APJ Abdul Kalam Technological University

Cluster 4: Kottayam

M. Tech Program in Electronics & Communication Engineering

(Signal Processing)

Scheme of Instruction & Syllabus: 2015 Admissions

Compiled By

Rajiv Gandhi Institute of Technology, Kottayam

July 2015

APJ Abdul Kalam Technological University

Cluster 4: Kottayam

M. Tech Program Electronics and Communication Engineering (Signal Processing)

Credit requirements **:** 66 credits (21+19+14+12)

Normal Duration : Regular: 4 semesters; External Registration: 6 semesters;

Maximum duration : Regular: 6 semesters; External Registration: 7 semesters.

Courses: Core Courses : Either 4 or 3 credit courses;

Elective courses: All of 3 credits

ELIGIBILITY: B. Tech/B.E in Electronics and Communication Engg, Applied Electronics& Instrumentation Engg, Electronics & Instrumentation Engg, Electrical & Electronics Engg, Biomedical Engg, Computer science &Engg.

Allotment of credits and examination scheme:-

Semester 1 (Credits: 21)

Exam Slot	Course No:	Name	L- T - P	Internal Marks	End Semester Exam		Credits
					Marks	(hrs)	
A	04 EC 6701	Mathematical foundation for Signal Processing	4-0-0	40	60	3	4
B	04 EC 6703	Advanced Digital Communication Technologies	3-0-0	40	60	3	3
C	04 EC 6705	DSP Algorithms And Architecture	3-0-0	40	60	3	3
D	04 EC 6707	Digital Image & Video Processing	3-0-0	40	60	3	3
E	04 EC 6XXX	Elective - I	3-0-0	40	60	3	3
	04 GN 6001	Research Methodology	0-2-0	100	0	0	2
	04 EC 6791	Seminar - I	0-0-2	100	0	0	2
	04 EC 6793	Advanced signal Processing Lab- I	0-0-2	100	0	0	1
		Total	22				21

**See List of Electives-I for slot E*

List of Elective - I Courses

Exam Slot	Course No.	Course Name
E	04 EC 6709	Digital filter design & Applications
E	04 EC 6711	Multidimensional Signal Processing
E	04 EC 6713	Wireless Communication system
E	04 EC 6715	Advanced Digital System Design

Semester 2 (Credits: 19)

Exam Slot	Course No:	Name	L- T - P	Internal Marks	End Semester Exam		Credits
					Marks	(hrs)	
A	04 EC 6702	Adaptive Signal Processing	4-0-0	40	60	3	4
B	04 EC 6704	Wavelet Transforms-Theory and Applications	3-0-0	40	60	3	3
C	04 EC 67XX	Elective- II	3-0-0	40	60	3	3
D	04 EC 67XX	Elective - III	3-0-0	40	60	3	3
E	04 EC 67XX	Elective - IV	3-0-0	40	60	3	3
	04 EC 6792	Mini Project	0-0-4	100	0	0	2
	04 EC 6794	Advanced signal Processing Lab-II	0-0-2	100	0	0	1
		Total	22				19

List of Elective - II Courses

Exam Slot	Course Code	Course Name
C	04 EC 6706	Multirate Signal Processing
C	04 EC 6708	Compressed Sensing
C	04 EC 6712	Array Signal Processing
C	04 EC 6714	VLSI architectures for DSP

List of Elective - III Courses

Exam Slot	Course Code	Course Name
D	04 EC 6716	Signal Compression-Theory and Methods
D	04 EC 6718	Biomedical Signal Processing
D	04 EC 6722	Detection & Estimation
D	04 EC 6724	Design of Embedded systems

List of Elective - IV Courses

Exam Slot	Course Code	Course Name
E	04 EC 6726	Transform Theory
E	04 EC 6728	Optical Signal Processing
E	04 EC 6732	Coding Theory
E	04 EC 6734	FPGA System Design

Summer Break

Exam Slot	Course No:	Name	L- T - P	Internal Marks	End Semester Exam		Credits
					Marks	(hrs)	
NA	04 EC 7790	Industrial Training	0-0-4	NA	NA	NA	Pass /Fail
		Total	4				0

Semester 3 (Credits: 14)

Exam Slot	Course No:	Name	L- T - P	Internal Marks	End Semester Exam		Credits
					Marks	Duration (hrs)	
A	04 EC 77XX	Elective - V	3-0-0	40	60	3	3
B	04 EC 77XX	Elective - VI	3-0-0	40	60	3	3
	04EC7791	Seminar - II	0-0-2	100	0	0	2
	04EC7793	Project (Phase - I)	0-0-12	50	0	0	6
		Total	20				14

**See List of Electives-IV for slot A* ^*See List of Electives-V for slot B*

List of Elective - V Courses

Exam Slot	Course Code	Course Name
A	04 EC 7701	Linear & Nonlinear Optimization
A	04 EC 7703	Pattern Recognition & Analysis
A	04 EC 7705	Secure Communication
A	04 EC 7707	Digital Control Systems

List of Elective - VI Courses

Exam Slot	Course Code	Course Name
B	04 EC 7709	Markov Modeling & Queing Theory
B	04 EC 7711	Speech & Audio Signal Processing
B	04 EC 7713	Error Control Coding
B	04 EC 7715	Artificial Neural Network

Semester 4 (Credits: 12)

Exam Slot	Course No:	Name	L- T - P	Internal Marks	External Evaluation Marks		Credits
NA	04 EC 7794	Project (Phase -II)	0-0-21	70	30	NA	12
		Total	21				12

Total: 66

COURSE CODE	COURSE NAME	L-T-P: C	YEAR
04 EC 6701	**Mathematical Foundation for Signal Processing**	**4-0-0:4**	**2015**

Pre-requisites: Matrices and their properties, Probability fundamentals

Course Objectives:

To give the Student:-

- skills in abstract algebra
- the skills to identify linear transformation and transforms and its role in linear system
- familiarity with basic and common probability distributions
- ability to classify random processes, random vectors, and random sequences
- skills to compute statistics of random vectors in terms of mean vector,
- power vector, correlation matrix, and joint probability density
- function using elementary linear algebra and probability theory
- the ability to determine criteria for convergence of random sequences
- skill to assess whether a process or sequence is stationary in any sense

Syllabus

Vector spaces-Matrices in Linear Algebra-Probability- Joint CDF and PDF ,Conditional Expectations - convergences in probability and in distribution-Random process, Correlation and Covariance, autocorrelation and auto covariance functions-Random Vector-Time-averages and Ergodicity,Power Spectral density- Markov chain- applications of Poisson and Markov process.

Course Outcome:

Students who successfully complete this course will have demonstrated the knowledge and ability to

- understand the formulation of problems in abstract algebra framework
- understand and represent linear transformations
- understand the role of matrices in linear transformation representations
- have a comprehensive knowledge of different function spaces and their roles in engineering
- compute statistics of random processes and random sequences in
- terms of correlation function, power spectrum density, probability density functions, mean, power, and higher order statistics using Fourier analysis and probability theory
- compute correlation function, power spectrum density, probability density functions, mean, power, and higher order statistics of outputs of liner systems whose inputs are random processes or sequences using Fourier analysis and probability theory
- assess whether a process is ergodic in mean, power, correlation, or probability density function express a random process using K-L and other orthogonal function expansions
- apply the concepts of probability, random vectors, random sequences, and random processes to analyze statistical problems in signal processing and image processing

Text Books:

1. Paul R. Halmos, *Finite-Dimensional Vector Spaces*, Literary Licensing,2013
2. Todd K. Moon and Wynn C. Stirling, *Mathematical Methods and Algorithms for Signal Processing*, Prentice Hall,1999

References:

1. Henry Stark and John W. Woods, Probability and Random Processes with Applications to Signal Processing", Pearson Education, Third edition.

2. A. Papoulis and S. UnnikrishnaPillai, Probability, Random Variables and Stochastic Processes,TMH.2002

3.Probabilty and Random Proces, W.Davenport, Wiley,1970

4.Linear Algebra Done Right , Sheldon Axler,Springer,1997

5. Arch W. Naylor and George R. Sell, *Linear Operator Theory in Engineering and Science*, Springer,2000

6. Peter D. Lax, *Linear Algebra*, Wiley Students Edition,2007

7.D. C. Lay, *Linear Algebra and Its Applications*, 3rd Edition, Pearson, 2002

8.G. Strang, *Linear Algebra and Its Applications*, Nelson Engineering, 2007

9.Kreyszig,.*Functional Analysis,*Wiley,1989

COURSE PLAN

COURSE CODE:	COURSE TITLE	CREDITS	
04 EC 6701	**Mathematical Foundation for Signal Processing**	**4-0-0:4**	
MODULES		**Contact Hours**	**Sem. Exam Marks (%)**
MODULE 1:Vector spaces: Linear independence, basis, dimension,normed linear spaces, inner product spaces,Hilbert space and Banachspaces,Cauchy-Schwartz inequalities ,subspaces , orthogonal vectors, Direct sum,lineartransformations,orthogonalprojections,Fourier basis - DFT as a linear transformation		12	15
MODULE 2:Matrices in Linear Algebra: Matrix representation of least square problems, minimum error in Hilbert space approximations,column space, row space-(Matrix), rank nullity theorem, co-ordinate system, change of basis–(finite space)Eigen values and vectors, diagonolisation of matrices,Eigen decomposition Karhunen-Loeve expansions,Singular value decompostion,LU factorisation		10	15
INTERNAL TEST 1 (MODULE 1 & 2)			
MODULE 3:Probability, conditional Probability, Independent events discrete and continuous random variables and probability distributions,Moment Generating functions, Characteristic functions, Joint CDF and PDF ,Conditional Expectations,sequence of random variables: almost sure and mean-square convergences, convergences in probability and in distribution,laws of large numbers, central limit theorem		10	15
MODULE 4: Random process, Correlation and Covariance, autocorrelation and auto covariance functions, Jointly Gaussian Random Variables. Random Vector: - Definition, Joint statistics, Covariance matrix and its properties.Stationarity and its different forms,LTI systems and random process,linear time-invariant systems with WSS process as an input- time and frequency domain analyses		9	15
INTERNAL TEST 2 (MODULE 3 & 4)			
MODULE 5:Time-averages and Ergodicity,Power Spectral density, properties.examples of random processes: white noise,Wienerprocess,Poisson and Markov processes		9	20
MODULE 6: Markov chain(basics only) Examples of applications of Poisson and Markov process -(description only)Chapman-Kolmogrov theorem		6	20

,Toeplitz and Circulant matrices-properties and some applications,Fourier Series for WSS Processes.		

COURSE CODE	COURSE NAME	L-T-P:C	YEAR
04 EC 6703	Advanced Digital Communication Technologies	3-0-0:3	2015

Pre-requisites:Nil

Course Objectives:

- To understand the concepts communication of noise channels.
- Effect of synchronization in communication.
- Concepts of band limited channels.

Syllabus

Random Variables and processes, cross correlation and autocorrelation functions. Communication over Additive Gaussian noise channels, Optimum waveform receiver in additive white Gaussian noise (AWGN) channels, Cross correlation receiver, Matched filter receiver and error probabilities, Characterization of fading multipath channels- Statistical models for fading channels- Optimum non-coherent receivers, Communication over band limited channels: Nyquist criterion for zero ISI, equalization techniques.

Course Outcome:

- The student will be able to analyze various aspects of digital communication Techniques

Text Books:

1. J.G Proakis, " Digital Communication", MGH 4th edition, 1995

References:

1. Edward A. Lee and David G. Messerschmitt, " Digital Communication", Allied Publishers (second edition)

2. J Marvin K. Simon, Sami M. Hinedi and William C Lindsey, " Digital communication techniques" PHI

3. William Feller, " An introduction to Probability Theory and its applications", vol 11, Wiley 2000

4. Sheldon M. Ross, " Introduction to probability models", Academic press, 7th edition

COURSE PLAN

COURSE CODE:	COURSE TITLE	CREDITS	
04 EC 6703	**Advanced Digital Communication Technologies**	**3-0-0:3**	
MODULES		**Contact Hours**	**Sem. Exam Marks (%)**
MODULE 1:Random Variables and processes: Review of random variable: Moment generating function, Chernoff bound,Markov's inequality,Chebyshev's inequality, Central limit theorem, Chi square, Rayleigh and Rician distributions, correlation, Covariance matrix,Stationary processes, wide sense stationary processes, cross correlation and autocorrelation functions		8	15
MODULE 2: Communication over Additive Gaussian noise channels: 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.		6	15
INTERNAL TEST 1 (MODULE 1 & 2)			
MODULE 3: 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,		7	15
MODULE 4:Optimum waveform receiver for coloredgaussian noise channels- Karhunen-Loeve expansion approach, whitening.Optimum non-coherent receiver in random amplitude, random phase channels-performance of digital modulation schemes such as BPSK, QPSK, FSK, DPSK etc over wireless channels.		7	15
INTERNAL TEST 2 (MODULE 3 & 4)			
MODULE 5: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		7	20

functions- key multipath parameters,Rayleigh and Ricean fading channels		
MODULE 6:Communication over band limited channels: Communication over band limited channels,Optimum pulse shaping-Nyquist criterion for zero ISI, partial response signaling,equalization techniques- zero forcing linear equalization- decision feedback equalization	7	20

COURSE CODE	COURSE NAME	L-T-P:C	YEAR
04 EC 6705	**DSP ALGORITHMS AND ARCHITECTURE**	**3-0-0:3**	**2015**

Pre-requisites:

Computer Organization and Architecture, Microprocessors and Microcontrollers

Course Objectives:

- 1.To understand the architecture, and programming of DSP processors
- 2. Able to handle design programs on MATLAB

Syllabus

Need for special DSP processors, Von Neumann versus Harvard Architecture, Basic Pipeline: Implementation Details- Pipeline Hazards, Instruction Level Parallelism ,Computer arithmetic- Signed Digit Numbers- Logarithmic and Residue Number System ,CORDIC Algorithm, architecture Details of BlackFin processor & TMS320C64X , Digital Signal Processing Applications, Design Programs using - Real Time Implementation on DSP processors.

Course Outcome:

The student will be able to program the various applications of DSP processors.

Text Books:

1. RulphChassaing, Digital Signal Processing and Applications with the C6713 and C6416 , Wiley, 2005
2. Nasser Kehtarnawaz, Real Time Signal Processing Based on TMS320C6000, Elsevier,2004

References:

1. JL Hennesy, D.A. Patterson, Computer Architecture A Quantitative Approach; 3rd Edition, Elsevier India
2. Uwe Mayer-BAeses , Digital Signal Processing with FPGAs, Springer, 2001.
3. Users manual for of various fixed and floating point DSPs, TMS320C6x Data Sheets from TI.
4. Blackfin Processor Hardware Reference, Analog Devices, Version 3.0, 2004.

COURSE PLAN

COURSE CODE:	COURSE TITLE	CREDITS	
04 EC 6705	**DSP ALGORITHMS AND ARCHITECTURE**	**3-0-0:3**	
MODULES		**Contact Hours**	**Sem. Exam Marks (%)**
MODULE 1: Need for special DSP processors, Von Neumann versus Harvard Architecture Review of Pipelined RISC. Architectures of superscalar and VLIW fixed and floating point processors. Architecture and Instruction Set Design.		6	15
MODULE 2: Performance and Benchmarks- SPEC CPU 2000, EEMBC DSP benchmarks. Basic Pipeline: Implementation Details, Pipeline Hazards (based on MIPS 4000 arch		6	15
INTERNAL TEST 1 (MODULE 1 & 2)			
MODULE 3:Instruction Level Parallelism (ILP): Concepts, Dynamic Scheduling - Reducing Data hazards, Dynamic Hardware Prediction - Reducing Branch Hazards. Multiple Issue- Hardware-based Speculation , Limitations of ILP. Review of Memory Hierarchy, Cache design, Cache Performance Issues & Improving Techniques.		8	15
MODULE 4:Computer arithmetic- Signed Digit Numbers(SD) - Multiplier Adder Graph , Logarithmic and Residue Number System (LNS, RNS)Index Multiplier – Pipelined Adders - Modulo Adders,Distributed Arithmetic(DA) - CORDIC Algorithm.		8	15
INTERNAL TEST 2 (MODULE 3 & 4)			
MODULE 5: Case studies: Introduction to architecture Details of (a) BlackFin processor (Analog Devices) (b) TMS320C64X Digital Signal Processing Applications: FIR and IIR Digital Filter Design, Filter Design		7	20

Programs using MATLAB,Fourier Transform: DFT, FFT programs using MATLAB		
MODULE 6: Real Time Implementation on DSP processors- Factors to be considered for optimized implementation based on processor architecture: Implementation of simple Real Time Digital Filters, FFT using DSP [Only familiarity with instruction set is expected. It is not required to memorize all the instructions.]	7	20
END SEMESTER EXAM		

COURSE CODE	COURSE NAME	L-T-P:C	YEAR
04 EC 6707	**Digital Image& Video Processing**	**3-0-0:3**	**2015**

Pre-requisites:

Digital Signal Processing, Engineering Mathematics

Course Objectives:
Visual information plays an important role in almost all areas of our life. Thiscourse introduces the fundamentals of digital image processing. It emphasizes general principles of image processing, rather than specific applications. It cover topics such as image representation, color representations, sampling and quantization, point operations, linear image filtering and correlation, transforms and subband decompositions, and nonlinear filtering, contrast and color enhancement, image restoration and compression. It also introduces the basicconcepts of video processing.

Syllabus
Digital Image fundamentals-2D linear and circular convolution,.Unitary Transforms for Image processing,, Image Enhancement,Image restoration, Inverse filtering, Wiener filtering, Constrained Least Squares restoration, Interactive restoration, Geometric transformations.Image Segmentation,Color Image Processing: color models-Image Compression, Wavelet based compression techniques. Video Processing, Video Compression, Video coding standards.

Course Outcome:

The student will understand the various aspects of image and video signal processing.

Text Books:

Digital Image Processing- Gonzalez and Woods, Pearson education, 2002.
2.Fundamentals of Digital Image Processing – A K Jain, Pearson education, 2003.

References:

1.Digital Image Processing- W K Pratt, John Wiley, 2004
2.Digital Signal and Image Processing- Tamal Bose, John Wiley publishers.
3.Two dimensional signal and Image Processing- J S Lim, Prentice Hall
4. Iain E Richardson, H.264 and MPEG-4 Video Compression, John Wiley & Sons, September 2003
5. A. M. Tekalp, Digital Video Processing , Prentice-Hall
6. A Bovik, Handbook of Image & Video Processing, Academic Press, 2000

COURSE PLAN

COURSE CODE:	COURSE TITLE	CREDITS	
04 EC 6707	**Digital Image& Video Processing**	**3-0-0:3**	
MODULES		**Contact Hours**	**Sem. Exam Marks (%)**
MODULE 1:Digital Image fundamentals-2D linear and circular convolution,Kronecker products, Unitary and orthogonal matrices.Unitary Transforms for Image processing: General Unitary Transforms,DFT, DCT, DST, Hadamard Transform.		7	15
MODULE 2:Image Enhancement: Spatial Domain Methods: point processing - intensity transformations, histogram, processing, image subtraction, image averaging. Spatial filtering- smoothing filters, sharpening filters,Frequency Domain methods- low pass filtering, high pass filtering, homomorphic filtering, generation of spatial masks from frequency domain specifications,Color Image Processing: color models- RGB, CMY, YIQ, HIS , Pseudo coloring, intensity slicing, gray level to color transformation.		8	15
INTERNAL TEST 1 (MODULE 1 & 2)			
MODULE 3:Image restoration: Degradation model, Diagonalization of circulant and doubly block circulantmatrices,Algebraic approaches-Inverse filtering, Wiener filtering,Constrained Least Squares restoration, Interactive , Restoration,Geometric transformations.		6	15
MODULE 4:Image Segmentation: Detection of discontinuities- point, line, edge and combined detection,edge linking and boundary description, local and global processing using Hough Transform- Thresholding,Region oriented segmentation – basic formulation, region growing by pixel aggregation, region splitting and merging,.use of motion in segmentation		7	15
INTERNAL TEST 2 (MODULE 3 & 4)			
MODULE 5:Image Compression: Fundamentals, redundancy: coding, interpixel, psychovisual, fidelity criteria,Models, Elements of information theory, error free compression - variable length, bit plane, lossless predictive, lossy compression- lossy predictive, transform coding, Fundamentals of JPEG image compression, Wavelet based compression techniques- EZW, SPIHT,JPEG 2000.		8	20
MODULE 6:Video Processing: Representation of Digital Video,Spatio-temporal sampling; Motion Estimation Video Filtering; Video Compression,Video coding standards- H.264		6	20

END SEMESTER EXAM			
COURSE CODE	**COURSE NAME**	**L-T-P:C**	**YEAR**
04 EC 6709	**DIGITAL FILTER DESIGN & APPLICATIONS**	**3-0-0:3**	**2015**

Pre-requisites:

Engineering Mathematics, Signals & Systems

Course Objectives:

This course includes an in depth treatement of the topic digital filter design. It will strengthen the student's understanding of the foundations of DSP, filter design aspects in view of major application areas. It also covers the implementation issues such as finite word length effects which is a very important aspect of digital processing. It also covers the adaptive filter design concepts and spectral estimation methods which are used extensively in today's engineering applications.

Syllabus

LTI Systems Minimum phase, maximum phase and mixed phase systems. All-pass filters. DFT. Discrete cosine transform. Design of FIR filters,Realization structures-Finite word length effects-Implementation techniques- FIR filter design with MATLAB or Octave. Design of IIR filter,Realization structures--Implementation techniques.Application examples. IIR filter design with MATLAB or Octave. Adaptive Digital Filters,Wiener filter-LMS adaptive algorithm-Recursive least squares algorithm-Power Spectrum Estimation, Nonparametric and Parametric methods for Power Spectrum Estimation.

Course Outcome:

Students who successfully complete this course will have demonstrated the knowledge and ability to

- Design FIR & IIR filters
- Realize filters
- Analyse adaptive digital filters
- Understand the basic concepts of spectrum estimation

Text Books:

1. Emmanuel C Ifeachor, Barrie W.Jervis, *Digital Signal Processing, A practical Approach,*2/e, Pearson Education.

2. Proakis, Manolakis, *Digital Signal Processing: Principles, Algorithms, and Applications,* 4/e, Pearson Education.

3. Johnny R. Johnson, *Introduction to Digital Signal Processing,*PHI,1992

4. Ashok Ambardar, *Digital Signal Processing: A Modern Introduction,* Thomson,IE,2007.

References:

1. Douglas F. Elliott*, Handbook of Digital Signal Processing- Engineering Application ,* Academic Press.

2. Robert J.Schilling, Sandra L.Harris, *Fundamentals of Digital Signal Processing using MATLAB,*Thomson,2005

3. Ingle, Proakis, *Digital Signal Processing Using MATLAB,* Thomson, 1/e

4. Jones D*. Digital Filter Design* [Connexions Web site]. June 9, 2005. Available at: http://cnx.rice.edu/content/col10285/1.1/

COURSE PLAN

COURSE CODE:	COURSE TITLE	CREDITS	
04 EC 6709	DIGITAL FILTER DESIGN & APPLICATIONS	3-0-0:3	
MODULES		Contact Hours	Sem. Exam Marks (%)
MODULE 1:LTI Systems & Transform LTI systems as frequency selective filters. Invertibility of LTI systems. Minimum phase, maximum phase and mixed phase systems.All-pass filters. Design of digital filters by placement of poles and zeros. DFT as a linear transformation. Linear filtering methods based on DFT. Frequency analysis of signals using DFT. Discrete cosine transform		8	15
MODULE 2:Design of FIR filters , Introduction-Specifications-Coefficient calculation methods-Window, Optimal and Frequency sampling methods-Comparison of different methods , Realization structures-Finite word length effects-Implementation techniques-Application examples.FIR filter design with MATLAB or Octave. Implementation of FIR filtering in general purpose digital signal processors.		9	15
INTERNAL TEST 1 (MODULE 1 & 2)			
MODULE 3:Design of IIR filter: Introduction-Specifications. Coefficient calculation methods-Pole zero placement, Impulse invariant, Matched Z transform and Bilinear Z transform(BZT) .Design using BZT and classical analog filters.IIR filter coefficients by mapping S plane poles and zeros.		8	15
MODULE 4:Realization structures-Finite word length effects-Implementation techniques. Application examples. IIR filter design with MATLAB or GNU/OCTAVE , Implementation of IIR , filtering in general purpose digital signal processors.		7	15
INTERNAL TEST 2 (MODULE 3 & 4)			
MODULE 5:Adaptive Digital Filters: Concepts -Wiener filter-LMS adaptive algorithm-Recursive least,squares algorithm- Lattice Ladder filters.Application of Adaptive filters		5	20
MODULE 6:Power Spectrum Estimation: Estimation of spectra from finite-duration signals.Nonparametric and Parametric methods for Power Spectrum Estimation		5	20
END SEMESTER EXAM			

COURSE CODE	COURSE NAME	L-T-P:C	YEAR
04 EC 6711	Multidimensional Signal Processing	3-0-0:3	2015

Pre-requisites: Signal Processing

Course Objectives:

To give the Student:-

- The ability to understand the basic concept of Multidimensional Signal Processing

Syllabus

- Multidimensional Discrete signals and Multidimensional systems
- Multidimensional DFT
- Design and implementation of two dimensional FIR filters
- Design and implementation of two dimensional IIR filters
- Multidimensional Recursive systems
- Reconstruction of signals

Course Outcome:

Students who successfully complete this course will have demonstrated the knowledge and ability to

- Understand the basic concept of Multidimensional signals.
- Design and implement Two dimensional FIR and IIR filters.

Text Books:

1. Multidimensional Digital Signal Processing - Dan E Dudgeon and R M Mersereau, Prentice Hall

References:

1. Digital Signal and Image Processing- Tamal Bose, John Wiley publishers.
2. Two dimensional signal and Image Processing- J S Lim, Prentice Hall.

COURSE PLAN

<table>
<tr><th>COURSE CODE:</th><th>COURSE TITLE</th><th colspan="2">CREDITS</th></tr>
<tr><td>04 EC 6711</td><td>Multidimensional Signal Processing</td><td colspan="2">3-0-0:3</td></tr>
<tr><td colspan="2">MODULES</td><td>Contact Hours</td><td>Sem. Exam Marks (%)</td></tr>
<tr><td colspan="2">MODULE 1: 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.</td><td>6</td><td>15</td></tr>
<tr><td colspan="2">MODULE 2: 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.</td><td>5</td><td>15</td></tr>
<tr><td colspan="4">INTERNAL TEST 1 (MODULE 1 & 2)</td></tr>
<tr><td colspan="2">MODULE 3: 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</td><td>6</td><td>15</td></tr>
<tr><td colspan="2">MODULE 4: 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 prefiltering design method, Frequency domain design techniques, stabilization techniques.</td><td>9</td><td>15</td></tr>
<tr><td colspan="4">INTERNAL TEST 2 (MODULE 3 & 4)</td></tr>
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MODULE 5: Multidimensional Recursive systems: Finite order difference equations- realizing LSI systems using difference equations, recursive computability, boundary conditions, ordering the computation of output samples.Multidimensional Z Transforms, stability of 2 D recursive systems, stability theorems, Two dimensional complex cepstrum.	7	20
MODULE 6: 2 dimensional Inverse problems: Constrained iterative signal restoration; iterative techniques for constrained deconvolution and signal extrapolation, reconstructions from phase or magnitude. Reconstruction of signals from their projections: Projection slice theorem, Discretization of the Reconstruction problem, Fourier domain reconstruction algorithms, Convolution/ back-projection algorithms, iterative reconstruction algorithms, Fan beam algorithms, Projection of discrete signals.	9	20
END SEMESTER EXAM		

COURSE CODE	COURSE NAME	L-T-P:C	YEAR
04 EC 6713	WIRELESS COMMUNICATION SYSTEM	3-0-0:3	2015

Pre-requisites:

Course Objectives:

To familiarise with different channel models

- To impart knowledge in the concept of fading and diversity.
- To familiarise with different techniques in cellular communication
- To introduce the concept of spread spectrum and CDMA
- To impart knowledge in fading channel capacity in different systems

Syllabus

Fading and Diversity -Cellular Communication - Multiple Access: FDM/TDM/FDMA/TDMA-Spread spectrum and CDMA-Fading Channel Capacity-Multiple Input Multiple output (MIMO) systems- Cellular Wireless Communication Standards
: GSM ,IS 95 CDMA- 3G systems:UMTS& CDMA 2000 standards and specifications.

Course Outcome:

After Learning this course, the student will be able to:-

- Describe and Enumerate the various methods of Radio Propagation
- Explain and illustrate the various concepts used in diversity techniques
- Describe the concept of cellularCommunication

Explain the various concepts associated with CDMA systems

Text Books:

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, PHI, 2001.

References:

1. G.L Stuber, Principles of Mobile Communications, 2nd edition, Kluwer Academic Publishers.
2. KamiloFeher, Wireless digital communication, PHI, 1995.
3. R.L Peterson, R.E. Ziemer and David E. Borth, Introduction to Spread Spectrum

COURSE PLAN

COURSE CODE:	COURSE TITLE	CREDITS	
04 EC 6713	WIRELESS COMMUNICATION SYSTEM	**3-0-0:3**	
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		5	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
INTERNAL TEST 1 (MODULE 1 & 2)			
MODULE 3:Cellular Communication : Cellular Networks,MultipleAccess:FDM/TDM/FDMA/TDMA- Spatial reuse- Co-channel interference Analysis- Hand over Analysis- Erlang Capacity Analysis- Spectral efficiency and Grade of Service- Improving capacity - Cell splitting and sectorization		7	15
MODULE 4:Diversity in DS-SS systems- Rake Receiver- Performance analysis.Spread Spectrum Multiple Access-CDMA Systems- Interference Analysis for Broadcast and Multiple Access Channels-Capacity of cellular CDMA networks- Reverse link power control- Hard and Soft hand off strategies.		7	15
INTERNAL TEST 2 (MODULE 3 & 4)			
MODULE 5:Fading Channel Capacity: Capacity of Wireless Channels- Capacity of flat and frequency selective fading channels- Multiple Input Multiple output (MIMO) systems- Narrow band multiple antenna system model- Parallel Decomposition of MIMO Channels- Capacity ofMIMO Channels.		7	20
MODULE 6:Cellular Wireless Communication Standards Second generation cellular systems: GSM specifications and Air Interface - specifications, IS 95 CDMA 3G systems:UMTS& CDMA 2000 standards and specifications		6	20
END SEMESTER EXAM			

COURSE CODE	COURSE NAME	L-T-P:C	YEAR
04 EC 6715	**Advanced Digital System Design**	**3-0-0:3**	**2015**

Pre-requisites: Digital System Design

Course Objectives:

To give the Student:-

- The ability to understand the basic concepts of digital system

Syllabus

- MSI and LSI circuits and their applications
- Synchronous sequential circuits
- Asynchronous sequential circuits
- Designing with Programmable Logic Devices
- Complex Programmable Logic Devices and Field Programmable Gate Arrays
- Timing issues in Digital system design

Course Outcome:

Students who successfully complete this course will have demonstrated the knowledge and ability to

- Understand the basic concepts of digital system
- Design systems as per the requirement

Text Books:

- Charles H. Roth ,*Fundamentals of Logic Design*, Thomson Publishers, 5th ed.
- Milos D Ercegovac, Tomas Lang, *Digital systems and hardware / firmware algorithm*, John Wiley, 1985

References:

- William I. Fletcher, *A Systematic Approach to Digital Design,* PHI, 1996.
- N.N Biswas,*Logic Design Theory*, Prentice Hall of India, 1st Edn,1993.
- ZviKohavi, *Switching and Finite automata Theory*, Tata McGraw Hill, 2nd ed
- Jan M. Rabaey, A. Chandrakasan, B. Nikolic, *Digital Integrated Circuits- A Design perspective*, Pearson education/ Prentice-Hall India Ltd, 2nd ed
- Comer, *Digital Logic State Machine Design*, Oxford University Press, 3rd ed.

COURSE PLAN

COURSE CODE:	COURSE TITLE	CREDITS	
04 EC 6715	**Advanced Digital System Design**	**3-0-0:3**	
MODULES		**Contact Hours**	**Sem. Exam Marks (%)**
MODULE 1: MSI and LSI circuits and their applications: Arithmetic circuits, comparators, Multiplexers, Code Converters, XOR & AOI Gates Multi module implementation of sequential systems – Multi module registers - and counters. Design of sequential systems with small number of standard modules, State register Counters and RAM with combinational networks Multi module implementation of sequential systems – Multi module registers and counters.		7	15
MODULE 2:Synchronous sequential circuits: Clocked Synchronous State Machine Analysis, Mealy and Moore machines Finite State Machine design procedure – derive state diagrams and state tables, state reduction methods, and state assignments. Implementing the states of FSM.		8	15
INTERNAL TEST 1 (MODULE 1 & 2)			
MODULE 3:Asynchronous sequential circuits: Analysis, Derivation of excitation table, Flow table reduction, state assignment, transition table, Desgn of asynchronous Sequential circuits, Race conditions and cycles, Static and dynamic hazards, Methods for avoiding races and hazards, essential hazards.Basics of SM charts.		8	15
MODULE 4:Designing with Programmable Logic Devices: Read – Only Memories, Programmable Array Logic PALs, Programmable Logic Arrays PLAs, PLA minimization and PLA folding , Other Sequential PLDs, Design of combinational and sequential circuits using PLD's.		7	15
INTERNAL TEST 2 (MODULE 3 & 4)			
MODULE 5: Complex Programmable Logic Devices and Field Programmable Gate Arrays , Altera Series FPGAs ,Xilinx Series FPGAs		6	20
MODULE 6:Timing issues in Digital system design: timing classification-synchronous timing basics – skew and jitter , latch based clocking- self timed circuit design - self timed logic, completion signal generation,self timedsignaling–synchronizers and arbiters.		6	20
END SEMESTER EXAM			

COURSE CODE	COURSE NAME	L-T-P:C	YEAR
04 GN 6001	RESEARCH METHODOLOGY	0 -2-0:2	2015

Pre-requisites: Nil

Course Objectives:

- To get introduced to research philosophy and processes in general.
- To formulate the research problem and prepare research plan
- To apply various numerical /quantitative techniques for data analysis
- To communicate the research findings effectively

Syllabus

Introduction to the Concepts of Research Methodology, Research Proposals, Research Design, Data Collection and Analysis, Quantitative Techniques and Mathematical Modeling, Report Writing

Course Outcome:

Students who successfully complete this course would learn the fundamental concepts of Research Methodology, apply the basic aspects of the Research methodology to formulate a research problem and its plan. They would also be able to deploy numerical/.quantiative techniques for data analysis. They would be equipped with good technical writing and presentation skills.

Text Books:

1. Research Methodology: Methods and Techniques', by Dr. C. R. Kothari, New Age International Publisher, 2004

2 Research Methodology: A Step by Step Guide for Beginners' by Ranjit Kumar, SAGE Publications Ltd; Third Edition

Reference Books:

1. Research Methodology: An Introduction for Science & Engineering Students', by Stuart Melville and Wayne Goddard, Juta and Company Ltd, 2004
2. Research Methodology: An Introduction' by Wayne Goddard and Stuart Melville, Juta and Company Ltd, 2004
3. Research Methodology, G.C. Ramamurthy, Dream Tech Press, New Delhi
4. Management Research Methodology' by K. N. Krishnaswamy et al, Person Education

COURSE PLAN

COURSE CODE:	COURSE TITLE	CREDITS	
04 GN 6001	**RESEARCH METHODOLOGY**	**0-2-0:2**	
MODULES		**Contact Hours**	**Sem. Exam Marks (%)**
MODULE 1: Introduction to Research Methodology, Concepts of Research, Meaning and Objectives of Research, Research Process, Types of Research, Type of research: Descriptive vs. Analytical, Applied vs. Fundamental, Quantitative vs. Qualitative, and Conceptual vs. Empirical		5	15
MODULE 2: Criteria of Good Research, Research Problem, Selection of a problem, Techniques involved in definition of a problem, Research Proposals – Types, contents, Ethical aspects, IPR issues like patenting, copyrights.		4	15
INTERNAL TEST 1 (MODULE 1 & 2)			
MODULE 3: Meaning, Need and Types of research design, Literature Survey and Review, Identifying gap areas from literature review, Research Design Process, Sampling fundamentals, Measurement and scaling techniques, Data Collection – concept, types and methods, Design of Experiments.		5	15
MODULE 4: Probability distributions, Fundamentals of Statistical analysis, Data Analysis with Statistical Packages, Multivariate methods, Concepts of correlation and regression, Fundamentals of time series analysis and spectral analysis		5	15
INTERNAL TEST 2 (MODULE 3 & 4)			
MODULE 5: Principles of Thesis Writing, Guidelines for writing reports & papers, Methods of giving references and appendices, Reproduction of published material, Plagiarism, Citation and acknowledgement		5	20
MODULE 6: Documentation and presentation tools – LATEX, Office Software with basic presentations skills, Use of Internet and advanced search techniques,		4	20
END SEMESTER EXAM			

COURSE CODE	COURSE NAME	L-T-P-C	YEAR
04 EC 6791	**SEMINAR-I**	**0-0-2 :2**	**2015**

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

COURSE CODE	COURSE NAME	L-T-P	YEAR
04 EC 6793	**ADVANCED SIGNAL PROCESSING LAB-I**	**0-0-2:1**	**2015**

Objective: To experiment the concepts introduced in the core and elective courses offered in the first semester with the help of MATLAB and DSP kit.

EXPECTED OUTCOME:

The student will be able to analyze and implement the concepts in the core / elective courses offered in the first semester.

COURSE CODE	COURSE NAME	L-T-P:C	YEAR
04 EC 6702	Adaptive Signal Processing	4-0-0:4	2015

Pre-requisites: Signal Processing

Course Objectives:

To give the Student:-

- The ability to understand the basic concept of Adaptive Signal Processing.

Syllabus

Adaptive systems

- Theory of adaptation with stationary signals
- Gradient estimation and its effects on adaptation]
- Important adaptive algorithms and Applications of Adaptive signal processing
- Other adaptive algorithms
- Adaptive modeling

Course Outcome:

Students who successfully complete this course will have demonstrated the knowledge and ability to

- Understand the basic concept of Adaptive Signal Processing.

Text Books:

- Adaptive signal processing: Widrow and Stearns, Pearson
- Statistical and Adaptive signal processing- Manalokis, Ingle and Kogon, Artech House INC., 2005.

References:

- Adaptive filter theory- 4th edition, Simon Haykin, Prentice Hall
- Adaptive filters- A H Sayed, John Wiley
- Adaptive filtering primer with MATLAB – A Poularikas, Z M Ramadan, Taylor and Francis Publications
- Digital Signal and Image processing- Tamal Bose, John Wiley publications.

COURSE PLAN

COURSE CODE:	COURSE TITLE	CREDITS	
04 EC 6702	**Adaptive Signal Processing**	**4-0-0:4**	
MODULES		**Contact Hours**	**Sem. Exam Marks (%)**
MODULE 1: 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		9	15
MODULE 2: Theory of adaptation with stationary signals: Input correlation matrix, Eigen values and eigen vectors of the i/p correlation matrix ,Searching the performance surface: Basic ideas of gradient search, Stability and rate of convergence, Learning curve, Newton's method, Steepest descent method, Comparison		10	15
INTERNAL TEST 1 (MODULE 1 & 2)			
MODULE 3: 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.		9	15
MODULE 4: Important adaptive algorithms and Applications of Adaptive signal processing: 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.		10	15
INTERNAL TEST 2 (MODULE 3 & 4)			
MODULE 5: Other adaptive algorithms-LMS Newton, Sequential regression, Recursive least squares, Adaptive recursive filters, Random search algorithm, Adaptive lattices predictor, Adaptive filters with orthogonal signals.		9	20
MODULE 6: Adaptive modelling of a multi-path communication channel, adaptive model in geophysical exploration, Inverse modelling, Adaptive interference cancelling: applications in Bio-signal processing		9	20
END SEMESTER EXAM			

COURSE CODE	COURSE NAME	L-T-P: C	YEAR
04 EC 6704	Wavelet Transforms: Theory and Applications	3-0-0:3	2015

Pre-requisites: Linear Algebra, Filter Bank preliminaries

Course Objectives:

To give the Student:-

- -concepts of the basic signal representation and Fourier transforms
- -concepts of Multi Resolution Analysis and Wavelets
- -an Understanding of the wavelet transform in both continuous and discrete domain
- -an ability to design of wavelets using Lifting scheme
- -an ability to the apply Wavelet transform in signal processing
- -explain the concepts, theory, and algorithms behind wavelets from an interdisciplinary perspective that unifies harmonic analysis (mathematics), filter banks (signal processing), and multiresolution analysis (computer vision).

Syllabus

Continuous Wavelet Transform-Discrete wavelet Transform-
Alternative wavelet representations- Bi-orthogonal Wavelets-Lifting scheme-Image Compression

Course Outcome:

Students who successfully complete this course will have demonstrated the knowledge and ability to

- -use Fourier tools to analyse signals and understand their strengths and shortcomings
- -gain knowledge about MRA, its evolution from a vector space and representation of functions using wavelet bases
- -acquire knowledge about various wavelet transforms and design wavelet
- transform
- -apply wavelet transform for various signal & image processing applications
- -master the modern signal processing tools using signal spaces, bases, operators and series expansions.
- apply wavelets, filter banks, and multiresolution techniques to a problem at hand,andjustify why wavelets provide the right tool

Text Books:

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, Pears

3. Ripples in Mathematics: Discrete Wavelet Transform,A.Jensen,Anders la Cour-Harbo

References:

1. Wavelets and filter banks- G Strang and T Q Nguyen, Wellesley Cambridge Press, 1998.
2. Fundamentals of Wavelets: Theory, Algorithms and Applications- J C Goswamy and A K Chan, Wiley-Interscience publications, John Wiley and sons, 1999
3. Wavelets and Multiwavelets- F Keinert, SIAM, Chapman and Hall/CRC, 2004
4. Ten Lectures on Wavelets- Ingrid Daubechies, SIAM, 1990
5. Wavelet Analysis- The scalable structure of Information- H L Resnikoff, R. O. Wells,Jr., Springer, 2004.
6. A wavelet tour of signal processing-the sparse way, StephaneMallat,Elsevier,Third edition,2009
7. Wavelets&SubbandCoding,Vetterli&Kovacevic, Prentice Hall, 1995
8. Gerald Kaiser, A friendly guide to wavelets, Birkhauser/Springer International Edition, 1994, Indian reprint 2005.

COURSE PLAN

COURSE CODE:	COURSE TITLE	CREDITS	
04 EC 6704	**Wavelet Transforms: Theory and Applications**	**3-0-0:3**	
MODULES		**Contact Hours**	**Sem. Exam Marks (%)**
MODULE 1: 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. Comparison of wavelets and any two time frequency transforms.		7	15
MODULE 2:Discrete wavelet Transform: Discrete wavelet transforms and discrete time wavelet transforms.Approximations of vectors in nested linear vector spaces,Example of an MRA, Formal definition of MRA, Construction of general orthonormal MRA, a Wavelet basis for MRADigital filtering interpretations- Decomposition and Reconstruction		9	15

filters, examples of orthogonal basis generating wavelets, interpreting orthonormal MRA for Discrete time signals, Mallat algorithm , Filter bank implementation of DWT		
INTERNAL TEST 1 (MODULE 1 & 2)		
MODULE 3:Alternative wavelet representations- Biorthogonal Wavelets: biorthogonality in vector space, biorthogonal wavelet bases,signal representation using biorthogonal wavelet system, advantages of biorthogonalwavelets,biorthogonal analysis and synthesis, Filter bank implementation	7	15
MODULE 4:Two dimensional Wavelets, filter bank implementation of two dimensional wavelet transform,Haar wavelet and properties,Shannon wavelet and properties,Daubechies family of wavelet properties Comparison of different wavelets	6	15
INTERNAL TEST 2 (MODULE 3 & 4)		
MODULE 5:Lifting scheme: Wavelet Transform using polyphase matrix factorization, Geometrical foundations of the lifting scheme,lifting scheme in the z- domain mathematical preliminaries for polyphase factorization ,Dealing with Signal Boundary	8	20
MODULE 6:Image Compression: short descriptions on EZW Coding, SPIHT and Wavelet Difference Reduction Compression Algorithm,Denoising, speckle removal, edge detection and object isolation,communication applications – scaling functions as signalingpulses,two specific applications of wavelet transforms in signal processing.	7	20
END SEMESTER EXAM		

COURSE CODE	COURSE NAME	L-T-P:C	YEAR
04 EC 6706	Multirate Signal Processing	3-0-0:3	2015

Pre-requisites: Digital signal processing

Course Objectives:

- The course focuses on multirate signal processing which is the basic to modern signal processing. Topics include multirate signal processing material such as decimation, interpolation, filter banks, polyphase filtering, advanced filtering structures and nonuniformsampling .

Syllabus

Single-Rate Discrete-Time Signals and Systems-Basic Sampling alteration schemes: Time-Domain Representation of Down-Sampling and Up-Sampling-Frequency-Domain Characterization -Polyphase Decomposition- Multistage Systems-Filters in Multirate Systems
FIR & IIR Filters for Sampling Rate Conversion -Sampling Rate Conversion by a Fractional Factor-Sampling Rate Alteration by an Arbitrary Factor- Fractional-Delay Filters-Lth-Band FIR Digital Filters-Complementary FIR Filter Pairs-Multirate FIR Filter Banks- Octave Filter banks.

Course Outcome:

Students who successfully complete this course will have demonstrated the knowledge and ability to analysemultirate system with multiple sampling rates.

Text Books:

1. Multirate filtering for Digital Signal processing- MATLAB applications, LjiljanaMilic, Information Science Reference, Hershey- New York, 2009

References:

1. Multirate systems and filter banks. P.P. Vaidyanathan Prentice Hall.PTR. 1993.
2. Multirate digital signal processing .N.J. Fliege.John Wiley 1994.
3. Multirate Digital Signal Processing, R.E. Crochiere. L. R Prentice Hall. Inc.19834. Sanjit K. Mitra, " Digital Signal Processing: A computer based approach." McGrawHill. 1998.

COURSE PLAN

COURSE CODE:	COURSE TITLE	CREDITS	
04 EC 6706	Multirate Signal Processing	3-0-0:3	
MODULES		Contact Hours	Sem. Exam Marks (%)
MODULE 1: Review of Single-Rate Discrete-Time Signals and Systems.Basic Sampling alteration schemes: Time-Domain Representation of Down-Sampling and Up-Sampling,Frequency-Domain Characterization of Down-Sampling and Up-Sampling, Decimation and Interpolation,Identities, Cascading, Sampling-Rate Alteration Devices,Polyphase Decomposition, Multistage Systems.		8	15
MODULE 2:Filters in Multirate Systems,FIR Filters for Sampling Rate Conversion :Direct Implementation Structures for FIR Decimators and Interpolators ,Poly-phase Implementation of Decimators and Interpolators,Memory Saving Structures for FIR,Poly-phase Decimators and Interpolators,Computational Efficiency of FIR Decimators and Interpolators		7	15
INTERNAL TEST 1 (MODULE 1 & 2)			
MODULE 3:IIR Filters for Sampling Rate Conversion: Direct Implementation Structures for IIR Filters for Decimation and Interpolation,Computational Requirements for IIR Decimators and Interpolators,IIR Filter Structures Based on Polyphase Decomposition		6	15
MODULE 4: Sampling Rate Conversion by a Fractional Factor: Sampling Rate Conversion by a Rational Factor, Spectrum of the Resampled Signal,Polyphase Implementation of Fractional Sampling Rate Converters,Rational Sampling Rate Alteration with Large Conversion Factors,Sampling Rate Alteration by an Arbitrary Factor, Fractional-Delay Filters		7	15
INTERNAL TEST 2 (MODULE 3 & 4)			
MODULE 5:Lth-Band FIR Digital Filters,Lth-Band Linear-Phase FIR Filters: Definitions and Properties,Polyphase Implementation of FIR Lth-Band,Filters,Separable Linear-Phase Lth-Band FIR Filters, Minimum-Phase and Maximum-Phase Transfer Functions,Halfband FIR Filters		5	20
MODULE 6:Complementary FIR Filter Pairs,Definitions of Complementary Digital Filter Pairs, Constructing High pass FIR Filters, Analysis and Synthesis Filter Pairs, FIR Complementary Filter Pairs,Multirate FIR Filter Banks: Two Channel FIR Filter bank, Alias free filter banks, Perfect reconstruction and Near Perfect reconstruction, Orthogonal Two channel FIR filter bank, Tree structured Multi-channel filter banks,Filter banks with equal pass bands, Octave Filter banks.		9	20
END SEMESTER EXAM			

OURSE CODE	COURSE NAME	L-T-P:C	YEAR
04 EC 6708	Compressed Sensing	3-0-0:3	2015

Pre-requisites: Nil

Course Objectives:

- To give the Student , the basic concept of compressed sensing

Syllabus

- An invitation to compressive sensing
- Sparse solutions of underdetermined systems
- Basic Algorithms
- Coherence
- Restricted Isometry property
- Sparse Recovery With Random Matrices
- Gelfand widths of 1 –Balls

Course Outcome:

- An overview of compressed sensing

Text Books:

- *Simon Foucart & HolgerRauhut, A mathematical introduction to compressive sensing Springer*

References:

1. *Yonina C, EldarGittakutyniok,Compressedsensing,Theory&Applications,Cambridge University Press*

COURSE PLAN

COURSE CODE:	COURSE TITLE	CREDITS	
04 EC 6708	COMPRESSED SENSING	3-0-0:3	
MODULES		Contact Hours	Sem. Exam Marks (%)
MODULE 1: An invitation to compressive sensing :what is compressive sensing, Applications ,Motivations &Extensions,Sparse solutions of underdetermined systems : Sparsity& compressibility-Minimal number of measurements –NP –hardness of lo minimisation		8	15
MODULE 2: Basic Algorithms: Optimisation methods –Greedy methods-Thresh holding –Based Methods, Basis pursuit: Null Space Property, Stability, Robustness, Recovery of individual vectors, The projected cross- polytope-Low –Rank Matrix recovery		8	15
INTERNAL TEST 1 (MODULE 1 & 2)			
MODULE 3:Coherence: Definition & Basic properties,- matrices with small coherence-Analysis of orthogonal Matching pursuit, Analysis of basis pursuit, Analysis of thresh holding algorithms		6	15
MODULE 4:Restricted Isometryproperty :Definition & Basic properties,analysis of basis pursuit, Analysis of thresh holding algorithms, Analysis of Greedy algorithms		5	15
INTERNAL TEST 2 (MODULE 3 & 4)			
MODULE 5: Sparse Recovery With Random Matrices: RestritedIsometry property for subgaussian matrices-Nonuniform Recovery, Restricted Isometry property for Gaussian Matrices-Relation to Johnson-LindenstraussEmbeddings		7	20
MODULE 6:Gelfand widths of 1 –Balls: Definition And Relation to compressive Sensing-Estimate for Gelfand widths of 11 –Balls ,Application to the Geometry of Banach spaces , Instance optimality and Quotient property random(basic Concepts only)- sampling in Bounded Orthonormal systems(basic Concepts only.		8	20
END SEMESTER EXAM			

COURSE CODE	COURSE NAME	L-T-P:C	YEAR
04 EC 6712	ARRAY SIGNAL PROCESSING	3-0-0:3	2015

Pre-requisites: Nil

Course Objectives:

To give the Student:-

- The ability to understand the basic concept of Array Signal Processing.

Syllabus

- Spatial Signals
- Spatial Frequency
- Sensor Arrays
- Direction of Arrival Estimation
- Direction of Arrival Estimation Subspace methods
- Higher order statistics in Signal Processing

Course Outcome:

Students who successfully complete this course will have demonstrated the knowledge and ability to

- Understand the basic concept of Array Signal Processing.

Text Books:

1. Array Signal Processing: Concepts and Techniques., Dan E. Dugeon and Don H. Johnson. (1993).
   a. Prentice Hall.
2. Statistical and Adaptive signal processing- Manalokis, Ingle and Kogon, Artech House INC., 2005.

References:

1. Spectral Analysis of Signals. PetreStoica and Randolph L. Moses. (2005, 1997) Prentice Hall.
2. Array Signal Processing [Connexions Web site].February 8, 2005. Available at:
   a. http://cnx.rice.edu/content/col10255/1.3/

COURSE PLAN

COURSE CODE:	COURSE TITLE	CREDITS	
04 EC 6712	Array Signal Processing	3-0-0:3	
MODULES		Contact Hours	Sem. Exam Marks (%)
MODULE 1: Spatial Signals: Signals in space and time. Spatial frequency, Direction vs. frequency. Wave fields. Farfield and Near field signals.		6	15
MODULE 2: Spatial Frequency: Aliasing in spatial frequency domain. Spatial Frequency Transform, Spatial spectrum. Spatial Domain Filtering. Beam Forming. Spatially white signal		7	15
INTERNAL TEST 1 (MODULE 1 & 2)			
MODULE 3: 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		8	15
MODULE 4: Direction of Arrival Estimation : Non parametric methods - Beam forming and Capon methods. Resolution of Beam forming method.		7	15
INTERNAL TEST 2 (MODULE 3 & 4)			
MODULE 5: Direction of Arrival Estimation Subspace methods - MUSIC, Minimum Norm and ESPRIT techniques. Spatial Smoothing.		7	20
MODULE 6: Higher order statistics in Signal Processing: Moments, Cumulants and poly spectra, Higher order moments and LTI systems.		7	20
END SEMESTER EXAM			

COURSE CODE	COURSE NAME	L-T-P:C	YEAR
04 EC 6714	VLSI architectures for DSP	**3-0-0:3**	**2015**

Pre-requisites: Nil

Course Objectives:

To give the Student:-

- The ability to understand the basic concepts of VLSI DSP Architectures.

Syllabus

Pipelining and parallel processing- folding- Fast convolution – Scaling and round off noise –
Digital lattice filter structures-Bit level arithmetic architectures-Synchronous, wave and asynchronous pipelines-

Course Outcome:

Students who successfully complete this course will have demonstrated the knowledge and ability to

- Understand the basic concepts of VLSI DSP Architectures.

Text Books:

1. Charles H. Roth ,*Fundamentals of Logic Design*, Thomson Publishers, 5th ed.
2. Milos D Ercegovac, Tomas Lang, *Digital systems and hardware / firmware algorithm*,John Wiley, 1985

References:

1. William I. Fletcher, *A Systematic Approach to Digital Design,* PHI, 1996.
2. N.N Biswas,*Logic Design Theory*, Prentice Hall of India, 1st Edn,1993.
3. ZviKohavi, *Switching and Finite automata Theory*, Tata McGraw Hill, 2nd ed.
4. Jan M. Rabaey, A. Chandrakasan, B. Nikolic, *Digital Integrated Circuits- A Design*
    a. *perspective*, Pearson education/ Prentice-Hall India Ltd, 2nd ed
5. Comer, *Digital Logic State Machine Design*, Oxford University Press, 3rd ed.

COURSE PLAN

COURSE CODE:	COURSE TITLE	CREDITS	
04 EC 6714	**VLSI Architectures for DSP**	**3-0-0:3**	
MODULES		**Contact Hours**	**Sem. Exam Marks (%)**
MODULE 1:Pipelining and parallel processing- pipelining of FIR filters, Parallel processing, pipelining and parallel processing for low power , retiming- definitions and properties, solving system of inequalities, retiming techniques.		7	15
MODULE 2:Fast convolution – Cook Toom Algorithm, Winograd Algorithm, Iterated convolution, Cyclic convolution Algorithmic strength reduction in filters and transforms- Parallel FIR filters, DCT and IDCT		7	15
INTERNAL TEST 1 (MODULE 1 & 2)			
MODULE 3: Scaling and round off noise – scaling and round off noise, state variable description of digital filters,Scaling and round off noise computation, round off noise in pipelined IIR filters, Round off noise computation using state variable description, slow down, retiming and pipelining.		7	15
MODULE 4:Digital lattice filter structures- Schur algorithm, Digital basic lattice filters, Derivation of one multiplier Lattice filter , Derivation of scaled-normalized lattice filter, Round off noise calculation in Lattice filters		7	15
INTERNAL TEST 2 (MODULE 3 & 4)			
MODULE 5: Bit level arithmetic architectures- parallel multipliers, interleaved floor plan and bit plane based digital filters, Bit serial filter design and implementation, Canonic signed digital arithmetic		7	20
MODULE 6:Synchronous, wave and asynchronous pipelines- Synchronous pipelining and clocking styles, clock skew and clock distribution in bit level pipelined VLSI designs, Wave pipelining, asynchronous pipelining		7	20
END SEMESTER EXAM			

COURSE CODE	COURSE NAME	L-T-P:C	YEAR
04 EC 6716	Signal Compression Theory and Methods	**3-0-0:3**	**2015**

Pre-requisites: Nil

Course Objectives:

- To familiarise with different coding techniques.
- To introduce the concept of rate distortion theory.
- To introduce different types of transforms
- To familiarise with different data compression standards

Syllabus

Information Theory- Compression Techniques - Huffman Coding - Arithmetic Coding - Dictionary Techniques - Predictive Coding - Rate distortion theory-Quantization - Transforms- Analysis/Synthesis Schemes-Data,Audio ,Image and Video Compression Standards.

Course Outcome:

The student would have demonstrated the ability to understand different types of coding techniques, rate distortion theory and various transform coding techniques,

Text Books:

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.

References:

1. "Rate Distortion Theory: A Mathematical Basis for Data Compression", Toby Berger, Prentice Hall,Inc., 1971.
2. "The Transform and Data Compression Handbook", K.R.Rao, P.C.Yip, CRC Press., 2001.
3. "Information Theory and Reliable Communication", R.G.Gallager, John Wiley & Sons, Inc., 1968.
4. "Multiresolution Signal Decomposition: Transforms, Subbands and Wavelets", Ali N. Akansu, Richard A. Haddad, Academic Press. 1992
5. "Wavelets and Subband Coding", Martin Vetterli, JelenaKovacevic, Prentice Hall Inc., 1995

6. "Elements of Information Theory," Thomas M. Cover, Joy A. Thomas, John Wiley & Sons, Inc., 1991.

COURSE PLAN

COURSE CODE:	COURSE TITLE	CREDITS	
04 EC 6716	**Signal Compression Theory and Methods**	**3-0-0:3**	
MODULES		**Contact Hours**	**Sem. Exam Marks (%)**
MODULE 1: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		7	15
MODULE 2: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		7	15
INTERNAL TEST 1 (MODULE 1 & 2)			
MODULE 3: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.		8	15
MODULE 4:Mathematical Preliminaries for Transforms, KarhunenLoeve Transform, Discrete Cosine and Sine Transforms, Discrete Walsh Hadamard Transform, Lapped transforms ,Transform coding - Subbandcoding,Wavelet Based Compression - Analysis/Synthesis Schemes		8	15
INTERNAL TEST 2 (MODULE 3 & 4)			
MODULE 5:Audio Compression standards: MPEG, Philips PASC, Sony ATRAC, Dolby AC-3,Image Compression standards: JBIG, GIF, JPEG & JPEG derived industry standards, CALIC, SPIHT,EZW, JPEG 2000		6	20
MODULE 6: Data Compression standards: Zip and Gzip.Video Compression Standards: MPEG, H.261, H.263 & H264.		6	20
END SEMESTER EXAM			

COURSE CODE	COURSE NAME	L-T-P:C	YEAR
04 EC 6718	Biomedical Signal Processing	**3-0-0:3**	**2015**

Pre-requisites: Nil

Course Objectives:

To give the Student:-

- To impart knowledge about the principle of different types of bio-medical signals
- To give ideas about the interpretation of various signals in biomedical applications
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Syllabus

Introduction to Biomedical Signals, Review of linear systems- Detection of biomedical signals in noise- Classification of biomedical signals , Cardio vascular applications- ECG Signal Processing , Data Compression- Neurological Applications- Modeling EEG

Course Outcome:

Students who successfully complete this course will have demonstrated the knowledge and ability to

- Understand the basic concept of Biomedical signals
- Understand the basic concept of Applications of Biomedical signals

Text Books:

1. Biomedical Signal Processing: Principles and techniques, D.C.Reddy, Tata McGraw Hill,
2. Biosignal and Biomedical Image Processing, Marcel Dekker, Semmlow, 2004

References:

1. Biomedical Signal Processing & Signal Modeling, Bruce, Wiley, 2001
2. Bioelectrical Signal Processing in Cardiac & Neurological Applications, Sörnmo, Elsevier
3. Biomedical Signal Analysis, Rangayyan, Wiley 2002.
4. Introduction to Biomedical Engineering, 2/e, Enderle, Elsevier, 2005

COURSE PLAN

COURSE CODE:	COURSE TITLE	CREDITS	
04 EC 6718	**Biomedical Signal Processing**	**3-0-0:3**	
MODULES		**Contact Hours**	**Sem. Exam Marks (%)**
MODULE 1:Introduction to Biomedical Signals - Examples and acquisition 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.		9	15
MODULE 2:Concurrent, coupled and correlated processes - illustration with case studies - Adaptive and optimal filtering .Modelling of Biomedical signals Detection of biomedical signals in noise - removal of artefacts of one signal embedded in another -Maternal-Fatal ECG - Muscle-contraction interference. Event detection – case studies with ECG & EEG - Independent component Analysis - Cocktail party problem applied to EEG signals –		8	15
INTERNAL TEST 1 (MODULE 1 & 2)			
MODULE 3:Classification of biomedical signals.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		6	15
MODULE 4: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.		8	15
INTERNAL TEST 2 (MODULE 3 & 4)			
MODULE 5:Neurological Applications : The electroencephalogram - EEG rhythms & waveform - categorization of EEG activity - recording techniques , EEG applications- Epilepsy, sleep disorders, brain computer interface.		5	20
MODULE 6:Modeling EEG- linear, stochastic models - Non linearmodeling 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.		6	20

END SEMESTER EXAM			
COURSE CODE	**COURSE NAME**	**L-T-P:C**	**YEAR**
04 EC 6722	**Detection and estimation**	**3-0-0:3**	**2015**

Pre-requisites: Linearalgebra, Random Process

Course Objectives:

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

Syllabus

Fundamentals of Detection Theory-Hypothesis Testing- Detection of Signals in White Gaussian Noise - Fundamentals of Estimation Theory-Estimation Techniques-Deterministic Parameter Estimation-Random Parameter Estimation-State Estimation-Kalman Filter

Course Outcome:

The student will be able to

1. Differentiate and apply methods of detection for deterministic and random signals to solve problems
2. Solve problems involving estimation of different signals

Text Books:

1. M D Srinath, P K Rajasekaran, R Viswanathan, Introduction to Statistical Signal Processing with Applications, "Pearson"
2. Steven M. Kay, "Statistical Signal Processing: Vol. 1: Estimation Theory, Vol. 2: Detection Theory," Prentice Hall Inc., 1998.

References:

1. Jerry M. Mendel, "Lessons in Estimation Theory for Signal Processing, Communication and Control," Prentice Hall Inc., 1995
2. Ralph D. Hippenstiel, "Detection Theory- Applications and Digital Signal Processing", CRC Press, 2002.
3. Bernard C. Levy, "Principles of Signal Detection and Parameter Estimation", Springer, New York, 2008.
4. Harry L. Van Trees, "Detection, Estimation and Modulation Theory, Part 1 and 2," John Wiley & Sons Inc. 1968.
5. Neel A. Macmillan and C. Douglas Creelman, "Detection Theory: A User's Guide (Sec. Edn.)" Lawrence Erlbaum Associates Publishers, USA, 2004.
6. Monson H. Hayes, "Statistical Digital Signal Processing and Modelling," John Wiley

& Sons Inc., 1996.

COURSE PLAN

COURSE CODE:	COURSE TITLE	CREDITS	
04 EC 6722	Detection and estimation	**3-0-0:3**	
MODULES		**Contact Hours**	**Sem. Exam Marks (%)**
MODULE 1:Fundamentals of Detection Theory : Hypothesis Testing: Bayes' Detection, MAP Detection, ML Detection, Minimum Probability of Error Criterion, Min-Max Criterion, Neyman-Pearson Criterion, Multiple Hypothesis,Composite Hypothesis Testing: Generalized likelihood ratio test (GLRT),Receiver Operating Characteristic Curves		8	15
MODULE 2:Detection of Signals in White Gaussian Noise (WGN) Binary Detection of Known Signals in WGN, M-ary Detection of Known Signals in WGN, Matched Filter Approach, Detection of signals with Random Parameters		6	15
INTERNAL TEST 1 (MODULE 1 & 2)			
MODULE 3:Fundamentals of Estimation Theory : Role of Estimation in Signal Processing, Unbiased Estimation, Minimum variance unbiased(MVU) estimators, Finding MVU Estimators Cramer-Rao Lower Bound, Linear Modeling-Examples Sufficient Statistics, Use of Sufficient Statistics to find the MVU Estimator		7	15
MODULE 4:Estimation TechniquesDeterministic Parameter Estimation: Least Squares Estimation Batch processing Recursive Least Squares Estimation, Best Linear Unbiased Estimation Likelihood and Maximum Likelihood Estimation		7	15
INTERNAL TEST 2 (MODULE 3 & 4)			
MODULE 5:Random Parameter Estimation: Bayesian Philosophy, Selection of a Prior PDF Bayesian linear model Minimum Mean Square Error Estimator, Maximum a Posteriori Estimation		7	20
MODULE 6: State Estimation: Prediction, Single and Multistage Predictors,Filtering, The Kalman Filter		7	20
END SEMESTER EXAM			

COURSE CODE	COURSE NAME	L-T-P:C	YEAR
04 EC 6724	Design of Embedded Systems	3-0-0:3	2015

Pre-requisites: Nil

Course Objectives:

- To provide an introduction to the design of embedded systems including their hardware and software architectures, design methodologies and tools, and communication protocols..
- To get a clear understanding of the various interfacing concepts and to learn more on RTOS.

Syllabus

Embedded Design Process, Embedded System Development Environment, Memory Systems, Embedded Programing, Embedded Communication Protocols , Embedded Firmware Design And Development

Course Outcome:

After Learning this course, the student will be able to understand:-

- Systems approach to Embedded Systems
- Industrial applications of embedded systems
- Deal with complex issues in embedded systems both systematically and creatively

Text Books:

1. Steve Heath, Embedded System Design Elsevier Publications 2005
2. Gajski and Vahid, "Specification and Design of Embedded systems", Prentice Hall. 2002

References:

1. Embedded Systems Design: An Introduction to Processes, Tools, and Techniques by Arnold S. Berger CMP Books, 2002
2. Frank Vahid and Tony Givargis, Embedded System Design-A Unified Hardware/Software Introduction",,John Wiley & Sons,2002.
3. K. V. Shibu," Introduction To Embedded Systems", Tata McGraw-Hill Education Pvt. Ltd. 2009
4. Raj Kamal, Embedded Systems Tata McGraw-Hill Education, 2008

COURSE PLAN

COURSE CODE:	COURSE TITLE	CREDITS	
04 EC 6724	**Design of Embedded Systems**	**3-0-0:3**	
MODULES		**Contact Hours**	**Sem. Exam Marks (%)**
MODULE 1:EMBEDDED DESIGN PROCESS:Embedded system overview, Design challenge ,Product specification , Hardware / Software partitioning , Hardware and software design , Integration ,Product testing Selection Processes , General-purpose Processors, Single-purpose Processors, and Application Specific Processors , Use of software tools for development of an Embedded system.		8	15
MODULE 2:EMBEDDED SYSTEM DEVELOPMENT ENVIRONMENT: Fundamental issues in hardware software co-design, Computational models in embedded design.The Integrated development environment (IDE), Types of files generated on cross compilation, Disassembler/Decompilers, Emulators and debugging, Boundary scan		6	15
INTERNAL TEST 1 (MODULE 1 & 2)			
MODULE 3:MEMORY SYSTEMS:Memory Technologies, DRAM Technology, Video RAM,SRAM ,DRAM,EPROM and OTP ,Memory organization ,Cache memory -Cache size and organization ,Cache coherency . RTOS: Introduction, Basic OS functions, Process Management, Scheduling and Interrupt-latency control functions, Timer Functions and Time Management, IPC Synchronization.		6	15
MODULE 4:EMBEDDED PROGRAMING:Integrated development environment Tools, Compiling, Linking and locating , Downloadingand debugging, Emulators and simulators processor, Overview of PIC AVR family of microcontrollers and ARM processors.		9	15
INTERNAL TEST 2 (MODULE 3 & 4)			
MODULE 5:EMBEDDED COMMUNICATION PROTOCOLS :Embedded Networking: Introduction – Serial/Parallel Communication –Serial communication protocols -RS232 standard – RS485 – Synchronous Serial Protocols -Serial Peripheral Interface (SPI)The I2C Bus, The CAN bus, SHARC link Ports, Ethernet, Internet, Bluetooth: Specification, Protocol, Cable replacement protocol.		7	20
MODULE 6:EMBEDDED FIRMWARE DESIGN AND DEVELOPMENT: Embedded firmware design approaches, Embedded firmware development language.Real time operating system (RTOS) based embedded system design: Operating system basics, Types of OS,		6	20

Tasks, Process and threads , Multiprocessing and multitasking, Task scheduling, Threads, Processing and scheduling: Putting them altogether, Task communication, task synchronization, Device drivers, How to choose an RTOS.		
END SEMESTER EXAM		

COURSE CODE	COURSE NAME	L-T-P:C	YEAR
04 EC 6726	**Transform Theory**	**3-0-0:3**	**2015**

Pre-requisites: Nil

Course Objectives:

To impart a thorough knowledge in transforms

Syllabus

Linear Operators on Finite-dimensional Vector Spaces- eigenvalues, eigenvectors and eigenspace of a linear operator- Orthogonal transformations, Singular value decomposition , Normed Linear Spaces-Bounded Linear Operators and Spectral Theory - Theory of Distributions-The making of Laplace transform and Fourier transform-Lapped Transforms Karhunen-Loeve transform - The Making of Continuous Wavelet Transform

Course Outcome:

Students who successfully complete this course will have basic concept in transform.

Text Books:

1. Arch W. Naylor and George R. Sell, "Linear Operator Theory in Engineering and Science," 2nd Edition, Springer-Verlag, New York, 1982.
2. Larry Smith, "Linear Algebra," 2nd Edition, Springer-Verlag, New York 1982

References:

1. LokenathDebnath and PiotrMikusinski, "Hilbert Spaces with Applications," 3rd Edition, Academic Press, Indian reprint 2006.
2. A. David Wunsch, "Complex Variables with Applications," 2nd Edition, Addison-Wesley Publishing Company, New York, 1994.
3. Erwin Kreyszig, "Introductory Functional Analysis with Applications," John Wiley and Sons, 1989.
4. George Bachman and Lawrence Narici, "Functional Analysis," Dover Publications Inc., 2000.
5. Frederick W Byron, Jr and Robert W Fuller, "Mathematics of Classical and Quantum Physics," Dover Publications Inc., 1992.

6. Athanasios Papoulis, “Fourier Integral and its Applications,” McGraw-Hill International, New York, 1962.
7. Athanasios Papoulis, “Systems and Transforms with Applications in Optics,” McGraw-Hill International, New York, 1968.
8. Anthony N. Michel and Charles J. Herget, “Applied Algebra and Functional Analysis,” Dover Publications Inc., 1993.
9. Stephen G. Mallat, “A Wavelet Tour of Signal Processing,” 2nd Edition, Academic Press, 2000.
10. Gerald Kaiser, “A Friendly Guide to Wavelets,” Birkhauser/Springer International Edition, 1994, Indian reprint 2005.
11. Ingrid Daubechies, “Ten Lectures on Wavelets,” SIAM, 1990.

COURSE PLAN

COURSE CODE:	COURSE TITLE	CREDITS	
04 EC 6726	**Transform Theory**	**3-0-0:3**	
MODULES		**Contact Hours**	**Sem. Exam Marks (%)**
MODULE 1:Eigenvalue problems, eigenvalues, eigenvectors and eigenspace of a linear operator,Linear operators with an eigenbasis, decomposition of vector spaces, Similarity transformations - Diagonalization, Primary decomposition theorem, Jordan Canonical form/decomposition; Fredholm alternative theorem, Least squares solutions and pseudoinverses,LU decomposition, Orthogonal transformations, Singular value decomposition,Householder transformation.		10	15
MODULE 2:Functionals - Norm, Convergence - Cauchy sequence, Completeness of vector spaces;Infinite dimensional vector spaces - Normed linear spaces; Banach Spaces, Inner product spaces, Hilbert spaces; Continuous linear operators.		6	15
INTERNAL TEST 1 (MODULE 1 & 2)			
MODULE 3:Bounded Linear Operators and Spectral Theory Bounded linear operators in finite dimensional inner product spaces -Adjoint of an operator, Norm of an operator; Self-adjoint operators - Spectral analysis of self-adjoint operators; Bessel's inequality, Parseval's identity; Reisz Representation Theorem, Compact linear operators		7	15
MODULE 4:Theory of Distributions,Generalized functions and the Dirac's delta; Differential operators - Green's function and the inverse linear operators. The making of Laplace transform and Fourier transform, Self-reciprocal functions and operators under Fourier transform - The construction of Fractional Fourier transform; Construction of z-transform- Discrete-time Fourier transform and discrete Fourier transform.		8	15
INTERNAL TEST 2 (MODULE 3 & 4)			
MODULE 5:Lapped Transforms Karhunen-Loeve transform - Lapped orthogonal transforms and biorthogonal transforms – Construction of discrete cosine and sine transforms.		5	20
MODULE 6:The Making of Continuous Wavelet Transform Reisz basis, Resolution of unity, Definition of frames, Geometrical considerations and the general notion of a frame, Frame projector, Example - windowed Fourier frames;Continuous wavelet transform.		6	20
END SEMESTER EXAM			

COURSE CODE	COURSE NAME	L-T-P:C	YEAR
04 EC 6728	OPTICAL SIGNAL PROCESSING	3-0-0:3	2015

Pre-requisites: Nil

Course Objectives:

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Syllabus

Basics of signal processing and optics-The Fresnel Transforms, the Fourier transform-
Spectrum Analysis and Spatial Filtering-Applications for optical signal processing-Acousto-optic cell spatial light modulators-Heterodyne systems- optical Radio.

Course Outcome:

Students who successfully complete this course will have demonstrated the knowledge and ability to understand the basics of signal processing and optics

Text Books:

1. Anthony Vanderlugt, Optical signal processing: Wiley-Interscience
2. Dr. Hiroshi Ishikawa , Ultrafast All-Optical Signal Processing Devices: Wiley

References:

1. Francis T. S. Yu, SugandaJutamulia,Optical Signal Processing, Computing, and Neural Networks: Krieger Publishing Company

2. D. Casasent, Optical data processing-Applications, Springer-Verlag, Berlin

3. H.J. Caulfield, Handbook of holography, Academic Press New York

4. P.M. Dufffieux, The Fourier Transform and its applications to Optics, John Wiley and sons

5 J. Horner ,Optical Signal Processing Academic Press

6.Joseph W. Goodman, Introduction to Fourier Optics, second edition McGraw Hill.

COURSE PLAN

COURSE CODE:	COURSE TITLE	CREDITS	
04 EC 6728	**OPTICAL SIGNAL PROCESSING**	**3-0-0:3**	
MODULES		**Contact Hours**	**Sem. Exam Marks (%)**
MODULE 1:Basics of signal processing and optics, Characterization of a General signal, examples ofsignals, Spatial signal. Basic laws of geometrical optics, Refractions by mirrors, the lens formulas, General Imaging conditions, the optical invariant, Optical Aberrations.		8	15
MODULE 2:Physical Optics, The Fresnel Transforms, the Fourier transform, Examples of Fourier transforms, the inverse Fourier transform, Extended Fourier transform analysis, Maximum information capacity and optimum packing density, System coherence		10	15
INTERNAL TEST 1 (MODULE 1 & 2)			
MODULE 3:Spectrum Analysis, Light sources, spatial light modulators, The detection process in Fourier domain, System performance parameters, Dynamic range. Some fundamentals of signal processing		7	15
MODULE 4:Spatial Filters, Binary Spatial Filters, Magnitude Spatial Filters, Phase Spatial Filters, Real valued Spatial Filters, Interferometric techniques for constructing Spatial Filters. Optical signal processor and filter generator, Applications for optical signal procesing		8	15
INTERNAL TEST 2 (MODULE 3 & 4)			
MODULE 5:Acousto-optic cell spatial light modulators, Applications of acousto-optic devices. Basic Acousto-optic power spectrum analyzer.		5	20
MODULE 6:Heterodyne systems: Interference between two waves, the optical Radio.		4	20
END SEMESTER EXAM			

COURSE CODE	COURSE NAME	L-T-P:C	YEAR
04 EC 6732	Coding Theory	3-0-0:3	2015

Pre-requisites: Nil

Course Objectives:

To give the Student:-

- A sound background in concepts of Information theory and channel coding.
- An introduction to traditional binary and non-binary channel coding algorithms.
- A foundation on the, extensively used, latest capacity approaching codes

Syllabus

Entropy-Lossless source coding-Asymptotic Equipartition Property-Channel Capacity-Continuous Sources and Channels-Finite Field Arithmetic

Course Outcome:

Students who successfully complete this course will have demonstrated the knowledge and ability to

- Students who successfully complete this course will have a sound background in binary and non-binary error-correcting codes, covering different classes of channel codes-block codes and convolutional codes
- Study the construction of various algebraic codes in the finite fields
- Appreciate the use of iterative probabilistic decoding algorithms
- Motivated to take up research works and projects on the design of efficient communication systems using proper channel codes in standard channel models.

Text Books:

1. T. Cover and J. Thomas, Elements of Information Theory, John Wiley & Sons 1991.
2. Taub& Schilling, Principles of communication systems, TMH.

References:

1. Shulin& Daniel J. Costello, Error control coding – Fundamentals and Application,
2. Prentice Hall Ed.RobertGallager, “Information Theory and Reliable Communication”, John Wiley & Sons.
3. R. J. McEliece, “The theory of information & coding”, Addison Wesley Publishing Co., 1977.
4. T. Bergu, Rate Distortion Theory a Mathematical Basis for Data Compression, PH Inc. 1971.
5. Special Issue on Rate Distortion Theory, IEEE Signal Processing Magazine, November 1998.
6. Bernard Sklar, Digital Communication, 2/e, Pearson Education, 2001.

COURSE PLAN

COURSE CODE:	COURSE TITLE	CREDITS	
04 EC 6732	Coding Theory	**3-0-0:3**	
MODULES		**Contact Hours**	**Sem. Exam Marks (%)**
MODULE 1:Entropy- Memory less sources- Markov sources- Entropy of a discrete Random variable- Joint, conditional and relative entropy Mutual Information and conditional mutual information- Chain relation for entropy, relative entropy and mutual Information		6	15
MODULE 2:Lossless source coding- Uniquely decodable codes- Instantaneous codes- Kraft's inequality - Optimal codes- Huffman code- Shannon's Source Coding Theorem.		6	15
INTERNAL TEST 1 (MODULE 1 & 2)			
MODULE 3:Asymptotic Equipartition Property (AEP)- High probability sets and typical sets- Method of typical sequence as a combinatorial approach for bounding error probabilities.		6	15
MODULE 4:Channel Capacity- Capacity computation for some simple channels- Arimoto-Blahut algorithm- Fano's inequality-Proof of Shannon's Channel Coding Theorem and its converse- Channels with feed back- Joint source channel coding Theorem.		6	15
INTERNAL TEST 2 (MODULE 3 & 4)			
MODULE 5:Differential Entropy- Joint, relative and conditional differential entropy- Mutual information , Waveform channels- Gaussian channels- Mutual information and Capacity , calculation for Band limited Gaussian channels- Shannon limit- Parallel Gaussian Channels-Capacity of channels with colored Gaussian noise- Water filling.		9	20
MODULE 6:Introduction, Groups- Rings- Fields- Arithmetic of Galois Field-Integer Ring- Polynomial Rings- Polynomials and Euclidean algorithm, primitive elements , Construction and basic properties of Finite Fields-Computations using Galois Field arithmetic- sub fields- Minimal polynomial and conjugates- Vector space- Vector Subspace- Linear Independence.		9	20
END SEMESTER EXAM			

COURSE CODE	COURSE NAME	L-T-P:C	YEAR
04 EC 6734	FPGA System Design	3-0-0:3	2015

Pre-requisites: Nil

Course Objectives:

To give the Student:-

- To learn the various programmable devices and their architecture
- To get the concepts of FSM

Syllabus

Programmable logic Devices- FPGAs-Finite State Machines -FSM Architectures-System Level Design-Introduction to advanced FPGAs: Xilinx Virtex and ALTERA Stratix

Course Outcome:

- Apply the basics of programmable devices, FPGA technology and design process. Students who successfully complete this course will get an idea of FSM

Text Books:

1. Field Programmable Gate Array Technology - S. Trimberger, Edr, 1994, Kluwer Academic Publications.
2. Engineering Digital Design - RICHARD F.TINDER, 2nd Edition, Academic press.
3. Fundamentals of logic design-Charles H. Roth, 4th Edition Jaico Publishing House.

References:

1. Digital Design Using Field Programmable Gate Array, P.K. Chan & S. Mourad, 1994, Prentice Hall.
2. Field programmable gate array, S. Brown, R.J. Francis, J. Rose, Z.G. Vranesic, 2007, BS

COURSE PLAN

COURSE CODE:	COURSE TITLE	CREDITS	
04 EC 6734	FPGA System Design	**3-0-0:3**	
MODULES		**Contact Hours**	**Sem. Exam Marks (%)**
MODULE 1:Programmable logic Devices: ROM, PLA, PAL, CPLD, FPGA Features, Architectures and Programming. Applications and Implementation of MSI circuits using Programmable logic Devices.		7	15
MODULE 2: FPGAs: Field Programmable Gate Arrays- Logic blocks, routing architecture, design flow, technology mapping for FPGAs, Case studies Xilinx XC4000 & ALTERA's FLEX 8000/10000 FPGAs.		7	15
INTERNAL TEST 1 (MODULE 1 & 2)			
MODULE 3:Finite State Machines (FSM): Top Down Design, State Transition Table, State assignments for FPGAs,Realization of state machine charts using PAL, Alternative realization for state machine charts using microprogramming, linked state machine, encoded state machine.		8	15
MODULE 4:FSM Architectures: Architectures Centered around non registered PLDs, Design of state machines centeredaround shift registers, One_Hot state machine, Petrinets for state machines-Basic concepts and properties, Finite State Machine-Case study.		7	15
INTERNAL TEST 2 (MODULE 3 & 4)			
MODULE 5: System Level Design: Controller, data path designing, Functional partition, Digital front end digital design tools for FPGAs. System level design using mentor graphics/Xilinx EDA tool (FPGA Advantage/Xilinx ISE), Design flow using FPGAs.		8	20
MODULE 6:Introduction to advanced FPGAs: Xilinx Virtex and ALTERA Stratix Case studies: Design considerations using FPGAs of parallel adder cell, parallel adder sequential circuits, counters, multiplexers, parallel controllers.		7	20
END SEMESTER EXAM			

COURSE CODE	COURSE NAME	L-T-P:C	YEAR
04 EC 6792	MINI PROJECT	0-0-4:2	2015

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

COURSE CODE	COURSE NAME	L-T-P:C	YEAR
04 EC 6794	ADVANCED SIGNAL PROCESSING LAB-II	0-0-2:1	2015

Objective: To experiment the concepts introduced in the core and elective courses offered in the second semester with the help of MATLAB and DSP kit.

EXPECTED OUTCOME:

The student will be able to analyze and implement the concepts in the core / elective courses offered in the second semester.

SUMMER BREAK

COURSE CODE	COURSE NAME	L-T-P:C	YEAR
04 EC 7790	INDUSTRIAL TRAINING	0-0-4: Pass/Fail	2015

COURSE CODE	COURSE NAME	L-T-P:C	YEAR
04 EC 7701	LINEAR AND NONLINEAR OPTIMIZATION	3-0-0:3	2015

Pre-requisites: Nil

Course Objectives:

To give the Student:-

- An ability to solve Linear programming Problems
- An ability to solve nonlinear programming,
- Apply constrained optimization techniques in real applications

Syllabus

Linear programming, nonlinear programming, constrained optimization

Course Outcome:

Students who successfully complete this course will have demonstrated the knowledge and ability to solve problem using Linear programming, nonlinear programming, constrained optimization

Text Books:

1. David G Luenberger, .Linear and Non Linear Programming., 2nd Ed, Addison-
2. Wesley, 1984
3. S.S.Rao, .Engineering Optimization.; Theory and Practice; Revised 3rd Edition, New
4. Age International Publishers, New Delhi
5. Fletcher R., Practical methods of optimization, John Wiley, 1980.

References:

1. Hillier and Lieberman, Introduction to Operations Research, McGraw-Hill, 8th
2. edition, 2005.
3. Saul I Gass, Linear programming, McGraw-Hill, 5th edition, 2005.
4. Bazarra M.S., Sherali H.D. &Shetty C.M., Nonlinear Programming Theory and
5. Algorithms, John Wiley, New York, 1979.
6. Kalyanmoy Deb, Optimization for Engineering: Design-Algorithms and Examples,
7. Prentice Hall (India), 1998.
8. S. M. Sinha, Mathematical programming: Theory and Methods, Elsevier, 2006

COURSE PLAN

COURSE CODE:	COURSE TITLE	CREDITS	
04 EC 7701	LINEAR AND NONLINEAR OPTIMIZATION	3-0-0:3	
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.		7	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.		6	15
INTERNAL TEST 1 (MODULE 1 & 2)			
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- and parametric programming		10	15
MODULE 4:The primal simplex method -Dual linear programs - Primal, dual, and duality theory - The dual simplex method -The primal-dual algorithm-Duality applications. Post optimization problems: Sensitivity analysis		8	15
INTERNAL TEST 2 (MODULE 3 & 4)			
MODULE 5:Nonlinear Programming: Minimization and maximization of convex functions- Local & Global optimum- Convergence-Speed of convergence. Unconstrained optimization: One dimensional minimization - Elimination methods: Fibonacci & Golden section search -Gradient methods - Steepest descent method.		6	20
MODULE 6:Constrained optimization: Constrained optimization with equality and inequality constraints. Kelley's convex cutting plane algorithm - Gradient projection method - Penalty Function methods		7	20
END SEMESTER EXAM			

COURSE CODE	COURSE NAME	L-T-P:C	YEAR
04 EC 7703	Pattern Recognition & Analysis	3-0-0:3	2015

Pre-requisites: Nil

Course Objectives:

To give the Student:-

- An introduction to features, feature vectors and classifiers
- An understanding of Non-Linear classifiers
- To get introduced to Clustering- Cluster analysis Proximity measures and Clustering Algorithms.

Syllabus

Introduction - features, feature vectors and classifiers, Non-Linear classifiers- Two layer and three layer perceptrons, Non-Linear classifiers- Support Vector machines, Clustering- Cluster analysis Proximity measures, Clustering Algorithms.

Course Outcome:

Students who successfully complete this course will have demonstrated the knowledge and ability to understand feature vectors and classifiers, Non-Linear classifiers- Two layer and three layer perceptrons, Non-Linear classifiers- Support Vector machines, Clustering- and Clustering Algorithms

Text Books:

1. SergiosTheodoridis, KonstantinosKoutroumbas, “Pattern Recognition”, Academic Press, 2006.

2. Richard O. Duda and Hart P.E, and David G Stork, Pattern classification , 2nd Edn., John Wiley & Sons Inc., 2001

References:

1. Fu K.S., Syntactic Pattern recognition and applications, Prentice Hall, Eaglewood cliffs, N.J., 1982

2. Andrew R. Webb, Statistical Pattern Recognition, John Wiley & Sons, 2002.

3. Christopher M Bishop, Pattern Recognition and Machine Learning, Springer 2007

4 Earl Gose, Richard Johnsonbaugh, and Steve Jost; Pattern Recognition and Image Analysis, PHI Pvte.Ltd., NewDelhi-1, 1999.

COURSE PLAN

<table>
<tr><th>COURSE CODE:</th><th>COURSE TITLE</th><th colspan="2">CREDITS</th></tr>
<tr><td>04 EC 7703</td><td>Pattern Recognition & Analysis</td><td colspan="2">3-0-0:3</td></tr>
<tr><td colspan="2">MODULES</td><td>Contact Hours</td><td>Sem. Exam Marks (%)</td></tr>
<tr><td colspan="2">MODULE 1:Introduction - features, feature vectors and classifiers, Supervised versus unsupervised pattern recognition. Classifiers based on Bayes Decision theory- introduction, discriminant functions and decision surfaces, Bayesian classification for normal distributions,Estimation of unknown probability density functions, the nearest neighbour rule.</td><td>7</td><td>15</td></tr>
<tr><td colspan="2">MODULE 2:Linear classifiers,- Linear discriminant functions and decision hyper planes, The perceptron algorithm, MSE estimation, Logistic determination, Support Vector machines</td><td>6</td><td>15</td></tr>
<tr><td colspan="4">INTERNAL TEST 1 (MODULE 1 & 2)</td></tr>
<tr><td colspan="2">MODULE 3:Non-Linear classifiers- Two layer and three layer perceptrons, Back propagation algorithm, Networks with Weight sharing, Polynomial classifiers, Radial Basis function networks.</td><td>6</td><td>15</td></tr>
<tr><td colspan="2">MODULE 4:Device Drivers Non-Linear classifiers- Support Vector machines-nonlinear case, Decision trees,combining classifiers, Feature selection, Receiver Operating Characteristics (ROC) curve,Classseparability measures, Optimal feature generation, The Bayesian information</td><td>9</td><td>15</td></tr>
<tr><td colspan="4">INTERNAL TEST 2 (MODULE 3 & 4)</td></tr>
<tr><td colspan="2">MODULE 5:Clustering- Cluster analysis, Proximity measures, Clustering Algorithms - Sequential algorithms, Neural Network implementation. Hierarchical algorithms - Agglomerative algorithms, Divisive algorithms. Schemes based on function optimization - Fuzzy clustering algorithms, Probabilistic clustering, K - means algorithm.</td><td>8</td><td>20</td></tr>
<tr><td colspan="2">MODULE 6:Clustering algorithms based on graph theory , Competitive learning algorithms, Binary Morphology Clustering Algorithms Boundary detection methods, Valley seeking clustering, Kernel clustering methods. Clustering validity.</td><td>6</td><td>20</td></tr>
<tr><td colspan="4">END SEMESTER EXAM</td></tr>
</table>

COURSE CODE	COURSE NAME	L-T-P:C	YEAR
04 EC 7705	SECURE COMMUNICATION	3-0-0:3	2015

Pre-requisites: Nil

Course Objectives:

To give the Student:-

- An understanding of rings and fields
- An understanding of Basic encryption techniques
- Ability to design Private key and Public key cryptosystems

Syllabus

Rings and fields, Basic encryption techniques, Private key and Public key cryptosystems, Elliptic curves

Course Outcome:

Text Books:

1. Douglas A. Stinson, "Cryptography, Theory and Practice", 2nd edition, Chapman & Hall, CRC Press Company, Washington
2. William Stallings, " Cryptography and Network Security", 3rd edition, Pearson Education

References:

1. Lawrence C. Washington, " Elliptic Curves", Chapman & Hall, CRC Press Company, Washington.
2. David S. Dummit, Richard M. Foote, " Abstract Algebra", John Wiley & Sons
3. EvangelosKranakis, " Primality and Cryptography", John Wiley & Sons
4. Rainer A. Ruppel, " Analysis and Design of Stream Ciphers", Springer Verlag

COURSE PLAN

COURSE CODE:	COURSE TITLE	CREDITS	
04 EC 7705	SECURE COMMUNICATION	3-0-0:3	
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- Euler theorem -Chinese Remainder Theorem –Primality		8	15
MODULE 2: Basic encryption techniques - Concept of cryptanalysis - Shannon's theory - Perfect secrecy -Block ciphers - Cryptographic algorithms - Features of DES - Stream ciphers - Pseudorandom sequence generators – linear complexity - Non-linear combination of LFSRs -Boolean functions		9	15
INTERNAL TEST 1 (MODULE 1 & 2)			
MODULE 3: Private key and Public key cryptosystems - One way functions - Discrete log problem - Factorization problem - RSA encryption - Diffie Hellmann key exchange - Message authentication and hash functions		8	15
MODULE 4: Digital signatures - Secret sharing - features of visual cryptography - other applications of cryptography.		5	15
INTERNAL TEST 2 (MODULE 3 & 4)			
MODULE 5: Elliptic curves - Basic theory - Weirstrass equation - Group law - Point at Infinity -Elliptic curves over finite fields - Discrete logarithm problem on EC		7	20
MODULE 6: Elliptic curve cryptography -Diffie Hellmann key exchange over EC - Elgamal encryption over EC – ECDSA		5	20
END SEMESTER EXAM			

COURSE CODE	COURSE NAME	L-T-P:C	YEAR
04 EC 7707	Digital Control Systems	3-0-0:3	2015

Pre-requisites: Control systems

Course Objectives:

To give the Student:-

- The ability to understand the basic concept of Digital Control Systems

Syllabus

- Sampling process
- Z Transform methods
- Design of digital control systems
- Design of Digital Control Systems: Cascade and feedback compensation
- State variable methods
- Response between sampling instants

Course Outcome:

Students who successfully complete this course will have demonstrated the knowledge and ability to

- Understand the basic concept of Digital Control Systems

Text Books:

- Digital Control systems, Benjamin C Kuo, Saunders College publishing, 1997.
- Digital control and state variable methods, M Gopal, Tata McGraw Hill publishers, 1997.

References:

- Discrete time control systems, Katsuhito Ogata, Prentice Hall
- Digital Control systems, Constantine H Houpis and Gary B Lamont, McGraw Hill

COURSE PLAN

COURSE CODE:	COURSE TITLE	CREDITS	
04 EC 7707	**Digital Control Systems**	**3-0-0:3**	
MODULES		**Contact Hours**	**Sem. Exam Marks (%)**
MODULE 1:Sampling process: 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.		7	15
MODULE 2: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.		7	15
INTERNAL TEST 1 (MODULE 1 & 2)			
MODULE 3: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		6	15
MODULE 4: 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.		9	15
INTERNAL TEST 2 (MODULE 3 & 4)			
MODULE 5: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		6	20
MODULE 6: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, Case study examples using MATLAB/clones.		7	20
END SEMESTER EXAM			

COURSE CODE	COURSE NAME	L-T-P:C	YEAR
04 EC 7709	MARKOV MODELLING AND QUEUING THEORY	3-0-0:3	2015

Pre-requisites: Nil

Course Objectives:

- **To give an idea of different models used in queuing theory**

Syllabus

Stochastic Processes-Markov Models- Single Class & Multi-class Queuing Networks-
Time Delays and Blocking in Queuing Networks

Course Outcome:

At the end of the course the student have the basic concept of queuing models.

Text Books:

1. Ronald W. Wolff, Stochastic Modeling and The Theory of Queues, Prentice-Hall International, Inc, 1989.
2. Peter G. Harrison and Naresh M. Patel, Performance Modeling of Communication Networks and Computer Architectures, Addison-Wesley, 1992.
3. Gary N. Higginbottom, Performance Evaluation of Communication Networks, Artech House, 1998

References:

1. Anurag Kumar, D. Manjunath, and Joy Kuri, Communication Networking: An Analytical Approach, Morgan Kaufman Publ. 2004.
2. D. Bertsekas and R. Gallager, Data Networks, Prentice Hall of India, 2001.
3. Ross, K.W., Multiservice Loss Models for Broadband Telecommunication Networks, Springer-Verlag, 1995.
4. Walrand, J., An Introduction to Queueing Networks, Prentice Hall, 1988.
5. Cinlar, E., Introduction to Stochastic processes, Prentice Hall, 1975.
6. Karlin, S. and Taylor, H., A First course in Stochastic Processes, 2nd edition Academic press, 1975

COURSE PLAN

COURSE CODE:	COURSE TITLE	CREDITS	
04 EC 7709	MARKOV MODELLING AND QUEUING THEORY	**3-0-0:3**	
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; Continuous Time Markov Chain - Pure-Jump Continuous- Time Chains, Regular Chains, Birth and Death Process, Semi-Markov Processes.		10	15
INTERNAL TEST 1 (MODULE 1 & 2)			
MODULE 3:Single Class Queuing Networks: Simple Markovian queues; M/G/1 queue; G/G/1 queue; Open queuing networks; Closed queuing networks; Mean value analysis;		6	15
MODULE 4:Multiclass traffic model; Service time distributions; BCMP networks; Priority systems.		6	15
INTERNAL TEST 2 (MODULE 3 & 4)			
MODULE 5:Time Delays in Queuing Networks: Time delays in single server queue; Time delays in networks of queues;		6	20
MODULE 6:Blocking in Queuing Networks: Types of Blocking; Two finite queues in a closed network; Aggregating Markovian states.		6	20
END SEMESTER EXAM			

COURSE CODE	COURSE NAME	L-T-P:C	YEAR
04 EC 7711	SPEECH& AUDIO SIGNAL PROCESSING	3-0-0:3	2015

Pre-requisites: Nil

Course Objectives:

- To understand concept of speech & music production
- To analyse the speech/audio coding and processing techniques

Syllabus

Mechanism of speech production - Acoustic theory of speech production -digital models – ARModel, ARMA model -auto correlation-Spectral analysis of speech -Speech coding -Speech Transformations - Audio Processing-Music Production

Course Outcome:

- The student will be able to analyze various aspects of speech and audio signal processing Techniques

Text Books:

1. Rabiner L.R. & Schafer R.W., Digital Processing of Speech Signals, Prentice Hall Inc.

2. O'Shaughnessy, D. Speech Communication, Human and Machine. Addison-Wesley.

References:

1. Thomas F. Quatieri , Discrete-time Speech Signal Processing: Principles and Practice Prentice Hall, Signal Processing Series.

2. Rabiner L.R. & Gold, Theory and Applications of Digital Signal Processing, Prentice Hall of India

3. Jayant, N. S. and P. Noll. Digital Coding of Waveforms: Principles and Applications to Speech and Video. Signal Processing Series, Englewood Cliffs: Prentice- Hall

4. Deller, J., J. Proakis, and J. Hansen. Discrete-Time Processing of Speech Signals. Macmillan.

5. Ben Gold & Nelson Morgan , Speech and Audio Signal Processing, John Wiley & Sons, Inc.

6. Owens F.J., Signal Processing of Speech, Macmillan New Electronics

7. Saito S. & Nakata K., Fundamentals of Speech Signal Processing, Academic Press,Inc.

COURSE PLAN

COURSE CODE:	COURSE TITLE	CREDITS	
04 EC 7711	SPEECH& AUDIO SIGNAL PROCESSING	3-0-0:3	
MODULES		Contact Hours	Sem. Exam Marks (%)
MODULE 1:Mechanism of speech production - Acoustic theory of speech production (Excitation, Vocal tract model for speech analysis, Formant structure, Pitch)- digital models – linear prediction of speech - AR Model, ARMA model -auto correlation - formulation of LPC equation - solution of LPC equations - Levinson Durbin algorithm – Levinson recursion - Schur algorithm – lattice formulations and solutions - PARCOR coefficients		7	15
MODULE 2:Spectral analysis of speech - Short Time Fourier analysis - filter bank design. Auditory Perception: Psychoacoustics- Frequency Analysis and Critical Bands – Masking properties of human ear.		5	15
INTERNAL TEST 1 (MODULE 1 & 2)			
MODULE 3:Speech coding -subband coding of speech - transform coding - channel vocoder – formant vocoder – cepstralvocoder - vector quantizer coder- Linear predictive Coder. Speech synthesis - pitch extraction algorithms - gold rabiner pitch trackers - autocorrelation pitch trackers - voice/unvoiced detection - homomorphic speech processing – homomorphic systems for convolution - complex cepstrums – pitch extraction using homomorphic speech processing. Sound Mixtures and Separation - CASA, ICA & Model based separation.		11	15
MODULE 4:Speech Transformations - Time Scale Modification - Voice Morphing. Automatic speech recognition systems - isolated word recognition - connected word recognition –large vocabulary word recognition systems - pattern classification - DTW, HMM – speaker recognition systems - speaker verification systems – speaker identification Systems		8	15
INTERNAL TEST 2 (MODULE 3 & 4)			
MODULE 5:Audio Processing : Non speech and Music Signals - Modeling -Differential, transform and subband coding of audio signals & standards - High Quality Audio coding using Psychoacoustic models - MPEG Audio coding standard.		6	20
MODULE 6:Music Production - sequence of steps in a bowed string instrument - Frequency response measurement of the bridge of a violin. Audio Data bases and applications - Content based retrieval.		5	20

END SEMESTER EXAM			
COURSE CODE	**COURSE NAME**	**L-T-P:C**	**YEAR**
04 EC 7713	**Error control coding**	**3-0-0:3**	**2015**

Pre-requisites:

Course Objectives:

- **To give the basic ideas of error control coding**
- **To impart knowledge about different types of codes used in communication**

Syllabus
Finite Field Arithmetic-Linear Block Codes-Cyclic Codes-Convolutional Codes-Soft Decision and Iterative Decoding

Course Outcome:

At the end of the course the student have the fundamentals of error control coding.

Text Books:

1. R.E. Blahut, "Theory and Practice of Error Control Coding", MGH 1983.
2. W.C. Huffman and Vera Pless, "Fundamentals of Error correcting codes", Cambridge University Press, 2003.
3. Shu Lin and Daniel. J. Costello Jr., "Error Control Coding: Fundamentals and applications", Prentice Hall Inc, 1983.

References:

1. Rolf Johannesson, Kamil Sh. Zigangirov, "Fundamentals of Convolutional Coding", Universities Press(India) Ltd. 2001.
2. Sklar, ' Digital Communication', Pearson Education.

COURSE PLAN

COURSE CODE:	COURSE TITLE	CREDITS	
04 EC 7713	**Error control coding**	**3-0-0:3**	
MODULES		**Contact Hours**	**Sem. Exam Marks (%)**
MODULE 1:Finite Field Arithmetic: Introduction, Groups- Rings- Fields- Arithmetic of Galois Field- Integer Ring- Polynomial Rings- Polynomials and Euclidean algorithm, primitive elements, Construction and basic properties of Finite Fields- Computations using Galois Field arithmetic- sub fields- Minimal polynomial and conjugates		6	15
MODULE 2:Vector space - Vector Subspace- Linear independence.		4	15
INTERNAL TEST 1 (MODULE 1 & 2)			
MODULE 3:Linear Block Codes: Linear Block codes- Properties- Minimum Distance- Error detection and correction- Standard Array and Syndrome decoding- Hamming codes- Perfect and Quasiperfect codes - Extended codes- Hadamard codes.		8	15
MODULE 4:Cyclic Codes: Basic theory of Cyclic codes- Generator and Parity check matrices – Cyclic encoders- Error detection & correction- decoding of cyclic codes- Cyclic Hamming codes- Binary Golay codes- BCH codes- Decoding of BCH codes-The Berlekamp- Massey decoding algorithm. Reed Solomon codes- Generalized Reed Solomon codes- MDS codes.		10	15
INTERNAL TEST 2 (MODULE 3 & 4)			
MODULE 5:Convolutional Codes: Generator matrices and encoding- state, tree and trellis diagram - Transfer function - Maximum Likelihood decoding Hard versus Soft decision decoding – The Viterbi Algorithm- Free distance- Catastrophic encoders.		8	20
MODULE 6:Soft Decision and Iterative Decoding: Soft decision Viterbi algorithm- Two way APP decoding- Low density parity check codes- Turbo codes - Turbo decoding.		6	20
END SEMESTER EXAM			

COURSE CODE	COURSE NAME	L-T-P:C	YEAR
04 EC 7715	Artificial Neural Network	3-0-0:3	2015

Pre-requisites: Nil

Course Objectives:

To give the Student:-

- The ability to understand the basic concept of Artificial Neural Network
- The ability to understand the basic concept of relation between biological neural network and artificial Neural Network
- The ability to understand the basic concept of Genetic algorithms

Syllabus

Introduction to Artificial Neural Network- Supervised and unsupervised learning- Statistical pattern recognition perspective of ANNs- Recurrent Neural Networks, Attractor neural networks- Fuzzy Systems-Genetic algorithms and Evolutionary programming

Course Outcome:

Students who successfully complete this course will have demonstrated the knowledge and ability to

- Understand the basic concept of Artificial Neural Network

Text Books:

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.

References:

1. Introduction to Artificial Systems, J M Zurada, Jaico Publishers
2. Neural Networks –A Comprehensive Foundation, Simon Haykins, PHI
3. Advanced Methods in Neural Computing, Wasserman P.D, Van Nostrand Reinhold, NewYork.
4. Fuzzy Logic with Engineering Applications, Timothy J. Ross: TMH
5. Methods of Optimization". G. R Walsh, John Wiley & Sons.
6. Fuzzy Logic and Genetic Algorithms, Rajasekharan&Pai Neural Networks, PHI
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

COURSE CODE:	COURSE TITLE	CREDITS	
04 EC 7715	Artificial Neural Network	3-0-0:3	
MODULES		Contact Hours	Sem. Exam Marks (%)
MODULE 1: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		5	15
MODULE 2:Supervised and unsupervised learning, concepts of generalization and fault tolerance Supervised learning: Perceptrons and LMS, Back propagation Neural Networks, Fast variants of Back propagation		6	15
INTERNAL TEST 1 (MODULE 1 & 2)			
MODULE 3: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, Image classification application, PNNs		10	15
MODULE 4:Recurrent Neural Networks: Dynamical systems, states, state vectors, state equations, attractors and stability, linear and non linear 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.		9	15
INTERNAL TEST 2 (MODULE 3 & 4)			
MODULE 5:Fuzzy Systems: Fuzzy sets, Membership functions, Measures of fuzziness, Fuzzification and defuzzification . Fuzzy relations, Neural Networks and Fuzzy logic, Fuzzy neurons, Fuzzy perceptron, Fuzzy classification networks using Backpropagation , Fuzzy ART		6	20
MODULE 6: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 ,		6	20

Applications		

COURSE CODE	COURSE NAME	L-T-P-C	YEAR
04 EC 7791	SEMINAR-II	0-0-2 :2	2015

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

COURSE CODE	COUSE NAME	L-T-P	YEAR
04 EC 7793	PROJECT (PHASE-I)	0-0-12:6	2015

In Project Phase-I, the students are expected to select an emerging research area in the field of specialization. After conducting a detailed literature survey, they should compare and analyze research work done and review recent developments in the area and prepare an initial design of the work to be carried out. It is mandatory that the students should refer National and International Journals and conference proceedings while selecting a topic for their project. He/She should select a recent topic from a reputed International Journal, preferably IEEE/ACM. Emphasis should be given for introduction to the topic, literature survey, and scope of the proposed work along with some preliminary work carried out on the project topic. Students should submit a copy of Phase-I project report covering the content discussed above and highlighting the features of work to be carried out in Phase-II of the project. The candidate should present the current status of the project work and the assessment will be made on the basis of the work and the presentation, by a panel of internal examiners in which one will be the internal guide. The examiners should give their suggestions in writing to the students so that it should be incorporated in the Phase–II of the project. Project phase 1 undergo an evaluation by a panel of examiners.

COURSE CODE	COUSE NAME	L-T-P	YEAR
04 EC 7794	**PROJECT (PHASE II)**	**0-0-21:12**	**2015**

In the fourth semester, the student has to continue the project work and after successfully finishing the work, he / she has to submit a detailed bounded project report. The work carried out should lead to a publication in a National / International Conference or Journal. The papers received acceptance before the M. Tech evaluation will carry specific weightage.

TOTAL MARKS:100

Project evaluation by the supervisor/s : 30 Marks

Evaluation by the External expert : 30 Marks

Presentation & evaluation by the Committee : 40 Marks