Bansilal Ramnath Agarwal Charitable Trust's

Vishwakarma Institute of Information Technology, Pune-48

(An Autonomous Institute affiliated to Savitribai Phule Pune University)

Curriculum for

F.Y. M. Tech.

(E&TC - Signal Processing)

2017 Course

Department of Electronics & Telecommunication Engineering

VISION:

- Excellence in Electronics & Telecommunication Engineering Education

MISSION:

- Provide excellent blend of theory and practical knowledge. sustainable development of society
- Establish centre of excellence in post graduate studies and research.
- Prepare engineering professionals with highest ethical values and a sense of responsible citizenship.

Structure for First Year M. Tech. Electronics and Telecommunication Engineering with effect from academic year 2017 – 2018

First Year - Semester I

Course Code	Course	Teaching Scheme		Examination Scheme					Total	Credits
				Formative Assessment			Summative Assessment			
		L	P	ISE		CE	ESE	PR/OR		
				T1	T2					
ETPA11171	Advanced Digital Signal Processing *	4	-	15	15	20	50	-	100	4
ETPA11172	Image and Video Processing *	4	-	15	15	20	50	-	100	4
ETPA11173	Linear Algebra *	4	-	15	15	20	50	-	100	4
ETPA11174	Elective I* (Program Specific)	4	-	15	15	20	50	-	100	4
ETPA11175	Elective II (Department Specific)	4	-	15	15	20	50	-	100	4
ETPA11176	Seminar I	-	2	-	-	50	-	50	100	1
ETPA11177	Lab practice I	-	8	-		50	-	50	100	4
AP1	Audit Course	-	-	-	-	-	-	-	-	-
	Total	20	10	75	75	200	250	100	700	25

*Lab Practice I comprises of courses with course code ETPA11171, ETPA11172, ETPA11173, ETPA11174

Elective I:

ETPA11174A: Soft Computing
ETPA11174B: Artificial Intelligence
ETPA11174C: Estimation and Detection Theory
ETPA11174D: Advanced RISC and DSPs

Elective II:

ETPA11175A: Mixed Signal Processing
ETPA11175B: Joint Time Frequency Analysis
ETPA11175C: Statistical Signal Processing
ETPA11175D: Biometrics

Audit Courses:

Project Management
Technical Writing and Documentation
Cyber and Information Security
R/Python Programming
Any online certification course apart from courses in the curriculum

First Year – Semester II

Course Code	Course	Teaching Scheme		Examination Scheme					Total	Credits
				Formative Assessment			Summative Assessment			
		L	P	ISE		CE	ESE	PR/OR		
				T1	T2					
ETPA12171	Computer Vision *	4	-	15	15	20	50	-	100	4
ETPA12172	Biomedical Signal Processing *	4	-	15	15	20	50	-	100	4
ETPA12173	Research Methodology *	4	-	15	15	20	50	-	100	4
ETPA12174	Elective III	4	-	15	15	20	50	-	100	4
ETPA12175	Elective IV	4	-	15	15	20	50	-	100	4
ETPA12176	Seminar II	-	2	-	-	50	-	50	100	1
ETPA12177	Intellectual Property Rights	1	-	-	-	50	-	-	50	1
ETPA12178	Lab Practice II	-	6	-	-	50	-	50	100	3
	Total	21	8	75	75	250	250	100	750	25

*Lab Practice II comprises of courses with course code ETPA12171, ETPA12172, ETPA12173

Elective III:

ETPA12174A: Speech Signal Processing
ETPA12174B: Pattern Recognition
ETPA12174C: Acoustic Signal Processing
ETPA12174D: Signal Processing for Industrial Systems

Elective IV:

ETPA12175A: VLSI Architectures for DSP
ETPA12175B: Still Image and Video Compression
ETPA12175C: Optimization Techniques
ETPA12175D: Satellite and Radar Signal Processing

Second Year – Semester I

Course Code	Course	Teaching Scheme		Examination Scheme					Total	Credits
				Formative Assessment			Summative Assessment			
		L	P	ISE T1	ISE T2	CE	ESE	PR/OR		
ETPA21171	Open Elective (Institute)	3	-	15	15	20	-	-	50	3
ETPA21172	Foreign Language (German/French)/Business English	2	-	-	-	50	-	-	50	2
ETPA21173	Environmental Studies	1	2			50			50	2
ETPA21174	Internship / Value added course / In-house Project	-	8	-	-	100	-	100	200	8
ETPA21175	Project Stage I	-	10	-	-	100	-	100	200	10
AP2	Audit Course	-	-	-	-	-	-	-	-	-
	Total	6	20	15	15	320	-	200	550	25

Audit Courses:

Embedded System Design using TI/TIVA Architecture
System Modelling using LabVIEW
Internet of Things (IoT)
Cloud Computing
Business Economics
Any online certification course apart from courses in the curriculum

Second Year – Semester II

Course Code	Course	Teaching Scheme		Examination Scheme					Total	Credits
				Formative Assessment			Summative Assessment			
		L	P	ISE T1	ISE T2	CE	ESE	PR/OR		
ETPA22171	Project Stage II	-	25	-	-	100	-	100	200	25
	Total	-	25	-	-	100	-	100	200	25

Semester – I

Advanced Digital Signal Processing (ETPA11171)

Teaching Scheme
Credits : 4
Lectures : 4 Hrs/week

Examination Scheme
F. A. : 50 Marks
S. A. : 50 Marks

Prerequisite :
1. Digital Signal Processing
2. Fundamentals of Matrices

Course Objectives:
1. To build an understanding of Multirate DSP.
2. To introduce the concept of Adaptive filters.
3. To introduce concept of Linear Prediction and efficient computation of LPC.
4. To build an understanding of estimation of Power Spectrum of Random Processes

Course Outcomes:
Upon learning the course the student will be able to
1. Apply the concept of Multirate Signal Processing.
2. Use Adaptive filtering for real life applications.
3. Compute linear prediction coefficients in efficient manner.
4. Analyze the discrete time signals by estimating power spectrum using various methods.

Unit I : DFT and Z Transform
Review of DFT, Linear Filtering, Goertzel Algorithm, Review of Z - Transform, Rational Z–Transform, Analysis of LTI systems, Causality and Stability.

Unit II : Digital Filters
Design of FIR filters using Window method and Frequency Sampling method, Design of IIR filters using Bilinear transformation

Unit III : Review of Random Processes and Multirate Signal Processing
Need of Multirate DSP, Decimation, Interpolation; Design of sampling rate conversion by a non-integer factor; Design of two stage sampling rate converter, Software implementation of sampling rate converters; Sample rate conversion using poly-phase filter structure; Application to sub band coding and CD Hi-fi systems.

Unit IV : Adaptive filters
Need of Adaptive filters, main components of adaptive filters, Wiener Hopf equation, LMS algorithm, various configuration of adaptive filters

Unit V : Linear Prediction
Innovation representation of random signals; Rational power spectra, AR, MA, ARMA; Forward and backward linear prediction; Solution of the normal equation – Levinson – Durbin Algorithm.

Unit VI : Power Spectrum Estimation
Estimation of spectra from finite duration observation of signals; Estimation of autocorrelation and power spectrum of random signals; Non-parametric methods for power spectrum estimation – Periodogram method, modified periodogram method, Bartlett method

Text Books :
1. John G. Proakis, Dimitris G. Manolakis, "Digital Signal Processing: Principles, algorithms and applications" Fourth edition, Pearson Prentice Hall.
2. E.C.Ifeachor, B.W.Jervid, "Digital Signal Processing: A practical approach", 2nd ed., Pearson Education.

Reference Books :

1. P P Vaidyanathan “Multirate systems and filter banks”, PHI.
2. Simon Haykin, “Adaptive Filter Theory”, 4th edition Pearson Education.

Prepared by: Prof. A. V. Bang

BOS member:

BOS chairperson:

Image and Video Processing (ETPA11172)

Teaching Scheme
Credits : 4
Lectures : 4 Hrs/week

Examination Scheme
F. A. : 50 Marks
S. A. : 50 Marks

Prerequisite : Digital Signal Processing

Course Objectives:

1. To introduce students to digital images and its acquisition fundamentals
2. To learn basic techniques / algorithms used in enhancement, compression and restoration in spatial and frequency domain transformations
3. To expose students to the techniques used for image analysis.
4. Introduce students to the applications of DIP
5. To introduce video processing and compression fundamentals.
6. To learn and use MATLAB toolbox

Course Outcomes:

1. Graduates will have background of Human Visual perception
2. Graduates will know how to process two dimensional image data
3. Graduates will have knowledge of Image transform and their properties
4. Graduates will have understanding of image processing algorithms for image enhancement, image restoration, compression, segmentation
5. Graduates will be able to implement image processing algorithms for given application

Unit I : Digital Image Fundamentals
Simple image formation model, Image sampling and quantization - basic relationships between pixels - imaging geometry. Elements of human visual perception, Image statistics. Elements of human visual perception, MTF, Image statistics.

Unit II : Image Enhancement in Spatial and Frequency domain
Spatial domain methods: point processing - intensity transformations, histogram processing, image subtraction, image averaging; Image zooming, Spatial filtering - smoothing filter, sharpening filter.2D-DFT, FFT.

Unit III : Image Compression
Image Compression: Fundamentals, Lossless Compression schemes like Huffman, Arithmatic, LZW and lossless Prediction. 2D-DCT, KL, Hadamard Image compression using DCT, zig-zag scanning, still image compression standard - baseline JPEG. Vector Quantization.

Unit IV : Image Segmentation
Image Segmentation: Fundamentals, point, line and edge and combined detection, Thresholding Edge linking Hough transform, Region oriented segmentation - basic formulation, region growing by pixel aggregation, region splitting and merging, Segmentation using watersheds.

Unit V : Morphological Operations
Basics, SE, Erosion, Dilation, Opening, Closing, Hit-or-Miss Transform, Boundary Detection, Hole filling, Connected components, thinning, thickening, skeletons. Fourier descriptors, chain code and other image features. Texture Analysis

Unit VI : Video Processing
Analog Video, Digital Video, Motion estimation and detection, video enhancement, Video compression fundamentals.

