marks (%)
1	Basic Concepts in RF Design Nonlinearity and time variance (Sec. 2.1 [2]), Effects of nonlinearity (Sec. 2.2 [2]), Noise (Sec. 2.3 [2]), Sensitivity and dynamic range (Sec. 2.4 [2]). Passive IC Components Interconnects and skin effect (Sec. 4.2 [1]), Resistors (Sec. 4.3 [1]), Capacitors (Sec. 4.4 [1]), Inductors (Sec. 4.5 [1]). MOS device review	**11**	**25**

	Field Effect Transistors (Sec. 5.3 [1]), MOSFET long channel approximation (Sec. 5.4 [1]), MOSFET short channel approximation (Sec. 5.6 [1]).		
2	High frequency amplifier design Rise time, delay and bandwidth (Sec.8.5 [1]), Zeros to enhance bandwidth (Sec. 9.2 [1]), Shunt-series amplifiers (Sec. 9.3 [1]), Tuned amplifiers (Sec. 9.5 [1]), Cascaded amplifiers (Sec. 9.7[1]). Low noise amplifier design Intrinsic MOS noise parameters (Sec. 12.2 [1]), Power match versus noise match (Sec. 12.3 [1]), Large signal performance (Sec. 12.6 [1]), Design examples (Sec. 12.5 [1]).	**10**	**25**
FIRST INTERNAL TEST			
3	RF Power amplifiers and mixers Amplifiers - Class A, AB, B, C, D, E, F (Sec. 15.3 – 15.6 [1]), Mixers - conversion gain, noise figure, linearity and isolation, spurs (Sec. 13.2 [1]), Multiplier based mixers (Sec. 13.4 [1]), Subsampling mixers (Sec. 13.5 [1]). Phased Lock Loops and Voltage controlled oscillators PLL -Linearized PLL models (Sec. 16.3 [1]), Phase detectors (Sec. 16.5 [1]), VCO – resonators (Sec. 17.4 [1]), Negative resistance oscillators (Sec. 17.6 [1]).	**10**	**25**
SECOND INTERNAL TEST			
4	Frequency synthesis Introduction (Sec. 17.7 [1]), Synthesizers with static moduli (Sec. 17.7.2 [1]), Synthesizers with dithering moduli (Sec. 17.7.3 [1]), Combinational synthesizers (Sec. 17.7.4 [1]), Direct digital synthesis (Sec. 17.7.5 [1]).	**11**	**25**

	Radio architectures Receiver architectures (Sec.19.2 [1]), Transmitter architectures (Sec. 19.4 [1]), WLAN transceiver (Sec. 19.6.2 [1]).		
END SEMESTER EXAM			

Course No	Course Title	Credits	Year
06EC6348	Spectral Analysis & Methods	3-0-0: 3	2015

Pre-requisites: A basic course in DSP

Course Objectives:

- To introduce the basic concepts of spectral estimation
- To understand and compare the various techniques used in parametric and non-parametric estimation
- To introduce the concept of filter banks and its application in spectral analysis.

Syllabus:

Energy and Power Spectral Density, Properties, The Spectral Estimation problem, PSD Estimation - Non-parametric methods**:** Periodogram and Correlogram methods; Parametric methods**:** ARMA/AR process, Various methods, Parametric methods for line spectra, MUSIC, ESPRIT Algorithms, Filter bank methods**.**

Course Outcome:

The student will be able to

- Formulate a spectral analysis problem and identify suitable techniques for spectral estimation.
- Identify and apply suitable methods for parametric and non parametric estimation
- Apply filter bank methods to spectral analysis and estimation problems

Text Books:

1. *Stoica , Randolph L. Moses, "Introduction to Spectral Analysis" , Pearson Prentice Hall 2005*

References:

2. *Kay S. M ,"Modern Spectral Estimation Theory & Applications" , Prentice Hall 2010*
3. *Monalakis, Ingle and Kogen, "Statistical and Adaptive Signal Processing", Tata McGraw Hill 2005.*
4. *Monson H. Hayes, "Statistical Digital Signal Processing and Modelling", Wiley 2008*

COURSE PLAN

Course No	Course Title	Credits	Year
06EC6348	**Spectral Analysis & Methods**	**3-0-0: 3**	**2015**
Module		Hours	End Sem Exam Marks (%)
1	Basic Concepts: Introduction, Energy Spectral Density of deterministic signals, Power spectral density of random signals, Properties of ESD/PSD, The Spectral Estimation problem	**10**	**25**
2	PSD Estimation - Non-parametric methods: Periodogram and Correlogram method, Computation via FFT, Properties of Periodogram, Blackman-Tuckey method, Window design considerations, Refined periodogram methods : Bartlet method, Welch method	**10**	**25**
FIRST INTERNAL TEST			
3	PSD Estimation - Parametric methods: Parametric method for rational spectra: Covariance structure of ARMA process, AR signals - Yule-Walker method, Least square method - Levinson-Durbin Algorithm, MA	**12**	**25**

	signals, ARMA Signals - Modified Yule-Walker method. Parametric method for line spectra: Models of sinusoidal signals in noise, Non-linear least squares method, Higher order Yule-Walker method, MUSIC and Pisarenko methods, Min Norm method, ESPRIT method.		
SECOND INTERNAL TEST			
4	Filterbank methods: Filterbankinterpertation of periodogram, , refined filterbank method for higher resolution spectral analysis - Slepia base-band filters, Capon method, Filter Bank Reinterpretation of the periodogram	**10**	**25**
END SEMESTER EXAM			

Course No	Course Title	Credits	Year
06EC6448	**Embedded System Design**	3-0-0:3	**2015**

Pre-requisites:A basic course in digital Electronics and Micro processor hardware and software

Course Objectives:

- To introduce the embedded system design metrics and processor, IC and design technologies.
- To study the detailed architecture and design of single purpose and general purpose processors (SPP&GPP)
- To study the design of embedded systems that are compute oriented and control oriented applying the above knowledge.

Syllabus:

Embedded system overview**,** Design metrics, Processor Technology, IC Technology, Design Technology. Processor Design: Custom Single purpose Processor: RT level Custom Single purpose Processor Design, Optimizing Custom Single purpose Processors- Optimizing the original program, FSMD, datapath& FSM, General purpose Processors- Basic architecture. Digital camera example- User's perspective, Designer's perspective, Informal functional specification, Non-functional specification, Executable specification, Different Implementations and analysis, Control Systems example- open-looped & closed-looped automobile cruise controller, PID controllers, embedded controller design, Fuzzy control, Benefits & Issues of Computer Based Control Implementations.

Course Outcome:

The student will be able to generate different configurations during the design of compute oriented and control oriented embedded systems, using SPPs and GPPs in various combinations and to evaluate in the light of the constraints demanded by the design metrics to arrive at a best design for the problem in hand.

Text Books:

1. *Frank Vahid, Tony D. Givargis, "Embedded System Design – A Unified Hardware/ Software Introduction", John Wiley and Sons, Inc 2002.*

References:

2. *Jonathan W. Valvano, "Embedded Microcomputer systems", Brooks / Cole, Thompson Learning , 2003.*
3. *Steve Heath, Butter worth Heinemann, "Embedded Systems Design", Elsevier, 2002.*
4. *Gajski and Vahid, "Specification and Design of Embedded systems", Prentice Hall.1996*
5. *Timothy J. Ross, "Fuzzy Logic with Engineering Applications", Wiley, 1996.*
6. *M Ganesh, "Introduction to Fuzzy Sets and fuzzy logic", Prentice Hall India,2006.*

