FACULTY OF ENGINEERING

Savitribai Phule Pune University

Syllabus for the

M.E (Electronics & Telecommunications Engineering –Signal Processing)

(2017 Course)

(w.e.f. June 2017)

M.E.(Electronics and Telecommunications- Signal Processing)

2017 Pattern

Syllabus Structure

First Year – Semester I

Sr.No.	Subject Code	Subject	Examination Scheme				Total		Credits
				Paper					
			L/P	ISA	ESA	TW	OR		
1	504401	Mathematics for Signal Processing	4	50	50	-	-	100	4
2	504402	Digital Image and Video Processing	4	50	50	-	-	100	4
3	504403	Advanced Digital Signal Processing	4	50	50	-	-	100	4
4	504404	Research Methodology	4	50	50	-	-	100	4
5	504405	Elective I	5	50	50	-	-	100	5
6	504406	Lab. Practice I	4	-	-	50	50	100	4
		Total	**25**	**250**	**250**	**50**	**50**	**600**	**25**

Elective I:

1) Advanced RISC and Digital Signal Processors
2) Mixed Signal Processing
3) Estimation and Detection Theory
4) Joint Time Frequency Analysis

First Year – Semester II

Sr.No.	Subject Code	Subject	Examination Scheme				Total		Credits
				Paper					
			L/P	ISA	ESA	TW	OR		
1	504407	Biomedical Signal Processing	4	50	50	-	-	100	4
2	504408	Speech Processing	4	50	50	-	-	100	4
3	504409	Computer Vision	4	50	50	-	-	100	4
4	504410	Elective II	5	50	50	-	-	100	5
5	504411	Lab. Practice II	4	--	---	50	50	100	4
6	504412	Seminar I	4	-	-	50	50	100	4
		Total	**25**	**200**	**200**	**100**	**100**	**600**	**25**

Elective II:

1) Soft Computing
2) Pattern Recognition
3) Architectures in Signal Processing
4) Biometrics

Second Year – Semester I

Sr. No.	Subject Code	Subject	Examination Scheme					Total	Credits
				Paper					
			L/P	ISA	ESA	TW	OR		
1	604401	Statistical Signal Processing	4	50	50	-	-	100	4
2	604402	Still Image and Video Compression	4	50	50	-	-	100	4
3	604403	Elective III*	5	50	50	-	-	100	5
4	604404	Seminar II	4	--	----	50	50	100	4
5	604405	Project Stage I	8	--	---	50	50	100	8
		Total	**25**	**150**	**150**	**100**	**100**	**500**	**25**

*****Elective III will be combination of subjects with 3 credits and 2 credits

Elective with 3 credits

1) Value Education, Human rights and Legislative procedures
2) Environmental studies
3) Renewable Energy Studies
4) Disaster Management
5) Knowledge Management
6) Foreign Language
7) Economics for engineers
8) Engineering risk – Benefit and analysis

Elective with 2 credits

1) Optimization techniques
2) Fuzzy Mathematics
3) Design and Analysis of algorithms
4) CUDA

Second Year – Semester II

Sr.No.	Subject Code	Subject	Examination Scheme				Total		Credits
				Paper					
			L/P	ISA	ESA	TW	OR		
4	604406	Seminar III	5	--	----	50	50	100	5
5	604407	Project Stage II	20	--	---	150	50	200	20
		Total	**25**		**--**	**200**	**100**	**300**	**25**

<u>Semester I</u>

504401 Mathematics for Signal Processing

Credits: 4

Teaching Scheme:

Lectures : 4 hr/week

Examination Scheme:

In-Sem : 50 Marks
End-Sem : 50 Marks

Course Objectives:

- To provide students with a good understanding of the concepts and methods of linear algebra
- To help the students develop the ability to solve problems using linear algebra.
- To provide students with a good understanding of the concepts of probability domain
- To develop understanding of random processes and spectral analysis

Course Outcomes:

On completion of the course, student will be able to
1). Solve systems of linear equations using multiple methods
2) Demonstrate understanding of the concepts of vector space and subspace.
3) Demonstrate application of probability to real life phenomenon.
4)Determine different statistical parameters of given distributions.

Course Contents

Module I : Vector Spaces (7 Hrs)

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.

Module II : Solutions Of Linear System, Eigen Values and orthogonality(14 Hrs)

Homogeneous and Nonhomogeneous systems, Gaussian elimination, Null Space and Range, Rank and nullity, Consistency conditions in terms of rank, Row Reduced Form,

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

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

Module III : Random variables and Random Processes (8 Hrs)

Definition of random variables, continuous and discrete random variables, cumulative distribution function (cdf) for discrete and continuous random variables; probability mass function (pmf), probability density functions (pdf) and properties, Transformation of Random variables, statistical parameters of random variable

Expectation: mean, variance and moments of a joint random variable, Joint moments, conditional expectation; covariance and correlation; independent, uncorrelated and orthogonal random variables, Central limit theorem, chebyshev inequality, Some standard distributions

Module IV : Random Process (6 Hrs)

Random process: realizations, discrete and continuous time processes, examples

Stationarity: strict-sense stationary (SSS) and wide-sense stationary (WSS) processes Autocorrelation function of a real WSS process and its properties, cross-correlation function, Ergodicity and its importance

Linear time-invariant system with a WSS process as an input: stationarity of the output, auto-correlation and power-spectral density of the output.

References :

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

2. Peebles Jr. P.Z., “Probability Random Variables and Random Signal Principles”, Tata McGraw-Hill Publishers, Fourth Edition, New Delhi, 2002.(For units 3, 4 and 5).

3. H. Stark and J.W. Woods, “Probability and Random Processes with Applications to Signal Processing”, Pearson Education (Asia), 3rd Edition, 2002.

4. S.Andrill&E.Hecker,Elemenrtary -Linear Algebra-Else Verinc 2003

5. K.Hoffman&R.Kunze,Linear Algebra-PHI,1996.

6 . Leon-Garcia,A, “Probability and Random Processes for Electrical Engineering”, Pearson Education Asia, Second Edition, 2007

7. A. Papoulis, ‘Probability, Random Variables, and Stochastic Processes’, 4th ed

List of Practicals

1.To solve simultaneous equations of 3 variables using matrices.

2. To find the Eigen values and Eigen vectors of a matrix.

3. To plot PDFs of different standard distributions and calculate their statistical parameters.

4. Write a matlabprogram verify central limit theorem using different distributions.

5.To Calculate mean value and plot autocorrelation function of output LTI system for given input random process.

504402 **Image and Video Processing**

Credits: 4

Teaching Scheme: **Examination Scheme:**

Lectures : 04Hr/week **In-Sem : 50 Marks**
End-Sem : 50 Marks

Course Objectives:

- To understand mathematical skills in analyzing and solving problems in image and video processing: Basic 2-D signal processing, 2-D Fourier and other transforms, convolution and filtering operations in 2-D.
- Basic understanding of the need for effective use of scarce resources such as storage and bandwidth, and ways to provide effective use of them by data compression; social impacts and applications of object recognition systems, such as in security, entertainment and automation fields.
- Learn to design and integrate components of image processing systems to satisfy given requirements: Selecting the design parameters for optimal performance of related image processing systems; designing and integrating enhancement and restoration techniques for different applications; object segmentation and recognition algorithms.
- To use the software based simulation and design tools necessary for practical image processing applications : Design and implementation of enhancement, restoration, coding, and transformation algorithms for image and video data.

Course Outcomes:

On completion of the course, student will be able to

1)Analyze and solve problems in image enhancement, compression and segmentation
2) Design and integrate image processing components to satisfy given requirement of a application.
3) Use software simulation and design tool for practical image processing

Course Contents

Module I : Image representation and Image Transforms **(10Hrs)**

Gray scale and colour Images, image sampling and quantization. Fundamentals of color image processing. Color models - RGB, CMY, YIQ, HIS, Pseudo – coloring.

Two dimensional orthogonal transforms: DFT, WHT, Haar transform, KLT, DCT and Wavelet Transform.

Module II : Image Enhancement and Image Restoration **(10Hrs)**

Image Enhancement – Point and Mask processing of images, filters in spatial and frequency domains, histogram-based processing, homomorphic filtering. Edge detection , LOG filters. Pseudo coloring.**Image Restoration**: Degradation Models, PSF, circulant and block - circulant matrices, deconvolution, restoration using inverse filtering, Wiener filtering and maximum entropy-based methods

Module III : Image Compression and Segmentation (12Hrs)

Fundamental concepts of image compression - Compression models - Information theoretic perspective – Fundamental coding theorem. Lossless Compression: Huffman Coding- Arithmetic coding - Bit plane coding - Run length coding. Lossy compression: Transform coding - Image compression standards.