Text Books :
1. Gonzalez and Woods, "Digital Image Processing", Pearson Education,
2. S. Jayaraman, S. Esakkiraian "Digital Image Processing", Tata McGraw-Hill Education

Reference Books :

1. Pratt William K. "Digital Image Processing", John Wiley & sons
2. Joshi, Madhuri A., Mehul S. Raval, Yogesh H. Dandawate, Kalyani R. Joshi, and Shilpa P. Metkar. Image and Video Compression: Fundamentals, Techniques, and Applications. CRC Press, 2014.
3. Al.Bovik,” Handbook of Image and Video Processing “ Academic Press

Prepared by: Dr. Y. H. Dandawate

BOS member:

BOS chairperson:

Linear Algebra (ETPA11173)

Teaching Scheme
Credits : 4
Lectures : 4 Hrs/week

Examination Scheme
F. A. : 50 Marks
S. A. : 50 Marks

Prerequisite : Fundamental of Matrices

Course Objectives:

1. To provide students with a good understanding of the concepts and methods of linear algebra
2. To help the students develop the ability to solve problems using linear algebra.
3. To connect linear algebra to other fields both within and without mathematics.
4. To develop abstract and critical reasoning by studying logical proofs and the axiomatic method as applied to linear algebra.

Course Outcomes:

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

1. Solve systems of linear equations using multiple methods, including Gaussian elimination and matrix inversion.
2. Carry out matrix operations, including inverses and determinants.
3. Demonstrate understanding of the concepts of vector space and subspace.
4. Demonstrate understanding of linear independence, span, and basis.
5. Determine eigen values and eigenvectors and solve eigen value problems.

Unit I : Vector Spaces

Vector spaces, Subspaces, Linear combinations and subspaces spanned by a set of vectors, Linear dependence and Linear independence, Spanning Set and Basis, Finite dimensional spaces, Dimension, Range and Null space, Rank and Nullity, Rank Nullity theorem, Four fundamental subspace

Unit II : Solutions of Linear Systems

Simple systems, Homogeneous and Nonhomogeneous 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 Column operations, Row Reduced Form, Triangular Matrix Factorization

Unit III : Orthogonality

Inner product, Inner product Spaces, Cauchy – Schwarz inequality, Norm, Orthogonality, Gram – Schmidt orthonormalization, Orthonormal basis, Decomposition of a vector with respect to a subspace and its orthogonal complement – Pythagorus Theorem

Unit IV : Eigenvalues and Eigenvectors

Requirement of diagonaization, Eigenvalue – Eigenvector pairs, characteristic equation, Algebraic multiplicity, Eigenvectors, Eigenspaces and geometric multiplicity

Unit V : Diagonalizable Matrices

Diagonalization criterion, The diagonalizing matrix, Cayley-Hamilton theorem, Annihilating polynomials, Minimal Polynomial, Diagonalizability and Minimal polynomial, Real symmetric and Hermitian Matrices, Properties of eigenvalues and eigenvectors, Unitary/Orthoginal diagonalizbility of Complex Hermitian/Real Symmetric matrices

Unit VI : Applications of Linear Algebra (Case studies)

Applications of Linear algebra in signal processing domain. Discussion and demonstration of various case studies viz. speech, image processing, etc

Text Books :

1. Gilbert Strang-Linear Algebra and It's Applications-CENGAGE Learning

Reference Books :

1. K.Hoffman & R.Kunze, Linear Algebra-PHI, 1996.
2. S. Andrill & E. Hecker, Elemenrtary -Linear Algebra-Else Verinc 2003.

Prepared by: Prof. A. V. Chitre

BOS member:

BOS chairperson:

Elective I : Soft Computing (ETPA11174A)

Teaching Scheme
Credits : 4
Lectures : 4 Hrs/week

Examination Scheme
F. A. : 50 Marks
S. A. : 50 Marks

Prerequisite : Matrix Computation

Course Objectives:

1. Introduce a relatively new computing paradigm for creating intelligent machines useful for solving complex real world problems.
2. Insight into the tools that make up the soft computing technique: fuzzy logic, artificial neural networks and hybrid systems Techniques.
3. To create awareness of the application areas of soft computing technique.
4. Provide alternative solutions to the conventional problem solving techniques in image/signal processing, pattern recognition/classification, control system.

Course Outcomes:

Upon completion of the course, students should be able to:

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
4. Apply genetic algorithms to combinatorial optimization problems
5. Apply neural networks to pattern classification and regression problems
6. Effectively use existing software tools to solve real problems using a soft computing approach.
7. Evaluate and compare solutions by various soft computing approaches for a given problem.

Unit I : Artificial Neural Network - I

Biological neuron, Artificial neuron model, concept of bias and threshold, Activation functions, Mc Culloch-Pits Neuron Model, learning paradigms: supervised, unsupervised, reinforcement, Linear neuron model: concept of error energy, gradient descent algorithm and application of linear neuron for linear regression,: Learning mechanisms: Hebbian, Delta Rule, Perceptron and its limitations.

Unit II : Artificial Neural Network - II

Multilayer perceptron (MLP) and back propagation algorithm, Application of MLP for classification, Self-Organizing Feature Maps, k-means clustering, Learning vector quantization Radial Basis Function networks: Cover's theorem, mapping functions, Application of RBFN for classification. Introduction to wavelet.

Unit III : Fuzzy Logic - I

Concept of Fuzzy number, fuzzy set theory (continuous, discrete), Operations on fuzzy sets, Fuzzy membership functions (core, boundary, support), primary and composite linguistic terms, Concept of fuzzy relation, composition operation (T-norm, T-conorm) of Fuzzy if-then rules. De-fuzzification, fuzzification (Max membership principle, Centroid method, Weighted average method).

Unit IV : Fuzzy Logic - II

Concept of fuzzy inference, Implication rules- Dienes-Rescher Implication, Mamdani Implication, Zadeh Implication, Fuzzy Inference systems -Mamdani fuzzy model, Sugeno fuzzy model, Tsukamoto fuzzy model,. Architecture of a FLC: Mamdani Type, advantages of FLC, Example Aircraft landing control problem.

Unit V : Genetic Algorithms

GA History, Basic concept, Working Principle, Encoding, Fitness Function, Reproduction, Genetic Modeling, Inheritance operators - Cross Over, Mutation, Bit wise Operators, Inversion and Deletion,

Convergence of GA and Applications
Unit VI : Hybrid Systems Genetic Algorithm based Back propagation Network, Fuzzy – Back propagation, Fuzzy Logic Controlled Genetic Algorithms. Case studies in Engineering, Introduction of deep learning, convolutional neural networks.
Text Books : 1. Fundamentals of Neural Networks: Architectures, Algorithms and Applications, Laurene Fausett, Pearson Education, Inc, 2008. 2. Fuzzy Logic With Engineering Applications, Third Edition Thomas, Timothy Ross, John Wiley & Sons,2010 3. Neuro-Fuzzy and Soft Computing, J.S. Jang, C.T. Sun, E. Mizutani, PHI Learning Private Limited. 4. Principles of Soft Computing, S. N. Sivanandam, S. N. Deepa, John Wiley & Sons, 2007. 5. Rajasekaran, S. and Vijayalakshmi Pai, G.A.: "Neural Networks, Fuzzy Logic and Genetic Algorithms: Synthesis and Applications", Prentice Hall of India.
Reference Books : 1. Introduction to the theory of neural computation, John Hertz, Anders Krogh, Richard Palmer, Addison –Wesley Publishing Company, 1991. 2. Neural Networks A comprehensive foundation, Simon Haykin,Prentice Hall International Inc-1999. 3. Neural and Adaptive Systems: Fundamentals through Simulations, José C. Principe Neil R. Euliano, W. Curt Lefebvre, John-Wiley & Sons, 2000. 4. Pattern Classification, Peter E. Hart, David G. Stork Richard O.Duda,Second Edition,2000 . 5. Pattern Recognition, Sergios Theodoridis, Konstantinos Koutroumbas, Fourth Edition, Academic Press, 2008. 6. A First Course in Fuzzy Logic, Third Edition, Hung T. Nguyen, Elbert A. Walker, Taylor & Francis Group, LLC, 2008. 7. Introduction to Fuzzy Logic using MATLAB, S. N. Sivanandam, S.Sumathi, S. N. Deepa, Springer Verlag, 2007.

Prepared by: Prof. M. S. Deshmukh

BOS member:

BOS chairperson:

Elective I : Artificial Intelligence (ETPA11174B)

Teaching Scheme
Credits : 4
Lectures : 4 Hrs/week

Examination Scheme
F. A. : 50 Marks
S. A. : 50 Marks

Prerequisite : Optimization and basic programming skills

Course Objectives:

1. To learn various types of algorithms useful in Artificial Intelligence (AI).
2. To convey the ideas in AI research and programming language related to emerging Technology.
3. To understand the concepts of machine learning, probabilistic reasoning, robotics, computer vision, and natural language processing

Course Outcomes:

1. Design and implement key components of intelligent agents and expert systems.
2. To apply knowledge representation techniques and problem solving strategies to common AI applications.
3. Apply and integrate various artificial intelligence techniques in intelligent system development as well as understand the importance of maintaining intelligent systems
4. Build rule-based and other knowledge-intensive problem solvers

Unit I : Foundation

Intelligent Agents, Agents and environments, Good behavior, The nature of environments, structure of agents, Problem Solving, problem solving agents, example problems, Searching for solutions, uniformed search strategies, avoiding repeated states, searching with partial information.

Unit II : Searching

Search and exploration, Informed search strategies, heuristic function, local search algorithms and optimistic problems, local search in continuous spaces, online search agents and unknown environments, Constraint satisfaction problems (CSP), Backtracking search and Local search for CSP, Structure of problems, Games: Optimal decisions in games, Alpha- Beta Pruning, imperfect real-time decision, games that include an element of chance

Unit III : Knowledge Representation

First order logic, representation revisited, Syntax and semantics for first order logic, Using first order logic, Knowledge engineering in first order logic, Inference in First order logic, prepositional versus first order logic, unification and lifting, forward chaining, backward chaining, Resolution, Knowledge representation, Ontological Engineering, Categories and objects, Actions - Simulation and events, Mental events and mental objects

Unit IV : Learning

Learning from observations: forms of learning, Inductive learning, Learning decision trees, Ensemble learning, Knowledge in learning, Logical formulation of learning, Explanation based learning, Learning using relevant information, Inductive logic programming, Statistical learning methods, Learning with complete data, Learning with hidden variable, EM algorithm, Instance based learning, Neural networks - Reinforcement learning, Passive reinforcement learning, Active reinforcement learning, Generalization in reinforcement learning

Unit V : Perception and Expert System

Visual perception-Waltz's algorithm, Introduction to Expert System, Architecture and functionality, Example Expert system

Unit VI : Natural Language Understanding Why NL, Formal grammar for a fragment of English, Syntactic analysis, Augmented grammars, Semantic interpretation, Ambiguity and disambiguation, Discourse understanding, Grammar induction, Probabilistic language processing, Probabilistic language models	
Text Books : 1. Stuart Russell, Peter Norvig, "Artificial Intelligence", A Modern Approach, Pearson Education/Prentice Hall of India 2. Elaine Rich and Kevin Knight, "Artificial Intelligence", Tata McGraw-Hill.	
Reference Books : 1. Nils J. Nilsson, "Artificial Intelligence: A new Synthesis", Harcourt Asia Pvt. Ltd 2. George F. Luger, "Artificial Intelligence-Structures and Strategies for Complex Problem Solving", Pearson Education/ PHI	

Prepared by: Dr. S. V. Kulkarni

BOS member:

BOS chairperson:

Elective I : Estimation and Detection Theory (ETPA11174C)

Teaching Scheme
Credits : 4
Lectures : 4 Hrs/week

Examination Scheme
F. A. : 50 Marks
S. A. : 50 Marks

Prerequisite : Fundamentals of Probability

Course Objectives:

1. To make students understand linear models and their relationship with probability distributions
2. To make students aware of Computation of Cramer Rao Lower Bounds
3. To estimate parameters with multiple criteria: minimum variance, maximum likelihood, Bayesian assumptions
4. To make students learn to Detect multiple types of signals: deterministic signals, random signals, signals with unknown parameters

Course Outcomes:

At the end of the course, student will be able to

1. Acquire basics of statistical decision theory used for signal detection and estimation.
2. Examine the detection of deterministic and random signals using statistical models.
3. Examine the performance of signal parameters using optimal estimators.
4. Analyze signal estimation in discrete-time domain using filters.