COURSE PLAN

Course No	Course Title	Credits	Year
06EC6448	**Embedded System Design**	**3-0-0: 3**	**2015**
Module		Hours	End Sem Exam Marks (%)
1	Embedded system overview**,** Design challenge: Optimizing design metrics, Processor Technology, General purpose Processors, Single purpose Processors,	**8**	**25**

	and Application Specific Processors, IC Technology: Full custom/ VLSI, Semicustom ASIC, PLD, Trends, Design Technology. (ch 1[1])		
2	Processor Design: Custom Single purpose Processor: RT level combinational components, RT level sequential components, Custom Single purpose Processor Design, RT level Custom Single purpose Processor Design, Optimizing Custom Single purpose Processors, Optimizing the original program, Optimizing the FSMD, Optimizing the datapath, optimizing the FSM. General purpose Processors: Basic architecture, Datapath, Control unit, Memory, Pipelining, Superscalar and VLIW architectures. Application Specific instruction set Processors (ASIP's), Microcontrollers, DSP, Less General ASIP environments, Selecting a Microprocessor/ General purpose Processor. (ch 2&3 [1])	**14**	**25**
FIRST INTERNAL TEST			
3	Digital camera example- Introduction, Digital camera User's perspective, Designer's perspective, Specification Informal functional specification, Non-functional specification, Executable specification, Implementation 1: 8051-based design, FDCT Implementation 2: fixed point FDCT, Implementation 3: hardware FDCT. (ch 7[1])	**12**	**25**
SECOND INTERNAL TEST			
4	Open-loop and closed –loop control systems, an open-looped automobile cruise controller, a closed-loop	**8**	**25**

	automobile cruise controller, General control systems and PID controllers, Control objectives, Modeling real physical systems, Controller design, Fuzzy control, Practical Issues Related to Computer based Control, Benefits of Computer Based Control Implementations. (ch 9[1])		
END SEMESTER EXAM			

Course No	Course Title	Credits	Year
06EC6158	**Principles of Secure Communication**	3-0-0:3	**2015**

Pre-requisites: A basic course in Number Theory

Course Objectives:

- To introduce abstract algebra and their applications in cryptography.
- To introduce some of the Encryption standards and applications of symmetric and asymmetric cryptography.
- Understand the basics of Elliptic Curve Cryptography

Syllabus:

Groups, Rings and Fields, Euler's Theorem, Fermat's Theorem, Primality, Symmetric ciphers ,Public key cryptosystems, Message Authentication Code, Hash Functions, Digital Signatures, Elliptic Curve Arithmetic, System Security

Course Outcome:

- The students will be able to apply the concepts of field arithmetic in different cryptographic algorithms.
- The students will be able to design good cryptographic algorithms with less hardware resources and less time complexity.

Text Books &References:

1. *William Stallings, "cryptography and Network Security", 4th Edition, Pearson Education,2010.*

References:

1. *Dummit and Foote, "Abstract algebra", John Wiley and Sons Inc.,2004*
2. *Douglas A. Stinson, "Cryptography, theory and practice", 2nd edition, Chapman & Hall, CRC press Company,2002.*
3. *Lawrence C. Washington, "elliptic curves", Chapman & Hall, CRC Press,2008.*
4. *Rainer ARuppel, "Analysis and Design of stream ciphers", Springer Verlag.*

COURSE PLAN

Course No	Course Title	Credits	Year
06EC6158	**Principles of Secure Communication**	**3-0-0: 3**	**2015**
Module		Hours	End Sem Exam Marks (%)
1	Finite Fields and Introduction to Number Theory Groups, Rings and Fields[4.1], Modular arithmetic[4.2], Euclidean algorithm[4.3] , Arithmetic over GF(p) , polynomial arithmetic and arithmetic over GF(2^n)[4.4 - 4.6]. Prime numbers [8.1], Miller Rabin algorithm [8.3], Fermat's Theorem, Euler's Totient function, Euler's Theorem [8.2], Chinese Remainder Theorem[8.4], primitive root and Discrete logarithm[8.5].	**12**	**25**
2	Symmetric Ciphers and Confidentiality using symmetric Encryption Symmetric cipher model [2.1], Substitution Techniques: Caesar cipher, Monoalphabetic and polyalphabetic ciphers, Playfair cipher and Hill cipher [2.2].	**10**	**25**

	Transposition Techniques [2.3]. Feistel Cipher [3.1], DES Encryption and Decryption Algorithms [3.2], AES Encryption and Decryption Algorithms [5.2]. Random Number Generation: Uses, Linear Congruential Generators, Pseudo Random Number Generation from counter [7.4]. Key Distribution: A key distribution scenario, Hierarchical Key Control [7.3].		
FIRST INTERNAL TEST			
3	Public key cryptosystems Principles of public key cryptosystems [9.1]. RSA Algorithm: Description of the algorithm, Computational complexity, the factoring problem [9.2]. Diffie Hellman key exchange and man in the middle attack [10.2]. Message Authentication Code (MAC): uses, requirements for MACs [11.3]. Hash Functions: simple hash function, uses, and requirements for hash function [11.4]. Digital Signatures: Direct Digital Signature, Arbitrated Digital Signature [13.1].	**10**	**25**
SECOND INTERNAL TEST			
4	Introduction to Elliptic Curve Cryptography and System Security Elliptic Curve Arithmetic: Elliptic curves over real, Z_p and GF(2^m) , Geometric Description of addition [10.3], Analog of Diffie Hellman key exchange [10.4]. System Security: Intruders [18.1], intrusion detection: Audit records, Statistical anomaly detection, Honey pots [18.2]. Viruses: terminology of malicious programs, nature of viruses, types of viruses [19.1], antivirus approaches [19.2]. Firewalls: Characteristics, types of firewalls [20.1].	**10**	**25**
END SEMESTER EXAM			

Course No	Course Title	Credits	Year
06EC6258	**Speech and Audio Processing**	3-0-0: 3	**2015**

Pre-requisites: A basic course in Speech and Audio processing

Course Objectives:

- To introduce the concept of Time domain analysis and Frequency domain analysis of speech signal
- To analyse various digital speech models
- To analyse various speech coding and speech processing methods
- To introduce the concept of audio processing and various audio coding standards

Syllabus:

Speech Production, Speech Analysis, Digital Speech Models, LPC Analysis, Speech Coding, Speech Processing, Audio Processing, Music Production.

Course Outcome:

The student will be able to apply the concepts of

- Time domain and frequency domain analytical methods in speech processing
- Speech coding in communication engineering
- MPEG audio coding in audio processing applications

Text Books:

1. *Douglas O'Shaughnessy, Speech Communications: Human & Machine, IEEE Press, Hardcover 2nd edition, 1999; ISBN: 0780334493.*
2. *Nelson Morgan and Ben Gold, Speech and Audio Signal Processing : Processing and Perception Speech and Music, July 1999, John Wiley & Sons, ISBN: 0471351547.*

References:

3. *Rabiner and Schafer, Digital Processing of Speech Signals, Prentice Hall, 1978.4.*
4. *Rabiner and Juang, Fundamentals of Speech Recognition, Prentice Hall, 1994.*
5. *Thomas F. Quatieri, Discrete-Time Speech Signal Processing: Principles and Practice, Prentice Hall; 1st edition ,2008*
6. *Donald G. Childers, Speech Processing and Synthesis Toolboxes, John Wiley & Sons, September 1999.*
7. *Rabiner L.R. & Gold, Theory and Applications of Digital Signal Processing, Prentice Hall of India,1985.*
8. *Jayant, N. S. and P. Noll. Digital Coding of Waveforms: Principles and Applications to Speech and Video Signal Processing Series, Englewood Cliffs: Prentice-Hall ,1984*
9. *Ben Gold & Nelson Morgan, Speech and Audio Signal Processing, John Wiley & Sons, Inc.*,2011

COURSE PLAN

Course No	Course Title	Credits	Year
06EC6258	**Speech and Audio Processing**	**3-0-0: 3**	**2015**
Module		Hours	End Sem Exam Marks (%)
1	Speech Production: - Acoustic theory of speech production- Excitation, Vocal tract model for speech analysis, Formant structure, Pitch. (Chapter 3 [1]) Speech Analysis :- Short-Time Speech Analysis (Chapter 6.2 [1]) , Time domain analysis - Short time energy, short time zero crossing Rate, ACF (Chapter 6.3 [1])	**10**	**25**

