SEMESTER-II

CORE SUBJECTS

08 EC 6212	**WIRELESS COMMUNICATION** *Hours/Week: Lecture – 3 hours*	**Credits – 3**

Course Objectives:

This course gives a thorough treatment of the principles of Wireless Mobile communication. Upon completion of the course, the student will have knowledge about

- *Different types of fading in wireless channels and their mitigation*
- *Diversity schemes and MIMO channels*
- *Cellular communication systems – GSM and CDMA*
- *Cellular communication standards*

Course outcomes

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

- *Analyze the Different types of fading in wireless channels and their mitigation*
- *Analyze the Diversity schemes and MIMO Channels*
- *Analyze the multiple access techniques.*
- *Analyze the cellular communication systems – GSM and CDMA*

Module I (6 hours)

Fading: Wireless Channel Models- path loss and shadowing models- statistical fading models- Narrow band and wideband fading models- Review of performance of digital modulation schemes over wireless channels

ModuleII (7 hours)

Diversity- Repetition coding and Time Diversity- Frequency and Space Diversity-Receive Diversity- Concept of diversity branches and signal paths- Combining methods- Selective diversity combining - Switched combining- maximal ratio combining-Equal gain combining- performance analysis for Rayleigh fading channels.

Module III (13 hours)

Fading Channel Capacity: Capacity of Wireless Channels- Capacity of flat and frequency selective fading channels- Multiple Input Multiple output (MIMO) systems- Narrow band multiple antenna system model- Parallel Decomposition of MIMO Channels- Capacity of MIMO Channels.

Module IV (13 hours)

Cellular Communication: Cellular Networks- Multiple Access: FDM/TDM/FDMA/TDMA- Spatial reuse- Co-channel interference Analysis- Hand over Analysis- Erlang Capacity Analysis- Spectral efficiency and Grade of Service- Improving capacity - Cell splitting and sectoring.

Module V (7 hours)

Spread spectrum and CDMA: Overview of CDMA systems: Direct sequence and frequency hoped systems-spreading codes-code synchronization-Channel estimation-power control-Multiuser detection- Spread Spectrum Multiple Access- CDMA Systems- Interference Analysis for Broadcast and Multiple Access Channels- Capacity of cellular CDMA networks- Reverse link power control- Hard and Soft hand off strategies.

Module VI (8 hours)

Cellular Wireless Communication Standards-Second generation cellular systems:
Brief discussion specifications on GSM, CDMA, Wideband CDMA, Wi-Fi, Wi-max
Introduction to multicarrier Communication: OFDM, MCCDMA

References:

1. Andrea Goldsmith, "Wireless Communications", Cambridge University press.
2. Simon Haykin and Michael Moher, " Modern Wireless Communications", Pearson Education.
3. T.S. Rappaport, "Wireless Communication, principles & practice".
4. G.L Stuber, "Principles of Mobile Communications", 2nd edition, Kluwer Academic Publishers.
5. Kamilo Feher, 'Wireless digital communication', PHI.
6. R.L Peterson, R.E. Ziemer and David E. Borth, "Introduction to Spread Spectrum Communication", Pearson Education.
7. A.J.Viterbi, "CDMA- Principles of Spread Spectrum", Addison Wesley.

Internal continuous assessment: 40 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of these. There will be a minimum of two tests in each subject.

End semester Examination: 60 marks

08 EC 6222	**ESTIMATION AND DETECTION** *Hours/Week: Lecture – 3 hours*	**Credits – 3**

Course Objectives:

Upon completion of this course, the students will have an understanding of the different criteria and methods used in detection theory, Methods and measures ofestimation, Properties and characteristics of estimators and principles of state estimation.