Image Segmentation: Pixel classification, Bi-level thresholding, Multi-level thresholding, P-tile method, Adaptive thresholding, Spectral & spatial classification, Edge detection, Hough transform, Region growing and region merging. Morphological operators. Boundary Extraction, Boundary representation, Region representation, Moment representation, Structure, Shape features, Texture feature.

Module IV : Video Processing **(8Hrs)**

Fundamental Concepts in Video – Types of video signals, Analog video, Digital video, Color models in video, Motion Estimation; Video Filtering; Video Compression, Video coding standards.

References :

1. Gonzalez and Woods, "Digital Image Processing", Pearson Education,

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

3. A. K. Jain, Fundamentals of digital image processing, Prentice Hall of India, 1989.

4. Pratt William K. "Digital Image Processing", John Wiley & sons

5. A. M. Tekalp, Digital Video Processing , Prentice-Hall, 1995

List of Practical's :

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
4. Extraction of frames from video, improve the quality and convert them back to compressed video.

504403 Advanced Digital Signal Processing

Credits:4

Teaching Scheme: **Examination Scheme:**

Lectures : 4hrs/week

In-Sem : 50 Marks
End-Sem : 50 Marks

Course Objectives:

- To build an understanding of Multirate DSP.
- To introduce the concept of Adaptive filters.
- To build an understanding of various processor architectures and implementation of DSP algorithms

Course Outcomes:

On completion of the course, student will be able to

1) apply the concept of Multirate Signal Processing.
2) use Adaptive filtering for real life applications.
3) to implement DSP algorithms on digital signal processors.

Course Contents

Module I : Overview of DSP (8 Hrs)

Discrete Fourier Transform, FIR filters, design techniques of linear phase FIR filters using frequency sampling method, IIR filters by bilinear transformation.

Module II :Multi rate DSP and Adaptive filters(12 Hrs)

Decimation, Interpolation, Sampling rate conversion by a non-integer factor, Multistage decimator, polyphase structure, applications of Multirate DSP.

Need of adaptive filters, adaptive filters as system identification, Wiener Hopf Equation, LMS adaptive algorithms, configuration of adaptive filters, recursive least square algorithms, adaptive telephone echo cancellation, Adaptive filtering of ocular artifacts from the human EEG.

Module III : Random signals and Processes (8 Hrs)

Review of deterministic signals, Characterization of Random Signals and Processes, Time averages and Ensemble averages, (mean, variance, correlation) Wide sense stationary and Ergodic processes.

Module IV : DSP processors(10Hrs)

DSP Architectures: Von Neumann Architecture, Harvard Architecture, Super Harvard Architecture, VLIW Architecture, Fixed and Floating point DSPs, Multiple access memory, multiport memory, circular buffering, MC unit, Barrel shifter, Booth‟s multiplication algorithm, VLSI architecture-Parallel processing and pipelining, Implementation of FIR, IIR filters, Decimation, interpolation algorithm.

References:

1. John G. Proakis, Oimitris G. Manolakis-Digital Signal Processing-Principles, algorithms & applications, PHI, 1997.
2. E. C. Ifleachor and B. W. Jervis, "Digital Signal Processing- A Practical Approach", 2nd Edition, Pearson education.
3. Avtar Singh, S. Srinivasan, "Digital Signal Processing Implementation using DSP, Microprocessors with examples from TMS 320C54XX", Thomas Publication.
4. S.K. Mitra - Digital Signal Processing- TMH, 1998.
5. Proakis-Advanced Digital Signal Processing Macmillan publishing company, 1992.

List of Experiments

1. To decimate/interpolate a signal.
2. To implement LMS algorithm for adaptive filtering.
3. To convert Direct form to Lattice Coefficients.
4. To implement FIR filter on TMS 320C54XX or equivalent DSP processor.

504404 **Research Methodology**

Credits:4

Teaching Scheme:
Lectures: 4 Hrs/Week

Examination Scheme:
Theory: 50 Marks (In Semester)
50 Marks (End Semester)

The Objectives of this course are:-

- Create research process and basic instrumentation schemes.
- Analyze the statistics of defined problem.
- Calculate performance analysis for modeling and prediction.
- Develop research proposal process.

Course Outcomes:

On completion of the course, student will be 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.

Module I :

Definition, Research Characteristics, Research Need, Objectives and types of research: Motivation and objectives – Research methods vs. Methodology, Types of research – Descriptive vs. Analytical, Applied vs. Fundamental, Quantitative vs. Qualitative, Conceptual vs. Empirical.

Module II :

Research Formulation – Defining and formulating the research problem -Selecting the problem - Necessity of defining the problem - Importance of literature review in defining a problem – Literature review – Primary and secondary sources – reviews, treatise, monographs-patents – web as a source – searching the web - Critical literature review – Identifying gap areas from literature review - Development of working hypothesis. Summarizing a Technical Paper - Summary Template Online tools - Google, CiteSeer, ACM Digital Library, IEEE, The on-line Computer Science Bibliography, Searching patents

Module III :

Research design, sampling design and scaling techniques – Research design – Basic PrinciplesNeed of research design –– Features of good design – Important concepts relating to research design, basic principles of experimental designs, implications of sample design, steps in sample design, criteria for selecting sampling procedure, characteristics of good sampling design, different types of sample design. Scaling techniques: measurement scales, sources of error, the technique of developing measurement tool, important scaling techniques, scale construction techniques.

Data Collection and Analysis:- Observation and Collection of primary and secondary data - Methods of data collection, processing operations, types of analysis, statistics in research, measures of central tendency, measures of dispersion, measures of asymmetry, measures of relationships, simple regression analysis, multiple correlation and regression, partial correlation.

Module IV:

Reporting and thesis writing – Structure and components of scientific reports - Types of report – Technical reports and thesis – Significance – Different steps in the preparation – Layout, Structure and Language of typical reports – Illustrations and tables - Bibliography, referencing and footnotes - Oral presentation – Planning – Preparation –Practice – Making presentation – Use of visual aids - Importance of effective communication - Documentation and presentation tools: LATEX

Types of technical papers - Journal papers, Conference papers, Survey Papers, Poster papers, Review papers Comparison, Structure of a survey, conference and journal paper, Organization and flow of Thesis/ Project Report, Research proposal: preparation, budgeting, presentation, funding agencies for engineering research, Intellectual property rights and patent law – Trade Related Aspects of Intellectual Property Rights

References

1. Kothari, C.R., Research Methodology: Methods and Techniques. New Age International
2. Garg, B.L., Kapadia, R., Agarwal, F. and Agarwal, U.K., An Introduction to Research Methodology, RBSA Publishers
3. Suresh Sinha, Anil K Dhiman, Research Methodology, ESS Publications, Volumes 2
4. Day R.A., How to Write and Publish a Scientific Paper, Cambridge University Press
5. Wadehra, B.L. Law relating to Patents, Trade Marks, Copyright designs and geographical indications. Universal Law Publishing

List of Experiments:

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. LaTeX /Document Structure, Document classes, Packages, The document environment, Book structure

504405 Advanced RISC and Digital Signal Processors (Elective I)

Credits: 4

Teaching Scheme:

Lectures : 4 Hrs/week +
1 Hr/week for Software Tools

Examination Scheme:

In-Sem : 50 Marks
End-Sem : 50 Marks

Course Objectives:

- To Introduce with embedded systems and ARM architecture.
- To develop understanding of hardware of ARM cortex processors
- To introduce students Digital signal processors, its architecture and applications.

Course Outcomes:
On completion 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.

Course Contents

Module I : Introduction to Embedded systems and ARM CORTEX Processors (8 Hrs)

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,

Module II : ARM Cortex 3 processors (10Hrs)
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
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, building of project, viewing memory and graphics, use of breakpoints. IDE for ARM processors.

Module III : DSP Architecture (10Hrs)
Digital Signal Processor Architectures, hardware units as MAC unit, Barrel shifter, Address generators, pipelining, circular buffering, memory configurations, peripherals and input/output, Fixed point and floating point formats and digital signal processors, Concept of Real Time Processing.

Module IV : Architecture of TMS Processors **(8 Hrs)**

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

References :

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.

4.Sloss Andrew N, Symes Dominic, Wright Chris, "ARM System Developer's Guide:Designing and Optimizing", Morgan Kaufman Publication.

5. NXP Semiconductor 1768 Microcontroller datasheet and User Manua

6. Lapsley P., Bier J., Shoham A., Lee E.A. "DSP Processor Fundamentals-Architecture and Features" (IEEE Press)

7. Technical references and user manuals on www.arm.com and Texas Instruments www.ti.com

List of Practical's

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.

