SCHEME AND SYLLABUS FOR M.TECH (FULL TIME) DEGREE COURSE

in

ELECTRONICS ENGINEERING (2015 Scheme)
(Specialization: Signal Processing)
(Faculty of Engineering)
At

ALAPPUZHA/PATHANAMTHITTA CLUSTER

of the

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

Tech (Full Time) Degree Course in
ELECTRONICS ENGINEERING
(Specialization: Signal Processing)

SCHEME

Semester I

Exam Slot	*Course Code*	*Course Title*	*L-T-P*	*Internal Marks*	*End Semester Exam Marks*	*Duration (Hrs)*	*Credits*
A	03EC6401	Linear Algebra for Signal Processing	3-1-0	40	60	3	4
B	03 EC 6411	Probability & Random Process	3-1-0	40	60	3	4
C	03 EC 6421	Multi rate Signal Processing	3-1-0	40	60	3	4
D	03 EC 6431	Digital Signal Processors	3-0-0	40	60	3	3
E		Elective I	3-0-0	40	60	3	3
S	03 RM 6001	Research Methodology	1-1-0	100	0	0	2
U	03 EC 6821	Signal Processing Lab I	0-0-2	100	0	0	1
T	03 EC 6901	Seminar I	0-0-2	100	0	0	2
Total credits for Semester I							***23***

ELECTIVE I

1. 03 EC 6441 Modulation & Coding Theory
2. 03 EC 6451 Artificial Neural Networks
3. 03 EC 6461 Advanced Digital System Design
4. 03 EC 6471 Signal Compression Techniques

SEMESTER II

Exam Slot	*Course Code*	*Course Title*	*L-T-P*	*Internal Marks*	*End Semester Exam Marks*	*Duration (Hrs)*	*Credits*
A	03EC 6402	Estimation & Detection Theory	3-1-0	40	60	3	4
B	03EC 6412	Digital image Processing	3-0-0	40	60	3	3
C	03EC 6422	Adaptive Signal Processing	3-0-0	40	60	3	3
D		Elective II	3-0-0	40	60	3	3
E		Elective III	3-0-0	40	60	3	3
V	03EC 6902	Mini Project	0-0-4	100	0	0	2
U	03EC 6832	Signal Processing Lab II	0-0-2	100	0	0	1
Total credits for Semester II							***19***

ELECTIVE II

1. 03EC 6432 Speech processing & coding
2. 03EC 6442 Wavelet theory & applications
3. 03EC 6452 Multidimensional Signal Processing
4. 03EC 6462 Optical Signal Processing

ELECTIVE III

1. 03EC 6472 VLSI Architectures For DSP
2. 03EC 6482 Pattern Recognition
3. 03EC 6492 Audio signal processing
4. 03EC 6502 Array Signal Processing

SEMESTER III

Exam Slot	*Course code*	*Course Title*	*L-T-P*	*Internal Marks*	*End Semester Exam Marks*	*Duration (Hrs)*	*Credits*
A		Elective IV	3-0-0	50	50	3	3
B		Elective V	3-0-0	50	50	3	3
	03EC 7903	Seminar II	0-0-2	100	0	0	2
	03EC 7913	Project Phase I	0-0-8	50	0	0	6
Total credits for semester III							*14*

ELECTIVE IV

1. 03EC 7403 Soft Computing
2. 03EC 7413 Wireless Networks
3. 03EC 7423 Biomedical Signal Processing
4. 03EC 7433 Multimedia Security

ELECTIVE V

1. 03EC 7443 Time Frequency Analysis
2. 03EC 7453 Computer Vision
3. 03EC 7463 Digital Control system
4. 03EC 7473 Optimization Techniques

Semester IV

Exam Slot	*Course code*	*Course Title*	*L-T-P*	*Internal Marks*	*End Semester Exam Marks*	*Duration (Hrs)*	*Credits*
A	03EC 7914	Project Phase II	0-0-21	70	30	-	12
Total credits for semester IV							*12*

	Credits
Grand total credits (Semester I to IV)	**68**

SEMESTER I

Course No.	Course Name	L-T-P-Credits	Year of Introduction
03EC 6401	**LINEAR ALGEBRA FOR SIGNAL PROCESSING**	**3-1-0**	**2015**

Syllabus:

Algebraic Structures**,** Vector space, Orthonormal basis, Isomorphic vector spaces, Linear Transformations, Matrix representation, coordinate transformation, projection, Matrix Methods, Fourier basis, wavelet basis.

References

1. G. Strang, *Linear Algebra and Its Applications*, Nelson Engineering, 2007.
2. G.F.Simmons, *Topology and Modern Analysis*, McGraw Hill
3. D. C. Lay, *Linear Algebra and Its Applications*, 3rd Edition, Pearson, 2002.
4. Frazier, Michael W, *An Introduction to Wavelets Through Linear Algebra*, EC Sringer Publications,
5. Hoffman Kenneth and Kunze Ray, *Linear Algebra*, Prentice Hall of India
6. Reichard Bronson, Academic Press.

Course Plan

Module	Content	Hours	Semester Exam Marks
I	**Algebraic Structures**: Sets - functions - operators- Group - homomorphism of groups - Ring - Field - Vector space - Subspaces - direct sum - metric space - inner product space - Lp space- Banach space - Hilbert space.	**16**	**25%**
II	**Linear independence**: basis - dimension - orthonormal basis- finite dimensional vector spaces- isomorphic vector spaces - Examples of finite and infinite dimensional vector spaces -RN, CN	**16**	**25%**

First Internal Exam

III	**Linear Transformations**:- Linear Transformations – four fundamental subspaces of linear transformation – inverse transformation - rank nullity theorem - Matrix representation of linear transformation – square matrices – unitary matrices - Inverse of a square matrix - Change of basis – coordinate transformation - system of liner equations – existence and uniqueness of solutions- projection – least square solution – pseudo inverse.	**15**	**25%**
IV	**Matrix Methods and Transforms**: - Eigen values, Eigen vectors, Generalized Eigen vectors Diagonalizability - orthogonal diagonalization - Symmetric, Hermitian and Unitary matrices (transformations) - Jordan canonical form - Fourier basis - DFT as a linear transformation –Translation invariant linear transformation -wavelet basis -wavelet transforms.	**15**	**25%**
Second Internal Exam			
End semester Exam			

Course No.	Course Name	L-T-P-Credits	Year of Introduction
03 EC 6411	**PROBABILITY & RANDOM PROCESS**	**3-1-0**	**2015**

Syllabus

Probability, Random Variable, Expectation, Random process, Wide sense Stationarity,
Random processes as inputs to linear time invariant systems, Random Sequences, ARMA Models, Band limited and WSS periodic Processes.

References

1. Henry Stark and John W. Woods, *Probability and Random Processes with Applications to Signal Processing*, Pearson Education, Third edition.
2. Athanasios Papoulis and S. Unnikrishna Pillai. *Probability, Random Variables and Stochastic Processes*, TMH
3. Gray, R. M. and Davisson L. D, *An Introduction to Statistical Signal Processing*.

Course Plan

Module	Content	Hours	Semester Exam Marks
I	**Introduction**: Sets, Fields and Events, Definition of probability, Joint, Conditional and Total Probability, Bayes' Theorem and applications. Random Variable:- Definition, Probability Distribution Function, Probability Density function, Common density functions, Continuous, Discrete and Mixed random Variables, Conditional and Joint Distributions and densities, independence of random variables. Functions of Random Variables: One function of one random variable, one function of two random variables, two functions of two random variables.	**16**	**25%**

II	**Expectation**: Fundamental Theorem of expectation, Moments, Joint moments, Moment Generating functions, Characteristic functions, Conditional Expectations, Correlation and Covariance, Jointly Gaussian Random Variables. Random Vector: - Definition, Joint statistics, Covariance matrix and its properties. Random Processes: - Basic Definitions, Poisson Process, Wiener Process, Markov Process, Birth- Death Markov Chains, Chapman-Kolmogorov Equations, Stationarity, Wide sense Stationarity, WSS Processes and LSI systems.	**16**	**25%**
First Internal Exam			
III	**Random processes as inputs to linear time invariant systems**: power spectral density, Gaussian processes as inputs to LTI systems, white Gaussian noise. Periodic and cyclostationary processes. Chebyshev and Schwarz Inequalities, Chernoff Bound, Central Limit Theorem.	**15**	**25%**
IV	**Random Sequences**: Basic Concepts, WSS sequences and linear systems, Markov Random sequences, ARMA Models, Markov Chains, Convergence of Random Sequences: Definitions, Laws of large numbers. Advanced Topics: Ergodicity, Karhunen- Leove Expansion, Representation of Band limited and periodic Processes: WSS periodic Processes, Fourier series for WSS Processes.	**15**	**25%**
Second Internal Exam			
End semester Exam			

Course No.	Course Name	L-T-P-Credits	Year of Introduction
03 EC 6421	**MULTIRATE SIGNAL PROCESSING**	**3-1-0**	**2015**

Syllabus

Sampling, Decimation and Interpolation, Digital Filter Banks, Polyphase representation, QMF bank, Perfect reconstruction, Uniform and non-uniform bank, Para unitary PR Filter Banks, Quantization Effects, Cosine Modulated pseudo QMF Bank.

References

1. P.P. Vaidyanathan, *Multirate Systems and Filter Banks*, Pearson-Education, Delhi, 2004.
2. N.J. Fliege,*Multirate digital signal processing*, John Wiley 2000.
3. Sanjit K. Mitra, *Digital Signal Processing: A computer based approach*, McGraw Hill.2010.
4. R.E. Crochiere, L. R., *Multirate, Digital Signal Processing*, Prentice Hall. Inc. 1983.
5. J.G. Proakis, D.G. Manolakis, *Digital Signal Processing: Principles. Algorithms and Applications*, 4th Edn. Prentice Hall India, 2006.
6. B.Boashash, *Time-Frequency Signal Analysis and Processing: A Comprehensive Reference*, Elsevier, UK, 2003.

Course Plan

Module	Content	Hours	Semester Exam Marks
I	**The sampling theorem:** sampling at sub Nyquist rate - Basic Formulations and schemes. Basic Multirate operations**:** Decimation and Interpolation - Digital Filter Banks- DFT Filter Bank- Identities- Poly phase representation Maximally decimated filter banks: Poly phase representations - Errors in the QMF bank- Perfect reconstruction (PR) QMF Bank - Design of an alias free QMF Bank.	**16**	**25%**
II	Uniform band and non uniform filter bank - tree structured filter bank- Errors created by filter bank system- Poly phase representation- perfect reconstruction systems.	**16**	**25%**

First Internal Exam			
III	Para unitary PR Filter Banks- Filter Bank Properties induced by paraunitarity - Two channel FIR paraunitary QMF Bank- Linear phase PR Filter banks- Necessary conditions for Linear phase property- Quantization Effects: -Types of quantization effects in filter banks. Coefficient sensitivity effects, dynamic range and scaling.	**15**	**25%**
IV	Cosine Modulated pseudo QMF Bank- Alas cancellation-phase - Phase distortion- Closed form expression- Poly phase structure- PR Systems.	**15**	**25%**
Second Internal Exam			
End semester Exam			

Course No.	Course Name	L-T-P-Credits	Year of Introduction
03 EC 6431:	**DIGITAL SIGNAL PROCESSORS**	**3-0-0**	**2015**

Syllabus

Architectural features of DSP, Programming in C vs Programming in assembly, TMS 320 C 6x, Linear and Circular Addressing Modes, SHARC Digital Signal Processor, Practical applications

References

1. *Digital Signal Processing: A Practical guide for Engineers and scientists*, Steven W Smith,Newness (Elsevier), 2003

2. *Digital Signal Processing and applications with the C6713 and C6416 DSK*, Rulf Chassaing,Wiley-Interscience, 2005

3. *Real time Digital Signal Processing*, Sen M Kuo, Bob H Lee, John Wiley and Sons, 2001.

4. *Digital Signal Processing Implementation using the TMS320C6000 DECS Platform*, 1st Edition; Naim Dahnoun. Prentice Hall. Inc. 2000

5. *Digital Signal Processing* - *A Student Guide*, 1st Edition, T.J. Terrel and Lik-Kwan Shark; Macmillan Press Ltd.

6. *Digital Signal Processing: A System Design Approach*, 1st Edition, David J Defatta J, Lucas Joseph G &Hodkiss William S; John Wiley

7. *Digital Signal Processing- A Practical approach*, E C Elfeachor and B W Jervis, Pearson, 2005.

8. *A Simple approach to Digital Signal processing*, 1st Edition, KreigMarven& Gillian Ewers; Wily Interscience.

9. *DSP FIRST* - *A Multimedia Approach*, 1st Edition, James H. McClellan, Ronald Schaffer and Mark A. Yoder; Prentice Hall.

Course Plan			
Module	**Content**	**Hours**	**Semester Exam Marks**
I	DSPs and Conventional Microprocessors, Circular Buffering, Architectural features of DSP- Von Neumann, Harvard, Super Harvard architectures, Fixed vs. Floating point DSP processors, Programming in C vs Programming in assembly, Speed benchmarks for DSPs, Multiprocessing for high Speed DECS applications.	**16**	**25%**
II	TMS 320 C 6x**:** Architecture, Functional Units, Fetch and Execute Packets, Pipelining, Registers, Linear and Circular Addressing Modes, Indirect Addressing, Circular Addressing,TMS320C6x Instruction Set, Assembly Code Format, Types of Instructions, Assembler Directives, Linear Assembly, ASM Statement within C, C Callable Assembly Function, Timers, Interrupts, Multichannel Buffered Serial Ports, Direct Memory Access, Memory Considerations, Fixed- and Floating-Point Formats, Code Improvement, Constraints	**16**	**25%**
First Internal Exam			
III	SHARC Digital Signal Processor: - Architecture - IOP Registers - Peripherals - Synchronous Serial Port - Interrupts -Internal/External/Multiprocessor Memory Space - Multiprocessing - Host Interface - Link Ports.	**15**	**25%**

IV	Some Practical applications of Digital Signal Processors**:** Sine wave generators, Noise generators, DTMF Tone detection, Adaptive echo cancellation, Acoustic echo cancellation, Speech enhancement.	**15**	**25%**
Second Internal Exam			
End semester Exam			

Course No.	Course Name	L-T-P-Credits	Year of Introduction
03 EC 6441	**MODULATION AND CODING THEORY**	**3-0-0**	**2015**

Syllabus

Signal space representation of communication signals, Optimum waveform receiver, probability of error, Coloured Gaussian noise channels, Karhunen-Loeve expansion approach, Digital communication over fading channels, non-coherent receiver, Rayleigh and Ricean channels, Performance of digital modulation schemes. Communication over band limited channels, ISI, equalization, Coded modulation schemes, Information Theory, channel capacity for Gaussian channels, Linear Codes, Cyclic codes, Convolutional codes.

References

1. J.G Proakis, " *Digital Communication*", MGH 4th edition, 2001
2. M. Cover and J. A. Thomas, *Elements of Information Theory*, John Wiley, New York, 2nd edition 2006.
3. Edward A. Lee and David G. Messerschmitt, " *Digital Communication*", Allied Publishers (second Edition)
4. J Marvin K. Simon, Sami M. Hinedi and William C Lindsey, " *Digital communication techniques*" PHI
5. U. Madhow, *Fundamentals of Digital Communication*, Cambridge University Press, 2008.
6. R. H. Morelos-Zaragoza, *The Art of Error Correcting Coding*, John Wiley, New York, 2006.
7. W. Ryan and S. Lin, *Channel Codes: Classical and Modern*, Cambridge University Press, 2009

Course Plan			
Module	**Content**	**Hours**	**Semester Exam Marks**
I	Characterization of communication signals and systems-signal space representation-connecting linear vector space to physical waveform space- scalar and vector communication over memory less channels. Optimum waveform 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, Optimum waveform receiver for coloured Gaussian noise channels- Karhunen-Loeve expansion approach, whitening	**16**	**25%**
II	Digital communication over fading channels Characterization of fading multipath channels- Statistical models for fading channels- Time varying channel impulse response- narrow band fading models- wideband fading models- channel correlation functions- key multipath parameters- Rayleigh and Ricean fading channels, Optimum non-coherent receiver in random amplitude, random phase channels- performance of non-coherent receiver in random amplitude, random phase channels- performance in Rayleigh and Ricean channels- performance of digital modulation schemes such as BPSK, QPSK, FSK, DPSK etc over wireless channels	**16**	**25%**
First Internal Exam			

III	Communication over band limited channels: Communication over band limited channels- Optimum pulse shaping- Nyquist criterion for zero ISI, Partial response signalling- equalization techniques- zero forcing linear equalization- decision feedback equalization. MMSE, ZFE, FSE; Carrier and clock synchronization; Effects of phase and timing jitter; Coded modulation schemes: TCM; Digital transmission over fading channels.	**15**	**25%**
IV	Review of Information Theory; Shannon's noiseless coding theorem; Encoding of discrete sources. Discrete memoryless channels; Shannon's noisy coding theorem and converse for discrete channels; Differential entropy; Calculation of channel capacity for Gaussian channels. Coding Theory: Linear Codes, distance bounds, generator and parity check matrices, error-syndrome table; Cyclic codes, generator and parity check polynomials; BCH codes and Reed-Solomon Codes; An overview of convolutional codes; Turbo codes, LPDC codes	**15**	**25%**
Second Internal Exam			
End semester Exam			

Course No.	Course Name	L-T-P-Credits	Year of Introduction
03EC6451:	**ARTIFICIAL NEURAL NETWORK**	**3-0-0**	**2015**

Syllabus

Neural Networks and architectures, Supervised and unsupervised learning, Statistical pattern recognition, Support vector machines, Recurrent Neural Networks, linear and nonlinear dynamical systems, Attractor, Genetic algorithm based machine learning classifier system, Applications.

References

1.*Neural Networks, A Class room approach*, Satish Kumar, Tata McGraw Hill, 2004

2.*Artificial Intelligence and Intelligent Systems*, N.P Padhy, Oxford University Press, 2005.

3.*Introduction to Artificial Systems*, J M Zurada, Jaico Publishers

4.*Neural Networks* –A Comprehensive Foundation, Simon Haykins, PHI

5.*Advanced Methods in Neural Computing*, Wasserman P.D, Van Nostrand Reinhold, New York.

6. *Methods of Optimization*. G. R Walsh, John Wiley & Sons.

7. *Artificial Intelligence*, Elaine Rich, Kevin Knight, Tata McGraw Hill, 2006

8. *Artificial Neural Networks*, Yegnanarayana, PHI, 1999.

9. *Introduction to Artificial Intelligence*, E.Cherniak, D. McDermott, Addison – Wesley Pub.1987.

10. *Fundamentals of Neural Networks- Architectures, Algorithms and Applications*- L. Fausett, Pearson-Education, 2007.

Course Plan

Module	Content	Hours	Semester Exam Marks
I	Introduction to ANNs: Classical AI and Neural Networks, Human brain and the biological neuron, Artificial Neurons, Neural Networks and architectures, feed forward and feedback architectures, geometry of binary threshold neurons and their networks, Supervised and unsupervised learning, concepts of generalization and fault tolerance. Supervised learning**:** Perceptrons and LMS, Back propagation Neural Networks.	**16**	**25%**

II	Statistical pattern recognition perspective of ANNs: Bayes theorem, Implementing classification decisions with the Bayes theorem, interpreting neuron signals as probabilities, Multilayered networks, error functions, posterior probabilities, error functions for classification problems, Support vector machines, RBFNNs, regularization theory, learning in RBFNNs.	**16**	**25%**
First Internal Exam			
III	Recurrent Neural Networks**:** Dynamical systems, states, state vectors, state equations, attractors and stability, linear and nonlinear dynamical systems, Lyupanov stability, Cohen Grossberg theorem, Attractor neural networks: Associative learning, associative memory, Hopfield memory, Simulated annealing and the Boltzmann Machine, BAM, ART principles, Self Organizing Maps.	**15**	**25%**
IV	Genetic algorithms and Evolutionary programming**:** Genetic algorithms – operators, working, Genetic algorithm based machine learning classifier system. Swarm Intelligent Systems: Ant Colony Systems (ACO): Biological concept, artificial systems - Applications, Particle Swarm Intelligent Systems – PCO method, Applications.	**15**	**25%**
Second Internal Exam			
End semester Exam			

Course No.	Course Name	L-T-P-Credits	Year of Introduction
03EC6461:	**ADVANCED DIGITAL SYST EM DESIGN**	**3-0-0**	**2015**

Syllabus

Combinational circuit design, Sequential Circuit Design, Finite State Machine, Programmable Logic Devices, combinational and sequential circuits using PLDs, Asynchronous sequential circuits, hazards, State machine charts, Shannon's Expansion Theorem, Consensus Theorem, Threshold logic.

References:

1. *Fundamentals of Digital Design*, Charles H. Roth, Jr., PWS Pub. Co. 1998.
2. *Digital Design Fundamentals*, Kenneth J Breeding, Prentice Hall, Englewood Cliffs, New Jersey, 1989.
3. *A Systematic Approach to Digital Design*, William I. Fletcher, PHI, 1996.
4. *Introduction to Digital Design*, James E. Palmer, David E. Perlman, Tata McGraw Hill, 1996.
5. *Logic Synthesis*, S.Devadas, A.Ghosh and K.Keutzer, McGraw Hill, 1994.
6. *Logic Design Theory*, N.N Biswas, Prentice Hall of India, 1st Edn, 1993.
7. *Digital Design Principles and Practices*, John F. Wakerly, Prentice Hall, 4th Edition, 2001.

Course Plan

Module	Content	Hours	Semester Exam Marks
I	Combinational circuit design: using multiplexers, code convertors, XOR & AOI gates, Sequential Circuit Design: Clocked Synchronous State Machine Analysis, Mealy and Moore machines, Finite State Machine design procedure – state diagrams, state tables, state reduction methods, state assignments. Incompletely specified state machines, implementing the states of FSM.	**16**	**25%**

II	Designing with Programmable Logic Devices: Read Only Memories, Programmable Array Logic, Programmable Logic Arrays, PLA minimization and PLA folding, Other Sequential PLDs, Design of combinational and sequential circuits using PLDs. XILINX FPGAs – Configurable Logic Block (CLB), Input/ Output Block (IOB), Programmable Interconnection Points (PIP), XILINX CPLDs	**16**	**25%**
First Internal Exam			
III	Asynchronous sequential circuits: Derivation of excitation table, Race conditions and cycles, Static and dynamic hazards, Methods for avoiding races and hazards, essential hazards, Designing with SM charts – State machine charts, Derivation of SM charts, and Realization of SM charts.	**15**	**25%**
IV	Advanced Topics in Boolean algebra: Shannon's Expansion Theorem, Consensus Theorem, Reed Muller Expansion, Design of Static Hazard free and dynamic hazard free logic circuits, Threshold logic, Symmetric functions.	**15**	**25%**
Second Internal Exam			
End semester Exam			

Course No.	Course Name	L-T-P-Credits	Year of Introduction
03EC6471:	**SIGNAL COMPRESSION TECHNIQUES**	**3-0-0**	**2015**

Syllabus

Information Theory, Compression Techniques, Lossless and Lossy, Applications, Rate distortion function, Uniform & Non-uniform Quantization, Transforms, Data Compression standards, Speech Compression , Audio Compression, Image Compression and Video Compression Standards.

References

1. *Introduction to Data Compression*, Khalid Sayood, Morgan Kaufmann Publishers., Second Edn. 2005.
2. *Data Compression*: The Complete Reference", David Salomon, Springer Publications, 4th Edn. 2006.
3. *Elements of Information Theory*, Thomas M. Cover, Joy A. Thomas, John Wiley & Sons, 2nd Edn, 2006
4. *Rate Distortion Theory: A Mathematical Basis for Data Compression*, Toby Berger, Prentice Hall,Inc., 1971.
5. *The Transform and Data Compression Handbook*, K.R.Rao, P.C.Yip, CRC Press. 2001.
6. *Information Theory and Reliable Communication*, R.G.Gallager, John Wiley & Sons, Inc., 1968.
7. *Multiresolution Signal Decomposition: Transforms, Sub bands and Wavelets*, Ali N. Akansu, Richard A.Haddad, Academic Press.2nd edition, 2000
8. "*Wavelets and Subband Coding*", Martin Vetterli, Jelena Kovacevic, Prentice Hall Inc., 1995.

Course Plan

Module	Content	Hours	Semester Exam Marks
I	Review of Information Theory: The discrete memoryless information source - Kraft inequality; optimal codes, Source coding theorem. Compression Techniques - Lossless and Lossy Compression – Mathematical Preliminaries for Lossless Compression -Huffman Coding - Optimality of Huffman codes – Extended Huffman Coding – Adaptive Huffman Coding - Arithmetic Coding - Adaptive Arithmetic coding, Run Length Coding, Dictionary Techniques - Lempel-Ziv coding, Applications - Predictive Coding – Prediction with Partial Match – Burrows Wheeler Transform, Dynamic Markov Compression.	**16**	**25%**

II	Rate distortion theory**:** Rate distortion function R(D),Properties of R(D); Calculation of R(D) for the binary source and the Gaussian source, Rate distortion theorem, Converse of the Rate distortion theorem, Quantization - Uniform & Non-uniform - optimal and adaptive quantization, vector quantization and structures for VQ, Optimality conditions for VQ, Predictive Coding - Differential Encoding Schemes.	**16**	**25%**
First Internal Exam			
III	Mathematical Preliminaries for Transforms, Karhunen-Loeve Transform, Discrete Cosine and Sine Transforms, Discrete Walsh Hadamard Transform, Lapped transforms - Transform coding - Subband coding -Wavelet Based Compression - Analysis/Synthesis Schemes.	**15**	**25%**
IV	Data Compression standards: Zip and Gzip, Speech Compression Standards: PCM-G.711, ADPCM G.726, SBC G.722, LD-CELP G.728, CS-ACELP (-A) G.729, MPC-MLQ , G.723.1, GSM HR VSELP, IS-54 VSELP, IS-96 QCELP, MELP, FS 1015, LPC10, FS1016, CELP, G721. Audio Compression standards: MPEG, Philips PASC, Sony ATRAC, Dolby AC-3, Image Compression standards: JBIG, GIF, JPEG & JPEG derived industry standards, CALIC, ECSIHT, EZW, JPEG 2000. Video Compression Standards: MPEG, H.261, H.263 & H264.	**15**	**25%**
Second Internal Exam			
End semester Exam			

Course No.	Course Name	L-T-P	Credits	Year of Introduction
03RM6001	Research methodology	1-1-0	2	2015

Course Objectives:

- This course is designed to familiarize the student with the research process, problem identification strategies and formulation of a research plan by doing case studies

Syllabus

Introduction to Research Methodologies - Objectives -motivation in research- Significance of research - interaction between industries and research units –research and innovation

Research Formulation- - literature review–

Ethics in research: – copy right – plagiarism – citation – acknowledgement

Research Design – and Report writing

Case Studies : Department / stream specific case study and preparation of a research plan or a review paper

Expected Outcomes:

- Students will be able to write a review paper after critically evaluating the state of the art development in a topic of interest
- Students will acquire capability to write a research proposal in the form of a technical paper which could lead the student towards his / her final thesis topic
- **No formal end semester examination is intended – Evaluation is based on internal oral presentations and a Technical Report or a Research Plan or a Review Paper**

References

1. R. Paneersalvam, "Research Methodology",Prentice Hall of India Pvt. Ltd.,2011
2. Mike Martin, Roland Schinzinger, "Ethics in Engineering" ,McGraw Hill Education, Fourth Edition,.2014
3. Vinod V Sople," Managing Intellectual Property-The Strategic Imperative, EDA", Prentice of Hall Pvt. Ltd.,2014
4. Kothari C R &Gaurav Garg – "Research Methodology- Methods and Techniques",New Age International(P) Ltd Publications,2006
5. Day A Robert,"How to write and publish a scientific paper",Cambridge University,UK,2012
6. Leedy P D,"Practical Research-Planning and Design", Prentice Hall of India Pvt. Ltd.

COURSE PLAN

Module	Contents	Hours Allotted	% of Marks in End-Semester Examination
I	**Introduction** –Need for research- objectives and motivations in research- Significance of research - -need for interaction between	**4**	**25%**

	academic institutions, industrial and research establishments – research and innovation. Research Formulation- Identifying a research problem- - literature review– **confirming to a research problem based on literature review.**		
FIRST INTERNAL EXAM			
II	Research Ethics – Environmental impacts – Ethical issues - Intellectual Property Rights – Patents – legal formalities in filing patent in India – Copy right– plagiarism – citation and acknowledgement.	3	25%
III	**Research design** –Prepare research plan. **Report writing** – types of report – research report, research proposal, funding agencies for research concerned to the specialization, significance of peer reviewed articles and technical paper- - simple exercises - oral presentation	3	
SECOND INTERNAL EXAM			
IV	**Case Studies** The student is expected to **prepare a research plan** relating to a topic of current interest in the concerned specialization, which has appeared in a recent journal. A minimum of 20 related referred articles should be critically studied. On the basis of this, the student is expected to prepare a review report/paper of publishable quality. **This paper has to be presented for open defence before the departmental committee. (This would carry 50% marks)**	6	50%

END SEMESTER EXAM

Course No.	Course Name	L-T-P-Credits	Year of Introduction
03EC6821	**SIGNAL PROCESSING LAB I**	**0-0-2**	**2015**

Reference:

1 *Digital Signal Processing and applications with the C6713 and C6416 DSK*, Rulf Chassaing,Wiley-Interscience, 2005

2. *Digital Signal Processing Implementation using the TMS320C6000 DECS Platform*, 1st Edition; Naim Dahnoun. Prentice Hall. Inc. 2000

Syllabus

DSP PROCESSOR LAB EXPERIMNETS USING TMS320C6X PROCESSORS

1. Familiarization of DSP processor TMS320C6X
2. Arithmetic operations using various addressing modes
3. Implementation of Linear and Circular Convolution
4. Discrete Fourier transform
5. Finite impulse response filters.
6. Infinite impulse response filters
7. Waveform generation
8. Real time program

Course No.	Course Name	L-T-P-Credits	Year of Introduction
03EC6901	**SEMINAR I**		**2015**

Students have to register for the seminar and select a topic in consultation with any faculty member offering courses for the programme. They are required to choose a topic of their interest from Signal Processing related topics preferably from outside the M.ech syllabus and give a seminar on that topic. 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 coverage of the topic, presentation and ability to answer the questions put forward by the committee.

SEMESTER II

Course No.	Course Name	L-T-P-Credits	Year of Introduction
03 EC 6402:	**ESTIMATION AND DETECTION THEORY**	**3-1-0**	**2015**

Syllabus:

Detection Theory, Decision Theory, and Hypothesis Testing, Detection with unknown signal parameters, Parameter Estimation, Properties of estimators, Linear Signal Waveform Estimation, Applications of detection and estimation

References

1. S.M. Kay, *Fundamentals of Statistical Signal Processing: practical algorithm development*, Prentice Hall,2013

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, 2001.

4. H.V. Poor, *An Introduction to Signal Detection and Estimation*, 2nd edition, Springer, 2010.

5. L.L. Scharf, Statistical *Signal Processing*, *Detection and Estimation Theory*, Addison-Wesley, 1991

Course Plan			
Module	**Content**	**Hours**	**Semester Exam Marks**

I	**Detection Theory, Decision Theory, and Hypothesis Testing** :Review of Probability Theory, Elementary hypothesis testing, Bayes rule, mini-max rule, Neyman-Pearson rule; compound hypothesis testing; generalized likelihood-ratio test; Detection with unknown signal parameters, Signal detection in the presence of noise, Chernoff bound, asymptotic relative efficiency; sequential detection	**16**	**25%**
II	**Nonparametric detection, sign test, rank test. Parameter Estimation**: Minimum Mean Squared error estimator, Maximum a Posteriori estimator, linear estimators, Maximum likelihood parameter estimator, invariance principle.	**16**	**25%**
First Internal Exam			
III	**Properties of Estimators:** Estimation efficiency, Cramer-Rao lower bound, Fisher information matrix; least squares, weighted least squares, best linear unbiased estimation. Linear Signal Waveform Estimation: Wiener and Kalman Filtering, Lattice filter structure, Levinson Durbin and innovation algorithms.	**15**	**25%**
IV	**Applications of Detection and Estimation:** Applications in diverse fields such as communications, system identification, adaptive filtering, pattern recognition, speech processing, and image processing.	**15**	**25%**
Second Internal Exam			
End semester Exam			

Course No.	Course Name	L-T-P-Credits	Year of Introduction
03 EC 6412	**DIGITAL IMAGE PROCESSING**	**3-0-0**	**2015**

Syllabus

Image representation, Two dimensional orthogonal transforms,Image enhancement, Edge detection, Image Restoration, Image Segmentation, Fundamental concepts of image compression,Morphological image processing,Color Image Processing.

References

1.Digital Image Processing- Gonzalez and Woods, Pearson education, 2002.

2.Fundamentals of Digital Image Processing – A K Jain, Pearson education, 2003.

3.Digital Image Processing- W K Pratt, John Wiley, 2004

4.Digital Signal and Image Processing- Tamal Bose, John Wiley publishers.

5.Two dimensional signal and Image Processing- J S Lim, Prentice Hall.

6. A. Bovik, *Handbook of Image & Video Processing*, Academic Press, 2000.

7. S. J. Solari, *Digital Video and Audio Compression*, McGraw-Hill, 1997

Course Plan

Module	Content	Hours	Semester Exam Marks
I	**Image representation:** Gray scale and colour Images, image sampling and quantization. Two dimensional orthogonal transforms: DFT, WHT, Haar transform, KLT, DCT. Image enhancement - filters in Spatial and frequency domains, histogram-based processing, homomorphic filtering. Edge detection - non parametric and model based approaches, LOG filters, localization problem	**16**	**25%**
II	**Image Restoration:** Degradation Models, PSF, circulant and block - circulant matrices, deconvolution , restoration using inverse filtering, Wiener filtering and maximum entropy based methods Image Segmentation: Pixel classification, Bi-level thresholding , Multi-level thresholding, P-tile method, Adaptive thresholding, spectral &spatial classification, Edge detection, Hough transform, Region growing	**16**	**25%**
First Internal Exam			
III	**Fundamental concepts of image compression** - Compression models - Information theoretic perspective - Fundamental coding theorem - Lossless Compression: Huffman Coding- Arithmetic coding - Bit plane coding - Run length coding - Lossy compression: Transform coding - Image compression standards.	**15**	**25%**
IV	**Morphological image processing**: Binary morphology- Erosion, Dilation, Opening and closing operations, Applications, Basic gray scale morphology operations;Color Image Processing**:** color models- RGB, CMY, YIQ, HIS, Pseudo coloring, intensity slicing, gray level to color transformation.	**15**	**25%**
Second Internal Exam			

End semester Exam

Course No.	Course Name	L-T-P-Credits	Year of Introduction
03 EC 6422:	ADAPTIVE SIGNAL PROCESSING	3-0-0	2015

Syllabus:

Adaptive systems, Theory of adaptation with stationary signals, Searching the performance surface, Gradient estimation and its effects on adaptation, Important adaptive algorithms, Applications of Adaptive signal processing

References

1.Adaptive signal processing: Widrow and Stearns, Pearson
2.Statistical and Adaptive signal processing- Manalokis, Ingle and Kogon, Artech House INC.
3.Adaptive filter theory- 4th edition, Simon Haykin, Prentice Hall
4.Adaptive filters- A H Sayed, John Wiley
5.Adaptive filtering primer with MATLAB – A Poularikas, Z M Ramadan, Taylor and Francis Publications.
6.Digital Signal and Image processing- Tamal Bose, John Wiley publications

Course Plan

Module	Content	Hours	Semester Exam Marks

I	**Adaptive systems:** Definitions and characteristics, Open and Closed loop adaptation, Adaptive linear combiner, Performance function, Gradient and minimum mean square error, performance function, Gradient and minimum mean square error, Alternate expressions of gradient. Theory of adaptation with stationary signals: Input correlation matrix, Eigen values and Eigen vectors of the i/p correlation matrix.	**16**	**25%**
II	**Searching the performance surface:** Basic ideas of gradient search, Stability and rate of convergence, Learning curve, Newton's method, Steepest descent method, Comparison .Gradient estimation and its effects on adaptation: Gradient component estimation by derivative measurement, performance penalty, Variances of the gradient estimate, effects on the weight – vector solution, Excess mean square error and time constants, misadjustments, total misadjustments and other practical considerations.	**16**	**25%**
First Internal Exam			
III	**Important adaptive algorithms:** LMS Algorithm, Derivation, Convergence of the weight vector, learning curve, noise vector in weight vector solution, mis adjustment, performance, Z Transforms in Adaptive signal processing, other adaptive algorithms- LMS Newton , Sequential regression, Recursive least squares, adaptive recursive filters, random search algorithms, Adaptive Lattice predictor, Adaptive filters with orthogonal signals.	**15**	**25%**
IV	**Applications of Adaptive signal processing:** Adaptive modeling of a multi-path communication channel, adaptive model in geophysical exploration, Inverse modeling, Adaptive interference canceling: applications in Bio-signal processing.	**15**	**25%**

Second Internal Exam
End semester Exam

Course No.	Course Name	L-T-P-Credits	Year of Introduction
03 EC 6432:	**SPEECH PROCESSING AND CODING**	**3-0-0**	**2015**
Syllabus Speech Production, Articulatory Phonetic and Acoustic Phonetics, speech Analysis-time domain and frequency domain analysis, Parametric representation of speech, Speech coding, speech processing, Issues of Voice transmission over Internet.			
References 1. Douglas O'Shaughnessy, *Speech Communications: Human & Machine,* IEEE Press, Hardcover 2nd edition, 1999; ISBN: 0780334493. 2. Nelson Morgan and Ben Gold, *Speech and Audio Signal Processing: Processing and Perception Speech and Music,* July 1999, John Wiley & Sons, 2nd edition, 2011 *7.* Rabiner and Schafer, *Theory and Application of Digital Processing of Speech Signals,* Prentice Hall, 2010. 4. Rabiner and Juang, *Fundamentals of Speech Recognition,* Prentice Hall, 1994. 5. Thomas F. Quatieri, Discrete-*Time Speech Signal Processing: Principles and Practice,* Prentice Hall,1 edition,2001 6. Donald G. Childers, *Speech Processing and Synthesis Toolboxes,* John Wiley & Sons, September 1999; ISBN: 0471349593			

