PROGRAMME EDUCATIONAL OBJECTIVES (PEOS):
1. To provide theoretical and conceptual knowledge of digital signal processing in the areas like radar, VLSI, speech and image processing
2. To educate graduates in the field of biomedical and optical signals along with relevant processor architectures to enable them to take up a career in the core industry
3. To offer topics in the advanced digital signal processing techniques with applications to multi-dimensional data processing and analysis
4. To familiarize different hardware and software designing tools to design DSP systems.

PROGRAMME OUTCOMES (POS):

Engineering Graduates will be able to:

1. **Engineering knowledge**: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

2. **Problem analysis**: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

3. **Design/development of solutions**: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

4. **Conduct investigations of complex problems**: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

5. **Modern tool usage**: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.

6. **The engineer and society**: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

7. **Environment and sustainability**: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

8. **Ethics**: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

9. **Individual and team work**: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

10. **Life-long learning**: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
PROGRAM SPECIFIC OBJECTIVES (PSOS)

1. Students will be able to design adaptive filters for a given application and to design multi-rate DSP systems.
2. Students completing this course are expected to have a good understanding of the DSP based real time data processing system for various DSP based high speed applications.

Provide mapping of 1) POs to PEOs and 2) PSOs to PEOs.
Use the following marking:

Contribution 1: Reasonable  2:Significant  3:Strong

MAPPING OF PROGRAMME EDUCATIONAL OBJECTIVES WITH PROGRAMME OUTCOMES

A broad relation between the programme objective and the outcomes is given in the following table

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## PROFESSIONAL ELECTIVES (PE)∗

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# ANNA UNIVERSITY, CHENNAI
## AFFILIATED INSTITUTIONS
### M.E. DIGITAL SIGNAL PROCESSING
#### REGULATIONS – 2017
##### CHOICE BASED CREDIT SYSTEM
##### CURRICULA AND SYLLABI

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### EMPLOYABILITY ENHANCEMENT COURSE (EEC)

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## PROFESSIONAL ELECTIVES (PE)∗
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OBJECTIVES:
The main objective of this course is to provide the student with a repertoire of mathematical methods that are essential to the solution of advanced problems encountered in the field of signal processing. This course covers a broad spectrum of mathematical techniques including linear algebra, Bessel functions, linear programming, numerical solution of algebraic equations and differential equations.

UNIT I LINEAR ALGEBRA

UNIT II BESSEL FUNCTIONS
Bessel's equation – Bessel function – Recurrence relations - Generating function and orthogonal property for Bessel functions of first kind – Fourier - Bessel expansion.

UNIT III LINEAR PROGRAMMING

UNIT IV NUMERICAL SOLUTION OF ALGEBRAIC EQUATIONS

UNIT V NUMERICAL SOLUTION OF ORDINARY DIFFERENTIAL EQUATIONS

TOTAL: 60 PERIODS

OUTCOMES:
After completing this course, students should demonstrate competency in the following skills:
- Concepts on vector spaces, linear transformation, inner product spaces, eigenvalues and generalized eigenvectors.
- Apply various methods in linear algebra to solve system of linear equations.
- Solution of Bessel's differential equations, Bessel functions and its properties.
- Could develop a fundamental understanding of linear programming models, able to develop a linear programming model from problem description, apply the simplex method for solving linear programming problems.
- Solve an algebraic or transcendental equation and linear system of equations using an appropriate numerical method.
- Numerical solution of differential equations by single and multistep methods.
REFERENCES:

DS5191 DSP PROCESSOR ARCHITECTURE AND PROGRAMMING

OBJECTIVES:
The objective of this course is to provide in-depth knowledge on
- Digital Signal Processor basics
- Third generation DSP Architecture and programming skills
- Advanced DSP architectures and some applications.

UNIT I FUNDAMENTALS OF PROGRAMMABLE DSPs
Multiplier and Multiplier accumulator – Modified Bus Structures and Memory access in PDSPs – Multiple access memory – Multi-port memory – VLIW architecture- Pipelining – Special Addressing modes in P-DSPs – On chip Peripherals.

UNIT II SPECIAL FUNCTIONS
Architecture – Assembly language syntax - Addressing modes – Assembly language Instructions - Pipeline structure, Operation – Block Diagram of DSP starter kit – Application Programs for processing real time signals.

UNIT III LINEAR PROGRAMMING

UNIT IV ALGEBRAIC EQUATIONS
Architecture of ADSP-21XX and ADSP-210XX series of DSP processors- Addressing modes and assembly language instructions – Application programs –Filter design, FFT calculation.

UNIT V ORDINARY DIFFERENTIAL EQUATIONS

TOTAL :45 PERIODS
OUTCOMES:
Students should be able to:
- Become Digital Signal Processor specialized engineer
- DSP based System Developer

REFERENCES:
3. RulphChassaing, Digital Signal Processing and Applications with the C6713 and C6416DSK, A JOHN WILEY & SONS, INC., PUBLICATION, 2005

AP5152 ADVANCED DIGITAL SIGNAL PROCESSING L T P C
3 2 0 4

OBJECTIVES:
- The student comprehends mathematical description and modelling of discrete time random signals.
- The student is conversant with important theorems and algorithms.
- The student learns relevant figures of merit such as power, energy, bias and consistency.
- The student is familiar with estimation, prediction and filtering concepts and techniques.