504405 Mixed-Signal Processing(Elective I)

Credits: 4

Teaching Scheme:	**Examination Scheme:**	
Lectures : 4 Hrs/week +	**In-Sem**	**: 50 Marks**
1 Hr/week for Software Tools	**End-Sem**	**: 50 Marks**

Course Objectives:

- To learn how to design CMOS digital to analog and analog to digital converters.
- To learn effect of noise and optimization of it in data converters.
- To learn how to analyze and design switched-capacitor circuits.
- To learn working and applications of PLLs and DLL for frequency synthesis.

Course Outcomes:

On completion of the course, student will be able to

1) design data conversion circuits with minimizing switching and phase noise, and jitter.

2) understand concept of switched capacitor circuits.

3) analyze and design switched capacitor circuits like amplifiers, integrators, and filters

4) understand concept, working, and applications of PLLs and DLL.

Course Contents

Module I : D/A Converter Architectures (8 Hrs)

Digital to analog converter specifications, DAC architectures: Cyclic DAC, Pipeline DAC, R-2R ladder DAC, Charge-scaling DAC

Module II :A/D Converter Architectures (10 Hrs)

Analog to digital converter specifications, Sample-and-Hold (S/H) Characteristics, ADC architectures: Flash ADC, Pipeline ADC, Integrating ADCs, Successive Approximation ADC, Oversampling ADC

ModuleIII : Data Converter SNR (12Hrs)

Data Converter SNR: An Overview, Improving SNR using Averaging, Decimating Filters for ADCs, Interpolating Filters for DACs, Using Feedback to Improve SNR
Phase-Locked Loops :
Simple PLL, Charge-pump PLLs, Nonideal effects in PLL, Delay-locked loops, Applications of PLL

ModuleIV: Switched-Capacitor Circuits (10 Hrs)

Switched capacitor amplifiers, Switched capacitor integrators, First and second order switched capacitor circuits

References :

1. R. Jacob Baker, "CMOS: Circuit Design, Layout, and Simulation," 3rd Edition, Wiley-IEEE press.
2. R. Jacob Baker, "CMOS: Mixed-Signal Circuit Design," 2nd Edition, Wiley-IEEE press.
3. P. E. Allen and D. R. Holberg, "CMOS Analog Circuit Design," International student edition/Indian edition, Oxford University press.
4. BehzadRazavi, "Design of Analog CMOS Integrated Circuits," TMH edition.
5. BehzadRazavi, "Principles of data conversion system design," Wiley IEEE Press.
6. Tony Carusone, David Johns, and Kenneth Martin, "Analog Integrated Circuit Design," Wiley student edition, Wiley.

List of Practical's

1. Write SPICE code for 8-bit ideal ADC. Simulate and comment on the results.

2. Write SPICE code for 8-bit ideal DAC. Simulate and comment on the results.

3. Find the SNR, SNDR, SFDR of practical DAC and ADC for some given reference voltages, sampling frequencies and input voltages. Comment on the results.

504405 Estimation and Detection Theory (Elective I)

Credits: 4

Teaching Scheme:	Examination Scheme:	
Lectures : 4hrs/week +	**In-Sem**	**: 50 Marks**
1 Hr/week for Software Tools	**End-Sem**	**: 50 Marks**

Course Objectives:

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

Course Outcomes:

On completion 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.

Course Contents

Module I: Statistical Decision Theory (8 Hrs)

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

Module II : Detection of deterministic Signals: (8Hrs)

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

Module III : Detection of Random Signals (8Hrs)

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

Module IV: Estimation of Signal Parameters: (12Hrs)

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

References :

1.S. M. Kay, "Fundamentals of Statistical Signal Processing: Estimation Theory", Prentice Hall PTR, 1993.

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

3. H. L. Van Trees, "Detection, Estimation and Modulation Theory: Part I, II, and III", John Wiley, NY, 1968.

4 .Signal Detection and Estimation Second Edition by Mourad Barkat, Pearson education

List of Practicals

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.

504405 Joint Time Frequency Analysis (Elective I)

Credits:4

Teaching Scheme:	**Examination Scheme:**	
Lectures : 4 hrs/week + 1 Hr/week for Software Tools	**In-Sem**	**: 50 Marks**
	End-Sem	**: 50 Marks**

Course Objectives:

- To provide students the basic foundation of vector spaces
- To make students understand the essence of multi resolution analysis
- To introduce students to different family of wavelets
- To make students understand the different application areas of Joint time frequency analysis

Course Outcomes:

On completion of the course, student will be able to

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.

Course Contents

Module I : Introduction (8 Hrs)

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, Fundamentals of Hilbert Transform.

Module II : Bases for Time-Frequency Analysis (8Hrs)

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.

Module III : Multiresolution Analysis **(10 Hrs)**

HaarMultiresolution Analysis, MRA Axioms, Spanning Linear Subspaces, nested subspaces, Orthogonal Wavelets Bases, Scaling Functions, Conjugate Mirror Filters, Haar 2-band filter Banks, Study of upsamplers and downsamplers, 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.

Module IV : Wavelets **(10 Hrs)**

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

Construction and design. Case study of bi-orthogonal 5/3 tap 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.
Applications of wavelets in audio, speech ,image and video processing.

References :

1. S. Mallat, "A Wavelet Tour of Signal Processing," Academic Press, Second Edition, 1999.
2. L. Cohen, “Time-frequency analysis”, Prentice Hall, 1995.
3. G. Strang and T. Q. Nguyen, "Wavelets and Filter Banks", Wellesley-Cambridge Press, Revised Edition, 1998.
4.. I. Daubechies, "Ten Lectures on Wavelets", SIAM, 1992.
5. P. P. Vaidyanathan, "Multirate Systems and Filter Banks", Prentice Hall, 1993.
6. M. Vetterli and J. Kovacevic, "Wavelets and Subband Coding", Prentice Hall, 1995

504405 **Software Tools (Elective I)**

Credits:1

Teaching Scheme:

Lectures: 1Hrs/Week

Introduction to software tools such as Octave, MATLAB, SCILAB, LAB VIEW, RTLinux, VxWorks, µCOS-II, Tiny OS, ANDROID, Xilinx, Microwind, Tanner, TCAD Tools, CAD Feko, IE-3D, Phython, OpenCV.

*For each Subject under Elective I the student Shall study open source/evaluation versions of at least one software tools mentioned above and should present term paper.

504406 **Lab Practice I**

Credits:4

Teaching Scheme:
Practical's : 4 Hrs/Week

Examination Scheme:
Theory: 50 Marks (TW)
50 Marks (OR)

Lab Practice I: The laboratory work will be based on completion of minimum two assignments/experiments confined to the courses of the semester.

SEMESTER II

504407 Biomedical Signal Processing

Credits: 4

Teaching Scheme: **Examination Scheme:**

Lectures : 4 hr/week **In-Sem : 50 Marks**
End-Sem : 50 Marks

Course Objectives:

- To learn bio signal and bio-images.
- To understand use of signal processing in medical application.

Course Outcomes:

On completion of the course, student will be able to

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 various image processing algorithms and techniques for MRI images.

4) The student will be able to understand various sources of distortions in biomedical signals and its remedial techniques.

Course Contents

Module I : (8 Hrs)

General Physiology: Cell, Cell junction, basic cell function, electrical activity of the cell.

Introduction of biomedical signals: Origin of bio-signal, action potential, Different biotransducers.

Cardiovascular system : Heart structure , cardiac cycle, Electrical activity of the heart , electrical activity of the brain ,genesis of ECG, ECG lead system , EEG,PCG.

Module II : Diagnostic Biomedical Imaging: (8 Hrs)

Types of Medical Images, ultrasound, X-ray, CT, PET, and SPECT, MRI, Functional MRI, ultrasonic diagnostic imaging.

Sources of contamination and variation of biomedical signals.

Analog Signal processing of bio-signals: Bioelectric Amplifier, Biomedical instrumentation systems, Instrumentation amplifier, Isolation amplifier, Active filters, Aliasing effect, Anti-aliasing filters.

Module III : D igital Signal processing of bio-signals:(10 Hrs)

AR, Eigen analysis spectral analysis, Time-frequency methods: Spectrogram, Wigner-Ville and other methods, Principal Component Analysis, Independent Component Analysis. Radon Transform, Inverse Radon Transform

Module IV : Modelling of biomedical Systems : (10 Hrs)

Point processes-parametric system modelling-All pole, pole zero modelling, electromechanical models of signal generation, Analysis of nonstationary signals, Noise Characteristics, Noise reduction by Ensemble Averaging and Linear Filtering,Spectral Analysis of Heart Rate Variability Characterisation- Fixed segmentation-short time fourier transform-Adaptive segmentation- adaptive filters for segmentation- RLS and Lattice filter .

References :

1. MetinAkay, “Biomedical Signal Processing”, Academic press, Inc.
2. , E.N. Bruce, “Biomedical Signal Processing & Signal Modeling,” Wiley Publications
3. D. C. Reddy ,.“ Biomedical Signal Processing Principles and Techniques”, Tata McGraw-Hill,2005.
4. John L., Semmlow, “Bio-signal and Biomedical Image Processing”, Marcel Deccar Publications ,2004.

List of Practicals :

1.To write a program to extract the fiducial points from the ECG signal.Analyze the results using suitable mother wavelet.

2.To write a program to eliminate the various artifacts present in the biosignal.Assume a suitable biosignal or image.Study the effect of following transforms on thesignal
a)STFT b)Wignerville distribution

3. Design and implement ECG acquisition system .Use a suitable SIMULATION software and implement it.

4.Study of various bioimaging techniques

504408 **Speech Processing**

Credits:4

Teaching Scheme: **Examination Scheme:**

Lectures : 4hrs/week **In-Sem : 50 Marks**

End-Sem : 50 Marks

Course Objectives:

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

Course Outcomes:

On completion of the course, 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.

Course Contents

Module I : Basics of Speech (8 Hrs)

Mechanism of Speech Production, Acoustic Phonetics, LTI model, LTV model, voiced and unvoiced decision making, speech parameters, pitch and formants, pitch frequency measurement using AMDF, autocorrelation, Parallel processing approachand using spectral domain. STFT, Spectrogram.

Module II :Linear Prediction Coefficients (8Hrs)

Forward linear prediction, autocorrelation method, Levinson Durbin algorithm, relation between formants and LPC, Pitch detection using LPC parameters, Burg algorithm Line spectral pair frequencies, transformation from LPC to LSP and LSP to LPC.

Module III : Homomorphic processing (8 Hrs)

Homomorphic processing, Cepstrum, evaluation of pitch and formants using cepstrum, mel scale, Mel Frequency Cepstral Coefficients, Perceptual linear prediction, Wavelet analysis of speech.

Module IV : Speech Coding (12Hrs)

Speech quantization and coding, Uniform and non uniformquantizers, compandedquantizer, forward and backward adaptive quantizers, waveform coding of speech, PCM, companded PCM, ADPCM, DM etc. Speech & audio coding standards.- G.726, LPC-10, DTW, HMM,

Applications

Speech enhancement techniques for periodic, wide band and interfering speech, echo cancellation, speech recognition, speaker recognition and speaker verification,

References :

1. R Rabiner and S.W. Schafer, “Digital processing of speech signals”; Pearson Education.
2. Dr. ShailaApte- “Speech and audio processing”, Wiley India Publication, 2013
3.Thomas F. Quateri , “Discrete Time Speech Signal Processing: Principles and Practice”
4.Deller J. R. Proakis J. G. and Hanson J.H., “Discrete Time Processing of Speech Signal”, Macmillian.
5.L.R Rabinar and B.H. Juang and Yegnanarayana, “Fundamentals of Speech Recognition”, Pearson Publishers

List of Practicals:

1. Write a matlab program to compute the energy and ZCR of a speech sentence in order to determine the voiced and unvoiced part of the sentence. Plot the energy and ZCR contour.
2. Write a matlab program to compute the pitch contour of a speech sentence using AMDF method. Plot the pitch contour.
3. Write a matlab program to compute the LPC,using Levinson-Durbin algorithm, of the vowels and determine the formant frequencies.
4. Write a matlabprogram to perform the cepstral analysis of speech signal and detect thepitch from the voiced part using cepstrum analysis.

504409 Computer Vision

Credits: 4

Teaching Scheme: **Examination Scheme:**

Lectures : 04 hr/week **In-Sem : 50 Marks**

End-Sem : 50 Marks

Course Objectives:

- 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.
- To introduce students to Stereo Imaging techniques, Multi-View geometry and 3D reconstruction algorithms.
- To study the techniques and algorithms used for Object tracking in Videos.
- To introduce Object recognition techniques.
- To develop and test basic Computer Vision algorithms in MATLAB.

Course Outcomes:

On completion of the course, student will be able to

1. have understanding of image formation and working of camera as image sensor, camera parameters and calibration.
2. pursue knowledge of stereo imaging, its applications and challenges
3. have conceptual understanding of computer vision algorithms for motion tracking
4. work with real time 3D problems based on the understanding of stereo vision techniques and algorithms
5. apply Object tracking and Recognition techniques in real life applications like Surveillance ,Security and industry.

Course Contents

Module I : Image Formation **(12 Hrs)**

Introduction to Computer Vision, Applications and Challenges. Pinhole camera, field of view, radiometry basics, Basic 2D and 3D transformations, Perspective camera model, camera parameters, Camera Calibration, Color models Like Lab.Digitalcamera,block diagram and specifications, Bayers pattern.

Applications of Computer vision **:**

Computational photography : High dynamic range imaging, Super-resolution and blur removal, Image matting and compositing, Texture analysis and synthesis, Thermal imaging.

Module II : Stereo Vision **(10Hrs)**

Introduction, Simple stereo system , Stereo parameters ,Correspondence techniques, Epipolar geometry, eight point algorithm , Rectification, 3D reconstruction, Shape from texture and focus, volumetric representations.

Module III :Image features and alignment **(8 Hrs)**

Edge ,line,points, corners and curve detections. Hough transform for lines and curves, fitting ellipse to image data, feature alignment using least squares, RANSAC, scale invariant feature transform, Image stiching.

Module IV : Motion **(8 Hrs)**

Introduction, motion field, Optical flow , motion estimation using differential and motion based techniques such as Kalman filter and their applications.

References:

1. EmanueleTrucco, Alessandro Verri, "Introductory Techniques for 3-D Computer Vision", Prentice Hall, 1998
2. Richard Szeliski, "Computer vision algorithms and applications", Springer 2011
3. Forsyth and Ponce, Computer Vision" A Modern Approach" , Pearson,2003 Second Edition
4. Linda Shapiro and George Stockman "Computer Vision", Prentice Hall

List of Practicals

1. Implementation of 2D translational ,rotational and scaling transformations on image.
2. Implementation of face recognition algorithm using eigenfaces.
3. Calibration of digital or mobile camera using camera calibration toolbox. List all intrinsic and Extrinsic parameters.
4. Plot of disparity map from stereo images.

504410 Soft Computing (Elective II)

Credits: 4

Teaching Scheme: **Examination Scheme:**

Lectures : 4Hrs/week+ **In-Sem : 50 Marks**
1 Hr/week for **End-Sem : 50 Marks**
Software Tools

Course Objectives:

- Introduce a relatively new computing paradigm for creating intelligent machines usefulfor solving complex real world problems.
- Insight into the tools that make up the soft computing technique: fuzzy logic, artificialneural networks and hybrid systems Techniques.
- To create awareness of the application areas of soft computing technique
- Provide alternative solutions to the conventional problem solving techniques inimage/signal processing, pattern recognition/classification, control system.
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Course Outcomes:

On completion of the course, student will be able to

1). Use a new tool /tools to solve a wide variety of real world problems
2) Find an alternate solution , which may offer more adaptability, resilience and optimization
3) Identify the suitable antenna for a given communication system
4) Gain knowledge of soft computing domain which opens up a whole new career option and tackle real world research problems

Course Contents

Module I :Artificial Neural Networks(10 Hrs)

Soft Topologies of neuralnetworks, learning paradigms: supervised, unsupervised, reinforcement, Learning mechanisms: Hebbian,DeltaRule,Perceptron and its limitations,Supervised learning Networks:Adaptive Linear Neuron,Multiple Adaptive Linear Neuron,Back Propagation etwork,Radial Basis Function Network**,**Artificial Neural Networks -UnSupervised Networks
Fixed weight competitive Nets,Kohonenself Organizing Feature maps,Learning Vector Quantization,AdaptiveResonantnetworks,

Module II :Artificial Neural networks:Special Networks (8 Hrs)

Hopfield Networks ,Simulated annealing network,BoltzmannMachine,GaussianMachine,probabilistic Neural Networks,CognitronNetworks,NeocognitronNetworks,Optican Neural networks

Module III : Fuzzy Logic -I (12 Hrs)
Concept of Fuzzy number, fuzzy set theory(continuous, discrete) o 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) o Fuzzy if-then rules. Fuzzification , Membership Value Assignment techniques, De-fuzzification (Maxmembership principle, Centroid method, Weighted average method), 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,

Module IV : Fuzzy Logic –II(10Hrs)

Implementation of a simple two-input single output FIS employing Mamdani model Computing Advanced NeuroFuzzy Modelling:
Fuzzy Logic Controllers:Comparison with traditionalPID control, advantages of FLC, Architecture of a FLC: Mamdani Type , Example Aircraftlanding control problem.
ANFIS: Adaptive Neuro-Fuzzy Inference Systems: Introduction to ANFIS Architecture
Hybrid Learning Algorithm**,** ANFIS as a Universal Approximator
Data Clustering Algorithms: Introduction, K-Means Clustering, Fuzzy C-Means Clustering,

References :
1. Neuro- Fuzzy and Soft Computing, J.S. Jang, C.T. Sun, E. Mizutani, PHI Learning Private Limited.
2. Principles of Soft Computing , S. N. Sivanandam, S. N. Deepa, John Wiley & Sons, 2007 " Title of the book" Publisher ,edition ,Year
3. Fundamentals of Neural Networks: Architectures, Algorithms And Applications, LaureneFausett, Pearson Education, Inc, 2008 .
4. Fuzzy Logic With Engineering Applications, Third Edition Thomas, Timothy Ross, John Wiley & Sons,2010

List of Practicals :
1. Implement simple logic network using MP neuron model
2. Implement a simple linear regressor with a single neuron model
3. Implement and test MLP trained with back-propagation algorithm
4. Implement and test RBF network
5. Implement SOFM for character recognition
6. Implement fuzzy membership functions (triangular, trapezoidal, gbell, PI, Gamma, Gaussian)
7. Implement defuzzyfication (Max-membership principle, Centroid method, Weighted average method)

504410 Pattern Recognition(Elective II)

Credits: 4

Teaching Scheme:	**Examination Scheme:**
Lectures : 4hrs/week +	**In-Sem : 50 Marks**
1 Hr/week for Software Tools	**End-Sem : 50 Marks**

Course Objectives:

- To understand the fundamentals of patterns recognition.
- To learn clustering concepts, feature extraction techniques.
- To bring in the ideas of neural network, fuzzy logic for pattern recognition.

Course Outcomes:

On completion of the course, student will be able to

1) Understand and apply various algorithms for pattern recognition .
2) Gain knowledge on how to apply classifier to particular application.
3) Realize structural pattern recognition and feature extraction techniques.

Course Contents

Module I : Introduction To Pattern Recognition (10 Hrs)

Basic elements of pattern recognition and its requirement, classifiers- linear Discriminant functions and hyperplanes, Perceptron algorithms, Support vector machines, supervised learning -parametric estimation, maximum likelihood estimation - Bayesian parameter estimation approach, Problems with Bayes approach , Pattern classification by distance functions , Minimum distance pattern classifier.

Module II : Unsupervised Learning And Clustering(8 Hrs)

Formulation of Unsupervised learning ,Clustering concept , k-Means clustering, Fuzzy k-Means clustering, Hierarchical clustering procedures , Graph theoretic approach to pattern clustering , Validity of clustering solutions.

Module III : Feature Extraction And Structural Pattern Recognition (10 Hrs)

Karhunen - Loevetransformation , Feature selection through functions approximation, Recognition of syntactic description, Parsing , Stochastic grammars and applications , Graph based structural representation.

Module IV :Recent Advances(8 Hrs)

Neural network structures for pattern recognition, multilayer feedforward network, Unsupervised learning in neural pattern recognition ,Self organizing Maps, -Fuzzy logic - Fuzzy pattern classifiers . Principle of neuro-fuzzy techniques.

References :

1. Robert .Schalkoff, "Pattern Recognition : Statistical, Structural and Neural Approaches", Wiley, India-edition,
2. Tou and Gonzales, "Pattern Recognition Principles", Wesley Publication Company.
3 Duda R.O., Hart.P.E.,and Stork D.G ," Pattern Classification" , Wiley India-edition
4 .SergiosTheodoridis and KonstantinosKoutroumbas"Pattern Recognition", fourth edition, Academic press an imprint of Elsevier,UK
5. Sankar Pal and SushmitaMitra "Neuro Fuzzy pattern Recognition" Wiley system for intelligent system

List of Practicals:

1. Implementation of classifiers using linear discriminant and hyper planes.
2. Implementation of one and two dimensional self organizing neural networks.
3. Implementation of classifiers using different distance functions.
4.Case study of pattern recognition using ANN / SVM.

504410 Architectures for Signal Processing(Elective II)

Credits: 4

Teaching Scheme:	**Examination Scheme:**
Lectures : 4hrs/week	**In-Sem : 50 Marks**
1 Hr/week for Software Tools	**End-Sem : 50 Marks**

Course Objectives:

- To learn principle and designing pipeline and parallel architectures.
- To learn various signal processing architecture transformation techniques.
- To learn various serial and parallel arithmetic architectures,
- To learn designing architectures for low power consumption.
- Addresses the use of programmable DSP processors for the implementation of DSP applications.

Course Outcomes:

On completion of the course, student will be able to

1. Know how to transform DSP algorithms into VLSI efficiently.
2. design pipeline and parallel architectures for optimization of either speed or power.
3. select appropriate transformation technique to trade-off speed, power and area.
4. design arithmetic architectures for various arithmetic operations.
5. know how to map DSP algorithms to the programmable DSP processors.

Course Contents

Module I : Pipeline and Parallel Architectures (10Hrs)

Representations of DSP algorithms, Loop bound and iteration bound, Pipelining of FIR filters, Parallel processing, Pipelining and parallel processing for low power.

Programmable Digital Signal Processors :

Evolution of Programmable DSPs, Features of DSP processors, DSP processors for mobile and wireless communication.

Module II :Transformation Techniques (10 Hrs)

Retiming: Properties of retiming, Retiming techniques, Unfolding: Algorithm for unfolding, Properties of unfolding, Applications of unfolding, Folding: Folding transformation, Register minimization techniques

ModuleIII : Fast Convolution and Bit-level Arithmetic Architectures (10Hrs)

Cook-Toom algorithm, Winograd algorithm, Iterated convolution, Cyclic convolution, Parallel multipliers, Bit-serial multipliers, Bit-serial filter design, Canonic signed digit arithmetic, Distributed arithmetic

ModuleIV: Low-Power Design (8Hrs)

Scaling versus power consumption, Power analysis, Power reduction techniques, Power estimation

References :

1.KeshabParhi, “VLSI Digital Signal Processing Systems, Design and Implementation” John-Wiley & sons.

2.KeshabParhi and Takao Nishitani, “Digital Signal Processing for Multimedia Systems” Marcel Dekker Inc.

3. S. Y. Kuang, H. J. Whitehouse, T. Kailath, “VLSI and Modern Signal Processing”, Prentice Hall

List of Practicals :

1. Write a Matlab program to compute the iteration bound using Longest Path Matrix (LPM) algorithm.
2 . Write a Matlab program to compute the iteration bound using Minimum Cycle Mean (MCM) algorithm.
3 . Write a Matlab program to determine if the system of inequalities has a solution, and find a solution if one exists using
a. the Bellman-Ford algorithm and
b. the Floyd-Warshall algorithm
4. Write a Matlab program to retime a DFG for clock period minimization. Use program written in assignment no. 3 as a function in this program to find out shortest path matrix and to solve system of inequalities.

504410 Biometrics (Elective II)

Credit: 4

Teaching Scheme: **Examination Scheme:**

Lectures: 04 Hrs/Week+ **Insem: 50**

1 Hr/week for Software Tools

Endsem: 50

Course Objectives:

- **U**nderstand the need of biometrics, its types and different performance measures
- Study physiological and behavioural biometrics, feature extraction and matching
- **S**tudy limitation of unibiometric system, need and importance of multibiometric system, types of fusion carried out at different levels
- **U**nderstand 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, student will be able to

1. Analyze the characteristics of physiological and behavioural 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

Module – I:

Biometric Fundamentals **(08Hrs)**

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

Module – II:

Physiological Biometrics **(10Hrs)**

Introduction to various physiological biometrics like Facial scan, Ear scan, Retina scan, Iris scan, Finger scan, Automated fingerprint identification system in detail, Palm print, Hand geometry analysis, hand vascular pattern technology, dental identification

Module – III:

Behavioural Biometrics(12Hrs)

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

Module – IV:

Introduction to Multibiometrics(08Hrs)

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.

References :

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, KarthikNandakumar, Anil K. Jain, “Handbook of Multibiometrics”, Springer 2006

4. Charles A. Shoniregun, Stephen Crosier, “Securing Biometrics Applications”, Springer 2006

5. Nalini K. Ratha, VenuGovindaraju, “Advances in Biometrics – sensors, Algorithms and Systems”, Springer, USA 2008.

List of Practicals:

1. Implement any one physiological biometric system for verification/ Identification
2. Implement any one behavioural biometric system for verification/ Identification
3. Implement feature level or score level biometric fusion for verification/ Identification.
4. Case study of any one application of biometric

504410 **Software Tools*(Elective II)**

Credits:1

Teaching Scheme:

Examination Scheme:
Theory: 50 Marks (In Semester)
50 Marks (In Semester)

Lectures: 1 Hr/Week

Introduction to software tools such as Octave, MATLAB, SCILAB, LAB VIEW, RTLinux, VxWorks, µCOS-II, Tiny OS, ANDROID, Xilinx, Microwind, Tanner, TCAD Tools, CAD Feko, IE-3D, Phython, OpenCV.

*For each Subject under Elective II the student Shall study open source/evaluation versions of at least one software tools mentioned above (not covered during semester –I) and should present term paper.

504411 Lab Practice II

Credits:4

Teaching Scheme:
Lectures: 4 Hrs/Week

Examination Scheme:
Theory: 50 Marks (TW)
50 Marks (OR)

Lab Practice II: The laboratory work will be based on completion of minimum two assignments/experiments confined to the courses of the semester.

504412 Seminar I

Credits:4

Teaching Scheme:
4 Hrs/Week

Examination Scheme:
Term Work : 50 Marks
Oral/ Presentation: 50 Marks

Seminar I: shall be on the topic relevant to latest trends in the field of concerned branch, preferably on the topic of specialization based on the electives selected by him/her approved by authority. The student shall submit the seminar report in standard format, duly certified for satisfactory completion of the work by the concerned guide and head of the Department/Institute.

SECOND YEAR

SEMESTER I

604401 Statistical Signal Processing

Credits:4

Teaching Scheme: **Examination Scheme:**

Lectures : 4hrs/week **In-Sem : 50 Marks**
End-Sem : 50 Marks

Course Objectives:

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

Course Outcomes:

On completion of the course, student will be able to

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

Course Contents

Module I : Discrete Time Random Processes (6 Hrs)

Filtering of Random Processes, Spectral Factorization, Innovations representation of Random Process, AR, MA and ARMA processes

Module II :Signal Modeling: (8 Hrs)

Least Square methods for signal modeling and its disadvantages,PadeApproximation,Prony's and Shank's Methods for signal Modeling.

Module III : Linear Prediction (12Hrs)

Forward and Backward linear prediction, Yule-Walker equation, Reflection coefficients, Lattice structures, Relationship of AR process to linear prediction, Solution of Normal equations, Levinson-Durbin algorithm, selection of order of LPC filter, Schur algorithm, Wiener filter, noise cancellation using FIR wiener filter

Adaptive filters : Need of adaptive filters, steepest descent method, LMS algorithm, convergence, application using LMS algorithms, Normalize LMS.

Module IV : Parameter Estimation (10Hrs)

Principle of estimation and applications, Properties of estimates, unbiased and consistent estimators, Minimum Variance Unbiased Estimates (MVUE), Maximum likelihood estimation. Spectral estimation, method of periodogram, Bartlett method, Welch method, Blackman-Tukey method, Power spectrum estimation using AR model.

References :

1.M. H. Hayes, ‘Statistical Digital Signal Processing and Modelling’, Wiley, (1996)
2. John G. Proakis, Dimitris G. Manolakis-Digital Signal Processing-Principles, algorithms & applications, PHI, 1997.
3**.** E. C. Ifeachor and B. W. Jervis, “Digital Signal Processing- A Practical Approach”, 2nd Edition, Pearson education.
4. S. M. Kay,“Fundamentals of Statistical Signal Processing: Estimation Theory”, Prentice Hall, 1993.
5. Proakis-Advanced Digital Signal Processing Macmillan publishing company, 1992.

604402 **Still Image and Video Compression**

Credits: 4

Teaching Scheme: **Examination Scheme:**

Lectures : 4 Hrs/week **In-Sem : 50 Marks**

End-Sem : 50 Marks

Course Objectives:

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

Course Outcomes:

On completion of the course, student will be able to

1. 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.

Course Contents

Module I : Vector Quantization **(8 Hrs)**

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.

Module II : Wavelet based Image Compression **(8 Hrs)**

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

Module III : Video and Audio Compression basics **(10Hrs)**

Analog and digital video, Temporal Redundancy, Motion estimation, Video Signal Representation Hybrid video CODEC. Audio Psychoacoustic Model, MPEG Audio Coding, Layer II Coding, Layer III Coding—mp3, Dolby AC3 (Dolby Digital) 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,

Module IV : Video Compression Standards **(10 Hrs)**

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

References:

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.

3. Mohammed Ghanbari , Standard Codecs**:** Image Compression to Advanced Video Coding", IEE publication.

4. V. Bhaskaran and K. Konstantinides, "Image video compression standards: algorithms and architecture," Kluwer Academic Publishers

5. Joan Mitchell "MPEG and Video compression standard" Springer

6. Iain E. G. Richardson"H.264 and MPEG-4 Video Compression" Wiley publication

Elective-III

Select one subjects from Group-I, and one subject from Group-II from the following list as Elective-III.

Group		Subject	Credit
I	1	Value Education, Human Rights and Legislative Procedures	3
	2	Environmental Studies	3
	3	Renewable Energy Studies	3
	4	Disaster Management	3
	5	Knowledge Management	3
	6	Foreign Language	3
	7	Economics for Engineers	3
	8	Engineering Risk – Benefit Analysis	3
II	1	Optimization Techniques	2
	2	Fuzzy Mathematics	2
	3	Design and Analysis of Algorithms	2
	4	CUDA	2

604403A Value Education, Human rights and Legislative procedures (Elective III)

Credits:3

Teaching Scheme:

Lectures: 3 Hrs/Week

Examination Scheme*:

In-Sem : 50 Marks

End-Sem : 50 Marks

Module I : (8 Hrs)

Values and Self Development-Social values and individual attitudes, Work ethics, Indian vision of humanism, Moral and non moral valuation, Standards and principles, Value judgments. Importance of cultivation of values, Sense of duty, Devotion, Self reliance, Confidence, Concentration, Truthfulness, Cleanliness, Honesty, Humanity, Power of faith, National unity, Patriotism, Love for nature, Discipline.

Module II :(8 Hrs)

Personality and Behavior Development- Soul and scientific attitude, God and scientific attitude, Positive thinking, Integrity and discipline, Punctuality, Love and kindness, Avoiding fault finding, Free from anger, Dignity of labor, Universal brotherhood and religious tolerance, True friendship, Happiness vs. suffering love for truth, Aware of self destructive habits, Association and cooperation, Doing best, Saving nature.

Module III : (8 Hrs)

Human Rights- Jurisprudence of human rights nature and definition, Universal protection of human rights, Regional protection of human rights, National level protection of human rights, Human rights and vulnerable groups. Legislative Procedures- Indian constitution, Philosophy, fundamental rights and duties, Legislature, Executive and Judiciary, Constitution and function of parliament, Composition of council of states and house of people, Speaker, Passing of bills, Vigilance, Lokpal and functionaries References

References

1. Chakraborty, S.K., Values and Ethics for Organizations Theory and Practice, Oxford University Press, New Delhi, 2001.

2. Kapoor, S.K., Human rights under International Law and Indian Law, Prentice Hall of India, New Delhi, 2002.

3. Basu, D.D., Indian Constitution, Oxford University Press, New Delhi, 2002.

4. Frankena, W.K., Ethics, Prentice Hall of India, New Delhi, 1990.

5. Meron Theodor, Human Rights and International Law Legal Policy Issues, Vol. 1 and 2, Ox ford University Press, New Delhi, 2000.

604403A Environmental studies (Elective III)

Credits:3

Teaching Scheme:

Lectures: 3 Hrs/Week

Examination Scheme*:

In-Sem : 50 Marks

End-Sem : 50 Marks

Module I : (8 Hrs)

Introduction and Natural Resources: Multidisciplinary nature and public awareness, Renewable and nonrenewal resources and associated problems, Forest resources, Water resources, Mineral resources, Food resources, Energy resources, Land resources, Conservation of natural resources and human role. Ecosystems: Concept, Structure and function, Producers composers and decomposers, Energy flow, Ecological succession, Food chains webs and ecological pyramids, Characteristics structures and functions of ecosystems such as Forest, Grassland, Desert, Aquatic ecosystems.

Module II : (8 Hrs)

Environmental Pollution- Definition, Causes, effects and control of air pollution, water pollution, soil pollution, marine pollution, noise pollution, thermal pollution, nuclear hazards, human role in prevention of pollution, Solid waste management, Disaster management, floods, earthquake, cyclone and landslides.

Module III : (8 Hrs)

Social issues and Environment- Unsustainable to sustainable development, Urban problems related to energy, Water conservation and watershed management, Resettlement and re-habitation, Ethics, Climate change, Global warming, Acid rain, Ozone layer depletion, Nuclear accidents, holocaust, Waste land reclamation, Consumerism and waste products, Environment protection act, Wildlife protection act, Forest conservation act, Environmental issues in legislation, population explosion and family welfare program, Environment and human health, HIV, Women and child welfare, Role of information technology in environment and human health.

References

1. Agarwal, K.C., “Environmental Biology”, Nidi Publication Ltd., Bikaner, 2001.

2. BharuchaErach, “Biodiversity of India,”Mapin Publishing Pvt. Ltd., Ahmadabad, 2002.

3.Bukhootsow, B.,” Energy Policy and Planning”, Prentice Hall of India, New Delhi, 2003.

4.Cunningham, W.P., “ Environmental Encyclopedia”, Jaico Publishing House, Mumbai, 2003.

604403A Renewable Energy Studies (Elective III)

Credits:3

Teaching Scheme:
Lectures:3 Hrs/Week

Examination Scheme*:
In-Sem : 50 Marks
End-Sem : 50 Marks

Module I : Solar Energy:(8 Hrs)

Photovoltaic Systems: Introduction to the Major Photovoltaic System Types, Current–Voltage Curves for Loads, Grid-Connected Systems: Interfacing with the Utility, DC and AC Rated Power, The "Peak-Hours" Approach to Estimating PV Performance, Capacity Factors for PV Grid Connected Systems¸ PV Powered Water Pumping, PV systems – off grid systems and scope for inclusive growth of rural India.

Module II :Wind Energy:(8 Hrs)

Wind Energy: wind speed and power relation, power extracted from wind, wind distribution and wind speed predictions. Wind power systems: system components, Types of Turbine, Choice of generators, electrical load matching, power control, Effect of wind speed variations, tower height and its effect, Variable speed operation, maximum power operation, control systems, Design consideration of wind farms and control

Module III : Other Energy Sources:(8 Hrs)

Biomass – various resources, energy contents, technological advancements, conversion of biomass in other form of energy – solid, liquid and gases. Gasifiers, Biomass fired boilers, Co-firing, Generation from municipal solid waste, Issues in harnessing these sources. Mini and micro hydel plants scheme layout economics. Tidal and wave energy, Geothermal and Ocean-thermal energy conversion (OTEC) systems – schemes, feasibility and viability. Fuel cell- types and operating characteristics, efficiency, energy output of fuel cell

References

1. Renewable energy technologies - R. Ramesh, Narosa Publication.
2. Energy Technology – S. Rao, Parulkar
3. Non-conventional Energy Systems – Mittal, Wheelers Publication.
4. Clark W. Gellings, "The Smart Grid: Enabling Energy Efficiency and Demand Response",CRC Press
5. Renewable Energy Technologies – Chetan Singh Solanki, PHI Learning Pvt. Ltd.

604403A Disaster Management (Elective III)

Credits:3

Teaching Scheme:	**Examination Scheme*:**
Lectures: 3 Hrs/Week	**In-Sem : 50 Marks**
	End-Sem : 50 Marks

Module I : (8 Hrs)

Introduction :Concepts and definitions: disaster, hazard, vulnerability, risk, capacity, impact, prevention, mitigation). Disasters classification; natural disasters (floods, draught, cyclones, volcanoes, earthquakes, tsunami, landslides, coastal erosion, soil erosion, forest fires etc.); manmade disasters (industrial pollution, artificial flooding in urban areas, nuclear radiation, chemical spills etc); hazard and vulnerability profile of India, mountain and coastal areas, ecological fragility

Module II : (8 Hrs)

Disaster Impacts :Disaster impacts (environmental, physical, social, ecological, economical, political, etc.); health, psycho-social issues; demographic aspects (gender, age, special needs); hazard locations; global and national disaster trends; climate-change and urban disasters.

Module III : (8 Hrs)

Disaster Risk Reduction (DRR) : Disaster management cycle – its phases; prevention, mitigation, preparedness, relief and recovery; structural and non-structural measures; risk analysis, vulnerability and capacity assessment; early warning systems, Post-disaster environmental response (water, sanitation, food safety, waste management, disease control); Roles and responsibilities of government, community, local institutions, NGOs and other stakeholders; Policies and legislation for disaster risk reduction, DRR programmes in India and the activities of National Disaster Management Authority.

References

1. http://ndma.gov.in/ (Home page of National Disaster Management Authority).
2. http://www.ndmindia.nic.in/ (National Disaster management in India, Ministry of Home Affairs).
3. PradeepSahni, 2004, Disaster Risk Reduction in South Asia, Prentice Hall.
4. Singh B.K., 2008, Handbook of Disaster Management: techniques & Guidelines, Rajat Publication.
5. Ghosh G.K., 2006, Disaster Management ,APH Publishing Corporation.

604403A Knowledge Management (Elective III)

Credits:3

Teaching Scheme:
Lectures:3 Hrs/Week

Examination Scheme*:
In-Sem : 50 Marks
End-Sem : 50 Marks

Module I : (8 Hrs)

Introduction: Definition, evolution, need, drivers, scope, approaches in Organizations, strategies in organizations, components and functions, understanding knowledge; Learning organization: five components of learning organization, knowledge sources, and documentation. Essentials of Knowledge Management; knowledge creation process, knowledge management techniques, systems and tools.

Module II : (8 Hrs)

Organizational knowledge management; architecture and implementation strategies, building the knowledge corporation and implementing knowledge management in organization. Knowledge management system life cycle, managing knowledge workers, knowledge audit, and knowledge management practices in organizations, few case studies

Module III : (4 Hrs)

Futuristic KM: Knowledge Engineering, Theory of Computation, Data Structure.

References

1. Knowledge Management – a resource book – A Thohothathri Raman, Excel, 2004.

2. Knowledge Management- Elias M. AwadHasan M. Ghazri, Pearson Education

3. The KM Toolkit – Orchestrating IT, Strategy & Knowledge Platforms, AmritTiwana, Pearson, PHI, II Edn.

4. The Fifth Discipline Field Book – Strategies & Tools For Building A learning organization PeterSenge et al. Nicholas Brealey 1994

5. Knowledge Management – Sudhir Warier, Vikas publications

6. Leading with Knowledge, MadanmohanRao, TataMc-Graw Hill.

604403A Foreign Language (Elective III)

Credits:3

Teaching Scheme:
Lectures:3 Hrs/Week

Examination Scheme*:
In-Sem : 50 Marks
End-Sem : 50 Marks

Module I : (8 Hrs)

Pronunciation guidelines; Single vowels, Accentuated vowels, Vowels and consonants combinations, Consonants; Numbers 1-10 Articles and Genders; Gender in French, Plural articles, Some usual expressions. Pronouns and Verbs; The verb groups, The pronouns, Present tense, Some color Adjectives and Plural ; Adjectives, Some adjectives, Our first sentences, More Numbers.

Module II : (8 Hrs)

Sentences Structures; Some Prepositions, Normal Sentences, Negative Sentences, Interrogative Sentences, Exercises The Family; Vocabulary ,Conversation, Notes on Pronunciation, Notes on Vocabulary, Grammar, Liaisons Guideline. D'oùviens-tu (Where do you come from); Vocabulary, Conversation, Notes on Vocabulary, Liaisons Guidelines . Comparer (Comparing); Vocabulary, Conversation, Notes on Vocabulary, Grammar Liaisons Guidelines, Ordinal Numbers

Module III : (8 Hrs)

Le temps (Time); Vocabulary, Grammar, Time on the clock Additional French Vocabulary; Vocabulary related to - The Family, Vocabulary related to - Where do you come from? French Expressions and Idioms; Day-to-day Life, At Work, The car, Sports, Specia Events Other French Flavours; Nos cousins d'Amérique - Québec et Accadie, Au pays de la bière et des frites, Mettez-vous à l'heure Suisse, Vé, peuchère, le françaisbien de chez nous

References

http://www.jump-gate.com/languages/french/index.html

604403A Economics for Engineers (Elective III)

Credits:3

Teaching Scheme:	**Examination Scheme:**
Lectures: 3 Hrs/Week	**In-Sem : 50 Marks**
	End-Sem : 50 Marks

Module I : (8 Hrs)

Introduction to the subject: Micro and Macro Economics, Relationship between Science, Engineering, Technology and Economic Development. Production Possibility Curve, Nature of Economic Law, Time Value of Money: concepts and application. Capital budgeting; Traditional and modern methods, Payback period method, IRR, ARR, NPV, PI (with the help of case studies)

Module II : (8 Hrs)

Meaning of Production and factors of production, Law of variable proportions and returns to scale. Internal and external economies and diseconomies of scale. Concepts of cost of production, different types of costs; accounting cost, sunk cost, marginal cost, Opportunity cost. Break even analysis, Make or Buy decision (case study). Relevance of Depreciation towards industry. Meaning of market, types of market, perfect competition, Monopoly, Monopolistic, Oligopoly. (Main features). Supply and law of supply, Role of demand and supply in price determination.

Module III : (8 Hrs)

Indian Economy, nature and characteristics. Basic concepts; fiscal and monetary policy, LPG, Inflation, Sensex, GATT, WTO and IMF. Difference between Central bank and Commercial banks

References

1. Jain T.R., Economics for Engineers, VK Publication
2. Singh Seema, Economics for Engineers, IK International
3. Chopra P. N., Principle of Economics, Kalyani Publishers
4. Dewett K. K., Modern economic theory, S. Chand
5. H. L. Ahuja., Modern economic theory, S. Chand

604403A Engineering risk – Benefit and Analysis (Elective III)

Credits:3

Teaching Scheme:	**Examination Scheme*:**
Lectures: 3 Hrs/Week	**In-Sem : 50 Marks**
	End-Sem : 50 Marks

Module I : (8 Hrs)

Introduction- Knowledge and Ignorance, Information Uncertainty in Engineering Systems, Introduction and overview of class; definition of Engineering risk; overview of Engineering risk analysis. Risk Methods: Risk Terminology, Risk Assessment, Risk Management and Control, Risk Acceptance, Risk Communication, Identifying and structuring the Engineering risk problem; developing a deterministic or parametric model System Definition and Structure: System Definition Models, Hierarchical Definitions of Systems, and System Complexity.

Module II : (8 Hrs)

Reliability Assessment: Analytical Reliability Assessment, Empirical Reliability Analysis Using Life Data, Reliability Analysis of Systems

Module III : (8 Hrs)

Reliability and probabilistic risk assessment (RPRA), decision analysis (DA), and cost-benefit analysis (CBA). All of these pertain to decision making in the presence of significant uncertainty. In ERBA, the issues of interest are: The risks associated with large engineering projects such as nuclear power reactors, the International Space Station, and critical infrastructures; the development of new products; the design of processes and operations with environmental externalities; and infrastructure renewal projects

References

1. Risk Analysis in Engineering and Economics, B. M. Ayyub, Chapman-Hall/CRC Press, 2003.
2. Hoyland, Arnljot, and Rausand, Marvin. System Reliability Theory. Hoboken, NJ: WileyInterscience, 1994. ISBN: 9780471471332.
3. Clemen, Robert, ― Making Hard Decisions: An Introduction to Decision Analysis (Business Statistics) ― PHI publications

604403B Optimization Techniques (Elective III)

Credits:2

Teaching Scheme:
Lectures: 2 Hrs/Week

Examination Scheme*:
In-Sem : 50 Marks
End-Sem : 50 Marks

Module I : (6 Hrs)

First and second order conditions for local interior optima (concavity and uniqueness), Sufficient conditions for unique global optima; Constrained optimization with Lagrange multipliers; Sufficient conditions for optima with equality and inequality constraints;

Module II : (8 Hrs)

Recognizing and solving convex optimization problems. Convex sets, functions, and optimization problems. Least-squares, linear, and quadratic optimization. Geometric and semidefinite programming. Vector optimization. Duality theory. Convex relaxations. Approximation, fitting, and statistical estimation. Geometric problems. Control and trajectory planning

Books:

1. Stephen Boyd and LievenVandenberghe, Convex Optimization, Cambridge University Press.
2. A. Ben-Tal, A. Nemirovski, Lectures on Modern Convex Optimization: Analysis,Algorithms, and Engineering Applications, SIAM.
3. D. P. Bertsekas, A. Nedic, A. E. Ozdaglar, Convex Analysis and Optimization,Athena Scientific.
4. D. P. Bertsekas, Nonlinear Programming, Athena Scientific.
5. Y. Nesterov, Introductory Lectures on Convex Optimization: A Basic Course, Springer.
6. J. Borwein and A. S. Lewis, Convex Analysis and Nonlinear Optimization:Theory and Examples, Springer.

604403B **Fuzzy Mathematics** **(Elective III)**

Credits:2

Teaching Scheme:
Lectures: 2 Hrs/Week

Examination Scheme*:
In-Sem : 50 Marks
End-Sem : 50 Marks

Module I : **(8 Hrs)**

Definition of a Fuzzy set; Elements of Fuzzy logic. Relations including, Operations, reflexivity, symmetry and transitivity; Pattern Classification based on fuzzy relations

Module II : **(6 Hrs)**

Fuzzy Models: Mamdani , Sugeno, Tsukamoto

Books:

1. Neuro-Fuzzy and Soft Computing by S.R.Jung, Sun, Mizutani,

604403B **Design and Analysis of Algorithm (Elective III)**

Credits:2

Teaching Scheme:
Lectures: 2 Hrs/Week

Examination Scheme*:
In-Sem : 50 Marks
End-Sem : 50 Marks

Module I : **(8 Hrs)**

Introduction- Fundamental characteristics of an algorithm. Basic algorithm analysis – Asymptotic analysis of complexity bounds– best, average and worst-case behaviour, standard notations for expressing algorithmic complexity. Empirical measurements of performance, time and space trade-offs in algorithms.

Module II : **(8 Hrs)**

Properties of big-Oh notation – Recurrence equations – Solving recurrence equations – Analysis of linear search. Divide and Conquer: General Method – Binary Search – Finding Maximum and Minimum – Merge Sort – Greedy Algorithms: General Method – Container Loading – Knapsack

Books:

Algorithm Design – Jon Kleinberg and Eva Tardos Introduction to Algorithms – T.H. Corman

604403B **CUDA (Elective III)**

Credits:2

Teaching Scheme:
Lectures: 2 Hrs/Week

Examination Scheme*:
In-Sem : 50 Marks
End-Sem : 50 Marks

Module I : (8 Hrs)

History of GPUs leading to their use and design for HPC- The Age of Parallel Processing, The Rise of GPU Computing ,CUDA, Applications of CUDA, Development Environment, Introduction to CUDA C, Kernel call, Passing Parameters, Querying Devices, Using Device Properties

Module II : (6 Hrs)

Parallel Programming in CUDA C - CUDA Parallel Programming, Splitting Parallel Blocks, Shared Memory and Synchronization, Constant Memory, Texture Memory, CUDA events, Measuring Performance with Events.

Books:

1. Programming Massively Parallel Processors: A Hands-on Approach –second edition by David B. Kirk, Wen-mei W. Hwu.
2. CUDA by Example - An Introduction to General-Purpose GPU Programming by Jason Sanders ,Edward Kandrot- Addison Wesley
3. GPU Computing Gems Emerald Edition -Applications of GPU Computing Series by Wen-mei, W. Hwu
4. CUDA Programming: A Developer's Guide to Parallel Computing with GPUs by shane cook

604404 Seminar II

Credits:4

Teaching Scheme:
4 Hrs/Week

Examination Scheme:
Term Work : 50 Marks
Oral/ Presentation: 50 Marks

Seminar II : shall be on the topic relevant to latest trends in the field of concerned branch, preferably on the topic of specialization based on the electives selected by him/her approved by authority. The student shall submit the seminar report in standard format, duly certified for satisfactory completion of the work by the concerned guide and head of the Department/Institute.

64405 Project Stage- I

Credits:8

Teaching Scheme:
Lectures: 8 Hrs/Week

Examination Scheme:
Term Work : 50 Marks
Oral/ Presentation: 50 Marks

Project Stage – I

Project Stage – I is an integral part of the project work. In this, the student shall complete the partial work of the project which will consist of problem statement, literature review, project overview, scheme of implementation (Mathematical Model/SRS/UML/ERD/block diagram/ PERT chart, etc.) and Layout & Design of the Set-up. As a part of the progress report of Project work Stage-I, the candidate shall deliver a presentation on the advancement in Technology pertaining to the selected dissertation topic. The student shall submit the duly certified progress report of Project work Stage-I in standard format for satisfactory completion of the work by the concerned guide and head of the Department/Institute.

SECOND YEAR

SEMESTER II

604406 SeminarIII

Credits:5

Teaching Scheme:
5 Hrs/Week

Examination Scheme:
Term Work : 50 Marks
Oral/ Presentation: 50 Marks

Seminar III: shall preferably an extension of seminar II. The student shall submit the duly certified seminar report in standard format, for satisfactory completion of the work by the concerned guide and head of the Department/Institute.

604407 Project Stage- II

Credits:20

Teaching Scheme:
20 Hrs/Week

Examination Scheme:
Term Work : 150 Marks
Oral/ Presentation: 50 Marks

Project Stage – II

In Project Stage – II, the student shall complete the remaining part of the project which will consist of the fabrication of set up required for the project, work station, conducting experiments and taking results, analysis & validation of results and conclusions. The student shall prepare the duly certified final report of project work in standard format for satisfactory completion of the work by the concerned guide and head of the Department/Institute.