**KERALA TECHNOLOGICAL UNIVERSITY**

**(PALAKKAD CLUSTER-08)**

**SCHEME AND SYLLABI**

**M. TECH. PROGRAMME**

**COMMUNICATION ENGINEERING**

**(ELECTRONICS & COMMUNICATION ENGINEERING DEPT.)**

(2015 Admission onwards)

**Scheme of M.Tech Programme in Communication Engineering**

**SEMESTER 1 (Credits:20-23)**

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| **Exam slot** | **Course**  **No.** | **Name** | **Hours per week** | | | **Int.**  **Mark** | **End Semester Exam** | | **Credits** |
| **L** | **T** | **P** | **Marks** | **Duration**  **(Hrs)** |
| A | 08EC6011 | Advanced Digital Communication Techniques | 4 | 0 | 0 | 40 | 60 | 3 | 4 |
| B | 08EC6021 | Wireless Mobile Networks | 3 | 0 | 0 | 40 | 60 | 3 | 3 |
| C | 08EC6031 | Communication Networks | 3 | 0 | 0 | 40 | 60 | 3 | 3 |
| D | 08EC6041 | Mathematics for Communication Engineers | 3 | 0 | 0 | 40 | 60 | 3 | 3 |
| E | 08EC6051 | Elective-I | 3 | 0 | 0 | 40 | 60 | 3 | 3 |
|  | 08GN6101 | Research Methodology |  | 2 | 0 | 100 | 0 | 0 | 2 |
|  | 08EC6071 | *Seminar* |  |  | 2 | 100 | 0 | 0 | 2 |
|  | 08EC6081 | Communication modeling and Simulation Laboratory | *0-* | 0 | 2 | 100 | 0 | 0 | 2 |
| TOTAL | | | 16 | 2 | 4 | 500 | 300 |  | 22 |

**Note:** 8 hours/week is meant for departmental assistance by students

**ELECTIVE-I**

08EC6051 (A) - Optimisation Techniques

08EC6051 (B)- Detection and Estimation

08EC6051 (C)- RF MEMS for Wireless Communication

08EC6051 (D) – CDMA Technology

**SEMESTER 2 (Credits:18-19)**

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| **Exam slot** | **Course**  **No.** | **Name** | **Hours per week** | | | **Int.**  **Mark** | **End Semester Exam** | | **Credits** |
| **L** | **T** | **P** | **Marks** | **Duration**  **(Hrs)** |
| A | 08EC6012 | Advanced Digital Signal Processing | 3 | 0 | 0 | 40 | 60 | 3 | 3 |
| B | 08EC6022 | OFDM for Wireless Communication | 3 | 0 | 0 | 40 | 60 | 3 | 3 |
| C | 08EC6032 | Advanced Optical Communication | 3 | 0 | 0 | 40 | 60 | 3 | 3 |
| D | 08EC6042 | Elective | 3 | 0 | 0 | 40 | 60 | 3 | 3 |
| E | 08EC6052 | Elective | 3 | 0 | 0 | 40 | 60 | 3 | 3 |
|  | 08EC6062 | Mini Project | 0 | 0 | 4 | 100 | 0 | 0 | 2 |
|  | 08EC6072 | Signal Processing Laboratory | *0* | 0 | 2 | 100 | 0 | 0 | 2 |
| TOTAL | | | 15 | 0 | 6 | 400 | 300 |  | 19 |

**Note:** 8 hours/week is meant for departmental assistance by students

**ELECTIVE-II**

08EC6042 (A)- Smart Antennas

08EC6042 (B)-High performance Networks

08EC6042 (C)- Spectrum Analysis Techniques

08EC6042 (D)- Cognitive Radio Technology

**ELECTIVE-III**

08EC6052 (A)- Error control Coding

08EC6052 (B)-RF Design of Communication Systems

08EC6052 (C)- VLSI for Wireless Communication

08EC6052 (D)- Wireless Sensor Networks

**SEMESTER 3 (Credits:14)**

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| **Exam slot** | **Course**  **No.** | **Name** | **Hours per week** | | | **Int.**  **Mark** | **End Semester Exam** | | **Credits** |
| **L** | **T** | **P** | **Marks** | **Duration**  **(Hrs)** |
| A | 08EC7011 | Elective | 3 | 0 | 0 | 40 | 60 | 3 | 3 |
| B | 08EC7021 | Elective | 3 | 0 | 0 | 40 | 60 | 3 | 3 |
|  | 08EC7031 | Seminar | 0 | 0 | 2 | 100 | 0 | 0 | 2 |
|  | 08EC7041 | Project (Phase-1) | 0 | 0 | 12 | 50 | 0 | 0 | 6 |
| TOTAL | | | 6 | 0 | 14 | 230 | 120 |  | 14 |

**Note:** 8 hours/week is meant for departmental assistance by students

**ELECTIVE-IV**

08EC7011 (A)-Advanced Techniques for Wireless Reception

08EC7011 (B)-Secure Communication

08EC7011 (C)-Modeling and Simulation of Communication Systems

08EC7011 (D)- Advanced Image Processing

**ELECTIVE-V**

08EC7021 (A)-Markov Modeling and Queuing Theory

08EC7021 (B)-Space Time Coding & MIMO Systems

08EC7021 (C)-Multimedia Compression Techniques

08EC7021 (D)- Ultra Wideband Communication Systems

**SEMESTER 4 (Credits:12)**

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| **Exam slot** | **Course**  **No.** | **Name** | **Hours per week** | | | **Int.**  **Mark** | **End Semester Exam** | | **Credits** |
| **L** | **T** | **P** | **Marks** | **Duration**  **(Hrs)** |
|  | 08EC7012 | Project (Phase 2) | 0 | 0 | 21 | 70 | 30 |  | 12 |
| TOTAL | | | 0 | 0 | 21 | 70 | 30 |  | 12 |

**Note:** 8 hours/week is meant for departmental assistance by students

Total: 67

**SEMESTER I**

**Course No:** 08EC6011 **Course Title: Advanced Digital Communication Credits: 4-0-0: 4 Year :2015**

**Pre-requisites: Basic course on Digital Communication.**

***Course Objectives:***

The course objective is to understand the representation of signals, the different methods of digital modulation and demodulation methods, prepare mathematical background for optimum detection, analyze error performance of a digital communication system , represent channels under different fading conditions

***Syllabus***

Fundamental techniques of generation, transmission, and reception of communication system related signals applicable for a wide range of communication applications. Different signal representation and modulation schemes for digital transmission and, detection methods and error analysis for system design, optimum performance and reception. Analysis of AWGN channels; Band limited channels with out and with ISI. Analysis of distortion channels and fading channels.

***Course Outcomes:***

After successfully completing the course students will be able to

1. Analyze the performance of a baseband and pass band digital communication systems.
2. Analyze the error performance of digital modulation techniques.
3. Design optimum receivers for digital modulation techniques
4. Design digital communication systems under given power spectral and error performance constrains.
5. Design of transmitting and receiving filters for a known channel and for time varying channel.
6. Analyze Performance of communication channels with distortion and fading.

***References:***

1. John G. Proakis and Masoud Salehi ---Digital Communication, McGraw Hill, 5th edition, 2014.
2. Edward. A. Lee and David. G. Messerschmitt, Digital Communication, Allied Publishers (second edition).2010
3. J Marvin.K.Simon, Sami. M. Hinedi and William. C. Lindsey, Digital Communication Techniques, PHI, 2008
4. Bernard Sklar ,Digital Communication Fundamentals and applications,2nd edition, 2009
5. Robert G Gallagar , Principles of Digital Communication March , 2nd Ed.2008 .
6. Simon Haykin ,Digital Communication Systems-, Wiley India Publications, 2013
7. Ian Glover ,Digital Communication , 4th edition 2008

*Internal continuous assessment is in the form of tests, class assignments, mini projects on modeling and analysis of the system using any tool and seminars on extended syllabus.*

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| **COURSE NO:** 08EC6011 **COURSE TITLE** Advanced Digital Communication Techniques **(L-T-P : 4-0-0) CREDITS:4** | | |
| **MODULES** | **Contact**  **hours** | **Sem.Exam**  **Marks;%** |
| MODULE : 1  **Introduction**: Digital communication system (description of different modules of the block diagram), Complex baseband representation of signals, Gram-Schmidt orthogonalization procedure. M-ary orthogonal signals, bi-orthogonal signals, simplex signal waveforms | 8 | 10 |
| MODULE : 2  **Modulation**: Pulse amplitude modulation (binary and M-ary, QAM), Pulse position modulation (binary and M-ary), Carrier modulation (M-ary ASK, PSK, FSK, DPSK), Continuous phase modulation (QPSK and variants, MSK, GMSK). | 8 | 10 |
| **FIRST INTERNAL TEST** |  |  |
| MODULE : 3  **Receiver in additive white Gaussian noise channels**: Coherent and noncoherent demodulation: Matched filter, Correlator demodulator, square-law, and envelope detection; Detector: Optimum rule for ML and MAP detection Performance: Bit-error-rate, symbol error rate for coherent and noncoherent schemes. | 10 | 20 |
| MODULE : 4  **Band-limited channels**: Optimum pulse shaping- Nyquist criterion for **zero ISI** . Pulse shape design for channels **with ISI**: Nyquist pulse, Partial response signaling (duobinary and modified duobinary pulses), demodulation  **Synchronization techniques**:-Early-Late Gate, MMSE, ML and spectral line methods. | 10 | 20 |
| **SECOND INTERNAL TEST** |  |  |
| MODULE : 5  **Channels with distortion:** Design of transmitting and receiving filters for a known channel and for time varying channel. Equalizers: Zero forcing linear Equalization, Decision feedback equalization- Adaptive Equalization. | 10 | 20 |
| MODULE : 6  **Communication over fading channels**: Characteristics of fading channels, Rayleigh and Rician channels, receiver performance-average SNR, outage probability, amount of fading and average bit/symbol error. | 10 | 20 |

**Course No:** 08EC6021 **Course Title:** Wireless Mobile Networks **Credits: 3-1-0: 4 Year : 2015**

**Pre-requisites:NIL**

***Course Objective:***

To facilitate the student to have a good insight on PCS and GSM, get a good knowledge about the fundamentals of wireless networking ,different systems and services.

***Syllabus* :**

Fundamental concepts of architecture and mobility management of PCS, GSM, GPRS architecture, IEEE802.11, WAP architecture and basic concepts of 3G mobile services, WLL architecture, Global Mobile Satellite systems and brief idea of various aspects of wireless security and challenges involved in mobile computing, idea of Bluetooth technology, Mobile IP and Mobile Transport layer.

***Course Outcome:***

Students who successfully complete this course will be able to

* Have a clear understanding of different mobile networks and their basic architecture starting from 2G to 3G.
* Understand the security aspects in wireless networks and the challenges of wireless mobile networks..

**References**:

1. Theodore S. Rappaport “Wireless Communication- Principles and practices,” 2nd Ed., , Pearson Education Pvt. Ltd, 2003.

2. William Stallings, “Wireless communications and Networks”, 2nd ed. PHI 2007.

3. V.K.Garg , Wireless Network Evolution: 2G to 3G",Prentice Hall , 2002 ..

3. Jochen Schiller “Mobile communications,”, Pearson Education Pvt. Ltd., 2002.

4. DJ.Goodman "Wireless Personal Communication Systems", Addisson Wesley, 2007.

*Internal continuous assessment is in the form of tests, class assignments, mini projects on modeling and analysis of the system using any tool and seminars on extended syllabus.*

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| **COURSE NO:** 08EC6021 **COURSE TITLE**: Wireless Mobile Networks **(L-T-P : 3-0-0) CREDITS:3** | | |
| **MODULES** | **Contact**  **hours** | **Sem.Exam**  **Marks;%** |
| **Module 1**  Introduction to Personal Communication Services: PCS architecture, Mobility management, Network Signalling.  GSM system overview, GSM architecture, Mobility Management, Network signaling, Characteristics of SIM, Security protocols, Authentication. | **7** | **15** |
| **Module 2**  GPRS: GPRS architecture, GPRS network nodes.  Mobile Data Communication: WLAN IEEE802.11 std., Architecture, MAC layer, Synchronization, Power Management, Roaming, IEEE802.11a, 802.11b, new developments. | **7** | **15** |
| **FIRST INTERNAL TEST** |  |  |
| **Module 3**  Wireless Application Protocol: Mobile Internet Standard, WAP Gateway and protocols, WAP architecture and environment, push architecture, push/pull services, WAP 2.0, J2ME, BREW.  3G Mobile Services: Introduction to International Mobile Telecommunication 2000, WCDMA and CDMA 2000. | **7** | **15** |
| **Module 4**  WLL: WLL architecture, WLL Technologies.  Global Mobile Satellite Systems, Case studies of IRIDIUM and GLOBALSTAR systems.  Wireless Security: Public key infrastructure and certification authority | **7** | **15** |
| **SECOND INTERNAL TEST** |  |  |
| **Module 5**  Challenges of mobile computing, File Systems and WWW architectures for mobile computing.  Bluetooth Technology- Bluetooth protocol architecture- Link Management, Logical Link Control, Bluetooth profiles, Bluetooth security. | **7** | **20** |
| **Module 6**  Mobile IP: Network elements, Packet delivery, Agent Discovery, Registration, Tunnelling and Encapsulation, Optimization, IPv6, IP Micromobility support, DHCP and Mobile IP- Mobile Transport layer-Traditional TCP and Implications on mobility, Indirect and Snooping TCP- TCP over 2.5/3G networks-Performance enhancing process. | **7** | **20** |

**Course No:** 08EC6031 **Course Title: Communication Networks Credits:** 3-0-0: 3 **Year :**2015

**Pre-requisites:** *Nil*

***Course Objectives:***

1. Understand the basics of network communication.
2. Introduction to advanced networking concepts

***Syllabus***

General issues in the transport of data traffic over networks of digital transmission media. Architectural concepts in ISO's OSI layered model. Leyering in the Internet. Application layer; HTTP, SMTP, telnet, ftp. TCP/IP protocol stack. Transport layer; issues and standards, TCP, UDP. Network layer; IP, topology, routing, flow control, congestion control. Internetworking. Data link layer; ARQ schemes and their analysis. Multiple Access. LANs; IEEE LAN standards. Wirless LANs; IEEE 802.11. ATM Networks. Multimedia Networks. QoS issues in networks. Modelling and performance analysis of networks: Markov chain theory, queueing models: Little's Theorem, M/M/1, M/M/m, M/M/α, M/M/m/m, M/G/1 Queueing systems, Priority Queueing.