Course Outcomes:

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

- *Analyze the Signal detection in the presence of noise*
- *Apply the concepts of estimation and detection in various signal processing applications.*

Module I (8 hours)

Detection theory: Binary decisions - Single observation. Maximum likelihood decision criterion; Neymann-Pearson criterion; Probability of error criterion

Module II (9 hours)

Bayes risk criterion; Minimax criterion; Robust detection; Receiver operating characteristics. Binary decisions - Multiple observations

Module III (9 hours)

Vector observations- The general Gaussian problem
Waveform observation in additive Gaussian noise; The integrating optimum receiver; Matched filter receiver.

Module IV (10 hours)

Estimation theory: Methods
Maximum likelihood estimation; Bayes cost method Bayes estimation criterion - Mean square error criterion; Uniform cost function; absolute value cost function Linear minimum variance - Least squares method; Estimation in the presence of Gaussian noise - Linear observation; Non-linear estimation.

Module V (9 hours)

Properties of estimators: Bias, E_ciency, Cramer Rao bound Asymptotic properties; Sensitivity and error analysis.
State estimation: Prediction; Kalman filter

Module VI (9 hours)

Sufficient statistics and statistical estimation of parameters: Concept of sufficient statistics; Exponential families of distributions; Exponential families and Maximum likelihood estimation; Uniformly minimum variance unbiased estimation.

References:

2. James L. Melsa and David L. Cohn, "Decision and Estimation Theory," McGraw Hill.
3. Dimitri Kazakos, P. Papantoni Kazakos, "Detection and Estimation," Computer Science Press.
4. Steven M. Kay, "Statistical Signal Processing: Vol. 1: Estimation Theory, Vol. 2: Detection Theory," Prentice Hall Inc.
5. Harry L. Van Trees, "Detection, Estimation and Modulation Theory, Part 1," John Wiley & Sons Inc.
6. Jerry M. Mendel, "Lessons in Estimation Theory for Signal Processing, Communication and Control," Prentice Hall Inc.
7. Sophocles J. Orfanidis, "Optimum Signal Processing," 2 nd edn., McGraw Hill.
8. Monson H. Hayes, "Statistical Digital Signal Processing and Modelling," John Wiley & Sons Inc.

Internal continuous assessment: 40 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of these. There will be a minimum of two tests in each subject.

End semester Examination: 60 marks

08 EC 6232	**CODING THEORY** *Hours/Week::Lecture – 3 hours*	**Credits – 3**

Course Objectives:

Provides a thorough understanding of the theory and design of Channel codes for error control. The course begins with an introduction to the basic Mathematical concepts and develops systematically through Linear block codes to the Convolutional Codes.

Course Outcomes:

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

- *Analyze the channel coding methods*
- *Apply various coding and evaluate their performance.*

Module I (9 hours)

Introduction to algebra: Groups- Rings- Fields- Binary Field arithmetic-Arithmetic of Galois Field- Integer Ring- Finite Field based on Integer Ring- Polynomial Rings- Finite Field based on Polynomial Rings-Primitive elements- Construction and basic properties of Finite Fields- Computations using Galois Field arithmetic

Module II (9 hours)

Vector spaces- Vector subspaces- Linear independence. Linear Block Codes Matrix description of Linear Block codes- Minimum Distance of a Block code-- Error detecting and correcting capabilities of a Block code- Standard Array and Syndrome decoding

Module III (9 hours)

Hamming codes- Perfect and Quasi-perfect codes- Extended codes- Hadamard codes- Binary Golay codes- BCH codes-Performance- Decoding of BCH codes, Reed Solomon codes-Encoding and Decoding

Module IV (9 hours)

Cyclic Codes: Polynomial description-Minimal polynomial and conjugates- Generator and parity-Check matrices of cyclic codes- Encoding of cyclic codes- Syndrome computation- Error detection - decoding of cyclic codes- Cyclic Hamming codes

Module V (9 hours)

Convolutional Coding: Structural properties-Encoders for convolutional coding – State representation and the state diagram- The Tree diagram - The Trellis diagram- Transfer function of a Convolutional code – Systematic and Non-systematic Convolutional codes – Catastrophic error propagation in Convolutional codes

Module VI (9 hours)

Maximum likelihood decoding of Convolutional codes – Hard versus Soft decision decoding - The Viterbi Algorithm – Sequential decoding – Concept of interleaving – Block interleaving –Convolutional interleaving – Concatenated codes-Turbo codes – Basic concepts – Encoding with recursive systematic codes.