Unit I : Statistical Decision Theory

Bayesian, minimax, and Neyman-Pearson decision rules, likelihood ratio, receiver operating characteristics, composite hypothesis testing, locally optimum tests, detector comparison techniques, asymptotic relative efficiency.

Unit II : Detection of Deterministic Signals

Matched filter detector and its performance; generalized matched filter; detection of sinusoid with unknown amplitude, phase, frequency and arrival time, linear model.

Random Signals

Estimator-correlator, linear model, general Gaussian detection, detection of Gaussian random signal with unknown parameters, weak signal detection.

Unit III : Detection of Random Signals

Estimator-correlator, linear model, general Gaussian detection, detection of Gaussian random signal with unknown parameters, weak signal detection.

Unit IV : Estimation of Signal Parameters

Minimum variance unbiased estimation, Fisher information matrix, Cramer-Rao bound, sufficient statistics, minimum statistics, complete statistics; linear models; best linear unbiased estimation; maximum likelihood estimation, invariance principle; estimation efficiency; Bayesian estimation: philosophy, nuisance parameters, risk functions, minimum mean square error estimation, maximum a posteriori estimation.

Unit V : Signal Estimation in Discrete-Time

Linear Bayesian estimation, Weiner filtering, dynamical signal model, Discrete Kalman filtering.

Unit VI : Applications of Estimation and Detection

Applications in various domains Viz. Control systems, Object tracking, non- linear prediction etc.

Text Books :

1. H. L. Van Trees, "Detection, Estimation and Modulation Theory: Part I, II, and III", John Wiley, NY, 1968.
2. S. M. Kay, "Fundamentals of Statistical Signal Processing: Estimation Theory", Prentice Hall PTR, 1993.

Reference Books :

1. S. M. Kay, "Fundamentals of Statistical Signal Processing: Detection Theory", Prentice Hall PTR, 1998.
2. Signal Detection and Estimation Second Edition by Mourad Barkat, Pearson education

Prepared by: Prof. A. V. Chitre

BOS member:

BOS chairperson:

Elective I : Advanced RISC and DSPs (ETPA11174D)

Teaching Scheme
Credits : 4
Lectures : 4 Hrs/week

Examination Scheme
F. A. : 50 Marks
S. A. : 50 Marks

Prerequisite : 1. Embedded Processors
2. Microcontroller Applications

Course Objectives:
1. To introduce with embedded systems and ARM architecture.
2. To develop understanding of hardware of ARM cortex processors
3. To introduce students Digital signal processors, its architecture and applications.

Course Outcomes:
At the end of the course, student will be able to:
1. Study ARM Processor based Embedded System design
2. Understand ARM 3 Processors and interfaces
3. Demonstrate hardware functionalities of DSP and design of algorithm and software for implementation of basic DSP operations.

Unit I : Introduction to Embedded systems and ARM CORTEX Processors
Definition and characteristics of embedded systems, Introduction to Embedded system design Life-Cycle Models, Design Metrics. Embedded System Development tools, Introduction to ARM, Power aware design, Introduction to Development Platform Trends (only introduce IDE, board Details and Application) Arduino, Beaglebone, Rasberry PI, Intel Galileo Gen 2,ARM CORTEX series features, Improvement over classical series, CORTEX A, R, M processors series, Features and applications, Survey of CORTEX based controllers from various manufacturers.

Unit II : ARM Cortex 3 processors - I
ARM-M3 Based Microcontroller LPC1768: Features, Architecture (Block Diagram & Its Description), System Control, Clock & Power Control, Pin Connect Block. CMSIS Standard, Bus Protocols: Ethernet, CAN, USB, Bluetooth

Unit III : ARM Cortex 3 processors - II
Compilers and Simulators for DSP and ARM Processors: Selection criteria of Digital Signal Processor, sampling and quantization, coder-decoder, overview of C compiler, Assembler, linker, simulator, emulator. Code composer studio, creating, and building of project, viewing memory and graphics, use of breakpoints. IDE for ARM processors.

Unit IV : DSP Architecture – I
Digital Signal Processor Architectures, hardware units as MAC unit, Barrel shifter, Address generators, pipelining, circular buffering.

Unit V : DSP Architecture – II
Memory configurations, peripherals and input/output, Fixed point and floating point formats and digital signal processors, Concept of Real Time Processing.

Unit VI : Architecture of TMS Processors
Architecture of TMS320C54XX and TMS320C6713, features, instruction sets, memory considerations, data types , addressing modes , various fields of application of the two processors.

Text Books :
1. Embedded Systems Architecture, Programming and Design Rajkamal
2. Joseph Yiu, "The definitive guide to ARM Cortex-M3", Elsevier, 2nd Edition.
3. Venkatramani B. and Bhaskar M. "Digital Signal Processors: Architecture, Programming and

Applications" –Second Edition TMH.

Reference Books :

1. Sloss Andrew N, Symes Dominic, Wright Chris, "ARM System Developer's Guide: Designing and Optimizing", Morgan Kaufman Publication.
2. NXP Semiconductor 1768 Microcontroller datasheet and User Manua
3. Lapsley P., Bier J., Shoham A., Lee E.A. "DSP Processor Fundamentals-Architecture and Features" (IEEE Press)
4. Technical references and user manuals on www.arm.com and Texas Instruments www.ti.com

Prepared by: Dr. S. V. Kulkarni

BOS member:

BOS chairperson:

Elective II : Mixed Signal Processing (ETPA11175A)

Teaching Scheme
Credits : 4
Lectures : 4 Hrs/week

Examination Scheme
F. A. : 50 Marks
S. A. : 50 Marks

Prerequisite : Analog CMOS Circuit Design

Course Objectives:

1. Addresses the data converter architectures suitable for mixed-signal applications.
2. Addresses continuous-time and discrete-time filters.
3. Addresses PLL and DLL circuits to generate clock.

Course Outcomes:

At the end of the course students will be able to

1. Understand the challenges in mixed signal design.
2. Analyze the requirements of mixed analog and digital designs.
3. Design basic building blocks of mixed signal applications
4. Identify the mixed signal building blocks for implementation of DSP algorithms

Unit I : DAC Architectures

Fundamentals of data converter, Sample and hold circuit, DAC and ADC specifications, DAC architectures: Resistor string, R/2R ladder, Current steering, Charge-scaling, Cyclic DAC, Pipeline DAC

Unit II : ADC Architectures

ADC architectures: Flash ADC, Pipeline ADC, Integrating ADC, Successive approximation ADC, and Oversampling ADCs

Unit III : Implementation of Data Converters

A Wide-Swing Current-Mode R-2R DAC, The Voltage-Mode DAC, Implementing ADCs: Implementing the S/H, The Cyclic ADC, The Pipeline ADC

Unit IV : Integrator-based CMOS Filters

Low-pass filters, Active-RC integrators, MOSFET-C integrators, Gm-C integrators, Filtering topologies: The bilinear transfer function, The biquadratic transfer function, Filters using noise shaping

Unit V : Switched Capacitor Filters

Basics of switched capacitor circuits, z-Domain models of switched capacitor circuits, First-Order and second-order switched capacitor circuits, Switched-capacitor filter architectures

Unit VI : Phase-Locked Loops

Simple PLL, Charge-Pump PLLs, Nonideal effects in PLL, Delay-Locked loops, Applications of PLL and DLL

Text Books :

1. R. Jacob Baker, "CMOS circuit design, layout and simulation" Third edition, IEEE press
2. R. Jacob Baker, "CMOS mixed-signal circuit design" IEEE press

Reference Books :

1. P. E. Allen and D. R. Holberg, "CMOS Analog Circuit Design" Oxford university press.
2. Behzad Razavi, "Design of Analog CMOS Integrated Circuits" Tata McGraw-Hill Higher Education

Prepared by: Prof. K. J. Raut

BOS member:

BOS chairperson:

Elective II : Joint Time Frequency Analysis (ETPA11175B)

Teaching Scheme	**Examination Scheme**
Credits : 4	F. A. : 50 Marks
Lectures : 4 Hrs/week	S. A. : 50 Marks

Prerequisite :

1. Basic transforms
2. Basics of digital filters

Course Objectives:

1. To provide students the basic foundation of vector spaces
2. To make students understand the essence of multiresolution analysis
3. To introduce students to different family of wavelets
4. T make students understand the different application areas of Joint time frequency analysis

Course Outcomes:

1. Understand the properties of various scaling functions and their wavelets.
2. Understand the properties of multiresolution analysis.
3. Construct the scaling functions using infinite product formula and iterative procedure.
4. Implement wavelets in various problems like image compression, denoising etc.

Unit I : Introduction

Review of Fourier Transform, Parseval Theorem and need for joint time-frequency Analysis. Concept of non-stationary signals, Short-time Fourier transform (STFT), Uncertainty Principle, Localization/Isolation in time and frequency, Hilbert Spaces, Banach Spaces, Fundamentals of Hilbert Transform.

Unit II : Bases for Time-Frequency Analysis

Wavelet Bases and filter Banks, Tilings of Wavelet Packet and Local Cosine Bases, Wavelet Transform, Real Wavelets, Analytic Wavelets, Discrete Wavelets, Instantaneous frequency, Quadratic time-frequency energy, Wavelet Frames, Dyadic wavelet Transform, Construction of Haar and Roof scaling function using dilation equation and graphical method.