***Course Outcome*:**

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

1. Identify the different types of network topologies and protocols
2. Identify the different types of network devices and their functions within a network

***References:***

1. Kumar, D. Manjunath and J. Kuri, Communication Networking: An Analytical Approach, Morgan Kaufmann Publisher, 2004.
2. D. Bertsekas and R. Gallager, Data Networks, 2nd Edition,Prentice Hall of India, New Delhi, 2002.
3. J. K. Kurose and K. W. Ross, Computer Networking: A Top-Down Approach Featuring Internet, Pearson Education, 2012.
4. J. Walrand and P. Varaiya, High-Performance Communication Networks, 2nd Edition, Harcourt Asia, 2000

*Internal continuous assessment is in the form of tests, class assignments, mini projects on modeling and analysis of the system using any tool and seminars on extended syllabus.*

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| **COURSE NO:** 08EC6031 **COURSE TITLE**: Communication Networks **(L-T-P : 3-0-0) CREDITS:3** | | |
| **MODULES** | **Contact**  **hours** | **Sem.Exam**  **Marks;%** |
| Module 1  General issues in the transport of data traffic over networks of digital transmission media. Architectural concepts in ISO's OSI layered model. Leyering in the Internet. | 7 | 15 |
| Module 2  Application layer; HTTP, SMTP, telnet, ftp. TCP/IP protocol stack. Transport layer; issues and standards, TCP, UDP. | 7 | 15 |
| **FIRST INTERNAL TEST** |  |  |
| Module 3  Network layer; IP, topology, routing, flow control, congestion control. Internetworking. Data link layer; ARQ schemes and their analysis. | 7 | 15 |
| Module 4  Multiple Access. LANs; IEEE LAN standards. Wirless LANs; IEEE 802.11. | 7 | 15 |
| **SECOND INTERNAL TEST** |  |  |
| Module 5  ATM Networks. Multimedia Networks. QoS issues in networks. | 7 | 20 |
| Module 6  Modelling and performance analysis of networks: Markov chain theory, queueing models: Little's Theorem, M/M/1, M/M/m, M/M/α, M/M/m/m, M/G/1 Queueing systems, Priority Queueing. | 7 | 20 |

**Course No:** 08EC6041 **Course Title: *Mathematics for Communication Engineers* Credits:** 3-0-0: 3 **Year :**2015

**Pre-requisites:** *Nil*

***Course Objective:***

To develop analytical capability and to impart knowledge in Mathematical and Statistical methods

and their applications in Engineering and Technology and to apply these concepts in engineering

problems they would come across.*.*

***Syllabus:***

Vector space- Solving linear equations- orthogonality- Eigen values and Eigen vectors- SVD- diagonalization - Concept of pseudo inverse-linear transformation and representation- random variables-Review of axioms of probability-Bayes rule-probability density and mass functions- moment generating and characteristic functions- Characteristics of stochastic processes-special functions

**Course Outcomes**:

At the end of the course, Students will be able to understand

* Mathematical and Statistical concepts
* linear algebra, probability
* apply the concepts in solving the engineering problems.

**References:**

1. Gilbert Strang ,Introduction to linear algebra, , Wellesley- Cambridge press, 2009
2. Howard Arton and ChrisRorres ,Elementary linear algebra: Applications version, Wiley India, 2005
3. A.Papoulis and S.Unnikrishna Pillai, Probability,random variables and stochastic processes, McGraw Hill 2001
4. Hwei P Hsu, Theory and problems of of probability, random variables and random processes, Schaum’s outline series, McGraw Hill 1997.
5. Churchil R.V., "*Operational Mathematics*". Mc Graw Hill

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| **COURSE NO:** 08EC6041 **COURSE TITLE**: Mathematics for Communication Engineers **(L-T-P : 3-0-0) CREDITS:3** | | |
| **MODULES** | **Contact**  **hours** | **Sem.Exam**  **Marks;%** |
| MODULE : 1  **Vector spaces**- sub spaces-Solving linear equations- null space- independence –basis-dimension- orthogonality-least square approximation-Gram Schmidt orthogonalization- Eigen values and Eigen vectors-positive definite matrix- algebraic and geometric multiplicity – similar matrices- SVD- diagonalization | 7 | 20 |
| MODULE : 2  Concept of pseudo inverse-linear transformation and representation- complex vector space-unitary, normal and Hermitian matrices-definition of Fourier space- Applications of Linear algebra in constructing curves and surfaces through specified points, cubic spline interpolation, linear programming, Markov models and computer graphics | 8 | 20 |
| **FIRST INTERNAL TEST** |  |  |
| MODULE : 3  Random Variables -Review of Probability distributions - Random variables -Moment generating functions and their properties - Functions of Random variables | 5 | 10 |
| MODULE : 4  Review of axioms of probability-Bayes rule-probability density and mass functions-Bernaulli, Binomial,uniform, Gaussian,Poisson, exponential, Rayleigh, Cauchy and Racian distributions-mean and variance-functions of random variables-joint pdf-covariance-correlation coefficient-moment generating and characteristic functions-laws of large numbers-central limit theorem | 8 | 20 |
| **SECOND INTERNAL TEST** |  |  |
| MODULE : 5  Characteristics of stochastic processes-continuity, derivative and integrals of continuous stochastic processes-properties of autocorrelation and cross-correlation functions-power spectral density-cross-power spectral density-white noise-response of discrete time linear systems to random inputs | 7 | 15 |
| MODULE : 6  Special functions Series solutions - Bessel's equation - Bessel Functions - Legendre's equation - Legendre Polynomials - Rodrigue's formula - Recurrence relations - Generating Functions and orthogonal property for Bessel functions of the first kind | 7 | 15 |

**Course No:** 08EC6051 (A) **Course Title: Optimization Techniques Credits:** 3-0-0: 3 **Year :**2015

***Pre-requisites:*** Nil

***Course Objective:***

The aim of this course is to expose students to various deterministic optimization tools and techniques.

***Syllabus:***

*An overview of mathematical modeling, mapping and functions-vectors and vector spaces-convex sets and convex cones-linear programming –classical optimization techniques-linear optimization algorithms-non-linear programming- various constrained & unconstrained optimization techniques*

***Course Outcome:***

*.At the end of the course students will be able to:*

* *acquire the mathematical background required for optimization.*
* *understand continuous functions vector spaces and convex and concave functions.*
* *To model and apply linear and nonlinear programming techniques and algorithms to optimize performance of the systems*

**References:**

1. David G Luenberger, *Linear and Non Linear Programming*, 2nd Ed, Addison-Wesley.

2. S.S.Rao, *Engineering Optimization.; Theory and Practice*; Revised 3rd Edition, New Age International Publishers, New Delhi

3. S.M. Sinha, *Mathematical programming: Theory and Methods*, Elsevier, 2006.

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 andAlgorithms*, John Wiley, New York.

7.Kalyanmoy Deb, *Optimization for Engineering: Design-Algorithms and Examples*,Prentice Hall (India), 2008.

*Internal continuous assessment is in the form of tests, class assignments, mini projects on modeling and optimization of the system using any tool and seminars on extended syllabus.*

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| **COURSE NO**08EC6051(A) **COURSE TITLE**: Optimisation Techniques **(L-T-P : 3-0-0) CREDITS:3** | | |
| **MODULES** | **Contact**  **hours** | **Sem.Exam**  **Marks;%** |
| MODULE : 1  **Mathematical Background:** Sequences and Subsequences- Mapping and functions-Continuous functions- Infimum and Supremum of functions- Minima and maxima of functions- Differentiable functions. | 5 | 10 |
| MODULE : 2  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. | 5 | 10 |
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| MODULE : 3  Convex sets and Convex cones- 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- Generalization of convex functions. | 5 | 20 |
| **FIRST INTERNAL TEST** |
| MODULE : 4  **Linear Programming:** Introduction -Optimization model, formulation and applications -Classical optimization techniques: Single and multi variable problems-Types of constraints. Linear optimization algorithms: The simplex method -Basic solution and extreme point -Degeneracy | 7 | 20 |
| **SECOND INTERNAL TEST** |  |  |
| MODULE : 5  **Nonlinear Programming**: Minimization and maximization of convex functions- Local & Global optimum - Convergence-Speed of convergence. Unconstrained optimization: One dimensional minimization - Elimination methods: Fibonacci & Golden section search - Gradient methods - Steepest descent method | 8 | 20 |
| MODULE : 6  Constrained optimization: Lagrangian method - Sufficiency conditions - Kuhn-Tucker optimality conditions- Rate of convergence - Engineering applications Quadratic programming problems-Convex programming problems. | 12 | 20 |

**Course No:** 08EC6051 (B) **Course Title: Detection and Estimation Credits:** 3-0-0: 3 **Year :**2015

***Pre-requisites*:** Nil

***Course Objective*:**

To introduce Detection theory and impart knowledge in both single observation and multiple observations. To introduce the need of Estimation theory and different methods for estimation. To understand the different properties of estimators

To introduce state estimation

***Syllabus:***

Hypothesis testing: Binary and multiple hypothesis testing, Performance of Binary Receivers in AWGN, Sequential Detection and Performance- Signal detection with random parameters: Detection of known signals in nois- Composite Hypothesis Testing-Detection of multiple hypotheses: Different Criteria, Signal-Space Representations, Performance of M-ary Detection Systems, Sequential Detection of Multiple Hypotheses- Fundamentals of estimation theory: Formulation of the General Parameter Estimation Problem-Types of Estimation Problems-Properties of estimators- Parameter estimation

**Course Outcome:**

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

* Apply discrete-time and continuous-time signal theory to estimate the signal parameters.
* Extract useful information from random observations in communications.
* Design and analyze optimum detection schemes
* understand different estimation schemes as ML, LSE and MMSE estimators.

***References:***

[1] Harry L. Van Trees, “ Detection, Estimation, and Modulation Theory, Part I,” John Wiley & Sons, Inc. 2001.

[2] Steven M.kay, “Fundamentals of Statistical signal processing, volume-1: Estimation theory”. Prentice Hall 1993.

[3] Steven M.kay, “Fundamentals of Statistical signal processing, volume-2: Detection theory”. Prentice Hall 1993

[4] A.Papolis and S.Unnikrishna Pillai, “Probability, Random Variables and stochastic processes, 4e”. The McGraw-Hill 2002.

*Internal continuous assessment is in the form of tests, class assignments, mini projects on detection and estimation schemes and seminars on extended syllabus.*

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| **COURSE NO:** 08EC6051(B) **COURSE TITLE**: Detection and Estimation **(L-T-P : 3-0-0) CREDITS:3** | | |
| **MODULES** | **Contact**  **hours** | **Sem.Exam**  **Marks;%** |
| MODULE : 1  **Hypothesis testing**: Binary hypothesis testing, MAP criteria, bayes risk, Neyman-Pearson theorem, multiple hypothesis tests, Performance of Binary Receivers in AWGN, Sequential Detection and Performance. | 7 | 20 |
| MODULE : 2  **Signal detection with random parameters**: Detection of known signals in noise, Matched filter, Performance evaluations, Composite Hypothesis Testing, Unknown Phase, Unknown Amplitude, Unknown Frequency | 7 | 20 |
| **FIRST INTERNAL TEST** |  |  |
| MODULE : 3  **Detection of multiple hypotheses**: Bayes Criterion, MAP Criterion, M-ary Detection Using Other Criteria, Signal-Space Representations, Performance of M-ary Detection Systems, Sequential Detection of Multiple Hypotheses, Linear models, Rayleigh fading sinusoid | 10 | 25 |
| MODULE : 4  **Fundamentals of estimation theory**: Formulation of the General Parameter Estimation Problem, Relationship between Detection and Estimation Theory, Types of Estimation Problems. | 4 | 10 |
| **SECOND INTERNAL TEST** |  |  |
| MODULE : 5  **Properties of estimators**: Unbiasedness, efficiency, Criteria for good estimators, Minimum variance unbiased estimation, Cramer-Rao lower bound, asymptotic properties. | 9 | 15 |
| MODULE : 6  **Parameter estimation**: Random parameter, Bayes estimation, Mean square error (MSE), linear minimum mean-square estimates, linear square estimation, Maximum Likelihood Estimation, Least Square Estimation, Generalized Likelihood Ratio Test, Linear minimum variance | 5 | 10 |

**Course No:** 08EC6051 (C) **Course Title: RF MEMS for Wireless Communication Credits:** 3-0-0: 3 **Year :**2015

**Pre-requisites:** *Nil*

***Course Objective:***

The objective of this course is to make the students understand the fundamentals of RF MEMS circuit elements, MEMS based circuit design and its applications to wireless communications.

***Syllabus:***

Introduction to Wireless systems and elements of RF circuit design- MEMS based wireless appliances enable ubiquitous connectivity. Physical aspects of RF circuit design- Introduction to Micro fabrication Techniques-RF MEMS switches, inductor and capacitor -Actuation Mechanisms in MEMS- RF MEMS relays and switches- Micromachined RF filters- Micromachined antennas- Switched delay lines. Micromachined transmission lines-RF MEMS based circuit design and case studies

***Course Outcome:***

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

* introduce the physical aspects of RF circuit design
* familiarize with Micro fabrication and Actuation Mechanisms in MEMS
* know RF MEMS circuit elements such as switches, resonators
* understand the working of RF MEMS Phase Shifters, Filters, Oscillators
* explore on various Case Study of RF MEMS Devices

***References:***

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

and sons, LTD, 2003

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

2002.