References :

1. Shu Lin and Daniel. J. Costello Jr., "Error Control Coding: Fundamentals and applications", Prentice Hall Inc.
2. R.E. Blahut, "Theory and Practice of Error Control Coding", MGH.
3. W.C. Huffman and Vera Pless, "Fundamentals of Error correcting codes", Cambridge University Press.
4. Rolf Johannesson, Kamil Sh. Zigangirov, "Fundamentals of Convolutional Coding", Universities Press (India) Ltd.
5. Sklar, ' Digital Communication', Pearson Education.

Internal continuous assessment: 40 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of these. There will be a minimum of two tests in each subject.

End semester Examination: 60 marks

ELECTIVE II

08 EC 6242 (A)	**MULTIRATE SIGNAL PROCESSING AND FILTER BANKS** *Hours/Week: Lecture – 3 hours*	**Credits – 3**

Course Objectives:

Upon completion this course, the student will have deep understanding of the theory, design and applications of

- *QMF banks*
- *Perfect Reconstruction filters*
- *Cosine modulated Filter banks.*

Course Outcomes:

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

- *Design various filter banks*
- *Apply various filter banks*

Module I (9 Hours)

Fundamentals of Multirate Theory: The sampling theorem - sampling at sub- Nyquist rate - Basic Formulations and schemes - Basic Multirate operations- Decimation and Interpolation - Digital Filter Banks- DFT Filter Bank- Identities

Module II (9 Hours)

Maximally decimated filter banks: Polyphase representation - Errors in the QMF bank- Perfect Reconstruction (PR) QMF Bank - Design of an alias free QMF Bank

Module III (9 Hours)

M-channel perfect reconstruction filter banks: Uniform band and non uniform filter bank - tree structured filter bank- Errors created by filter bank system- Polyphase representation- perfect reconstruction systems

Module IV (8 Hours)

Perfect reconstruction (PR) filter banks: Para-unitary PR Filter Banks- Filter Bank Properties induced by paraunitarity- Two channel FIR paraunitary QMF Bank-

Module V (8 Hours)

Linear phase PR Filter banks- Necessary conditions for Linear phase property- Quantization Effects: -Types of quantization effects in filter banks. - coefficient sensitivity effects, dynamic range and scaling.

Module VI (11 Hours)

Cosine Modulated filter banks: Cosine Modulated pseudo QMF Bank- Alas cancellation- phase - Phase distortion- Closed form expression- Polyphase structure- PR Systems.

References:

1. P.P. Vaidyanathan. “Multirate systems and filter banks.” Prentice Hall. PTR.
2. N.J. Fliege. “Multirate digital signal processing .” John Wiley.
3. Sanjit K. Mitra. “ Digital Signal Processing: A computer based approach.” McGrawHill
4. R.E. Crochiere. L. R. “Multirate Digital Signal Processing”, Prentice Hall. Inc.

5. J.G. Proakis. D.G. Manolakis. “Digital Signal Processing: Principles. Algorithms and Applications”, 3rd Edn. Prentice Hall India.

Internal continuous assessment: 40 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of these. There will be a minimum of two tests in each subject.

End semester Examination: 60 marks

08 EC 6242(B)	**SPECTRAL ANALYSIS OF SIGNALS** *Hours/Week: Lecture – 3 hours*	**Credits – 3**

Course Objectives:

This course deals with the different methods for Power Spectrum Estimation. Upon completion of this course, students will be well versed with

- *Power and Energy spectral density of signals*
- *Parametric and non parametric methods of estimation of PSD*
- *Filter bank methods of spectral analysis.*

Course Outcomes:

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

- *Analyze the Power and Energy spectral density of signals*
- *Analyze the Filter bank methods of spectral analysis.*

Module I (12 Hours)

Power Spectral Density: Energy spectral density of deterministic signals, Power spectral density of random signals, Properties of PSD.