Unit III : Multiresolution

Haar Multiresolution Analysis, MRA Axioms, Spanning Linear Subspaces, nested subspaces, Orthogonal Wavelets Bases, Scaling Functions, Conjugate Mirror Filters, Haar 2-band filter Banks, Study of up-samplers and down samplers, Conditions for alias cancellation and perfect reconstruction, Discrete wavelet transform and relationship with filter Banks, Frequency analysis of Haar 2-band filter banks, scaling and wavelet dilation equations in time and frequency domains, case study of decomposition and reconstruction of given signal using orthogonal framework of Haar 2-band filter bank.

Unit IV : Wavelets

Daubechies Wavelet Bases, Daubechies compactly supported family of wavelets, Daubechies filter coefficient calculations, Case study of Daub-4 filter design, Connection between Haar and Daub-4, Concept of Regularity, Vanishing moments. Other classes of wavelets like Shannon, Meyer, Battle-Lamarie.

Unit V : Bi-orthogonal wavelets and Applications

Construction and design. Case study of bi-orthogonal 5/3 taps design and its use in JPEG 2000. Wavelet Packet Trees, Time-frequency localization, compactly supported wavelet packets, case study of Walsh wavelet packet bases generated using Haar conjugate mirror filters till depth level 3. Lifting schemes for generating orthogonal bases of second-generation wavelets.

Unit VI : JTFA Applications

Riesz Bases, Scalograms, Time-Frequency distributions: fundamental ideas, Applications: Speech, audio, image and video compression; signal denoising, feature extraction, inverse problem.

Text Books :

1. S. Mallat, "A Wavelet Tour of Signal Processing," Academic Press, Second Edition, 1999.
2. L. Cohen, "Time-frequency analysis", Prentice Hall, 1995.

Reference Books :

1. G. Strang and T. Q. Nguyen, "Wavelets and Filter Banks", Wellesley-Cambridge Press, Revised Edition, 1998.
2. I. Daubechies, "Ten Lectures on Wavelets", SIAM, 1992.
3. P. P. Vaidyanathan, "Multirate Systems and Filter Banks", Prentice Hall, 1993.
4. M. Vetterli and J. Kovacevic, "Wavelets and Subband Coding", Prentice Hall, 1995 24

Prepared by: Prof. A. V. Chitre

BOS member:

BOS chairperson:

Elective II : Statistical Signal Processing (ETPA11175C)

Teaching Scheme
Credits : 4
Lectures : 4 Hrs/week

Examination Scheme
F. A. : 50 Marks
S. A. : 50 Marks

Prerequisite :

1. Digital Signal Processing
2. Linear Algebra & Random Processes

Course Objectives:

1. To build an understanding of signal modelling using different methods
2. To introduce Lattice structures and Linear Prediction.
3. To implement Wiener FIR filter for noise cancellation.

Course Outcomes:

Upon learning the course the student will be able to

1. Use appropriate methods for signal modeling.
2. Compute linear prediction coefficients in efficient manner.
3. Apply Wiener filter for noise cancellation.

Unit I : Random Signals and Processes

Review of deterministic signals, random signals ; mean, variance, correlation function; power spectra; DT random signals ; Time averages for DT random process, ergodicity, white noise, power spectrum, AR(p),MA(q) and ARMA(p,q)

Unit II : Signal Modeling using Least Squares Methods

Introduction, Least Square methods for signal modeling and its disadvantages, Innovation representation of random signals, Pade approximation, Prony's and Shank's Methods for signal Modeling.

Unit III : Lattice structures and Linear Prediction

Lattice filters, Linear Prediction, Normal Equations, Autocorrelation method, Levinson recursion, Covariance method, Burg's algorithm, Line spectral frequencies

Unit IV : Wiener Filtering

Introduction, FIR Wiener filter for filtering and linear prediction, Causal IIR Wiener filter, Noncausal IIR Wiener filter, Discrete Kalman filter

Unit V : Power Spectrum Estimation

Estimation of spectra from finite duration observation of signals; Estimation of autocorrelation and power spectrum of random signals; Non-parametric methods for power spectrum estimation – Periodogram method, modified periodogram method, Bartlett method, Welch method & Blackman-Tukey method.

Unit VI : Adaptive Filtering

Introduction, FIR adaptive filters, Steepest descent adaptive filter, LMS algorithm, Applications, RLS adaptive filters.

Text Books :

1. John G. Proakis, Dimitris G. Manolakis, "Digital Signal Processing: Principles, algorithms and applications" Fourth edition, Pearson Prentice Hall.
2. Monson Hayes, "Statistical Digital Signal Processing and Modeling", Wiley.

Reference Books :

1. Dimitris G. Manolakis, Vinay K. Ingle, Stephen M. Kogon, "Statistical and Adaptive Signal Processing", McGraw-Hill.
2. S. M. Kay, "Fundamentals of Statistical Signal Processing: Estimation Theory", Prentice Hall, 1993.

Prepared by: Prof. A. V. Bang

BOS member:

BOS chairperson:

Elective II : Biometrics (ETPA11175D)

Teaching Scheme
Credits : 4
Lectures : 4 Hrs/week

Examination Scheme
F. A. : 50 Marks
S. A. : 50 Marks

Prerequisite : Signal and Image Processing

Course Objectives:

1. Understand the need of biometrics, its types and different performance measures
2. Study physiological and behavioral biometrics, feature extraction and matching
3. Study limitation of unibiometric system, need and importance of multibiometric system, types of fusion carried out at different levels
4. Understand the human machine interface problems with respect to machine interface, case study and integrating various components of biometrics for various application.

Course Outcomes:

On completion of the course the student will be able to:

1. Analyze the characteristics of physiological and behavioral biometrics.
2. Integrating the different biometrics at different fusion level to form Multi-modal biometric system.
3. Design and analyze simple module of biometric based system.

Unit I : Biometric Fundamentals

Definition, Biometrics versus traditional techniques, Operation of Biometric system, Characteristics of biometrics, Key biometric processes: Verification - Identification-Biometric matching, performance measures in biometric systems, Assessing the privacy risks of biometrics, Different biometric standards, Application of Biometrics

Unit II : Physiological Biometrics - I

Introduction to various physiological biometrics like Facial scan, Ear scan, Retina scan, Iris scan, Finger scan, Automated fingerprint identification system in detail.

Unit III : Physiological Biometrics - II

Palm print, Hand geometry analysis, hand vascular pattern technology, dental identification.

Unit IV : Behavioral Biometrics - I

Signature scan, Keystroke scan, Voice scan, Gait recognition, Gesture recognition, Video face,
Mapping the body technology. Biometric User Interface and Applications:
Biometric interfaces: Human machine interface Human side interface: Iris scanner interface, Hand geometry and fingerprint sensor.

Unit V : Behavioral Biometrics - II

Machine side interface: Parallel port -Serial port-Network topologies, Case study: Palm Scanner interface. Categorizing biometric applications, Application areas: Criminal and citizen identification.

Unit VI : Introduction to Multibiometrics

Introduction and need of multi-biometric system, levels of fusion – sensor level fusion, feature level

fusion – feature normalization, score level fusion, Examples of multimodal biometric systems.
Text Books : 1. Anil K Jain, Patrick Flynn and Arun A Ross, "Handbook of Biometrics", Springer, USA, 2010. 2. Kenneth Revett, "Behavioral Biometrics – A Remote Access Approach", Wiley, 2008. 3. Arun A. Ross, Karthik Nandakumar, Anil K. Jain, "Handbook of Multibiometrics", Springer 2006
Reference Books : 1. Charles A. Shoniregun, Stephen Crosier, "Securing Biometrics Applications", Springer 2006. 2. Nalini K. Ratha, Venu Govindaraju, "Advances in Biometrics – sensors, Algorithms and Systems", Springer, USA 2008.

Prepared by: Dr. Y. H. Dandawate

BOS member:

BOS chairperson:

Seminar I (ETPA11176)

Teaching Scheme
Credits : 1
Practical : 2Hrs/week

Examination Scheme
F. A. (CE) : 50 Marks
S. A. (Oral) : 50 Marks

Objectives:
1. To enable the students to apply fundamental knowledge for understanding state of the art information about any topic relevant to curriculum
2. To make the students aware of ethical and professional practices
3. To enhance communication skills of the students
4. To study modern tools with an understanding of their limitations

Outcomes:
By the end of the course, the students will be able to
1. Write a detailed report about the topic in the prescribed format
2. Present the contents of the topic effectively through oral presentation

Seminar I shall be on any topic of student's own choice approved by the faculty. The oral examination will be based on the technical contents of the topic to assess understanding of the student about the same. Students should prepare a power point presentation for its delivery in 15 minutes. The student should submit duly certified spiral bound report having the following contents.

- Introduction
- Literature Survey
- Theoretical contents/fundamental topics
- Relevance to the present national and global scenario (if relevant)
- Merits and Demerits
- Field Applications / case studies / Experimental work / software application / Benefit cost/ feasibility studies
- Conclusions
- References

A. Report shall be typed on A4 size paper with line spacing 1.5 on one side of paper.
Left Margin : - 25 mm
Right Margin : - 25 mm
Top Margin : - 25 mm
Bottom Margin : - 25 mm
B. Size of Letters
Chapter Number: - 12 font size in Capital Bold Letters- Times New Roman
Chapter Name: - 12 Font size in Capital Bold Letters- Times New Roman
Main Titles (1.1, 3.4 etc):- 12 Font size in Bold Letters- Sentence case. Times New Roman
Sub Titles (1.1.4, 2.5.3 etc):- 12 Font size in Bold Letters-Sentence case. Times New Roman
All other matter: - 12 Font size sentence case. Times New Roman
C. No blank sheet be left in the report
D. Figure name: - 12 Font size in sentence case-Below the figure.
E. Table title -12 Font size in sentence case-Above the table.

Prepared by: Dr. S. V. Kulkani   BOS member: BOS chairperson:

Lab Practice I (ETPA11177)

Teaching Scheme	**Examination Scheme**
Credits : 4	F. A. (CE) : 50 Marks
Practical : 8 Hrs/week	S. A. (Oral) : 50 Marks

List of Experiments:

Note: First two sessions will be on hands-on practice on programming skills and exposure of software tools.

Advanced Digital Signal Processing (Practical):

1. Implement a single stage decimator/interpolator. Plot the spectrum at each stage of decimator/interpolator.
2. Implement LMS algorithm to remove noise from a signal.
3. Implement Levinson – Durbin algorithm to compute LPC.
4. Implement periodogram method to compute power spectrum.
5. Implement Welch method to compute power spectrum
6. Read a speech signal and compute its LPCs.