3. G.M.Rebeiz , *“RF MEMS Theory , Design and Technology”,*Wiley , 2003.

4. S. Senturia, *“Microsystem Design*” , Kluwer, Springer, 2001.

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| **COURSE NO:** 08EC6051(C) **COURSE TITLE**: RF MEMSfor Wireless Communication **(L-T-P : 3-0-0) CREDITS:3** | | |
| **MODULES** | **Contact**  **hours** | **Sem.Exam**  **Marks;%** |
| MODULE : 1  Wireless systems and elements of RF circuit design- conceptual wireless systems, wireless transceiver architectures, power and bandwidth-efficient wireless systems & challenges, MEMS based wireless appliances enable ubiquitous connectivity | 4 | 10 |
| MODULE : 2  Physical aspects of RF circuit design, skin effect, transmission lines on thin substrates, self-resonance frequency, quality factor packaging, practical aspects of RF circuit design, dc biasing, impedance mismatch effects in RF MEMS | 6 | 10 |
| **FIRST INTERNAL TEST** |  |  |
| MODULE : 3  Introduction to Microfabrication Techniques- Materials properties, Bulk and surface micromachining, Wet and dry etching, Thin-film depositions (LPCVD, Sputtering, Evaporation),other techniques (LIGA, Electroplating)Actuation Mechanisms in MEMS- Piezoelectric, Electrostatic, Thermal, Magnetic | 8 | 20 |
| MODULE : 4  RF MEMS relays and switches. Switch parameters. Actuation mechanisms. Bistable relays and micro actuators. Dynamics of switching operation. MEMS inductors and capacitors. Micromachined inductor. Effect of inductor layout. Modeling and design issues of planar inductor. Gap tuning and area tuning capacitors. Dielectric tunable capacitors. | 8 | 20 |
| **SECOND INTERNAL TEST** |  |  |
| MODULE : 5  Micromachined RF filters. Modeling of mechanical filters. Electrostatic comb drive. Micromechanical filters using comb drives. Electrostatic coupled beam structures.Micromachined antennas. Microstrip antennas – design parameters. Micromachining to improve performance. Reconfigurable antennas.MEMS phase shifters. Types. Limitations. Micromachined transmission lines.Coplanar lines. | 8 | 20 |
| MODULE : 6  RF MEMS filters - A Ka-Band millimeter-wave Micromachined tunable filter, A High-Q 8-MHz MEM Resonator filter, RF MEMS Oscillators - fundamentals, A 14-GHz MEM Oscillator, A Ka - Band Micromachined cavity oscillator, A 2.4 GHz MEMS based voltage controlled oscillator. | 8 | 20 |

**Course No:** 08EC6051 (D) **Course Title:** CDMA Technology  **Credits:** 3-0-0: 3 **Year :**2015

**Pre-requisites:** NIL

***Course Objective:***

To provide the Student a foundation in the fundamentals of CDMA Technology; clear idea about power control, Link structure, link design,PN Offset planning etc; an introduction to multi carrier CDMA

;

Syllabus:

CDMA Concept-spread spectrum communication-spreading codes-DS-FH systems-performance-RAKE Receiver-power control-capacity-hand over-Link structure-Forward and Reverse-Call processing states-CDMA Design engineering-PN offset planning-CDMA Performance engineering-Search windows-CDMA Traffic engineering-MC-CDMA

***Course Outcome:***

Students who successfully complete this course will be able to

* understand the fundamental concepts of CDMA technology
* Apply the basic equations to design the links
* Using the concept and design the search windows
* understand the basics of multiuser CDMA

**Reference Books:**

1. Samuel C Yang, “CDMA RF System Engineering”, - Artech House Mobile Communication Library , 2004.

2. John B.. Groe and Lawrence E. Larson, “ CDMA Mobile Radio Design”, Artech house 2000.

3. Kamil SH.Zingangirav, “Theory of Code Division Multiple Access Communication”, IEEE press – Wiley Interscience, 2004.

*Internal continuous assessment is in the form of tests, class assignments, mini projects and seminars on extended syllabus.*

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| **COURSE NO:** 08EC6051(D) **COURSE TITLE**: CDMA Technology **(L-T-P : 3-0-0) CREDITS:3** | | |
| **MODULES** | **Contact**  **hours** | **Sem.Exam**  **Marks;%** |
| MODULE : 1  The CDMA concept**:** Need for spread spectrum communication – Spreading codes – Direct sequence and Frequency hopping spread spectrum communication system – Spread spectrum performance – Basic DS CDMA – Elements – RAKE receiver | 7 | 15 |
| MODULE : 2  Power control in CDMA – Soft handover – Inter frequency handover – Capacity – Effects of loading, sectorisation and voice activity-concepts of multicarrier CDMA | 7 | 15 |
| **FIRST INTERNAL TEST** |  |  |
| MODULE : 3  **Link structure and Call processing:** Asymmetric links - Forward link – Pilot channel – Sync channel – Paging channel – Traffic channel – Modulator – Reversing access channel – Traffic channel | 8 | 20 |
| MODULE : 4  Call processing states – Initialization state – Idle state – Access state – Traffic channel state. | 4 | 10 |
| **SECOND INTERNAL TEST** |  |  |
| MODULE : 5  **CDMA Design Engineering:** Forward Link analysis – Pilot channel – Traffic channel – Reverse link – Traffic channel – Reverse link rise – Frequency reuse factor - PN offset planning – Short PN sequence – Co PN offset – Adjacent PN offset. | 8 | 20 |
| MODULE : 6  **CDMA Performance and Traffic engineering**: Channel supervision-Power control parameters - Search window sizes - Field optimization – Traffic intensity  MC-CDMA - Signal Structure, Downlink Signal, Uplink Signal, Spreading Techniques, Pre-Equalization, Combined Equalization | 8 | 20 |

**Course No:** 08EC6061 **Course Title:** Research Methodology **Credits:** 1-1-0: 2 **Year :**2015

**Pre-requisites:** *Nil*

***Course Objective:***

The main objective of the course is to provide a familiarization with research methodology and to induct the student into the overall research process and methodologies. This course addresses: The scientific research process and the various steps involved formulation of research problem and research design, Design of experiments, Thesis preparation and presentation. Research proposals, publications and ethics, important research methods in engineering As a tutorial type course, this course is expected to be more learner centric and active involvement from the learners are expected which encourages self-study and group discussions. The faculty mainly performs a facilitator’s role.

***Syllabus:***

Overview of research methodology - Research process, scientific method, research design process.

Research Problem and Design - Formulation of research task, literature review and web as a

source, problem solving approaches, experimental research, and ex post facto research. Thesis

writing, reporting and presentation -Interpretation and report writing, principles of thesis writing format of reporting, oral presentation, seminars and conferences Research proposals, publications and ethics

Research proposals, research paper writing, considerations in publishing, citation, plagiarism and intellectual property rights. Research methods – Modelling and Simulation, mathematical modelling, graphs, heuristic optimization, simulation modelling, measurement design, validity, reliability, scaling, sample design, data collection methods and data analysis

***Course Outcome:***

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

* Discuss research methodology concepts, research problems, research designs, thesis

preparations, publications and research methods.

* Analyse and evaluate research works and to formulate a research problem to pursue

research

* Prepare a thesis or a technical paper, and present or publish them
* Apply the various research methods followed in engineering research for formulation and

design of own research problems and to utilize them in their research project.

***References:***

C. R. Kothari, “*Research Methodology, Methods and Techniques”*, New Age

International Publishers

2. K. N. Krishnaswamy, Appa Iyer Sivakumar, M. Mathirajan, “*Management Research*

*Methodology, Integration of principles”, Methods and Techniques*, Pearson Education

3. R. Panneerselvam, *“Research Methodology”*, PHI Learning

Deepak Chawla, Meena Sondhi, “*Research Methodology–concepts & cases”*, Vikas

Publg House

5. J.W Bames, *“Statistical Analysis for Engineers and Scientists”*, McGraw Hill,

N.York

6. Schank Fr., “*Theories of Engineering Experiments”*, Tata Mc Graw Hill Publication.

7. Willktnsion K. L, Bhandarkar P. L, “*Formulation of Hypothesis”*, Himalaya

Publication.

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| **COURSE NO:** 08GN6101 **COURSE TITLE**: Research Methodology **(L-T-P : 3-0-0) CREDITS:2** | | |
| **MODULES** | **Contact**  **hours** | **Sem.Exam**  **Marks;%** |
| MODULE : 1  **Overview of Research Methodology**  Research concepts – meaning – objectives – motivation - types of research –research process – criteria for good research – problems encountered by Indian researchers -scientific method - research design process – decisional | 5 | 15 |
| MODULE : 2  **Research Problem and Design**  Formulation of research task – literature review –methods – primary and secondary sources – web as a source – browsing tools -formulation of research problems – exploration - hypothesis generation -problem solving approaches-introduction to TRIZ(TIPS)- experimental research – principles -Laboratory experiment - experimental designs - ex post facto research - qualitative research | 5 | 15 |
| **FIRST INTERNAL TEST** |  |  |
| MODULE : 3  **Thesis writing, reporting and presentation**  Interpretation and report writing – techniques of interpretation – precautions in interpretation –significance of report writing – principles of thesis writing- format of reporting - different steps in report writing – layout and mechanics of research report -references – tables – figures – conclusions. Oral presentation – preparation - making presentation – use  of visual aids - effective communication-preparation for and presentation in seminars and conferences | 4 | 15 |
| MODULE : 4  **Research proposals, publications, ethics and IPR**  Research proposals - development and evaluation –research paper writing – layout of a research paper -journals in engineering – considerations in publishing –scientometry-impact factor- other indexing like h-index – citations - open access publication -ethical issues -plagiarism –software for plagiarism checkingintellectual property right- patenting case studies . | 5 | 15 |
| **SECOND INTERNAL TEST** |  |  |
| MODULE : 5  **Research methods – Modelling and Simulation**  Modelling and Simulation – concepts of modelling –mathematical modelling - composite modelling –modelling with – ordinary differential equations –partial differential equations – graphs heuristics and heuristic optimization - simulation modelling | 5 | 20 |
| MODULE : 6 **Research Methods – Measurement, sampling and**  **Data acquisition**  Measurement design – errors -validity and reliability in measurement - scaling and scale construction – sample design - sample size determination - sampling errors -data collection procedures - sources of data – data collection methods - data preparation and data analysis | 4 | 20 |

**Course No:** 08EC6071 **Course Title:** Seminar **Credits:** 0-0-2: 2 **Year :**2015

**Objective:**

*To assess the debating capability of the student to present a technical topic. Also to impart training to a student to face audience and present his/her ideas and thus creating self esteem and courage that are essential for an engineer.*

Students have to register for the seminar and select a topic in recent trends in communication and signal processing in consultation with any faculty member offering courses for the programme. A detailed write-up on the topic of the seminar is to be prepared in the prescribed format given by the Department. The seminar shall be of 30 minutes duration followed by 10 minutes for discussion and a committee with the Head of the department as the chairman and two faculty members from the department as members shall evaluate the seminar based on the coverage of the topic, presentation and ability to answer the questions put forward by the committee.

**Course No:** 08EC6081 **Course Title:** Communication Modeling and Simulation Laboratory

**Credits:** 0-0-2: 2 **Year :**2015

**Objective:** *Upon completion, the students will* be *able to design and implement using hardware and software,* Acquire *sufficient expertise in simulating these systems using MATLAB or* GNU Octave*,* *Be able to design and implement self standing systems of their choice with sufficient complexity.*

Syllabus:

Data Conditioning and Reconditioning, Baseband digital data transmission, BPSK/DPSK/DEPSK generation and Detection, QPSK/DQPSK generation and Detection, QAM/DQAM generation and Detection, Convolutional code generation and detection, Simulation of digital communication systems.

***Course outcome:***

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

* Identify the different line codes and infer the quality of the received signal using eye diagram
* Appreciate the principle of generation and detection of BPSK, DPSK, DEPSK, MSK, GFSK, GMSK signals.
* Appreciate the principle of generation and detection of QPSK, DQPSK signals.
* Generate and detect rate ½ convolutional code
* Use a software tool to generate time domain and frequency domain descriptions of various binary digital modulation schemes.

Reference:

WH Tranter, Principles of Communication Systems Simulation, Pearson Asia, 2010

**SEMESTER II**

**Course No:** 08EC6012 **Course Title:** Advanced Digital Signal Processing **Credits:** 3-0-0: 3 **Year :**2015

**Pre-requisites : Nil**

**Course Objectives:**

To impart the student

1. Knowledge for the design of stable adaptive filter for a particular signal filtering environment with a strong analytical background
2. Various mathematical methods for the estimation of power spectral density of given signal.

Syllabus:

Wiener filter; Principle of adaptive filter, different schemes and applications; linear prediction; Method of steepest descent; LMS, NLMS, RLS filters; Kalman filter; Spectral estimation methods

**Course Outcome**

Students who successfully complete this course will be able to

* formulate suitable adaptive schemes to obtain a cleaner signal from a noisy environment.
* apply a proper analytical procedure for estimating the power spectral density of signals.