Module II (7 Hours)

PSD Estimation - Non-parametric methods : Estimation of PSD from finite data, Non-parametric methods : Periodogram properties, bias and variance analysis, Blackman-Tuckey method

Module III (7 Hours)

Window design considerations, time-bandwidth product and resolution - variance trade-offs in window design, Refined periodogram methods : Bartlet method, Welch method.

Module IV (8 Hours)

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, Two stage least square method, Burg method for AR parameter estimation.

Module V (7 Hours)

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, Min-norm method, ESPIRIT method.

Module VI (13 Hours)

Filterbank methods: Filterbank interpolation of periodogram, Slepia base-band filters, refined filterbank method for higher resolution spectral analysis, Capon method, Introduction to higher order spectra.

References:

1.Introduction to Spectral Analysis, Stoica , R.L. Moses, Prentice Hall
2.Modern Spectral Estimation Theory & Applications, Kay SM, Prentice Hall
3 Marple, Introduction to Spectral Analysis, Prentice Hall

Internal continuous assessment: 40 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of these. There will be a minimum of two tests in each subject.

End semester Examination: 60 marks

08 EC 6242 (C)	**SPREAD SPECTRUM AND CDMA SYSTEMS** *Hours/Week: Lecture – 3 hours*	**Credits – 3**

Course Objectives:

Upon completion of this course, students will have deep insight on spread spectrum communication systems. The course imparts knowledge about principle of spread spectrum and use of orthogonal codes, performance of CDMA systems under AWGN and fading channels, use of CDMA systems in cellular communication and important CDMA standards.

Course Outcomes:

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

- *Generate various spreading sequences and codes.*
- *Comment about the feasibility of given Spread Spectrum system from its performance analysis.*
- *Provide solutions to various issues present in Spread Spectrum systems.*

Module I (7 Hours)

Introduction to spread spectrum communication, pulse noise jamming, low probability of detection, direct sequence spread spectrum, frequency-hopping and time-hopping spread spectrum systems, correlation functions

Module II (7 Hours)

Spreading sequences- maximal-length sequences, gold codes, Walsh orthogonal codes- properties and generation of sequences Synchronization and Tracking: delay lock and tau-dither loops, coarse synchronization- principles of serial search and match filter techniques.

Module III (13 Hours)

Performance of spread spectrum system under AWGN, multi-user Interference, jamming and narrow band interferences Low probability of intercept methods, optimum intercept receiver for direct sequence spread spectrum, Error probability of DS-CDMA system under AWGN and fading channels, RAKE receiver

Module IV (8 Hours)

Basics of spread spectrum multiple access in cellular environments, reverse Link power control, multiple cell pilot tracking, soft and hard handoffs, cell coverage issues with hard and soft handoff, spread spectrum multiple access outage, outage with imperfect power control, Erlang capacity of forward and reverse links.

Module V (6 Hours)

Multi-user Detection -MF detector, decorrelating detector, MMSE detector. Interference Cancellation: successive, Parallel Interference Cancellation, performance analysis of multiuser detectors and interference cancellers.

Module VI (13 Hours)

General aspects of CDMA cellular systems, IS-95 standard, Downlink and uplink, Evolution to Third Generation systems, WCDMA and CDMA-2000 standards, Principles of Multicarrier communication, MCCDMA and MC-DS-CDMA.