Image and Video Processing (Practical):

1. Implementation of filters: The case study consisting of application of nearly all kind of filters for enhancing of the image.
2. Implementation of Encoding and decoding scheme in JPEG image compression standard. The entropy coding step can be excluded. The performance of the JPEG with different quality factors should be analyzed.
3. A case study for measuring various parameters such as area, perimeter, shape of the objects in an image. This also includes counting the number of different objects in an image. The complete process involves edge detection for segmentation/segmentation using techniques like thresholding, region growing etc, morphological operations

Linear Algebra (Practical):

1. To solve simultaneous equations of 3 variables using matrices.
2. To find the Eigen values and Eigen vectors of a matrix.
3. To solve linear system by Cramer's rule.
4. To construct complex matrix (Fourier domain) and verify different properties (symmetry, orthogonality).
5. To implement power method for finding dominant eigen value of matrix
6. To implement Principal component analysis technique.
7. To find inverse of lower triangular matrix

Elective I: Soft Computing (Practical):

1. Implement a simple linear regressor with a single neuron model.
2. Implement and test MLP trained with back propagation algorithm.
3. Implement and test RBF or SOFM network for some application.
4. Implement FIS with Mamdani inferencing mechanism.

5. A small project: may include classification or regression problem, using any soft computing technique studied earlier.

Elective I: Artificial Intelligence (Practical):

1. Write a program to implement Tic-Tac-Toe game problem.
2. Write a program to implement BFS (for 8 puzzle problem or Water Jug problem or any AI search problem).
3. Write a program to implement DFS (for 8 puzzle problem or Water Jug problem or any AI search problem)
4. Write a program to implement Single Player Game (Using Heuristic Function).
5. Write a program to Implement A* Algorithm

Elective I: Estimation and Detection Theory (Practical):

1. Write a program to implement a matched filter to eliminate noise from a noisy signal.
2. Write a program to generate and plot the time series, histogram and estimated PDF for real white Gaussian noise. Compare the results with complex white Gaussian noise.
3. Write a program to generate white Gaussian noise of different sample lengths. Plot histograms of estimated variances, 95% confidence intervals, and confidence interval lengths and specify the percentage of times the true variance is within the confidence interval.
4. Write a program to generate Gaussian and exponential distributions of different sample lengths. Plot histograms of estimated variances, 95% confidence intervals, and confidence interval lengths and specify the percentage of times the true variance is within the confidence interval.

Elective I: Advanced RISC and DSPs (Practical):

1. Interfacing USB & CAN of LPC 1768.
2. One experiment based on any one of development Platform: Arduino, Beaglebon, Rasberry PI, Intel Galileo Gen 2
3. Write a program in C for Finite impulse response LPF or HPF or BPF filter and implement on TMS 320C XXX processor.
4. Interfacing of LCD with LPC 1768.

Prepared by:

1. Dr. Y. H. Dandawate
2. Dr. S. V. Kulkarni
3. Prof. A. V. Bang
4. Prof. A. V. Chitre
5. Prof. M. S. Deshmukh

BOS member:

BOS chairperson:

Semester - II

Computer Vision (ETPA12171)

Teaching Scheme
Credits : 4
Lectures : 4 Hrs/week

Examination Scheme
F. A. : 50 Marks
S. A. : 50 Marks

Prerequisite : 1. Digital Image Processing
2. Linear Algebra

Course Objectives:

1. To introduce students to Projections, Camera Models and Camera Calibration used for image formation. Computer Vision fundamentals, applications and challenges and complexities in Computer Vision Systems.
2. To introduce students to Stereo Imaging techniques, Multi-View geometry and 3D reconstruction algorithms.
3. To study the techniques and algorithms used for Object tracking in Videos.
4. To introduce Object recognition techniques.
5. To develop and test basic Computer Vision algorithms in MATLAB.

Course Outcomes:

By the end of the course, students will able to

1. Develop understanding of image formation and working of camera as image sensor.
2. Understand need and procedure of camera calibration
3. have knowledge of stereo imaging, its applications and challenges
4. conceptualize and understand computer vision algorithms for motion tracking
5. develope understanding of infrared imaging
6. to select and calibrate camera based on the application requirements.
7. to work with real time 3D problems based on the understanding of stereo vision techniques and algorithms.
8. to apply Object tracking and Recognition techniques in real life applications like Surveillance Security and industry.

Unit I : Introduction to Computer Vision and Image Formation
Purpose, state of the art Applications , Challenges in computer vision, CMOS CCD image sensors, Projective Geometry, Camera parameters, Camera Calibration Digital camera, Bayers pattern.

Unit II : Stereo Imaging
Concept, triangulation, Correspondence, Epipolar geometry, rectification, RANSAC algorithm, dynamic programming. 3D reconstruction.

Unit III : Motion and Objective tracking
Basics of motion, corner detector, optical flow by Lucas Kanade and Horn and Shunk, mean shift tracking, Kalman filter, Object Tracking, condensation. Scale Invariant Feature Transform

Unit IV : Range Imaging
Infrared and thermal imaging, Principle and applications. Different types of range camera such as TOF, interferometry. High dynamic range imaging, Introduction to ifm OD200 3-D Camera.

Unit V : Image stitching
Image registration, techniques, panorama creation, Motion models, Global alignment, Compositing. Introduction to image based rendering.

Unit VI : Computational photography

Photometric calibration, High dynamic range imaging, Super-resolution and blur removal, Image matting and compositing, Texture analysis and synthesis

Text Books :

1. Richard Szeliski, Computer vision algorithms and applications, springer
2. Mubarak Shah, Fundamentals of Computer Vision, Online book
3. Emanuele Trucco, Alessandro Verri, "Introductory Techniques for 3-D Computer Vision", Prentice Hall, 1998
4. Ballard and Brown. "Computer Vision." Prentice Hall.

Reference Books :

1. Linda Shapiro and George Stockman: Computer Vision, Prentice Hall
2. Forsyth and Ponce, Computer Vision: A Modern Approach, Prentice Hall

Prepared by: Dr. Y. H. Dandawate

BOS member:

BOS chairperson:

Biomedical Signal Processing (ETPA12172)

Teaching Scheme
Credits : 4
Lectures : 4 Hrs/week

Examination Scheme
F. A. : 50 Marks
S. A. : 50 Marks

Prerequisite : Digital signal processing

Course Objectives:

1. To introduce students to various bio signals and methods of acquiring them.
2. To introduce students to model the biomedical systems and will be able to analyze bio signals captured under different conditions.
3. To introduce students to implement the compression techniques of bio medical signals for storage and data transfer purpose and different classification techniques.
4. To make students understand various sources of distortions in biomedical signals and its remedial techniques.

Course Outcomes:

1. The students will be acquainted to various bio signals and methods of capturing them.
2. They will be able to model the biomedical systems and will be able to analyze ECG signals captured under different conditions.
3. The student will be able to implement the compression techniques of bio medical signals for storage and data transfer purpose and different classification techniques.
4. The student will be able to implement various image processing algorithms and techniques for MRI and FMRI images.
5. The student will be able to understand various sources of distortions in biomedical signals and its remedial techniques.

Unit I: Introduction to bio-medical signals and their acquisition

Origin of bio-signal, action potential, nerve and muscle cells and their electrical activity, electrical activity of the heart, genesis of ECG, ECG lead systems, electrical activity of the brain, EEG signal and its acquisition, EMG signals and its acquisition. Sources of contamination and variation of bio-signals.

Unit II : Analog signal processing of bio-signals

Overview of biomedical instrumentation systems, Requirements of biomedical instrument design. biomedical sensors, electrodes and their characteristics, instrumentation amplifier, isolation amplifier, active filters(commonly used topologies), ADCs, aliasing effect, anti-aliasing filters, grounding, shielding, bonding and EMI filters: Principles and types of grounding, shielding and bonding with reference to Biomedical equipment. Introduction of analog front ends available in market.

Unit III : Digital Signal processing of bio-signals

Review of FIR, IIR Filters, Weiner filters, adaptive filters. Model-based spectral analysis, AR, Eigen analysis, spectral analysis, Time-frequency methods: Spectrogram, Wigner-Ville and other methods, Principal Component Analysis, Independent Component Analysis, Transformed component analysis. Application of Continuous Wavelet Transform and Discrete Wavelet transform for biomedical signal analysis.

Unit IV : ECG signal analysis

Electrocardiogram: Signal analysis of event related potentials, morphological analysis of ECG waves, Envelope extraction and analysis of activity, application- Normal and Ectopic ECG beats, Phonocardiography. Classification of signals.

Unit V : Diagnostic Biomedical Imaging Types of Medical Images, Process of image acquisition, Issues in image acquisition. Types of Medical imaging viz: CT, PET, and SPECT, MRI, Functional MRI, ultrasonic diagnostic imaging. Fan Beam Geometry, Radon Transform, Inverse Radon Transform: Parallel Beam Geometry.
Unit VI : Soft computing approaches for biomedical signal classification Concept of AUC, ROC, Confidence Interval, Performance parameters, Binary / Multi-class classifier Artificial Neural networks, (Multilayer perceptron, Radial basis function networks) as classifiers.
Text Books : 1. Eugene N. Bruce, Biomedical Signal Processing and Signal Modelling, John Wiley & Sons,2000 2. Rangaraj M. Rangayyan, Biomedical Signal Analysis A case study approach, John Wiley & Sons, 2002. 3. Rangaraj M. Rangayyan, Biomedical Image Analysis, , CRC Press, 2005
Reference Books : 1. Jaakko Malmivuo & Robert Plonsey, Bioelectromagnetism - Principles and Applications of Bioelectric and Biomagnetic Fields, Oxford University Press, New York, 1995. 2. John L Semmlow ,Signals and Systems for Bioengineers, Second Edition: A MATLAB-Based Introduction, Academic Press, 2011 3. John L Semmlow, Biosignal and Biomedical Image Processing MATLAB-Based Applications-Second Edition, Marcel Dekker, Inc, 2008

Prepared by: Dr. R. S. Talware

BOS member:

BOS chairperson:

Research Methodology (ETPA12173)

Teaching Scheme
Credits : 4
Lectures : 4 Hrs/week

Examination Scheme
F. A. : 50 Marks
S. A. : 50 Marks

Prerequisite : Statistical Signal Processing

Course Objectives:

1. To acquaint the student with the research problem & its scope, objectives, and errors.
2. To make the student understand the basic instrumentation schemes & data collection methods.
3. To make the student understand various statistical techniques.
4. To make student analyze, model and predict the performance of experimental system.
5. To acquaint the student to develop the research proposals.

