KERALA TECHNOLOGICAL UNIVERSITY

(THRISSUR CLUSTER - 07)

SCHEME AND SYLLABI

of

M. TECH.

in

COMMUNICATION ENGINEERING & SIGNAL PROCESSING

OFFERING DEPARTMENT

ELECTRONICS & COMMUNICATION ENGINEERING

CLUSTER LEVEL GRADUATE PROGRAM COMMITTEE

1.	Dr Devdas Menon, Professor, IIT Madras, Chennai	Chairman
2	Principal, Government Engineering College Trichur, Thrissur	Convener
3	Principal, AXIS College of Engineering & Technology, East Kodaly, Murikkingal, Thrissur	Member
4	Principal, IES College of Engineering, Chittilappilly, Thrissur	Member
5	Principal, MET'S School of Engineering, Mala, Thrissur	Member
6	Principal, Royal College of Engineering & Technology, Akkikkavu, Thrissur	Member
7	Principal, Vidya Academy of Science & Technology, Thalakkottukara, Thrissur	Member
8	Principal, Thejus Engineering College, Vellarakkad, Erumappetty, Thrissur	Member
9	Principal, Universal Engineering College, Vallivattom, Konathakunnu, Thrissur	Member
10	Principal, Sahrdaya College of Engineering & Technology, Kodakara, Thrissur	Member

CERTIFICATE

This is to certify that

1. The scheme and syllabi are prepared in accordance with the regulation and guidelines issued by the KTU from time to time and also as per the decisions made in the CGPC meetings.
2. The suggestions/modifications suggested while presenting the scheme and syllabi before CGPC on 25.6.2015 have been incorporated.
3. There is no discrepancy among the soft copy in MS word format, PDF and hard copy of the syllabi submitted to the CGPC.
4. The document has been verified by all the constituent colleges.

Coordinator in charge of syllabus revision of the programme

(Name, designation and College Name)

Principal of the lead college

(Name and Name of the College)

Principals of the colleges in which the programme is offered

Name of the college	Principal's Name	Signature
Government Engineering College Trichur, Thrissur	Dr. K P Indiradevi	

Date: Chairman
Place:

VISION and MISSION of the Programme

VISION

To achieve academic excellence through quality education in the intertwined fields of Communication Engineering and Signal Processing

MISSION

To impart quality education by providing excellent learning and research environment, enabling the students to apply signal processing techniques innovatively to address the challenges in the rapidly growing field of communication engineering for the benefit of humanity.

PROGRAM EDUCATIONAL OBJECTIVES (PEOs)

a. To meet the requirements of talented Research and Development professionals solving real-life problems arising in the field of Electronics, Communication Engineering and Signal Processing.

b. To meet the requirements of faculty with specialization in Communication Engineering and Signal Processing in academic institutions.

c. To cater to the needs of engineering professionals in Signal Processing / Communication related IT sectors.

d. To foster the students' ability to think differently so that they develop into entrepreneurs, opening their own business enterprises.

e. To train our students to meet the requirements in the modern multi-disciplinary research scenario which is a blend of many conventional disciplines including Electronics, Mathematics, Biology, Optics, Mechanics and Medicine

PROGRAM OUTCOMES (POs)

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

A. Apply the knowledge gained from advanced Mathematics and Engineering courses to research problems in Communication Engineering and Signal Processing.

B. Design, Conduct or Simulate experiments in areas related to Communication Engineering and Signal Processing and critically analyze the results.

C. Design/Model Signal Processing algorithms/systems for research applications in Communication Engineering, conduct performance evaluation and comparison with the results reported in literature.

D. Function effectively in groups to undertake projects in interdisciplinary areas.

E. Perform identification and formulation of open research problems in the field of Communication Engineering in pursuance of possible solutions.

F. Understand the significance of professional and ethical responsibility.

G. Communicate effectively with the technical community and disseminate the knowledge acquired to the benefit of society.

H. Understand the impacts of technical solutions to engineering problems on the society.

I. Recognize the importance and need for an active and co-operative lifelong-learning attitude.

J. Understand the prevailing professional and societal issues.

K. Develop skills to apply modern engineering tools and techniques.

Scheme of M-Tech programme in Communication Engineering & Signal Processing

Semester I

Exam Slot	Course No:	Name	Hours/ Week			Internal Marks	End Semester Exam		Credits
			L	T	P		Marks	Duration (hrs)	
A	07MA 6013	Mathematics for Communication Engineering	4	0	0	40	60	3	4
B	07EC 6203	Advanced Digital Communication	4	0	0	40	60	3	4
C	07EC 6205	Information Theory	4	0	0	40	60	3	4
D	07EC 6207	Advanced Digital Signal Processing	3	0	0	40	60	3	3
E	07EC 62X9	Elective I	3	0	0	40	60	3	3
	07GN 6001	Research Methodology	0	2	0	100	0	0	2
	07EC 6211	Advanced Communication Engineering Lab	0	0	2	100	0	0	1
	07EC 6213	Introduction to seminar	0	0	1				
TOTAL			**18**	**2**	**3**	**400**	**300**		**21**

Semester II

Exam Slot	Course No:	Name	Hours/ Week			Internal Marks	End Semester Exam		Credits
			L	T	P		Marks	Duration (hrs)	
A	07EC 6202	Estimation and Detection	4	0	0	40	60	3	4
B	07EC 6204	Wireless Communication	3	0	0	40	60	3	3
C	07EC 6206	Real Time Digital Signal Processing	3	0	0	40	60	3	3
D	07EC 62X8	Elective II	3	0	0	40	60	3	3
E	07EC 62X2	Elective III	3	0	0	40	60	3	3
	07EC 6214	Seminar	0	0	2	100	0	0	2
	07EC 6216	Mini Project	0	0	4	100	0	0	2
	07EC 6218	Signal Processing Lab	0	0	2	100	0	0	1
TOTAL			**16**		**8**	**500**	**300**		**21**

Semester III

Exam Slot	Course No:	Name	Hours/Week			Internal Marks	End Semester Exam		Credits
			L	T	P		Marks	Duration (hrs)	
A	07EC 72X1	Elective IV	3	0	0	40	60	3	3
B	07EC 72X3	Elective V	3	0	0	40	60	3	3
	07EC 7205	Seminar	0	0	2	100	0	0	2
	07EC 7207	Project (Phase 1)	0	0	12	50	0	0	6
TOTAL			**6**		**14**	**230**	**120**		**14**

Semester IV

Exam Slot	Course No:	Name	Hours/Week			Internal Marks	End Semester Exam		Credits
			L	T	P		Marks	Duration (hrs)	
	07EC 7202	Project (Phase 2)	0	0	21	70	30		**12**

L – Lecture, T – Tutorial, P – Practical

Total number of credits for the PG Programme: 21+21+14+12 = 68

LIST OF ELECTIVE COURSES OFFERED

Semester I

Elective I

1. 07EC6209 Optimization Techniques
2. 07EC6219 Markov Modeling and Queuing Theory
3. 07EC6229 Digital Image Processing
4. 07EC6239 Biomedical Signal Processing
5. 07EC6249 R F System Design

Semester II

Elective II

1. 07EC6228 Multirate Signal Processing
2. 07EC6238 Adaptive Signal Processing
3. 07EC6248 Advanced Optical Communication
4. 07EC6258 Antenna theory and Design
5. 07EC6268 Multidimensional Signal Processing

Elective III

6. 07EC6222 Wavelets Theory and Applications
7. 07EC6232 Coding theory
8. 07EC6242 Communication Networks
9. 07EC6252 Computational Electromagnetics
10. 07EC6262 High Speed Digital Systems
11. 07EC6272 Spectrum Analysis of Signals

Semester III

Elective IV

1. 07EC7201 Transform Theory
2. 07EC7211 Wireless sensor networks
3. 07EC7221 Pattern recognition and Machine learning
4. 07EC7231 Speech and Audio Signal Processing
5. 07EC7241 Secure Communication

Elective V

6. 07EC7203 Cognitive and Software Defined Radio
7. 07EC7213Embedded System Design
8. 07EC7223Multimedia Compression Techniques
9. 07EC7233Linear System Theory
10. 07EC7243 Compressed Sampling: Principles and Algorithms

SYLLABI

Semester I

Core Courses

07MA 6013 MATHEMATICS FOR COMMUNICATION ENGINEERING

Credits: 4-0-0: 4 **Year :2015**

Prerequisite: Matrix theory and Probability theory

Course objectives

- To provide necessary basic concepts in statistical signal analysis.
- To study random processes and its properties
- To have an idea of vector spaces

Syllabus

Operations on random variables, Distributions, Density functions, Moment generating function, Conditional Expectation, Transformation of Random Variables, Classification of general stochastic processes, Review of basics of linear algebra: Rank, Solutions of Equations, Gram- Schmidt Orthogonalization Procedure, Linear transformations, Matrix representation, Eigen values and Eigen vectors of linear operator, Random Processes, Markov Chains, Basic limit theorem, Continuous Time Markov Chains, Birth and death processes, Finite state continuous time Markov chains, Second Order Stochastic Processes, Wide sense Stationary processes, Spectral density function, Low pass and band pass processes, White noise integrals, Linear Predictions and Filtering, Applications in Signal Processing and Communication: (To be engaged by a faculty from the ECE Dept. in 2/3 hours)

Course outcomes

- Have a good knowledge of standard distributions which can describe real life phenomena.
- Acquire skills in handling situations involving several random variables and functions of random variables
- Better appreciation on the concepts of vector spaces

References

1. Kenneth Hoffman and Ray Kunze, Linear Algebra, 2nd Edition, PHI.
2. Erwin Kreyszig, Introductory Functional Analysis with Applications, John Wiley& Sons.
3. Irwin Miller and Marylees Miller, John E. Freund's Mathematical Statistics, 6th Edition, PHI.
4. S. Karlin & H.M Taylor, A First Course in Stochastic Processes, 2nd edition, Academic Press, New York.
5. S. M. Ross, Introduction to Probability Models, Harcourt Asia Pvt. Ltd. And Academic Press.
6. J. Medhi, Stochastic Processes, New Age International, New Delhi.
7. A Papoulis, Probability, Random Variables and Stochastic Processes, 3rd Edition,McGraw Hill.
8. John B Thomas, An Introduction to Applied Probability and Random Processes,John Wiley & Sons.

COURSE PLAN

07MA 6013 MATHEMATICS FOR COMMUNICATION ENGINEERING (L-T-P : 4-0-0) CREDITS:4		
MODULES	**Contact hours**	**Sem.Exam Marks;%**
Module 1: Operations on random variables: Random Variables, Distributions and Density functions, Moments and Moment generating function, Multivariate distributions, Independent Random Variables, Marginal and Conditional distributions.	9	15
Module 2: Conditional Expectation, Transformation of Random Variables, elements of stochastic processes, Classification of general stochastic processes.	9	15
FIRST INTERNAL TEST		
Module 3: Review of basics of linear algebra: Rank, Solutions of Equations Linear Algebra: Vector spaces, subspaces, Linear dependence, Basis and Dimension, Inner product spaces, Gram- Schmidt Orthogonalization Procedure	9	15
Module 4: Linear transformations, Kernels and Images, Matrix representation of linear transformation, Change of basis, Eigen values and Eigen vectors of linear operator, Quadratic form.	9	15
SECOND INTERNAL TEST		
Module 5: Random Processes: Markov Chains- Definition, Examples, Transition Probability Matrices of a Markov Chain, Classification of states and chains, Basic limit theorem, Limiting distribution of Markov chains. Continuous Time Markov Chains: General pure Birth processes and Poisson processes, Birth and death processes, Finite state continuous time Markov chains	10	20
Module 6: Second Order Processes: Second Order Stochastic Processes, Linear operations and second order calculus, Stationary processes, Wide sense Stationary processes, Spectral density function, Low pass and band pass processes, White noise and white noise integrals, Linear Predictions and Filtering. Applications in Signal Processing and Communication: (To be engaged by a faculty from the ECE Dept. in 2/3 hours)	10	20

Internal Assessment:40 Marks

Assessment procedure

i) Two internal tests, each having 15%
ii) Tutorials/Assignments/ Mini projects having 10%
iii) End Semester examination having 60%

07EC 6203 ADVANCED DIGITAL COMMUNICATION

Credits: 4-0-0: 4 **Year :2015**

Prerequisite: Digital Communication at the under graduate level

Course Objectives

- To introduce various digital modulation schemes and channel models.
- To address the issues related with the recent developments in the area of Modern Communication.
- To evaluate the performance of the systems and study the application.

Syllabus

Review of Random Variables and Processes, Characterization of Communication Signals and Systems, Signal space representation, Optimum waveform receiver in additive white Gaussian noise (AWGN) channels, Correlation receiver, Matched filter receiver and error probabilities, Optimum Receiver for Signals with random phase in AWGN Channels, Probability of error for envelope detection, Digital Communication over Fading Channels, Optimum noncoherent receiver in random amplitude random phase channels, Performance of digital Modulation schemes, Communication over band limited channels, Optimum pulse shaping, Equalization Techniques

.**Course outcomes**

- Understand the design issues of Digital Communication over Additive Gaussian Noise Channels, over Band limited Channels and Fading Multipath Channels
- Better appreciation of various digital communication receivers, equalization techniques etc.

References

1. J.G. Proakis, Digital Communication, MGH 4th edition.
2. Edward. A. Lee and David. G. Messerschmitt, Digital Communication, Allied Publishers (second edition).
3. Marvin.K.Simon, Sami. M. Hinedi and William. C. Lindsey, Digital Communication Techniques, PHI
4. William Feller, An introduction to Probability Theory and its applications, Wiley
5. Sheldon.M.Ross, Introduction to Probability Models, Academic Press, 7th edition

COURSE PLAN

07EC 6203 ADVANCED DIGITAL COMMUNICATION (L-T-P : 4-0-0) CREDITS:4		
MODULES	**Contact hours**	**Sem. Exam Marks;%**
Module 1: Review of Random Processes: Moment generating function, Chernoff bound, Markov's inequality, Chebyshev's inequality, Central limit Theorem, Chi square, Rayleigh and Rician distributions, Correlation, Covariance matrix,	9	15
Module 2: Stationary processes, wide sense stationary processes, ergodic process, crosscorrelation and autocorrelation functions, Gaussian processes Communication over Additive Gaussian Noise Channels, Characterization of Communication Signals and Systems: Signal space representation -Overview, Signal detection in Gaussian channels.	10	15
FIRST INTERNAL TEST		
Module 3: Optimum receiver in additive white Gaussian noise (AWGN) channels, Cross correlation receiver, Matched filter receiver and error probabilities. Optimum Receiver for Signals with random phase in AWGN Channels, Optimum receiver for Binary Signals, Optimum receiver for M-ary Orthogonal signals, Probability of error for envelope detection of M-ary Orthogonal signals	10	15
Module 4: Digital Communication over Fading Channels: Characterization of Fading Multipath Channels, Rayleigh and Rician Fading channels, Optimum non coherent receiver in random amplitude random phase channels, performance in Rayleigh and Rician channels,	9	15
SECOND INTERNAL TEST		
Module 5: Performance of digital Modulation schemes such as BPSK, QPSK, FSK, DPSK etc over wireless channels, Communication over bandlimited channels: Optimum pulse shaping	9	20
Module 6: Equalization Techniques- Zero forcing linear Equalization- Decision feedback equalization- Adaptive Equalization- Receiver synchronization: Frequency and phase synchronization-symbol synchronizations.	9	20

Internal Assessment:40 Marks

Assessment procedure

i) Two internal tests, each having 15%
ii) Tutorials/Assignments/ Mini projects having 10%
iii) End Semester examination having 60%

. 07EC 6205 INFORMATION THEORY

Credits: 4-0-0: 4 **Year :2015**

Prerequisite: A first course in Probability Theory and Random Processes

Course Objectives

- To provide a deep understanding of Information and its measurement
- To familiarize the students with the various Source coding schemes
- To impart the students the concept of Channel capacity for both discrete and continuous channels and Shannon's theorems.
- To give the knowledge of Rate distortion theory and its applications

Syllabus

Representation of discrete sources, Entropy, Lossless source coding, Uniquely decodable codes, Optimal codes, Huffman code, Shannon's Source Coding Theorem, Discrete channels, Channel Capacity, Arimoto- Blahut algorithm, Shannon's Channel Coding Theorem, Modeling of continuous sources and channels, Differential Entropy, Mutual information, Mutual information and Capacity calculation for Band limited Gaussian channels, Shannon limit-Introduction to Rate Distortion Theory

Course Outcomes

- Deep understanding of Information and its measurement
- Familiarization of various source coding schemes
- Familiarization of the concept of Channel capacity for both discrete and continuous channels and Shannon's theorems
- Thorough understanding of Rate distortion theory and its applications

References:

1. T. Cover and Thomas, Elements of Information Theory, John Wiley & Sons
2. Robert Gallager, Information Theory and Reliable Communication, John Wiley & Sons.
3. R. J. McEliece, The theory of information & coding, Addison Wesley Publishing Co.
4. T. Bergu, Rate Distortion Theory a Mathematical Basis for Data Compression PH Inc.
5. Special Issue on Rate Distortion Theory, IEEE Signal Processing Magazine, November 1998.