References:

1. R. L. Peterson, R. Ziemer and D. Borth, "Introduction to Spread Spectrum Communications," Prentice Hall.
2. A. J. Viterbi, "CDMA - Principles of Spread Spectrum Communications,"

Addison-Wesley.
3. Vijay K. Garg, Kenneth Smolik, Joseph E. Wilkes, Applications of CDMA in Wireless/Personal Communications, Prentice Hall.
4. S. Verdu, “ Multiuser Detection” , Cambridge University Press.
5. M. K. Simon, J. K. Omura, R. A. Scholts and B. K. Levitt, “ Spread Spectrum Communications Handbook”, McGraw- Hill.
6. Cooper and McGillem, “Modern Communications and Spread Spectrum” McGraw- Hill.
7. J. G. Proakis, “Digital Communications,” McGraw Hill, 4th ed.
8. S. Glisic and B. Vucetic, “Spread Spectrum CDMA Systems for Wireless Communications,” Artech House,

Internal continuous assessment: 40 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of these. There will be a minimum of two tests in each subject.

End semester Examination: 60 marks

08 EC 6242 (D)	**MARKOV MODELING AND QUEUEING THEORY** *Hours/Week: Lecture – 3 hours*	**Credits – 3**

Course Objectives:

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.

Course Outcomes:

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

- *Analyze the Markov chains and Markov models of systems*
- *Apply Markov models in the analysis of queuing networks.*

Module I (14 Hours)

Stochastic Processes: Renewal Processes - Reward and Cost Models, Poisson Process; Point Processes; Regenerative Processes; Renewal Theorems.

Module II (7 Hours)

Markov Models: Discrete Time Markov Chain - Transition Probabilities, Communication Classes, Irreducible Chains

Module III (7 Hours)

Continuous Time Markov Chain - Pure-Jump Continuous-Time Chains, Regular Chains, Birth and Death Process, Semi-Markov Processes.

Module IV (7 Hours)

Single Class & Multi-class Queuing Networks: Simple Markovian queues; M/G/1 queue; G/G/1 queue; Open queuing networks; Closed queuing networks

Module V (6 Hours)

Mean value analysis; Multi-class traffic model; Service time distributions; BCMP networks; Priority systems.

Module VI (13 Hours)

Time Delays and Blocking in Queuing Networks: Time delays in single server queue; Time delays in networks of queues; Types of Blocking; Two finite queues in a closed network; Aggregating Markovian states.

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

8. Cinlar, E., Introduction to Stochastic processes, Prentice Hall.
9. Karlin, S. and Taylor, H., A First course in Stochastic Processes, 2nd edition Academic press.

Internal continuous assessment: 40 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of these. There will be a minimum of two tests in each subject.

End semester Examination: 60 marks

ELECTIVE III

08 EC 6252 (A)	**COMMUNICATION SWITCHING THEORY** *Hours/Week: Lecture – 3 hours*	**Credits – 3**

Course Objectives:

Upon completion of this course, the students will have a deep knowledge about the Communication switching methods, blocking in switching networks, traffic analysis and multiplexing systems.

Course Outcomes:

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

- *Analyze the the communication switching methods*
- *Analyze the traffic and lost calls*
- *Analyze the blocking in switching networks, traffic analysis and multiplexing systems.*

Module I (8 Hours)

Switching: Performance and architectural issues: Packet switches- Circuit switches. Time and Space division switching - Point to point circuit switching - multistage switching network - Paull's matix for representing connections - Strict sense non- blocking Clos network.

Module II (6 Hours)

Generalized circuit switching- Cross Point Complexity (CPC)- Fast packet switching- Self routing Banyan networks- Combinatorial limitations of Banyan networks.

Module III (9 Hours)

Types of blocking for a packet switch- Output conflicts- HOL blocking.

Traffic analysis: Traffic measurements, arrival distributions, Poisson process, holding/service time distributions, loss systems, lost calls cleared – Erlang-B formula, lost calls returning and lost calls held models, lost calls cleared and held models with finite sources, delay systems, Little's theorem, Erlang-C formula , M/G/1 model.

Module IV (5 Hours)

Blocking probability: Analysis of single stage and multistage networks –Blocking for Unique path routing- Alternate path routing- The Lee approximation – The Jacobaeus method.

Module V (13 Hours)

Multiplexing: Network performance and source characterization; Stream sessions in packet networks - deterministic analysis, stochastic analysis, circuit multiplexed networks.

Module VI (13 Hours)

Statistical multiplexing: blocking analysis in circuit multiplexed networks, with single rate or Multirate traffic- Models for performance analysis of integrated packet networks; deterministic models, worst case analysis; stochastic models, large deviations analysis.

The effective Bandwidth approach for Admission control - Models for traffic flow in packet networks, long range dependence and self similar processes.

References:

1. A. Kumar, D. Manjunath, J. Kuri, Communication Networking: An Analytical

Approach, Morgan Kaufman Publishers.
2. Hui, J.Y., Switching and Traffic Theory for Integrated Broadband Networks, Kluwer.

Internal continuous assessment: 40 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of these. There will be a minimum of two tests in each subject.

End semester Examination: 60 marks

08 EC 6252 (B)	**WAVELETS THEORY** *Hours/Week: Lecture – 3 hours*	**Credits – 3**

Course Objectives:

This course provides the students with a thorough foundation of Wavelet theory, construction of wavelets and their applications in signal analysis.

Course Outcomes:

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

- *Use Fourier tools to analyze signals*
- *Analyze the MRA and representation using wavelet bases*
- *Analyze the various wavelet transforms and design wavelet transform*

Module I (7 Hours)

Fourier and Sampling Theory, Generalized Fourier theory, Fourier transform, Short- time (windowed) Fourier transform, Time-frequency analysis, Fundamental notions of the theory of sampling.

Module II (7 Hours)

Theory of Frames: Bases, Resolution of unity, Definition of frames, Geometrical considerations and the general notion of a frame, Frame projector, Example – windowed Fourier frames.

Module III (7 Hours)

Wavelets: The basic functions, Specifications, Admissibility conditions, Continuous wavelet transform (CWT), Discrete wavelet transform (DWT). The multiresolution analysis , MRA axioms, Construction of an MRA from scaling functions - The dilation equation and the wavelet equation

Module IV (7 Hours)

Compactly supported orthonormal wavelet bases - Necessary and sufficient conditions fororthonormality.

Regularity and selection of wavelets: Smoothness and approximation order - Analysis in Soboleve space, Criteria for wavelet selection with examples.

Module V (13 Hours)

Splines, Cardinal B-spline MRA, Subband filtering schemes, Compactly supported orthonormal wavelet bases. Wavelet decomposition and reconstruction of functions in L^2(□). Fast wavelet transform algorithms - Relation to filter banks, Wavelet packets – Representation of functions, Selection of basis.

Module VI (13 Hours)

Biorthogonality and biorthogonal basis, Biorthogonal system of wavelets - construction, The Lifting scheme.

References:

1. Stephen G. Mallat, “A wavelet tour of signal processing” 2nd Edition Academic Press.
2. M. Vetterli, J. Kovacevic, “Wavelets and subband coding” Prentice Hall Inc.
3. Gilbert Strang and Truong Q. Nguyen, “Wavelets and filter banks” 2nd Edition

Wellesley- Cambridge Press.
4. Gerald Kaiser, "A friendly guide to wavelets" Birkhauser/Springer International Edition.
5. L. Prasad and S. S. Iyengar, "Wavelet analysis with applications to image processing" CRC Press.
6. J. C. Goswami and A. K. Chan, "Fundamentals of wavelets: Theory, Algorithms and Applications" Wiley-Interscience Publication, John Wiley & Sons.
7. Mark A. Pinsky, "Introduction to Fourier Analysis andWavelets" Brooks/Cole Series in Advanced Mathematics.
8. Christian Blatter, "Wavelets: A primer" A. K. Peters, Massachusetts.
9. M. Holschneider, "Wavelets: An analysis tool" Oxford Science Publications.
10. R. M. Rao and A. Bopardikar, "Wavelet transforms: Introduction to theory and applications" Addison-Wesley.
11. Ingrid Daubechies, "Ten lectures on wavelets" SIAM.
12. H. L. Resnikoff and R. O. Wells, Jr., "Wavelet analysis: The scalable structure of information"

Internal continuous assessment: 40 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of these. There will be a minimum of two tests in each subject.

End semester Examination: 60 marks

08 EC 6252 (C)	**COMMUNICATION NETWORKS** *Hours/Week: Lecture – 3 hours*	**Credits – 3**

Course Objectives:

This course provides a deep knowledge on Internet architecture, Quality of service issues in broad band networks, and Statistical multiplexing of communication networks.

Course Outcomes:

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

- *Identify the type of networks and protocols for a given network scenario.*
- *Estimate the performance and throughput of a given network.*
- *Design a network aimed at optimum performance.*

Module I (10 Hours)

Internet Architecture: Architectural concepts in ISO's OSI layered model, layering in the Internet. TCP/IP protocol stack. Transport layer - TCP and UDP. Network layer - IP, routing, internetworking.

Module II (10 Hours)

Data link layer:- ARQ schemes, multiple access, LANs.
Broadband services and QoS issues: Quality of Service issues in networks- Integrated service architecture- Queuing Disciplines- Weighted Fair Queuing- Random Early Detection

Module III (8 Hours)

Broadband services and QoS issues: Differentiated Services- Protocols for QS support- Resource reservation - RSVP- Multi protocol Label switching- Real Time transport protocol.

Module IV (10 Hours)

Introduction to Queuing theory: Markov chain- Discrete time and continuous time Markov chains- Poisson process- Queuing models for Data gram networks- Little's theorem- M/M/1 queuing systems- M/M/m/m queuing models- M/G/1 queue- Mean value analysis.

Module V (8 Hours)

Statistical Multiplexing in Communication Networks: Multiplexing: Network performance and source characterization; Stream sessions in packet networks -

Module VI (8 Hours)

Statistical Multiplexing in Communication Networks: deterministic analysis, stochastic analysis, circuit multiplexed networks.

References:

1. James. F. Kurose and Keith.W. Ross, "Computer Networks, A top-down approach featuring the Internet", Addison Wesley.
2. D. Bertsekas and R. Gallager, "Data Networks".
3. S. Keshav, "An Engineering Approach to Computer Networking", Addison Wesley
4. Peterson L.L. & Davie B.S., "Computer Networks: A System Approach", Morgan Kaufman Publishers.
5. Anurag Kumar, D. Manjunath, and Joy Kuri, Communication Networking: An Analytical Approach, Morgan Kaufman Publ.

Internal continuous assessment: 40 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of these. There will be a minimum of two tests in each subject.

End semester Examination: 60 marks

08 EC 6252 (D)	**SYSTEM DESIGN USING EMBEDDED PROCESSORS** *Hours/Week: Lecture – 3 hours*	**Credits – 3**

Course Objectives:

Upon completion of this course, the students will be able to program and interface PIC microcontroller, design and implement systems using PIC microcontrollers, development of embedded systems, gain knowledge about real time operating systems.

Course Outcomes:

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

- *Program PIC microcontroller*
- *Design and implement systems using PIC microcontrollers*
- *Develop embedded systems*
- *Design real time operating systems*

Module I (8 hours)

Microcontroller: Brief history of the PIC microcontroller - PIC18 features and block diagram-PIC18 Architecture and assembly language Programming, SFRs, RISC architecture in the PIC, Branch, Call, Time delay loop, PIC I/O Port programming, addressing modes, look-up table and table processing, Bank switching in the PIC18,

Module II (6 hours)

Data types and time delays in C, I/O Port programming in C, Bit-addressable I/O programming, logic operations in C, Data conversion programs in C.

Module III (14 hours)

PIC Peripherals and Interfacing: PIC18 timer programming in assembly and C, Serial Port programming in assembly and C, Interrupt programming in assembly and C, ADC and DAC interfacing, CCP and ECCP programming, DC Motor interfacing and PWM.

Module IV (6 hours)

Introduction to Embedded Systems: Characteristics of Embedded systems, Software embedded into a system- Device Drivers and Interrupt Servicing mechanisms.