Course Outcomes:

By the end of the course, students will able to

1. The student will learn research problem & its scope, objectives, and errors.
2. The student will learn the basic instrumentation schemes & data collection methods.
3. The student will study the various statistical techniques.
4. The students will study modeling and predict the performance of experimental system.
5. The student will learn to develop the research proposals.

Unit I : Research Problem

Meaning of research problem, Sources of research problem, Criteria / Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem.

Unit II : Statistical tests and measures

Correlation, Pearson correlation, Spearman correlation, Chi-square test, Paired T-test, Independent T-test, ANOVA analysis, ROC curve, Precision-Recall (PR) measure.

Unit III : Applied statistics

Regression analysis, Parameter estimation, Multivariate statistics, Principal component analysis, K-means clustering, Moments and response curve methods, State vector machines and uncertainty analysis

Unit IV : Modelling and prediction analysis

Modelling and prediction of performance. Setting up a computing model to predict performance of experimental system, Multiscale modelling and verifying performance of process system,

Unit V : Nonlinear analysis

Nonlinear analysis of system and asymptotic analysis, Verifying if assumptions hold true for a given apparatus setup, Plotting family of performance curves to study trends and tendencies, Sensitivity theory and applications.

Unit VI : Developing a Research Proposal

Format of research proposal, Individual research proposal, Institutional proposal. Proposal of a student – a presentation and assessment by a review committee consisting of Guide and external expert only. Other faculty members may attend and give suggestions relevant to topic of research.

Text Books :

1. Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science & engineering students", Juta Academic, 1996.
2. Wayne Goddard and Stuart Melville, "Research Methodology: An Introduction", New Age

International.

Reference Books :

1. Ranjit Kumar, "Research Methodology: A Step by Step Guide for Beginners", SAGE Publication, 2nd Edition.
2. C. R. Kothari and Gaurav Garg, "Research Methodology: Methods and Techniques", New Age International.
3. S. D. Sharma, "Operational Research", Kedar Nath, Ram Nath & co.

Prepared by: Prof. S. S. Joshi

BOS member:

BOS chairperson:

Elective III : Speech Signal Processing (ETPA12174A)

Teaching Scheme
Credits : 4
Lectures : 4 Hrs/week

Examination Scheme
F. A. : 50 Marks
S. A. : 50 Marks

Prerequisite :

1. Signals and Systems
2. Digital Signal Processing

Course Objectives:

1. To understand the basic concepts of speech processing techniques.
2. To understand various speech coding and enhancement techniques.
3. To get familiar with various applications of speech processing

Course Outcomes:

Upon learning the course the student will be able to

1. Apply signal processing concepts for extracting features of speech signal.
2. Use various algorithms for speech coding and enhancement
3. Understand various applications of speech processing.

Unit I : Speech Production, Acoustic Phonetics and speech processing

Introduction, Anotomy and Physiology of speech organs, Articulatory phonetic, Acoustic Phonetics, Acoustic theory of speech production, LTI and LTV model, coarticulation, prosody. Time-domain processing of speech: Short-time energy, pitch estimation using autocorrelation and AMDF, formant estimation, voiced/unvoiced classification. Frequency domain analysis: Short time analysis of speech, narrow and broad band spectrogram, cepstral domain analysis, mfcc, Homomorphic processing of speech signal, pitch detection and formant extraction.

Unit II : Linear Predictive coding of Speech

Basic principles of linear predictive analysis: Autocorrelation and covariance method, Solution of LPC equation: Cholesky decomposition solution for covariance method and Durban's recursive solution for Autocorrelation equations. Applications of LPC parameters: Pitch detection, Formant analysis LPC Vocoders, voiced excited LPC Vocoders

Unit III : Cepstrum

cepstral domain analysis, Homomorphic processing of speech signal, pitch detection and formant extraction, MFCC, Perceptual linear prediction

Unit IV : Speech Coding

Introduction: Quantization: Quantization error, SNR, Non-uniform quantization, Measures to evaluate speech quality, Time domain waveform coding, spectral coders, Vocoders: Phase, channel, homomorphic, vector quantization coders.

Unit V : Speech enhancement

Introduction, Nature of interfering signals, Speech enhancement techniques: spectral subtraction and filtering, harmonic filtering filtering and adaptive noise cancellation.

Unit VI : Applications of Speech processing

Speech recognition, speech synthesis, speaker recognition and verification: Basic principles, specific features and state of the art systems. Fundamentals of Template matching, Pattern classification, statistical methods like DTW,GMM, HMM

Text Books :

1. L. R. Rabiner and R. W. Schaffer, "Digital Processing of Speech signals", Pearson.
2. S.D. Apte, "Speech and Audio processing", Wiley India

Reference Books :

1. Ben Gold and Nelson Morgan, "Speech and Audio Signal Processing: Processing and Perception of Speech and Music", John Wiley, 2002.
2. Douglas O'Shaughnessy, " Speech communication: Human and Machine, Universities Press
3. Thomas F. Quatieri, "Discrete-time Speech Signal Processing: Principles and Practice", Pearson Education Asia, 2003

Prepared by: Prof. A. V. Bang

BOS member:

BOS chairperson:

Elective III : Pattern Recognition (ETPA12174B)

Teaching Scheme
Credits : 4
Lectures : 4 Hrs/week

Examination Scheme
F. A. : 50 Marks
S. A. : 50 Marks

Prerequisite : Statistics and Probability

Course Objectives:

1. Study the fundamental algorithms for pattern recognition.
2. To instigate the various classification techniques.
3. To originate the various structural pattern recognition and feature extraction techniques.
4. To study unsupervised classification techniques.

Course Outcomes:

By the end of the course, students will able to

1. Understand and apply various algorithms for pattern recognition.
2. Realize the Classification / clustering concepts and algorithms.
3. Bring out Statistical pattern recognition and feature extraction techniques

Unit I : Pattern Recognition Overview

Machine perception, Pattern recognition, Classification and Description, Patterns and feature Extraction with Example, Training and Learning in PR systems - Pattern recognition Approaches, Learning and Adaptation.

Unit II : Bayesian Decision Theory

Introduction, Bayesian Decision Theory; Continuous Features, Minimum error rate, classification, classifiers, discriminant functions, and decision surfaces; The normal density; Discriminant functions for the normal density. Maximum-likelihood estimation; Bayesian Estimation; Bayesian parameter estimation, Gaussian Case, general theory; Hidden Markov Models.

Unit III : Non-parametric Techniques

Introduction; Density Estimation; Parzen windows; kn – Nearest- Neighbor Estimation; The Nearest-Neighbor Rule; Metrics and Nearest-Neighbor Classification.

Unit IV : Classification

The least mean square classifier, Fisher's discriminant Classification using a Mahalanobis and other distance functions, Discriminant function and the maximum, Likelihood discriminant, Bayes minimum error rate and inimum risk discriminant, Multi-Category Classification: LMS approximation, LDA and other Approaches, Nearest neighbor, Classifier performance, Non-linear kernel methods, Non-linear regression.

Unit V : Feature Extraction and Selection

Entropy minimization, Karhunen - Loeve transformation, Feature selection through functions approximation, Binary feature selection

Unit VI : Recent Advances
Neural network structures for pattern recognition, Neural network based pattern associators, Unsupervised learning in neural pattern recognition, Self-organizing networks, Fuzzy logic, Fuzzy pattern classifiers, Pattern classification using Genetic Algorithms.

Text Books :

1. Robert J. Schalkoff, "Pattern Recognition: Statistical, Structural and Neural Approaches", John Wiley & Sons Inc., New York, 2007.
2. Tou and Gonzales, "Pattern Recognition Principles", Wesley Publication Company, London, 1974.

Reference Books :

1. Duda R.O., and Hart. P. E., "Pattern Classification and Scene Analysis", Wiley, New York, 1973.
2. R O Duda, P E Hart, D G Stock, "Pattern Classification", John Wiley and Sons, Second edition, 2001.

Prepared by: Dr. Y. H. Dandawate

BOS member:

BOS chairperson:

Elective III : Acoustic Signal Processing (ETPA12174C)

Teaching Scheme
Credits : 4
Lectures : 4 Hrs/week

Examination Scheme
F. A. : 50 Marks
S. A. : 50 Marks

Prerequisite :
1. Signals and Systems.
2. Digital Signal Processing

Course Objectives:
1. To understand the basic concepts of acoustic engineering.
2. To get familiar with acoustic echo and noise cancellation.
3. To get familiar with various applications of acoustic engineering.

Course Outcomes:
Upon learning the course the student will be able to
1. Understand basics of acoustic engineering.
2. Use various algorithms for acoustic echo and noise control.
3. Understand various applications of acoustic engineering..

Unit I : Basic of Acoustic Engineering
Echo and Reverberation, Acoustic wave, Transmission radiation and reflection, Room Acoustics, Room Transfer Function, Environmental Acoustics, Architectural acoustics, Transduction. Transfer function of acoustic pipe.

Unit II : Auditory System and Hearing
Anatomy, Physiology and Function of the Auditory System, Physiological Measures of Auditory Function, Auditory Processing Models, Speech Intelligibility and Signal Processing in Hearing Aids.

Unit III : Acoustic Echo and Noise Control
Human Perception of Echoes, Network Echo Problem, Acoustic Echo Problem, Adaptive Filters for Echo Cancellation, The LMS and NLMS Algorithms for Noise Reduction. Affine Projection algorithm, Fast Affine Projection Algorithm (FAP). Sub band Acoustic Echo Cancellation using FAP. Single Channel and Multichannel.

Unit IV : Fundamentals of Underwater Acoustics
Ocean Acoustic environment, measuring sound level, sources and receivers, sound velocity in sea water. Sound propagation in ocean, sound attenuation in sea water, Bottom loss, surface bottom and volume scattering. Snell's Law.

Unit V : Characteristics of Sonar systems
Sonar systems, active and passive sonar systems, transducers and their directives, Sensor array characteristics, receiving directivity index, beam patterns, shading and super directivity.

Unit VI : Applications
Acoustics Echo Noise Cancellation, Adaptive Beam Forming for acoustic noise cancellation, Materials and Architectures of acoustics Underwater and Oceanographic Acoustics: - Propagation and Signal Modeling, inverse Problems in Underwater Acoustics, Active and passive sonar.

Text Books :
1. Lawrance E Kinseler, "Fundamental of Acoustic", Wiley 4th Edition.
2. E. Hansler and G. Schmidt, "Topics in Acoustic Echo and Noise Control", Springer
3. L. M. Brekhovskikh and Yu. P. Lysanov, "Fundamental of Ocean Acoustics", Springer
4. Richard O. Nielsen, "Sonar Signal Processing", Artech House Publishers

Reference Books :

1. Steven L. Gay, Jacob Benesty. "Acoustic Signal Processing for Telecommunication", Springer.
2. Havelock David, Kuwano Sonoko, Vorländer Michael, "Handbook of Signal Processing in Acoustics", Springer 2008.