	Frequency domain analysis- Filter Banks, STFT, Spectrogram, Formant Estimation &Analysis (Chapter 6.4 [1]) , Cepstral Analysis (Chapter 6.6 [1])		
2	Digital Speech Models: - AR Model, ARMA model. (Chapter 6 [1]) LPC Analysis - LPC model, Auto correlation method, Covariance method, Levinson- Durbin Algorithm, Lattice form (Chapter 8 [3]) LSF, LAR, MFCC, Sinusoidal Model, GMM (Chapter 14.3 [5]), HMM (Chapter 25 [2])	**12**	**25**
FIRST INTERNAL TEST			
3	Speech coding :- Phase Vocoder, LPC, Sub-band coding, Adaptive Transform Coding , Harmonic Coding, Vector Quantization based Coders, CELP (Chapter 7 [1]) Speech processing :- Fundamentals of Speech recognition, Speech segmentation (Chapter 9 [3]) Text-to -speech conversion, speech enhancement, Issues of Voice transmission over Internet. (Chapter 30 [2])	**10**	**25**
SECOND INTERNAL TEST			
4	Audio Processing : Non speech and Music Signals Modelling -Differential, transform and sub band coding of audio signals & standards - High Quality Audio coding using Psycho acoustic models - MPEG Audio coding standard.(Chapter 35 [2])	**12**	**25**

	Music Production - sequence of steps in a bowed string instrument -Frequency response measurement of the bridge of a violin (Chapter 12 [2]) Audio Data bases and applications – Content based retrieval (Chapter 38 [2])		
END SEMESTER EXAM			

Course No	Course Title	Credits	Year
06EC6358	**EMI/EMC Based System Design**	3-0-0: 3	**2015**

Pre-requisites: Abasic course in Electromagnetic theory and Digital electronics

Course Objectives:

Define and highlight the effect of EMI in the present Electronics scenario with large number of high frequency devices working together specially in the nonlinear digital domain.

The importance in design to incorporate Emission reduction techniques and also make designed units not being susceptible is brought out.

Syllabus:

Definition of EMI and the essentiality of EMC. Nature and types of interferences which adversely affect other systems & modules and possible methods of reduction. Susceptibility reduction techniques of units specially the sensitive ones are covered. Design of PCBs, backplanes, power supply grounding methods for reducing emission as well as measures like zoning, isolation shielding to reduce susceptibility are covered. It is almost impossible to predict the EMI environment accurately and hence measurement of Emission levels and Susceptibility forms a very important part of the study. TEM CELL, OPEN AREA, CONTROLLED CHAMBERS and associated sensors and equipments are also covered.

Course Outcome:

An Electronics designer becomes aware of the pitfalls of not incorporating Interference reduction techniques at the design stage itself as well as Susceptibility reduction techniques for sensitive systems. EMI/EMC should not be an afterthought for it may be costly, difficult and time consuming process if a cut and try also known as Band-Aid approach is taken.

Text Books:

1. *V.P.Kodali Engineering EMC Principles, "Measurements & Technologies." IEEE Press New York,1996*
2. *Henry W.OTT , "Noise Reduction Techniques in Electronic Systems." A Wiley Inter Science Publication John Wiley & Sons , New York,1988*

References:

3. *Bemhard Keiser, "Principles of Electromagnetic Compatibility", Artech House Norwood,1987.*
4. *C.R.Paul, "Introduction to Electromagnetic Compatibility", John Wiley & Sons,1992.*
5. *Him R Fowler "Electronic Instrument Design" Oxford University Press, 2009.*

COURSE PLAN

Course No **06EC 6358**	Course Title **EMI/EMC Based System Design**	Credits **3-0-0: 3**	Year **2015**
Module		Hours	End Sem Exam Marks (%)
1	EMI definition, relevance in the present day scenario [1(2)].The necessity for EMC. Units used in EMI/EMC, use of Decibels. Source, Medium and Victim in the interference phenomenon. Conducted and Radiated modes of Interference and Susceptibility of the Victim. Transient coupling mode[1(2)]. EMI Coupling Conducted coupling through common impedance, Common power supplies. Radiated coupling—Electric, Magnetic and Electromagnetic [1(2)]. Digital circuit radiation	**12**	**25**

	Common Mode Radiation and ground loop/return Differential Mode Radiation, Magnetic Source. Increased effects foreseen in VLSI, ULSI and lower voltage operation[11(2)]. Principle of cross talk[3.6(1)]. Cable to Cable coupling and shielding. Field to Cable coupling and reduction—balanced, shielded schemes. Power Mains coupling of External and Internally generated transients. Common mode and Differential mode interference filtering and Common Mode Choke. Transient Reduction: Transient Suppressors/limiters, Snubbers, Transient Absorbers for AC &DC[2(2), 3.6(1), 7.2(1),10.3(1),11.7(1)].		
2	Emi Reduction Techniques Noise and Interference techniques include the following: Shielding, Grounding & Bonding, Balancing, Filtering Separation & Orientation, Isolation, Device selection, Signal level control, Cable Design &Routing[2,3,4,6(2),11.5 & 11.6(1)].	**10**	**25**
FIRST INTERNAL TEST			
3	Design For Pcbs ESD as part of EMI. Protection of Devices and Modules while being handled by Human being. Non ideal behaviour of Passive components R,C &L and their mounting.Optimum selection of Active components based on speed required,fan-out requirements and output drive. Behaviour and Design of PCB traces at high	**10**	**25**

	frequencies.Trace Impedance and control. Cross Talk control routing for PCBs. Analog circuit power supply decoupling,Digital circuit decoupling in PCBs.Grounding techniques in complex boards like a Mixed signal application.Zoning & Hardware grouping to minimise interference.Multilayer PCBs,Ground planes and VIAS and their functions.Termination requirements at high frequencies[12.2(2),5(2),12.6(5),6(2),7.5(5),4.2(2), 8.2(5)].		
SECOND INTERNAL TEST			
4	Emi Measurements & Standards Open Test Site,TEM Cell,Shielded Mesh and Anechoic Chamber lined with Absorbing materials. Radiation Sensors, Rx/Tx Antennas.Conduction Sensors for Injection & Coupling out[5.1-5.4(1),6.1-6.3.2(1),7.4-7.4.2(1)]. Test Instruments Spectrum Analyser & Receivers. Measurement method and setup using TEM cell for Emission&Susceptibility EMI standards,Civilian Standards CISPR, FCC, IEC, and EN.Emission levels for Conducted and Radiation, in Commercial/Industrial and Domestic Environments.MIL standards MIL 461E & MIL462E and its relevance[15(1)]	**10**	**25**
END SEMESTER EXAM			

Course No	Course Title	Credits	Year
06EC6068/ 06EC6062	**Mini Project**	0-0-4: 2	**2015**

Course Objectives:

- To develop practical ability and knowledge about practical tools/techniques
- To solve the actual problems related to the industry, academic institutions or similar area using the tools/technique

Syllabus:

Students can take up any application level/system level project pertaining to a relevant domain. Projects can be chosen either from the list provided by the faculty or in the field of interest of the student. For external projects, students should obtain prior permission after submitting the details to the guide and synopsis of the work. The project guide should have a minimum qualification of ME/M.Tech in relevant field of work. At the end of each phase, presentation and demonstration of the project should be conducted, which will be evaluated by a panel of examiners. A detailed project report duly approved by the guide in the prescribed format should be submitted by the student for final evaluation. Publishing the work in Conference Proceedings/ Journals with National/ International status with the consent of the guide will carry an additional weightage in the review process.

Course Outcome:

On successful completion of this course students :

- Gained practical ability and knowledge about practical tools/techniques.
- Would enable them to gain experience in solving actual problems related to the industry, academic institutions or similar area.

Course No	Course Title	Credits	Year
06EC6078	**Wireless Communication Lab II**	0-0-3: 1	**2015**

Pre-requisites: A basic course in Digital Communication, Wireless Communication

Course Objectives:

To Understand and analyze the concepts introduced in Wireless Communication, Communication Networks, Coding Theory and Wireless Networks

Syllabus:

Tools:

MATLAB, NS2 ADS, System Vue or any other equivalent tool

Suitable Hardware Tools like Spectrum Analyser Signal Generator, Digital, RF Communication Kit.

Suggested flow of experiments: (These are minimum requirements; Topics could be added in concurrence with the syllabus of elective subjects offered)

- Familiarizing and calibration of Spectrum Analyzer
- Characteristics of various communication block using Spectrum Analyzer
- Antenna Gain Measurement with Spectrum Analyzer
- End-to-End RF Transceiver Measurement
- Familiarizing ADS
- Tuning & Optimization using ADS
- Harmonic Balance Oscillator using ADS
- Electromagnetic Simulation using ADS
- Design and Simulation of Patch Antenna
- Familiarizing System Vue
- Noise Waveform Generation and Filtering

- Differential Encoding
- CIC Filtering
- QPSK Modulation and Demodulation
- I & Q Modulation

Course Outcome:

On successful completion of this course students will be able :

- To analyze the Concepts introduced in Wireless Communication, Communication Networks, Coding Theory and Wireless Networks courses

Text Books &References:

1. *J.G. Proakis, and M. Salehi, "Contemporary Communication Systems using MATLAB, Bookware Companion Series, 2006.*
2. *E. Aboelela, "Network Simulation Experiments Manual," The Morgan Kaufmann Series in Networking, 2007.*

SEMESTER III

Course No	Course Title	Credits	Year
06EC7117	**Linear and Nonlinear Optimisation**	3-0-0: 3	**2015**

Pre-requisites:A basic course in Linear Algebra

Course Objectives:

- To introduce the concepts of continuous functions and quadratic forms
- To introduce the concept of optimization and linear programming
- To introduce the concept of unconstrained optimization and nonlinear programming
- To introduce the concept of constrained optimization and optimality conditions

Syllabus:

Introduction To Optimization, Linear Transformation, Linear Equations, Linear Programming, Non-Linear Programming, Unconstrained Optimization, Constrained Optimization, Lagrange Multiplier

Course Outcome:

The student will be able to apply the concepts of

- Linear equations in optimization and detection
- Linear programming and optimization in communication networks
- Nonlinear programming, constrained and unconstrained optimization

Text Books:

1. *David G Luenberger, Yinyu Ye,".Linear and Non Linear Programming"., 3rd Ed, Springer 2008.*
2. *S. S. Rao, "Engineering Optimization, Theory and Practice" , Revised 3rd Edition, New Age International Publishers, New Delhi.*

References:

1. *Fletcher R., "Practical methods of optimization", John Wiley, 2nd Ed, 1987.*
2. *E.K.P Chong, Stanislow H. Zak, "An introduction to optimization", Wiley, 4th Ed, 2013.*
3. *Kalyanmoy Deb, Optimization for Engineering: Design-Algorithms and Examples, Prentice Hall (India), 1998.*
4. *Hillier and Lieberman," Introduction to Operations Research", McGraw-Hill, 8th edition, 2005.*
5. *Saul I Gass, "Linear programming", McGraw-Hill, 5th edition, 2005.*
6. *Bazarra M.S., Sherali H.D. & Shetty C.M., "Nonlinear Programming Theory and Algorithm"s, John Wiley, New York*
7. *S. M. Sinha, "Mathematical programming: Theory and Method"s, Elsevier, 2006.*

COURSE PLAN

Course No	Course Title	Credits	Year
06EC 7117	**Linear and Nonlinear Optimisation**	**3-0-0: 3**	**2015**
Module		Hours	End Sem Exam Marks (%)
1	Mathematical Background: Sequences and Subsequences- Mapping and functions- Continuous functions- Infimum and Supremum of functions- Minima and maxima of functions- Differentiable functions. Vectors and vector spaces- Matrices- Linear transformation- Quadratic forms- Definite quadratic forms- Gradient and Hessian- Linear equations- Solution of a set of linear equations-Basic solution and degeneracy. Convex sets and Convex cones-	**10**	**25**

	Introduction and preliminary definition- Convex sets and properties- Convex Hulls- Extreme point- Separation and support of convex sets- Convex Polytopes and Polyhedra- Convex cones- Convex and concave functions- Basic properties- Differentiable convex functions (Chapter 3 [2])		
2	Introduction to Optimization - Classical optimization techniques: Single and multivariable problems-Types of constraints (Chapter 2 [2]). Linear Programming: Standard form, Linear optimization algorithms - The simplex method -Basic solution and extreme point -Degeneracy-The primal simplex method - Dual linear programs - Primal, dual, and duality theory - The dual simplex method -The primal-dual algorithm. Interior Point Methods – Karmarkars's method.(Chapter4 [2])	**12**	**25**
FIRST INTERNAL TEST			
3	Nonlinear Programming: First order necessary conditions, Second order conditions, Minimization and maximization of convex functions- Local & Global optimum- Convergence-Speed of convergence (Chapter 7 [1]).Unconstrained optimization: One dimensional minimization - Elimination method, Fibonacci & Golden section search (Chapter 5[2]). Gradient methods - Steepest descent method, Newton's method, Conjugate Gradient Method (Chapter 6 [2].	**10**	**25**
SECOND INTERNAL TEST			

4	Constrained optimization: Constrained optimization with equality and inequality constraints (Chapter 11 [1]). Kelley's convex cutting plane algorithm (Chapter 14 [1])- Gradient projection method (Chapter 12 [1]) - Penalty Function methods (Chapter 13 [1]). Lagrange multipliers - Sufficiency conditions – Karush Kuhn Tucker optimality conditions (Chapter 11 [1]). Quadratic programming (Chapter 10 [3]) -Convex programming. (Chapter 9 [3])	**10**	**25**
END SEMESTER EXAM			

Course No	Course Title	Credits	Year
06EC7217	**Advanced Communications**	3-0-0: 3	**2015**

Pre-requisites:A basic course in Communication networks

Course Objectives:

To familiarize the topics of current research interest and open research problems in

- Compressive Sensing
- Cognitive Radio Networks
- Energy efficient communication networks
- mmWave Communication.

Syllabus:

Introduction to Compressive Sensing, An overview of Reconstruction algorithms, Introduction to Cognitive Radio Networks, Spectrum Sensing, Spectrum Decision- Spectrum Sharing and Mobility, Introduction to Cognitive Radio Networks, Spectrum Sensing, Spectrum Decision- Spectrum Sharing and Mobility, Energy efficient Communication,Green Cellular Networks- mechanisms for green wireless communications, Millimeter wave Communication (mmWave) **,** mmWave MIMO.

Course Outcome:

At the end of this course students will be able to apply the concepts of

- Compressive sensing in communication engineering problems.
- Spectrum Sensing, Spectrum Decision and Spectrum Sharing in Cognitive radio networks.
- energy harvesting in power constrained wireless networks.
- mmWave communication to design Gigabit wireless networks.

References:

Module 1:

1. *SaadQaisar, Rana Muhammad Bilal, Wafa Iqbal, MuqaddasNaureen and Sungyoung Lee, "Compressive Sensing: From Theory to Applications, A Survey", the Journal of Communications and Networks, IEEE, 2013.*
2. *R. G. Baraniuk, "Compressive sensing," IEEE Signal Processing Magazine, vol. 24, no. 4, pp. 118-121, July 2007.*
3. *Mark A. Davenport, Marco F. Duarte, Yonina C. Eldar and GittaKutyniok, "Introduction to Compressed Sensing," in Compressed Sensing: Theory and Applications, Y. Eldar and G. Kutyniok, eds., Cambridge University Press, 2011.*
4. *GittaKutyniok, "Compressed Sensing: Theory and Applications", http://www.inatel.br/docentes/dayan/easyfolder/TP542/Artigos/Compressed%20Sensing%20-%20Theory%20and%20Applications.pdf.*
5. *Marco F. Duarte and Yonina C. Eldar, "Structured Compressed Sensing: From Theory to Applications," IEEE Transactions on Signal Processing, Vol. 59 No. 9, pp. 4053-4085, September 2011.*
6. *R. Baraniuk, J. Romberg, and M. Wakin, "Tutorials on compressive sensing."*

Module:2

1. *Ian F. Akyildiz, Won-Yeol Lee, Mehmet C. Vuran, and ShantidevMohanty, A Survey on Spectrum Management in Cognitive Radio Networks", Cognitive Radio Communications and Networks, IEEE Communications Magazine, April 2008.*
2. *Ian F. Akyildiz , Won-Yeol Lee and Kaushik R. Chowdhury, "CRAHNs: Cognitive radio ad hoc networks", Ad Hoc Networks, Elsevier, 2009.*
3. *Beibei Wang And K. J. Ray Liu, "Advances In Cognitive Radio Networks: A Survey" Journal of Selected Topics in Signal Processing, IEEE, vol. 5, no. 1, February 2011.*
4. *RazaUmara, Asrar and U.H. Sheikh, "A comparative study of spectrum awareness techniques for cognitive radio oriented wireless networks", Physical Communication, Elsevier, 2012.*