**References**

1 Simon .O. Haykin ,Adaptive filter theory, , 5th Edition, Prentice Hall, Upper Saddle River, New Jersey, 2013.

2 Monson H Hayes,Statistical Digital Signal Processing and Modeling, John Wiley, New York 2006.

3 Alexander D Poularikas, Zayed M Ramadan ,Adaptive filtering primer with Matlab, CRC Press, 2011

4 Vijay K Madisetti , Digital Signal Processing Handbook,2nd Edition, CRC Press 2009

5 Paulo S R Diniz,Adaptive filtering: Algorithms and Practical implementation, 3rd Edition, Springer 2008.

6 Ali H Sayed, Adaptive filters, Wiley- IEEE Press, 2008

 7.Adaptive signal processing, E-learning course from NPTEL, [www.mptel.ac.in](http://www.mptel.ac.in/)

*Internal continuous assessment is in the form of tests, class assignments, mini projects and seminars on extended syllabus.* *The theory/evaluation is to be supplemented with computer simulation experiments using a suitable package.*

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| **COURSE NO:** 08EC6012 **COURSE TITLE**: Advanced Digital Signal Processing **(L-T-P : 3-0-0) CREDITS:3** | | |
| **MODULES** | **Contact**  **hours** | **Sem.Exam**  **Marks;%** |
| Module1-Review of stochastic processes, autocorrelation function, power spectral density, properties, Introduction to signal modeling, AR, MA, ARMA models | 9 | 15 |
| Module2-Yule-Walker equations, Levinson-Durbin recursion algorithm, Wiener filter, orthogonality, Wiener-Hopf equation, solving | 9 | 15 |
| **FIRST INTERNAL TEST** |  |  |
| Module3-Principle of adaptive filter,LMS filter weight updating, different schemes and applications | 10 | 15 |
| Module4-Linear predictor, implementation , Methods of steepest descent and stochastic gradient descent algorithms | 9 | 15 |
| **SECOND INTERNAL TEST** |  |  |
| Module5-LMS, NLMS, RLS, exponentially weighted RLS algorithms, convergence issues, Kalman filters | 9 | 20 |
| Module6-Non-parametric and parametric methods of power spectral density estimation : Periodogram, modified periodogram, Bartlette, Welch, Blackman\_tukey methods, minimum variance and maximum entropy methods, AR/MA/ARMA methods, Eigen vector methods, Pisarenko, MUSIC methods | 10 | 20 |

**Course No:** 08EC6022**Course Title:** OFDM for Wireless Communication **Credits:** 3-0-0: 3 **Year :**2015

**Objective:**

The aim of the paper is to introduce to the students the basics of OFDM scheme used in wireless communication. The students will be introduced with the applications also.

***Syllabus:***

Basics of OFDM- OFDM principles, system model - Guard time and cyclic extension -choice of parameters-Coding and modulation- Forward error correcting coding – Interleaving - Coded modulation -channel estimation- Coherent and Differential Detection –OFDMA- Difference between OFDMA and MC-CDMA. OFDMA system description- capacity of OFDMA

***Course Outcome:***

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

* Understand the concepts of an OFDM system, Coding and modulation scheme , channel estimation techniques
* Gather knowledge about OFDMA and understand its difference from MC-CDMA.
* completely design an OFDM system for the given parameters and analyze the system

**References:**

1. Richard Van Nee and Ranjee Prasad, “OFDM for Wireless Multimedia

Communication”, Artech House, 2000.

2. Mare Engels, “Wireless OFDM systems”, Klumer Academic publishers, 2002.

3. Prasad. R, “Universal Wireless Personnel Communications”, Artech House, 1998.

*Internal continuous assessment is in the form of tests, class assignments, mini projects on modeling and simulation of system and seminars on extended syllabus.*

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| **COURSE NO:** 08EC6022 **COURSE TITLE** OFDM for Wireless Communication  **(L-T-P : 3-0-0) CREDITS:3** | | |
| **MODULES** | **Contact**  **hours** | **Sem.Exam**  **Marks;%** |
| MODULE : 1  **OFDM Basics:** Introduction to Wireless OFDM – OFDM principles, system model – Generation of sub carrier using IFFT, Guard time and cyclic extension, windowing, choice of OFDM parameters, OFDM signal processing. | 10 | 25 |
| MODULE : 2  **Coding and Modulation:** Introduction – Forward error correcting coding – Interleaving – Quadrature Amplitude modulation – Coded modulation– | 5 | 10 |
| **FIRST INTERNAL TEST** |  |  |
| MODULE : 3  Synchronization – sensitivity to phase noise and frequency offset and timing errors – Synchronization using cyclic extension and special training symbols | 5 | 10 |
| MODULE : 4  **Channel estimation for OFDM system:** Coherent Detection – Coherent detection – one and two dimensional channel estimators, special training symbols, Decision directed channel estimation | 7 | 20 |
| **SECOND INTERNAL TEST** |  |  |
| MODULE : 5  Differential detection – Differential detection in the time and frequency domain – Differential amplitude and phase shift keying | 5 | 10 |
| MODULE : 6  **Orthogonal Frequency Division Multiple Access:** Frequency hopping in OFDMA, Difference between OFDMA and MC-CDMA. OFDMA system description – channel coding, modulation, Time and Frequency synchronization, Initial modulation timing and frequency offset synchronization accuracy, power control, random frequency hopping operation – Dynamic channel allocation (simple and fast) – capacity of OFDMA. | 10 | 25 |

**Course No:** 08EC6032 **Course Title:** Advanced Optical Communication **Credits:** 3-0-0: 3 **Year :**2015

***Course Objective:***

*This course is aimed to provide the students the various optical networking schemes and their important issues.*

***Syllabus:***

Optical fibers: review of fundamentals- optical components- introduction to OICs and its applications- SONET/SDH- infrastructure- 1G optical networks-SONET/SDH-infrastructure ESCON-HIPPI=MAN-2G Networks-WDM Technology-- DWDM – issues in WRN- OTDM Technology Important issues of OTDM – optical solitons – FTH and PON Technology -PON– Near space communication –ISL-AON-Next generation optical internets – burst switching – packet switching (IP-over-WDM) –- Access networks – AON,FTTC,FTTH,MONET – Traffic grooming – Optical fiber burst switching

***Course Outcomes:***

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

* understand 1G and 2G optical networks-WDM technology,
* FTH and PON technology and next generation optical internets

**References:**

1. Rajiv Ramaswami and Kumar N. Sivarajan, “ Optical networks – A Practical Perspective”, A Harcourt Publishers International Company, 2000.

2. R.G. Junsperger, “ Integrated Optics – Theory and Technology, Springer Series in Optical Sciences”, 4th Edition.

3. Gerg Keiser, “Optical Fiber Communications”, McGraw Hill International Edition, 2001.

4. John Gowar, “Optical Communications Systems”, 2nd Edition PHI of India, 2003.

5. John M. Senior , “Optical Fiber Communications Principles and Practice”,. PHI, 2002.

6. G.P. Agarwal, “Non-Linear Optics”, Academic Press.

7. StamatiosV.Kartalopoulos,”Understanding SONET/SDH and ATM Communication Network for Next Millennium”, PHI , 2000.

8. C.SivaRam Murthy and Mohan Gurusamy, “ WDM Optical Networks: Concepts, Design and Algorithms” PHI , India, 2002.

*Internal continuous assessment is in the form of tests, class assignments, mini projects on modeling and simulation of system and seminars on extended syllabus.*

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| **COURSE NO:** 08EC6032 **COURSE TITLE** Advanced Optical Communication  **(L-T-P : 3-0-0) CREDITS:3** | | |
| **MODULES** | **Contact**  **hours** | **Sem.Exam**  **Marks;%** |
| MODULE : 1  **Components**  Introduction to optical components – optical amplifiers –types – issues in optical amplifiers – photonic switching – cross connect – wavelength conversion – multiplexer – demultiplexer – filters – tunable filters – introduction to OICs and its applications. | 8 | 20 |
| MODULE : 2  **First Generation Optical Networks**  SONET/SDH- multiplexing, elements of a SONET/SDH infrastructure- SONET/SDH physical layer. Computer interconnects-ESCON, Fiber channel, HIPPI. Metropolitan area networks – FDDI, ATM. Layered architecture – SONET/SDH layers – Second generation optical network layers. | 8 | 20 |
| **FIRST INTERNAL TEST** |  |  |
| MODULE : 3  **WDM Technology**  Introduction – WDM optical networking evolution – enabling technologies for WDM optical networks – WDM optical network architecture – DWDM – issues in WRN. | 7 | 25 |
| MODULE : 4  **OTDM Technology** Important issues of OTDM – optical solitons – applications of solitons. Optical pulse compression – fiber grating compressor – soliton effect compressor. | 7 | 10 |
| **SECOND INTERNAL TEST** |  |  |
| MODULE : 5  **FTH and PON Technology-**Proposed architecture and issues of Fiber to the home (FTH) – Passive optical networks (PON) – Near space communication – Open air optical communication – Inter satellite link hops (ISL). Introduction to all optical networks (AON). | 6 | 15 |
| MODULE : 6 **Next generation optical internets** – burst switching – packet switching (IP-over-WDM) –- Access networks – AON,FTTC,FTTH,MONET – Traffic grooming – | 6 | 10 |

**Course No:** 08EC6042 (A) **Course Title:** Smart Antennas **Credits:** 3-0-0: 3 **Year :**2015

***Course Objective*:**

*This course is aimed to introduce the students with the concepts of smart antenna technology , the modeling and estimation. At the end of the course student will be able to have a good knowledge about all the modern smart wireless systems.*

***Syllabus:***

Introduction-Spatial processing for wireless systems. Adaptive antennas. Beam forming networks. Digital radio receiver techniques and software radios- Smart antenna techniques for CDMA-Coherent and non-coherent CDMA spatial processors- Characterization of spatio-temporal radio channels-Spatio – temporal channel mode-. Optimal spatial filtering-Optimal spatial filtering – adaptive algorithms for CDMA5. DOA estimation-DOA estimation – conventional and subspace methods. ML estimation techniques.

***Course Outcome:***

At the end of the course will be able to:

* get clear concept of adaptive antennas, beam forming networks and smart antennas.
* to design and analyze smart antennas for different systems and various channel conditions.
* do DOA estimation based on various techniques and for different conditions

**References:**

1. T.S.Rappaport & J.C.Liberti, Smart Antennas for Wireless Communication, Prentice Hall (PTR) ,

1999.

2. R.Janaswamy, Radio Wave Propagation and Smart Antennas for Wireless Communication,

Kluwer, 2001.

3. M.J. Bronzel, Smart Antennas, John Wiley, 2004.

*Internal continuous assessment is in the form of tests, class assignments, mini projects on modeling and simulation of system and seminars on extended syllabus.*

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| **COURSE NO:** 08EC6042(A) Smart antennas **COURSE TITLE (L-T-P : 3-0-0) CREDITS:3** | | |
| **MODULES** | **Contact**  **hours** | **Sem.Exam**  **Marks;%** |
| MODULE : 1  **Introduction:**Spatial processing for wireless systems. Adaptive antennas. Beam forming networks. Digital radio receiver techniques - software radios and cognitive radios | 10 | 25 |
| MODULE : 2  **Smart antenna techniques for CDMA:**Coherent and non-coherent CDMA spatial processors. Dynamic re-sectoring. Range and capacity extension – multi-cell systems. | 10 | 25 |
| **FIRST INTERNAL TEST** |  |  |
| MODULE : 3  **Characterization of spatio-temporal radio channels:** Spatio–temporal channel models. Environment and signal parameters. Geometrically based single bounce elliptical model. | 8 | 20 |
| MODULE : 4  Optimal spatial filtering – adaptive algorithms for CDMA. Multitarget decision – directed algorithm. | 4 | 10 |
| **SECOND INTERNAL TEST** |  |  |
| MODULE : 5  DOA estimation – conventional and subspace methods. ML estimation techniques | 4 | 10 |
| MODULE : 6  Estimation of the number of sources using eigen decomposition. Direction finding and true ranging PL systems. Elliptic and hyperbolic PL systems. TDOA estimation techniques | 6 | 10 |

**Course No:** 08EC6042 (B) **Course Title:** High performance Communication Networks  **Credits:** 3-0-0: 3 **Year :**2015

**Pre-requisites:** *Communication Networks Basic Paper*

**Course Objective:**

This course describes the fundamental principles to develop a comprehensive understanding of network architectures, control, performance, and wireless networks that explains current and emerging networking technologies.

***Syllabus:***

Networking basic concepts-network monitoring-Broadband networks-routing protocols and routing metrics-classification-IP networks-technology trends-circuit switched networks-Intelligent networks-ATM networks-adaptation layer-ATM signaling-Traffic classes-traffic management-high performance networks with WiMax and UWB- WiMax overview-time hopping UWB-Direct sequence UWB-multiband

Course Outcome:

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

* have a thorough knowledge about various networks
* apply various routing protocols
* Get a through idea about various IP networks and ATM networks.
* to get a chance to know the basics about the networks for WiMax and UWB

**References:**

1. Jean warland and Pravin Varaiya, “High Performance Communication Networks,” 2nd Edition,

Harcourt and Morgan Kanffman Publishers, London, 2008

2. Leon Gracia and Widjaja, “Communication networks,” Tata McGraw Hill, 2008.

3. Lumit Kasera and Pankaj Sethi, “ATM Networks,” Tata McGraw Hill, 2000.

4 Keiji Tachikawa, “W-CDMA Mobile Communication System,” John Wiley & Sons, 2002.

5. David tung chong wong, Peng-yong kong, Ying-chang liang, Kee chaing chua and Jon W. Mark,

“Wireless Broadband Networks,” John Wiley & Sons, 2009.