Prepared by: Prof. A. V. Bang

BOS member:

BOS chairperson:

Elective III : Signal Processing for Industrial Systems (ETPA12174D)

Teaching Scheme
Credits : 4
Lectures : 4 Hrs/week

Examination Scheme
F. A. : 50 Marks
S. A. : 50 Marks

Prerequisite :
1. Power Electronics
2. Control and Instrumentation

Course Objectives:
1. To learn the nature of different types of signals in the industrial systems.
2. To understand different sensors and transducers for the signal sensing in different applications.
3. To understand electronic hardware systems for processing and control.
4. To apply signal processing for different industrial applications.
5. To learn signal processing for Smart cities and Smart Grids application.

Course Outcomes:
By the end of the course, students will able to
1. Understand the nature of signals in a particular industrial application.
2. Select sensors, transducers and processing hardware for a particular industrial application.
3. Select proper signal processing tools and methods for a particular application.
4. Design, build, and test hardware and software for a particular application.
5. Design an EMI/RFI compatible system.

Unit I : Nature of signals in Industrial systems
Signals in power electronic converters, Machine vibrations, Audio signals generated from machines, machine control parameters, like torque, speed, pressure, force, velocity, acceleration, audio signals from cracks and rusting in civil structures. Generating signatures of signals for different applications.

Unit II : Sensors and Transducers
Sensors and transducers for different physical parameters, initial signal conditioning
Hardware, isolating the signal, generating digital form of the signal.

Unit III : DSP Processors
DSP processors, architecture, interfacing the conditioned signals, speed, resolution,
Accuracy issues, Developing programs for signal processing and generating analog outputs.

Unit IV : Mechanical Vibrations
Basic sources of signals, frequency bandwidths, detection sensors, measurement systems, measurement limitations, anechoic chambers, Analysis.

Unit V : Power Electronic Converters
Voltages and currents in controlled converters, Motor currents in 1Φ and 3Φ systems,
For Induction, Synchronous PMSM, BLDC and switched reluctance motors. Torque pulsations,

Unit VI : Diagnostic analysis and applications
Fault signal analysis and predictions, Failure predictions using artificial Intelligence tools like ANN , Fuzzy logic, Motion control , EMI/EMC standards, Smart Power Grids and protection relays.
Applications in electric vehicles.

Text Books : 1. Hammit Taliyat, "DSP-based Electromechanical Motion Control," CRC press. 2. Ned Mohan, Tore Undeland and William Robbins, "Power Electronics: Converters, Applications & Design," Wiley India
Reference Books: G. Liptak, "Instrument Engineers' Handbook, Volume Two: Process Control and Optimization," CRC press.

Prepared by: Prof. V. M. Aranake

BOS member:

BOS chairperson:

Elective IV : VLSI Architectures for DSP (ETPA12175A)

Teaching Scheme	**Examination Scheme**
Credits : 4	F. A. : 50 Marks
Lectures : 4 Hrs/week	S. A. : 50 Marks

Prerequisite :

1. Digital Logic Design
2. Digital Signal Processing

Course Objectives:

1. Addresses the methodologies needed for designing custom or semi-custom VLSI circuits for some typical signal processing applications.
2. Addresses how to map DSP algorithms into VLSI efficiently.
3. Addresses transformation techniques for architecture optimization.

Course Outcomes:

By the end of the course, students will able to

1. Have knowledge of various optimization algorithms.
2. Understand need of optimization of VLSI architectures.
3. Have knowledge of various transformation techniques to optimize DSP architectures.

Unit I : Pipeline and Parallel Architectures

DSP application demands and scaled CMOS technology, Representation of DSP algorithms, Loop bound and iteration bound, Pipelining and parallel processing of FIR filters, Pipelining and parallel processing for low power

Unit II : Transformation Techniques

Retiming: Properties of retiming, retiming techniques, Unfolding: properties and applications of unfolding, An algorithm for unfolding, Folding: Folding algorithm, Register minimization techniques

Unit III : Digital Lattice Filter Structures

Schur algorithm, Digital basic lattice filters, Derivation of one-multiplier lattice filter, Round off noise calculation in lattice filters, Pipelining of lattice IIR filters, Design examples of pipelined lattice filters, Low-power CMOS lattice IIR filters

Unit IV : Bit-level Arithmetic Architectures

Parallel multipliers, Baugh Wooley carry save multiplier, Booth Wallace Tree multipliers, Bit-serial multipliers, Bit-serial filter design, Canonic signed digit arithmetic, Distributed arithmetic

Unit V : Programmable DSPs, Video and Media DSPs

Introduction, Architecture overview, Real-time processing, Media MPU, Video DSP and Media Processors, Comparison of architectures

Unit VI : Case Studies

T-RISC stack microprocessors, LISA wavelet processor design, Nios based FFT design

Text Books :

1. Keshab Parhi, "VLSI Digital Signal Processing Systems, Design and Implementation" John-

Wiley & sons. 2. U. Meyer-Baese, "Digital Signal Processing with Field Programmable Gate Arrays", third edition, Springer.
Reference Books : Keshab Parhi and Takao Nishitani, "Digital Signal Processing for Multimedia Systems" Marcel Dekker Inc.

Prepared by: Prof. K. J. Raut

BOS member:

BOS chairperson:

Elective IV : Still Image and Video Compression (ETPA12175B)

Teaching Scheme	**Examination Scheme**
Credits : 4	F. A. : 50 Marks
Lectures : 4 Hrs/week	S. A. : 50 Marks

Prerequisite : Digital Image Processing

Course Objectives:

1. To introduce students to various techniques such as Wavelets, DCT etc used for compressing Still Image and Videos.
2. To introduce students to widely used Image and Video standards like JPEG2000, MPEG, H.264.
3. To develop ability to select proper algorithm/ modify if required to suit specific application.

Course Outcomes:

By the end of the course, students will able to

1. Understand overview of compression standards like JPEG 2000, MPEG1, MPEG2
2. Gain knowledge of features of various compression standards.
3. Develop ability to choose compression standard for the given application.
4. Understand techniques used in data compression.

Unit I : Image Compression using Vector Quantization

Introduction, Advantages of Vector Quantization over Scalar Quantization, The Linde-Buzo-Gray Algorithm, Tree-Structured Vector Quantizers, Structured Vector Quantizers, Variations on the Theme, Concept of Fractals and compression using fractals.

Unit II : Wavelet based Image Compression

Introduction, Wavelets, Multiresolution Analysis and the Scaling Function, Implementation Using Filters, Image Compression, Embedded Zerotree Coder, Set Partitioning in Hierarchical Trees, JPEG 2000 compression standard- Preprocessor, Core encoder, Post processing, ROI encoding, scalability

Unit III : Video Compression basics

Analog and digital video, Temporal Redundancy, Motion estimation, Video Signal Representation

Unit IV : Video Compression Standards – I

MPEG1-Video structure, Group of Pictures, Picture slice, Macro- block and block, Motion estimation, Coding of I, P, B and D type pictures, Video Buffer, MPEG2- Difference between MPEG1 and MPEG2, scalability feature, applications.

Unit V : Video Compression Standards – II

MPEG4- Video object plane, shape coding, H.263 and H.264- Video coding for low bit rates, motion vector coding, coefficient coding, protection against error. Overview of MPEG-7 and MPEG -21

Unit VI : Audio Coding

Introduction , Spectral Masking, Temporal Masking, Psychoacoustic Model, MPEG Audio Coding, Layer II Coding, Layer III Coding—mp3, Dolby AC3 (Dolby Digital)

Text Books :

1. Sayood, Khalid. "Introduction to data compression". Newnes, 2012.

2. Joshi, M. A., Raval, M. S., Dandawate, Y. H., Joshi, K. R., & Metkar, S. P. (2014). "Image and Video Compression: Fundamentals, Techniques, and Applications, CRC Press.

Reference Books :

1. Mohammed Ghanbari, Standard Codecs: Image Compression to Advanced Video Coding", IEE publication.
2. V. Bhaskaran and K. Konstantinides, "Image video compression standards: algorithms and architecture," Kluwer Academic Publishers
3. Joan Mitchell "MPEG and Video compression standard" Springer
4. Iain E. G. Richardson "H.264 and MPEG-4 Video Compression" Wiley publication

Prepared by: Dr. Y. H. Dandawate

BOS member:

BOS chairperson:

Elective IV : Optimization Techniques (ETPA12175C)

Teaching Scheme	**Examination Scheme**
Credits : 4	F. A. : 50 Marks
Lectures : 4 Hrs/week	S. A. : 50 Marks

Prerequisite :

1. Mathematics – I
2. Mathematics – II
3. Mathematics – III

Course Objectives:

1. To introduce students to optimization techniques and basic concepts of Linear programming
2. To equip the students to advance Linear Programming techniques.
3. To impart the knowledge of Non Linear Programming through unconstrained optimization techniques.
4. To make students aware of dynamic programming.
5. To impart the knowledge of different Stochastic Methods of optimization.
6. To expose students to benefits of game theory and to furnish them to solve the water resources

Course Outcomes:

By the end of the course, students would be able to

1. Well conversant with optimization techniques and its components.
2. Implement LPP with all its variants.
3. Use of NLP like constrained and unconstrained optimization.
4. Use of Dynamic Programming for problems related to project investment.
5. Implement sequencing, queuing theory and simulation to stochastic problems.
6. Use the fundamental of game theory to optimize the practical problem.

Unit I : Linear Programming I

Introduction to Optimization techniques, Linear programming basic concepts, graphical method, Simplex method, Big M Method, Two phase method, Duality, sensitivity analysis.

Unit II : Linear Programming II

Application of Linear Programming in electronics engineering, Transportation Model and its variants, Assignment Model and its variants.

Unit III : Non Linear Programming

Unconstrained one Dimensional search methods: Dichotomous search method, Fibonacci, Golden section, Multivariable unconstrained techniques: Steepest ascent and Descent methods, Newton's methods, Constrained technique: Lagrangian Multiplier.

Unit IV : Dynamic Programming

Multi stage decision processes, Principle of optimality, recursive equation, Applications of D.P.

Unit V : Stochastic Methods

Sequencing– n jobs through 2, 3 and M machines, Queuing Theory: elements of Queuing system and its operating characteristics, waiting time and ideal time costs, Kendall's notation, classification of Queuing models, single chanel Queuing theory: Model I (Single channel Poisson Arrival with exponential services times, Infinite population Simulation: Monte Carlo Simulation

Unit VI : Games Theory
Theory of games, 2 person zero sum game with and without saddle point, mixed strategies (2 x n games or m x 2 games), 2 x 3 game with no dominance, graphical method.