COURSE PLAN

07EC 6205 INFORMATION THEORY (L-T-P : 4-0-0) CREDITS:4		
MODULES	**Contact hours**	**Sem. Exam Marks;%**
Module 1: Information and Sources: Definition of information-Zero Memory sources- Concepts of entropy-Logarithmic inequalities-Properties of entropy-Extension of a Zero memory source-Markov information sources- Entropy calculation- Entropy of a discrete Random variable- Joint, conditional and relative entropy	9	15
Module 2: Properties of Codes: Uniquely decodable codes-Instantaneous -codes- Construction of an instantaneous code - Kraft's inequality- Discussion, Statement and Proof – McMillan's inequality	9	15
FIRST INTERNAL TEST		
Module 3: Coding Information Sources: Average length of a code -Optimal codes: Shannon codes- Fano codes -Huffman Coding –Optimality of Huffman Codes- r-ary compact codes-Code efficiency and Redundancy- - Shannon's source coding theorem– Lempel Ziv codes -Arithmetic coding	9	15
Module 4: Channels and Mutual Information: Information channel- Probability relations in a channel- A priori and A posteriori entropies-Generalization of Shannon's First theorem-Mutual information- Properties of mutual information-Noiseless channels and deterministic channels-Cascaded channels-Reduced channels and sufficient reductions.	9	15
SECOND INTERNAL TEST		
Module 5: Channel Capacity**:** - Definition of Channel capacity--Capacity of Binary symmetric and Binary Erasure channels-Capacity of symmetrical and asymmetrical channels - Computing channel capacity- Arimoto-Blahut algorithm-Fano's inequality- Shannon's Channel Coding Theorem	10	20
Module 6: Continuous Sources and Channels: Information measure for Continuous sources and channels-Differential Entropy- Joint, relative and conditional differential entropy-Mutual information- Gaussian channels- Mutual information and Capacity calculation for Band limited Gaussian channels-Shannon limit.	10	20

Internal Assessment:40 Marks

Assessment procedure

i) Two internal tests, each having 15%
ii) Tutorials/Assignments/ Mini projects having 10%
iii) End Semester examination having 60%

07EC6207 ADVANCED DIGITAL SIGNAL PROCESSING

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

Prerequisite: A basic course in Digital Signal Processing

Course Objectives

- To provide an overview of time frequency analysis which will help the students to design and implement various systems
- To familiarize the students with multirate signal processing principles.
- To equip the students to work with various linear prediction algorithms.
- To enable the students to appreciate various applications of nonlinear signal processing systems.
- To familiarize the students with power spectrum estimation of signals using parametric and non-parametric methods.

Syllabus

Review of FIR and IIR Digital Filters, Park-McClellan′s method, Nonlinear and Nonstationary signal Processing, Multirate system fundamentals, Time domain and frequency domain analysis, Identities, Polyphase representation, Multirate filter banks, Forward and Backward Linear Prediction, Optimum reflection coefficients for the Lattice Forward and Backward Predictors, Solution of the Normal Equations, Levinson Durbin Algorithm, Schur Algorithm, Properties, Energy density spectrum, Estimation of the Autocorrelation and power spectrum of random signals, Non-parametric spectral estimation, Parametric spectral estimation, Yule-Walker , Burg method, AR , MA and ARMA models.

Course Outcomes

- Design multirate systems for applications like Subband coding, Transmultiplexers, Digital audio systems, Adaptive filters etc
- Design linear prediction systems using Levinson-Durbin algorithm.
- Have an understanding of Nonlinear and Nonstationary signal Processing Systems
- Have a better appreciation of the uses of parametric and non-parametric methods for power spectrum estimation of signals

References

1. John G. Proakis and D.G. Manolakis, Digital Signal Processing: Principles, Algorithms and Applications, Prentice Hall.
2. A.V. Oppenheim and Schafer, Discrete Time Signal Processing, Prentice Hall.

3. L.R. Rabiner and B. Gold, Theory and Application of Digital Signal Processing, Prentice Hall.
4. J.R. Johnson, Introduction to Digital Signal Processing, Prentice Hall.
5. D. J.DeFatta, J. G. Lucas and W. S. Hodgkiss, Digital Signal Processing, J Wiley and Sons, Singapore.
6. Kenneth E. Barner, Gonzalo R. Arce, Nonlinear Signal and Image Processing: Theory, Methods, and Applications
7. Jaakko Astola, Pauli Kuosmanen, Fundamentals of Nonlinear Digital Filtering
8. Gonzalo R. Arce, Nonlinear Signal Processing: A Statistical Approach

COURSE PLAN

07EC6207 ADVANCED DIGITAL SIGNAL PROCESSING (L-T-P : 3-0-0) CREDITS:3		
MODULES	**Contact hours**	**Sem. Exam Marks;%**
Module 1: Review of FIR and IIR Digital Filters: Window method, Park-McClellan′s method- Design of IIR Digital Filters- Nonlinear and Nonstationary signal Processing**:** Nonlinear filters-median filters-Applications. Analysis of nonstationary signals	7	15
Module 2: Multirate system fundamentals: Basic multirate operations – up-sampling and down sampling, Time domain and frequency domain analysis– Identities of multirate operations– Interpolator and decimator design– Rate conversion– Polyphase representation- Multirate filter banks	7	15
FIRST INTERNAL TEST		
Module 3: Linear Prediction : Forward and Backward Linear Prediction – Forward Linear Prediction, Backward Linear Prediction, Optimum reflection coefficients for the Lattice Forward and Backward Predictors	7	15
Module 4: Solution of the Normal Equations: Levinson Durbin Algorithm, Schur Algorithm. Properties of Linear Prediction Filters	7	15
SECOND INTERNAL TEST		
Module 5: Power spectrum estimation: Energy density spectrum-Estimation of the Autocorrelation and power spectrum of random signals - DFT in power spectrum estimation -Non-parametric spectral estimation: Barlett method, Welch method, Blackman and Tukey Method-Performance characteristics-Computational requirements	7	20
Module 6: Parametric spectral estimation: Yule-Walker method for AR model parameters, Burg method, Selection of AR model order- MA and ARMA models	7	20

Internal Assessment:40 Marks

Assessment procedure

i) Two internal tests, each having 15%
ii) Tutorials/Assignments/ Mini projects having 10%
iii) End Semester examination having 60%

Elective Courses

07EC6209 OPTIMIZATION TECHNIQUES

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

Prerequisite: Fundamental knowledge of calculus and linear algebra

Course Objectives

- To introduce the methods of unconstrained optimization
- To provides the student with a collection of optimization modelling and solution tools that can be useful in a variety of industries and functions

Syllabus

Mathematical Background: Sequences and Subsequences; Vectors and vector spaces- Matrices- Linear transformation; Quadratic forms; Linear equations- Solution of a set of linear equations-Basic solution and degeneracy; Linear Programming: Introduction -Optimization model, formulation and applications-Classical optimization techniques; Nonlinear programming: Minimization and maximization of convex functions- Local & Global optimum- Convergence-Speed of convergence. Unconstrained Optimization.

Course Outcomes

- Translate a verbal or graphical description of a decision problem into a valid optimization model, by identifying variables, constraints, and an objective function.
- Interpret the meaning and assess the validity of a particular optimization model.
- Find solutions to optimization problems using the most appropriate algorithm.
- Perform sensitivity analysis by tracing the effects of varying a parameter on the optimal decision variables and the objective function.

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.
4. Hillier and Lieberman Introduction to Operations Research, McGraw - Hill, 8th edition.
5. Saul I Gass, Linear programming, McGraw - Hill, 5th edition.

6. Bazarra M.S., Sherali H.D. & Shetty C.M., Nonlinear Programming Theory and Algorithms, John Wiley, New York.
7. Kalyanmoy Deb, Optimization for Engineering: Design - Algorithms and Examples, Prentice Hall (India).

COURSE PLAN

07EC6209 OPTIMIZATION 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. 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.	**9**	**15**
Module 2: 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.	**9**	**15**
FIRST INTERNAL TEST		
Module 3: 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 - The primal simplex method- Dual linear programs - Primal, dual, and duality theory - The dual simplex method - The primal - dual algorithm - Duality applications.	**8**	**15**
Module 4: Post optimization problems: Sensitivity analysis and parametric programming - 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	**6**	**15**

SECOND INTERNAL TEST		
Module 5: Constrained optimization: Constrained optimization with equality and inequality constraints. Kelley′s convex cutting plane algorithm – Gradient projection method – Penalty Function methods.	**5**	**20**
Module 6: Constrained optimization: Lagrangian method – Sufficiency conditions – Kuhn – Tucker optimality conditions – Rate of convergence – Engineering applications, Quadratic programming problems – Convex programming problems	**5**	**20**

Internal Assessment:40 Marks

Assessment procedure

i) Two internal tests, each having 15%
ii) Tutorials/Assignments/ Mini projects having 10%
iii) End Semester examination having 60%

07EC6219 MARKOV MODELING AND QUEUING THEORY

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

Prerequisite: Course in Random Processes and Probablity theory

Course objective

- Thorough understanding of Markov chains and Markov models of systems.
- Better knowledge of queuing theory
- Application of Markov models in the analysis of queuing networks.

Syllabus

Stochastic Processes: Renewal Processes - Reward and Cost Models, Poisson Process; Point Processes; Regenerative Processes; Markov Models: Discrete Time Markov Chain; Continuous Time Markov Chain - Pure-Jump Continuous-Time Chains, Regular Chains, Birth and Death Process, Semi-Markov Processes; Single Class & Multi-class Queuing Networks: Open queuing networks; Closed queuing networks; Mean value analysis; Multi-class traffic model; 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.

Course outcomes

- Model, Design and Analyze communication networks

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.

COURSE PLAN

07EC6219 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.	**8**	**15**
Module 2: Markov Models: Discrete Time Markov Chain - Transition Probabilities, Communication Classes, Irreducible Chains	**6**	**15**
FIRST INTERNAL TEST		
Module 3: Continuous Time Markov Chain -Pure-Jump Continuous-Time Chains, Regular Chains, Birth and Death Process,Semi-Markov Processes	**7**	**15**
Module 4: Single Class & Multi-class Queuing Networks: Simple Markovian queues; M/G/1 queue; G/G/1 queue	**6**	**15**
SECOND INTERNAL TEST		
Module 5: Open queuing networks; Closed queuing networks; Mean value analysis, Multi-class traffic model; Service time distributions; BCMP networks; Priority systems.	**7**	**20**
Module 6: 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.	**8**	**20**

Internal Assessment:40 Marks

Assessment procedure

i) Two internal tests, each having 15%
ii) Tutorials/Assignments/ Mini projects having 10%
iii) End Semester examination having 60%

07EC6229 DIGITAL IMAGE PROCESSING

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

Prerequisites: A basic course in Digital Signal Processing

Course Objectives

- Get a thorough understanding of digital image representation and processing techniques
- Understand the various steps in digital image processing.

Syllabus

Image representation, Two dimensional orthogonal transforms - DFT, FFT, WHT, Haar transform, KLT, DCT, Image enhancement, histogram-based processing, homomorphic filtering, Edge detection, LOG filters, localization problem, Image Restoration restoration using inverse filtering, Wiener filtering and maximum entropy-based methods, Mathematical morphology, gray scale morphology, applications, Image and Video Compression Standards,Sub-band Decomposition, Entropy Encoding, JPEG, JPEG2000, MPEG, Image texture analysis, statistical models for textures, Hough Transform, Computer tomography, Radon transform, Back-projection operator, Fourier-slice theorem, CBP and FBP methods, ART, Fan beam projection.

Course Outcomes

- Understand various techniques for image representation
- Ability to process the image in spatial and transform domain for better enhancement.

References

1. Gonzalez and Woods, Digital image processing, Prentice Hall, 2002..
2. A. K. Jain, Fundamentals of digital image processing, Prentice Hall of India, 1989.
3. M. Haralick, and L.G. Shapiro, Computer and Robot Vision, Vol-1, Addison Wesley, Reading, MA, 1992

COURSE PLAN

07EC6229 DIGITAL IMAGE PROCESSING (L-T-P : 3-0-0) CREDITS:3		
MODULES	**Contact hours**	**Sem. Exam Marks;%**
Module 1: Image representation - Gray scale and colour Images, image sampling and quantization, Two dimensional orthogonal transforms - DFT, FFT, WHT, Haar transform, KLT, DCT.	**7**	**15**
Module 2: Image enhancement - filters in spatial and frequency domains, histogram-based processing, homomorphic filtering	**7**	**15**
FIRST INTERNAL TEST		
Module 3: Edge detection - non parametric and model based approaches, LOG filters, localization problem, Image Restoration - PSF, circulant and block - circulant matrices, deconvolution, restoration using inverse filtering, Wiener filtering and maximum entropy-based methods	**7**	**15**
Module 4: Mathematical morphology - binary morphology, dilation, erosion, opening and closing, duality relations, gray scale morphology, applications such as hit-and-miss transform, thinning and shape decomposition,Image and Video Compression Standards- Lossy and lossless compression schemes: Sub-band Decomposition, Entropy Encoding, JPEG, JPEG2000, MPEG.	**7**	**15**
SECOND INTERNAL TEST		
Module 5: Image texture analysis: co-occurrence matrix, measures of textures, statistical models for textures. Hough Transform, boundary detection, chain coding, segmentation and thresholding methods	**7**	**20**
Module 6: Computer tomography: parallel beam projection, Radon transform, and its inverse, Back-projection operator, Fourier-slice theorem, CBP and FBP methods, ART, Fan beam projection	**7**	**20**

Internal Assessment:40 Marks

Assessment procedure

i) Two internal tests, each having 15%
ii) Tutorials/Assignments/ Mini projects having 10%
iii) End Semester examination having 60%

07EC6239 BIOMEDICAL SIGNAL PROCESSING

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

Prerequisites: A basic course in Digital Signal Processing

Course Objectives

- To impart knowledge about the principle of different types of bio-medical signals
- To apply innovative techniques of signal processing for computational processing and analysis of biomedical signals.
- To extract useful information from biomedical signals by means of various signal processing techniques.

Syllabus

Origin of bio-potentials, Examples of Biomedical signals, ECG, EEG, EMG, Tasks in Biomedical Signal Processing, Fourier Transform and Time Frequency Analysis, (Wavelet) of biomedical signals, Processing of Random & Stochastic signals, Spectral estimation, Properties and effects of noise in biomedical instruments, Concurrent, coupled and correlated processes, Adaptive and optimal filtering, Modeling of Biomedical signals, Detection of biomedical signals in noise, Maternal-Fetal, Cardio vascular applications, ECG data acquisition, ECG Signal Processing, QRS detection, Spectral analysis of heart rate variability, Neurological Applications, EEG, Nonlinear modeling, artifacts, characteristics and processing, Model based spectral analysis, EEG segmentation.

Course Outcomes

- Understands how basic concepts and tools of science and engineering can be used in understanding and utilizing biological processes.
- Hands-on approach to learn about signal processing and physiological signals through the application of digital signal processing methods to biomedical problems.