*Internal continuous assessment is in the form of tests, class assignments, mini projects on modeling and simulation of system and seminars on extended syllabus.*

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| **COURSE NO:** 08EC6042(B) **COURSE TITLE**:  **High performance Networks (L-T-P : 3-0-0) CREDITS:3** | | |
| **MODULES** | **Contact**  **hours** | **Sem.Exam**  **Marks;%** |
| MODULE : 1  **Introduction-**Networking principles, Digitalization Service and layered architecture, traffic characterization and QoS, network services; Network elements; Network Monitoring; Network Control; network mechanisms ;Network Element Management | 6 | 20 |
| MODULE : 2  **Broadband Networks-**Introduction ; Multihop Wireless Broadband Networks: Mesh Networks ; Importance of Routing Protocols ;Routing Metrics ; Packet Scheduling; Admission Control; Classification of Routing Protocols ; MANET Routing Protocols ; | 8 | 20 |
| **FIRST INTERNAL TEST** |  |  |
| MODULE : 3  **IP Networks-**Technology Trends in IP Networks, internet protocol, IP Packet communications in Mobile  Communication Networks ;TCP and VDP, Performance of TCP/IP networks; Circuits Switched Networks- SONET, DWDM, Fiber to home, DSL; Intelligent Network (IN) Scheme; Comparison with Conventional Systems ; Merits of the IN Scheme ; CATV. | 10 | 20 |
| MODULE : 4  **ATM Networks**  Introduction to ATM; The ATM Reference Model ; The ATM Layer; The ATM Adaptation Layer (AAL) ; AAL1 ;AAL2 ; AAL3/4 ; AAL5; Traffic Classes; Traffic Management and Quality of Service ; Traffic Descriptor ; Traffic Shaping; ABR and Traffic Congestion ; | 6 | 10 |
| **SECOND INTERNAL TEST** |  |  |
| MODULE : 5  Network Management ; Layer Management; ATM Signaling ; ATM Addressing Format ;; Connection Establishment; IP/ATM Internetworking ;IP Multicast over ATM | 4 | 10 |
| MODULE : 6  **High Performance Networking With WiMAX and Ultra Wideband (WPAN)**  Introduction ; WiMAX Overview ; Competing Technologies ; Overview of the Physical Layer ; PMP Mode ; Mesh Mode ; Multihop Relay Mode. Introduction; Time-Hopping Ultra wideband; Direct Sequence Ultra wideband; Multiband; Other Types of UWB. | 8 | 20 |

**Course No:** 08EC6042 (C) **Course Title:** Spectrum Analysis Techniques  **Credits:** 3-0-0: 3 **Year :**2015

***Course Objective*:**

To introduce Power spectral density,to impart knowledge in different methods of PSD estimation both in Nonparametric & parametric methods and to introduce the filter bank methods for spectral analysis

***Syllabus:***

Power spectral density-random signals and deterministic signals-PSD estimation-parametric and non parametric methods-Estimation of PSD from finite data, Periodogram properties, bias and variance analysis, Blackman-Tuckey method, Window design considerations, Refined periodogram methods : Bartlet method, Welch method-Parametric method for rational spectra:- Parametric method for line spectra: Models of sinusoidal signals in noise, Non-linear least squares method, Higher order Yule-Walker method, MUSIC and Pisayenko methods, Minnorm method, ESPIRIT method-Filter method

***Course Outcome:***

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

* understand various spectral analysis techniques-derivation of PSD using parametric and non parametric methods
* analyse the spectrum using PSD and filter method

**References:**

1. R.L. Moses, Stoica , Introduction to Spectral Analysis, Prentice Hall, 2009

2. Kay SM, Modern Spectral Estimation Theory & Applications, Prentice Hall, 2010

*Internal continuous assessment is in the form of tests, class assignments, mini projects on modeling and simulation of system and seminars on extended syllabus.*

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| **COURSE NO:** 08EC6042( C) **COURSE TITLE**:  **Spectrum Analysis Techniques (L-T-P : 3-0-0) CREDITS:3** | | |
| **MODULES** | **Contact**  **hours** | **Sem.Exam**  **Marks;%** |
| MODULE : 1  *Power Spectral Density:* Energy spectral density of deterministic signals, Power spectral density of random signals, Properties of PSD | 6 | 20 |
| MODULE : 2  *PSD Estimation - Non-parametric methods:* Estimation of PSD from finite data, Nonparametric methods : Periodogram properties, bias and variance analysis, Blackman-Tuckey method, | 8 | 20 |
| **FIRST INTERNAL TEST** |  |  |
| MODULE : 3  Window design considerations, time-bandwidth product and resolution – variance trade-offs in window design, Refined periodogram methods : Bartlet method, Welch method. | 5 | 15 |
| MODULE : 4  *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 signals, Modified Yule-Walker method, Twostage least square method, Burg method for AR parameter estimation. | 8 | 15 |
| **SECOND INTERNAL TEST** |  |  |
| MODULE : 5  *Parametric method for line spectra:* Models of sinusoidal signals in noise, Non-linear least squares method, Higher order Yule-Walker method, MUSIC and Pisayenko methods, Minnorm method, ESPIRIT method | 8 | 15 |
| MODULE : 6  *Filterbank methods:* Filterbank interpertation of periodogram, Slepia base-band filters,refined filterbank method for higher resolution spectral analysis, Capon method, introduction to higher order spectra. | 7 | 15 |

**Course No:** 08EC6042 (D) **Course Title: COGNITIVE RADIO TECHNOLOGY Credits:** 3-0-0: 3 **Year :**2015

***Course Objective:***

To make the student undersatnd the concept of SDR and Cognitive Radio and also to make the students aware of the research challenges in this field

***Syllabus:***

Basic concepts of SDR-hardware and software architecture-spectrum management-SDR development process and design-Application software –cognitive radio technology-concept-

Available technologies-CR related activities-applications-CR technical challenges-hidden primary user problem-spectrum sensing methods-classification-various methods of spectrum sensing

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**Course outcomes:**

After the course the students will be able to:

* have an awareness of the spectrum scarcity
* understand how SDR and CR help to find a solution to this problem
* get understanding about various stages of CR
* understand the technical challenges in this field
* sense the spectrum using various methods.

**REFERENCES**

1. Huseyin Arslan , *“Cognitive Radio, Software Defined Radio and Adaptive wireless system,*

Springer, 1 edition ,September 24, 2007

2. Bruce A Fette*, “Cognitive Radio Technology”,* Academic Press, 2009.

3. Mitola, J. and J. Maguire, G. Q., *“Cognitive radio: making software radios more personal,”*

IEEE Personal Commun. Mag., vol. 6, no. 4, pp. 13–18, Aug. 1999.

4. Tevfik Y¨ucek and H¨useyin Arslan, *“A Survey of Spectrum Sensing Algorithms for Cognitive Radio Applications”* , IEEE Communications Surveys & Tutorials, Vol. 11, No.1,First Quarter 2009, Pp 116-130.

5.http://www.comsoc.org/best-readings/cognitive-radio

*Internal continuous assessment is in the form of tests, class assignments, mini projects on modeling and simulation of system and seminars on extended syllabus.*

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| **COURSE NO:** 08EC6042(D) **COURSE TITLE**:  Cognitive Radio Technology **(L-T-P : 3-0-0) CREDITS:3** | | |
| **MODULES** | **Contact**  **hours** | **Sem.Exam**  **Marks;%** |
| MODULE : 1  **SOFTWARE DEFINED RADIO**  Basic SDR – Software and Hardware Architecture of an SDR – Spectrum Management – Managing unlicensed spectrum – Noise Aggregation | 8 | 20 |
| MODULE : 2  **- SDR AS PLATFORM FOR COGNITIVE RADIO** Introduction – Hardware and Software architecture – SDR development process and Design –Application software – Component development – Waveform development – cognitive waveform Development | 8 | 20 |
| **FIRST INTERNAL TEST** |  |  |
| MODULE : 3  **- COGNITIVE RADIO TECHNOLOGY I**ntroduction – Radio flexibility and capability – Aware – Adaptive – Comparison of Radio capabilities and Properties – Available Technologies – IEEE 802 Cognitive Radio related activities –Application. | 8 | 20 |
| MODULE : 4  **CR- TECHNICAL CHALLENGES**  Design Challenges associated with CR – Hardware requirements – Hidden primary user problem – | 5 | 10 |
| **SECOND INTERNAL TEST** |  |  |
| MODULE : 5  Detecting spread spectrum primary users – sensing duration and frequency – security | 5 | 10 |
| MODULE : 6  **-** SPECTRUM SENSING Overview – Classification - Matched filter – waveform based sensing – cyclostationary based sensing – Energy detector based sensing – Radio Identifier – Cooperative sensing- other sensing methods | 8 | 20 |

**COURSE NO:** 08EC6052 ( A) **COURSE TITLE**:  **Error control Coding**   **(L-T-P : 3-0-0) CREDITS:3**

**Pre-requisites: Basic course on Information theory and coding.**

***Course Objectives:***

1. To study the basic coding algebra required to understand further modules of the subject.

2. To review coding and decoding methods of linear block codes and cyclic codes.

3. To understand coding and decoding of Low-Density Parity check (LDPC) codes.

4. To understand coding and decoding of Low-Density Parity check (LDPC) codes.

5. To understand the role of Turbo codes in the WiMax/3GPP standards.

6. To understand the role of LDPC codes in the WiMax/3GPP standards.

**Syllabus: I**ntroduction to traditional coding theory and an overview of modern coding methods. Concept of Coding Algebra. Review of Encoding and Decoding methods of Llinear block codes, and cyclic codes. Encoding and Decoding methods of convolution codes, turbo codes and low-density parity-check (LDPC) codes. Turbo codes and LDPC codes in the WiMax/3GPP standards- Space Time Coding

***Course Outcomes:***

After successfully completing the course students will be able to

* Design encoders and Decoders of linear block codes for a given generator matrix
* Design encoders and Decoders of cyclic codes for a given generator matrix
* Design encoders and Decoders of convolution codes for given generator vectors
* design encoders and Decoders of LDPC codes, for a given generator matrix
* Design encoders and Decoders of Turbo codes
* To analyze the role of encoders and Decoders of Turbo codes in the WiMax/3GPP standards
* To analyze the role of encoders and Decoders of LDPC codes in the WiMax/3GPP standards-

***References :***

* Shu Lin and D. J. Costello, “Error Control Coding: Fundamentals and Applications”2e, 2004,
* Todd K Moon ,Error Correction Coding: Mathematical Methods and Algorithms—July 2005.
* Bernard Sklar ,Digital Communication Fundamentals and applications---2nd edition
* Robert G Gallagar ,Principles of Digital Communication Hardcover-March 2008 .
* Simon Haykin, Digital Communication Systems-May 2013 Wiley India Publications
* Ian Glover , Digital Communication by 2008 edition

*Internal continuous assessment is in the form of tests, class assignments, mini projects and seminars on extended syllabus.*

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| **COURSE NO:** 08EC6052 ( A) **COURSE TITLE**:  **Error control Coding**   **(L-T-P : 3-0-0) CREDITS:3** | | |
| **MODULES** | **Contact**  **hours** | **Sem.Exam**  **Marks;%** |
| **Module I:**  Coding Algebra—Definition of groups and fields. Galois Fields. Polynomials over GF (2). Irreducible and Primitive polynomials. Extension field of GF (2).  Review of Linear Block Codes and Cyclic codes. Generator and parity-check matrices, Minimum Distance, Syndrome decoding. | 7 | 20 |
| MODULE : 2  **Module II** Low-Density Parity check (LDPC) codes, Regular LDPC codes, Gallager construction of LDPC codes.Low-density Parity-check Codes: Ensembles of LDPC codes, Message-passing decoders, Threshold phenomenon and density evolution.  Socket construction of regular LDPC codes, Tanner Graphs, Neighbourhoods and cycles in graphs.Gallager A decoding algorithm for LDPC codes and its analysis, LDPC Threshold.Irregular LDPC codes, Node and edge perspective). | 12 | 25 |
| **FIRST INTERNAL TEST** |  |  |
| MODULE : 3  Sequential decoding algorithms & burst error correcting  Code -Tree diagrams – The Fano algorithm – The Stack algorithm – Performance analysis for Sequential-decoders – Burst error correcting codes – Decoding of single burst error correcting cyclic codes –  Fire interleaved codes – Phased burst error correcting codes – Concatenated codes | 6 | 15 |
| MODULE : 4**-**  Trellis coded modulation(tcm) and turbo code -M-ary signaling – One and Two-dimensional TCM – Multiple TCM – Decoding and performance analysis – Implementational considerations – | 5 | 10 |
| **SECOND INTERNAL TEST** |  |  |
| MODULE : 5  Turbo codes – Encoding parallel concatenated codes-decoding algorithms, Error Floor and Weight Distribution. Low Density Parity Check Codes – Construction, Tanner graphs, Decoding.-Encoding – Performance Evaluation-  using bounding techniques – Turbo decoding- BCJR algorithm for decoding – Applications | 7 | 20 |
| MODULE : 6  Space Time Coding – Fading Channels, Rayleigh Fading, MIMO Channel, Space Time Block Codes, Space – Time Trellis Codes. | 5 | 10 |

**Course No:** 08EC6052 (B) **Course Title:** RF Design of Communication Systems **Credits:** 3-0-0: 3 **Year :**2015

*Course Objective:*

*The objective of the paper is to facilitate the student with the understanding of RF design of various components for the use in communication devices and to* impart the modeling of RF system design in the field of communication system

***Syllabus:***

RF filter and resonators-design-realization-RF diodes-BJT-FETs-transistor models-characterization-impedance matching-amplifiers-stabilty consideration-amplifier design-oscillators-mixers-design-high frequency consideration***-***RF amd microwave antennas-metamaterials

***Course objective:***

At the end of the course the student will get through concepts about RF Filter designing, RF active components, RF transistor amplifier design, Oscillators and mixers used in RF design and RF antennas

**REFERENCES**

1. Reinhold Ludwig, Gene Bogdanov**,** *"RF circuit design, theory and applications",* Pearson

Asia Education, 2nd edition, 2009.

2. D.Pozar, *"Microwave Engineering"*, John Wiley & Sons, New York, 2008.

3. Bahil and P. Bhartia, *"Microwave Solid State Circuit Design",* Wiley-Interscience, 2003.

4. George.D.Vandelin, Anthony M.Pavis and Ulrich L.Rohde, “Microwave circuits design using linear and non linear techniques”, John Wiley and sons 1990.