Module V (7 hours)

Inter-process Communication and Synchronisation of Processes, Tasks and Threads: Multiple Processes in an Application - Data sharing by multiple tasks and routines- Inter Process Communication

Module VI (13 hours)

Real Time Operating Systems:

Operating System Services, I/O Subsystems - Network Operating Systems - Real Time and Embedded System Operating systems

Interrupt routines in RTOS Environments - RTOS Task Scheduling models, Interrupt Latency and response Times - Standardization of RTOS - Ideas of Embedded Linux. Case study using ARM processor/PIC microcontroller

References:

1. PIC Microcontroller and Embedded Systems using assembly and C for PIC18 – Muhammad Ali Mazidi, Roind D. Mckinay, Danny Causey; Pearson Education.
2. Design with PIC microcontroller – John Peatman; Printice Hall
3. Rajkamal; "Embedded Systems Architecture; Programming and Design"; Tata McGraw Hill Publications.
4. Real-time Systems - Jane Liu, PH 2000
5. Real-Time Systems Design and Analysis : An Engineer's Handbook: Phillip A Laplante
6. Embedded Software Primer - Simon, David E.
7. Tornado API Programmers guide

Internal continuous assessment: 40 marks

Internal continuous assessment is in the form of periodical tests, assignments, seminars or a combination of these. There will be a minimum of two tests in each subject.

End semester Examination: 60 Marks

08 EC 6262 (P)	**MINI PROJECT** *Hours/Week: Practical- 4 hours*	**Credits – 2**

Course Objectives:
To develop project as per the detailed problem formulation. Perform analytical and comparative analysis of the developed system. Submit a report at the end of the semester covering details of all the phases of project preliminaries, project work and result. .

Guidelines:
1. Students are expected to take up any industry defined problem or research oriented definition as a Mini project.
2. Detail study of existing solutions for the selected topic must be done.
3. Students are required to implement/simulate existing solutions (algorithms/techniques/methods) for their selected topic.
4. Post-implementation work would include preparing a report including comparative study of implemented/simulated solutions and their results.

Evaluation:

Department will constitute an Evaluation Committee to review the project work. The concerned head of the department shall be the chairman of this committee. It shall have two senior faculty members from the same department and the project supervisor.

Internal continuous assessment: 100 marks

Progress evaluation by the project supervisor	:40 Marks
Presentation & evaluation by committee	:60 Marks

08 EC 6272 (P)	**ADVANCED COMMUNICATION LAB** *Hours/Week: Practical -2 hours*	**Credits – 2**

Course Objectives:

Upon completion, the students will

- *Be able to design enlisted experiments and implement using hardware*
- *Acquire sufficient expertise in simulating these systems using MATLAB*
- *Be able to design and implement self standing systems of their choice with sufficient complexity.*

Course Outcomes:

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

- *Implement and compare various modulation schemes*
- *Simulate various systems using MATLAB*
- *Simulate and implement signal processing techniques.*

Tools :

Numerical Computing Environments – GNU Octave or MATLAB or any other equivalent tool

List of Experiments:

1. Implementation of digital modulation schemes – BASK, BFSK, BPSK. Plot BER vs E_b / N_0. in AWGN channels.
2. Performance comparison of QPSK, DPSK, MSK & GMSK.
3. Communication over fading channels – Rayleigh fading & Rician fading channels.
4. Comparison of diversity combining techniques – SC, EGC & MRC.
5. Simulation of CDMA systems.
6. Implementation of Matched filter, Correlation receiver & Equalizer.
7. Gram Schmidt Orthogonalization of waveforms.
8. Carrier recovery and bit synchronization.
9. Implementation of multicarrier communication.
10. Plotting Eye pattern.
11. Constellation diagram of various digital modulation schemes.

Internal continuous assessment: 100 marks

Practical Records/Outputs: 40%

Regular Class Viva Voce: 20%

Final Test: 40%