References

1. Bruce, Biomedical Signal Processing & Signal Modeling, Wiley, 2001
2. Sörnmo, Bioelectrical Signal Processing in Cardiac & Neurological Applications, Elsevier
3. Rangayyan, Biomedical Signal Analysis, Wiley 2002.
4. Semmlow, Marcel Dekker, Biosignal and Biomedical Image Processing, 2004
5. Enderle, Introduction to Biomedical Engineering, 2/e, Elsevier, 2005
6. D.C.Reddy , Biomedical Signal Processing: Principles and techniques, Tata McGraw Hill, New Delhi, 2005

COURSE PLAN

07EC6239 BIOMEDICAL SIGNAL PROCESSING (L-T-P : 3-0-0) CREDITS:3		
MODULES	**Contact hours**	**Sem. Exam Marks;%**
Module 1: Origin of bio-potentials-Introduction to Biomedical Signals - Examples of Biomedical signals - ECG, EEG, EMG etc - Tasks in Biomedical Signal Processing - Review of linear systems - Fourier Transform and Time Frequency Analysis - (Wavelet) of biomedical signals	**7**	**15**
Module 2: Processing of Random & Stochastic signals - spectral estimation – Properties and effects of noise in biomedical instruments, Concurrent, coupled and correlated processes - illustration with case studies - Adaptive and optimal filtering - Modeling of Biomedical signals	**7**	**15**
FIRST INTERNAL TEST		
Module 3: Detection of biomedical signals in noise - removal of artifacts of one signal embedded in another -Maternal-Fetal ECG – Muscle -contraction interference. Event detection - case studies with ECG & EEG	**7**	**15**
Module 4: Cardio vascular applications : Basic ECG - Electrical Activity of the heart- ECG data acquisition – ECG parameters & their estimation - Use of multiscale analysis for ECG parameters estimation - Noise &Artifacts- ECG Signal Processing: Baseline Wandering, Power line interference, Muscle noise filtering	**7**	**15**
SECOND INTERNAL TEST		
Module 5:QRS detection- Heart Rate Variability – Time Domain measures - -Spectral analysis of heart rate variability, Neurological Applications: The electroencephalogram - EEG rhythms & waveform - categorization of EEG activity - recording techniques	**7**	**20**
Module 6:EEG applications- Epilepsy, sleep disorders, brain computer interface. Modeling EEG- linear, stochastic models - Non linearmodeling of EEG - artifacts in EEG & their characteristics and processing - Model based spectral analysis - EEG segmentation	**7**	**20**

Internal Assessment:40 Marks

Assessment procedure

i) Two internal tests, each having 15%
ii) Tutorials/Assignments/ Mini projects having 10%
iii) End Semester examination having 60%

07EC6249 R F SYSTEM DESIGN

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

Prerequisite: A basic course in Electromagnetic field theory

Course Objectives

- Familiarize how to use Smith chart.
- Get an overview about the details of microwave switches and phase shifters.
- Get an idea about microwave filters.

Syllabus

Review of Transmission Line Theory, Lumped Element Model, SWR and Impedance Mismatches, Planar Transmission Lines Strip-line, Micro-strip, Coplanar-Line, Smith Chart, Reflection Coefficient, Load Impedance, Impedance & Admittance Transformations, Parallel and Series Connection, Revision of S-Parameters, RF Filter Design, Special Filter Realizations- Filter Implementations, Networks Impedance Matching using Discrete Components, Single& Double Stub Matching Network, Quarter-Wave Transformers, RF Amplifiers Oscillators, Mixers and their Characteristics, Stability Considerations, Constant VSWR Circles, Low Noise Circuits; Broadband High Power and Multistage Amplifiers

Course Outcomes

- Understand the importance of Smith chart in various design applications.
- Should be able to design microwave filters.

References

1. Reinhold Ludwig & Powel Bretchko, RF Circuit Design – Theory and Applications, IEd., Pearson Education Ltd., 2004.
2. David M. Pozzar , Microwave Engineering, 3rd , Wiley India, 2007.
3. Mathew M. Radmanesh, Advanced RF & Microwave Circuit Design-The Ultimate Guide to System Design, Pearson Education Asia, 2009
4. Davis W. Alan, Radio Frequency Circuit Design, Wiley India, 2009.
5. Cotter W. Sayre, Complete Wireless Design, 2nd, McGraw-Hill, 2008.

COURSE PLAN

07EC6249 R F SYSTEM DESIGN (L-T-P : 3-0-0) CREDITS:3		
MODULES	**Contact hours**	**Sem. Exam Marks;%**
Module 1: Transmission Line Theory: Review of Transmission Line Theory- Lumped Element Model- Field Analysis of Transmission Lines- Terminated Lossless Lines- SWR and Impedance Mismatches.	**7**	**15**
Module 2: Planar Transmission-Lines: Strip-line, Micro-strip, Coplanar-Line. Smith Chart: Reflection Coefficient- Load Impedance- Impedance Transformation- Admittance Transformation- Parallel and Series Connection- Revision of S-Parameters.	**7**	**15**
FIRST INTERNAL TEST		
Module 3: RF Filter Design Overview; Basic Resonator and Filter Configuration- Special Filter Realizations- Filter Implementations- Coupled Filter.	**7**	**15**
Module 4: Impedance Matching: Networks Impedance Matching using Discrete Components- Micro-strip line Matching Networks- Single Stub Matching Network- Double Stub Matching Network,	**7**	**15**
SECOND INTERNAL TEST		
Module 5: Quarter-Wave Transformers- Multi-Section and Tapered Transformers, RF Amplifiers Oscillators, Mixers and their Characteristics: Amplifier Power Relations- Stability Considerations- Constant Gain Circles- Noise Figure Circles- Constant VSWR Circles	**7**	**20**
Module 6: Low Noise Circuits; Broadband High Power and Multistage Amplifiers- Basic Oscillator Model- High Frequency Oscillator Configurations- Basic Characteristics of Mixers.	**7**	**20**

Internal Assessment:40 Marks

Assessment procedure

i) Two internal tests, each having 15%
ii) Tutorials/Assignments/ Mini projects having 10%
iii) End Semester examination having 60%

07GN6001 : RESEARCH METHODOLOGY

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

Prerequisites : Nil

Course Objectives

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
- 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, 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.

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 modeling, graphs, heuristic optimization, simulation modeling, 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.

- Analyze 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.

REFERENCE BOOKS

1. 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
4. 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.
8. Fred M Kerlinger , Research Methodology
9. Ranjit Kumar, Research Methodology – A step by step guide for beginners, Pearson Education
10. John W Best, James V Kahan – Research in Education , PHI Learning
11. Donald R. Cooper, Pamela S. Schindler, Business Research Methods, 8/e, Tata McGraw-Hill Co Ltd
12. Sinha, S.C. and Dhiman, A.K., 2002. Research Methodology, Ess Ess Publications. 2 volumes
13. Trochim, W.M.K., 2005. Research Methods: the concise knowledge base, Atomic Dog Publishing. 270p.
14. Coley, S.M. and Scheinberg, C. A., 1990, "Proposal Writing", Sage Publications.
15. Day, R.A., 1992.How to Write and Publish a Scientific Paper, Cambridge University Press.
16. Fink, A., 2009. Conducting Research Literature Reviews: From the Internet to Paper. Sage Publications
17. Donald H.McBurney, Research Methods, 5th Edition, Thomson Learning, ISBN:81-315-0047- 0,2006
18. Garg, B.L., Karadia, R., Agarwal, F. and Agarwal, U.K., 2002. An introduction to Research Methodology, RBSA Publishers..
19. Wadehra, B.L. 2000. Law relating to patents, trademarks, copyright designs and geographical indications. Universal Law Publishing
20. Carlos, C.M., 2000. Intellectual property rights, the WTO and developing countries: the TRIPS agreement and policy options. Zed Books, New York.
21. Additional suitable web resources
22. Guidelines related to conference and journal publications

Course Plan

Modules	Contact hours	Int. 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 research	5	10%
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	10%
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	4	10%
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 checking- intellectual property right- patenting case studies	5	10%
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	10%

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	10%
THIRD INTERNAL TEST		

Internal Assessment:100 Marks

Internal continuous assessment is in the form of periodical tests and assignments. There are three tests for the course (3 x 20 = 60 marks) and assignments (40 marks). The assignments can be in the form of seminar, group tasks, case studies, research work or in a suitable format as decided by the teacher.

07EC6211 ADVANCED COMMUNICATION ENGINEERING LAB

Credits: 0-0-2: 1 **Year :2015**

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/LabVIEW.

Tools: Numerical Computing Environments- MATLAB/LabVIEW or any other equivalent tool.

Experiments

1. Implementation of digital modulation schemes-BASK,BFSK,BPSK. Plot BER vs Eb/N0 in AWGN channel.
2. Performance comparison of QPSK ,DPSK,MSK&GMSK.
3. Communication over fading channels-Rayleigh fading &Rician fading.
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.
12. Familiarization of HFSS.

Course Outcomes

- Design and implement self standing systems of their choice with sufficient complexity.

Internal Assessment:100 Marks

Assessment procedure

i) Practical Records /outputs 40%
ii) Regular Class Viva-Voce 20%
iii) Final Test (Objective) 40%

07EC6213 INTRODUCTION TO SEMINAR

Credits: 0-0-1: 0 **Year: 2015**

Pre- requisites: Nil

Course Objectives:

- To improve the debating capability of the student to present a technical topic
- To impart training to the student to face audience and present his ideas and thus creating self esteem and courage essential for an engineer

Outline:

Individual students are required to choose a topic of their interest and give a seminar on that topic for about 30 minutes. A committee consisting of at least three faculty members shall assess the presentation of the seminar. The committee will provide feedback to the students about the scope for improvements in communication, presentation skills and body language. Each student shall submit one copy of the report of the seminar topic.

Course Outcomes:

- The graduate will have improved the debating capability and presentation skills in any topic of his choice.

Semester II

Core Courses

07EC6202 ESTIMATION AND DETECTION

Credits: 4-0-0: 4 **Year :2015**

Prerequisite: Linear algebra, Probability and Random Processes, Digital Communication

Course Objectives

- Familiarize the concepts of detection theory and elementary hypothesis testing
- Understand the concepts of linear and nonlinear estimation techniques.
- Get an overview of the applications of detection and estimation in Communication Engineering and Signal Processing.

Syllabus

Fundamentals of Detection Theory, Bayes rule, minimax rule, Neyman-Pearson rule, Receiver operating characteristics, Compound hypothesis testing, Signal Detection with unknown signal parameters, Signal detection in the presence of noise, Chernoff bound, Asymptotic relative efficiency, Nonparametric detection, Estimation Theory and Techniques: Minimum variance unbiased estimation, Cramer-Rao lower bound, Linear models, Sufficient statistics, Best linear unbiased estimators, Maximum likelihood estimation, The Least squares approach, Linear and Nonlinear Bayesian Estimators, Wiener and Kalman Filters, Monte Carlo methods, Importance sampling, Particle filters, Applications of detection and estimation in the fields of communications, signal/image processing and system identification.

Course Outcomes

- Should be able to use the tools of probability and signal processing to estimate signals/ parameters and detect events from the noisy data available.
- Apply the estimation and detection techniques learned to research problems in the areas of signal processing/communication.

References

1. S.M. Kay, Fundamentals of Statistical Signal Processing: Detection Theory, Prentice Hall, 1998

2. S.M. Kay, Fundamentals of Statistical Signal Processing: Estimation Theory, Prentice Hall, 1993
3. H.L. Van Trees, Detection, Estimation and Modulation Theory, Part I, Wiley, 1968.
4. H.V. Poor, An Introduction to Signal Detection and Estimation,2nd edition, Springer, 1994.
5. L.L. Scharf, Statistical Signal Processing, Detection and Estimation Theory, Addison-Wesley,1990
6. J.S. Liu, Monte Carlo Strategies in Scientific Computing. Springer-Verlag, 2001

COURSE PLAN

07EC6202 ESTIMATION AND DETECTION (L-T-P : 4-0-0) CREDITS:4		
MODULES	**Contact hours**	**Sem. Exam Marks;%**
Module 1: Detection Theory: Review of Probability Theory, Elementary hypothesis testing, Bayes rule, minimax rule, Neyman-Pearson rule, Receiver operating characteristics, Compound hypothesis testing, Generalized likelihood-ratio test	**10**	**15**
Module 2: Signal Detection: Detection with unknown signal parameters, Signal detection in the presence of noise, Chernoff bound, Asymptotic relative efficiency, Sequential detection, Nonparametric detection	**10**	**15**
FIRST INTERNAL TEST		
Module 3: Parameter Estimation: Minimum variance unbiased estimation, Cramer-Rao lower bound, Linear models, Sufficient statistics: Using sufficiency to find the MVU Estimator, Best linear unbiased estimators, Maximum likelihood estimation, Expectation maximization	**10**	**15**
Module 4: Bayesian Inference & Least Squares Estimation: The Least squares approach, General Bayesian estimators: Minimum mean square error estimator, Maximum A-Posteriori estimator	**10**	**15**
SECOND INTERNAL TEST		
Module 5: Linear and Nonlinear Bayesian Estimators**:** Linear Bayesian Estimators: Wiener and Kalman Filters, Monte Carlo methods : Importance sampling, Markov Chain Monte Carlo (MCMC), Nonlinear Bayesian Estimators: Particle filters.	**10**	**20**
Module 6: Applications of detection and estimation in the fields of communications, signal/image processing and system identification.	**6**	**20**

Internal Assessment:40 Marks

Assessment procedure

i) Two internal tests, each having 15%
ii) Tutorials/Assignments/ Mini projects having 10%
iii) End Semester examination having 60%

07EC6204 WIRELESS COMMUNICATION

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

Prerequisite: Course in Advanced Digital Communication

Course Objectives

- To introduce about various wireless channel models
- To understand the design issues in spread spectrum and multi user communication systems
- To have an idea about multi carrier modulations

Syllabus

Fading and Diversity, Wireless channel models, path loss and shadowing models, statistical fading models, Narrow band and wideband Fading models, time Frequency and space diversity, Combining methods, performance analysis for Rayleigh fading channels, Capacity of wireless channels, Multiple input Multiple Output systems, Parallel Decomposition of MIMO Channels, Capacity of MIMO Channels, Cellular Communication Networks, FDM/TDM/FDMA/ TDMA,Co-channel interference Analysis, Spectral efficiency and Grade of Service, Spread spectrum and CDMA , Direct sequence and frequency hoped systems, code synchronization, Channel estimation, power control, Interference analysis for Broadcast and Multiple Access Channels, Capacity of cellular CDMA networks, Reverse link power control, Hard and Soft hand off strategies.

Course outcomes

- Have an understanding about different types of fading in wireless channels and their mitigation.
- Understand various diversity techniques
- Understand MIMO channel capacity and multi carrier modulations, Cellular communication systems, Cellular communication standards.

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.
8. Kamilo Feher, Wireless digital communication, PHI.