5. Samuel T.Liao, “Microwave Circuits and analysis and amplifier design”, PHI, 1987.

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| **COURSE NO:** 08EC6052 ( B) **COURSE TITLE RF Design of Communication Systems (L-T-P : 3-0-0) CREDITS:3** | | |
| **MODULES** | **Contact**  **hours** | **Sem.Exam**  **Marks;%** |
| MODULE : 1  RESONATORS -Basic resonator and filter configurations-special filter realization-filter implementation-coupled filter. | 7 | 10 |
| MODULE : 2  RF DIODE AND BJT-Diodes-bipolar junction transistor - RF field effect transistor-high electron mobility transistors diode-models-transistor models-measurement of active devices-scattering parameter device characterization. | 7 | 20 |
| **FIRST INTERNAL TEST** |  |  |
| MODULE : 3  IMPEDANCE MATCHING -Impedance matching using discrete components-microstrip line matching networks-amplifier classes of operation and biasing networks. | 7 | 20 |
| MODULE : 4  CHARACTERISTICS OF AMPLIFIERS -Characteristics of amplifier-amplifier power relations-stability consideration-constant gainbroadband, high power, and multistage amplifiers.- RF Transistor amplifier design | 7 | 20 |
| **SECOND INTERNAL TEST** |  |  |
| MODULE : 5  FREQUENCY OSCILLATORS and Mixers -Basic oscillator model-high frequency oscillator configuration-basic characteristics of mixer-design | 7 | 20 |
| MODULE : 6  RF And Microwave Antennas - Basic Antenna parameters,Feeding structure-Patch Antenna, Ring Antenna, Micro strip dipole, Micro strip arrays,Traveling wave Antenna, Antenna System for Mobile Radio-Antenna Measurements and Instrumentation. Introduction to metamaterials and EBG structures. | 7 | 10 |

**Course No:** 08EC6052 (C) **Course Title:** VLSI for Wireless Communication **Credits:** 3-0-0: 3 **Year :**2015

***Course Objective***:

This course covers the design of VLSI circuits used in modern wireless transceivers such as 4G/802.16 (Wimax), 3G/LTE (long term evolution),DCS-1800/GSM, DECT. A detail design example on MIMO (antenna interface) design, such as for wireless LAN, will also be covered. In the course design trade-offs in the transceivers are illustrated with practical, real life circuit examples, with low power as an important design objective.

***Syllabus:***

Components And Devices- Mixers- Intrinsic Noise in Single Ended Sampling Mixer -Extrinsic Noise in Single Ended Sampling-Mixer.- Frequency Synthesizers- A Complete Synthesizer Design Example (DECT Application)- Sub Systems -Data converters in communications, adaptive Filters, equalizers and transceivers- Implementations -VLSI architecture for Multitier Wireless System - Hardware Design Issues for a Next-generation CDMA System.

**Reference Books**

1. B.Razavi ,”RF Microelectronics” , Prentice-Hall ,1998.

2. Bosco H Leung “VLSI for Wireless Communication”, Pearson Education, 2002.

3. Thomas H.Lee, “The Design of CMOS Radio –Frequency Integrated Circuits‟,

Cambridge University Press ,2003.

4. Emad N Farag and Mohamed I Elmasry, “Mixed Signal VLSI Wireless Design -

Circuits and Systems”, Kluwer Academic Publishers, 2000.

5. Behzad Razavi, “Design of Analog CMOS Integrated Circuits” McGraw-Hill, 1999.

6. J. Crols and M. Steyaert, “CMOS Wireless Transceiver Design,” Boston, Kluwer

Academic Pub., 1997.

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| **COURSE NO:** 08EC6052 ( C) **COURSE TITLE**  VLSI for Wireless Communication **(L-T-P : 3-0-0) CREDITS:3** | | |
| **MODULES** | **Contact**  **hours** | **Sem.Exam**  **Marks;%** |
| MODULE : 1  **Components And Devices -**Integrated inductors, resistors, MOSFET and BJT AMPLIFIER DESIGN: Low Noise Amplifier Design - Wideband LNA - Design Narrowband LNA - Impedance Matching -Automatic Gain Control Amplifiers – Power Amplifiers | 7 | 20 |
| MODULE : 2  Mixers-Balancing Mixer - Qualitative Description of the Gilbert Mixer - Conversion Gain –Distortion – Low Frequency Case: Analysis of Gilbert Mixer – Distortion - High-Frequency Case – Noise – A Complete Active Mixer | 7 | 20 |
| **FIRST INTERNAL TEST** |  |  |
| MODULE : 3  Switching Mixer - Distortion in Unbalanced Switching Mixer – Conversion Gain in Unbalanced Switching Mixer - Noise in Unbalanced Switching Mixer - A Practical Unbalanced Switching Mixer. Sampling Mixer – Conversion Gain in Single Ended Sampling Mixer - Distortion in Single Ended Sampling Mixer -Intrinsic Noise in Single Ended Sampling Mixer -Extrinsic Noise in Single Ended Sampling Mixer. | 7 | 20 |
| MODULE : 4  **Frequency Synthesizers** Phase Locked Loops - Voltage Controlled Oscillators - Phase Detector – Analog Phase Detectors– Digital Phase Detectors - Frequency Dividers - LC Oscillators - Ring Oscillators - Phase Noise -A Complete Synthesizer Design Example (DECT Application). | 7 | 20 |
| **SECOND INTERNAL TEST** |  |  |
| MODULE : 5  **Sub Systems**  Data converters in communications, adaptive Filters, equalizers and transceivers | 7 | 10 |
| MODULE : 6  **Implementations-**VLSI architecture for Multitier Wireless System - Hardware Design Issues for a Next generation CDMA System. | 7 | 10 |

**Course No:** 08EC6052 (D) **Course Title:** Wireless Sensor Networks **Credits:** 3-0-0: 3 **Year :**2015

To facilitate the student

1. To identify the constituents of Wireless Sensor Networks -Understand the challenges in network coverage and the upcoming challenges in Sensor Networks
2. To identify different Medium Access Control Protocols for Wireless Sensor Networks and their relevance.
3. To get a good knowledge about the Routing Challenges, Design Issues and different Routing Protocols for Wireless Sensor Networks.
4. To acquire a good idea on the Design Issues, Existing Transport Protocols and Performance of Transport Control Protocols in Wireless Sensor Networks
5. To be aware of the Operating System Design Issues, different Operating Systems in Wireless Sensor Networks and Traffic Management.

**Syllabus :** Fundamental concepts of Wireless Sensor Networks, technical characteristics, advantages, classification, architecture, design directions, coverage, MAC protocols for WSN, Design issues, Routing protocols for WSN, Design issues, Transport for WSN, Design issues, Operating Systems for WSN, Design issues, Traffic management.

**Course Outcome:** Students who successfully complete this course will be able to:

* understand concepts and architecture of Wireless Sensor networks
* get an awareness of the MAC protocols, Routing protocols and Transport protocols of WSN and their design issues.

**References**:

1. Kazem Sohraby, Daniel Minoli and Taieb Znati, Wireless Sensor Networks: Technology, Protocols and Applications, Wiley Interscience, 2007.
2. Carlos de Morais Cordeiro and Dharma P Agrawal., Ad Hoc and Sensor Networks: Theory and Applications,CRC press, 2010
3. F. Zhao, C Guibas ,Wireless Sensor Networks, Elsevier, Morgan Kaufmann, 2004.
4. Mohammad Ilyas, Imad Mahgoub , Hand Book Of Sensor Networks, ,CRC Press, 2005.

*Internal continuous assessment is in the form of tests, class assignments, mini projects and seminars on extended syllabus*

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| **COURSE NO:** 08EC6052 ( D) **COURSE TITLE : Wireless Sensor Networks (L-T-P : 3-0-0) CREDITS:3** | | |
| **MODULES** | **Contact**  **hours** | **Sem.Exam**  **Marks;%** |
| MODULE : 1  Introduction and Overview of Wireless Sensor Networks-Constraints and Technical Challenges- Advantages of Sensor Networks (Energy Advantage and Detection Advantage)- Basic Wireless Sensor Technology, Wireless Transmission Technology and Systems- Classification of WSNs | 7 | 20 |
| MODULE : 2  Sensor Network Architectural elements- Sensor Network Applications- Smart Transportation- Collaborative Processing. Classification of WSNs, Characteristics, Technical Challenges, and Design Directions, Technical Approaches, Coverage in Wireless Sensor Networks. | 7 | 20 |
| **FIRST INTERNAL TEST** |  |  |
| MODULE : 3  Medium Access Control protocols for Wireless Sensor Networks-Fundamentals of MAC protocols-Schedule Based Protocols-Random Access Based Protocols- Sensor MAC-Case Study. | 7 | 15 |
| MODULE : 4  Routing protocols for Wireless Sensor Networks-Data Dissemination and Gathering-Routing Challenges and Design Issues-Routing Strategies in Wireless Sensor Networks-Flooding and its varients-LEACH-PEGASIS-Direct Diffusion-Geographical Routing | 7 | 15 |
| **SECOND INTERNAL TEST** |  |  |
| MODULE : 5  Transport Control for WSN-Traditional Transport Protocols-Design Issues-Existing Transport Protocols-Performance of Transport Control Protocols | 7 | 15 |
| MODULE : 6  Operating Systems for WSN-Operating System Design Issues-Example Operating Systems for WSN-Performance and Traffic Management. | 7 | 15 |

**Course No:** 08EC6062 **Course Title:** Mini Project  **Credits:** 0-0-4:2 **Year :**2015

***Course Objective:***

*To estimate the ability of the student in transforming the theoretical knowledge studied so far intoa practical problem in Communication engineering.*

*To prepare students for future employment and make students to do a mini project – either actual design and simulation using tools*

**Syllabus**

Internship in an organization - analyse design, and simulate latest systems and application based products.

**Expected Outcome**

Experience the discipline of working in a professional engineering organization.

Interact with other professional and non professional groups

Apply engineering methods such as design and problem solving.

Develop technical,inter personal and communication skills both oral and written

**Course No:** 08EC6072 **Course Title:** Signal Processing Lab **Credits:** 0-0-4:2 **Year :**2015

***Course Objective*:** *Upon completion, the students will*  *be able to design and implement using hardware and software,*  *Acquire sufficient expertise in simulating these systems using MATLAB or* GNU Octave *,* *Be able to design and implement self standing systems of their choice with sufficient complexity.*

Syllabus:

Filter design, Spectral analysis of speech signals. Speech processing based on LPC, power spectral density estimation, Multirate signal processing:-Interpolation and decimation, filter bank design,Adaptive signal processing:-LMS and RLS algorithm implementation for a selected application,Wavelet transform implementation. Image processing-evaluation of histogram and histogram equalization. Experiments with DSP kit TMS 320CXX/AD/equivalent, DTMF signal generation and detection with DSP algorithms

***Course outcome:***

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

* Design and simulate digital filters and various signal processing systems.

References:

GB Giannakis, Signal Processing Advances in Wireless and Mobile communication, PHPTR, 2001

**SEMESTER III**

**Course No:** 08EC7011 (A) **Course Title:** Advanced Techniques for Wireless Reception **Credits:** 3-0-0: 3 **Year :**2015

**Course Objective:**

To impart the knowledge about wireless reception techniques and signal processing techniques. Students will be introduced to the reception techniques used in the new generation wireless systems.

***Syllabus:***

Basic signal processing for wireless reception-linear receivers for synchronous CDMA-multiuser detection-blind and group blind-for non Gaussian channels-optimum space-time –turbo-linear and non-linear predictive techniques-signal processing for wireless reception- Bayesian and sequential Montecarlo signal processing- Blind adaptive equalization of MIMO channels-Signal processing for fading channels- Coherent detection based on the EM algorithm- Decision-feedback differential detection- Signal processing for coded OFDM systems

***Course Outcomes***

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

* have good understanding about various wireless reception techniques.
* design and model synchronous and multi-user CDMA detectors
* apply different signal processing techniques for wireless reception

***Referencs:***

1. *X.Wang & H.V.Poor, Wireless Communication Systems, Pearson, 2004.*
2. *R.Janaswamy, Radio Wave Propagation and Smart Antennas for Wireless*

*Communication, Kluwer, 2001.*

1. *Mohamed Ibnkahla, Signal Processing for Mobile Communications, CRC Press, 2005.*
2. *A.V.H. Sheikh, Wireless Communications Theory & Techniques, Kluwer Academic Publications, 2004.*
3. *A.Paulraj etal, Introduction to Space-time Wireless Communications, Cambridge University Press, 2003.*

*Internal continuous assessment is in the form of tests, class assignments, mini projects and seminars on extended syllabus*

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| **COURSE NO:** 08EC7011( A) **COURSE TITLE : Advanced Techniques for Wireless Reception (L-T-P : 3-0-0) CREDITS:3** | | |
| **MODULES** | **Contact**  **hours** | **Sem.Exam**  **Marks;%** |
| MODULE : 1  Wireless signaling environment. Basic signal processing for wireless reception. Linear receivers for synchronous CDMA. Blind and group-blind multiuser detection methods, Performance issues | 8 | 20 |
| MODULE : 2  Robust multiuser detection for non Gaussian channels; asymptotic performance ,implementation aspects.Adaptive array processing in TDMA systems. Optimum space-time multiuser detection | 10 | 25 |
| **FIRST INTERNAL TEST** |  |  |
| MODULE : 3  Turbo multiuser detection for synchronous and turbo coded CDMA. Narrowband interface suppression. | 6 | 15 |
| MODULE : 4  Linear and nonlinear predictive techniques. Code-aided techniques. Performance comparison. | 4 | 10 |
| **SECOND INTERNAL TEST** |  |  |
| MODULE : 5  Signal Processing for wireless reception: Bayesian and sequential Montecarlo signal processing. Blind adaptive equalization of MIMO channels .Signal processing for fading channels | 8 | 20 |
| MODULE : 6  Coherent detection based on the EM algorithm. Decision-feedback differential detection. Signal processing for coded OFDM systems. | 6 | 10 |

**Course No:** 08EC7011 (**B**) **Course Title:** Secure Communication **Credits:** 3-0-0: 3 **Year :**2015

***Pre-requisites*:** Brief idea of security aspects in Wireless Communication

***Course Objectives***:

To facilitate the student

1. To have a good insight on the encryption techniques
2. To get familiarised with the concept of private key and public key cryptosystems.
3. To get a good knowledge about the concept of Elliptic Curves, its relevance in implementing security in a wireless scenario, Electronic Mail Security, IP Security, Viruses and Firewalls.

**Syllabus:**

Fundamental concepts of Rings, Fields, Euclidean domain, Unique Factorization domain, Chinese Remainder Theorem, Euler Theorem. Concepts of Cryptanalysis, Perfect Secrecy, Shannon’s Theory., Block ciphers and Stream ciphers. Relevance of One way functions, Discrete Log problem and Factorization problem. Different Private key and Public key cryptosystems, Diffie Hellmann key exchange, Digital Signature, Message Authentication and Hash Functions. Theory of Elliptic Curves and applications of Elliptic Curves in providing secure communication. Electronic Mail Security, IP Security, Viruses, Firewalls.

***Course Outcome:***

Students who successfully complete this course will be able to:

* Understand the concepts of different encryption techniques, private and public key cryptosystem
* understand the security aspects in wireless communication, concept of Elliptic Curves and different techniques using Elliptic Curves so as to ensure security in the communication field. have knowledge on Electronic Mail Security, IP Security, Viruses, Firewalls.

**References**:

1.Douglas A. Stinson, “Cryptography, Theory and Practice”, 2nd edition, Chapman & Hall, CRC Press Company, Washington

2. William Stallings, “Cryptography and Network Security”, 3rd edition, Pearson Education

3. Lawrence C. Washington, “ Elliptic Curves”, Chapman & Hall, CRC Press Company, Washington.

4. David S. Dummit, Richard M. Foote, “Abstract Algebra”, John Wiley & Sons

5. Evangelos Kranakis, “Primality and Cryptography”, John Wiley & Sons

6. Rainer A. Ruppel, “Analysis and Design of Stream Ciphers”, Springer Verlag

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| **COURSE NO:** 08EC7011( B) **COURSE TITLE : Secure Communication (L-T-P : 3-0-0) CREDITS:3** | | |
| **MODULES** | **Contact**  **hours** | **Sem.Exam**  **Marks;%** |
| **Module 1**  Rings and fields - Homomorphism- Euclidean domains - Principal Ideal Domains - Unique Factorization Domains -- Euler theorem - Chinese Remainder Theorem -Primality | **7** | **15** |
| **Module 2**  Basic encryption techniques - Concept of cryptanalysis - Shannon's theory - Perfect secrecy - Block ciphers -Cryptographic algorithms - Features of DES - Stream ciphers - Pseudo random sequence generators. | **7** | **15** |
| **FIRST INTERNAL TEST** |  |  |
| **Module 3**  Private key and Public key cryptosystems - One way functions - Discrete log problem – Factorization problem - RSA encryption - Diffie Hellmann key exchange - Message authentication and hash functions -Digital signatures -- features of visual cryptography - other applications of cryptography - | **7** | **15** |
| **Module 4**  Elliptic curves - Basic theory - Weirstrass equation - Group law - Point at Infinity -Elliptic curves over finite fields - Discrete logarithm problem on EC - Elliptic curve cryptography - Diffie Hellmann key exchange over EC. | **7** | **15** |
| **SECOND INTERNAL TEST** |  |  |
| **Module 5**  Electronic Mail Security:- Pretty Good Privacy operation.  IP Security-Applications, IP Security Services.  Web Security- Web Security threats, Secure Electronic Transaction. | **7** | **20** |
| **Module 6**  Viruses and related threats- Malicious programs, Trap doors, Trojan Horses; Nature of viruses, Types of viruses. Macro viruses, Email viruses. Firewall characteristics. | **7** | **20** |

**Course No:** 08EC7011 (C) **Course Title:** Modeling and Simulation of Communication Systems **Credits:** 3-0-0: 3 **Year :**2015

***Course Objective:***

The aim of this course is to Interpret, Analyse, model and Process the communication signals, systems using appropriate modeling techniques and simulation tools.

***Syllabus:***

Identifying the role of simulation in Communication Systems- Mapping a problem into simulation model- Quadrarure Models- Low pass and band pass sampling- Linear band pass systems, LTI systems- Digital Filter models- Models and simulation techniques- Random Signal Models- Monte Carlo methods- Application to communication systems- Advanced Models- Modeling and simulation of baseband and band pass non linearities-case study

***Course Outcomes:***

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

* analyse and evaluate a communication system and suggest enhancements to improve the system performance
* Apply suitable tools to design, simulate and demonstrate the working of communication systems and signal processing as per the application needs
* Specify and design optimal modeling schemes for the given communication system problem to efficiently use the channel capacities and signal characteristics.

***References:***

1. WH Tranter, Principles of Communication Systems Simulation: Pearson Asia, 2010.

2. GB Giannakis, Signal Processing Advances in Wireless and Mobile communication, PHPTR, 2001

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| **COURSE NO**08EC7011( C) **COURSE TITLE : Modeling and Simulation of Communication Systems (L-T-P : 3-0-0) CREDITS:3** | | |
| **MODULES** | **Contact**  **hours** | **Sem.Exam**  **Marks;%** |
| MODULE 1**-Introduction**: Identifying the role of simulation in Communication Systems, Understanding analytically tractable and intractable systems, deterministic and stochastic simulations with examples, Mapping a problem into simulation model, system level modeling of timing recovery subsystem, linear vs nonlinear models, random process modeling and simulation, BER estimation | 8 | 20 |
| MODULE 2- **Quadrarure Models:** Low pass and band pass sampling, Up sampling and down sampling, simulation sampling frequency, Low pass simulation model for band pass signals and systems, low pass complex envelope- time domain and frequency domain representation, quadrature models for random band pass signals, Linear band pass systems, LTI systems, derivation of LPEQ components, Multi carrier signals, Nonlinear systems, time variant systems. | 8 | 20 |
| **FIRST INTERNAL TEST** |  |  |
| MODULE 3- **Digital Filter models:** Models and simulation techniques, CAD of IIR digital filters, PLL models, Nonlinear phase model, Simulating the PLL | 5 | 10 |
| MODULE 4- Random Signal Models: Generating and Processing random signals, uniform random number generators, testing the random number generators, Mapping uniform RVs to an arbitrary pdf, generating uncorrelated Gaussian random numbers, generating correlated Gaussian random numbers, PN sequence generators, Post processing, Graphical techniques, Histogram estimation, PSD estimation, Gain, Delay, SNR. | 6 | 15 |
| **SECOND INTERNAL TEST** |  |  |
| MODULE 5  **Monte Carlo methods**: Monte Carlo estimation, Application to communication systems, Monte Carlo simulation of PSK and QPSK systems, Semianalytic BER estimation for PSK and QPSK systems. | 7 | 15 |
| MODULE 6 **Advanced Models**: Modeling and simulation of baseband and band pass non linearities, Multi carrier case, Modeling and simulation of time varying systems, time and frequency descriptions of LTV systems, Modeling and simulation of waveform channels, multipath fading channel example, CASE STUDY – Modeling and Simulation of a cellular radio system, CCI and effects of sectoring, Generation of snapshots and SIR computation | 8 | 20 |

**Course No:** 08EC7011 ( D) **Course Title:** Advanced Image Processing **Credits:** 3-0-0: 3 **Year :**2015

***Course Objective:***

The objective of the course is to equip the students with techniques of modeling, analyzing and processing of images

***Syllabus:***

Digital Image Representation- Fundamental Steps in Digital Image Processing- Elements of Digital Image Processing Systems-fundamentals of digital image-image transformations-stereo imaging-image enhancement techniques- Pseudo-Color Image Enhancement- Image Restoration- Image Compression: Fundamentals of Compression- Image Segmentation- Image Representation and Description- Image recognition and interpretation

**Course Outcomes:** At the end of the course the student will be able to

* Interpret, Analyse, model and Process the Image data.
* Analyse and evaluate image processing system
* Simulate the working of image processing systems
* Identify optimal processing algorithm for the given Imaging problem.

**References:**

1. Rafael C Gonzalez and Richard E Woods, Digital Image Processing, 2nd editionPearson Education Asia, New Delhi, 2010.

2. . Chanda, D. DuttaMajumder, Digital Image Processing and Analysis, PHI, New Delhi, 2006.

3. A.K. Jain, Fundamentals of Digital Image Processing, PHI, New Delhi, 2006.

*Internal continuous assessment is in the form of tests, class assignments, mini projects and seminars on extended syllabus*

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| **COURSE NO:** 08EC7011( D) **COURSE TITLE : Advanced Image Processing**  **(L-T-P : 3-0-0) CREDITS:3** | | |
| **MODULES** | **Contact**  **hours** | **Sem.Exam**  **Marks;%** |
| MODULE : 1  **Introduction**: Digital Image Representation, Fundamental Steps in Digital Image Processing, Elements of Digital Image Processing Systems.  **Digital Image Fundamentals:** Elements of Visual Perception, A Simple image model, Image sensing and acquisition, Image Sampling and Quantization, Neighborhood of Pixels, Pixel Connectivity, Labeling of Connected Components, Distance Measures, Arithmetic and Logic Operations, Image Transformations, Perspective Transformations, Stereo Imaging | 8 | 20 |
| MODULE : 2  **Image Enhancement**: Spatial Domain Methods, Point processing, Intensity Transformations, Histogram Processing, Spatial filtering, Smoothing Filters, Sharpening Filters, Image Enhancement in the Frequency Domain, smoothing filters, Low Pass Filtering, sharpening filters, High Pass Filtering, Homomorphic filtering, Pseudo-Color Image Enhancement. | 8 | 20 |
| **FIRST INTERNAL TEST** |  |  |
| MODULE : 3  **Image Restoration:** Model of image degradation/ restoration process, noise models, restoration in presence of noise only- spatial filtering, periodic noise reduction by frequency domain filters, Inverse filtering. | 5 | 10 |
| MODULE : 4  **Image Compression**: Fundamentals of Compression, Image Compression Model, Error free Compression, Huffman and LZW coding, Lossy Predictive Coding, Transform Coding. | 4 | 10 |
| **SECOND INTERNAL TEST** |  |  |
| MODULE : 5  **Image Segmentation:** Detection of Discontinuities, Line Detection, Edge Detection, Edge Linking and Boundary Detection, Thresholding, Threshold Selection on Boundary Characteristics, Region Growing , Region Splitting and Merging, Use of motion in Segmentation. | 8 | 20 |
| MODULE : 6  **Image Compression**: Fundamentals of Compression, Image Compression Model, Error free Compression, Huffman and LZW coding, Lossy Predictive Coding, Transform Coding.  **Image Segmentation:** Detection of Discontinuities, Line Detection, Edge Detection, Edge Linking and Boundary Detection, Thresholding, Threshold Selection on Boundary Characteristics, Region Growing , Region Splitting and Merging, Use of motion in Segmentation. | 9 | 20 |

**Course No:** 08EC7021 (A) **Course Title:** Markov Modeling and Queueing Theory **Credits:** 3-0-0: 3 **Year :**2015

***Course Objective:***

This course is a thorough treatment of Markov chains and Markov models of systems. It also deals with the essential queuing theory and application of Markov models in the analysis of queuing networks..

***Syllabus:***

Stochastic Processes: Renewal Processes - Reward and Cost Models- Renewal Theorems- Markov Models: Discrete Time Markov Chain - Continuous Time Markov Chain -Pure-Jump Continuous-Time Chains, Regular Chains, Semi-Markov Processes- Single Class & Multi-class Queuing Networks: Simple Markovian queues; M/G/1 queue; G/G/1 queue; Open queuing networks; Closed queuing networks- Time Delays and Blocking in Queuing Networks.

***.Course outcomes:***

The student will be able to:

* understand about Markov chains and models.
* model networks using these concepts

**References:**

1. Ronald W. Wolff, Stochastic Modeling and The Theory of Queues, Prentice‐Hall

International.

2.Peter G. Harrison and Naresh M. Patel, Performance Modeling of Communication

Networks and Computer Architectures, Addison‐Wesley.

3.Gary N. Higginbottom, Performance Evaluation of Communication Networks*,*

Artech House.

4.Anurag Kumar, D. Manjunath, and Joy Kuri, Communication Networking: An

Analytical Approach, Morgan Kaufman Publ.

5. D. Bertsekas and R. Gallager, Data Networks*,* Prentice Hall of India.

6. Ross, K.W., Multiservice Loss Models for Broadband Telecommunication

Networks, SpringerVerlag.

7. Walrand, J., An Introduction to Queueing Networks, Prentice Hall.

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| **COURSE NO:** 08EC7021( A) **COURSE TITLE : Markov Modeling and Queuing Theory (L-T-P : 3-0-0) CREDITS:3** | | |
| **MODULES** | **Contact**  **hours** | **Sem.Exam**  **Marks;%** |
| MODULE : 1  Stochastic Processes: Renewal Processes - Reward and Cost Models, Poisson Process; Point Processes; Regenerative Processes; Renewal Theorems. | 10 | 25 |
| MODULE : 2  Markov Models: Discrete Time Markov Chain - Transition Probabilities, Communication Classes, Irreducible Chains; Continuous Time Markov Chain -Pure-Jump Continuous-Time Chains, Regular Chains, Birth and Death Process, Semi-Markov Processes. | 10 | 25 |
| **FIRST INTERNAL TEST** |  |  |
| MODULE : 3  Single Class Queuing Networks: Simple Markovian queues; M/G/1 queue; G/G/1 queue; Open queuing networks; Closed queuing networks; Mean value analysis | 5 | 10 |
| MODULE : 4Multi-class Queuing Networks: Multi-class traffic model; Service time distributions; BCMP networks; Priority systems. | 5 | 10 |
| **SECOND INTERNAL TEST** |  |  |
| MODULE : 5  Time Delays in Queuing Networks: Time delays in single server queue; Time delays in networks of queues; | 6 | 15 |
| MODULE : 6Blocking in Queuing Networks :Types of Blocking; Two finite queues in a closed network; Aggregating Markovian states. | 6 | 15 |

**Course No:** 08EC7021 (B) **Course Title:** Space Time Coding & MIMO Systems

**Credits:** 3-0-0: 3 **Year :**2015

***Course objective:***

Purpose of the course is to provide a comprehensive coverage of space time coding techniques for multiple input,multiple-output (MIMO) communication systems.

***Syllabus:***

MIMO chaneel models-capacity of MIMO channels-Ergodic and outage capacity- Space Time Diversity Aspects - Sources and types of diversity-analysis under different fading conditions- Space Time receivers- Space Time Block Codes- Alamouti's code for two transmit antennas- Code Design Criteria for quasi-static Channels- Orthogonal Designs- Space Time Trellis Codes

***Course Outcomes:***

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

* Analyse a MIMO system
* Apply space time block codes and analyse the performance of the system

-**References:**

1.A. Paulraj, R. Nabar and D. Gore , “Introduction to Space Time Wireless

Communications”, Cambridge University press.

2.B.Vucetic and J. Yuan, Space-Time Coding, John Wiley, 2003.

3.E.G. Larsson and P. Stoica, “Space-Time Block Coding for Wireless Communications”,

Cambridge University press.

4 .H. Jafarkhani, “Space-Time Coding: Theory and Practice”, Cambridge University

press

5.D. Tse and P. Viswanath, “Fundamentals of Wireless Communication”, Cambridge

University press.

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| **COURSE NO:** 08EC7021( B) **COURSE TITLE : Space Time Coding & MIMO Systems (L-T-P : 3-0-0) CREDITS:3** | | |
| **MODULES** | **Contact**  **hours** | **Sem.Exam**  **Marks;%** |
| MODULE : 1  **Information theoretic aspects of MIMO**  Review of SISO communication - MIMO channel models - Classical i.i.d. and extended channels -Frequency selective and correlated channel models - Capacity of MIMO channels - Ergodic and Outage Capacity - Capacity bounds - Influence of channel properties on capacity. | 10 | 25 |
| MODULE : 2  **MIMO Diversity and Spatial Multiplexing**  Space Time Diversity Aspects - Sources and types of diversity - analysis under Rayleigh fading – Diversity and Channel knowledge - MIMO Spatial multiplexing - | 6 | 20 |
| **FIRST INTERNAL TEST** |  |  |
| MODULE : 3  Space Time receivers - ML - MMSE - ZF – Sphere decoding - BLAST receivers - DMG tradeoff in MIMO systems. | 5 | 10 |
| MODULE : 4  **Space Time Block Codes-**Alamouti's code for two transmit antennas - Comparison with dual-branch receive diversity STBC based on real/complex orthogonal designs - | 6 | 15 |
| **SECOND INTERNAL TEST** |  |  |
| MODULE : 5  Code Design Criteria for quasi-static Channels (Rank, Determinant and Euclidean Distance) - Orthogonal Designs - Generalized Orthogonal Designs -. Representation of STTC- shift register, generator matrix, state-transition diagram, trellis | 9 | 20 |
| MODULE : 6  **Space Time Trellis Codes**  Diagram - Code construction. Delay diversity as a special case of STTC- Performance Analysis. | 6 | 10 |

**Course No:** 08EC7021 (C) **Course Title:** Multimedia Compression Techniques **Credits:** 3-0-0: 3 **Year :**2015

***Course Objective:***

*The course will impart*  important approaches to data and multimedia compression, along with some of the practical techniques needed to construct data compression and reliability.

***Syllabus:***

Fundamental Concepts in Video and Digital Audio- Need for Compression - Text Compression techniques- Audio Compression techniques- Basic sub-band coding- Image Compression techniques- JPEG Standard – Sub-band coding algorithms: Design of Filter banks- Video Compression techniques**-** DVI technology

***Course outcomes:***

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

* understand the techniques for text, image, audio and video compression
* apply existing compression standards and compression utilities available
* to appreciate the mathematical impact on the evolution of technology.

***References:***

1.Khalid Sayood : Introduction to Data Compression, Morgan Kauffman Harcourt India, 2nd Edition, 2000.

2. David Salomon : Data Compression – The Complete Reference, Springer Verlag New York Inc., 2nd Edition, 2001.

3. Yun Q.Shi, Huifang Sun : Image and Video Compression for Multimedia Engineering - Fundamentals, Algorithms & Standards, CRC press, 2003.

4. Peter Symes : Digital Video Compression, McGraw Hill Pub., 2004.

5. Mark S.Drew, Ze-Nian Li : Fundamentals of Multimedia, PHI, 1st Edition, 2003.

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| **COURSE NO:** 08EC7021(C) **COURSE TITLE : Multimedia Compression Techniques (L-T-P : 3-0-0) CREDITS:3** | | |
| **MODULES** | **Contact**  **hours** | **Sem.Exam**  **Marks;%** |
| MODULE : 1  **Introduction-**  Special features of Multimedia – Graphics and Image Data Representations –Fundamental Concepts in Video and Digital Audio – Storage requirements for multimedia applications -  Need for Compression - Taxonomy of compression techniques – Overview of source coding, source models,scalar and vector qua ntization theory – Evaluation techniques –Error analysis and methodologies | 8 | 20 |
| MODULE : 2 **Text Compression-**  Compaction techniques – Huffmann coding – Adaptive Huffmann coding – Arithmatic coding-  Shannon-Fano coding – Dictionary techniques – LZW family algorithms | 6 | 15 |
| **FIRST INTERNAL TEST** |  |  |
| MODULE : 3 **Audio Compression-** Audio compression techniques - μ- Law and A- Law companding. Speech compression waveform codecs-source codecs- hybrid codecs-Shorten compressor, Frequency domain and filtering –Basic sub-band coding – | 6 | 20 |
| MODULE : 4  Application to speech coding – G.722 –Application to audio coding –MPEG audio, progressive encoding for audio – Silencecompression, speech compression techniques – Formant and CELP Vocoders. | 5 | 10 |
| **SECOND INTERNAL TEST** |  |  |
| MODULE : 5  **Image Compression**Predictive techniques – DM, PCM, DPCM: Optimal Predictors and Optimal Quantization–Contour based compression – Transform Coding – JPEG Standard – Sub-band coding algorithms: Design of Filter banks – Wavelet based compression: Implementation using filters – EZW, SPIHT coders –JPEG 2000 standards – JBIG, JBIG2 Standards | 10 | 20 |
| MODULE : 6 **Video Compression-** Video compression techniques and standards – MPEG Video Coding I: MPEG – 1 and 2 MPEG Video Coding II: MPEG – 4 and 7 – Motion estimation and compensation techniques –H.261 Standard – DVI technology – PLV performance – DVI real time compression – Packet Video. | 7 | 15 |

**Course No:** 08EC7021 (D) **Course Title:** Ultra Wide Band Communication **Credits:** 3-0-0: 3 **Year :**2015

***Course Objective:***

This course focuses on the basic signal processing techniques that concerns present and future dynamic UWB communication systems. This course encompasses all areas of design and implementation of UWB systems.

Syllabus:

UWB signals and systems with UWB waveforms- signal processing techniques for UWB systems nd UWB channel modelling-UWB multipath channel model -UWB communications and advanced WB pulse generation- UWB transmitter/receiver – Multiple access techniques in UWB – Capacity of WB systems -UWB antennas and arrays, position and location with UWB signals- – Conventional antennas and Impulse antennas for UWB systems -UWB communication standards and advanced topics in UWB communication systems

-***Course Outcomes:***

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

* develop a comprehensive overview of UWB system
* design that spans propagation, transmit and receive antenna implementations, standards and advanced topics, modulation and multiple access, network issues, and applications.

**REFERENCES**

1. M. Ghavami, L. B. Michael and R. Kohno, *“Ultra Wideband signals and systems in*

*Communication Engineering”*, 2nd Edition, John Wiley & Sons, NY, USA, 2007.

2. Jeffrey H. Reed, *“An Introduction to Ultra Wideband Communication systems”,* Prentice Hall Inc., NJ, USA, 2012.

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| **COURSE NO:** 08EC7021( D) **COURSE TITLE : Ultra Wideband Communication Systems (L-T-P : 3-0-0) CREDITS:3** | | |
| **MODULES** | **Contact**  **hours** | **Sem.Exam**  **Marks;%** |
| MODULE : 1 UWB Signals And Systems With UWB WaveformsIntroduction – Power spectral density – Pulse shape – Pulse trains – Spectral masks – Multipath –Penetration haracteristics – Spatial and spectral capacities – Speed of data transmission – Gaussian waveforms – Designing waveforms for specific spectral masks – Practical constraints and effects of imperfections. | 8 | 20 |
| MODULE : 2 Signal Processing Techniques For UWB Systems And Uwb Channel Modeling  Effects of a lossy medium on a UWB transmitted signal – Time domain analysis – Frequency domain techniques – A simplified UWB multipath channel model – Path loss model – Two-ray UWB propagation model – Frequency domain autoregressive model. | 8 | 20 |
| **FIRST INTERNAL TEST** |  |  |
| MODULE : 3**- UWB** Communications And Advanced UWB Pulse Generation  UWB modulation methods – Pulse trains – UWB transmitter/receiver – Multiple access techniques in UWB – Capacity of UWB systems – Comparison of UWB with other wideband communication systems – | 5 | 10 |
| MODULE : 4**-**  Interference and coexistence of UWB with other systems – Hermite pulses – Orthogonal prolate spheroidal wave functions – Wavelet packets in UWB PSM – Applications of UWB communication systems. | 5 | 10 |
| **SECOND INTERNAL TEST** |  |  |
| MODULE : 5 **UWB** antennas and arrays, position and location with UWB signals  Antenna fundamentals – Antenna radiation for UWB signals – conventional antennas and Impulse antennas for UWB systems – Beamforming for UWB signals – Radar UWB array systems –  Wireless positioning and location – GPS techniques – Positioning techniques – Time resolution issues – UWB positioning and communications | 8 | 20 |
| MODULE : 6  **-** UWB Communication Standards And Advanced Topics In UWB Communication SystemsUWB standardization in wireless personal area networks – DS-UWB proposal – MB-OFDM UWB proposal – IEEE proposals for UWB channel models – UWB ad-hoc and sensor networks –M IMO and Space-time coding for UWB systems – Self interference in high data-rate UWB communications – Coexistence of DS-UWB with WIMAX | 8 | 20 |

**COURSE NO:** 08EC7031 **COURSE TITLE Seminar (L-T-P : 0-0-2) CREDITS:2**

**Objective:**

*To assess the debating capability of the student to present a technical topic. Also to impart training to a student to face audience and present his/her ideas and thus creating self esteem and courage that are essential for an engineer.*

Students have to register for the seminar and select a topic in recent trends in communication and signal processing in consultation with any faculty member offering courses for the programme. The seminar topic must be related with the project undertaken. A detailed write-up on the topic of the seminar is to be prepared in the prescribed format given by the Department. The seminar shall be of 30 minutes duration followed by 10 minutes for discussion and a committee with the Head of the department as the chairman and two faculty members from the department as members shall evaluate the seminar based on the coverage of the topic, presentation and ability to answer the questions put forward by the committee.

**COURSE NO:** 08EC7041 **COURSE TITLE :** Project (Phase-1) **(L-T-P : 0-0-8) CREDITS:6**

**Objective:**

*To improve the professional competency and research aptitude by touching the areas which otherwise not covered by theory or laboratory classes. The project work aims to develop the work practice in students to apply theoretical and practical tools/techniques to solve real life problems related to industry and current research.*

The project work can be a design project / experimental project and or computer simulation project on chemical engineering or any of the topics related with chemical engineering stream. The project work is allotted individually on different topics. The students shall be encouraged to do their project work in the parent institute itself. If found essential, they may be permitted to continue their project outside the parent institute subject to the conditions in clause 10 of M.Tech regulations. Department will constitute an Evaluation Committee to review the project work. The Evaluation committee consists of at least three faculty members of which internal guide and another expert in the specified area of the project shall be two essential members.

The student is required to undertake the masters research project phase-I during the third

semester and the same is continued in the 4th semester.(Phase-II). Phase-I consists of preliminary thesis work, two reviews of the work and the submission of preliminary report. First review would highlight the topic, objectives, methodology and expected results. Second review evaluates the progress of the work, preliminary report and scope of the work which is to be completed in the 4th semester.

**SEMESTER IV**

**COURSE NO:** 08EC7012 **COURSE TITLE :** Project (Phase-2) **(L-T-P : 0-0-21) CREDITS:12**

**Objectives:**

*To improve the professional competency and research aptitude by touching the areas which otherwise not covered by theory or laboratory classes. The project work aims to develop the work practice in students to apply theoretical and practical tools/techniques to solve real life problems related to industry and current research*.

Masters Research project phase-II is a continuation of project phase-I started in the third semester. Before the end of the fourth semester, there will be two reviews, one at middle of the fourth semester and other towards the end. In the first review, progress of the project work done is to be assessed. In the second review, the complete assessment (quality, quantum and authenticity) of the Thesis is to be evaluated. Both the reviews should be conducted by guide and Evaluation committee.

This would be a pre qualifying exercise for the students for getting approval for the submission of the thesis. At least one technical paper is to be prepared for possible publication in National/International journal or conferences.The technical paper is to be submitted along with the thesis. The final evaluation of the project will be external evaluation.