UNIT I DISCRETE RANDOM SIGNAL PROCESSING 9+6

UNIT II SPECTRUM ESTIMATION 9+6

UNIT III LINEAR ESTIMATION AND PREDICTION 9+6

UNIT IV ADAPTIVE FILTERS 9+6
UNIT V  MULTIRATE DIGITAL SIGNAL PROCESSING  9+6

TOTAL  45+30 : 75 PERIODS

OUTCOMES:
- Formulate time domain and frequency domain description of Wide Sense Stationary process in terms of matrix algebra and relate to linear algebra concepts.
- Explain various noise types, Yule-Walker algorithm, parametric and non-parametric methods, Wiener and Kalman filtering, LMS and RMS algorithms, Levinson Durbin algorithm, adaptive noise cancellation and adaptive echo cancellation, speed verses convergence issues, channel equalization, sampling rate change, subband coding and wavelet transform.
- Calculate mean, variance, auto-correlation and PSD for WSS stochastic processes, and derive prediction error criterion, Wiener-Hoff equations, Parseval’s theorem, W-K theorem and normal equations.
- Design AR, MA, ARMA models, Weiner filter, anti aliasing and anti imaging filters, and develop FIR adaptive filter and polyphase filter structures.
- Simulate spectral estimation algorithms and basic models on computing platform.

REFERENCES:

DS5101  VIDEO COMPRESSION TECHNIQUES  L  T  P  C
3  0  0  3

OBJECTIVES:
- To understand the basics of Video representation in space and transform domains.
- To understand intra frame coding Techniques.
- To understand inter frame compression.
- To know the basics of Video Compression standards.
- To understand the basics of JPEG.

UNIT I  DIGITAL VIDEO REPRESENTATION  9
UNIT II  STILL IMAGE COMPRESSION TECHNIQUES  9
Spatial Redundancy Reduction- Predictive Coding - Transform Coding Techniques-Variable Length Coding_ Huffman Coding – Arithmetic Coding –Run Length Coding -Still Image Compression-JPEG.

UNIT III  VIDEO COMPRESSION  9
Inter-frame Coding- I, P,B and D frames-Motion estimation – Motion estimation with Half Pixel Precision-Bidirectional Motion estimation- MPEG2-Scalability.

UNIT IV  LOW BIT RATE VIDEO CODING  9
Coding for Video Conferencing – Overview of H.261 – Coding in H.263- Coding of Motion Vectors.

UNIT V  CONTENT BASED VIDEO CODING  9
Video Object Plane-encoding of VOPs-Segmenation-shape Coding- Texture Coding-MPEG-4 – Basics of content description, search and delivery in MPEG7.

OUTCOMES:
- To be able to design Video Compression schemes
- To be able to implement the state-of the art Video Standards
- To be able to design Motion pixel
- To be able to implement Video Conferencing
- To be able to design VOPs and MPEG7

REFERENCES:

TOTAL 45 PERIODS

DS5102  MODEL BASED SIGNAL PROCESSING  L  T  P  C
3  0  0  3

OBJECTIVES:
- Fundamentals of model based Processing
- Discrete Random Signals and systems
- State-Space Adaption Algorithms
- Applied Physics-Based Processors

UNIT I  DISCRETE RANDOM SIGNALS AND SYSTEMS  9
UNIT II ESTIMATION THEORY AND MODEL-BASED PROCESSORS

UNIT III LINEAR AND NON-LINEAR STATE-SPACE MODEL-BASED PROCESSORS

UNIT IV ADAPTIVE STATE-SPACE MODEL-BASED PROCESSORS

UNIT V APPLIED PHYSICS-BASED PROCESSORS

TOTAL 45 PERIODS

OUTCOMES:
- Become a Signal Processor engineer
- Model Based Signal Developer

REFERENCES:

DS5111 DIGITAL SIGNAL PROCESSING LABORATORY I

OBJECTIVES:
- To understand the Digital Signal Processor Starter Kit.
- To learn the basic experiments in the DSP Starter Kit.
- To known DSP Embedded System based Assembly and C Language.
LIST OF EXPERIMENTS:
1. Sine wave Generation Using Eight Points with DIP Switch Control
2. Sine wave Generation with Two Sliders for Amplitude and Frequency Control
3. Square, Ramp Generation Using a Lookup Table
4. Loop Program with Stereo Input and Stereo Output
5. Program to generate Echo with controls for different effects
6. Pseudorandom noise sequence generation program
7. Implementation of Four Different Filters: Low pass, High pass, Band pass, and Band Stop
8. FIR Implementation Using C Calling an ASM Function with a Circular Buffer
9. IR Filter Implementation Using Second-Order Stages in Cascade

TOTAL: 60 PERIODS

OUTCOMES:
Upon Completion of the course, the students will be able to:
- Install the DSP Starter Kit
- Write C & Assembly based Algorithms
- Write Basic and Advanced Digital filter based programmes

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:

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<td>TMS 320 C67X Kits</td>
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<td>2</td>
<td>MATLAB or Equivalent Licensed or Open Source S/W with Signal Processing Tool box</td>
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DS5291  ADVANCED DIGITAL IMAGE PROCESSING  L T P C
3 0 0 3

OBJECTIVES:
- To understand the image fundamentals.
- To understand the various image segmentation techniques.
- To extract features for image analysis.
- To introduce the concepts of image registration and image fusion.
- To illustrate 3D image visualization.

UNIT I  FUNDAMENTALS OF DIGITAL IMAGE PROCESSING  9
Elements of visual perception, brightness, contrast, hue, saturation, mach band effect, 2D image transforms-DFT, DCT, KLT, and SVD. Image enhancement in spatial and frequency domain, Review of morphological image processing
UNIT II SEGMENTATION
Edge detection, Thresholding, Region growing, Fuzzy clustering, Watershed algorithm, Active contour methods, Texture feature based segmentation, Model based segmentation, Atlas based segmentation, Wavelet based Segmentation methods

UNIT III FEATURE EXTRACTION
First and second order edge detection operators, Phase congruency, Localized feature extraction-detecting image curvature, shape features Hough transform, shape skeletonization, Boundary descriptors, Moments, Texture descriptors- Autocorrelation, Cooccurrence features, Runlength features, Fractal model based features, Gabor filter, wavelet features.