COURSE PLAN

07EC6204 WIRELESS COMMUNICATION (L-T-P : 3-0-0) CREDITS:3		
MODULES	**Contact hours**	**Sem. Exam Marks;%**
Module 1: 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.	**6**	**15**
Module 2: 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	**7**	**15**
FIRST INTERNAL TEST		
Module 3: Fading Channel capacity: Capacity of wireless channels- Capacity of flat and frequency selective fading channels- Multiple input Multiple Output systems- Narrow band multiple antenna system model- Parallel Decomposition of MIMO Channels- Capacity of MIMO Channels	**8**	**15**
Module 4: Cellular Communication: Cellular Networks- Multiple Access: FDM/TDM/ FDMA/ TDMA- Spatial reuse- Co-channel interference Analysis- Hand over Analysis- Erlang's Capacity Analysis- Spectral efficiency and Grade of Service- Improving capacity - Cell splitting and sectoring	**7**	**15**
SECOND INTERNAL TEST		
Module 5: 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	**7**	**20**
Module 6: Capacity of cellular CDMA networks- Reverse link power control- Hard and Soft hand off strategies, Multicarrier Communication: OFDM, MCCDMA	**7**	**20**

Internal Assessment:40 Marks

Assessment procedure

i) Two internal tests, each having 15%
ii) Tutorials/Assignments/ Mini projects having 10%
iii) End Semester examination having 60%

07EC6206 REAL TIME DIGITAL SIGNAL PROCESSING

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

Prerequisite: A basic course in Digital Signal Processing

Course Objectives

- To introduce architecture and programming of a typical Digital Signal Processor
- To familiarize the students with the FPGA architecture and modeling digital systems using Hardware Description Language (VHDL)
- To familiarize the students with the filter design using MATLAB
- To give the knowledge of DSP architecture design

Syllabus

Introduction to a popular DSP from Texas Instruments, CPU Architecture, Interrupts, Memory Interface, pipelining, Programming: Fixed point Instruction Set and Addressing Modes, TMS 320C67XX CPU Simple programming examples using C and assembly, Typical DSP development system, Code composer studio, CODECs, Digital Signal Processing Applications, Implementation of Real Time Digital filters, DTMF Tone Generation and Detection using DSP , Introduction to VHDL, Behavioral, Data flow and structural descriptions, VHDL codes for simple combinational and sequential circuits, State machine Design, Typical architecture of Field programmable Gate Array, Circuits and DSP Architecture Design, distributed arithmetic architectures,VLSI performance measures ,Introduction to System on Chip architecture

Course outcomes

- Design systems using Digital Signal Processor Family TMS 320 C67X.
- Simulate and implement Real Time Digital signal processing system in VHDL
- Design of Digital Filters using MATLAB
- Understanding of DSP architecture design

References

1. Rulph Chassaing, Worcester Polytechnic Institute, Digital Signal Processing and Application with C6713 and C6416 DSK, A Wiley-Interscience Publication
2. Naim Dahnoun, Digital Signal Processing Implementation using the TMS320C6000 DSP Platform, 1st Edition;
3. T.J. Terrel and Lik-Kwan Shark, Digital Signal Processing - A Student Guide,1st Edition; Macmillan Press Ltd.

4. David J Defatta J, Lucas Joseph G & Hodkiss William S, Digital Signal Processing: A System Design Approach, 1st Edition; John Wiley
5. Steven K Smith, Newnes, Digital Signal Processing-A Practical Guide for Engineers and Scientists, An imprint of Elsevier Science
6. Rulph Chassaing, DSP Applications using 'C' and the TMS320C6X DSK, 1st Edition
7. Andrew Bateman, Digital Signal Processing Design, 1st Edition, Warren Yates
8. Stephen Brown & Zvonko Vranesic, Fundamentals of Digital Logic with VHDL design, Tata McGraw Hill.
9. Perry D.L, VHDL, McGraw Hill

COURSE PLAN

07EC6206 REAL TIME DIGITAL SIGNAL PROCESSING (L-T-P : 3-0-0) CREDITS:3		
MODULES	**Contact hours**	**Sem. Exam Marks;%**
Module 1: Introduction to a popular DSP from Texas Instruments, CPU Architecture, CPU Data Paths and Control, Timers, Interrupts, Internal Data/ Program Memory, External Memory Interface, pipelining	**7**	**15**
Module 2: Programming; Fixed point Instruction Set and Addressing Modes, TMS 320C67XX CPU Simple programming examples using C and assembly. Typical DSP development system, support tools and files	**6**	**15**
FIRST INTERNAL TEST		
Module 3: Typical DSP development system, compiler, assembler, Code composer studio, CODECs, Digital Signal Processing Applications: Filter Design ,FIR & IIR Digital Filter Design, filter Design programs using MATLAB, Fourier Transform: DFT, FFT programs using MATLAB	**7**	**15**
Module 4: Real Time Implementation using DSP: Implementation of Real Time Digital filters using DSP, DTMF Tone Generation and Detection Introduction to VHDL: Entities and architectures	**7**	**15**
SECOND INTERNAL TEST		
Module 5:VHDL: Behavioral, Data flow and structural descriptions-Identifies, Data objects, Data types and attributes- Delay models- Delta delays- VHDL codes for simple combinational and sequential circuits- State machine Design, simple examples, Typical architecture of Field programmable Gate Array	**7**	**20**
Module 6: Circuits and DSP Architecture Design: Fast filtering algorithms (Winograd's, FFT), retiming and pipelining, block processing, folding, distributed arithmetic architectures -VLSI performance measures (area, power, and speed)-Introduction to System on Chip architecture	**8**	**20**

Internal Assessment:40 Marks

Assessment procedure

i) Two internal tests, each having 15%
ii) Tutorials/Assignments/ Mini projects having 10%
iii) End Semester examination having 60%

Elective Courses

07EC6228 MULTIRATE SIGNAL PROCESSING

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

Prerequisite: A Basic course in Digital Signal Processing

Course Objectives

- To understand the fundamentals of multirate signal processing
- To enable the students to appreciate various applications of multirate systems.
- To design and analyse multirate systems

Syllabus

Review of basic multirate operations and their spectral representation, Digital Filter Banks, DFT Filter Bank, Polyphase representation, Multistage design of Decimation and Interpolation Filters, M-Channel Maximally decimated filter banks, Polyphase representation,,Errors in the QMF bank, Perfect Reconstruction,tree structured filter bank, Transmultiplexers- input/ouput relations, Structure using polyphase matrices, Perfect Reconstruction -Cross talk free systems, Mth band filters, power complementary filters, Paraunitary PR Filter Banks, Two channel filter banks, Factorization of Paraunitary filterbanks, Lattice Structure, Linear phase PR Filter banks, Quantization Effects, Cosine Modulated pseudo QMF Bank, Alias cancellation, Closed form expression, Polyphase structure, Simulation of the systems using standard software tools like MATLAB/Labview

Course Outcomes

- To design perfect reconstruction filter bank systems
- To design and simulate Filter bank based 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. Fredric J. Harris, Multirate Signal Processing for Communication Systems, Prentice Hall. Inc
4. Sanjit K. Mitra. Digital Signal Processing: A computer based approach, McGraw Hill.
5. R.E. Crochiere. L. R. Multirate Digital Signal Processing, Prentice Hall. Inc.

COURSE PLAN

07EC6228 MULTIRATE SIGNAL PROCESSING (L-T-P : 3-0-0) CREDITS:3		
MODULES	**Contact hours**	**Sem. Exam Marks;%**
Module 1: Review of basic multirate operations and their spectral representation. Digital Filter Banks- DFT Filter Bank- Polyphase representation of Uniform DFT filterbanks., Multistage design of Decimation and Interpolation Filters, Simulation using standard software	**7**	**15**
Module 2: M-Channel Maximally decimated filter banks- Polyphase representation -Errors in the QMF bank- Perfect Reconstruction (PR) QMF Bank -Design of an alias free QMF Bank- Applications of Multirate systems, Uniform band and non- uniform bank filter bank- tree structured filter bank, Simulation using standard software	**7**	**15**
FIRST INTERNAL TEST		
Module 3 : Transmultiplexers- input/ouput relations, Structure using polyphase matrices, Perfect Reconstruction - Cross talk free systems Special filters and filter banks- half band filters, Mth band filters, power complementary filters, Simulation using standard software	**7**	**15**
Module 4: Paraunitary PR Filter Banks-Filter Bank Properties induced by paraunitariness-Two channel FIR paraunitary QMF Bank-Factorization of Paraunitary filterbanks- Lattice Structure, Simulation using standard software	**7**	**15**
SECOND INTERNAL TEST		
Module 5: Linear phase PR Filter banks, Necessary conditions for Linear phase property. Quantization Effects: -Types of quantization effects in filter banks,	**6**	**20**
Module 6: Cosine Modulated filter banks: Cosine Modulated pseudo QMF Bank - Alias cancellation-Elimination of Phase distortion-Closed form expression-Polyphase structure-PR systems, Simulation using standard software	**8**	**20**

Internal Assessment:40 Marks

Assessment procedure

i) Two internal tests, each having 15%
ii) Tutorials/Assignments/ Mini projects having 10%
iii) End Semester examination having 60%

07EC6238 ADAPTIVE SIGNAL PROCESSING

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

Prerequisites: A basic course in Digital Signal Processing

Course Objectives

- To introduce adaptive systems
- To understand the filter design related to adaptive signal processing
- To introduce different algorithms to implement adaptive signal processing
- Get a overall picture about applications of adaptive filters in various fields

Syllabus

Adaptive systems, adaptive linear combiner input signal and weight vectors, performance function, gradient and minimum mean square error, linear optimum filtering, orthogonality, Wiener – Hopf equation, Searching performance surface-stability and rate of convergence, Newton's method, method of steepest descent, LMS algorithm, LMS/Newton algorithm, sequential regression algorithm, adaptive recursive filters, random-search algorithms - lattice structure, Applications, adaptive modelling for multipath communication channel, FIR digital filter synthesis, inverse adaptive modelling, equalization, and deconvolution, adaptive equalization of telephone channels.

Course Outcomes

- To understand basic concepts of adaptive signal processing
- To apply adaptive signal processing techniques to solve various signal processing problems

References

1. Bernard Widrow and Samuel D. Stearns, Adaptive Signal Processing, Person Education, 2005.
2. Simon Haykin, Adaptive Filter Theory, Pearson Education, 2003.
3. John R. Treichler, C. Richard Johnson, Michael G. Larimore, Theory and Design of Adaptive Filters, Prentice-Hall of India, 2002
4. S. Thomas Alexander, Adaptive Signal Processing - Theory and Application, Springer-Verlag.
5. D. G. Manolokis, V. K. Ingle and S. M. Kogar, Statistical and Adaptive Signal Processing, Mc Graw Hill International Edition, 2000.

COURSE PLAN

07EC6238 ADAPTIVE SIGNAL PROCESSING (L-T-P : 3-0-0) CREDITS:3		
MODULES	**Contact hours**	**Sem.Exam Marks;%**
Module 1: Adaptive systems - definitions and characteristics - applications - properties-examples - adaptive linear combiner input signal and weight vectors - performance function-gradient and minimum mean square error - linear optimum filtering-orthogonality	**7**	**15**
Module 2: Wiener – Hopf equation-performance surface, Searching performance surface-stability and rate of convergence - learning curve	**7**	**15**
FIRST INTERNAL TEST		
Module 3: Gradient search - Newton's method - method of steepest descent - comparison - gradient estimation - performance penalty - variance - excess MSE and time constants – misadjustments	**7**	**15**
Module 4: LMS algorithm, convergence of weight vector-LMS/Newton algorithm - properties - sequential regression algorithm	**7**	**15**
SECOND INTERNAL TEST		
Module 5: Adaptive recursive filters - random-search algorithms - lattice structure, Applications-adaptive modelling and system identification-adaptive modelling for multipath communication channel	**6**	**20**
Module 6: FIR digital filter synthesis, inverse adaptive modelling, equalization, and deconvolution-adaptive equalization of telephone channels	**8**	**20**

Internal Assessment:40 Marks

Assessment procedure

i) Two internal tests, each having 15%
ii) Tutorials/Assignments/ Mini projects having 10%
iii) End Semester examination having 60%

07EC6248 ADVANCED OPTICAL COMMUNICATION SYSTEMS

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

Prerequisite: A Basic course in Optical Communication

Course Objectives

- To provide an overview of the various components used in a fiber optical communication system
- To give an idea about WDM system and components
- To study coherent light wave systems and components

Syllabus

Rare earth doped fiber fabrication techniques and physical properties, Neodymium and Erbium doped fiber LASERs, Narrow line width and tunable fiber lasers, Q switched fiber lasers, Mode locked fiber lasers, Erbium doped fiber amplifiers, Semiconductor Optical Amplifiers, Light wave Systems, Long haul systems- computer aided design, Dispersion Managements, Pre-compensation and Post-compensation schemes, fiber Bragg gratings- Long Haul Light wave Systems, WDM Light wave Systems, Time-Division Multiplexing, Subcarrier Multiplexing, Soliton-Based Communications, Impact of Amplifier Noise, Coherent Light wave Systems, Modulation Format, Demodulation schemes

Course Outcomes

- Understand the functionality of each of the components that comprise a fiber-optic communication system: transmitter, fiber, amplifier, and receiver.
- Understand how semiconductor lasers work, and differentiate between direct modulation and external electro-optic modulation.
- Understand basic optical amplifier operation and its effect on signal power and noise in the system.
- Apply concepts listed above to the design of a basic communication link.

References:

1. Govind.PAgarwal , Fiber-Optic communication Systems, Wiley India, 2009.
2. RajappaPappannareddy, Introduction to Light wave Communication System, Arctech House, 2009
3. B. E. A. Saleh, M. C. Teich, Fundamentals of photonics, Wiley Inter science, 1991.
4. J. Wilson & J. F. B. Hawkes, Optoelectronics: An introduction, 2nd ed.,Prentice Hall, 1998
5. Raji Ramaswami, Kumar Sivarajan, Optical Networks, Morgan Kaufman, 2009

COURSE PLAN

07EC6248 ADVANCED OPTICAL COMMUNICATION SYSTEMS (L-T-P : 3-0-0) CREDITS:3		
MODULES	**Contact hours**	**Sem.Exam Marks;%**
Module 1: Rare earth doped fiber fabrication techniques and physical properties:- Theory and operation of LASER fiber devices-Neodymium and Erbium doped fiber LASERs-Broadband operation- Narrow line width and tunable fiber lasers- Q switched fiber lasers- Mode locked fiber lasers-Rare earth doped fluoride glass fibers	**7**	**15**
Module 2: Erbium doped fiber amplifiers-Semiconductor Amplifiers-Semiconductor Optical Amplifiers-types-Raman Amplifiers- System Applications	**7**	**15**
FIRST INTERNAL TEST		
Module 3: Light wave Systems: System Architecture-Design guidelines- Long haul systems- computer aided design	**7**	**15**
Module 4: Dispersion Managements: Need for Dispersion Management- Pre-compensation Schemes- Post-compensation schemes-dispersion compensating fibers- Optical filters- fiber Bragg gratings- Long Haul Light wave Systems- High Capacity Systems	**7**	**15**
SECOND INTERNAL TEST		
Module 5: Multichannel Systems: WDM Light wave Systems-WMD Components-System Performance issues-Time-Division Multiplexing- Subcarrier Multiplexing	**6**	**20**
Module 1: Soliton Systems: Soliton-Based Communications-Los-Managed Solitons-Dispersion-Managed Soliton- Impact of Amplifier Noise. Coherent Light wave Systems: Modulation Format- Demodulation schemes- Bit-Error Rate- Sensitivity Degradation- system Performance	**8**	**20**

Internal Assessment:40 Marks

Assessment procedure

i) Two internal tests, each having 15%
ii) Tutorials/Assignments/ Mini projects having 10%
iii) End Semester examination having 60%

07EC6258 ANTENNA THEORY AND DESIGN

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

Prerequisite: A basic course in Electromagnetic field theory

Course Objectives

- To provide an in-depth understanding of the theory of different types of antennas used in communication systems.
- Introduce knowledge on practical antenna design for various applications

Syllabus

Fundamental Concepts on antenna radiation, Radiation pattern, reciprocity, directivity and gain, efficiency, **Friis** transmission equation, radiation integrals and auxiliary potential functions, radiation from Infinitesimal dipole, Radiation from Wires and Loops: dipoles for mobile communication, small circular loop, Antenna Arrays: Analysis of uniformly spaced arrays with uniform and non-uniform excitation amplitudes, extension to planar arrays, Aperture Antennas, Huygens' principle, design considerations, Babinet's principle, Radiation from sectoral and pyramidal horns, Broadband Antennas, Log-periodic antennas, frequency independent antennas, Microstrip Antennas, methods of analysis, design of rectangular and circular patch antennas, Concept and benefits of smart antennas

Course Outcomes

- Ability to analyse the basic antenna types and antenna arrays
- Understanding the design issues for various antennas

References:

1. C.A.Balanis,"Antenna Theory and Design", 3 rd Ed., John Wiley & Sons., 2005.
2. W. L.Stutzman, and G.A. Thiele,"Antenna Theory and Design", 2 nd Ed., John Wiley & Sons., 1998.
3. J. D. Kraus, "Antennas", Tata McGraw Hill, NewDelhi, 3" Edition, 2003
4. R.S.Elliot,"Antenna Theory and Design", Revised edition, Wiley-IEEE Press., 2003.
5. Additional Reading: 1. R.E. Collin, "Antennas and Radio Wave Propagation", McGrawHill., 1985.
6. F.B. Gross,"Smart Antennas for Wireless Communications", McGraw-Hill., 2005.
7. NPTEL course of Dr. Amalendu Patnaik Department of Electronics and Computer EngineeringIIT Roorkee.