Module 3:

1. *Pablo Serrano, Antonio de la Oliva, Paul Patras, Vincenzo Mancuso and Albert Banchs "Greening wireless communications: Status and future directions", Computer Communications, Elsevier, 2012.*
2. *ZiaulHasan, HamidrezaBoostanimehr and ZiaulHasan and HamidrezaBoostanimehr "Green Cellular Networks: A Survey, Some research issues and challenges", communications surveys & tutorials, ieee , volume:13 , issue: 4 , November 2011*
3. *XiaofeiWang et,al , "A Survey of Green Mobile Networks: Opportunities and Challenges", Mobile Networks and Applications, The Journal of Special Issues on Mobility of Systems, Users, Data and Computing, Springer Science+Business Media, vol. 17, no. 1, 2011.*
4. *Suarez et al. Greening wireless communications: Status and future directions, EURASIP Journal on Wireless Communications and Networking 2012*

Module 4:

1. *Yong Niu, et.al, "Athanasios V. Vasilakos A survey of millimeter wave communications (mmWave) for 5G: opportunities and challenges, Wireless Networks, Springer, April 2015.*
2. *Kao-Cheng Huang, Zhaocheng Wang, "Millimeter wave communication systems", John Wiley & Sons, Hoboken, New Jersey, 2011.*
3. *JonathanWells, "Multi-Gigabit Microwave and Millimeter-Wave Wireless Communications", Artech House, 2010.*
4. *Su-Khiong Yong, Pengfei Xia and Alberto Valdes-Garcia, "60GHz Technology for Gbps WLAN and WPAN: From Theory to Practice", Wiley 2010*
5. *Theodore S. Rappaport, Robert W. Heath Jr., Robert C. Daniels, James N. Murdock*
6. *"Millimeter wave wireless communications", Prentice Hall, 2014.*

COURSE PLAN			
Course No **06EC7217**	Course Title **Advanced Communication**	Credits **3-0-0: 3**	Year **2015**
Module		Hours	End Sem Exam Marks (%)
1	Introduction to Compressive Sensing- Compressive Signals- compressed sensing paradigm: Sparsity, Incoherence, compressive sensing problem Restricted Isometric Property (RIP), An overview of Reconstruction algorithms: Greedy iterative algorithm, Convex Relaxation, Iterative Thresholding, Combinatorial / Sublinear Algorithms, Non Convex Minimization Algorithms, BregmanIterative Algorithms, Applications, CS in communications and networks, CS in Future.	**11**	**25**
2	Introduction to Cognitive Radio Networks- Cognitive Radio Technology- Network Architecture- Spectrum and Network Heterogeneity- Comparison with Classical ad hoc networks - Spectrum Sensing- Spectrum Decision- Spectrum Sharing and Mobility- Network layer and Transport layer of CRN- Open problems and future research directions.	**11**	**25**
FIRST INTERNAL TEST			
3	Introduction to Energy consumption in wireless networks- Identifying the causes of inefficient energy consumption- Metrics for energy-efficiency-	**11**	**25**

	Mechanisms for improving energy efficiency- Green Cellular Networks- mechanisms for green wireless communications- Energy efficient resource management in Heterogeneous Networks Open challenges and future directions		
SECOND INTERNAL TEST			
4	Introduction- mmWavecharacteristics-Channel performance at 60GHz, Gigabit wireless communication, mmWave standards, Applications, Challenges, new research directions, mmWave Antennas: Path loss and antenna directivity, Beam steering antenna, mmWave MIMO: Spatial Diversity of Antenna Arrays, Multiple Antennas,mmWavedesign consideration.	**9**	**25**
END SEMESTER EXAM			

Course No	Course Title	Credits	Year
06EC7317	**MIMO and Multi Carrier Communications**	3-0-0:3	**2015**

Pre-requisites:A basic course in Wireless Communication

Course Objectives:

- To extend the knowledge gained through the wireless communication course to MIMO scenario and identify its challenges and issues.
- To understand the design principles of Orthogonal and Quasi orthogonal real and complex space time block codes and analyze their performance.
- To study the fundamentals of multi carrier Communication systems and its challenges.

Syllabus:

Review of SISO fading communication channels, Introduction to Multiple Antennas and Space-Time Communications, MIMO channel models, Capacity of MIMO channels, Spatial Diversity, MIMO spatial multiplexing, Diversity Multiplexing Trade-off, Code design criteria for quasi-static channels, Space time block codes on real and complex orthogonal designs, Performance analysis, Representation of STTC, Data Transmission Using Multiple Carriers,Synchronization in OFDM, Channel capacity and OFDM, PAPR-Reduction with Signal Distortion.

Course Outcome:

At the end of this course students will be able

- to appreciate the problems faced in SISO and apply solutions to overcome different issues faced in SISO through MIMO.
- to design and construct Real & Complex orthogonal and Quasi orthogonal STBC
- to apply the fundamental concepts of Multicarrier Communication to design of LTE systems

Text Books

1. *David Tse and Pramod Viswanath, "Fundamentals of Wireless Communication", Cambridge University Press 2005.*
2. *Andrea Goldsmith, "Wireless Communications", Cambridge University Press, 2005.*

References:

3. *Hamid Jafarkhani, "Space-Time Coding: Theory and Practice", Cambridge University Press 2005.*
4. *Paulraj, R. Nabar and D. Gore, "Introduction to Space-Time Wireless Communications", Cambridge University Press 2003.*
5. *E.G. Larsson and P. Stoica, "Space-Time Block Coding for Wireless Communications", Cambridge University Press 2008.*
6. *EzioBiglieri, Robert Calderbank et al "MIMO Wireless Communications" Cambridge University Press 2007.*
7. *Ahmad R.S. Bahai, B.R. Saltzberg, M. Ergen, " Multi carrier Digital Communications-Theory and Applications of OFDM", Second Edition, Springer.*
8. *Y. Li. G. Stuber, "OFDM for Wireless Communication", Springer, 2006.*
9. *R. Prasad, "OFDM for Wireless Communication", Artech House, 2006.*

COURSE PLAN

Course No	Course Title	Credits	Year
06EC7317	**MIMO and Multi Carrier Communications**	**3-0-0: 3**	**2015**
Module		Hours	End Sem Exam Marks (%)
1	Information Theoretic aspects of MIMO : Review of SISO fading communication channels (Ref 1),Multiple	**11**	**25**

	Antennas and Space-Time Communications (Ref 2).MIMO channel models-Classical i.i.d models, Frequency selective and Extended channels, (Ref 4, Ref 5), Capacity of MIMO channels-Ergodic and outage capacity (Ref 4).Spatial Diversity: Diversity and channel knowledge, Alamouti space time code(Ref 4). MIMO spatial multiplexing-BLAST receivers and Diversity Multiplexing Trade-off (Ref 3, Ref 4).		
2	Space Time Block Codes Code design criteria for quasi-static channels (Rank, determinant and Euclidean distance), Space time block codes on real and complex orthogonal designs: Orthogonal designs, Generalized orthogonal designs, Quasi-orthogonal designs and Performance analysis. Representation of STTC, Delay diversity as a special case of STTC and Performance analysis (Ref 2).	**11**	**25**
FIRST INTERNAL TEST			
3	Multicarrier Communication Multi carrier Modulation:Data Transmission Using Multiple Carriers,Multicarrier Modulation with Overlapping Subchannels, Discrete Implementation of Multicarrier Modulation(Ref 2) -OFDM system model - FFT implementation , Channel capacity and OFDM, Comparison with single carrier, (Ref 8)	**11**	**25**
SECOND INTERNAL TEST			

4	Challenges in Multicarrier Communication Synchronization in OFDM: Timing and Frequency Offset in OFDM-Pilot and Non pilot based methods.(Ref 8) Challenges in MulticarrierSystems(Ref 2) -PAPR properties of OFDM,PAPR-Reduction with Signal Distortion- signals – PAPR reduction techniques with signal distortion; Techniques for distortion less PAPR reduction – Selective mapping and Optimization techniques.(Ref 8)	**9**	**25**
END SEMESTER EXAM			

Course No	Course Title	Credits	Year
06EC7417	**Adaptive Signal Processing**	3-0-0:3	**2015**

Pre-requisites:A basic course in Digital Communication, Wireless Communication

Course Objectives:

1. To provide the mathematical framework for an understanding of adaptive statistical signal processing and filter structures will be introduced
2. To introduce different stochastic gradient Algorithms and their properties to develop an Adaptive filter that cater to the need of a particular application.
3. To familiarize the performance measures of the algorithms studied.
4. Introduce various other existing types of adaptive algorithms.

Syllabus:

Background and Preview, Weiner Filters, Linear Prediction, LMS adaptive Filtering, Normalized LMS Adaptive Filters, Frequency-domain Adaptive filters, Method Of Least Squares, Recursive Least-Squares Adaptive Filters, Kalman Filters, Finite Precision Effects, Tracking of Time varying Systems, Other adaptive filtering technique.

Course Outcome:

Student will be able to

- apply adaptive filtering algorithms for solving real world problems of interest in communication and signal processing
- use adaptive filters in system modelling
- demonstrate the application of adapting system identification to physical situations.

Text Books:

1. *Simon Haykin, "Adaptive filter theory" 4th edition, Prentice Hall,2013*
2. *A H Sayed, "Adaptive filters", John Wiley,2008*

References:

1. *Widrow and Stearns, "Adaptive signal processing", Pearson ,2007*
2. *Ali H. Sayed, "Fundamentals of Adaptive Filtering", John Wiley, 2003.*
3. *Manalokis, Ingle and Kogon, "Statistical and Adaptive signal processing" Artech House INC., 2005.*
4. *A Poularikas, Z M Ramadan, "Adaptive filtering primer with MATLAB "Taylor and Francis,2007*

COURSE PLAN

Course No	Course Title	Credits	Year
06EC 7417	**Adaptive Signal Processing**	**3-0-0: 3**	**2015**
Module		Hours	End Sem Exam Marks (%)
1	Background and Preview: The filtering problem - Linear optimum filters - Adaptive filters - Linear Filter structures – Approaches (Text Book 1 Pages 1-18) Weiner Filters: - Linear Optimum Filtering Problem Statement - Orthogonality Principle - MMSE - Wiener-Hopf Equations - Error performance surface - Linear regression model (Text Book 1 - 2.1-2.7)	**10**	**25**

	Linear Prediction: Forward Linear Prediction - Backward Linear Prediction - Levinson-Durbin Algorithm - Properties of Prediction-Error Filters lattice predictors joint-process estimation (Text Book 1 - 3.1-3.4, 3.8, 3.10)		
2	LMS adaptive Filtering: Method of steepest descent: Basic Idea , steepest descent algorithm applied to the wiener filter, stability, virtue and limitation.(Text Book 1 - 4.1-4.6). LMS adaptive Filters : Overview ,LMS adaptation Algorithm, Applications, Comparison of LMS Algorithm with Steepest Descent Algorithm, Convergence Analysis and Robustness of the LMS Filter (Text Book 1 - 5.1-5.3, 5.5, 5.10) Normalized LMS Adaptive Filters: Solution to constrained Optimization Problem, Stability ,Step-size control for Acoustic Echo Cancellation (Text Book 1 - 6.1, 6.2, 6.3) Frequency-domain Adaptive filters: Block Adaptive Filters ,Fast Block LMS Algorithm, Unconstrained Frequency Domain Adaptive Filters (Text Book 1 - 7.1, 7.2, 7.3)	**10**	**25**
FIRST INTERNAL TEST			
3	Method Of Least Squares: Statement of linear Least Squares Estimation Problem, Data Windowing , Minimum Sum Of Error Squares ,Normal Equations and	**11**	**25**

	Linear Least Squares Filter, Time Average Correlation Matrix, Properties of least Squares Estimates, MVDR (Minimum Variance Distortion less Response) Spectrum Estimation, Singular-Value Decomposition ,Pseudo inverse(Text Book 1 - 8.1-8.9, 8.11, 8.12) Recursive Least-Squares Adaptive Filters: Algorithm (Text Book 1 - 9.1-9.3, 9.7, 9.9)		
SECOND INTERNAL TEST			
4	Kalman Filters: Recursive Minimum Mean Square Estimation for Scalar random Variables, Statement of the Kalman Filtering Problem(Text Book 1 - 10.1, 10.2) Finite Precision Effects: Quantization Errors ,LMS Algorithm, RLS Algorithm (Text Book 1 - 13.1-13.3) Tracking of Time varying Systems :Tracking Performance of the LMS Algorithm and RLS Algorithm, Comparison(Text Book 1 - 14.3-14.6). Other adaptive filtering technique: Neural networks and multi-layer perceptrons, Adaptive IIR filtering. (Text Book 1 - 15.1,15.2,17.1,17.2)	**11**	**25**
END SEMESTER EXAM			

Course No	Course Title	Credits	Year
06EC7127	**RF MEMS**	3-0-0:3	**2015**

Pre-requisites: A basic course in Digital Communication, Wireless Communication

Course Objectives:

- To provide an introduction to micromachining techniques and their use in the fabrication of micro switches, capacitors and inductors
- To provide an exposure to MEMS and silicon technology applications to RF circuit design

Syllabus:

MEMS Actuation Schemes and Switches, MEMS Inductors and Capacitors, Micromachined RF filters, Micromachined transmission lines.

Course Outcome:

The students will be exposed to

- integration of MEMS into traditional Radio Frequency (RF) circuits that has resulted in systems with superior performance levels and lower manufacturing costs
- incorporation of MEMS based fabrication technologies into micro and millimetre wave systems which offers viable routes to ICs with MEMS actuators, antennas, switches and transmission lines

Text Books:

1. *Vijay K. Varadan, K. J. Vinoy and K. A Jose, "RF MEMS and their Applications", Wiley, 2003.*

References:

2. *H. J. D. Santos, "RF MEMS Circuit Design for Wireless Communications", Artech House, 2002.*

3. *Gabriel M. Rebeiz , "RF MEMS Theory , Design and Technology", Wiley , 2003.*
4. *Stephen D Senturia, "Microsystem Design", Kluwer Academic Publishers,2001.*
5. *Nitaigour Premchand Mahalik, "MEM"S, Tata McGraw-Hill, 2007.*

COURSE PLAN

Course No	Course Title	Credits	Year
06EC 7127	**RF MEMS**	**3-0-0: 3**	**2015**
Module		Hours	End Sem Exam Marks (%)
1	MEMS Actuation Schemes and Switches Introduction, Microfabrications for MEMS (T1-1.3), Electromechanical Transducers (T1-1.4) - Piezoelectric transducers (T1-1.4.1), Electrostrictive transducers (T1-1.4.2), Magnetostrictive transducers (T1-1.4.3), Electrostatic actuators (T1-1.4.4), Electromagnetic transducers (T1-1.4.5), Electro dynamic transducers (T1-1.4.6), Electro thermal actuators(T1-1.4.7), Comparison of electromechanical actuation schemes (T1-1.4.8), Piezo-resistive sensing (T1-1.5.1), Capacitive sensing(T1-1.5.2), Piezoelectric sensing(T1-1.5.3), Resonant sensing (T1-1.5.4), Surface acoustic wave sensors(T1-1.5.5), RF MEMS switches and Micro relays - Switch parameters (T1-3.2), Actuation mechanisms (T1-3.5), Bistable microrelays and micro actuators (T1-3.6), Dynamics of switching operation (T1-3.7).	**11**	**25**
2	MEMS Inductors(T1-4.3) - Self-inductance and mutual inductance (T1-4.3.1), Micromachined inductors (T1-	**11**	**25**

	4.3.2), Effect of inductor layout (T1-4.3.3), Reduction of stray capacitance of planar inductors (T1-4.3.4), Approaches for improving the quality factor (T1-4.3.5), Folded inductors (T1-4.3.6), Modeling and design issues of planar inductors (T1-4.3.7), Variable inductors (T1-4.3.8), Polymer-based inductors (T1-4.3.9). MEMS capacitors - MEMS gap-tuning capacitors (T1- 4.4.1), MEMS area-tuning capacitors (T1- 4.4.2), Dielectric tunable capacitors (T1-4.4.3).		
FIRST INTERNAL TEST			
3	Micromachined RF filters -Introduction (T1-5.1), Modeling of mechanical filters (T1-5.2), Modeling of resonators (T1-5.2.1), General considerations for mechanical filters (T1-5.2.3), Micromechanical filters (T1-5.3), Electrostatic comb drive(T1-5.3.1), Micromechanical filters using comb drives (T1-5.3.2), Micromechanical filters using electrostatic coupled beam structures (T1-5.3.3), Surface acoustic wave filters (T1-5.4), Basics of surface acoustic wave filter operation (T1-5.4.1), Wave propagation in piezoelectric substrates (T1-5.4.2), Design of interdigital transducers(T1-5.4.3), Single-phase unidirectional transducers (T1-5.4.4),Surface acoustic wave devices: capabilities, limitations and applications(T1-5.4.5), Bulk acoustic wave filters (T1-5.5). MEMS phase shifters-Types of phase shifters and their Limitations (T1-6.2).	**11**	**25**

	Switched delay lines (T1-6.3.1). Distributed MEMS phase shifters (T1-6.3.2), Polymer based phase shifters (T1-6.3.3).		
SECOND INTERNAL TEST			
4	Micromachined transmission lines (T1-7.2)- Losses in transmission lines(T1-7.2.1), Coplanar transmission lines(T1-7.2.2), Microshield and membrane-supported transmission lines (T1-7.2.3), Microshield circuit components(T1- 7.2.4), Micromachined waveguide components (T1-7.2.5). Micromachined antennas - Basic characteristics of Microstrip antennas (T1-8.2.1), Design parameters (T1-8.2.2), Micromachining techniques to improve performance (T1-8.3), Micromachined Reconfigurable antennas (T1-8.5).	**10**	**25**
END SEMESTER EXAM			

Course No	Course Title	Credits	Year
06EC7227	**Coding Theory**	**3-0-0:3**	**2015**

Pre-requisites:A basic course in Digital Communication, Wireless Communication

Course Objectives:

- To introduce the concepts of finite field arithmetic
- To analyse the encoding, decoding and error detection and error correction properties of linear block codes, cyclic codes and convolution codes

Syllabus:

Fields. Groups. Binary field arithmetic. Construction and basic properties of GF(2^m) fields. Vector spaces. Linear Block codes. Syndrome and Error detection. Hamming codes. Reed Muller codes. Cyclic codes. Binary and non-binary BCH codes. Reed Solomon Codes. Berlekamp Algorithm. Convolution codes-encoding, distance properties. Viterbi algorithm. Trellis based soft decision algorithm. Turbo coding. Low density parity check codes.

Course Outcome:

The student will be able to:

- perform operations using finite field arithmetic and construct Galois fields.
- apply the concepts of encoding, decoding and error detection and error correction of linear block codes, cyclic codes and convolution codes

Text Books:

1. *Shu Lin and Daniel J Costello, "Error Control Coding", 2nd edition, Pearson.*

References:

2. *A Neubauer, J Freudenberger, V Kuhn, "coding Theory, algorithms, architectures and applications", Wiley India Edition, 2012.*
3. *Robert H, Morelos-Zaragoza, "The art of error correcting coding", Wiley India Edition, 2013.*
4. *R E Blahut, "Theory and practice of error control coding", MGH 1983.*
5. *W C Huffman and Vera Pless, "Fundamentals of error correcting codes", Cambridge University Press, 2006.*
6. *Ron M Roth, "Introduction to coding theory", Cambridge University Press, 2006.*
7. *Elwyn R Berlekamp, "Algebraic coding Theory", McGraw Hill Book Company, 1984.*

COURSE PLAN

Course No	Course Title	Credits	Year
06EC7227	**Coding Theory**	**3-0-0: 3**	**2015**
Module		Hours	End Sem Exam Marks (%)
1	Introduction to Coding and Finite Field Arithmetic Introduction [1-1.1], Types of codes [1-1.2], Types of errors [1-1.5], Groups [1-2.1], Fields [1-2.2], Binary Field Arithmetic [1-2.3]. Construction of Galois Field GF(2^m) [1-2.4], Basic Properties of GF(2^m) [1-2.5], Computations using GF(2^m) arithmetic [1-2.6].	**15**	**25**
2	Linear Block Codes Introduction to Vector spaces [1-2.7], Matrices [1-2.8]. Introduction to Linear Block Codes [1-3.1], Syndrome and Error Detection [1-3.2], Minimum distance of LBC [1-3.3].	**13**	**25**

	Error detecting and correcting capabilities of block codes [1-3.4], Standard Array and Syndrome Decoding [1-3.5]. Important Linear Block codes: Hamming Codes [1-4.1], Reed Muller Codes [1-4.3].		
FIRST INTERNAL TEST			
3	Cyclic Codes Description of cyclic codes [1-5.1], Generator and Parity Check Matrices [1-5.2], Encoding of cyclic codes [1-5.3], Syndrome computation and Error Detection [1-5.4], Decoding of cyclic codes [1-5.5], Binary BCH codes: Binary primitive BCH codes [1-6.1], Decoding of BCH codes [1-6.2],Non Binary BCH codes: q-ary Linear Block Codes [1-7.1], Primitive BCH codes over GF(q)[1-7.2], Reed Solomon codes [1-7.3], Decoding of Non Binary BCH and RS codes: Berlekamp algorithm [1-7.4].	**13**	**25**
SECOND INTERNAL TEST			
4	Convolution Codes Encoding of Convolution codes [1-11.1], Structural properties of convolution codes [1-11.2], Distance properties of convolution codes [1-11.3], Viterbi algorithm [1-12.1], Soft output Viterbi algorithm [1-12.5], Trellis based soft decision algorithm: Viterbi decoding algorithm [1-14.1], Recursive Maximum likelihood	**15**	**25**

	decoding algorithm [1-14.2], Turbo Coding: Introduction to Turbo coding [1-16.1], Distance properties [1-16.2], Iterative decoding of turbo codes [1-16.5], Low density parity check codes: Introduction to LDPC codes [1-17.1], decoding of LDPC codes [1-17.6].		
END SEMESTER EXAM			

Course No	Course Title	Credits	Year
06EC7327	**Multi-rate and Multi-dimensional Signal Processing**	3-0-0: 3	**2015**

Pre-requisites: Linear Algebra and Applications, Basic course in Estimation and Detection Theory/ Digital Communication Techniques.

Course Objectives:

- To introduce the fundamentals of Multi-rate filter bank theory
- To analyse M-channel Perfect Reconstruction filters and learn its pol
- To analyse various feature extraction procedures and familiarise with various nonlinear classifiers
- To solve clustering problems through functional optimization and graph theory

Syllabus:

Fundamentals of Multirate Theory - Decimation and Interpolation, Polyphase representation, M-channel perfect reconstruction filter banks, Multidimensional systems – LTI systems, 2D systems, Fourier Transform, z-transform. Sampling continuous 2D signals , Aliasing and periodic sampling

Course Outcome:

The student will be able to apply the concepts of

- decimation and interpolation to design filter banks
- polyphase representation to implement perfect reconstruction filter banks.
- Multi-dimensional signals and systems to appreciate the applications in image processing.
- sampling and reconstruction of multidimensional signals to practice.

Text Books:

1. *P. P. Vaidyanathan, "Multirate systems and filter banks", Prentice Hall, PTR. 1993.*
2. *Sanjit K. Mitra, "Digital Signal Processing: A computer based approach", McGraw Hill, 1998.*

References:

3. *N. J. Fliege, "Multirate digital signal processing", John Wiley,1999.*
4. *John Woods, "Multidimensional signal, image, and video processing and coding", Academic Press, 2006.*
5. *Dudgeon Dan E., "Multidimensional Digital Signal Processing", Prentice Hall, Englewood Cliffs, New Jersey ,1984*
6. *Fredric J. Harris, "Multirate Signal Processing for Communication Systems", Prentice Hall, 2004.*
7. *LjiljanaMilic, "Multirate Filtering for Digital Signal Processing: MATLAB Applications", Information Science Reference; 1/e, 2008.*
8. *R. E. Crochiere& L. R. Rabiner, "Multirate Digital Signal Processing", Prentice Hall, Inc. 1983.*
9. *J. G. Proakis& D. G. Manolakis, "Digital Signal Processing: Principles. Algorithms and Applications", 3rd edition, Prentice Hall India, 1999.*
10. *Jae S. Lim, "Two- Dimensional Signal and Image Processing", Prentice Hall Englewood Cliffs, New Jersey, 1990.*

COURSE PLAN

Course No	Course Title	Credits	Year
06EC 7327	**Multi-rate and Multi-dimensional Signal Processing**	**3-0-0: 3**	**2015**
Module		Hours	End Sem Exam Marks (%)
1	Fundamentals of Multirate Theory: The sampling theorem - sampling at sub nyquist rate - Basic Formulations and schemes. Basic Multirate	**12**	**25**

	operations- Decimation and Interpolation - Digital Filter Banks- DFT Filter Bank-Identities- Polyphase representation. Maximally decimated filter banks: Polyphase representation- Errors in the QMF bank- Perfect reconstruction (PR) QMF Bank - Design of an alias free QMF Bank.		
2	M-channel perfect reconstruction filter banks: Uniform band and non-uniform filter bank - tree structured filter bank- Errors created by filterbank system- Polyphase representation- perfect reconstruction systems	**9**	**25**
FIRST INTERNAL TEST			
3	Multidimensional systems Fundamental operations on Multidimensional signals, Linear Shift - Invariant systems-cascade and parallel connection of systems- separable systems, stable systems- Frequency responses of 2D LTI Systems- Impulse response- Multidimensional Fourier transforms- z transform, properties of the Fourier and z transform.	**11**	**25**
SECOND INTERNAL TEST			
4	Sampling continuous 2D signals Periodic sampling with rectangular geometry- sampling density, Aliasing effects created by sampling - Periodic sampling with hexagonal geometry	**10**	**25**
END SEMESTER EXAM			

Course No	Course Title	Credits	Year
06EC7427	**Estimation and Detection Theory**	3-0-0: 3	**2015**

Pre-requisites:A basic course in Linear & Matrix Algebra

Course Objectives:

- To introduce the concepts different detection methods and hypothesis testing
- To introduce the fundamentals of estimation theory and use of sufficient statistics in estimation
- To analyse various estimation techniques

Syllabus:

Fundamentals of Detection Theory, Hypothesis Testing, Fundamentals of Estimation Theory, Fundamentals of Estimation Theory, Random Parameter Estimation

Course Outcome:

The student will be able to apply the concepts of

- Minimum probable error criterion in receiver design
- Estimation in signal processing
- Least square estimation and maximum likelihood estimation.

Text Books:

1. *Steven M. Kay, "Statistical Signal Processing: Vol. 1: Estimation Theory, Detection Theory," Vol. 2: Prentice Hall Inc., 1998.*

References:

2. *M D Srinath, P K Rajasekaran, R Viswanathan, "Introduction to Statistical Signal Processing with Applications", Pearson, 1995.*
3. *H. Vincent Poor, "An Introduction to Signal Detection and Estimation", 2nd Edition, Springer, 1994.*
4. *Jerry M. Mendel, "Lessons in Estimation Theory for Signal Processing, Communication and Control," Prentice Hall Inc., 1995*

COURSE PLAN

Course No	Course Title	Credits	Year
06EC7427	**Estimation and Detection Theory**	**3-0-0: 3**	**2015**
Module		Hours	End Sem Exam Marks (%)
1	Fundamentals of Detection Theory Hypothesis Testing: Bayes' Detection, MAP Detection, ML Detection, Minimum Probability of Error Criterion, Min-Max Criterion, Neyman-Pearson Criterion, Multiple Hypothesis, Composite Hypothesis Testing: Generalized likelihood ratio test (GLRT) (chapter 2,[3]),, Receiver Operating Characteristic Curves.	**12**	**25**
2	Fundamentals of Estimation Theory Role of Estimation in Signal Processing(chapter 1,[1]), Unbiased Estimation, Minimum variance unbiased(MVU) estimators, Finding MVU Estimators(chapter 2,[1]),	**12**	**25**

	Cramer-Rao Lower Bound(chapter 3,[1]), Linear Modeling-Examples(chapter 4,[1]), Sufficient Statistics, Use of Sufficient Statistics to find the MVU Estimator (chapter 5,[1])		
FIRST INTERNAL TEST			
3	Estimation Techniques Deterministic Parameter Estimation: Least Squares Estimation-Batch Processing, Recursive Least Squares Estimation(chapter 8,[1]), Best Linear Unbiased Estimation(chapter 6,[1]), Likelihood and Maximum Likelihood Estimation (chapter 7,[1])	**10**	**25**
SECOND INTERNAL TEST			
4	Estimation Techniques Random Parameter Estimation: Bayesian Philosophy, Selection of a Prior PDF, Bayesian linear model(chapter 10,[1]), Minimum Mean Square Error Estimator, Maximum a Posteriori Estimation (chapter 11, [1])	**10**	**25**
END SEMESTER EXAM			

Course No	Course Title	Credits	Year
06EC7037/ 06EC7031	**Seminar II**	0-0-2: 2	**2015**

Course Objectives:

- To introduce the students to cutting edge technology in the area of communication engineering.
- To develop the acumen of reading & comprehending technical papers and implementing the methods as mentioned them

Syllabus:

Each student shall present a seminar on any topic of interest related to the core / elective courses offered in the first semester of the M. Tech. Programme. He / she shall select the topic based on the references from international journals of repute, preferably IEEE journals. They should get the paper approved by the Programme Co-ordinator / Faculty member in charge of the seminar and shall present it in the class. Every student shall participate in the seminar. The students should undertake a detailed study on the topic and submit a report at the end of the semester. Marks will be awarded based on the topic, presentation, participation in the seminar and the report submitted.

Course Outcome:

This course will prepare the student to comprehend technical papers in their selected areas. This will eventually improve the quality of their main project. The ability to write and report technical results will be improved.

Course No	Course Title	Credits	Year
06EC7047/ 06EC7041	**Project (Phase 1)**	0-0-12: 6	**2015**

Course Objectives:

To prepare the student for the main project by

- identifying research problems in different areas of communication engineering.
- preparing a detailed literature review for the same by reading research journals and conference papers.

Syllabus:

In Master's Thesis Phase-I, the students are expected to select an emerging research area in the field of specialization. After conducting a detailed literature survey, they should compare and analyze research work done and review recent developments in the area and prepare an initial design of the work to be carried out as Master's Thesis. It is mandatory that the students should refer National and International Journals and conference proceedings while selecting a topic for their thesis. She/he should select a recent topic from a reputed International Journal, preferably IEEE/ACM. Emphasis should be given for introduction to the topic, literature survey, and scope of the proposed work along with some preliminary work carried out on the thesis topic.

Students should submit a copy of Phase-I thesis report covering the content discussed above and highlighting the features of work to be carried out in Phase-II of the thesis. The candidate should present the current status of the thesis work and the assessment will be made on the basis of the work and the presentation, by a panel of internal examiners in which one will be the internal guide. The examiners should give their suggestions in writing to the students so that it should be incorporated in the Phase–II of the thesis.

Course Outcome:

The student will be able to identify their domains and prepare literature review for the main project.

SEMESTER IV

Course No	Course Title	Credits	Year
06EC7018/ 06EC7012	**Project (Phase 2)**	0-0-21: 12	**2015**

Course Objectives:

To enable to student to

- work on research problems on an individual basis.
- design, test and record the results on the problems chosen in their respective domains.
- deduceinferences from the results and report them in scientific journals.

Syllabus:

In the fourth semester, the student has to continue the thesis work and after successfully finishing the work, he / she has to submit a detailed bounded thesis report. The evaluation of M Tech Thesis will be carried out by a panel of examiners including at least one external examiner appointed by university and internal examiner. The work carried out should lead to a publication in a National / International Conference or Journal. The papers received acceptance before the M.Tech.evaluation will carry specific weightage.

Course Outcome:

The students will be armed with the knowledge and skill set which makes them suitable for research and academic professions after completing the course in areas of communication engineering. The student will be able to identify a research problem, work on it and develop models/solution in a scientific manner.