UNIT IV REGISTRATION AND IMAGE FUSION

UNIT V 3D IMAGE VISUALIZATION
Sources of 3D Data sets, Slicing the Data set, Arbitrary section planes, The use of color, Volumetric display, Stereo Viewing, Ray tracing, Reflection, Surfaces, Multiply connected surfaces, Image processing in 3D, Measurements on 3D images.

TOTAL:45PERIODS

OUTCOMES:
Upon Completion of the course, the students will be able to
- Explain the fundamentals digital image processing.
- Describe image various segmentation and feature extraction techniques for image analysis.
- Discuss the concepts of image registration and fusion.
- Explain 3D image visualization.

REFERENCES:
OBJECTIVES:
- To understand the Radar Signal acquisition and sampling in multiple domains
- To provide clear instruction in radar DSP basics
- To equip the skills needed in both design and analysis of common radar algorithms
- To understand the basics of synthetic aperture imaging and adaptive array processing
- To illustrate how theoretical results are derived and applied in practice

UNIT I  INTRODUCTION TO RADAR SYSTEMS  9
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  SIGNAL MODELS  9
Components of a radar signal, amplitude models, types of clutters, noise model and signal-to-noise ratio, jamming, frequency models: the doppler shift, spatial models, spectral model

UNIT III  SAMPLING AND QUANTIZATION OF PULSED RADAR SIGNALS  9
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  RADAR WAVEFORMS  9
Introduction, The waveform matched filter, Matched filtering of moving targets, The ambiguity function, The pulse burst waveform, frequency-modulated pulse compression waveforms, Range sidelobe control for FM waveforms, the stepped frequency waveform, Phase-modulated pulse compression waveforms, COSTAS Frequency Codes.

UNIT V  DOPPLER PROCESSING  9
Alternate forms of the Doppler spectrum, Moving target indication (MTI), Pulse Doppler processing, dwell-to-dwell stagger, Pulse pair processing, additional Doppler processing issues, clutter mapping and the moving target detector, MTI for moving platforms: adaptive displaced phase center antenna processing

OUTCOMES:
Upon completion of the course, students will be able to:
- To be able to perform radar signal acquisition and sampling
- To be able to perform algorithm on radar processing
- To be able to design basic radar algorithm
- To be able to design on aperture imaging and array processing

REFERENCES:
5. Fred E. Nathanson, Radar Design Principles-Signal Processing and the environment PHI
OBJECTIVES:

- To introduce techniques for altering the existing DSP structures to suit VLSI implementations
- To introduce efficient design of DSP architectures suitable for VLSI

UNIT I  
PIPELINING AND PARALLEL PROCESSING OF DIGITAL FILTERS  9
Introduction to DSP systems – Typical DSP algorithms, Data flow and Dependence graphs – critical path, Loop bound, iteration bound, Longest path matrix algorithm, Pipelining and Parallel processing of FIR filters, Pipelining and Parallel processing for low power.

UNIT II  
ALGORITHMIC STRENGTH REDUCTION TECHNIQUE I  9

UNIT III  
ALGORITHMIC STRENGTH REDUCTION -II  9

UNIT IV  
BIT-LEVEL ARITHMETIC ARCHITECTURES  9
Bit-level arithmetic architectures – parallel multipliers with sign extension, parallel carry-ripple and carry-save multipliers, Design of Lyon’s bit-serial multipliers using Horner’s rule, bit-serial FIR filter, CSD representation, CSD multiplication using Horner’s rule for precision improvement, Distributed Arithmetic fundamentals and FIR filters.

UNIT V  
NUMERICAL STRENGTH REDUCTION, WAVE AND ASYNCHRONOUS PIPELINING  9

TOTAL: 45 PERIODS

OUTCOME:

- Ability to modify the existing or new DSP architectures suitable for VLSI.

REFERENCES:

OBJECTIVES:

- To study basic concepts of processing speech and audio signals
- To study and analyse various M-band filter-banks for audio coding
- To understand audio coding based on transform coders.
- To study time and frequency domain speech processing methods

UNIT I MECHANICS OF SPEECH AND AUDIO


UNIT II TIME-FREQUENCY ANALYSIS: FILTER BANKS AND TRANSFORMS

Introduction - Analysis-Synthesis Framework for M-band Filter Banks- Filter Banks for Audio Coding: Design Considerations - Quadrature Mirror and Conjugate Quadrature Filters - Tree-Structured QMF and CQF M-band Banks - Cosine Modulated "Pseudo QMF" M-band Banks - Cosine Modulated Perfect Reconstruction (PR) M-band Banks and the Modified Discrete Cosine Transform (MDCT) - Discrete Fourier and Discrete Cosine Transform - Pre-echo Distortion - Pre-echo Control Strategies

UNIT III AUDIO CODING AND TRANSFORM CODERS


UNIT IV TIME AND FREQUENCY DOMAIN METHODS FOR SPEECH PROCESSING


UNIT V PREDICTIVE ANALYSIS OF SPEECH


OUTCOMES:

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

- Evaluate audio coding and transform coders
- Discuss time and frequency domain methods for speech processing
- Explain predictive analysis of speech

TOTAL: 45 PERIODS
REFERENCES:

DS5211 DIGITAL SIGNAL PROCESSING LABORATORY II L T P C
0 0 4 2

OBJECTIVES:
- To be able to learn Matlab/Simulink software interface
- To be able to Digital Signal Processor Kit & Matlab/Simulink hardware interface
- Able to develop offline and Real Time Applications in Filters etc.