COURSE PLAN

07EC6258 ANTENNA THEORY AND DESIGN (L-T-P : 3-0-0) CREDITS:3		
MODULES	**Contact hours**	**Sem.Exam Marks;%**
Module 1: Fundamental Concepts on antenna radiation: Physical concept of radiation, Radiation pattern, near- and far-field regions, reciprocity, directivity and gain, effective aperture, polarization, input impedance, efficiency,Radiation integrals and auxiliary potential functions- Radiation from Infinitesimal dipole	**7**	**15**
Module 2: Radiation from Wires and Loops: finite-length dipole, linear elements near conductors, dipoles for mobile communication, small circular loop.	**7**	**15**
FIRST INTERNAL TEST		
Module 3: Antenna Arrays: Analysis of uniformly spaced arrays with uniform and non-uniform excitation amplitudes, extension to planar arrays.	**7**	**15**
Module 4: Aperture Antennas: Huygens' principle, radiation from rectangular and circular apertures, design considerations, Babinet's principle	**7**	**15**
SECOND INTERNAL TEST		
Module 5: Radiation from sectoral and pyramidal horns, design concepts. Broadband Antennas: Broadband concept, Log-periodic antennas, frequency independent antennas.	**7**	**20**
Module 6 : Microstrip Antennas: Basic characteristics of microstrip antennas, feeding methods, methods of analysis, design of rectangular and circular patch antennas. Basic Concepts of Smart Antennas: Concept and benefits of smart antennas, Fixed weight beamforming basics, Adaptive beam forming	**7**	**20**

Internal Assessment:40 Marks

Assessment procedure

i) Two internal tests, each having 15%
ii) Tutorials/Assignments/ Mini projects having 10%
iii) End Semester examination having 60%

07EC6268 MULTIDIMENSIONAL SIGNAL PROCESSING

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

Prerequisite: A basic course in Digital Signal Processing

Course objectives

- Expand knowledge within digital signal processing to multidimensional signals and systems

Syllabus

Fundamental operations on Multidimensional signals, cascade and parallel connection of systems, separable systems, stable systems, Frequency responses of 2D LTI Systems,- Multidimensional transforms, Sampling continuous 2D signals, Aliasing effects created by sampling, Periodic sampling with different sampling geometrics, DFT for periodically sampled signals, Fast Fourier transform for periodically sampled signals, The Discrete Cosine Transform, Multidimensional Digital Filter Design, Separable Filters, Linear phase filters, Implementation of FIR filters, design of FIR filters using windows, IIR Filters

Course outcomes

- Analysis and construction of multidimensional filters
- Spectral analysis of multidimensional signals.

References

1. Dudgeon Dan E. , Multidimensional Digital Signal Processing, Prentice Hall, Englewood Cliffs, New Jersey
2. P.P. Vaidyanathan, Multirate systems and filter banks, Prentice Hall. PTR. 1993.
3. JAE S. LIM, Two- Dimensional Signal and Image Processing, Prentice Hall Englewood Cliffs, New Jersey, 1990

COURSE PLAN

07EC6268 MULTIDIMENSIONAL SIGNAL PROCESSING (L-T-P : 3-0-0) CREDITS:3		
MODULES	**Contact hours**	**Sem.Exam Marks;%**
Module 1: Multidimensional Systems -Fundamental operations on Multidimensional signals, Linear Shift - Invariant systems- cascade and parallel connection of systems- separable systems, stable systems	**7**	**15**
Module 2: Frequency responses of 2D LTI Systems- Impulse response- Multidimensional Fourier transforms- z transform, properties of the Fourier and z transform.	**7**	**15**
FIRST INTERNAL TEST		
Module 3: Sampling continuous 2D signals-Periodic sampling with rectangular geometry- sampling density, Aliasing effects created by sampling – Periodic sampling with different sampling geometrics-hexagonal- Quincunx etc.- comparison	**8**	**15**
Module 4: Multidimensional Discrete Fourier Transform Multidimensional discrete Fourier transform- Properties of DFT, Circular convolution	**6**	**15**
SECOND INTERNAL TEST		
Module 5: Calculation of DFT- DFT for periodically sampled signals - Fast Fourier transform for periodically sampled signals- The Discrete Cosine Transform.	**6**	**20**
Module 6: Multidimensional Digital Filter Design Separable Filters- Linear phase filters- FIR Filters- Implementation of FIR filters - design of FIR filters using windows- Two dimensional window functions, IIR Filters	**8**	**20**

Internal Assessment:40 Marks

Assessment procedure

i) Two internal tests, each having 15%
ii) Tutorials/Assignments/ Mini projects having 10%
iii) End Semester examination having 60%

07EC6222 WAVELETS THEORY AND APPLICATIONS

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

Prerequisite: A basic course in Digital Signal Processing

Course Objectives

- To provide an overview of variable time-frequency analysis based on wavelets
- To familiarize the students with fundamentals of wavelet transform
- To enable the students to appreciate various applications of wavelet transform.
- To equip the students to work with various wavelet generation schemes.

Syllabus

Review of fundamentals of Fourier Transform, Generalized Fourier theory, Short-time Fourier transform, Time-frequency analysis, Fundamental notions of the theory of sampling. Theory of Frames, Wavelets and Multiresolution Analysis (MRA), Admissibility conditions, Continuous wavelet transform (CWT), Discrete wavelet transform (DWT), Construction of an MRA from scaling functions, The dilation equation and the wavelet equation, Compactly supported orthonormal wavelet bases, Necessary and sufficient conditions for orthonormality. Regularity and selection of wavelets, Design of non-classical wavelets: Splines, Cardinal B-spline MRA, Fast wavelet transform algorithms, Wavelet packets, Biorthogonal system of wavelets, The Lifting scheme. Applications

Course Outcomes

- Students should be able to assimilate research papers in this area easily.
- Should be able to design their own wavelets.

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 and Wavelets, Brooks/ColeSeries 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

COURSE PLAN

07EC6222 WAVELETS THEORY AND APPLICATIONS (L-T-P : 3-0-0) CREDITS:3		
MODULES	**Contact hours**	**Sem.Exam Marks;%**
Module 1: Review of fundamentals of Fourier Transform: Fourier and Sampling Theory, Generalized Fourier theory, Fourier transform, Short-time (windowed) Fourier transform, Time-frequency analysis, Fundamental notions of the theory of sampling	**7**	**15**
Module 2: 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	**6**	**15**
FIRST INTERNAL TEST		
Module 3: Wavelets and Multiresolution Analysis (MRA): The basic functions, Specifications, Admissibility conditions, Continuous wavelet transform (CWT), Discrete wavelet transform (DWT). The multiresolution analysis , Construction of an MRA from scaling functions - The dilation equation and the wavelet equation	**7**	**15**
Module 4: Compactly supported orthonormal wavelet bases - Necessary and sufficient conditions for orthonormality. Regularity and selection of wavelets: Smoothness and approximation order- Criteria for wavelet selection with examples	**6**	**15**
SECOND INTERNAL TEST		
Module 5: Design of non-classical wavelets: Splines, Cardinal B-spline MRA, Subband filtering schemes, Compactly supported orthonormal wavelet bases. Wavelet decomposition and reconstruction of functions in L 2 (R). Fast wavelet transform algorithms - Relation to filter banks, Wavelet packets – Representation of functions, Selection of basis	**8**	**20**
Module 6: Biorthogonality and biorthogonal basis, Biorthogonal system of wavelets -construction, The Lifting scheme. Applications of wavelets - compression and denoising of images and speech signals	**8**	**20**

Internal Assessment:40 Marks

Assessment procedure

i) Two internal tests, each having 15%
ii) Tutorials/Assignments/ Mini projects having 10%
iii) End Semester examination having 60%

07EC6232 CODING THEORY

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

Prerequisite: A basic course in Digital Communication

Course Objectives

- To provide the basic mathematical concepts needed to understand the different coding techniques.
- To familiarize the students with the fundamentals of linear block codes and their error correction capabilities..
- To impart the students the basic structure, properties, encoding and decoding details of cyclic codes.
- To familiarize the students with the fundamentals of convolutional coding and some advanced coding techniques.

Syllabus

Introduction to algebra: Groups, Fields, Arithmetic of Galois Field, Vector spaces, Linear Block Codes, Standard Array and Syndrome decoding, Hamming codes, Hadamard codes, Cyclic Codes, Encoding and decoding of cyclic codes, BCH codes, Reed Solomon , Convolutional Codes, The Trellis diagram, Maximum likelihood decoding of Convolutional codes, Viterbi Algorithm , Stack and Fano Algorithms, Advanced coding techniques, Concept of interleaving , Turbo codes, Trellis coded Modulation

Course Outcomes

- Thorough understanding of the theory and design of channel codes for error control.

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.

COURSE PLAN

07EC6232 CODING THEORY (L-T-P : 3-0-0) CREDITS:3		
MODULES	**Contact hours**	**Sem.Exam Marks;%**
Module 1: Introduction to algebra: Groups - Fields- Binary Field arithmetic - Arithmetic of Galois Field- Construction and basic properties of Finite Fields- Computations using Galois Field arithmetic- Vector spaces- Vector subspaces- Linear independence.	**6**	**15**
Module 2: Linear Block Codes: Matrix description of Linear Block codes- Encoding of Linear block codes- Minimum Distance of a Block code- Error detecting and correcting capabilities of a Block code- Standard Array and Syndrome decoding- Hamming codes- Hadamard codes.	**7**	**15**
FIRST INTERNAL TEST		
Module 3: 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	**7**	**15**
Module 4: Codes with Cyclic Structure: BCH codes - Performance- Decoding of BCH codes, Reed Solomon codes- Encoding and Decoding- Golay codes	**6**	**15**
SECOND INTERNAL TEST		
Module 5: Convolutional Codes: Encoders for convolutional coding -Transfer function of a Convolutional code – State representation and the state diagram- The Tree diagram - The Trellis diagram- Structural properties- Maximum likelihood decoding of Convolutional codes – Viterbi Algorithm – Sequential decoding – Stack and Fano Algorithms	**8**	**20**
Module 6: Advanced coding techniques: - Concept of interleaving – Block interleaving – Convolutional interleaving – Concatenated codes – Turbo codes – Trellis coded Modulation	**8**	**20**

Internal Assessment:40 Marks

Assessment procedure

i) Two internal tests, each having 15%
ii) Tutorials/Assignments/ Mini projects having 10%
iii) End Semester examination having 60%

07EC6242 COMMUNICATION NETWORKS

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

Prerequisite: Probability Theory and basic couse in Computer networks

Course Objectives

- To gain an understanding of the fundamentals of data communications networks
- To give an idea about the different queuing models used in data networks
- To study the different protocol stacks (OSI and TCP/IP) and to understand the functions and protocols within a layer
- To provide an overview of QoS issues in Internet

Syllabus

Internet Architecture: Application layer, Transport layer, Network layer, Link Layer-protocol stack. Broadband services and Quality of Service issues in networks, Queuing Disciplines, Weighted Fair Queuing, Random Early Detection, Differentiated Services, Multi protocol Label switching, Discrete time and continuous time Markov chains, Poisson process, Queuing models for Datagram networks, M/M/1 queuing systems, M/M/m/m queuing models, M/G/1 queue, Mean value analysis, Statistical Multiplexing in Communication Networks

Course Outcomes

- Understand layering in computer networks
- Understand the protocols, architectures and implementation issues
- Appreciate the use of queuing models for analyzing data 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 Publishers.

COURSE PLAN

07EC6242 COMMUNICATION NETWORKS (L-T-P : 3-0-0) CREDITS:3		
MODULES	**Contact hours**	**Sem.Exam Marks;%**
Module 1: 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	**7**	**15**
Module 2: Data link layer - ARQ schemes, multiple access, LANs, CSMA/CD, IEEE 802.11 wireless LANs Broadband services and QoS issues: Quality of Service issues in networks- Integrated service architecture- Queuing Disciplines- Weighted Fair Queuing - Random Early Detection	**8**	**15**
FIRST INTERNAL TEST		
Module 3: Differentiated Services- Protocols for QoS support- Resource reservation-RSVP- Multi protocol Label switching- Real Time transport protocol.	**6**	**15**
Module 4: 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.	**8**	**15**
SECOND INTERNAL TEST		
Module 5: Statistical Multiplexing in Communication Networks: Multiplexing: Network performance and source characterization-: Stream sessions in packet networks	**6**	**20**
Module 6: Statistical Multiplexing in Communication Networks - deterministic analysis, stochastic analysis, circuit multiplexed networks.	**7**	**20**

Internal Assessment:40 Marks

Assessment procedure

i) Two internal tests, each having 15%
ii) Tutorials/Assignments/ Mini projects having 10%
iii) End Semester examination having 60%

07EC6252 COMPUTATIONAL ELECTROMAGNETICS

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

Prerequisite: A basic course in Electromagnetic field theory

Course Objectives

- To provide an overview of mathematical background of computational electromagnetics
- To familiarize the students with various methods used in solving boundary value problems in electromagnetics.
- To enable the students to appreciate various applications of Electromagnetic waves.
- To equip the students to work with various Finite Element and difference algorithms.

Syllabus

Basics of Scientific Computing and Overview of Computational Electromagnetics, numerical integration, differentiation, CEM techniques, CEM modelling, Finite Difference Method, one dimensional FDTD, Finite Difference Time Domain Method in Two and Three Dimensions, 2D FDTD algorithm, 3D FDTD algorithm, Commercial implementations, Variational and galerkin weighted residual formulations, Laplace equation, high frequency variational functional, spurious modes, application to waveguide eigenvalue analysis, three-dimensional Whitney element, One-Dimensional Introduction to the Method of Moments, thin-wire electrodynamics and the methods of moments (MoM), Software interaction and Analyzing: Familarization of computational electromagnetics using standard software tools like MATLAB and HFSS.

Course Outcomes

- Design of applications with the help of Finite difference method, Finite time domain method, Method of moments etc.
- Able to create their own RF applications involving electromagnetics
- Highly mathematical ability to create and analyze the solutions need to solve various Electromagnetic projects.

References

1. D. B. Davidson, Computational Electromagnetics for RF and Microwave Engineering, Cambridge University Press, 2005.
2. J. Jin, The Finite Element Method in Electromagnetics, 2nd edition, Wiley, 2002.
3. Taflove and S. Hagness, Computational Electrodynamics- The Finite Difference Method,, Artech House, Third Edition, 2005.
4. F. Peterson, S. L. Ray, and R. Mittra, Computational Methods for Electromagnetics, Wiley,IEEE Press, 1997.

COURSE PLAN

07EC6252 COMPUTATIONAL ELECTROMAGNETICS (L-T-P : 3-0-0) CREDITS:3		
MODULES	**Contact hours**	**Sem.Exam Marks;%**
Module 1: Basics of Scientific Computing and Overview of Computational Electromagnetics: Numerical error, convergence, interpolation, extrapolation, numerical integration, numerical differentiation	**7**	**15**
Module 2: Direct and iterative matrix equation solvers.CEM techniques, CEM modelling, CEM, the future, Finite Difference Method: Overview of finite differences, one dimensional FDTD, Obtaining wideband data using the FDTD, Numerical dispersion in FDTD simulations	**7**	**15**
FIRST INTERNAL TEST		
Module 3: Finite Difference Time Domain Method in Two and Three Dimensions: 2D FDTD algorithm, PML absorbing boundary condition, 3D FDTD algorithm, Commercial implementations	**7**	**15**
Module 4: Variational and Galerkin weighted residual formulations: Laplace equation, Simplex coordinates, high frequency variational functional, spurious modes, vector (edge) elements	**7**	**15**
SECOND INTERNAL TEST		
Module 5: Variational and Galerkin weighted residual formulations: application to waveguide eigenvalue analysis, three-dimensional Whitney element. One-Dimensional Introduction to the Method of Moments**:** Electrostatic example	**7**	**20**
Module 6: One-Dimensional Introduction to the Method of Moments**:** Thin-wire electrodynamics and the methods of moments (MoM), more on basis functions, method of weighted residuals, Software interaction and Analyzing: Familarization of computational electromagnetics using standard software tools like MATLAB and HFSS	**7**	**20**

Internal Assessment:40 Marks

Assessment procedure

i) Two internal tests, each having 15%
ii) Tutorials/Assignments/ Mini projects having 10%
iii) End Semester examination having 60%

07EC6262 HIGH SPEED DIGITAL SYSTEMS

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

Prerequisite: Basic course in Digital Electronics, Electromagnetic theory

Course Objectives

- To acquaint the students with the problems associated with high-speed digital devices
- To provide an overview of power distribution and noise
- To study about timing and synchronization

Syllabus

Introduction to high speed digital design: Capacitance and inductance effects, High seed properties of logic gates , Speed and power, Modelling of wires, transmission,Power distribution and noise: Power supply network, local power regulation,IR , on chip bypass capacitors, power supply isolation, Noise sources in digital system, Signalling convention and circuits, Signalling modes for transmission lines, Driving lossy LC lines, simultaneous bi-directional signaling, Timing convention and synchronization, timing properties of clocked storage elements, pipeline timing, synchronization failure and meta-stability, PLL and DLL based clock aligners

Course Outcomes

- Understand the design issues in high speed digital devices
- Consider the different noise sources while designing a power distribution network
- Appreciate the significance of timing and synchronization

References

1. Howard Johnson and Martin Graham, High Speed Digital Design: A Handbook of BlackMagic, 3rd Edition, Prentice Hall Modern Semiconductor Design Series' Sub Series: PH Signal Integrity Library, 2006
2. Stephen H. Hall, Garrett W. Hall, and James A. McCall, High-Speed Digital System Design: A Handbook of Interconnect Theory and Design Practices, Wiley, 2007 3.
3. Kerry Bernstein, K.M. Carrig, Christopher M. Durham, and Patrick R. Hansen, High Speed CMOS Design Styles, Springer Wiley 2006
4. Ramesh Harjani, Design of High-Speed Communication Circuits (Selected Topics in Electronics and Systems), World Scientific Publishing Company, 2006

COURSE PLAN

07EC6262 HIGH SPEED DIGITAL SYSTEMS (L-T-P : 3-0-0) CREDITS:3		
MODULES	**Contact hours**	**Sem. Exam Marks;%**
Module 1: Introduction to high speed digital design: Frequency, time and distance - Capacitance and inductance effects - High seed properties of logic gates - Speed and power	**7**	**15**
Module 2: Modelling of wires -Geometry and electrical properties of wires - Electrical models of wires - transmission lines - lossless LC transmission lines - lossy LRC transmission lines - special transmission lines	**7**	**15**
FIRST INTERNAL TEST		
Module 3: Power distribution and noise: Power supply network - local power regulation - IR drops - area bonding - on chip bypass capacitors - symbiotic bypass capacitors - power supply isolation	**7**	**15**
Module 4: Noise sources in digital system - power supply noise - cross talk – inter-symbol interference, Noise Budget design, Statistical Analysis	**7**	**15**
SECOND INTERNAL TEST		
Module 5: Signalling convention and circuits: Signalling modes for transmission lines -signalling over lumped transmission media - signalling over RC interconnect -Driving lossy LC lines - simultaneous bi-directional signalling - terminations - transmitter and receiver circuits	**7**	**20**
Module 6: Timing convention and synchronization, Timing fundamentals - timing properties of clocked storage elements - signals and events -open loop timing level sensitive clocking - pipeline timing - closed loop timing - clock distribution - synchronization failure and meta-stability - PLL and DLL based clock aligners	**7**	**20**

Internal Assessment:40 Marks

Assessment procedure

i) Two internal tests, each having 15%
ii) Tutorials/Assignments/ Mini projects having 10%
iii) End Semester examination having 60%

07EC6272 SPECTRUM ANALYSIS OF SIGNALS

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

Prerequisites: A basic course in Digital Signal Processing

Course Objectives

- Understand the concepts of Non-parametric methods and Parametric method for rational spectra and line spectra.

Syllabus

Estimation of PSD from finite data, Nonparametric methods: Periodogram, Properties, , Time-Bandwidth Product and Resolution, -Modified Periodogram methods: Bartlett, Welch, Parametric methods for Rational Spectra, Covariance properties of AR, MA, ARMA processes,-Yule-Walker method, Levinson-Durbin algorithm,-Multivariate ARMA processes, Parametric methods for line spectra (sinusoids in noise), Models of sinusoids in noise, Higher-order YW method, Pisarenko, MUSIC, ESPRIT, Prony methods, Filter bank methods: Filter bank interpolation of periodogram, Slepia base-band filters, Capon method, Introduction to higher order spectra

Course Outcomes

- Should be able to apply these concepts in the contexts of estimation of PSD in course work/research.

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

COURSE PLAN

07EC6272 SPECTRUM ANALYSIS OF SIGNALS (L-T-P : 3-0-0) CREDITS:3		
MODULES	**Contact hours**	**Sem. Exam Marks;%**
Module 1: Estimation of PSD from finite data: Nonparametric methods: Periodogram, Properties, Bias and Variance analysis- BT method, Window design considerations, Time-Bandwidth Product and Resolution-variance tradeoffs in window design	**7**	**15**
Module 2: Modified Periodogram methods: Bartlett, Welch, Parametric methods for Rational Spectra: Covariance properties of AR, MA	**7**	**15**
FIRST INTERNAL TEST		
Module 3: Parametric methods for Rational Spectra: Covariance properties of ARMA processes -Yule-Walker method- Levinson-Durbin algorithm	**7**	**15**
Module 4: Multivariate ARMA processes: State-space representation, subspace parameter estimation, Parametric methods for line spectra (sinusoids in noise) -Models of sinusoids in noise,	**7**	**15**
SECOND INTERNAL TEST		
Module 5: Parametric methods for line spectra (sinusoids in noise) Higher-order YW method, Pisarenko, MUSIC, ESPRIT, Prony methods, Filter bank methods: Filter bank interpolation of periodogram	**6**	**20**
Module 6: Filter bank methods: Slepia base-band filters, refined filter bank method for higher resolution spectral analysis, Capon method, Introduction to higher order spectra	**8**	**20**

Internal Assessment:40 Marks

Assessment procedure

i) Two internal tests, each having 15%
ii) Tutorials/Assignments/ Mini projects having 10%
iii) End Semester examination having 60%

07EC 6214 SEMINAR

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

Prerequisite: Nil

Course Objectives : This course is intended for

- Increasing the breadth of knowledge
- Enhancing the ability of self study
- Improving presentation and communication skills
- Augmenting the skill of Technical Report Writing.

Outline and Evaluation procedure:

Students have to register for the seminar and select a topic 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 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 report and coverage of the topic, presentation and ability to answer the questions put forward by the committee.

Faculty member in charge of the seminar and another faculty member in the department nominated by the Head of the Department are the evaluators for the seminar.

Internal Assessment:100 Marks
The distribution of marks for seminar is as follows
Marks for the report: 30%
Presentation: 40%
Ability to answer questions on the topic: 30%

Course Outcomes:

The graduate will have acquired

- Debating capability and presentation skills in a technical topic of his interest.
- Knowledge about contemporary issues and research opportunities
- Capacity to communicate effectively and professionally in both verbal and written forms
- Capability for self education and lifelong learning

07EC6216 MINI PROJECT

Credits: 0-0-4: 2 **Year: 2015**

Prerequisite: Nil

Course Objectives:

- To practice the steps involved for the selection, execution, and reporting of the project

Outline and Evaluation procedure:

Individual students are required to choose a topic of their interest in the field of Communication Engineering and Signal Processing. The subject content of the mini project shall be from emerging / thrust areas, topics of current relevance having research aspects. The final evaluation of mini project will be carried out by a committee consisting of three faculty members from the department. The students should bring the report duly authenticated by the respective guide. Students individually will present their work before the committee. The report complete in all respects should be submitted to the Head of the department.

Course Outcomes:

- The graduate will have acquired skills to select and execute projects.
- The graduate will have acquired technical report writing skills.

Internal Assessment: 100 marks

The distribution of marks for the mini project is as follows.

Report – 20%

Demonstration and presentation – 50%,

Results -30%

07EC6216 SIGNAL PROCESSING LAB

Credits: 0-0-2: 1 **Year :2015**

Course Objective

- Acquire sufficient expertise in simulating the systems using MATLAB/LabVIEW or any other equivalent tool.

Course Outcomes

- Enables the students to explore the concepts of designing and implementing various systems using DSP kits.
- Upon completion, the students will be able to design enlisted experiments and implement using hardware

Tools: Numerical Computing Environments- MATLAB/LabVIEW or any other equivalent tool, DSP Kits.

Experiments

1. Generation of waveforms and observation of the output using thegraphical display utility of Integrated Development Environment (IDE)
2. Generation of a sine function and sampling of generated sine waveform, Observation of the spectrum and windowing effect.
3. Implementation of linear convolution on 1D and 2D signals.
4. Implementation of circular convolution on 1D and 2D signal.
5. Implementation of FIR filter (Filter coefficients may be obtained from MATLAB)
6. Implementation of FIR filter (Filter coefficients may be obtained from MATLAB)
7. Verification of FIR and IIR filters by inputting a signal from the signal from the signal generator (configure the codec in the DS development board)
8. Implementation of simple algorithms in audio and image processing.
9. Real time data exchange between MATLAB and IDE to transfer the data from computer to Development kit.
10. Assembly language programming

i) Implementation of linear convolution
ii) Implementation of circular convolution

Internal Assessment: 100 marks

Assessment procedure

i) Practical Records /outputs 40%
ii) Regular Class Viva-Voce 20%
iii) Final Test (Objective) 40%

Semester III

Elective Courses

07EC7201 TRANSFORM THEORY

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

Prerequisite: A basic course in Digital Signal Processing

Course objectives

- Provide deep understanding of the various transforms used in signal analysis

Syllabus

Introduction on the integral and discrete transforms and their applications, Review of Laplace Transform, Z transform, Continuous Fourier Transform, Discrete Time Fourier transform, Relations between the transforms, Short Term Fourier Transform(STFT), Heisenbergs uncertainty principle, Continuous wavelet transform (CWT), Hilbert Transforms, Radon Transform, Abel Transform, Sine transform, Co sine Transform, The Mellin Transform, Hankel Transform, Hartley Transform, Discrete Transforms and Applictions, Discrete Cosine transform and applications in JPEG, Discrete STFT (DSTFT), Discrete Wavelet Transform (DWT), lifting, Applications, image compression (JPEG 2000), Contourlet transform (CTT), Applications of CTT in image processing, Ridgelet and Curvelet transforms, New developments in DWT and CTT

Course outcomes

- Sound knowledge in the methods of Lapalce transform, Z-transform, the Fourier transforms, Wavelet transform, DCT and other transforms,
- Apply transforms in various fields like image compression.
- Understand new transforms like CTT and WBCT.

References

1. The Transforms and Applications Handbook, Second Edition - Edited by Alexander D. Poularikas, CRC Press
2. Integral and Discrete transforms with applications and error analysis, Abdul Jerri, Marcel Dekker Inc.
3. Integral Transforms and Their Applications Lokenath Debnath, Dambaru Bhatta, Taylor & Francis Inc

COURSE PLAN

07EC7201 TRANSFORM THEORY (L-T-P : 3-0-0) CREDITS:3		
MODULES	**Contact hours**	**Sem. Exam Marks;%**
Module 1: Introduction and Review: Introduction on the integral and discrete transforms and their applications- Need of reversibility- basis – Requirements of transforms- (Linear algebraic approach) - Review of Laplace Transform, Z transform,	**7**	**15**
Module 2: Review of Continuous Fourier Transform, Discrete Time Fourier transform, Discrete transform-Relations between the transforms- Integral Transforms: Short Term Fourier Transform(STFT) – Limitations of STFT - Heisenbergs uncertainty principle - Continuous wavelet transform (CWT) - Hilbert Transforms	**7**	**15**
FIRST INTERNAL TEST		
Module 3: Radon Transform - Abel Transform - Sine transform – Cosine Transform - The Mellin Transform - Hankel Transform - Hartley Transform	**7**	**15**
Module 4: Discrete Transforms and Applictions: Discrete Cosine transform and applications in JPEG - Discrete STFT (DSTFT) – Application of DSTFT in audio signal processing- Discrete Wavelet Transform (DWT) - lifting applied to DWT	**7**	**15**
SECOND INTERNAL TEST		
Module 5: Applications of DWT in audio signal processing - image compression (JPEG 2000) - At least one application of each transform in one dimensional, two-dimensional or three dimensional signals or multimedia signal processing (Example : compression, information security, watermarking, steganography, denoising, signal separation, signal classification), Limitations of DWT in image processing	**6**	**20**
Module 6: New Transforms and Applications: Contourlet transform (CTT) – Applications of CTT in image processing - Ridgelet and Curvelet transforms - New developments in DWT and CTT such as wavelet Based Contourlet Transform(WBCT)	**8**	**20**

Internal Assessment: 40 marks

Assessment procedure

i) Two internal tests, each having 15%
ii) Tutorials/Assignments/ Mini projects having 10%
iii) End Semester examination having 60%

07EC7211 WIRELESS SENSOR NETWORKS

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

Prerequisite: Wireless Communication

Course Objectives

- To provide knowledge about wireless sensor networks.

Syllabus

Wireless Lans, Pans And Mans, Technical issues, network architecture, physical layer, Mac layer, transport layer, middleware protocol group, WLL architecture, technologies, broadband wireless access, Ad-Hoc Wireless Networks, issues-medium access scheme, Wireless Sensor Networks, comparisons with MANET, design challenges, Mac protocols, Energy Management, Security & Reliability, Dynamic power management in sensor networks, unique security challenges in sensor networks and enabling mechanism, security architectures, privacy protection, reliability support in sensor networks, reliability problems in sensor networks, architecture of a distributed sensor system,

Course outcomes

- Thorough knowledge about ad-hoc wireless networks, wireless sensor networks,
- Better understanding of energy management, security and reliability in wireless sensor networks.

References:

1. C. Siva Ram Murthy and B.S Manoj, Ad-hoc wireless networks- architecture and protocols, Pearson education, 2nd, 2005.
2. Mohammad Ilyas and ImagMahgoub, Handbook of Sensor Networks : Compact Wireless and Wired Sensing Systems, CRC Press 2005.
3. Rajeev Shorey and A.Ananda, Mobile, Wireless and Sensor Networks Technology, Applications and Future Directions, John Wiley & Sons, 2006.
4. William Stallings, Wireless Communication and Networks, Prentice Hall, 2nd edition, 2005.
5. KavehPahlavan and Prashant Krishnamurthy, Principle of Wireless Networks- A Unified Approach, Prentice Hall, 2006.

COURSE PLAN

07EC7211 WIRELESS SENSOR NETWORKS (L-T-P : 3-0-0) CREDITS:3		
MODULES	**Contact hours**	**Sem. Exam Marks;%**
Module 1: Wireless Lans, Pans And Mans: Introduction, fundamentals of WLAN- Technical issues, network architecture, IEEE 802.11- physical layer, Mac layer mechanism, CSMA/CA.	**6**	**15**
Module 2: Bluetooth-specification, transport layer, middleware protocol group, Bluetooth profiles, WLL-generic WLL architecture, technologies, broadband wireless access, IEEE 802.16-differences between IEEE 802.11 and 802.16, physical layer, data link layer.	**7**	**15**
FIRST INTERNAL TEST		
Module 3: Ad-Hoc Wireless Networks: Introduction, issues-medium access scheme, routing, multicasting, transport layer protocol, pricing scheme, QoS provisioning, self-organization, security, addressing, service discovery, energy management, deployment consideration, ad-hoc wireless internet.	**8**	**15**
Module 4: Wireless Sensor Networks: Introduction-applications of sensor networks, comparisons with MANET, issues and design challenges, architecture- layered and clustered, data dissemination, data gathering, Mac protocols, location discovery, quality of sensor networks, coverage in wireless sensor networks- area coverage, point coverage, barrier coverage.	**8**	**15**
SECOND INTERNAL TEST		
Module 5: Energy Management, Security & Reliability: Dynamic power management in sensor networks- idle power management, active power management, system implementation, security and privacy protection in wireless sensor networks- unique security challenges in sensor networks and enabling mechanism, security architectures, privacy protection.	**7**	**20**
Module 6: Reliability support in sensor networks- reliability problems in sensor networks, architecture of a distributed sensor system, distributed services, mechanisms and tools, dynamic adaptation of distributed sensor applications	**6**	**20**

Internal Assessment: 40 marks

Assessment procedure

i) Two internal tests, each having 15%
ii) Tutorials/Assignments/ Mini projects having 10%
iii) End Semester examination having 60%

07EC7221 PATTERN RECOGNITION AND MACHINE LEARNING

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

Prerequisite: Probability Theory, Estimation and detection and Information Theory

Course Objectives

- Introduce the concepts, techniques, design and applications of machine learning to pattern recognition.
- Understand and implement classical algorithms in pattern recognition and machine learning.

Syllabus

Review of Probability Theory, Decision Theory and Information Theory, Supervised and unsupervised learning, Curse of dimensionality, Gaussian distribution, Maximum Likelihood estimation, Bayesian inference, Mixture of Gaussians, Hidden Markov models for sequential data classification Discrete hidden Markov models, Continuous density hidden Markov models. Fisher discriminant analysis, Principal component analysis, Non-parametric techniques for density estimation, Parzen-window method, K-Nearest Neighbour method, Non-metric methods for pattern classification, Linear models for regression and classification, Artificial Neural networks, Support Vector Machines, Unsupervised learning,

Course outcomes

- Understand and compare the various approaches to machine learning and pattern recognition implementations
- Describe and utilize a range of techniques for designing machine learning and pattern recognition systems for real-world applications

References:

1. C.M.Bishop, Pattern Recognition and Machine Learning, Springer
2. R.O.Duda, P.E.Hart and D.G.Stork, Pattern Classification, John Wiley
3. Tom Mitchell, Machine Learning, McGraw-Hill.

COURSE PLAN

07EC7221 PATTERN RECOGNITION AND MACHINE LEARNING (L-T-P : 3-0-0) CREDITS:3		
MODULES	**Contact hours**	**Sem.Exam Marks;%**
Module 1: Review of Probability Theory, Decision Theory and Information Theory. Concepts of learning, Supervised and unsupervised learning, Curse of dimensionality. Probability distributions, Parametric and Non-parametric methods, Gaussian distribution,	**6**	**15**
Module 2: Review of Decision Theory and Information Theory. Maximum Likelihood estimation, Bayesian inference, Mixture of Gaussians, Nearest-neighbour methods	**6**	**15**
FIRST INTERNAL TEST		
Module 3: Hidden Markov models for sequential data classification - Discrete hidden Markov models, Continuous density hidden Markov models. Dimension reduction methods - Fisher discriminant analysis, Principal component analysis.	**8**	**15**
Module 4: Non-parametric techniques for density estimation - Parzen-window method, K-Nearest Neighbour method. Non-metric methods for pattern classification - Non-numeric data or nominal data, Decision trees	**8**	**15**
SECOND INTERNAL TEST		
Module 5: Linear models for regression and classification, Perceptron, Artificial Neural networks, Support Vector Machines	**7**	**20**
Module 6: Unsupervised learning, Clustering - Criterion functions for clustering, Algorithms for clustering: K-means and Hierarchical methods	**7**	**20**

Internal Assessment: 40 marks

Assessment procedure

i) Two internal tests, each having 15%
ii) Tutorials/Assignments/ Mini projects having 10%
iii) End Semester examination having 60%

07EC7231 SPEECH AND AUDIO SIGNAL PROCESSING

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

Prerequisites

- Basics of sound waves, physics of sound, propagation, measurements
- Basics of phonetics, labeling of speech
- Basic understanding of sound recording, recording formats, microphone, speaker, Codecs
- Thorough understanding of signals and systems, digital signal processing concepts, windowing, spectral analysis, transforms.

Course Objectives

- To provide detailed knowledge of human speech production and perception mechanism
- To familiarize the students with signal processing techniques for analysis, modeling and modification of speech signals.
- To enable the students to appreciate various speech coding and speech enhancement systems.
- To familiarize the students with speech recognition, speaker identification and verification systems.

Syllabus

Fundamentals of speech production and perception, Anatomy and physiology of speech production, spectrographic analysis of speech,anatomy and physiology of human ear, speech perception, masking properties of human ear, hearing impairment, Short-time analysis of speech, analysis in time domain, frequency domain parameters, filter bank analysis, LPC analysis, cepstral analysis, Mel-cepstrum, Speech coding and speech enhancement, adaptive noise cancellation, principles of speech synthesis, Speech recognition, speaker verification, applications in language and accent identification.

Course Outcomes

- Understanding of human speech production and perception mechanism
- Application of signal processing techniques to analyse, model and modify speech signal.

- Have a better appreciation of systems for speech coding, speech enhancement, speech recognition, speaker identification and verification.

References:

1. Rabiner L.R. & Schafer R.W., Digital Processing of Speech Signals, Prentice Hall.
2. O′Shaughnessy, D. Speech Communication, Human and Machine, Addison-Wesley.
3. Thomas F. Quatieri, Discrete time Speech Signal Processing: Principles and Practice, Prentice Hall, Signal Processing Series.
4. Deller, J., Proakis, and J. Hansen. Discrete time processing of Speech Signals, Macmillan.
5. Benesty, M.M. Sondhi, Y. Huang (Eds.), Springer Handbook of Speech Processing, Berlin: Springer-Verlag.
6. Ben Gold & Nelson Morgan , Speech and Audio Signal Processing., John Wiley & Sons, Inc.
7. Saito S. & Nakata K., Fundamentals of Speech Signal Processing, Academic Press, Inc.
8. Papamichalis P.E., Practical Approaches to Speech Coding, Texas Instruments, Prentice Hall
9. Rabiner L.R. & Gold, Theory and Applications of Digital Signal Processing, Prentice Hall of India
10. Frederick N. Martin, Introduction to Audiology, Allyn and Bacon

COURSE PLAN

07EC7231 SPEECH AND AUDIO SIGNAL PROCESSING (L-T-P : 3-0-0) CREDITS:3		
MODULES	**Contact hours**	**Sem.Exam Marks;%**
Module 1: Fundamentals of speech production: Anatomy and physiology of speech production, categorization of speech sounds, articulatory phonetics, acoustic phonetics, co-articulation, prosody	**7**	**15**
Module 2: Analyzing the speech signal**:** Short-time analysis of speech, energy, zero crossing rate, autocorrelation, frequency domain analysis, filter bank analysis, short-time Fourier transform, pitch estimation and tracking, formant estimation and tracking, LPC analysis, autocorrelation method, covariance method, cepstral analysis, Mel-cepstrum	**10**	**15**
FIRST INTERNAL TEST		
Module 3: Fundamentals of speech perception**: A**natomy and physiology of human ear, speech perception, response of the ear to complex stimuli, critical bands, masking properties of human ear, perceptually important features, acoustic cues, vowel perception, consonant perception, hearing impairments	**7**	**15**
Module 4: Speech coding**:** Coding of speech signals, speech redundancies, measures to evaluate speech quality and intelligibility, high quality audio coding using psychoacoustic models, MPEG audio coding standard.	**6**	**15**
SECOND INTERNAL TEST		
Module 5: Speech enhancement**:** Speech enhancement techniques, spectral subtraction, adaptive noise cancellation, principles of speech synthesis, sinusoidal analysis/synthesis, time-scale and pitch-scale speech modification, signal processing for hearing aids	**6**	**20**
Module 6: Automatic speech and speaker recognition**:** Speech segmentation, parametric representation, temporal and spectral variability, hidden Markov models, speaker recognition, speaker verification, features, speaker recognition techniques	**6**	**20**

Internal Assessment: 40 marks

Assessment procedure

i) Two internal tests, each having 15%
ii) Tutorials/Assignments/ Mini projects having 10%
iii) End Semester examination having 60%

07EC7241 SECURE COMMUNICATION

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

Prerequisite: Basic Course on Information Theory and Coding

Course Objectives

- To introduce to various aspects of Communication over the Channels, for providing security.
- To have idea about the security issues for communication.

Syllabus

Rings and fields - Principal Ideal Domains - Splitting fields - Divisibility- Euler theorem - Chinese Remainder Theorem – Primality - Basic encryption techniques - Concept of cryptanalysis - Shannon's theory - Perfect secrecy - Block ciphers – DES – AES - Linear and Differential Cryptanalysis –Stream ciphers - Cryptanalysis of LFSR based stream ciphers - 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 - Secret sharing - features of visual cryptography - other applications of cryptography - Elliptic curves - Group law - Elliptic curve cryptography – Integer factorization - Diffie Hellmann key exchange over EC - Elgamal encryption over EC – ECDSA

Course Outcomes

- Understand the design issues of secure communication for encryption techniques.
- Understand the design issues on various security problems and its encryptions.
- Understand various secure communications for cryptography.

References

1. Douglas A. Stinson, Cryptography, Theory and Practice, 2nd edition, Chapman & Hall, CRC Press Company,Washington
2. Wade Trappe, Lawrence C. Washington, Introduction to Cryptography with Coding Theory, Second edition Pearson Education, 2006
3. William Stallings, Cryptography and Network Security, 4th edition, Pearson Education, 2006
4. Lawrence C. Washington, Elliptic Curves, Chapman & Hall, CRC Press Company, Washington.
5. David S. Dummit, Richard M. Foote, Abstract Algebra, John Wiley & Sons
6. Evangelos Kranakis, Primality and Cryptography, John Wiley & Sons
7. Rainer A. Ruppel, Analysis and Design of Stream Ciphers, Springer Verlag

COURSE PLAN

07EC7241 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- Field extensions- Splitting fields - Divisibility	**7**	**15**
Module 2: Euler theorem - Chinese Remainder Theorem – Primality, Basic encryption techniques - Concept of cryptanalysis - Shannon's theory - Perfect secrecy - Block ciphers - Cryptographic algorithms - Features of DES – Linear and Differential Cryptanalysis – AES	**7**	**15**
FIRST INTERNAL TEST		
Module 3: Stream ciphers -Pseudo random sequence generators – linear complexity - Non-linear combination of LFSRs - Boolean functions –Cryptanalysis of LFSR based stream ciphers	**7**	**15**
Module 4: 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	**7**	**15**
SECOND INTERNAL TEST		
Module 5: Digital signatures - Secret sharing - features of visual cryptography - other applications of cryptography, Elliptic curves - Basic theory - Weirstrass equation - Group law - Point at Infinity	**7**	**20**
Module 6: Elliptic curves over finite fields - Discrete logarithm problem on EC - Elliptic curve cryptography – Integer factorization - Diffie Hellmann key exchange over EC - Elgamal encryption over EC - ECDSA	**7**	**20**

Internal Assessment: 40 marks

Assessment procedure

i) Two internal tests, each having 15%
ii) Tutorials/Assignments/ Mini projects having 10%
iii) End Semester examination having 60%

07EC7203 COGNITIVE AND SOFTWARE DEFINED RADIO

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

Prerequisite: Course in Wireless communication and Digital Communication

Course Objectives

- Know the basics of the software defined radios.
- Learn the design of the wireless networks based on the cognitive radios
- Understand the concepts of wireless networks and next generation networks

Syllabus

Introduction To Software Defined Radio, software radio architecture evolution, SDR Architecture, Computational processing resources, software architecture, top level component interfaces, interface topologies among plug and play modules, Introduction to Cognitive Radios, optimization of radio resources, Artificial Intelligence Techniques, Cognitive Radio Architecture, Architecture maps, Building the Cognitive Radio Architecture on Software defined Radio Architecture, Next Generation Wireless Networks, The XG Network architecture, spectrum sensing, management, mobility and sharing, cross – layer design.

Course Outcomes

- Understand the basics of the software defined radios.
- Design the wireless networks based on the cognitive radios
- Better understanding of the concepts behind the wireless networks and next generation networks

Text Books:

1. Joseph MitolaIII, Software Radio Architecture: Object-Oriented Approaches to Wireless System Engineering, John Wiley & Sons Ltd. 2000.
2. Thomas W.Rondeau, Charles W. Bostain, Artificial Intelligence in Wireless communication, ARTECH HOUSE .2009.
3. Bruce A. Fette, Cognitive Radio Technology, Elsevier, 2009.
4. Ian F. Akyildiz, Won – Yeol Lee, Mehmet C. Vuran, ShantidevMohanty, Next generation / dynamic spectrum access / cognitive radio wireless networks: A Survey Elsevier Comput er Networks, May 2006.

References

1. Simon Haykin, Cognitive Radio: Brain –Empowered Wireless Communications, IEEE Journal on selected areas in communications, Feb 2005.
2. HasariCelebi, HuseyinArslan, Enabling Location and Environment Awareness in Cognitive Radios, Elsevier Computer Communications , Jan 2008.
3. Markus Dillinger, KambizMadani, Nancy Alonistioti, Software Defined Radio, John Wiley, 2003.
4. Huseyin Arslan, Cognitive Radio, SDR and Adaptive System, Springer, 2007.
5. Alexander M. Wyglinski, Maziarnekovee, Y. Thomas Hu, Cognitive Radio Communication and Networks, Elsevier, 2010.

COURSE PLAN

07EC7203 COGNITIVE AND SOFTWARE DEFINED RADIO (L-T-P : 3-0-0) CREDITS:3		
MODULES	**Contact hours**	**Sem.Exam Marks;%**
Module 1: Introduction To Software Defined Radio: Definitions and potential benefits, software radio architecture evolution, technology tradeoffs and architecture implications.	**7**	**15**
Module 2: SDR Architecture: Essential functions of the software radio, basic SDR, hardware architecture, Computational processing resources, software architecture, top level component interfaces, interface topologies among plug and play modules	**7**	**15**
FIRST INTERNAL TEST		
Module 3: Introduction to Cognitive Radios: Marking radio self-aware, cognitive techniques – position awareness, environment awareness in cognitive radios, optimization of radio resources, Artificial Intelligence Techniques	**7**	**15**
Module 4: Cognitive Radio Architecture: Cognitive Radio – functions, components and design rules, Cognition cycle – orient, plan, decide and act phases, Inference Hierarchy	**7**	**15**
SECOND INTERNAL TEST		
Module 5: Cognitive Radio Architecture : Architecture maps, Building the Cognitive Radio Architecture on Software defined Radio Architecture	**6**	**20**
Module 6: Next Generation Wireless Networks: The XG Network architecture, spectrum sensing, spectrum management, spectrum mobility, spectrum sharing, upper layer issues, cross – layer design.	**8**	**20**

Internal Assessment: 40 marks

Assessment procedure

i) Two internal tests, each having 15%
ii) Tutorials/Assignments/ Mini projects having 10%
iii) End Semester examination having 60%

07EC7213 EMBEDDED SYSTEM DESIGN

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

Prerequisite: A basic course in Microprocessor and Microcontroller

Course Objectives

- Students will understand current applications, trends and new directions in embedded systems
- Students will be able to program and interface PIC microcontroller
- Gain knowledge about real time operating systems.

Syllabus

Introduction to Embedded Systems, Software embedded into a system, Inter-process Communication and Synchronisation of Processes, Data sharing by multiple tasks and routines, Real Time Operating Systems, RealTime and Embedded System Operating systems, Interrupt routines in RTOS Environments, Ideas of Embedded Linux, PIC microcontroller,features and block diagram, Architecture and assembly language Programming, addressing modes, I/O Port programming in C, PIC Peripherals and Interfacing, PIC18 timer programming in C, Interrupt programming in C, ADC and DAC interfacing, CCP and ECCP programming, DC Motor interfacing and PWM

Course Outcomes

- Design and implement systems using PIC microcontrollers,
- Development of embedded systems

References:

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

COURSE PLAN

07EC7213 EMBEDDED SYSTEM DESIGN (L-T-P : 3-0-0) CREDITS:3		
MODULES	**Contact hours**	**Sem.Exam Marks;%**
Module 1: Introduction to Embedded Systems: Characteristics of Embedded systems, Software embedded into a system- Device Drivers and Interrupt Servicing mechanisms. Inter-process Communication and Synchronisation of Processes, Tasks and Threads:	**7**	**15**
Module 2: Multiple Processes in an Application - Data sharing by multiple tasks and routines- Inter Process Communication. Real Time Operating Systems: Operating System Services, I/O Subsystems – RealTime and Embedded System Operating systems	**7**	**15**
FIRST INTERNAL TEST		
Module 3: Interrupt routines in RTOS Environments - RTOS Task Scheduling models, Interrupt Latency and response Times - Ideas of Embedded Linux	**7**	**15**
Module 4: 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,	**7**	**15**
SECOND INTERNAL TEST		
Module 5: Bank switching in the PIC18, 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	**6**	**20**
Module 6: PIC Peripherals and Interfacing: PIC18 timer programming in C, Serial Port programming in C, Interrupt programming in C, ADC and DAC interfacing, CCP and ECCP programming, DC Motor interfacing and PWM.–Case study using PIC processor	**8**	**20**

Internal Assessment: 40 marks

Assessment procedure

i) Two internal tests, each having 15%
ii) Tutorials/Assignments/ Mini projects having 10%
iii) End Semester examination having 60%

07EC7223 MULTIMEDIA COMPRESSION TECHNIQUES

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

Prerequisite: A basic course in information theory

Course Learning Objectives

- To understand various text compression techniques
- To familiarize with audio compression techniques
- To equip student to work with various image compression algorithms

Syllabus

Brief history of data compression applications, Overview of information theory, Human audio, visual systems, Taxonomy of compression techniques, Source coding, rate distribution theory, vector quantization, Evaluation techniques, Text compression: Huffman coding-arithmetic coding, Shannon-Fano coding and dictionary techniques, LZW family algorithms, Audio compression: Audio compression techniquesprogressive encoding for audio-silence compression, speech compression techniques, Vocoders, Image compression, Predictive techniques, Contour based compression, Video compression techniques, Overview of Wavelet based compression and DVI technology-Motion video compression, DVI real time compression

Course Outcomes

- Understand the importance of data, audio and image compression
- Implement various audio and image compression algorithms

References:

1. SayoodKhaleed, Introduction to data compression, Morgan Kauffman,London,1995
2. Mark Nelson, Dta compression book, BPB Publishers, New Delhi, 1998
3. Watkinson,J. Compression in video and audio, Focal press,London.1995
4. Jan Vozer, Video compression for multimedia, AP press, NewYork,1995.

COURSE PLAN

07EC7223 MULTIMEDIA COMPRESSION TECHNIQUES (L-T-P : 3-0-0) CREDITS:3		
MODULES	**Contact hours**	**Sem.Exam Marks;%**
Module 1: Introduction: Brief history of data compression applications-Overview of information theory- redundancy- Human audio, visual systems, Taxonomy of compression techniques	**7**	**15**
Module 2: Source coding, source models- scalar quantization theory- rate distribution theory- vector quantization- structure of quantizer's- Evaluation techniques-error analysis and methodologies	**7**	**15**
FIRST INTERNAL TEST		
Module 3: Text compression: Compact techniques-Huffman coding-arithmetic coding-Shannon-Fano coding and dictionary techniques-LZW family algorithms- Entropy measures of performance-Quality measures	**7**	**15**
Module 4: Audio compression: Audio compression techniques-frequency domain and filtering-basic sub-band coding-application to speech coding-G.722-application to audio coding-MPEG audio, progressive encoding for audio-silence compression- speech compression techniques-Vocoders	**7**	**15**
SECOND INTERNAL TEST		
Module 5: Image compression: Predictive techniques-PCM, DPCM, DM. Contour based compression-quad trees, EPIC, SPIHT, Transform coding, JPEG, JPEG-2000, JBIG	**7**	**20**
Module 6: Video compression: Video signal representation-Video compression techniques-MPEG, Motion estimation techniques-H.261. Overview of Wavelet based compression and DVI technology- Motion video compression- PLV performance- DVI real time compression	**7**	**20**

Internal Assessment: 40 marks

Assessment procedure

i) Two internal tests, each having 15%
ii) Tutorials/Assignments/ Mini projects having 10%
iii) End Semester examination having 60%

07EC7233 LINEAR SYSTEM THEORY

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

Prerequisite: A course in Linear algebra

Course Objectives

- Understand the concepts of Vector spaces, linear maps, spectral theory, Inner-product spaces and Metric spaces.
- Develop the ability to solve problems and prove theorems around these concepts.

Syllabus

Finite dimensional Vector Spaces, Span and Linear Independence, Bases, Dimension, Linear Maps, The Matrix of a Linear Map, Eigenvalues and Eigenvectors, Invariant Subspaces, Polynomials Applied to Operators, Inner Product Spaces, Norms, Orthonormal Bases, Orthogonal Projections and Minimization Problems, Linear Functionals and Adjoints, Operators on Inner Product Spaces, Polar and Singular Value Decompositions, Infinite Dimensional Signal Spaces, Metric Spaces, Hilbert space.

Course Outcomes

- Should be able to apply the tools of abstract Linear Algebra to their course work/research.

References:

1. Sheldon Axler, Linear Algebra Done Right, Springer
2. Simmons, Introduction to Topology and Modern Analysis, Tata McGraw Hill.
3. Paul R. Halmos, Finite-Dimensional Vector Spaces, Springer
4. Todd K. Moon and Wynn C. Stirling, Mathematical Methods and Algorithms for Signal Processing, Pearson
5. Arch W. Naylor and George R. Sell, Linear Operator Theory in Engineering and Science, Springer
6. Peter D. Lax, Linear Algebra, Wiley Students Edition.
7. Michael W. Frazier, An Introduction to Wavelets Through Linear Algebra, Springer.

COURSE PLAN

07EC7233 LINEAR SYSTEM THEORY (L-T-P : 3-0-0) CREDITS:3		
MODULES	**Contact hours**	**Sem.Exam Marks;%**
Module 1: Finite dimensional Vector Spaces : Complex Numbers, Definition of Vector Space, Properties of Vector Spaces, Subspaces, Sums and Direct Sums, Finite dimensional Vector spaces: Span and Linear Independence, Bases, Dimension	**7**	**15**
Module 2: Linear Maps : Definitions and Examples, Null Spaces and Ranges,The Matrix of a Linear Map, Invertibility	**7**	**15**
FIRST INTERNAL TEST		
Module 3: Eigenvalues and Eigenvectors : Invariant Subspaces, Polynomials Applied to Operators, Upper-Triangular Matrices, Diagonal Matrices, Invariant Subspaces on Real Vector Spaces	**7**	**15**
Module 4: Inner Product Spaces : Inner Products, Norms, Orthonormal Bases, Orthogonal Projections and Minimization Problems, Linear Functionals and Adjoints. Some Important Bases : Standard Ordered Bases, DFT Bases, DCT Bases.	**7**	**15**
SECOND INTERNAL TEST		
Module 5: Operators on Inner Product Spaces : Self-Adjoint and Normal Operators, The Spectral Theorem, Normal Operators on Real Inner Product Spaces, Positive Operators, Isometries, Polar and Singular Value Decompositions.	**7**	**20**
Module 6: Metric Spaces : Definition, Convergence and Completeness, Banach space, Hilbert space.	**7**	**20**

Internal Assessment: 40 marks

Assessment procedure

i) Two internal tests, each having 15%
ii) Tutorials/Assignments/ Mini projects having 10%
iii) End Semester examination having 60%

07EC7243 COMPRESSED SAMPLING: PRINCIPLES AND ALGORITHMS

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

Prerequisite: A basic course in Signals and Systems

Course Objectives

- To provide deepth understanding of basic theory of sampling, signal spaces, multiresolution analysis etc
- Introduce knowledge on compressed sampling and sparse signal recovery

Syllabus

Fundamentals of sampling analog signals: Sampling of duration-limited signals and motivation for compressed sampling; Mathematical preliminaries: Signal spaces, topology; Sparse solution of under-determined system of equations; Multi-resolution analysis, Methods of signal representation and decomposition; Compressed sampling: Sparse representation of signals, Sparsity and compressibility; Construction of measurement basis, Sensing matrix; The Restricted Isometry Property (RIP); Mutual coherence between sensing and representation bases; Sparse signal recovery: Convex optimization based methods; Greedy algorithms; Iterative Re-weighted Least Squares Algorithm; Performance analysis.

Course Outcomes

- Better appreciation on the concepts of signal spaces
- Have a good knowledge of the basic theory and ideas showing when it is possible to reconstruct sparse or nearly sparse signals from undersampled data

References

1. S. G. Mallat, A Wavelet Tour of Signal Processing: The Sparse Way, Academic Press/Elsevier, 2009.
2. Richard G. Baraniuk, Mark A. Davenport, Marco F. Duarte, Chinmay Hegde (Collection Editors), An Introduction to Compressive Sensing, CONNEXIONS (Publishing) Rice University, Houston, Texas, 2012.
3. Michael Elad, Sparse and Redundant Representations, Springer, New York, 2010.
4. Yonina C. Eldar and Gitta Kutyniok, Compressed Sensing: Theory and Applications, Cambridge University Press, 2012.
5. Simon Foucart, Holger Rauhut, A Mathematical Introduction to Compressive Sensing, Springer/Birkhauser, New York, 2013.

COURSE PLAN

07EC7243 COMPRESSED SAMPLING: PRINCIPLES AND ALGORITHMS (L-T-P : 3-0-0) CREDITS:3		
MODULES	**Contact hours**	**Sem.Exam Marks;%**
Module 1: Fundamentals of Sampling Analog Signals, and Mathematical Preliminaries: Classical sampling theorem for band-limited signals; Bandpass sampling theorem; Sample-rate reduction and multi-channel sampling, Sampling of random signals; Sampling as a signal representation problem; Sampling of duration-limited signals and motivation for compressed sampling	**7**	**15**
Module 2: Signal spaces: normed linear spaces - topology, Convergence, completeness and stable signal synthesis; Hamel basis, Schauder basis and Riesz basis; Orthogonality and bi-orthogonality; Frames; Linear transformations and change of basis; Sampling as an isomorphism; Separable signal spaces and Decomposition of signals; Under-determined system of equations - methods of solution, sparse solution.	**7**	**15**
FIRST INTERNAL TEST		
Module 3: Multi-resolution analysis - Methods of signal representation and decomposition: Principles of Continuous and discrete wavelet transforms; Wavelet packets; Best basis identification, entropy methods; Computation Algorithms; Application in signal compression.	**7**	**15**
Module 4: Compressed Sampling**:** Sparse representation of signals - Sparsity and compressibility; Construction of measurement basis - Sensing matrix; Null-space conditions and the spark; The Restricted Isometry Property (RIP); RIP and null-space property;	**7**	**15**
SECOND INTERNAL TEST		
Module 5: Measurement bounds and condition for stable recovery; Coherence of measurement basis; mutual coherence between sensing and representation bases, Sparse Signal Recovery: The l_0 and l_p for p ϵ (0, 1), and the l_p-norm for p $\geq$1; Recovery through l_1-norm minimization; Recovery under noiseless and noisy conditions; Algorithms for sparse recovery - Design requirements;	**7**	**20**

Module 6: Convex optimization based methods: linear programming, Greedy algorithms: Matching pursuit, Orthogonal matching pursuit; Regularized orthogonal matching pursuit; Compressive sampling matching pursuit; Relaxation on the l_0: The l_p for pϵ(0, 1) as a weighted l_2 -norm; Iterative Re-weighted Least Squares Algorithm; Performance analysis of the recovery algorithms.	**7**	**20**

Internal Assessment:40 Marks

Assessment procedure

i) Two internal tests, each having 15%
ii) Tutorials/Assignments/ Mini projects having 10%
iii) End Semester examination having 60%

07EC 7205 SEMINAR

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

Prerequisite: Nil

Course Objectives : This course is intended for

- Increasing the breadth of knowledge
- Enhancing the ability of self study
- Improving presentation and communication skills
- Augmenting the skill of Technical Report Writing.

Outline and Evaluation procedure:

Students have to register for the seminar and select a topic 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 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 report and coverage of the topic, presentation and ability to answer the questions put forward by the committee.

Faculty member in charge of the seminar and another faculty member in the department nominated by the Head of the Department are the evaluators for the seminar.

Internal Assessment: 100 marks

Distribution of marks for the seminar is as follows.

Marks for the report: 30%
Presentation: 40%
Ability to answer questions on the topic: 30%

Course Outcomes:

The graduate will have acquired

- Debating capability and presentation skills in a technical topic of his interest.
- Knowledge about contemporary issues and research opportunities
- Capacity to communicate effectively and professionally in both verbal and written forms
- Capability for self education and lifelong learning

07EC 7207 PROJECT (Phase 1)

Credits: 0-0-12: 6 **Year: 2015**

Prerequisite : Nil

Course objectives*:*

- To identify current issues in the area of Communication Engineering and Signal Processing.
- 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.

. **Outline and Evaluation procedure:**

The student is required to undertake the project phase-I during the third semester and is continued in the 4th semester (Phase-II).

Normally students are expected to do the project within the college. However they are permitted to do the project in an industry or in a government research institute under a qualified supervisor from that organization. Progress of the project work is to be evaluated at the end of the third semester. For this a committee headed by the head of the department with two other faculty members in the area of the project and the project supervisor/s. If the project is done outside the college, the external supervisor associated with the student shall also be a member of the committee.

Phase-I consists of preliminary thesis work, two reviews of the work and the submission of preliminary report. First review should highlight the topic, objectives, methodology and expected results. Second review assesses the progress of the work, preliminary report and future plan of the work to be completed in the 4th semester. A preliminary report consisting of the work completed and scope of the work for the 4th semester should be submitted to the Head of department.

Project Progress evaluation details: Marks:50

Progress evaluation by the Project Supervisor : 20 Marks

Presentation and evaluation by the committee : 30 Marks

Course Outcomes:

The graduate will have acquired

- Knowledge about contemporary issues and research opportunities
- Capacity to communicate effectively and professionally in both verbal and written forms
- Capability of self education and lifelong learning
- Understanding of professional and ethical responsibility.

Semester IV

07EC 7202 PROJECT (Phase 2)

Credits: 0-0-21: 12 **Year: 2015**

Pre- requisites: Nil

Course 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.

Outline and Evaluation procedure:

Project phase-II is a continuation of project phase-I started in the third semester.

There would be two reviews in the 4th semester, first in the middle of the semester and the second at the end of the semester. First review is to evaluate the progress of the work. Second review would be a pre-submission presentation before the evaluation committee to assess the quality and quantum of the work done. This would be a pre-qualifying exercise for the students for getting approval by the Departmental committee for the submission of the thesis.

Final evaluation of the project will be taken up only if the student has earned all course credits listed in the first three semesters. Project evaluation shall be done by the same committee constituted in the third semester with an external expert, either from an academic/R&D organization or from Industry, as an additional member. Final project grading shall take into account the progress evaluation done in the third semester and the project evaluation in the fourth semester. If the quantum of work done by the candidate is found to be unsatisfactory, the committee may extend the duration of the project up to one more semester, giving reasons for this in writing to the student. Normally further extension will not be granted and there shall be no provision to register again for the project.

At least one technical paper is to be prepared for possible publication in journal or conferences. The technical paper is to be submitted along with the thesis. The final evaluation of the project will be external evaluation.

Project Progress evaluation details: Marks:100

Project evaluation by the supervisor/s : 30 Marks

Presentation & evaluation by the Committee : 40 Marks

Evaluation by the External expert : 30 Marks

Course Outcomes:

The graduate will have acquired

- Knowledge about contemporary issues and research opportunities
- Capacity to communicate effectively and professionally in both verbal and written forms
- Capability of self education and lifelong learning
- Understanding of professional and ethical responsibility