Course Plan			
Module	**Content**	**Hours**	**Semester Exam Marks**
I	**Speech Production:** - Acoustic theory of speech production-Excitation, Vocal tract model for speech analysis, Formant structure, Pitch. Articulatory Phonetic -Articulation, Voicing, Articulatory model. Acoustic Phonetics- Basic speech units and their classification.	**16**	**25%**
II	**Speech Analysis:** Short-Time speech Analysis, Time domain analysis (Short time energy, short time zero crossing Rate, ACF). Frequency domain analysis (Filter Banks, STFT, Spectrogram, Formant Estimation & Analysis), Cepstral Analysis.	**16**	**25%**
First Internal Exam			
III	**Parametric representation of speech:** AR Model, ARMA model. LPC Analysis (LPC model, Auto correlation method, Covariance method, Levinson-Durbin Algorithm, Lattice form).LSF, LAR, MFCC, Sinusoidal Model, GMM, HMM.	**15**	**25%**

IV	**Speech coding :** Phase Vocoder, LPC, Sub-band coding, Adaptive Transform Coding , Harmonic Coding, Vector Quantization based Coders, CELP, speech processing : Fundamentals of speech recognition, speech segmentation. Text-to-speech conversion, speech enhancement, speaker Verification, Language Identification, Issues of Voice transmission over Internet.	**15**	**25%**
Second Internal Exam			
End semester Exam			

Course No.	Course Name	L-T-P-Credits	Year of Introduction
03 EC 6442	**WAVELET THEORY AND APPLICATIONS**	**3-0-0**	**2015**

Syllabus

Continuous Wavelet Transform, Discrete wavelet Transform, Digital filtering interpretations, Alternative wavelet representations, Lifting scheme, Applications.

References

1.Insight into wavelets: From theory to Practice- K P Soman and K I Ramachandran, Prentice Hall of India

2.Wavelet Transforms: Introduction to theory and applications- R M Rao and A S Bopardikar, Pearson.

3.Wavelets and filter banks- G Strang and T Q Nguyen, Wellesley Cambridge Press, 1998.

4.Fundamentals of Wavelets: Thory, Algorithms and Applications- J C Goswamy and A K Chan, Wiley-Interscience publications, John Wiley and sons,2nd edition ,2011

5.Wavelets and Multiwavelets- F Keinert, SIAM, Chapman and Hall/CRC, 2004

6.Ten Lectures on Wavelets- Ingrid Daubechies, SIAM, 1992

7.Wavelet Analysis- The scalable structure of Information- H L Resnikoff, R. O. Wells,Jr., Springer, 2004.

Course Plan

Module	Content	Hours	Semester Exam Marks
I	**Continuous Wavelet Transform:** Continuous time frequency representation of signals, The Windowed Fourier Transform, Uncertainty Principle and time frequency tiling, Wavelets, Specifications, admissibility conditions, Continuous wavelet transform, CWT as a correlation, CWT as an operator, Inverse CWT. .	**16**	**25%**

II	**Discrete wavelet Transform:** Approximations of vectors in nested linear vector spaces, Example of an MRA, Formal definition of MRA, Construction of genera orthonormal MRA, a Wavelet basis for MRA, Digital filtering interpretations- Decomposition and Reconstruction filters, examples of orthogonal basis generating wavelets, interpreting orthonormal MRA for Discrete time signals, Mallat algorithm Filter bank implementation of DWT.	**16**	**25%**
First Internal Exam			
III	**Alternative wavelet representations-**Biorthogonal Wavelets: biorthogonality in vector space, biorthogonal wavelet bases, signal representation using biorthogonal wavelet system, advantages of biorthogonal wavelets, biorthogonal analysis and synthesis, Filter bank implementation, Two dimensional Wavelets, filter bank implementation of two dimensional wavelet transform.	**15**	**25%**
IV	**Lifting scheme:** Wavelet Transform using polyphase matrix factorization, Geometrical foundations of the lifting scheme, lifting scheme in the z- domain, Applications: Image Compression: EZW Coding, ECSIHT, Wavelet Difference Reduction Compression Algorithm, edge detection and object isolation, audio compression, communication applications – scaling functions as signaling pulses, Discrete Wavelet Multitone Modulation.	**15**	**25%**
Second Internal Exam			
End semester Exam			

Course No.	Course Name	L-T-P-Credits	Year of Introduction
03 EC 6452	MULTIDIMENSIONAL SIGNAL PROCESSING	3-0-0	2015

Syllabus:

Multidimensional Discrete signals and Multidimensional systems, Discrete Fourier analysis of multidimensional signals, Discrete Fourier analysis of multidimensional signals, Design and implementation of two dimensional FIR filters, Design and implementation of two dimensional FIR filters, Design and implementation of two dimensional IIR filters.

References

1. Multidimensional Digital Signal Processing - Dan E Dudgeon and R M Mersereau, Prentice Hall
2. Digital Signal and Image Processing- Tamal Bose, John Wiley publishers.
3. Two dimensional signal and Image Processing- J S Lim, Prentice Hall.

Course Plan

Module	Content	Hours	Semester Exam Marks
I	**Multidimensional Discrete signals and Multidimensional systems:** Frequency domain characterization of multidimensional signals and systems, sampling two dimensional signals, processing continuous signals with discrete systems, Discrete Fourier analysis of multidimensional signals: Discrete Fourier series representation of rectangularly periodic sequences, Multidimensional DFT, definition an properties, Calculation of DFT, Vector radix FFT, Discrete Fourier transforms for general periodically sampled signals, relationship between M dimensional and one dimensional DFTs. .	16	25%

II	**Design and implementation of two dimensional FIR filters:** Implementation, Design using windows, Optimal FIR filter design- least squares design, Design of cascaded and parallel 2 D FIR filters, Design and implementation of FIR filters using transformations.	**16**	**25%**
First Internal Exam			
III	**Design and implementation of two dimensional FIR filters**: Implementation, Design using windows, Optimal FIR filter design- least squares design, Design of cascaded and parallel 2 D FIR filters, Design and implementation of FIR filters using transformations. .	**15**	**25%**
IV	**Design and implementation of two dimensional IIR filters:** classical 2 D IIR filter implementations, Iterative implementation of 2 D IIR filters, signal flow graphs- circuit elements and their realizations, state variable realizations, Space domain Design techniques- Shank's method, Descent methods, Iterative pre filtering design method, Frequency domain design techniques, stabilization techniques.	**15**	**25%**
Second Internal Exam			
End semester Exam			

Course No.	Course Name	L-T-P-Credits	Year of Introduction
03 EC 6462:	**OPTICAL SIGNAL PROCESSING**	**3-0-0**	**2015**

Syllabus

Need for OECS, Fundamentals of OECS,A Basic Optical System, ImagingTransform conditions, spectrum Analysis, The 2 D Spectrum analyzer ,Applications of Optical spatial Filtering, Heterodyne systems,

References

1. Anthony VanderLugt, Optical Signal Processing, John Wiley & Sons. 2005.
2. D. Casasent, Optical data processing-Applications Sringer-Verlag, Berlin, 1978
3. P.M. Dufffieux, The Fourier Transform and its applications to Optics, John Wiley and sons 1983
4. J. Horner, Optical Signal Processing Academic Press 1988

Course Plan

Module	Content	Hours	Semester Exam Marks
I	Need for OECS, Fundamentals of OECS, The Fresnel Transform, Convolution and impulse response, Transform of a slit, Fourier Transforms in Optics, Transforms of Aperture functions, Inverse Fourier Transform. Resolution criteria. .	**16**	**25%**

II	A Basic Optical System, Imaging Transform conditions. Cascaded systems, scale of Fourier Transform Condition. Maximum information capacity and optimum packing density. Chirp _ Z transform and system Coherence. spectrum Analysis, spatial light Modulators, special detector arrays. Performance parameters for spectrum analyzers. Relationship between SNR and Dynamic range.	**16**	**25%**
First Internal Exam			
III	The 2 D Spectrum analyzer. spatial Filtering, Linear space Invariant systems, Parseval's theorem, Correlation, input/output spectral Densities, Matched filtering, Inverse Filtering. spatial Filters. Interferometers. spatial filtering systems. spatial Modulators .Applications of Optical spatial Filtering, Effects of small displacements.	**15**	**25%**
IV	Heterodyne systems. Temporal and spatial interference. Optimum photo detector size, Optical radio. Direct detection and Hetero dyne detection. Heterodyne spectrum Analysis. spatial and temporal Frequencies. The CW signal and a short pulse. Photo detector geometry and bandwidth. Power spectrum analyzer using a CCD array.	**15**	**25%**
Second Internal Exam			
End semester Exam			

Course No.	Course Name	L-T-P-Credits	Year of Introduction
03 EC 6472:	**VLSI ARCHITECHTURE FOR DSP**	**3-0-0**	**2015**

Syllabus

Pipelining and parallel processing of FIR digital filters, unfolding and retiming, Parallel FIR filters, Scaling and round off noise -round off noise in pipelined IIR filters, Evolution of programmable DSP processors.

References

1 Keshab K. Parhi, *VLSI Digital signal processing Systems: Design and Implementation,* John Wiley & Sons, 1999.

2 Uwemeyer- Baes, *DSP with Field programmable gate arrays,* Springer, 2001

3. Digital Signal Processors: Architectures , Implementations and applications, Sen M Kuo, Woon-Seng S. Gan, Prentice Hall, 2004

4.DECS integrated circuits, Lars Wanhammar, Academic Press, 1999

Course Plan

Module	Content	Hours	Semester Exam Marks
I	**Pipelining of FIR digital filters** -parallel processing for FIR systems -combined pipelining and parallel processing of FIR filters for low power -Pipelining in IIR filters –parallel processing for IIR filters -combined pipelining and parallel processing of FIR filters. .	**16**	**25%**

II	**Unfolding-** algorithm for unfolding, properties of unfolding, critical path, unfolding and retiming, applications .folding-folding transformation, register minimization techniques, register minimization in folded architectures.	**16**	**25%**
First Internal Exam			
III	**Parallel FIR filters** -discrete time cosine transform -implementation of DCT based on algorithm -architecture transformations -parallel architectures for rank order filters. Scaling and round off noise -round off noise in pipelined IIR filters -round off noise in lattice filters -pipelining of lattice IIR digital filters -low power CMOS lattice IIR filters. . .	**15**	**25%**
IV	**Evolution of programmable DSP processors** -DSP processors for mobile and wireless communications -processors for multimedia signal processing -FPGA implementation of DSP processors.	**15**	**25%**
Second Internal Exam			
End semester Exam			

Course No.	Course Name	L-T-P-Credits	Year of Introduction
03 EC 6482:	**PATTERN RECOGNITION AND MACHINE LEARNING**	**3-0-0**	**2015**

Syllabus

Introduction to Probability Theory, Decision Theory and Information Theory, Concepts of learning, Hidden Markov models for sequential data classification, Principal component analysis, Non-parametric techniques for density estimation, Linear models for regression and classification, clustering and Algorithms for clustering.

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

Module	Content	Hours	Semester Exam Marks
I	Introduction to 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, Maximum- Likelihood estimation, Bayesian inference, Mixture of Gaussians, Nearest-neighbor methods	**16**	**25%**

II	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.	**16**	**25%**
First Internal Exam			
III	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.	**15**	**25%**
IV	Linear models for regression and classification, Perceptron, Artificial Neural networks, Support Vector Machines. Unsupervised learning, Clustering - Criterion functions for clustering, Algorithms for clustering: K-means and Hierarchical methods	**15**	**25%**
Second Internal Exam			
End semester Exam			

Course No.	Course Name	L-T-P-Credits	Year of Introduction
03 EC 6492	**AUDIO SIGNAL PROCESSING**	**3-0-0**	**2015**

Syllabus

Signal Processing Models of Audio Perception, Basic anatomy of hearing System, Auditory Filter Banks, Spatial Audio Perception and rendering, Audio compression methods, Music Classification, Supervised Classifiers.

References

1. Audio Signal Processing and Coding, by Andreas spanias, Ted Painter and VenkittaramAtti, Wiley-Inter Science publication, 2006
2. Zhouyu Fu; Guojun Lu; Kai Ming Ting; Dengsheng Zhang; , "A Survey of Audio-Based Music Classification and Annotation," Multimedia, IEEE Transactions on, vol.13, no.2, pp.303-319, April 2011doi: 10.1109/TMM.2010.2098858
3. Scaringella, N.; Zoia, G.; Mlynek, D.; "Automatic genre classification of music content: a survey," Signal Processing Magazine, IEEE, vol.23, no.2, pp.133-141, March 2006 doi:10.1109/MECS.2006.1598089
4. Loizou, P. (1998). "Mimicking the human ear," IEEE Signal Processing Magazine, 15(5), 101-130.

Course Plan

Module	Content	Hours	Semester Exam Marks
I	Signal Processing Models of Audio Perception, Basic anatomy of hearing System : Outer ear, middle ear and inner ear, Cochlea and signal processing in cochlea, Auditory Filter Banks, Gamma-tone filters, Bark Scale, Mel frequency scale, Psycho-acoustic analysis, Critical Band Structure, Absolute Threshold of Hearing, Simultaneous Masking, Temporal Masking, Quantization Noise Shaping, MPEG psycho-acoustic model.	**16**	**25%**

II	Spatial Audio Perception and rendering .The physical and psycho-acoustical basis of sound localization and space perception. Head related transfer functions, Source localization and beam forming with arrays of microphones. Stereo and multi-channel audio, Sound Filed Synthesis, spatial audio standards Room acoustics: Sound propagation in rooms. Modeling. The influence of short and long term reverberation. Modeling room impulse responses and head related impulse responses.	**16**	**25%**
First Internal Exam			
III	Audio compression methods Sampling rate and bandwidth requirement for digital audio, Redundancy removal and perceptual irrelevancy removal, Loss less coding, sub-band coding, sinusoidal coding, Transform coding. Transform coding of digital audioMPEG2-AAC coding standard, MDCT and its properties, Pre-echo and pre-echo suppression, psycho-acoustic modeling, adaptive quantization and bit allocation methods, Loss less coding methods. Parametric Coding of Multi-channel audio Mid-Side Stereo, Intensity Stereo, Binaural Cue Coding, Audio quality analysis: Objective analysis methods- PEAQ, Subjective analysis methods - MOS score, MUSHRA score.	**15**	**25%**
IV	Music Classification: Music features: Genre, Timbre, Melody, Rhythm, Audio features for Music Classification, Low-level, Mid- Level and Song level classification features, Similarity measures for classification , Supervised Classifiers : k NN, GMM, HMM, and SVM based classifiers. Hearing aids Hearing loss, digital hearing aids, Cochlear implants: Electrode design, Simulation methods, transmission link and signal processing, Types of cochlear implants, performance analysis of cochlear implants.	**15**	**25%**
Second Internal Exam			

End semester Exam

Course No.	Course Name	L-T-P-Credits	Year of Introduction
03 EC 6502	**ARRAY SIGNAL PROCESSING**	**3-0-0**	**2015**

Syllabus

Spatial Signals, Far field and Near field signals ,Sensor Arrays, Spatial Frequency, spatial Domain Filtering, Direction of Arrival Estimation, Higher order statistics in Signal Processing.

References

1.Array Signal Processing: Concepts and Techniques., Dan E. Dugeon and Don H. Johnson. (1993). Prentice Hall.

2.Statistical and Adaptive signal processing- Manalokis, Ingle and Kogon, Artech House INC., 2005.

3. Spectral Analysis of Signals. PetreStoica and Randolph L. Moses. (2005, 1997) Prentice Hall.

4. Array Signal Processing [Connexions Web site].February 8, 2005. Available at: http://cnx.rice.edu/content/col10255/1.3/

Course Plan

Module	Content	Hours	Semester Exam Marks
I	Spatial Signals: Signals in space and time. spatial frequency, Direction vs. frequency. Wave fields. Far field and Near field signals.	**16**	**25%**

II	Sensor Arrays: spatial sampling, Nyquist criterion. Sensor arrays. Uniform linear arrays, planar and random arrays. Array transfer (steering) vector. Array steering vector for ULA. Broadband arrays.	**16**	**25%**
First Internal Exam			
III	Spatial Frequency: Aliasing in spatial frequency domain. spatial Frequency Transform, spatial spectrum. spatial Domain Filtering. Beam Forming. Spatially white signal.	**15**	**25%**
IV	Direction of Arrival Estimation: Non parametric methods - Beam forming and Capon methods. Resolution of Beam forming method. Subspace methods - MUSIC, Minimum Norm and ESPRIT techniques. spatial Smoothing .Higher order statistics in Signal Processing: Moments, Cumulants and poly spectra, higher order moments and LTI systems.	**15**	**25%**
Second Internal Exam			
End semester Exam			

Course No.	Course Name	L-T-P-Credits	Year of Introduction
03 EC 6902	MINI PROJECT	0-0-2	2015

Course No.	Course Name	L-T-P-Credits	Year of Introduction
03 EC 6832	SIGNAL PROCESSING LAB II	0-0-1	2015

1. **Representation of Gray scale and colour images.**
2. **Image transformations:** Grey level transformations, Histogram equalization and modifications, Geometric transformations, affine transformations.
3. **Image Transforms:** DFT, DCT, KLT, etc.
4. **Image filtering**: Fourier descriptors, linear and non-linear filtering operations in spatial and transform domain, Image convolutions, Separable convolutions, Sub-sampling and interpolation as convolution operations.
5. **Edge detection:** Edge enhancement by differentiation, Effect of noise, edge detection andcanny implementation, Edge detector performance evaluation.
6. **Segmentation:** Thresholding algorithms, Performance evaluation and ROC analysis Connected components labelling, Region growing and region adjacency graph (RAG), split and merge algorithms.

SEMESTER III

Course No.	Course Name	L-T-P-Credits	Year of Introduction
03 EC 7403	**SOFT COMPUTING**	**3-0-0**	**2015**

Syllabus

Basics of Fuzzy Sets, Basic structure and operation of fuzzy logic control systems, Concepts of Artificial Neural Networks, Neural Networks in Control Systems, Integration of Fuzzy and Neural Systems, Neural Network based Fuzzy Modeling , Data clustering algorithms, Survival of the Fittest, Rank space method AI search algorithm

References

1. JyhShing Roger Jang, Chuen-Tsai Sun, Eiji Mizutani, (1997), Neuro-Fuzzy and Soft Computing: A Computational Approach to Learning and Machine, Prentice Hall.
2. Chin –Teng Lin and C.S. George Lee,(1996) "Neural Fuzzy Systems" – A neuro fuzzy synergism to intelligent systems, Prentice Hall International.
3. Yanqing Zhang and Abraham Kandel (1998), Compensatory Genetic Fuzzy Neural Network and Their Applications, World Scientific.

Course Plan

Module	Content	Hours	Semester Exam Marks
I	Basics of Fuzzy Sets: Fuzzy Relations – Fuzzy logic and approximate reasoning – Design. Methodology of Fuzzy Control Systems – Basic structure and operation of fuzzy logic control systems.	**16**	**25%**
II	Concepts of Artificial Neural Networks: Basic Models and Learning rules of ANN's. Single layer perceptron networks – Feedback networks – Supervised and unsupervised learning approaches – Neural Networks in Control Systems.	**16**	**25%**

First Internal Exam			
III	Integration of Fuzzy and Neural Systems: Neural Realization of Basic fuzzy logic operations – Neural Network based fuzzy logic inference – Neural Network based Fuzzy Modeling – Types of Neural Fuzzy Controllers. Data clustering algorithms - Rule based structure identification-Neuro-Fuzzy controls - Simulated annealing.	**15**	**25%**
IV	Survival of the Fittest - Fitness Computations - Cross over - Mutation -Reproduction – Rank method–Rank space method AI search algorithm - Predicate calculus - Rules of interference – Semantic networks - Frames - Objects - Hybrid models - Applications.	**15**	**25%**
Second Internal Exam			
End semester Exam			

Course No.	Course Name	L-T-P-Credits	Year of Introduction
03 EC 7413	**WIRELESS NETWORKS**	**3-0-0**	**2015**

Syllabus

Multiple radio access, Medium Access Alternatives, Handoff and Roaming Support, Wireless wans, Wireless LANs, Other IEEE 802.11 standards, Adhoc and sensor networks, MAC and Routing protocols. Wireless MANs and PANs.

References

1. William Stallings, "Wireless Communications and networks" Pearson / Prentice Hall of India, 2nd Ed., 2007.
2. Dharma Prakash Agrawal& Qing-AnZeng, “Introduction to Wireless and Mobile Systems”, Thomson India Edition, 2nd Ed., 2007.
3. Vijay. K. Garg, “Wireless Communication and Networking”, Morgan Kaufmann Publishers, 2007.
4. KavethPahlavan, Prashant Krishnamurthy, "Principles of Wireless Networks", Pearson Education Asia, 2002.
5. Gary. S. Rogers & John Edwards, “An Introduction to Wireless Technology”, Pearson Education, 2007.
6. Clint Smith, P.E. & Daniel Collins, “3G Wireless Networks”, Tata McGraw Hill, 2nd Ed,. 2007.

Course Plan

Module	Content	Hours	Semester Exam Marks
I	Multiple radio access : Medium Access Alternatives: Fixed-Assignment for Voice Oriented Networks Random Access for Data Oriented Networks , Handoff and Roaming Support, Security and Privacy.	**16**	**25%**
II	Wireless wans: First Generation Analog, Second Generation TDMA – GSM, Short Messaging Service inGSM, Second Generation CDMA – IS-95, GPRS - Third Generation Systems (WCDMA/CDMA 2000); WIRELESS LANS: Introduction to wireless LANs - IEEE 802.11 WLAN – Architecture and Services, Physical Layer- MAC sublayer-MAC Management Sublayer, Other IEEE 802.11 standards, HIPERLAN, WiMax standard.	**16**	**25%**

First Internal Exam

III	Adhoc and sensor networks : Characteristics of MANETs, Table-driven and Source-initiated On Demand routing protocols, Hybrid protocols, Wireless Sensor networks- Classification, MAC and Routing protocols.	**15**	**25%**
IV	Wireless mans and pans: Wireless MANs – Physical and MAC layer details, Wireless PANs – Architecture of Bluetooth Systems, Physical and MAC layer details, Standards.	**15**	**25%**
Second Internal Exam			
End semester Exam			

Course No.	Course Name	L-T-P-Credits	Year of Introduction
03 EC 7423	**BIOMEDICAL SIGNAL PROCESSING**	**3-0-0**	**2015**

Syllabus

Introduction to Biomedical Signals, Review of linear systems, Processing of Random & Stochastic signals, Filtering in biomedical instruments, Concurrent, coupled and correlated processes, Detection of biomedical signals in noise, Event detection, Classification of biomedical signals, Cardio vascular applications, Noise & Artifacts, ECG Signal Processing, Heart Rhythm representation, Neurological Applications, The electroencephalogram

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

Module	Content	Hours	Semester Exam Marks
I	Introduction to Biomedical Signals - Examples of Biomedical signals - ECG, EEG, EMG etc - Tasks in Biomedical Signal Processing - Computer Aided Diagnosis. Origin of bio potentials - Review of linear systems - 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 - Filtering in biomedical instruments	**16**	**25%**
II	Concurrent, coupled and correlated processes - illustration with case studies - Adaptive and optimal filtering - Modeling of Biomedical signals - 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 – Independent component Analysis - Cocktail party problem applied to EEG signals - Classification of biomedical signals.	**16**	**25%**

First Internal Exam

III	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 – QRS detection - Arrhythmia analysis – Data Compression: Lossless & Lossy- Heart Rate Variability – Time Domain measures – Heart Rhythm representation - spectral analysis of heart rate variability - interaction with other physiological signals.	**15**	**25%**
IV	Neurological Applications: The electroencephalogram - EEG rhythms & waveform -categorization of EEG activity - recording techniques - EEG applications- Epilepsy, sleep disorders, brain computer interface. Modeling EEG-linear, stochastic models - Non linear modeling of EEG - artifacts in EEG & their characteristics and processing - Model based spectral analysis - EEG segmentation - Joint Time-Frequency analysis - correlation analysis of EEG channels - coherence analysis of EEG channels.	**15**	**25%**
Second Internal Exam			
End semester Exam			

Course No.	Course Name	L-T-P-Credits	Year of Introduction
03 EC 7433	**MULTIMEDIA SECURITY**	**3-0-0**	**2015**

Syllabus

Introduction to Digital Rights Management, Dimensions to content protection, Introduction to Digital Watermarking & Multimedia Security, Digital Watermarking - Theoretic Aspects, Theoretical Analysis of Digital Watermarking, Multimedia fingerprinting, Combining fingerprint modulation with coding, Multicast fingerprinting problem, Steganography, Multimedia Encryption, Image and Video encryption schemes.

References:

1. Ingemar Cox, Matthew Miller, Jeffrey Bloom, "Digital Watermarking : Principles and Practices", Morgan Kaufmann; 1st edition (October 15, 2001)
2. W. Zeng, H. Yu and C. Lin, Multimedia Security Technologies for Digital Rights Management, Elsevier, UK, 2006.
3. K. Karthik and D. Hatzinakos, Multimedia Encoding for Access Control With Traitor Tracing: Balancing Secrecy, Privacy and Traceability, VDM Verlag, ISBN: 978-3-8364-3638-0, Germany, 2008.
4. B. Furht and D. Kirovski (Eds.), Multimedia Security Handbook, CRC press, U.S., 2005.
5. B. Schneier, Applied Cryptography: Protocols, Algorithms and Source Code in C, 2nd EDITION, Wiley India, 2007 (Reprint).

Course Plan

Module	Content	Hours	Semester Exam Marks
I	Introduction to Digital Rights Management (DRM): Requirements of a DRM system, Architectures, Dimensions to content protection: Tracing (fingerprinting), authentication, Encryption, Key management and access control. Introduction to Digital Watermarking & Multimedia Security. Digital Watermarking- Basics: Models of Watermarking, Basic Message Coding, Error Correction Coding.	**16**	**25%**

II	Digital Watermarking - Theoretic Aspects : Mutual Information and Channel Capacity, How to Design a Good Digital Watermark, Information Theoretical Analysis of Digital Watermarking. Digital Watermarking Schemes :spread spectrum Watermarking, DCT-Domain Watermarking, DWT - Domain Watermarking, Quantization Watermarking.	**16**	**25%**
First Internal Exam			
III	Multimedia fingerprinting: Fingerprinting basics, Marking assumption, Collusion attack, Frame proof and anti-collusion codes; Combining fingerprint modulation with coding: Introduction to coded fingerprint modulation, Semi-fragile fingerprinting; Multicast fingerprinting problem: Bandwidth security trade off; Efficient security architectures: WHIM, Water casting, Chameleon cipher; Joint fingerprinting and decryption (JFD)framework; Finger casting.	**15**	**25%**
IV	Steganography, Introduction to Steganalysis Schemes, Introduction to Cryptography, Multimedia Encryption : Traditional symmetric key ciphers, Shannon's principles of confusion and diffusion; Overview of Advanced Encryption Standard (AES); Block and stream ciphers; Principles for selective encryption; Image and Video encryption schemes: Chaotic maps, Transform domain encryption, Huffman tree mutation; Streaming media encryption. Privacy preserving protocols: Zero knowledge protocols, Anonymous fingerprinting, Public key watermarking	**15**	**25%**
Second Internal Exam			

End semester Exam

Course No.	Course Name	L-T-P-Credits	Year of Introduction
03 EC 7443	**TIME FREQUENCY ANALYSIS**	**3-0-0**	**2015**

Syllabus

Introduction Review of Fourier Transform, Short-time Fourier transform, Fundamentals of Hilbert Transform, Bases for Time-Frequency Analysis Wavelet Bases and filter Banks, Multiresolution Analysis, Discrete wavelet transform and relationship with filter Banks, Wavelets Daubechies Wavelet Bases, JTFA Applications.

References:

1S. Mallat, "A Wavelet Tour of Signal Processing," Academic Press, Second Edition, 1999.

2. L. Cohen, “Time-frequency analysis”, Prentice Hall, 1995.

3. G. Strang and T. Q. Nguyen, "Wavelets and Filter Banks", Wellesley-Cambridge Press, Revised Edition, 1998.

4. I. Daubechies, "Ten Lectures on Wavelets", SIAM, 1992. P. P. Vaidyanathan, "Multirate Systems and Filter Banks", Prentice Hall, 1993.

5. M. Vetterli and J. Kovacevic, "Wavelets and Sub band Coding", Prentice Hall, 1995 24

Course Plan

Module	Content	Hours	Semester Exam Marks
I	Introduction Review of Fourier Transform, Parseval's Theorem and need for joint time-frequency Analysis. Concept of non-stationary signals, Short-time Fourier transform (STFT), Uncertainty Principle, Localization/Isolation in time and frequency, Hilbert spaces, Banach spaces, Fundamentals of Hilbert Transform. Bases for Time-Frequency Analysis Wavelet Bases and filter Banks, Tilings of Wavelet Packet and Local Cosine Bases, Wavelet Transform, Real Wavelets, Analytic Wavelets, Discrete Wavelets, Instantaneous frequency, Quadratic time-frequency energy, Wavelet Frames, Dyadic wavelet Transform, Construction of Haar and Roof scaling function using dilation equation and graphical method.	**16**	**25%**
II	Multi resolution Analysis Haar Multi resolution Analysis, MRA Axioms, spanning Linear Subspaces, nested subspaces, Orthogonal Wavelets Bases, Scaling Functions, Conjugate Mirror Filters, Haar 2-band filter Banks, Study of up samplers and down samplers, Conditions for alias cancellation and perfect reconstruction, Discrete wavelet transform and relationship with filter Banks, Frequency analysis of Haar 2-band filter banks, scaling and wavelet dilation equations in time and frequency domains, case study of decomposition and reconstruction of given signal using orthogonal framework of Haar 2-band filter bank.	**16**	**25%**
First Internal Exam			

III	Wavelets Daubechies Wavelet Bases, Daubechies compactly supported family of wavelets, Daubechies filter coefficient calculations, Case study of Daub-4 filter design, Connection between Haar and Daub-4, Concept of Regularity, Vanishing moments. Other classes of wavelets like Shannon, Meyer, Battle-Lamarie.	**15**	**25%**
IV	JTFA Applications Riesz Bases, Scalograms, Time-Frequency distributions: fundamental ideas, Applications: speech, audio, image and video compression; signal denoising, feature extraction, inverse problem.	**15**	**25%**
Second Internal Exam			
End semester Exam			

Course No.	Course Name	L-T-P-Credits	Year of Introduction
03 EC 7453	**COMPUTER VISION**	**3-0-0**	**2015**

Syllabus

Image Formation, The digital camera, Feature detection and matching, Segmentation, Structure from motion, Dense motion estimation,3D reconstruction, Surface representation, Object Detection and Recognition

References:

1. Computer Vision: Algorithms and Applications, Richard Szeliski, Springer 2010

2. Computer vision: A modern approach, by Forsyth and Ponce. Prentice Hall, 2002.

3. Computer & Machine Vision: Theory Algorithms Practicalities, E. R. Davies, ELSEIVER, Academic Press, 2012.

Course Plan

Module	Content	Hours	Semester Exam Marks
I	Image Formation: Geometric primitives and transformation, Photometric image formation, The digital camera. Feature detection and matching: Points and patches, Feature detectors and descriptors, Feature matching and tracking, Edge detection and edge linking. Hough transforms vanishing points.	**16**	**25%**
II	Segmentation: Region splitting and region merging, K-means and mixture of Gaussians, Mean shift, Graph cuts and energy-based methods. Structure from motion: Triangulation, Projective reconstruction, self-calibration, Factorization, Bundle adjustment, constrained structure and motion.	**16**	**25%**

First Internal Exam

III	Dense motion estimation: translational alignment, parametric motion, optical flow, multi frame motion estimation. 3D reconstruction: shape from X, shape from shading, photometric stereo, texture and shape from focus. Surface representation, point based volumetric and model based representations.	**15**	**25%**
IV	Object Detection and Recognition: Face detection, Pedestrian detection, Face recognition, Eigen faces, Active appearance and 3D shape models, Instance recognition, Category recognition, Bag of words, Part-based models, and recognition with segmentation, Context and scene understanding.	**15**	**25%**
Second Internal Exam			
End semester Exam			

Course No.	Course Name	L-T-P-Credits	Year of Introduction
03 EC 7463	**DIGITAL CONTROL SYSTEM**	**3-0-0**	**2015**

Syllabus

Sampling process, Z Transform methods, Design of digital control systems, Bode diagrams, digital controller, State variable methods, SISO systems.

References:

1.Digital Control systems, Benjamin C Kuo, Saunders College publishing, 2012.

2.Digital control and state variable methods, M Gopal, Tata McGraw Hill publishers, 2010.

3.Discrete time control systems, Katsuhito Ogata, Prentice Hall

4.Digital Control systems, Constantine H Houpis and Gary B Lamont, McGraw Hill

Course Plan

Module	Content	Hours	Semester Exam Marks
I	Sampling process: - continuous and sampled signal, uniform impulse sampling- time domain and frequency domain analysis, aliasing, sampling theorem, data reconstruction, zero order hold, first order hold. Z Transform methods: Z transform definition- theorem, inverse Z Transform, mapping s plane to Z plane, linear constant coefficient difference equation, solution by recursion and Z transform method, principles of discretization.	**16**	**25%**

II	Design of digital control systems: Digital Control systems, pulse transfer function, Z Transform analysis of closed loop and open loop systems, steady state accuracy, characteristic equation, stability, tests for stability, frequency domain analysis, Bode diagrams-gain margin, phase margin, root locus techniques.	**16**	**25%**
First Internal Exam			
III	Design of Digital Control Systems: Cascade and feedback compensation using continuous data controllers, digital controller- design using bilinear transformation, root locus based design, digital PID controllers, Dead beat control design.	**15**	**25%**
IV	State variable methods: State variable techniques for digital control systems, state space models algebraic transformation-canonical forms, interrelations between Z Transform models and state variable models, controllability, observability, stability, response between sampling instants using state variable approach, state feedback, pole placement using state feedback, dynamic output feedback, SISO systems, effect of finite word length on controllability and closed loop placement.	**15**	**25%**
Second Internal Exam			
End semester Exam			

Course No.	Course Name	L-T-P-Credits	Year of Introduction
03 EC 7473	**OPTIMIZATION TECHNIQUES**	**3-0-0**	**2015**

Syllabus

One dimensional – necessary and sufficient conditions, Search methods, Multivariable- necessary and sufficient conditions,Linear Programming, Non Linear Programming, Meta-heuristic optimization Techniques

References:

1.Optimization for Engineering Design, Algorithms and Examples. -PHI, ISBN -978-81-203-0943-2, Kalyanmoy Deb, IIT Kanpur.

Course Plan

Module	Content	Hours	Semester Exam Marks
I	One dimensional – necessary and sufficient conditions, Search methods- Fibonacci search, golden section search, Gradient methods- Newton- Raphson method, cubic search. Multivariable- necessary and sufficient conditions, Search methods- Evolutionary method, Hook-Jeevs pattern search, Gradient based methods- steepest descent, Newton's method, conjugate gradient method.	**16**	**25%**
II	Linear Programming - Systems of linear equations & inequalities, Formulation of linear programming problems, Theory of Simplex method, Simplex Algorithm, Two phase method-Duality, Dual Simplex method. .	**16**	**25%**

First Internal Exam			
III	Non Linear Programming- Kuhn-Tucker conditions- Necessary and Sufficiency theorem – transformation method – penalty function method search method – random search method, linearized search - Frank-Wolf method.	**15**	**25%**
IV	Meta-heuristic optimization Techniques- (Principle and implementation steps for examples related to engineering (signal processing, communication, control system) optimization of the following) Differential Evolution (DE), Harmony Search Algorithm (HSA), Artificial BeeColony Algorithm (ABC).	**15**	**25%**
Second Internal Exam			
End semester Exam			

Course No.	Course Name	L-T-P-Credits	Year of Introduction
03 EC 7903	**SEMINAR II**	**0-0-2**	**2015**

The student is expected to present a seminar in one of the current topics in Electronics, Communication, Instrumentation, Computers, Information Technology, Control systems and related areas with application of Signal Processing. The student will undertake a detailed study based on current published papers, journals, books on the chosen subject and submit seminar report at the end of the semester.

Course No.	Course Name	L-T-P-Credits	Year of Introduction
03 EC 7913	**PROJECT PHASE I**	**0-0-6**	**2015**

For the Project Phase -I the student is expected to start the preliminary background studies towards the Thesis by conducting a literature survey in the relevant field. He/she should broadly identify the area of the Thesis work, familiarize with the design and analysis tools required for the Thesis work and plan the experimental platform, if any, required for Thesis work. The student will submit a detailed report of these activities at the end of the semester. The marks distribution is as follows, Internal assessment of work by the Guide: 50 marks and Internal evaluation by the Committee in 50 Marks.

SEMESTER IV

Course No.	Course Name	L-T-P-Credits	Year of Introduction
03 EC 7914	**PROJECT PHASE II**	**0-0-12**	**2015**

Masters Research project phase-II is a continuation of project phase-I started in the third semester. Before the end of the fourth semester, there will be two reviews, one at middle of the fourth semester and other towards the end. In the first review, progress of the project work done is to be assessed. In the second review, the complete assessment (quality, quantum and authenticity) of the Thesis is to be evaluated. Both the reviews should be conducted by guide and Evaluation committee. This would be a pre qualifying exercise for the students for getting approval for the submission of the thesis. At least one technical paper is to be prepared for possible publication in journal or conferences. The technical paper is to be submitted along with the thesis. The final evaluation of the project will be external evaluation. The distribution of marks is as follows, Internal assessment of work by the Guide in 30 marks and Internal evaluation by the Committee in 70marks.