Text Books :

1. Premkumar Gupta and D. S. Hira, "Operations Research", S. Chand publication
2. Premkumar Gupta and D. S. Hira, "Problems in Opeartions Research", S.Chand publication

Reference Books :

1. S. S. Rao, "Engineering Optimazation : Theory and Practice", Wiley.
2. Taha Hamdey A. "Operation Research : An Introduction", Prentice Hall
3. Harvey M. Wagner, "Principles of Operation Research", Prentice Hall.

Prepared by: Dr. S. N. Londhe

BOS member:

BOS chairperson:

Elective IV : Satellite and Radar Signal Processing (ETPA12175D)

Teaching Scheme	**Examination Scheme**
Credits : 4	F. A. : 50 Marks
Lectures : 4 Hrs/week	S. A. : 50 Marks

Prerequisite : Radar Engineering, Wave Propagation, Satellite Communication

Course Objectives:

1. Understand the basic principle of operation of radar and classification of radars
2. Derive the expression for radar range equation
3. Understand basic detection of radar signals in noise
4. Understand the different types of receivers to detect the signal in noise
5. Understand types of differential GPS systems and applications of signal processing in remote sensing.

Course Outcomes:

By the end of the course, students will able to

1. Know the operation of CW, FM-CW, MTI and Pulse Doppler radar
2. Describe the range ambiguities and various system losses
3. Know parameters of radar receivers like noise figure, noise temperature
4. Design matched filter to detect the signals in noise environment
5. Derive the ambiguity function
6. Design the different types pulse compression coded waveforms
7. Know types of differential GPS systems and applications of signal processing in remote sensing.

Unit I : Introduction to RADAR System

History and application of radar, basic radar function, elements of pulsed radar, review of signal processing concepts and operations, A preview of basic radar signal processing,
radar system components, advanced radar signal processing

Unit II : Radar Signal Models

Components Of Radar Signals, Amplitude models, types of clutters, noise model and signal to noise ratio, frequency models, the doppler shift, spatial models, spectral model

Unit III : Sampling and Quantization of Pulsed RADAR Signals

Domains and criteria for sampling radar signals, Sampling in the fast time dimension, Sampling in slow time: selecting the pulse repetition interval, sampling the doppler spectrum, Sampling in the spatial and angle dimension, Quantization, I/Q Imbalance and Digital I/Q.

Unit IV : Navigation, Tracking and Safety Systems

Global Navigation Satellite Systems, Basic concepts of GPS, Space segment, Control segment, user segment, GPS constellation, GPS measurement characteristics, selective availability (AS), Anti spoofing (AS). Applications of Satellite and GPS for 3D position, Velocity, determination as function of time, Interdisciplinary applications. Regional Navigation Systems, Distress and Safety, Cospas, Sarsat, Inmarsat Distress System, Location-Based service.

Unit V : Inertial Navigation and Differential GPS Systems

Introduction to Inertial Navigation, Inertial Sensors, Navigation Coordinates, System Implementations, System-Level Error Models, Introduction to Differential GPS, LADGPSWADGPS, WAAS, GEO Uplink Subsystem (GUS), GEO Uplink Subsystem (GUS) Clock Steering Algorithms, GEO Orbit Determination, Problems

Unit VI : Remote Sensing Systems and Techniques
Introduction, Commercial Imaging, Digital Globe, Geo Eye, Meteorology, Meteosat, Land Observation Landsat, Remote Sensing Data, Sensors, Overview, Optical Sensors: Cameras, Non-Optical Sensors, Image Processing, Image Interpretation, System Characteristics.

Text Books :

1. Fundamentals of Radar Signal Processing, Mark A. Richards McGraw-Hill, New York, 2005
2. Radar systems, Peak Detection and Tracking, Michael O Kolawole, 2010, Elsevier
3. Introduction to Radar Systems 3/E, Skolnik, McGraw Hill.
4. Satellite systems for personal Applications, Madhavendra Richharia, A John Wiley and Sons, Ltd., Publication.
5. Dennis Roddy, 'Satellite Communication', McGraw Hill International, 4th Edition, 2006.
6. Wilbur L. Pritchard, Hendri G. Suyderhoud, Robert A. Nelson, 'Satellite Communication Systems Engineering', Prentice Hall/Pearson, 2007

Reference Books :

1. Principles of Radar and Sonar Signal Processing, Francois Le Chevalier, Artech House
2. Radar Principles, Peyton Z. Peebles, 2009 Wiley India
3. Radar Design Principles-Signal Processing and the environment, Fred E. Nathanson, PHI
4. Global Positioning Systems, Inertial Navigation, and Integration. MOHINDER S. GREWAL California State University at Fullerton, A John Wiley & Sons, Inc. Publication.

Prepared by: Prof. R. G. Purandare

BOS member:

BOS chairperson:

Seminar II (ETPA12176)

Teaching Scheme	**Examination Scheme**
Credits : 1	F. A. (CE) : 50 Marks
Practical : 2Hrs/week	S. A. (Oral) : 50 Marks

Objectives:

1. To enable the students to apply fundamental knowledge for understanding state of the art information about any topic relevant to curriculum.
2. To make the students aware of ethical and professional practices.
3. To enhance communication skills of the students.
4. To study modern tools with an understanding of their limitations.

Outcomes:

By the end of the course, the students will be able to

1. Write a detailed report about the topic in the prescribed format.
2. Present the contents of the topic effectively through oral presentation.

Seminar II shall be on the topic in continuation with that for Seminar I. The oral examination will be based on the technical contents of the topic to assess understanding of the student about the same. Students should prepare a power point presentation for its delivery in 15 minutes. The student should submit duly certified spiral bound report having the following contents.

- Introduction
- Literature Survey
- Theoretical contents/fundamental topics
- Relevance to the present national and global scenario (if relevant)
- Merits and Demerits
- Field Applications / case studies / Experimental work / software application / Benefit cost/ feasibility studies
- Conclusions
- References

A) Report shall be typed on A4 size paper with line spacing 1.5 on one side of paper.
Left Margin : - 25 mm
Right Margin : - 25 mm
Top Margin : - 25 mm
Bottom Margin : - 25 mm

B) Size of Letters
Chapter Number: - 12 font size in Capital Bold Letters- Times New Roman
Chapter Name: - 12 Font size in Capital Bold Letters- Times New Roman
Main Titles (1.1, 3.4 etc):- 12 Font size in Bold Letters- Sentence case. Times New Roman
Sub Titles (1.1.4, 2.5.3 etc):- 12 Font size in Bold Letters-Sentence case. Times New Roman
All other matter: - 12 Font size sentence case. Times New Roman

C) No blank sheet be left in the report

D) Figure name: - 12 Font size in sentence case-Below the figure.

E) Table title -12 Font size in sentence case-Above the table.

Prepared by: Dr. S. V. Kulkani BOS member: BOS chairperson:

Intellectual Property Rights (ETPA12175)

Teaching Scheme
Credits : 1
Lectures : 1 Hrs/week

Examination Scheme
F. A. (CE) : 50 Marks

Course Objectives:

1. To create awareness amongst the students for the Intellectual Property rights
2. To be able to know the domain of Commercialization of Intellectual Property Rights

Course Outcomes:

1. Students will be able to have awareness for the Intellectual Property rights
2. Students will know domain of Commercialization of Intellectual Property Rights

Unit I : Concept of Property vis-à-vis Intellectual Property

Concept of Property and Theories of Property - An Overview, Theories of Intellectual Property Rights, Intellectual Property as an Instrument of Development , Need for Protecting Intellectual Property-Policy Consideration

Unit II : Types of Intellectual Property:

Origin and Development- An Overview, Intellectual Property Rights as Human Right. - National Perspectives and International demands.

Unit III : Indian Patent Law

The Patents Act, 1970, Amendments to the Patents Act, Patentable Subject Matter, Patentability Criteria, Procedure for Filing Patent Applications, Patent Granting Procedure, Revocation, Patent Infringement and Remedies.

Unit IV : Commercialization of Intellectual Property Rights

Commercialization of Intellectual Property Rights by Licensing, Determining Financial Value of Intellectual Property Rights, Negotiating Payments Terms in Intellectual Property Transaction, Intellectual Property Rights in the Cyber World

Text Books :

Intellectual Property Rights-Infringement And Remedies Hardcover –Ananath Padmanabhan

Reference Books :

Intellectual Property Rights by Thomas G. Field Jr. et al. - U.S. Department of State, 2006

Prepared by: Dr. S. V. Kulkarni

BOS member: BOS chairperson:

Lab Practice II (ETPA12178)

Teaching Scheme
Credits : 3
Practicals : 6 Hrs/week

Examination Scheme
F. A. (CE) : 50 Marks
S. A. (Oral) : 50 Marks

List of Experiments:

Computer vision (Practical)
(MATLAB/ JAVA platform)

1. Implementation of basic transformations like translation, rotation and scaling in 2-D. This should be implemented using matrix transformation in MATLAB and not with direct functions. Optional: Other affine transformation like shearing etc

2. Study of the camera calibration toolbox and calibration of your own camera from the toolbox

3. Depth map estimation in stereo vision using block matching/ sub pixel estimation and dynamic programming

4. Face recognition using Eigen faces. A case study

Biomedical Signal Processing (Practical)

1. To acquire/ plot different bio signals with characterization of these signals using platforms like Matlab / Python. Explore different file formats used for bio-medical signals / images.

2. To study different imaging techniques with underlying principles and comparative analysis based on performance parameter and suitability of use for different detection.

3. Implement different noise removal and diffusion techniques on bio signals / medical images. Comparison of noise removal techniques.

4. Design and simulation of instrumentation amplifier, analog filter (LPF,HPF,BPF and notch topologies) (use of Multisim/ ORCAD PSpice/ Proteus or any SPICE based simulation program)

5. Study of digitized ECG signal (readily available at http://physionet.org). Observe spectrum and time domain characteristics like peak amplitudes, identify fiducial points (P,Q,R,S,T,U) (usage of MATLAB expected)

6. Design and implement a multi-class classifier (either using ANN or statistical classifier) for any one type of the signal or image.

   a. ECG / EEG/EMG signals

   b. CT / MRI / X-ray images

Research Methodology (Practical)

1. Design a typical research problem using scientific method

2. Design a data collection system using digital computer system.

3. Study the various analysis techniques.
4. Design and develop a computing model to predict the performance of experimental system.
5. Develop the following research proposal

Prepared by:

1. Dr. Y. H. Dandawate
2. Dr. R. S. Talware
3. Prof. S. S. Joshi

BOS member:

BOS chairperson: