KERALA TECHNOLOGICAL UNIVERSITY

Master of Technology

Curriculum, Syllabus and Course Plan

Cluster	**:**	*1*
Branch	**:**	*Electronics & Communication*
Stream	**:**	*Signal Processing*
Year	**:**	*2015*
No. of Credits	**:**	*67*

SEMESTER 1

Examination Slot	Course Number	Name	L-T-P	Internal Marks	End Semester Examination		Credits
					Marks	Duration (hours)	
A	01EC6301	Applied Linear Algebra	3-0-0	40	60	3	3
B	01EC6303	Random Processes and Applications	3-1-0	40	60	3	4
C	01EC6205	Advanced Digital Communication	3-1-0	40	60	3	4
D	01EC6307	DSP System Design	3-0-0	40	60	3	3
E		Elective I	3-0-0	40	60	3	3
S	01EC6999	Research Methodology	0-2-0	100			2
T	01EC6391	Seminar I	0-0-2	100			2
U	01EC6393	DSP Systems Lab	0-0-2	100			1
		TOTAL	**15-4-4**	**500**	**300**	**-**	**22**

TOTAL CONTACT HOURS : 23
TOTAL CREDITS : 22

Elective I

01EC6311 Speech Signal Processing
01EC6313 Optical Signal Processing
01EC6315 Biomedical Signal Processing

SEMESTER 2

Examination Slot	Course Number	Name	L-T-P	Internal Marks	End Semester Examination		Credits
					Marks	Duration (hours)	
A	01EC6302	Estimation and Detection Theory	3-1-0	40	60	3	4
B	01EC6304	Digital Image Processing	3-0-0	40	60	3	3
C	01EC6306	Multirate Systems and Wavelets	3-0-0	40	60	3	3
D		Elective II	3-0-0	40	60	3	3
E		Elective III	3-0-0	40	60	3	3
V	01EC6392	Mini Project	0-0-4	100			2
U	01EC6394	Image Processing Lab	0-0-2	100			1
		TOTAL	**15-1-6**	**400**	**300**	**-**	**19**

TOTAL CONTACT HOURS : 22
TOTAL CREDITS : 19

Elective II

01EC6312 Adaptive Signal Processing
01EC6314 Audio Signal Processing
01EC6316 Pattern Recognition and Machine Learning

Elective III

01EC6122 Design of VLSI Systems
01EC6218 Soft Computing
01EC6322 Optimization Techniques

SEMESTER 3

Examination Slot	Course Number	Name	L-T-P	Internal Marks	End Semester Examination		Credits
					Marks	Duration (hours)	
A		Elective IV	3-0-0	40	60	3	3
B		Elective V	3-0-0	40	60	3	3
T	01EC7391	Seminar II	0-0-2	100			2
W	01EC7393	Project (Phase 1)	0-0-12	50			6
		TOTAL	**6-0-14**	**230**	**120**	**-**	**14**

TOTAL CONTACT HOURS : 20
TOTAL CREDITS : 14

Elective IV

01EC7311 VLSI Structures for Digital Signal Processing
01EC7313 Space Time Coding and MIMO Systems
01EC7213 Secure Communication

Elective V

01EC7317 Array Signal Processing
01EC7319 Bio Informatics
01EC7315 Computer Vision

SEMESTER 4

Examination Slot	Course Number	Name	L-T-P	Internal Marks	End Semester Examination		Credit
					Marks	Duration (hours)	
W	01EC7394	Project (Phase 2)	0-0-23	70	30		12
		TOTAL	**0-0-23**	**70**	**30**	**-**	**12**

TOTAL CONTACT HOURS : 23
TOTAL CREDITS : 12

TOTAL NUMBER OF CREDITS: 67

SEMESTER – I

Syllabus and Course Plan

Course No.	Course Name	L-T-P	Credits	Year of Introduction
01EC6301	Applied Linear Algebra	3-0-0	3	2015

Course Objectives

1. To develop the skills in abstract algebra
2. To develop the skills to identify linear transformation and transforms and its role in linear systems
3. To develop the skills to formulate linear transformation problems in matrix form

Syllabus

Vector spaces, Linear independence, Linear Transformation, Coordinate transformation, System of linear equations, projection, pseudo inverse, Generalized Eigen vectors, Singular Value Decomposition

Expected Outcome

1. Understand the formulation of problems in abstract algebra framework
2. Understand and represent linear transformations
3. Understand the role of matrices in linear transformation representations

References

1. G. F. Simmons, Topology and Modern Analysis , McGraw Hill
2. Frazier, Michael W. An Introduction to Wavelets Through Linear Algebra, Springer Publications.
3. Hoffman Kenneth and Kunze Ray, Linear Algebra, Prentice Hall of India.
4. Reichard Bronson, Academic Press

COURSE PLAN

Module	Contents	Hours Allotted	% of Marks in End-Semester
I	Algebraic Structures: Group, Ring, Field Vector Spaces, Subspaces, Linear Combinations, Subspace spanned by set of vectors, Linear dependence and Linear independence, Spanning set and basis, Finite dimensional vector spaces	7	15
II	Solutions to Linear System of Equations : Simple systems, Homogeneous and Non-homogeneous systems, Gaussian elimination, Null Space and Range, Rank and nullity, Consistency conditions in terms of rank, General Solution of a linear system, Elementary Row and	7	15

Course No.	Course Name	L-T-P	Credits	Year of Introduction
	Column operations, Row Reduced Form, existence and uniqueness of solutions, projection, least square solution -pseudo inverse.			
FIRST INTERNAL EXAM				
III	Linear Transformations -four fundamental subspaces of linear transformation -inverse transformation - rank nullity theorem - Matrix representation of linear transformation, Change of Basis operation,	7	15	
IV	Inner product, Inner product Spaces, Cauchy – Schwarz inequality, Norm, Orthogonality, Gram – Schmidt orthonormalization, Orthonormal basis, Expansion in terms of orthonormal basis, Orthogonal complement, Decomposition of a vector with respect to a subspace and its orthogonal complement – Pythagoras Theorem	7	15	
SECOND INTERNAL EXAM				
V	Eigenvalue – Eigenvector pairs, characteristic equation, Algebraic multiplicity, Eigenvectors, Eigenspaces and geometric multiplicity, Diagonalization criterion, The diagonalizing matrix, Projections, Decomposition of the matrix in terms of projections, Real Symmetric and Hermitian matrices , Properties of Eigen values, Eigen vectors, Unitary/Orthogonal diaganalizability of Comples Hermitian/Real Symmetric Matrices, Spectral Theorem, Positive and Negative Definite and Semi Definite matrices.	7	20	
VI	General Matrices : Rank, Nullity, Range and Null Space of AA^T and A^TA, Singular Values, Singular Value Decomposition, Pseudoinverse and Optimal solution of a linear system of equations, The Geometry of Pseudoinverse	7	20	
END SEMESTER EXAM				

Course No.
Course Name
L-T-P
Credits
Year of Introduction

01EC6303
Random Processes and Applications
3-1-0
4
2015

Course Objectives

1. To provide necessary basic concepts in statistical signal analysis
2. To study about random processes and its properties
3. Apply the basic concepts to various elementary and some advanced applications

Syllabus

Probability theory, Random variable, Probability Density function, Conditional and Joint Distributions and densities, Functions of Random Variables, Expectation, Conditional Expectations, Random Vector, Random Processes, Chapman- Kolmogorov Equations, WSS Processes and LTI Systems, Inequalities, Central limit theorem, Random Sequences, Advanced Topics.

Expected Outcome

1. Have a fundamental knowledge of the basic probability concepts
2. Have a good knowledge of standard distributions which can describe real life phenomena
3. Acquire skills in handling situations involving several random variable and functions of random variables
4. Understand and characterize phenomena which evolve with respect to time in probabilistic manner

References

1. Henry Stark and John W. Woods "Probability and Random Processes with Applications to Signal Processing", Pearson Education, Third edition.
2. Athanasios Papoulis and S. Unnikrishna Pillai. Probability, Random Variables and Stochastic Processes, TMH
3. Gray, R. M. and Davisson L. D., An Introduction to Statistical Signal Processing. Cambridge University Press, 2004 (Available at: http://www.ee.stanford.edu/~gray/sp.pdf)
4. Oliver C. Ibe. , Fundamentals of Applied Probability and Random Process, Elseiver, 2005.

COURSE PLAN

Module
Contents
Hours Allotted
% of Marks in End-Semester Examination

I

Introduction: Sets, Fields and Events, Definition of probability, Joint, Conditional and Total Probability, Bayes' Theorem and applications. Random Variable:- Definition, Probability Distribution Function, Probability Density function, Common density functions, Continuous, Discrete and Mixed random Variables.

8
12

II

Conditional and Joint Distributions and densities, independence of random variables. Functions of Random Variables: One function of one random variable, One function of two random variables, Two functions of two random variables.

10

18

FIRST INTERNAL EXAM

III

Expectation: Fundamental Theorem of expectation, Moments, Joint moments, Moment Generating functions, Characteristic functions, Conditional Expectations, Correlation and Covariance, Jointly Gaussian Random Variables. Random Vector: - Definition, Joint statistics, Covariance matrix and its properties.

10
15

IV

Random Processes: -Basic Definitions, Poisson Process, Wiener Process, Markov Process, Birth- Death Markov Chains, Chapman- Kolmogorov Equations, Stationarity, Wide sense Markov Process Stationarity, WSS Processes and LTI Systems, Power spectral density, White Noise.

10
15

SECOND INTERNAL EXAM

V

Chebyshev and Schwarz Inequalities, Chernoff Bound, Central Limit Theorem. Random Sequences: Basic Concepts, WSS sequences and linear systems, Markov Random sequences, Markov Chains, Convergence of Random Sequences: Definitions, Laws of large numbers.

10
24

VI

Advanced Topics: Ergodicity, Karhunen- Leove Expansion, Representation of Bandlimited and periodic Processes: WSS periodic Processes, Fourier Series for WSS Processes

8

16

END SEMESTER EXAM

Course No.	Course Name	L-T-P	Credits	Year of Introduction
01EC6205	Advanced Digital Communication	**3-1-0**	**4**	**2015**

Course Objectives

1. To introduce the different aspects of digital communication over various channels, from design through performance issues to application requirement.
2. To give an idea on the advances in Multichannel and Multicarrier Systems design.

Syllabus

Digital Communication over Additive Gaussian Noise Channels- Optimum waveform receiver in additive white Gaussian noise. Digital Communication over Band limited Channels- Optimum receiver for channels with ISI and AWGN- Equalization Techniques. Spread spectrum Communication- modelling, application and synchronization of spread spectrum signals. Digital Communication over Fading Multipath Channels. Multiuser Communication - techniques and capacity.

Expected Outcome

1. Understand the design issues of Digital Communication over Additive Gaussian Noise Channels, over Band limited Channels and Fading Multipath Channels.
2. Understand the design issues in spread spectrum and multicarrier systems.
3. Understand various digital communication receivers and equalization

References

1. John G. Proakis, Digital Communications, 4/e, McGraw-Hill
2. Edward. A. Lee and David. G. Messerschmitt, “Digital Communication”, Allied Publishers (second edition).
3. Viterbi, A. J., and J. K. Omura. Principles of Digital Communication and Coding. NY: McGraw-Hill, 1979. ISBN: 0070675163.

4. Marvin K Simon, Sami M Hinedi, William C Lindsey - Digital Communication -Techniques – Signal Design & Detection, PHI.
5. Bernard Sklar," Digital Communications: Fundamentals and applications ", Prentice Hall 2001.
6. Andrea Goldsmith," Wireless Communications", Cambridge University Press 2005.

COURSE PLAN

Module	Contents	Hours Allotted	% of Marks in End-Semester
I	Characterization of Communication Signals and Systems: Representation of bandpass signals and systems. Signal space representation. Representation of digitally modulated signals: memoryless modulation methods, linear modulation with memory. Power spectra, Bandwidth efficiency.	8	15
II	Optimum receiver for additive white Gaussian noise channel: correlation demodulator, matched filter demodulator, optimum detector. Performance of optimum receiver for memoryless modulation techniques: probability of error for binary modulation and M-ary orthogonal signals, QPSK, QAM.	10	15
FIRST INTERNAL EXAM			
III	Communication through band limited channels: Signal design for bandlimited channels. Optimum receiver for channels with ISI and AWGN. Equalization techniques: Linear equalization, Decision feedback equalization, ML detectors. Adaptive equalization: Algorithms	10	15
IV	Multicarrier Systems: Data transmission with multiple carriers, Multicarrier modulation with overlapping subchannels, Mitigation of subcarrier fading. Discrete implementation of multicarrier modulation. challenges in multicarrier systems.	8	15
SECOND INTERNAL EXAM			
V	Digital communication through fading multipath channel: characterisation of fading multipath channel. The effect of signal characteristics on the choice of a channel model. Frequency-non selective slowly fading channel. Digital signalling over a frequency-selective slowly fading channel.	10	20
VI	Multiple access techniques- Capacity of multiple access methods. Spread spectrum principles, processing gain and jamming margin. Direct sequence spread spectrum (DSSS), Frequency Hopping Spread Spectrum (FHSS). Synchronisation of spread spectrum systems.	10	20

COURSE PLAN			
	CDMA signal and channel models, optimum receiver. Random access methods.		
END SEMESTER EXAM			

	Course Name	L-T-P	Credits	Year of Introduction
01EC6307	DSP System Design	**3-0-0**	**3**	**2015**

Course Objectives

1. To provide basic concepts in number representations
2. To study about issues in pipelining and DSP Processors

Syllabus

Introduction to Programmable DSP, Number systems, Distributed arithmetic and CORDIC algorithm, Basic Pipelining, Basic performance issue in pipelining, Simple implementation of MIPS, Instruction Level Parallelism, Dynamic Scheduling, Dynamic Hardware Prediction, Memory hierarchy, Introduction to TMS320C6X Processors and its programming tools.

Expected Outcome

1. Understand the fundamentals of DSP processor architecture
2. Have a good knowledge of Pipelining issues and numeric representations.

References

1. Digital Signal Processing with Field Programmable Gate Arrays, Uwe Meyer-Baese, Springer; 3rd edition
2. Digital Signal Processing and Application with C6713 and C6416 DSK, Rulph Chassaing, Worcester Polytechnic Institute, A Wiley Interscience Publication
3. J L Hennessy, D A Patterson, Computer Architecture A Quantitative Approach: 3rd Edition Elsevier India.
4. DSP Processor and Fundamentals: Architecture and Features. Phil Lapsley, JBier,

	Course Name	L-T-P	Credits	Year of Introduction

Amit Sohan, Edward A Lee; Wiley IEEE Press.
5. Sen M Kuo, Woon- Seng S Gan, Digital Signal Processors.

COURSE PLAN

Module	Contents	Hours Allotted	% of Marks in End-Semester
I	Introduction to Programmable DSP - Block Diagram. MAC (Multiply and Accumulate), Numeric Representations and Arithmetic: Classification of number system, Conventional fixed point number system, Carry free adders, Multiplier Adder Graph, Floating point number format, Unconventional fixed point number system: Signed digit numbers, LNS and RNS.	6	15
II	Chinese Remainder Theorem (CRT), Conversion of RNS to integer and Binary to RNS, Index Multiplier: Primitive mod root, Addition and Multiplication in index domain. Distributed Arithmetic (DA): Design, Signed DA system, CORDIC Algorithm: Rotation mode and Vectoring mode.	8	15
FIRST INTERNAL EXAM			
III	Basic Pipelining and Simple RISC Processors: RISC Architecture, instructions and its format, Implementation of RISC instruction set, Pipelining, Pipeline Registers, Basic performance issue in pipelining, Pipeline Hazards (based on MIPS), Reducing Pipeline Branch Penalties, Performance of pipeline with stalls.	6	15
IV	Simple implementation of MIPS, Basic pipeline for MIPS, Instruction Level Parallelism: Concepts, Dependences, RAW, WAW, and WAR hazards, Dynamic Scheduling - Reducing data hazards, Tomasulo's Algorithm.	6	15
SECOND INTERNAL EXAM			
V	Dynamic Hardware Prediction - Reducing branch hazards. 1-bit, 2-bit, correlating branch and tournament predictor, Limitations of ILP, Branch Target Buffer, Return address predictor, Memory hierarchy - Cache design, Cache performance review, Memory mapping techniques. Block identification and replacement.	8	20
VI	Introduction to TMS320C6X Processors: C6713 - Architecture -Functional Units- Pipelining, Peripherals, Linear and Circular addressing modes. Types of Instructions-Programming Examples, Typical DSP development system, support tools and files, compiler,	8	20

	Course Name	L-T-P	Credits	Year of Introduction
	assembler, Code composer studio.			
END SEMESTER EXAM				

Course No.
Course Name
L-T-P
Credits
Year of Introduction

01EC6311
Speech Signal Processing
3-0-0
3
2015

Course Objectives

1. Familiarize the basic mechanism of speech production and get an overview of articulatory and acoustic Phonetics
2. Learn the basic concepts of methods for speech analysis and parametric representation of speech
3. Acquire knowledge about various methods used for speech coding
4. Get a overall picture about various applications of speech processing

Syllabus

Speech production, Articulatory and Acoustic phonetics, Time domain analysis, Frequency domain analysis, Cepstral analysis, LPC analysis, GMM, HMM, Speech coding, Speech recognition, Speech enhancement, Text to speech

Expected Outcome

1. Understand basic concepts of speech production, speech analysis, speech coding and parametric representation of speech and apply it in practical applications
2. Ability to develop systems for various applications of speech processing

References

1. Douglas O'Shaughnessy, Speech Communications: Human & Machine, IEEE Press, Hardcover 2nd edition, 1999; ISBN: 0780334493.
2. Nelson Morgan and Ben Gold, Speech and Audio Signal Processing: Processing and Perception Speech and Music, July 1999, John Wiley & Sons, ISBN: 0471351547
3. Rabiner and Schafer, Digital Processing of Speech Signals, Prentice Hall, 1978.
4. Rabiner and Juang, Fundamentals of Speech Recognition, Prentice Hall, 1994.
5. Thomas F. Quatieri, Discrete-Time Speech Signal Processing: Principles and Practice, Prentice Hall; ISBN: 013242942X; 1st edition
6. Donald G. Childers, Speech Processing and Synthesis Toolboxes, John Wiley & Sons, September 1999; ISBN: 0471349593

COURSE PLAN

Module	Contents	Hours Allotted	% of Marks in End-Semester Examination
I	Speech Production: Acoustic theory of speech production (Excitation, Vocal tract model for speech analysis, Formant structure, Pitch). Articulatory Phonetics, and Acoustic Phonetics, Speech Analysis: Short-Time Speech Analysis, Time domain analysis (Short time energy, short time zero crossing Rate, ACF).	7	14
II	Frequency domain analysis (Filter Banks, STFT, Spectrogram, Formant Estimation & Analysis), Cepstral Analysis, MFCC	8	16
FIRST INTERNAL EXAM			
III	Parametric representation of speech: AR Model, ARMA model. LPC Analysis (LPC model, Auto correlation method, Covariance method, Levinson-Durbin Algorithm, Lattice form).	8	18
IV	Sinusoidal Model, GMM, Hidden Markov Model	5	12
SECOND INTERNAL EXAM			
V	Speech coding: Phase Vocoder, LPC, Sub-band coding, Adaptive Transform Coding, Harmonic Coding, Vector Quantization based Coders, CELP	7	20
VI	Speech processing: Fundamentals of Speech recognition, Speech segmentation. Text-to-speech conversion, speech enhancement, Speaker Verification, Language Identification, Issues of Voice transmission over Internet.	7	

20

END SEMESTER EXAM

Course No.	Course Name	L-T-P	Credits	Year of Introduction
01EC6313	Optical Signal Processing	3-0-0	3	2015

Course Objectives

1. Familiarize the basic theory of light propagation, concept of spatial frequency etc.
2. Learn the transform domain approach of different optical components like slit, lens, free space etc.
3. Acquire knowledge about various spectral analysis tools, filters and OSA
4. Get a overall picture about various photo receivers

Syllabus

Need and fundamentals of OSP, Fresnel Transform, Transform of a slit, Fourier Transforms in Optics, Resolution criteria, A Basic Optical System, Cascaded systems, Chirp _ Z transform and system Coherence. Spectrum Analysis, Spatial Filtering, Applications of Optical Spatial Filtering, Heterodyne systems, heterodyne spectrum Analysis. Photo detector geometry and bandwidth. Power spectrum analyzer using a CCD array.

Expected Outcome

1. Understand basic concepts of light propagation, spatial frequency and Spectral analysis
2. Ability to develop optical filters, modulators and detectors for various applications of light processing

References

1. Anthony Vander Lugt, Optical Signal Processing, John Wiley & Sons. 2005.
2. D. Casasent, Optical data processing-Applications Springer-Verlag, Berlin, 1978
3. P.M. Dufffieux, The Fourier Transform and its applications to Optics, John Wileyand sons 1983

COURSE PLAN

Module	Contents	Hours Allotted	% of Marks in End-Semester
I	Need for OSP, Fundamentals of OSP, The Fresnel Transform, Convolution and impulse response, Transform of a slit, Fourier Transforms in Optics, Transforms of Aperture functions, Inverse Fourier Transform. Resolution criteria.	6	15

Course No.	Course Name	L-T-P	Credits	Year of Introduction
II	A Basic Optical System, Imaging and Fourier Transform conditions. Cascaded systems, scale of Fourier Transform Condition. Maximum information capacity and optimum packing density. Chirp _ Z transform and system Coherence.	7	15	
FIRST INTERNAL EXAM				
III	Spectrum Analysis, Spatial light Modulators, special detector arrays. Performance parameters for spectrum analyzers. Relationship between SNR and Dynamic range. The 2 D spectrum Analyzer.	7	15	
IV	Spatial Filtering, Linear Space Invariant systems, Parseval's theorem ,Correlation, Input/Output Spectral Densities, Matched filtering, Inverse Filtering, Spatial Filters, Interferometers, Spatial filtering systems, Spatial Modulators, Applications of Optical Spatial Filtering, Effects of small displacements.	8	15	
SECOND INTERNAL EXAM				
V	Heterodyne systems. Temporal and spatial interference. Optimum photo detector size, Optical radio. Direct detection and Hetero dyne detection. Heterodyne spectrum Analysis.	7	20	
VI	Spatial and temporal Frequencies. The CW signal and a short pulse, Photo detector geometry and bandwidth. Power spectrum analyzer using a CCD array.	7	20	
END SEMESTER EXAM				

Course No.	Course Name	L-T-P	Credits	Year of Introduction
01EC6315	Biomedical Signal Processing	**3-0-0**	**3**	**2015**

Course Objectives

1. To develop innovative techniques of signal processing for computational processing and analysis of biomedical signals.
2. To extract useful information from biomedical signals by means of various signal processing techniques

Syllabus

Genesis and significance of bioelectric potentials, EOG, EMG and their monitoring and measurement, spectral analysis, correlation and estimation techniques, ECG: morphological studies and rhythm analysis, automated diagnosis based on decision theory, EEG evoked responses, epilepsy detection, EMG, wave pattern studies

Expected Outcome

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

References

1. Willis J Tompkins, Biomedical Signal Processing - ED, Prentice -Hall, 1993
2. D. C. Reddy ,"Biomedical Signal Processing: Principles and techniques" ,Tata McGraw Hill, New Delhi, 2005
3. Biomedical Signal and Image Processing" 2nd Edition by K. Najarian and R. Splinter , The CRC Press (2012)
4. Biomedical Signal Analysis: A Case Study Approach by Rangaraj M. Rangayyan, Akay Metin (Editor) Wiley Interscience 2001

COURSE PLAN

Module	Contents	Hours Allotted	% of Marks in End-Semester
I	Introduction to biomedical signals. The nature of biomedical signals, examples of biomedical signals ECG, EEG, EMG, EOG. objectives of biomedical signal analysis, difficulties in biomedical signal analysis, computer-aided diagnosis. Biomedical signal spectral analysis, digital and analog filtering, correlation and estimation techniques. EOG and EMG	6	15

Course No.	Course Name	L-T-P	Credits	Year of Introduction

II	Filtering for Removal of Artifacts, Time-domain Filters, Frequency-domain Filters. Optimal Filtering: The Wiener Filter, Adaptive Filters for Removal of Interference. Selecting an Appropriate Filter. Application: Removal of Artifacts in the ECG. Maternal - Fetal ECG. Muscle-contraction Interference	7	15
FIRST INTERNAL EXAM			
III	ECG: Pre-processing, wave form recognition, morphological studies and rhythm analysis, automated diagnosis based on decision theory. ECG Signal Processing: Baseline Wandering, Power line interference, Muscle noise filtering – QRS detection - Arrhythmia analysis	7	15
IV	The electroencephalogram - EEG rhythms & waveform - categorization of EEG activity - recording techniques - Evoked potential estimation, EEG evoked responses, average techniques, pattern recognition of alpha, beta, theta and delta waves in EEG waves- EEG applications- Epilepsy, sleep disorders, brain computer interface	8	15
SECOND INTERNAL EXAM			
V	Modelling EEG- linear, stochastic models – Non linear modelling 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.	7	20
VI	The Electromyogram (EMG) - Generation of electrical changes during muscle contraction- Recording Techniques and Applications -Amplitude and Power estimation of EMG signals - Time delay estimation in EMG signals -Modeling and decomposition of the EMG signal	7	20
END SEMESTER EXAM			

Course No.	Course Name	L-T-P	Credits	Year of Introduction
01EC6999	Research Methodology	0-2-0	2	2015

Course Objectives

1. To prepare the student to do the M. Tech project work with a research bias.
2. To formulate a viable research question.
3. To develop skill in the critical analysis of research articles and reports.
4. To analyze the benefits and drawbacks of different methodologies.
5. To understand how to write a technical paper based on research findings.

Syllabus

Introduction to Research Methodology-Types of research- Ethical issues- Copy right-royalty-Intellectual property rights and patent law-Copyleft- Openacess-

Analysis of sample research papers to understand various aspects of research methodology:

Defining and formulating the research problem-Literature review-Development of working hypothesis-Research design and methods- Data Collection and analysis- Technical writing- Project work on a simple research problem

Approach

Course focuses on students' application of the course content to their unique research interests. The various topics will be addressed through hands on sessions.

Expected Outcome

Upon successful completion of this course, students will be able to

1. Understand research concepts in terms of identifying the research problem
2. Propose possible solutions based on research
3. Write a technical paper based on the findings.
4. Get a good exposure to a domain of interest.
5. Get a good domain and experience to pursue future research activities.

References

1. C. R. Kothari, Research Methodology, New Age International, 2004
2. Panneerselvam, Research Methodology, Prentice Hall of India, New Delhi, 2012.
3. J. W. Bames, Statistical Analysis for Engineers and Scientists, Tata McGraw-Hill, New York.
4. Donald Cooper, Business Research Methods, Tata McGraw-Hill, New Delhi.
5. Leedy P. D., Practical Research: Planning and Design, McMillan Publishing Co.
6. Day R. A., How to Write and Publish a Scientific Paper, Cambridge University Press, 1989.
7. Manna, Chakraborti, Values and Ethics in Business Profession, Prentice Hall of India, New Delhi, 2012.
8. Sople, Managing Intellectual Property: The Strategic Imperative, Prentice Hall ofIndia, New Delhi, 2012.

COURSE PLAN

Course No.	Course Name	L-T-P	Credits	Year of Introduction

Module	Contents	Hours Allotted	% of Marks in End-Semester
I	Introduction to Research Methodology: Motivation towards research - Types of research: Find examples from literature. Professional ethics in research - Ethical issues-ethical committees. Copy right - royalty - Intellectual property rights and patent law - Copyleft- Openacess-Reproduction of published material - Plagiarism - Citation and acknowledgement. Impact factor. Identifying major conferences and important journals in the concerned area. Collection of at least 4 papers in the area.	5	
II	Defining and formulating the research problem -Literature Survey- Analyze the chosen papers and understand how the authors have undertaken literature review, identified the research gaps, arrived at their objectives, formulated their problem and developed a hypothesis.	4	
FIRST INTERNAL EXAM			
III	Research design and methods: Analyze the chosen papers to understand formulation of research methods and analytical and experimental methods used. Study of how different it is from previous works.	4	No end semester written examination
IV	Data Collection and analysis. Analyze the chosen papers and study the methods of data collection used. - Data Processing and Analysis strategies used– Study the tools used for analyzing the data.	5	
SECOND INTERNAL EXAM			
V	Technical writing - Structure and components, contents of a typical technical paper, difference between abstract and conclusion, layout, illustrations and tables, bibliography, referencing and footnotes-use of tools like Latex.	5	
VI	Identification of a simple research problem – Literature survey- Research design- Methodology –paper writing based on a hypothetical result.	5	
END SEMESTER EXAM			

Course No.	Course Name	L-T-P	Credits	Year of Introduction
01EC6391	Seminar I	**0-0-2**	**2**	**2015**

Course Objectives

To make students

1. Identify the current topics in the specific stream.
2. Collect the recent publications related to the identified topics.
3. Do a detailed study of a selected topic based on current journals, published papers and books.
4. Present a seminar on the selected topic on which a detailed study has been done.
5. Improve the writing and presentation skills.

Approach

Students shall make a presentation for 20-25 minutes based on the detailed study of the topic and submit a report based on the study.

Expected Outcome

Upon successful completion of the seminar, the student should be able to

1. Get good exposure in the current topics in the specific stream.
2. Improve the writing and presentation skills.
3. Explore domains of interest so as to pursue the course project.

Course No.	Course Name	L-T-P	Credits	Year of Introduction
01EC6393	DSP Systems Lab	**0-0-2**	**1**	**2015**

Course Objectives

1. Attain ability to develop projects using DSP processors
2. Familiarize the use of DSP processor based system for real time applications
3. Develop skill to use higher level as well as assembly language for implementation of DSP based system

List of Exercises / Experiments

Development Environment

Familiarization to DSP project development stages. Study of the features of the processor used. Development environment.

High Level Language Project Development

Developing projects in a high level language and cross-compiling. Familiarization with the debugging facilities of the IDE. Profiling. Optimizations in C.

Assembly Optimizations

Assembly coding. Function calling conventions. Calling assembly functions from C. Optimization by coding core modules in assembly.

Memory Map

Understand the memory map of the processor. Optimizations by using internal memory.

Real Time Processing.

Using the ADC and DAC for signal acquisition and play back. Real time filtering.

Mini Project (Compulsory)

The student should do a Mini project based on the above area, and a report should be submitted along with the lab record. A viva–voce will be conducted at the end of semester

Expected Outcome

1. Familiarization of DSP project development stages
2. Ability to develop applications using DSP based systems
3. Understand the use of DSP processors for real time signal processing

TextBook

1. Jones D. DSP Laboratory with TI TMS320C54x [Connexions Web site]. January 22, 2004. Available at: http://cnx.rice.edu/content/col10078/1.2/
2. The manuals of the IDE and Processor being used.

SEMESTER – II

Syllabus and Course Plan

Course No.	Course Name	L-T-P	Credits	Year of Introduction
01EC6302	Estimation And Detection Theory	3-1-0	4	2015

Course Objectives

1. Familiarize the basic concepts of detection theory, decision theory and elementary hypothesis testing
2. Acquire knowledge about parameter estimation, and linear signal waveform estimation
3. Get a broad overview of applications of detection and estimation

Syllabus

Detection theory, Hypothesis testing, Detection with unknown signal parameters, Non parametric detection, Parameter estimation, Cramer-Rao lower bound, Linear Signal Waveform Estimation, Levinson Durbin and innovation algorithms, Applications of detection and estimation.

Expected Outcome

1. Understand Signal detection in the presence of noise
2. Understand the basic concepts of estimation theory
3. Ability to apply the concepts of estimation and detection in various signal processing applications

References

1. S.M. Kay, Fundamentals of Statistical Signal Processing: Detection Theory, Prentice Hall, 1998
2. S.M. Kay, Fundamentals of Statistical Signal Processing: Estimation Theory, Prentice Hall, 1993
3. H.L. Van Trees, Detection, Estimation and Modulation Theory, Part I, Wiley, 1968.
4. H.V. Poor, An Introduction to Signal Detection and Estimation, 2nd edition, Springer, 1994.
5. L.L. Scharf, Statistical Signal Processing, Detection and Estimation Theory, Addison-Wesley:1990

COURSE PLAN

Module
Contents
Hours Allotted
% of Marks in End-Semester Examination

I

Detection Theory, Decision Theory, and Hypothesis Testing: Elementary hypothesis testing, Neyman-Pearson Theorem, Minimum probability of error, Bayes risk, Multiple hypothesis testing

10
15

II

Matched filter, Composite hypothesis testing: Generalized likelihood-ratio test. Detection of Signals with unknown Amplitude, Chernoff bound

9

15

FIRST INTERNAL EXAM

III

Parameter Estimation: Minimum Variance Unbiased Estimator, Cramer-Rao lower bound, Fisher information matrix, Linear Models, Best Linear Unbiased Estimator.

9
15

IV

Maximum Likelihood Estimation, Invariance principle, Least Square Estimation, Non-linear least square estimation, Minimum mean square estimation, Minimum mean absolute error, Maximum A Posteriori Estimators

9
15

SECOND INTERNAL EXAM

V

Linear Signal Waveform Estimation: Wiener Filter, Kalman Filter, Choosing an estimator

10
20

VI

Applications of detection and estimation**:** Applications in diverse fields such as communications, system identification, adaptive filtering, pattern recognition, speech processing, and image processing

9
20
END SEMESTER EXAM

Course No.	Course Name	L-T-P	Credits	Year of Introduction
01EC6304	Digital Image Processing	3-0-0	3	2015

Course Objectives

1. Understand the various steps in digital image processing.
2. Get a thorough understanding of digital image representation and processing techniques.
3. Ability to process the image in spatial and transform domain for better enhancement.

Syllabus

Image processing fundamentals, Two-dimensional transform techniques, Image representation and sampling, Image enhancement techniques, Image restoration techniques, Image and video compression standards, Image description and recognition, Mathematical morphology, Computer tomography, Image texture analysis

Expected Outcome

1. Understand various techniques for image representation
2. Understand various low level image processing techniques including reconstruction from Projections
3. Understand the fundamentals of high level image processing

References

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

COURSE PLAN

Module
Contents
Hours Allotted
% of Marks in End-Semester Examination
I

Image processing fundamentals. Two dimensional orthogonal transforms - DFT, FFT, WHT, Haar transform, KLT, DCT, Hough Transform.

8
15

II
Image representation - Gray scale and colour images. Image sampling and quantization. Image enhancement - filters in spatial and frequency domains, histogram-based processing, homomorphic filtering.

6

15
FIRST INTERNAL EXAM
III

Edge detection - non parametric and model based approaches, LOG filters, localization problem. Image Restoration - PSF, circulant and block - circulant matrices, deconvolution, restoration using inverse filtering, Wiener filtering and maximum entropy-based methods.

7
15

IV

Image and Video Compression Standards: Lossy and lossless compression schemes: Transform Based, Sub-band Decomposition, Entropy Encoding, JPEG, JPEG2000, MPEG. Image description and recognition - boundary detection, chain coding, segmentation and thresholding methods.

7
15

SECOND INTERNAL EXAM
V

Mathematical morphology - binary morphology, dilation, erosion, opening and closing, duality relations, gray scale morphology, applications such as hit-and-miss transform, thinning and shape decomposition.

7
20

VI

Computer tomography - parallel beam projection, Radon transform, and its inverse, Back-projection operator, Fourier-slice theorem, CBP and FBP methods, ART, Fan beam projection. Image texture analysis - co-occurrence matrix, measures of textures, statistical models for textures.

7
20

END SEMESTER EXAM

Course No.	Course Name	L-T-P	Credits	Year of Introduction
01EC6306	Multirate Systems And Wavelets	**3-0-0**	**3**	**2015**

Course Objectives

1. To familiarize with wavelet theory, its implementation and representation
2. To understand the fundamentals of multirate signal processing and its applications
3. To study the theory and construction of wavelets and its practical implementations

Syllabus

Fundamentals of multirate signal processing, Filter banks, Wavelet transform – continuous and discrete, Polyphase implementation, Designing orthogonal wavelet systems, Biorthogonal wavelets, Parametric design of orthogonal and biorthogonal wavelets

Expected Outcome

1. Design and implement perfect reconstruction filter bank systems
2. Implement multiphase and polyphase representation.
3. Design and implement wavelet based systems.
4. Design a compression or denoising system using wavelets

References

1. P. P. Vaidyanathan, Multirate Systems & Filter banks , Prentice Hall
2. K. P. Soman, K. I. Ramachandran, N. G. Resmi, PHI, Insight into wavelets From theory to practice
3. G. Strang& T. Nguyen , Wavelets and Filter bank, Wellesly-Cambridge
4. M. Vetterli & J. Kovacevic, Wavelets and sub band coding, Prentice Hall

Course No.	Course Name	L-T-P	Credits	Year of Introduction

COURSE PLAN

Module	Contents	Hours Allotted	% of Marks in End-Semester
I	Fundamentals of Multirate systems: Basic multirate operations and their spectral representation. Fractional Sampling rate alteration, Interconnection of building blocks, Noble identities, polyphase representations, Efficient structures for decimation and interpolation filters.	7	15
II	Uniform DFT filter banks, efficient structures for fractional decimation, Multistage implementations, Applications of multirate systems, 2-channel QMF filter banks, Errors in the QMF bank, conditions for perfect reconstruction, polyphase implementation, M- channel filter banks.	7	15
FIRST INTERNAL EXAM			
III	Wavelet Transforms: Continuous wavelet transform and short time Fourier transform, uncertainty principle and time-frequency tiling, Discrete wavelet transform: Haar scaling and wavelet functions, Daubechies wavelets.	7	15
IV	Designing orthogonal wavelet systems, Discrete wavelet transform and relation to filter banks, computing and plotting scaling and wavelet functions.	7	15
SECOND INTERNAL EXAM			
V	Biorthogonal wavelets: Biorthogonality in vector space, biorthogonal wavelet systems, construction of biorthogonal wavelet systems. Frequency domain approach for designing wavelets: derivation of Daubechies wavelets.	8	20
VI	Parametric design of orthogonal and biorthogonal wavelets, wavelet packet analysis, lifting schemes, Applications of wavelets in compression and denoising.	6	20
END SEMESTER EXAM			

Course No.	Course Name	L-T-P	Credits	Year of Introduction
01EC6312	Adaptive Signal Processing	**3-0-0**	**3**	**2015**

Course No.	Course Name	L-T-P	Credits	Year of Introduction

Course Objectives

1. Introduction to the goal and basics of adaptive signal processing.
2. Familiarize with the design and analysis of various adaptive algorithms and filters
3. Get an overall picture about applications of adaptive filters in various fields

Syllabus

Introduction to adaptive signal processing, LMMSE filters – Wiener and Kalman, Adaptive filters – LMS and RLS, Lattice filters, Tracking performance of time varying filters, Adaptive filters, Applications

Expected Outcome

1. Understand basic concepts of adaptive signal processing
2. Design and analyse convergence issues, computational complexities and optimality of different adaptive algorithms and filters
3. Ability to develop adaptive systems for various applications

References

1. S. Haykin. (1986). Adaptive Filters Theory. Prentice-Hall.
2. Dimitris G. Manolakis, Vinay K. Ingle, Stephan M Krgon*:* Statistical and Adaptive Signal Processing,McGraw Hill (2000)
3. Jones D. Adaptive Filters [Connexions Web site]. May 12, 2005. Available at:http://cnx.rice.edu/content/col10280/1.1/

COURSE PLAN

Module	Contents	Hours Allotted	% of Marks in End-Semester
I	Correlation matrix and its properties, its physical significance. Eigen analysis of matrix, structure of matrix and relation with its eigen values and eigen vectors. Spectral decomposition of correlation matrix, positive definite matrices and their properties their physical significance. Complex Gaussian processes.	6	15
II	LMMSE Filters: Goal of adaptive signal processing, some application scenarios, problem formulation, MMSE predictors, LMMSE predictor, orthogonality theorem (concept of innovation processes), Weiner filter, Yule-walker equation, unconstrained Weiner filter (in z domain),	7	15

Course No.	Course Name	L-T-P	Credits	Year of Introduction
	recursive Weiner filter (using innovation process).			
FIRST INTERNAL EXAM				
III	Kalman filter, recursions in Kalman filter, Extended Kalman filter, comparison of Kalman and weiner filters. Adaptive filters - Filters with recursions based on the steepest descent and Newton's method, criteria for the convergence, rate of convergence.	7	15	
IV	LMS filter, mean and variance of LMS, the MSE of LMS and misadjustment, Convergence of LMS. RLS recursions, assumptions for RLS, convergence of RLS coefficients and MSE. Lattice filters - Filter based on innovations, generation of forward and backward innovations, forward and reverse error recursions.	8	15	
SECOND INTERNAL EXAM				
V	Implementation of Weiner, LMS and RLS filters using lattice filters, Levinson Durbin algorithm, reverse Levinson Durbin algorithm. Tracking performance of the time varying filters - Tracking performance of LMS and RLS filters. Degree of stationarity and misadjustment, MSE derivations.	7	20	
VI	Applications: System identification, channel equalization, noise and echo cancellation. Applications in array processing, beam forming.	7	20	
END SEMESTER EXAM				

Course No.	Course Name	L-T-P	Credits	Year of Introduction
01EC6314	Audio Signal Processing	3-0-0	3	2015

Course Objectives

1. Study of Perception of Sound
2. Study of Audio Compression Schemes
3. Study of Audio Classification
4. Study of Hearing impairment and Hearing aids

Syllabus

Signal Processing Models of Audio Perception, Psycho-acoustic analysis, Spatial Audio Perception and rendering, Room acoustics, Audio compression methods, Parametric Coding of Multi-channel audio, Transform coding of digital audio, audio quality analysis, Music Classification, Hearing aids

Expected Outcome

1. Learn Signal processing models of sound perception and application of perception models in audio signal processing.
2. Acquire ability to implement audio compression algorithms and standards.
3. Acquire knowledge of audio classification algorithms.
4. Understand the signal processing algorithms for hearing aids.

References

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

COURSE PLAN

Module
Contents
Hours Allotted
% of Marks in End-Semester Examination

I

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

7
15

II

Spatial Audio Perception and rendering: The physical and psycho-acoustical basis of sound localization and space perception. Head related transfer functions, Source localization and beam forming with arrays of microphones. Stereo and multi-channel audio, Sound Filed Synthesis, Spatial audio standards. Room acoustics: Sound propagation in rooms. Modeling the influence of short and long term reverberation. Modeling room impulse responses and head related impulse responses.

7

15

FIRST INTERNAL EXAM

III

Audio compression methods: Sampling rate and bandwidth requirement for digital audio, Redundancy removal and perceptual irrelevancy removal, Loss less coding, sub-band coding, sinusoidal coding, Transform coding. Parametric Coding of Multi-channel audio: Mid- Side Stereo, Intensity Stereo, Binaural Cue Coding.

7
15

IV

Transform coding of digital audio:MPEG2-AAC coding standard, MDCT and its properties, Pre-echo and pre-echo suppression, psycho-acoustic modeling, adaptive quantization and bit allocation methods, Loss less coding methods. Audio quality analysis: Objective analysis methods- PEAQ, Subjective analysis methods - MOS score, MUSHRA score

7
15

SECOND INTERNAL EXAM

V

Music Classification: Music features: Genre, Timbre, Melody, Rhythm, Audio features for Music Classification, Low-level, Mid- Level and Song level classification features, Similarity measures for classification , Supervised Classifiers : k NN, GMM, HMM, and SVM based classifiers.

7
20

VI

Hearing aids: Hearing loss, digital hearing aids, Cochlear implants: Electrode design, Simulation methods, transmission link and signal processing, Types of cochlear implants, Performance analysis of cochlear implants.

7
20

END SEMESTER EXAM

Course No.
Course Name
L-T-P
Credits
Year of Introduction

01EC6316
Pattern Recognition And Machine Learning
3-0-0
3
2015

Course Objectives

1. To introduce the basic concepts and techniques of machine learning to pattern recognition
2. To design and applications of machine learning to pattern recognition
3. To understand and implement classical algorithms in pattern recognition and machine learning

Syllabus

Introduction to Probability Theory, Supervised and unsupervised learning, Parametric and Non-parametric methods, Probability distributions, Hidden Markov models for sequential data classification, Linear models for regression and classification, Clustering

Expected Outcome

1. Understand and compare the various approaches to machine learning and pattern recognition implementations
2. Describe and utilize a range of techniques for designing machine learning and pattern recognition systems for real-world applications
3. Design of classification and regression systems.

References

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

COURSE PLAN

Module	Contents	Hours Allotted	% of Marks in End-Semester Examination
I	Introduction to Probability Theory, Decision Theory and Information Theory. Concepts of learning, Supervised and unsupervised learning, Curse of dimensionality, Parametric and Non-parametric methods.	8	15
II	Probability distributions - Gaussian distribution, Maximum-Likelihood estimation, Maximum Aposteriori Estimation, Bayesian inference, Mixture of Gaussians, Nearest-neighbour methods.	6	15
FIRST INTERNAL EXAM			
III	Hidden Markov models for sequential data classification - Discrete hidden Markov models, Continuous density hidden Markov models. Dimension reduction methods - Fisher discriminant analysis, Principal component analysis.	7	15
IV	Non-parametric techniques for density estimation - Parzen-window method, K-Nearest Neighbour method. Non-metric methods for pattern classification - Non-numeric data or nominal data, Decision trees.	7	15
SECOND INTERNAL EXAM			
V	Linear models for regression and classification, Perceptron, Artificial Neural networks, Support Vector Machines.	7	20

VI

Unsupervised learning. Clustering - Criterion functions for clustering, Algorithms for clustering: K-means and Hierarchical methods.

7
20
END SEMESTER EXAM

Course No.	Course Name	L-T-P	Credits	Year of Introduction
01EC6122	Design Of VLSI Systems	**3-0-0**	**3**	**2015**

Course Objectives

1. Understand the basics of CMOS Inverter and other Logic Design Techniques
2. Get a feel of current design technology
3. In-depth knowledge about various memory elements

Syllabus

CMOS Inverter - Behavior and Performance, CMOS Circuit and Logic Design, Advanced techniques in CMOS Logic Circuits, Arithmetic Circuits in CMOS VLSI- Adders, High speed adders, Multipliers, Low power design, Designing Memory and Array Structures, Addressable or Associative Memories, Sense Amplifier

Expected Outcome

1. Understand the basics of VLSI Design
2. Understand the working of high speed adders and multipliers
3. Understand , various methods in the design of memory elements

References

1. John P. Uyemura, Introduction to VLSI Circuits and Systems, John Wiley & Sons 2002
2. Keshab K. Parthi, VLSI DIGITAL SIGNAL PROCESSING SYSTEMS, John Wiley & Sons 2002
3. Neil H. E. Weste, Kamran Eshranghian, Principles of CMOS Design, Pearson Education Asia 2000
4. Jan M. Rabaey and et al, DIGITAL INTEGRATED CIRCUITS, Pearson Edn. Inc. 2003

COURSE PLAN

Course No.	Course Name	L-T-P	Credits	Year of Introduction

Module	Contents	Hours Allotted	% of Marks in End-Semester
I	CMOS Inverter - Static Behaviour, Performance of CMOS Inverter - Dynamic Behaviour, Power Energy and Energy Delay, CMOS Circuit and Logic Design-CMOS Logic structures.	7	15
II	Advanced techniques in CMOS Logic Circuits-Mirror circuits, Pseudo nMOS, Tri-state circuits, Clocked CMOS, Dynamic CMOS Logic circuits, Dual Rail Logic Networks.	7	15
FIRST INTERNAL EXAM			
III	Arithmetic Circuits in CMOS VLSI-Bit Adder Circuits, Ripple Carry Adder, Carry Look Ahead Adders, Other High speed adders-Multiplexer based fast binary adders, Multipliers-Parallel multiplier, Wallace Tree and Dadda multiplier,	7	15
IV	Low power design- Scaling Versus Power consumption, Power reduction techniques	7	15
SECOND INTERNAL EXAM			
V	Designing Memory and Array Structures - Memory classification, Memory Core - Read Only Memories, Non-volatile Read Write Memories	7	20
VI	Content - Addressable or Associative Memories, Memory Peripheral Circuits - Address Decoders, Sense Amplifiers.	7	20
END SEMESTER EXAM			

Course No.	Course Name	L-T-P	Credits	Year of Introduction
01EC6218	Soft Computing	3-0-0	3	2015

Course Objectives

1. To familiarize various components of soft computing.
2. To give an overview of fuzzy Logic
3. To give a description on artificial neural networks with its advantages and application.

Syllabus

Basics of Fuzzy Sets, Fuzzy relations, Concepts of Artificial Neural Networks, Integration of Fuzzy and Neural Systems, Types of Neural Fuzzy Controllers, Survival of the Fittest, Predicate calculus, Semantic networks, Applications

Expected Outcome

1. Identify and describe soft computing techniques and their roles in building intelligent machines
2. Recognize the feasibility of applying a soft computing methodology for a particular problem
3. Apply fuzzy logic and reasoning to handle uncertainty and solve engineering problems

References

1. Chin –Teng Lin and C.S. George Lee, (1996) “Neural Fuzzy Systems” – A neuro fuzzy synergism to intelligent systems, Prentice Hall International.
2. JyhShing Roger Jang, Chuen-Tsai Sun, EijiMizutani, (1997), Neuro-Fuzzy and Soft Computing: A Computational Approach to Learning and Machine, Prentice Hall.
3. Yanqing Zhang and Abraham Kandel (1998), Compensatory Genetic Fuzzy Neural Network and Their Applications, World Scientific.
4. T. J. Ross (1995)-Fuzzy Logic with Engineering Applications, McGraw-Hill, Inc.
5. NihJ. Nelsson, "Artificial Intelligence - A New Synthesis", Harcourt Asia Ltd., 1998.
6. D.E. Goldberg, "Genetic Algorithms: Search, Optimization and Machine Learning", Addison Wesley, N.Y, 1989

COURSE PLAN

Module
Contents
Hours Allotted
% of Marks in End-Semester Examination

I

Basics of Fuzzy Sets: Fuzzy Relations. Methodology of Fuzzy Control Systems – Basic structure and operation of fuzzy logic control systems.

8
15

II

Concepts of Artificial Neural Networks: Basic Models and Learning rules of ANN's. Single layer perceptron networks – Feedback networks – Supervised and unsupervised learning approaches – Neural Networks in Control Systems.

8

15

FIRST INTERNAL EXAM

III

Integration of Fuzzy and Neural Systems: Neural Realization of Basic fuzzy logic operations – Neural Network based fuzzy logic inference – Neural Network based Fuzzy Modelling.

7
15

IV

Types of Neural Fuzzy Controllers. Data clustering algorithms - Rule based structure identification-Neuro-Fuzzy controls.

6
15

SECOND INTERNAL EXAM

V

Survival of the Fittest - Fitness Computations - Cross over - Mutation -Reproduction - Rank method– Rank space method AI search algorithm

6
20

VI

Predicate calculus - Rules of interference – Semantic networks - Frames - Objects - Hybrid models-Applications.

7
20
END SEMESTER EXAM

Course No.	Course Name	L-T-P	Credits	Year of Introduction
01EC6322	Optimization Techniques	**3-0-0**	**3**	**2015**

Course Objectives

1. To familiarize the students with the need of optimization in engineering
2. To introduce the students with the different types of optimization algorithms
3. To enable the students to select the suitable optimization technique for the particular problem

Syllabus

One dimensional- necessary and sufficient conditions, Search methods, Gradient methods, Multivariable- Search methods, Gradient based methods, Linear programming, Theory of Simplex method, Two phase method, Non Linear Programming, search method, Meta-heuristic optimization Techniques, Differential Evolution, Harmony Search Algorithm, Artificial Bee Colony Algorithm

Expected Outcome

1. Understand the role of optimization in engineering design.
2. Understand the working principle of optimization algorithms.
3. Understand the formulation of the problem and usage of optimization algorithms

References

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

COURSE PLAN

Module	Contents	Hours Allotted	% of Marks in End-Semester
I	One dimensional – necessary and sufficient conditions, Search methods- Fibonacci search, golden section search, Gradient methods- Newton- Raphson method, cubic search.	7	15
II	Multivariable- necessary and sufficient conditions, Search methods- Evolutionary method, Hook-Jeevs pattern search, Gradient based methods- steepest descent, Newton's method, conjugate gradient method.	7	15
FIRST INTERNAL EXAM			

Course No.	Course Name	L-T-P	Credits	Year of Introduction
III	Linear Programming - Systems of linear equations & inequalities, Formulation of linear programming problems, Theory of Simplex method, Simplex Algorithm, Two phase method-Duality, Dual Simplex method.	7	15	
IV	Non Linear Programming- Kuhn-Tucker conditions- Necessary and Sufficiency theorem – transformation method – penalty function method, search method –random search method, linearized search - Frank-Wolf method.	7	15	
SECOND INTERNAL EXAM				
V	Meta-heuristic optimization Techniques- (Principle and implementation steps for examples related to engineering (signal processing, communication, control system) optimization of the following)	7	20	
VI	Differential Evolution (DE), Harmony Search Algorithm (HSA), Artificial Bee Colony Algorithm (ABC).	7	20	
END SEMESTER EXAM				

Course No.	Course Name	L-T-P	Credits	Year of Introduction
01EC6392	Mini Project	**0-0-4**	**2**	**2015**

Course Objectives

To make students

Design and develop a system or application in the area of their specialization.

Approach

The student shall present two seminars and submit a report. The first seminar shall highlight the topic, objectives, methodology, design and expected results. The second seminar is the presentation of the work / hardware implementation.

Expected Outcome

Upon successful completion of the mini project, the student should be able to

1. Identify and solve various problems associated with designing and implementing a system or application.
2. Test the designed system or application.

Course No.	Course Name	L-T-P	Credits	Year of Introduction
01EC6394	Image Processing Lab	**0-0-2**	**1**	**2015**

Course Objectives

1. Implement the various image processing algorithms in MATLAB/C/C++.

List of Exercises / Experiments

Representation of Grayscale and colour images

Image transformations: Grey level transformations, Histogram equalization and modifications, Geometric transformations, affine transformations.

Image Transforms: DFT, DCT, KLT, etc.

Image filtering: Fourier descriptors, Linear and non-linear filtering operations in spatial and transform domain, Image convolutions, Separable convolutions, Sub-sampling and interpolation as convolution operations

Edge detection: Edge enhancement by differentiation, Effect of noise, edge detection and canny implementation, Edge detector performance evaluation.

Segmentation: Thresholding algorithms, Performance evaluation and ROC analysis Connected components labelling, Region growing and region adjacency graph (RAG), Split and merge algorithms.

Morphological operation: Erode and dilate as max and min operators on binary images, open, close, thinning and other transforms.

Computed Tomography: Implementation of FBP and CBP algorithms for parallel beam tomography.

Expected Outcome

1. Familiarisation and implementation of various image processing algorithms

Text Book

1. Gonzales/ Woods/ Eddins, Digital Image Processing using MATLAB, 2nd edition

SEMESTER – III

Syllabus and Course Plan

Course No.	Course Name	L-T-P	Credits	Year of Introduction
01EC7311	VLSI Structures For Digital Signal Processing	3-0-0	3	2015

Course Objectives

1. The ability to do pipelining and parallel processing.
2. Should be able to implement DCT based on architecture transformation.

Syllabus

Representations of DSP algorithms, Loop bound and iteration bound, Retiming, Folding and Unfolding Pipelining and parallel processing of FIR digital filters, combined pipelining and parallel processing of FIR filters for low power, Pipelining and parallel processing of IIR digital filters–Fast convolution-Fast FIR algorithms-implementation of DCT based on algorithm -architecture transformations- Rank order Filters.

Expected Outcome

1. Understand Pipelining and Parallel processing
2. Understand fast convolution
3. Understand structures useful in DSP implementation.

Text Book

1. Keshab K. Parhi, VLSI Digital signal processing Systems: Design and Implementation, John Wiley & Sons, 1999.
2. Uwe meyer- Baes, DSP with Field programmable gate arrays, Springer, 2001

COURSE PLAN

Module	Contents	Hours Allotted	% of Marks in End-Semester
I	Representations of DSP algorithms. Loop bound and iteration bound. Algorithms for Computing Iteration Bound-LPM Algorithm. Transformation Techniques: Retiming, Folding and Unfolding	8	15
II	Pipelining of FIR digital filters -parallel processing for FIR systems -combined pipelining and parallel processing of FIR filters for low power	8	15

Course No.	Course Name	L-T-P	Credits	Year of Introduction
FIRST INTERNAL EXAM				
III	Pipelining in IIR filters -parallel processing for IIR filters -combined pipelining and parallel processing of IIR filters.	7	15	
IV	Fast convolution-Cook-Toom Algorithm- Modified Cook-Toom Algorithm-Winograd Algorithm-cyclic convolution	6	15	
SECOND INTERNAL EXAM				
V	Parallel FIR filters –Fast FIR Algorithms-Discrete time cosine transform -implementation of DCT based on algorithm -architecture transformations	6	20	
VI	Parallel architectures for Rank Order filters-Odd Even Merge sort architecture-Rank Order filter architecture-Parallel Rank Order filters-Running Order Merge Order Sorter-Low power Rank Order filter.	7	20	
END SEMESTER EXAM				

Course No.
Course Name
L-T-P
Credits
Year of Introduction

01EC7313
Space Time Coding And Mimo Systems
3-0-0
3
2015

Course Objectives

1. To introduce diversity techniques, space time coding and receiver design.

Syllabus

Review of SISO communication, MIMO channels, Multidimensional channel modelling, Capacity of MIMO channels, Diversity, Diversity methods, Combining methods, Space-time code design criteria, Orthogonal space, Maximum-likelihood decoding and maximum ratio combining, Quasi-orthogonal space-time block codes, Space time trellis codes, Spatial multiplexing and receiver design, Using equalization techniques in receiver design, Combined spatial multiplexing and space-time coding, MIMO OFDM

Expected Outcome

1. Understand channel models and diversity techniques
2. Understand space time coding
3. Understand receiver design

TextBook

1. H. Jafarkhani,"Space Time Coding Theory and Practice" Cambridge University Press.
2. E. G. Larsson and P. Stoica, "Space Time Block coding for wireless communication". Cambridge University Press.
3. C. Oesteges and B. Clerckx, MIMO wireless communications from real world propogation to space time code design. Academic press.

COURSE PLAN

Module
Contents
Hours Allotted
% of Marks in End-Semester Examination

I

Review of SISO communication- MIMO channel models Transmission model for MIMO channels, Multidimensional channel modeling, Capacity of MIMO channels, Outage capacity.

8
15

II

Diversity-Principle, array and diversity gains, Diversity methods, Combining methods-maximum ratio combining, selection combining.

8

15

FIRST INTERNAL EXAM

III

Space-time code design criteria - Rank and determinant criteria, Trace criterion, Maximum mutual information criterion. Orthogonal space-time block codes - Alamouticode.

7
15

IV

Maximum-likelihood decoding and maximum ratio combining, orthogonal designs. Quasi-orthogonal space-time block codes- Pairwise decoding, Rotated QOSTBCs, Space time trellis codes.

6
15

SECOND INTERNAL EXAM

V

Spatial multiplexing and receiver design-Introduction, Spatial multiplexing, Sphere decoding, Using equalization techniques in receiver design, V-BLAST , D-BLAST, Turbo-BLAST

6
20

VI

Combined spatial multiplexing and space-time coding, MIMO OFDM

7
20

END SEMESTER EXAM

Course No.	Course Name	L-T-P	Credits	Year of Introduction
01EC7213	Secure Communication	3-0-0	3	2015

Course Objectives

1. As a graduate level course on secure communication, this course assure to deliver the students, a sound understanding of the number theoretic methods and algorithms used in classical and modern cryptography and their cryptanalysis.

Syllabus

Introduction to cryptography - stream and block ciphers- symmetric and public keys.

Expected Outcome

1. Learn theorems on the number and abstract algebra and develops the mathematical proof writing skills.
2. Learn mathematics behind the cryptography and the cryptographic standards.
3. Learn the algorithms used in cryptanalysis and their merits.
4. Initiate the talented students to propose and analyze new algorithms and methods in cryptology

Text Book

1. A Course in Number Theory and Cryptography, Neal Koblits, Springer, 2e.
2. Number Theory for Computing, Song Y Yan, Springer, 2e.
3. Elementary Number Theory with Applications, Thomas Koshy, Elsivier, 2e.

References

1. Fundamentals of Cryptology, Henk CA van Tilborg, Kluwer Academic Publishers.
2. Primality Testing and Integer Factorization in Public Key Cryptography, Song Y Yan, Springer, 2e.
3. Public Key Cryptography, ArtoSalomaa, Springer, 2e.
4. An Introduction to Theory of Numbers, I Niven, HS zuckerman etc.., John Wiley and Sons, 5e.
5. How to Prove it- A structured Approach, Daniel J Velleman, Cambridge UniversitPress, 2e.

COURSE PLAN

Module
Contents
Hours Allotted
% of Marks in End-Semester Examination

I

Introduction to cryptography - stream and block ciphers- symmetric and public keys. Basics -Mathematical proofs and methods. Complexity theory: Computational Complexity Classes P, NP- NP-Complete, NP-Hard, BPP. Number theory: primes, divisibility, linear Diophantine equations, congruences, systems of congruence equation, quadratic congruences. Wilson theorem, Fermat's little theorem, Euler's theorem. Multiplicative functions, Primitive roots, Quadratic residues, Legendre symbol, Continued fractions.

8
15

II

Elementary Algebraic Structures: Groups- subgroups, order, homomorphism, cyclic groups, generators. Rings- characteristics, Finite Fields. Polynomial Rings and their algebra over finite fields, multiplicative inverses. Discrete logarithm over groups. Elliptic Curves: as a group defined over finite field, number of points, order and algebra of rational points on elliptic curves.

8

15

FIRST INTERNAL EXAM

III

Classical Cryptography: Affine ciphers, hill ciphers, digraphs, enciphering matrices. Linear Feedback Shift Registers for PN sequences. Public key Cryptography: One way functions, Hash functions, Knapsack cryptosystems

7
15

IV

RSA, Deffie Helman Key Exchange system, El Gamal's Public key crypto system. Elliptic curve crypto system. Cryptographic standards: DES, AES, MD5, Digital Signature, Zero Knowledge Protocol.

6
15

SECOND INTERNAL EXAM

V

Cryptanalysis, Algorithms: Modular exponentiation, Fast group operations on Elliptic curves. Primality test- Fermat’s pseudo primality test, Strong prime test, Lucas Pseudo prime test, Elliptic curve test.

6
20

VI

Integer Factorization- Trial division, Fermat's method, CFRAC. Quadratic and Number Field Sieves. Algorithms for Discrete Logarithms: Baby-step Giant-step alg. Algorithms for Discrete Logarithm on Elliptic curves.

7
20

END SEMESTER EXAM

Course No.
Course Name
L-T-P
Credits
Year of Introduction

01 EC7317
Array Signal Processing

3-0-0
3
2015

Course Objectives

1. To introduce the student to the various aspect of array signal processing
2. Concept of Spatial Frequency is introduced along with the Spatial Sampling Theorem
3. Various array design methods and direction of arrival estimation techniques are introduced

Syllabus

Spatial Signals: Signals in space and time, Wavenumber -Frequency Space Spatial Sampling, Sensor Arrays, Uniform Linear Arrays, Beam Pattern Parameters, Array Design Methods, Narrow Band Direction of Arrival Estimation: Non parametric method.

Expected Outcome

1. Understands the important concepts of array signal processing
2. Understands the various array design techniques
3. Understands the basic principle of direction of arrival estimation techniques

Text Book

1. Harry L. Van Trees; Optimum Array Processing; Wiley-Interscience
2. Sophocles J Orfandis ; Electromagnetic Waves and Antennas.
3. Dan E Dugeon and Don H Johnson; Array Signal Processing: Concepts and Techniques; Prentice Hall
4. PetreStoica and Randolph L. Moses; Spectral Analysis of Signals; Prentice Hall

COURSE PLAN

Module

Contents

Hours Allotted

% of Marks in End-Semester Examination

I

Spatial Signals: Signals in space and time, Spatial Frequency Vs Temporal Frequency, Review of Co-ordinate Systems, Maxwell's Equation, Wave Equation. Solution to Wave equation in Cartesian Co-ordinate system -Wavenumber vector, Slowness vector

8

15

II

Wavenumber -Frequency Space Spatial Sampling: Spatial Sampling Theorem- Nyquist Criteria, Aliasing in Spatial frequency domain, Spatial sampling of multidimensional signals.

8

15

FIRST INTERNAL EXAM

III

Sensor Arrays: Linear Arrays, Planar Arrays, Frequency - Wavenumber Response and Beam pattern, Array manifold vector, Conventional Beam former, Narrowband beam former.

7

15

IV

Uniform Linear Arrays: Beam pattern in θ, u and ψ -space, Uniformly Weighted Linear Arrays. Beam Pattern Parameters : Half Power Beam Width, Distance to First Null, Location of side lobes and Rate of Decrease, Grating Lobes, Array Steering

6

15

SECOND INTERNAL EXAM

V

Array Design Methods : Visible region , Duality between Time -Domain and Space -Domain Signal Processing, Schelkunoff's Zero Placement Method, Fourier Series Method with windowing, Woodward -Lawson Frequency-Sampling Design

6

20

VI

Narrow Band Direction of Arrival Estimation: Non parametric method -Beam forming, Delay and sum Method, Capons Method. Subspace Methods -MUSIC, Minimum Norm and ESPIRIT techniques

7

20

END SEMESTER EXAM

Course No.
Course Name
L-T-P
Credits
Year of Introduction

01EC7319
Bioinformatics

3-0-0
3
2015

Course Objectives

1. The ability to analyze bio-sequences computationally
2. Should be able to use various tools for sequence study
3. Should be able to model biological systems.

Syllabus

The cell as basic unit of life-Prokaryotic cell and Eukaryotic cell, Scoring matrices, Analysis of bio-sequence signals, Systems Biology, Mathematical modelling

Expected Outcome

1. Understand the basics of genomes and proteomes
2. Understand how various algorithms and tools could be made use of for sequence analysis.
3. Understand the properties and modeling of biological systems.

Text Book

1. Claverie & Notredame, Bioinformatics - A Beginners Guide, Wiley-Dreamtech India Pvt.
2. Uri Alon, An Introduction to Systems Biology Design Principles of Biological Circuits, Chapman & Hall/CRC.
3. Marketa Zvelebil and Jeremy O. Baum, Understanding Bioinformatics, Garland Science.
4. Bryan Bergeron, Bioinformatics Computing, Pearson Education, Inc., Publication.
5. D. Mount, Bioinformatics: Sequence & Genome Analysis, Cold spring Harbor press.
6. C. A. Orengo D.T. Jones and J. M. Thornton, Bioinformatics- Genes, Proteins And Computers, Taylor & Francis Publishers.
7. Achuthsankar S. Nair et al. Applying DSP to Genome Sequence Analysis: The State of the Art, CSI Communications, vol. 30, no. 10, pp. 26-29, Jan. 2007.
8. Resources at web sites of NCBI, EBI, SANGER, PDB etc.

COURSE PLAN

Module
Contents
Hours Allotted
% of Marks in End-Semester Examination

I

The cell as basic unit of life-Prokaryotic cell and Eukaryotic cell - Central Dogma: DNA-RNA-Protein, Human Genome Project, SNP, Bioinformatics databases, Homologus, orthologus & paralogus sequences

8
15

II

Scoring matrices- PAM and BLOSUM matrices, pairwise sequence alignments: Needleman & Wuncsh, Smith & Waterman algorithms for pairwise alignments. BLAST and FASTA. Multiple sequence alignments (MSA) CLUSTALW. Basic concepts of phylogeny

8

15

FIRST INTERNAL EXAM

III

Computational approaches for bio-sequence analysis - Mapping bio-sequences to digital signals -various approaches -indicator sequences -distance signals -use of clustering to reduce symbols in amino acid sequences.

7
15

IV

Analysis of bio-sequence signals -case study of spectral analysis for exon location, chaos game representation of bio-sequences

6
15

SECOND INTERNAL EXAM

V

Systems Biology: System Concept- Properties of Biological systems, Self-organization, emergence, chaos in dynamical systems, linear stability, bifurcation analysis, limit cycles, attractors, stochastic and deterministic processes, continuous and discrete systems, modularity and abstraction, feedback, control analysis

6

20

VI

Mathematical modeling; Biological Networks- Signaling pathway, GRN, PPIN, Flux Balance Analysis, Systems biology v/s synthetic biology

7
20
END SEMESTER EXAM

Course No.	Course Name	L-T-P	Credits	Year of Introduction
01EC7315	Computer Vision	**3-0-0**	**3**	**2015**

Course Objectives

1. Introduce the standard computer vision problems and identify the solution methodologies.

Syllabus

Image Formation, Depth estimation and multiview cameras, Shape from X, feature extraction, Segmentation, Pattern analysis, Motion Analysis, Object Detection and Recognition.

Expected Outcome

1. Understand and implement the algorithms for 3D reconstruction from various cues.
2. Understand and implement the various segmentation, pattern analysis, objection detection/recognition methods.

Text Book

1. Computer Vision: Algorithms and Applications, Richard Szeliski, Springer 2010
2. Computer vision: A modern approach, by Forsyth and Ponce. Prentice Hall, 2002.
3. Computer & Machine Vision: Theory Algorithms Practicalities, E. R. Davies, ELSEIVER, Academic Press, 2012
4. Multiple View Geometry in Computer Vision, Richard Hartley and Andrew Zisserman, Second Edition, Cambridge University Press, March 2004

Course No.	Course Name	L-T-P	Credits	Year of Introduction

COURSE PLAN

Module	Contents	Hours Allotted	% of Marks in End-Semester
I	Fundamentals of Image Formation, Transformation: Orthogonal, Euclidean, Affine, Projective, etc. Perspective Projection, Homogeneous Coordinates, Vanishing points, Orthographic projection, Parallel Projection. Photometric image formation, The digital camera.	7	15
II	Depth estimation and Multiview cameras: Binocular Stereopsis: Camera and Epipolar Geometry; Homography, Rectification, RANSAC, 3-D reconstruction framework; Auto-calibration. Shape from X: Light at Surfaces; Phong Model; Reflectance Map; Albedo estimation; Photometric Stereo; Use of Surface Smoothness Constraint; Shape from Texture, color, motion and edges.	8	15
FIRST INTERNAL EXAM			
III	Feature Extraction: Edges - Canny, LOG, DOG; Line detectors (Hough Transform), Corners - Harris and Hessian Affine, Orientation Histogram, SIFT, SURF, HOG, Scale-Space Analysis- Image Pyramids and Gaussian derivative filters, Gabor Filters and DWT.	7	15
IV	Image Segmentation and Pattern Analysis : Image Region Growing, Edge Based approaches to segmentation, Graph-Cut, Mean-Shift, MRFs, Clustering: K-Means, Mixture of Gaussians, Dimensionality Reduction: PCA, LDA, ICA; Non-parametric methods.	7	15
SECOND INTERNAL EXAM			
V	Motion Analysis: Background Subtraction and Modeling, Optical Flow, KLT, Spatio-Temporal Analysis, Dynamic Stereo; Motion parameter estimation.	6	20
VI	Object Detection and Recognition: Face detection, Pedestrian detection, Face recognition, Eigen faces, Active appearance and 3D shape models, Instance recognition, Category recognition, Context and scene understanding.	7	20
END SEMESTER EXAM			

Course No.	Course Name	L-T-P	Credits	Year of Introduction
01EC7391	Seminar II	**0-0-2**	**2**	**2015**

Course Objectives

To make students

1. Identify the current topics in the specific stream.
2. Collect the recent publications related to the identified topics.
3. Do a detailed study of a selected topic based on current journals, published papers and books.
4. Present a seminar on the selected topic on which a detailed study has been done.
5. Improve the writing and presentation skills.

Approach

Students shall make a presentation for 20-25 minutes based on the detailed study of the topic and submit a report based on the study.

Expected Outcome

Upon successful completion of the seminar, the student should be able to

1. Get good exposure in the current topics in the specific stream.
2. Improve the writing and presentation skills.
3. Explore domains of interest so as to pursue the course project.

Course No.	Course Name	L-T-P	Credits	Year of Introduction
01EC7393	Project (Phase 1)	**0-0-12**	**6**	**2015**

Course Objectives

To make students

1. Do an original and independent study on the area of specialization.
2. Explore in depth a subject of his/her own choice.
3. Start the preliminary background studies towards the project by conducting literature survey in the relevant field.
4. Broadly identify the area of the project work, familiarize with the tools required for the design and analysis of the project.
5. Plan the experimental platform, if any, required for project work.

Approach

The student has to present two seminars and submit an interim Project report. The first seminar would highlight the topic, objectives, methodology and expected results. The first seminar shall be conducted in the first half of this semester. The second seminar is the presentation of the interim project report of the work completed and scope of the work which has to be accomplished in the fourth semester.

Expected Outcome

Upon successful completion of the project phase 1, the student should be able to

1. Identify the topic, objectives and methodology to carry out the project.
2. Finalize the project plan for their course project.

SEMESTER – IV

Syllabus and Course Plan

Course No.	Course Name	L-T-P	Credits	Year of Introduction
01EC7394	Project (Phase II)	**0-0-23**	**12**	**2015**

Course Objectives

To continue and complete the project work identified in project phase 1.

Approach

There shall be two seminars (a midterm evaluation on the progress of the work and pre submission seminar to assess the quality and quantum of the work). At least one technical paper has to be prepared for possible publication in journals / conferences based on their project work.

Expected Outcome

Upon successful completion of the project phase II, the student should be able to

1. Get a good exposure to a domain of interest.
2. Get a good domain and experience to pursue future research activities.