LIST OF EXPERIMENTS
1. MATLAB–DSK Interface Using RTDX
2. MATLAB–DSK Interface Using RTDX for FIR Filter Implementation
3. Adaptive Filter for Sinusoidal Noise Cancellation
4. Adaptive Predictor for Cancellation of Narrowband Interference Added to a Desired Wideband Signal
5. DSK Interface Using RTDX with MATLAB Functions for FFT and Plotting
6. mini-project based on the Matlab/Simulink-DSK

TOTAL: 45 PERIODS

OUTCOMES:
Upon Completion of the course, the students will be able to:
- Design & Develop a Digital Signal Processor based applications
- Design & Develop a Digital Signal Processor & Matlab/Simulink based various applications

LIST OF EQUIPMENT FOR A BATCH OF 30 STUDENTS:
SL. NO. DESCRIPTION OF EQUIPMENT QUANTITY REQUIRED
1 TMS 320 C67X Kits 10
2 MATLAB or Equivalent Licensed or Open Source S/W with Signal Processing Tool box 15
3 CRO 50 MHz 10
4 function Generator 1 MHz 10
5 Speakers 10
In this course, students will develop their scientific and technical reading and writing skills that they need to understand and construct research articles. A term paper requires a student to obtain information from a variety of sources (i.e., Journals, dictionaries, reference books) and then place it in logically developed ideas. The work involves the following steps:

1. Selecting a subject, narrowing the subject into a topic
2. Stating an objective.
3. Collecting the relevant bibliography (atleast 15 journal papers)
4. Preparing a working outline.
5. Studying the papers and understanding the authors contributions and critically analysing each paper.
6. Preparing a working outline
7. Linking the papers and preparing a draft of the paper.
8. Preparing conclusions based on the reading of all the papers.
9. Writing the Final Paper and giving final Presentation

Please keep a file where the work carried out by you is maintained.

Activities to be carried Out

<table>
<thead>
<tr>
<th>ACTIVITY</th>
<th>INSTRUCTIONS</th>
<th>SUBMISSION WEEK</th>
<th>EVALUATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>Selection of area of interest</td>
<td>You are requested to select an area of interest, topic and state an objective</td>
<td>2nd week</td>
<td>3 % Based on clarity of thought, current relevance and clarity in writing</td>
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<tr>
<td>and topic</td>
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<tr>
<td>Stating an Objective</td>
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<tr>
<td>Collecting Information about</td>
<td>1. List 1 Special Interest Groups or professional society</td>
<td>3rd week</td>
<td>3% (the selected information must be area specific and of international and national standard)</td>
</tr>
<tr>
<td>your area &amp; topic</td>
<td>2. List 2 journals</td>
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<td>3. List 2 conferences, symposia or workshops</td>
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<td>4. List 1 thesis title</td>
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<td></td>
<td>5. List 3 web presences (mailing lists, forums, news sites)</td>
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<td></td>
<td>6. List 3 authors who publish regularly in your area</td>
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<td>7. Attach a call for papers (CFP) from your area</td>
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<tr>
<td>Collection of Journal papers in the topic in the context of the objective – collect 20 &amp; then filter</td>
<td><strong>4th week</strong></td>
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</tbody>
</table>
| • You have to provide a complete list of references you will be using - Based on your objective - Search various digital libraries and Google Scholar  
• When picking papers to read - try to:  
  • Pick papers that are related to each other in some ways and/or that are in the same field so that you can write a meaningful survey out of them,  
  • Favour papers from well-known journals and conferences,  
  • Favour “first” or “foundational” papers in the field (as indicated in other people’s survey paper),  
  • Favour more recent papers,  
  • Pick a recent survey of the field so you can quickly gain an overview,  
  • Find relationships with respect to each other and to your topic area (classification scheme/categorization)  
  • Mark in the hard copy of papers whether complete work or section/sections of the paper are being considered | **6%** |
| **Reading and notes for first 5 papers** | **5th week** |
| **Reading Paper Process**  
• For each paper form a Table answering the following questions:  
  • What is the main topic of the article?  
  • What was/were the main issue(s) the author said they want to discuss?  
  • Why did the author claim it was important?  
  • How does the work build on other’s work, in the author’s opinion?  
  • What simplifying assumptions does the author claim to be making?  
  • What did the author do?  
  • How did the author claim they were going to evaluate their work and compare it to others?  
  • What did the author say were the limitations of their research?  
  • What did the author say were the important directions for future research?  
Conclude with limitations/issues not addressed by the paper ( from the perspective of your survey) | **8%** |
<p>| <strong>Reading and notes for next5 papers</strong> | <strong>6th week</strong> |
| <strong>Repeat Reading Paper Process</strong> | <strong>8%</strong> |
| <strong>( the table given should indicate your understanding of the paper and the evaluation is based on your conclusions about each paper)</strong> |</p>
<table>
<thead>
<tr>
<th>Reading and notes for final 5 papers</th>
<th>Repeat Reading Paper Process</th>
<th>7th week</th>
<th>8% (the table given should indicate your understanding of the paper and the evaluation is based on your conclusions about each paper)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Draft outline 1 and Linking papers</td>
<td>Prepare a draft Outline, your survey goals, along with a classification / categorization diagram</td>
<td>8th week</td>
<td>8% (this component will be evaluated based on the linking and classification among the papers)</td>
</tr>
<tr>
<td>Abstract</td>
<td>Prepare a draft abstract and give a presentation</td>
<td>9th week</td>
<td>6% (Clarity, purpose and conclusion) 6% Presentation &amp; Viva Voce</td>
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<tr>
<td>Introduction Background</td>
<td>Write an introduction and background sections</td>
<td>10th week</td>
<td>5% (clarity)</td>
</tr>
<tr>
<td>Sections of the paper</td>
<td>Write the sections of your paper based on the classification / categorization diagram in keeping with the goals of your survey</td>
<td>11th week</td>
<td>10% (this component will be evaluated based on the linking and classification among the papers)</td>
</tr>
<tr>
<td>Your conclusions</td>
<td>Write your conclusions and future work</td>
<td>12th week</td>
<td>5% (conclusions – clarity and your ideas)</td>
</tr>
<tr>
<td>Final Draft</td>
<td>Complete the final draft of your paper</td>
<td>13th week</td>
<td>10% (formatting, English, Clarity and linking) 4% Plagiarism Check Report</td>
</tr>
<tr>
<td>Seminar</td>
<td>A brief 15 slides on your paper</td>
<td>14th &amp; 15th week</td>
<td>10% (based on presentation and Viva-voce)</td>
</tr>
</tbody>
</table>

**TOTAL : 30 PERIODS**
OBJECTIVES:
- The students will be able to understand frequency domain signals
- The students will be able to know about the optical properties of the signals
- Can aware of the Optical signal Imaging techniques
- Understand Laser optical signal Applications

UNIT I  ANALYSIS OF TWO DIMENSIONAL SIGNALS AND SYSTEMS  9
Review of one-dimensional Fourier analysis, analysis of two-dimensional signals and systems, Fourier analysis in two dimensions, localization, linear systems and Fourier analysis, two dimensional sampling theory.

UNIT II  FOUNDATIONS OF SCALAR DIFFRACTION THEORY  9
Kirchoff and Rayleigh-Sommerfield formulations, comparison of kirchoff and Rayleigh Sommerfield theories, huygens-fresnel principle, non-monochromatic waves, diffraction at boundaries, angular spectrum of plane waves fresnel and fraunhofer diffraction Fresnel approximation, fraunhofer approximation, examples of fraunhofer diffraction patterns, examples of fresnel diffraction calculations.

UNIT III  WAVE OPTICS ANALYSIS OF COHERENT OPTICAL SYSTEMS  9
Thin lens as phase transformation, Fourier transforming properties of lenses, image formation monochromatic illumination, analysis of complex coherent optical systems.

UNIT IV  TRANSFER FUNCTIONS AND FREQUENCY ANALYSIS OF OPTICAL IMAGING SYSTEMS  9
Generalized treatment of imaging systems, amplitude transfer function, frequency response for coherent and incoherent imaging, aberrations and their effect on frequency response,Comparison of coherent and incoherent imaging, resolution beyond classical diffraction limit.

UNIT V  WAVEFRONT MODULATION  9
Photographic film, liquid crystals and other modulators, diffractive optical elements, analog optical information processing, incoherent image processing systems, coherent optical image processing systems. Holography- wavefront reconstruction problem, gabor and leith, upatnieks holograms, image locations and magnification, different types of holograms- thick holograms, recording materials, computer-generated holograms, degradation of holographic images, holography with spatially incoherent light, applications.

TOTAL  45  PERIODS

OUTCOMES:
- Expertise frequency domain optical signals
- Deduce Optical signal Imaging techniques
- Development of Laser optical signal Applications

REFERENCES:
OBJECTIVES:
- To introduce the neural networks as means for computational learning.
- To present the basic network architectures for classification and regression.
- To provide knowledge of computational and dynamical systems using neural networks.
- To perform algorithmic training of various neural networks.
- To understand training and limitations of learning self-organizing systems.

UNIT I
**UNIT I BASIC LEARNING ALGORITHMS**
9

UNIT II
**RADIAL-BASES FUNCTION NETWORKS AND SUPPORT VECTOR MACHINES RADIAL BASIS FUNCTION NETWORKS**
9

UNIT III
**COMMITTEE MACHINES**
9

**NEURODYNAMICS SYSTEMS**

UNIT IV
**ATTRACTOR NEURAL NETWORKS:**
9
ADAPTIVE RESONANCE THEORY:
Noise-Saturation Dilemma - Solving Noise-Saturation Dilemma – Recurrent On-center – Off surround Networks – Building Blocks of Adaptive Resonance – Substrate of Resonance Structural Details of Resonance Model – Adaptive Resonance Theory – Applications

UNIT V SELF ORGANISING MAPS

PULSED NEURON MODELS:

OUTCOMES:
- The Students can deduce the basic Computational Algorithms
- Can explore mathematical based computational Algorithms
- Use different methods for the various applications

REFERENCES:

AP5093 ROBOTICS L T P C
3 0 0 3

OBJECTIVES:
- To understand robot locomotion and mobile robot kinematics
- To understand perception in robotics
- To understand mobile robot localization
- To understand mobile robot mapping
- To understand simultaneous localization and mapping (SLAM)
- To understand robot planning and navigation

UNIT I LOCOMOTION AND KINEMATICS

UNIT II ROBOT PERCEPTION
UNIT III  MOBILE ROBOT LOCALIZATION

UNIT IV  MOBILE ROBOT MAPPING

UNIT V  PLANNING AND NAVIGATION
Introduction to planning and navigation – planning and reacting – path planning – obstacle avoidance techniques – navigation architectures – basic exploration algorithms

TOTAL : 45 PERIODS

OUTCOMES:
Upon Completion of the course, the students will be able to
- Explain robot locomotion
- Apply kinematics models and constraints
- Implement vision algorithms for robotics
- Implement robot localization techniques
- Implement robot mapping techniques
- Implement SLAM algorithms
- Explain planning and navigation in robotics

REFERENCES:

DS5002  INTRODUCTION TO MACHINE LEARNING

OBJECTIVES:
- To understand the machine learning theory
- To implement linear and non-linear learning models
- To implement distance-based clustering techniques
- To build tree and rule based models
- To apply reinforcement learning techniques
UNIT I  FOUNDATIONS OF LEARNING

UNIT II  LINEAR MODELS

UNIT III  DISTANCE-BASED MODELS

UNIT IV  TREE AND RULE MODELS

UNIT V  REINFORCEMENT LEARNING

TOTAL : 45 PERIODS

OUTCOMES:
- Upon Completion of the course, the students will be able to
- To explain theory underlying machine learning
- To construct algorithms to learn linear and non-linear models
- To implement data clustering algorithms
- To construct algorithms to learn tree and rule-based models
- To apply reinforcement learning techniques

REFERENCES
OBJECTIVES

- It provides a solid foundation in advanced biomedical signaling and imaging systems including up-to-date coverage of commercially relevant topics.
- It focuses on biomedical signals, processing the signals, and validate the methods and results for optimization of clinical applications
- To introduce techniques for automated classification and decision making to aid diagnosis

UNIT I SIGNAL, SYSTEM AND SPECTRUM


UNIT II TIME SERIES ANALYSIS AND SPECTRAL ESTIMATION

Time series analysis – linear prediction models, process order estimation, non stationary process, fixed segmentation, adaptive segmentation, application in EEG, PCG and HRV signals, model based ECG simulator. Spectral estimation – Blackman Tukey method, periodogram, and model based estimation. Application in Heart rate variability, PCG signals.

UNIT III ADAPTIVE FILTERING AND WAVELET DETECTION

Filtering – LMS adaptive filter, adaptive noise cancelling in ECG, improved adaptive filtering in FECG, EEG and other applications in Bio signals, Wavelet detection in ECG – structural features, matched filtering, adaptive wavelet detection, detection of overlapping wavelets.

UNIT IV BIOSIGNAL CLASSIFICATION AND RECOGNITION

Signal classification and recognition – Statistical signal classification, linear discriminant function, direct feature selection and ordering, Back propagation neural network based classification. Application in Normal versus Ectopic ECG beats and other biomedical applications

UNIT V TIME FREQUENCY AND MULTIVARIATE ANALYSIS

Time frequency representation, spectrogram, Time-scale representation, scalogram, wavelet analysis – Data reduction techniques, ECG data compression, ECG characterization, Feature extraction-Wavelet packets, Multivariate component analysis-PCA, ICA

TOTAL: 45 PERIODS

REFERENCES:

OBJECTIVES:
- The student understands Maximum Likelihood estimation, point and scale estimation.
- The student is familiar with binary and colour image processing basics.
- The student can handle median based operations.
- The student has knowledge about sorting operations.
- The student can explain various implementation technologies.

UNIT I  LINEAR SIGNAL PROCESSING AND STATISTICAL PRELIMINARIES  9

UNIT II  BINARY IMAGE AND COLOUR IMAGE PROCESSING  9

UNIT III  INTRODUCTION TO NON LINEAR FILTERS  9

UNIT IV  ALGORITHMS  9

UNIT V  ARCHITECTURE AND APPLICATIONS OF NONLINEAR FILTERS  9

OUTCOMES:
- Derive Maximum Likelihood criterion in the least square sense.
- Define the rules and standards for binary and colour image processing.
- Describe different sorting algorithms.
- Design simple median based filters.
- Develop different architecture schemes for nonlinear filters.

REFERENCES
OBJECTIVES

- To know basis of the Antenna Signals and its types
- To know about the representation of the Antenna acquisition signals in different domains
- To understand statistical techniques of the signal representation
- To be able to study different applications of the Antenna Systems

UNIT I  INTRODUCTION
Antenna parameters, Basic Antenna elements, Array Fundamentals- Element pattern, directive gain, Directivity, Power Gain, Polarization, array pattern, array gain, array taper efficiency, Pencil beam array, linear array synthesis-schelknoff ‘s polynomial array, binomial array, Chebyshev array, Microstrip patch array, Noise in communication.

UNIT II  SPATIAL SIGNALS AND SENSOR ARRAYS

UNIT III  SPATIAL FREQUENCY

UNIT IV  DIRECTION OF ARRIVAL ESTIMATION

UNIT V  APPLICATIONS OF ARRAY SIGNAL PROCESSING
RADAR, Sonar, Seismic, Acoustics, Wireless Communications and networks and Radio Astronomy signal processing applications

TOTAL : 45 PERIODS

OUTCOMES:

- To be able to design Antenna based signal Acquisition System
- To be able to develop different mathematical techniques for signal acquired from the Antenna Receiver system
- To be able to understand different Antenna Acquisition Applications

REFERENCES:

OBJECTIVES:
- To understand the basics of Ad-hoc & Sensor Networks.
- To learn various fundamental and emerging protocols of all layers.
- To study about the issues pertaining to major obstacles in establishment and efficient management of Ad-hoc and sensor networks.
- To understand the nature and applications of Ad-hoc and sensor networks.
- To understand various security practices and protocols of Ad-hoc and Sensor Networks.

UNIT I MAC & TCP IN AD HOC NETWORKS

UNIT II ROUTING IN AD HOC NETWORKS

UNIT III MAC, ROUTING & QOS IN WIRELESS SENSOR NETWORKS

UNIT IV SENSOR MANAGEMENT

UNIT V SECURITY IN AD HOC AND SENSOR NETWORKS

TOTAL: 45 PERIODS

OUTCOMES:
Upon Completion of the course, the students should be able to
- Identify different issues in wireless ad hoc and sensor networks.
- To analyze protocols developed for ad hoc and sensor networks.
- To identify and address the security threats in ad hoc and sensor networks.
- Establish a Sensor network environment for different type of applications.
OBJECTIVES:

- Encryption techniques and key generation techniques
- To learn about Authentication and security measures
- To study security system and wireless security analysis

UNIT I SYMMETRIC CIPHERS

UNIT II PUBLIC-KEY ENCRYPTION AND HASH FUNCTIONS

UNIT III NETWORK SECURITY PRACTICE

UNIT IV SYSTEM SECURITY

UNIT V WIRELESS SECURITY

TOTAL: 45 PERIODS
OUTCOMES:
To be able to present Encryption techniques and key generation techniques
Has practice in Authentication and security measures
Having exposure of security system and wireless security issues

REFERENCES:

DS5006 UNDERWATER ACOUSTICS SIGNAL PROCESSING L T P C
3 0 0 3

OBJECTIVES:
- To understand the characteristics of Underwater Channel
- To understand the principles of SONAR
- To understand the challenges in underwater signal processing

UNIT I UNDERWATER ACOUSTIC CHANNEL 9
Underwater Channel Characterization – Sound Transmission Losses-Acoustic Characteristics of surface layer-Ambient Noise in the ocean- Correlation properties of Ambient Noise

UNIT II SONAR 9
Basics of SONAR- correlation and ambiguities-Wideband Synthetic Aperture SONAR processing-Discrete Spatial arrays-Beam steering- Target Angle Estimation –Array Shading:

UNIT III TARGET DETECTION 9
Passive Acoustic signatures of Ships and Submarines-Target strength for Active Systems-Hypothesis testing- receiver operating Characteristics-estimation of signal Parameters

UNIT IV STATISTICAL PROCESSING & ADAPTIVE SPATIAL FILTERING 9
Monostatic Sounding of Single point Targets-Target strength estimation from Echo ensemble-Optimum Filter for Maximum SNR-High Resolution Beam Forming

UNIT V UNDERWATER ACOUSTIC COMMUNICATION 9
Underwater Bio Telemetry System -system Design principle-Speech Coding and Decoding-Transmission and Detection of speech

TOTAL :45 PERIODS
OUTCOMES:
- To be able to design underwater signal processing systems
- To be able to analyze the performance of underwater signal processing systems

REFERENCES
1. Robert S.H. Istepanian and MilicaStojanovic, Underwater Acoustic Digital signal processing & communication system, Kluwer academic Publisher, 2002

AP5191 EMBEDDED SYSTEM DESIGN

OBJECTIVES:
The students should be made to:
- Learn design challenges and design methodologies
- Study general and single purpose processor
- Understand bus structures

UNIT I EMBEDDED SYSTEM OVERVIEW
Embedded System Overview, Design Challenges – Optimizing Design Metrics, Design Methodology, RT-Level Combinational and Sequential Components, Optimizing Custom Single-Purpose Processors.

UNIT II GENERAL AND SINGLE PURPOSE PROCESSOR
Basic Architecture, Pipelining, Superscalar and VLIW architectures, Programmer’s view, Development Environment, Application-Specific Instruction-Set Processors (ASIPs) Microcontrollers, Timers, Counters and watchdog Timer, UART, LCD Controllers and Analog-to-Digital Converters, Memory Concepts.

UNIT III BUS STRUCTURES

UNIT IV STATE MACHINE AND CONCURRENT PROCESS MODELS

UNIT V EMBEDDED SOFTWARE DEVELOPMENT TOOLS AND RTOS

TOTAL: 45 PERIODS

OUTCOMES:
At the end of this course, the students should be able to:
- Explain different protocols
- Discuss state machine and design process models
- Outline embedded software development tools and RTOS
REFERENCES:

DS5007    REAL TIME OPERATING SYSTEMS    L    T    P    C
                        3    0    0    3

OBJECTIVES:
- To expose the students to the fundamentals of interaction of OS with a computer and User computation
- To teach the fundamental concepts of how process are created and controlled with OS
- To study on programming logic of modeling Process based on range of OS features
- To compare types and Functionalities in commercial OS, application development using RTOS
- To involve Discussions/ Practice/Exercise onto revising & familiarizing the concepts acquired over the 5 Units of the subject for improved employability skills

UNIT I    REVIEW OF OPERATING SYSTEMS

UNIT II    OVERVIEW OF RTOS

UNIT III    REAL TIME MODELS AND LANGUAGES
Event Based –Process Based and Graph based Models –Real Time Languages –RTOS Tasks – RT scheduling -Interrupt processing –Synchronization –Control Blocks –Memory Requirements.

UNIT IV    REAL TIME KERNEL
Principles –Design issues –Polled Loop Systems –RTOS Porting to a Target –Comparison and Basic study of various RTOS like –VX works –Linux supportive RTOS –C Executive.

UNIT V    APPLICATION DEVELOPMENT USING OS
Discussions on Basics of Linux supportive RTOS–uCOS-C Executive for development of RTOS Application–introduction to Android Environment-The Stack–Android User Interface–Preferences, the File System, the Options Menu and Intents, with one Case study

TOTAL :45 PERIODS
OUTCOMES:
- The learning process delivers insight into scheduling, disciplining various embedded & Computational processes with improved design strategies.
- Improved Employability and entrepreneurship capacity due to knowledge up gradation on recent trends in embedded systems design.

REFERENCES:

VL5191 DSP INTEGRATED CIRCUITS L T P C 3 0 0 3

OBJECTIVES:
- To familiarize the concept of DSP and DSP algorithms.
- Introduction to Multirate systems and finite wordlength effects
- To know about the basic DSP processor architectures and the synthesis of the processing elements

UNIT I INTRODUCTION TO DSP INTEGRATED CIRCUITS 9
Introduction to Digital signal processing, Sampling of analog signals, Selection of sample frequency, Signal-processing systems, Frequency response, Transfer functions, Signal flow graphs, Filter structures, Adaptive DSP algorithms, DFT-The Discrete Fourier Transform, FFT Algorithm, Image coding, Discrete cosine transforms, Standard digital signal processors, Application specific ICs for DSP, DSP systems, DSP system design, Integrated circuit design.

UNIT II DIGITAL FILTERS AND FINITE WORD LENGTH EFFECTS 9
FIR filters, FIR filter structures, FIR chips, IIR filters, Specifications of IIR filters, Mapping of analog transfer functions, Mapping of analog filter structures, Multi rate systems, Interpolation with an integer factor L, Sampling rate change with a ratio L/M, Multi rate filters. Finite word length effects - Parasitic oscillations, Scaling of signal levels, Round-off noise, Measuring round-off noise, Coefficient sensitivity, Sensitivity and noise.

UNIT III DSP ARCHITECTURES 9
DSP system architectures, Standard DSP architecture-Harvard and Modified Harvard architecture. Ideal DSP architectures, Multiprocessors and multi computers, Systolic and Wave front arrays, Shared memory architectures.

UNIT IV SYNTHESIS OF DSP ARCHITECTURES 9
Synthesis: Mapping of DSP algorithms onto hardware, Implementation based on complex PEs, Shared memory architecture with Bit – serial PEs. Combinational & sequential networks- Storage elements – clocking of synchronous systems, Asynchronous systems - FSM
UNIT V ARITHMETIC UNIT AND PROCESSING ELEMENTS  
Conventional number system, Redundant Number system, Residue Number System, Bit-parallel and Bit-Seril arithmetic, Digit Serial arithmetic, CORDIC Algorithm, Basic shift accumulator, Reducing the memory size, Complex multipliers, Improved shift-accumulator. Case Study : DCT and FFT processor

TOTAL: 45 PERIODS

OUTCOMES:
- Get to know about the Digital Signal Processing concepts and its algorithms
- Get an idea about finite word length effects in digital filters
- Concept behind multi rate systems is understood.
- Get familiar with the DSP processor architectures and how to perform synthesis of processing elements

REFERENCES:

BM5291 APPLIED MEDICAL IMAGE PROCESSING  
OBJECTIVES:
- To develop computational methods and algorithms to analyze and quantify biomedical data
- To understand the fundamentals of medical image processing techniques.

UNIT I IMAGE FUNDAMENTALS  
Image perception, MTF of the visual system, Image fidelity criteria, Image model, Image sampling and quantization – two dimensional sampling theory, Image quantization, Optimum mean square quantizer, Image transforms – DFT, DCT, KLT, SVD.

UNIT II IMAGE ENHANCEMENT AND RESTORATION  
Histogram equalization and specification techniques, Noise distributions, Spatial averaging, Directional smoothing, Median, Geometric mean, Harmonic mean, Contra harmonic mean filters, Homomorphic filtering, Color image enhancement. Image Restoration - degradation model, Unconstrained and constrained restoration, Inverse filtering- Wiener filtering

UNIT III MEDICAL IMAGE REPRESENTATION  
Pixels and voxels – algebraic image operations - gray scale and color representation- depth-color and look up tables - image file formats- DICOM- other formats- Analyze 7.5, NiftI and Interfile, Image quality and the signal to noise ratio

UNIT IV MEDICAL IMAGE ANALYSIS AND CLASSIFICATION  
Image segmentation- pixel based, edge based, region based segmentation. Image representation and analysis, Feature extraction and representation, Statistical, Shape, Texture, feature and image classification – Statistical, Rule based, Neural Network approaches
UNIT V IMAGE REGISTRATIONS AND VISUALIZATION

Rigid body visualization, Principal axis registration, Interactive principal axis registration, Feature based registration, Elastic deformation based registration, Image visualization – 2D display methods, 3D display methods, virtual reality based interactive visualization.

TOTAL: 45 PERIODS

OUTCOMES:

- Students will be able to apply image processing concepts for medical images.
- Will be able to analyze Morphology, Segmentation techniques and implement these in images.
- Enables quantitative analysis and visualization of medical images of numerous modalities such as PET, MRI, CT, or microscopy

REFERENCES:


DS5008 MIXED SIGNAL PROCESSING

OBJECTIVES:

- To know the fundamentals of Signals, Filters and Sampling process
- To understand the design techniques of analog and digital filters Structures
- To know the fundamentals of analog and digital conversion techniques in logical design
- To understand the various conversion architectures for analog and digital signal processing

UNIT I SIGNALS, FILTERS AND SAMPLING


UNIT II ANALOG FILTERS

Integrator Building Blocks- Lowpass Filters, Active-RC Integrators, MOSFET-C Integrators, gm-C (Transconductor-C) Integrators, Discrete-Time Integrators, Filtering Topologies- The Bilinear Transfer Function, The Biquadratic Transfer Function
UNIT III DIGITAL FILTERS
SPICE Models for DACs and ADCs- The Ideal DAC, The Ideal ADC, Number Representation, Sinc-Shaped Digital Filters- The Counter, Lowpass Sinc Filters, Bandpass and Highpass Sinc Filters, Interpolation using Sinc Filters, Decimation using Sinc Filters, Filtering Topologies- FIR Filters, Stability and Overflow, The Bilinear Transfer Function, The Biquadratic Transfer Function

UNIT IV DATA CONVERTER FUNDAMENTALS

UNIT V DATA CONVERTER ARCHITECTURES
DAC Architectures- Digital Input Code, Resistor String, R-2R Ladder Networks, Current Steering, Charge-Scaling DACs, ADC Architectures- Flash, The Two-Step Flash ADC, The Pipeline ADC, Integrating ADCs, The Successive Approximation ADC, The Oversampling ADC

OUTCOMES:
- To be able to design analog and digital filters Structures
- To be able to carry out the filters design in data conversions
- To be able to design conversion architectures for DSP algorithms.

REFERENCES:

DS5009 DIGITAL MODULATION AND CODING

OBJECTIVES:
- To learn about representation of signals in information coding aspect
- To learn various modulation techniques
- To learn error detection and correction information coding
- To learn various method of coding

UNIT I BAND PASS DATA TRANSMISSION
Geometric representation of signals; Coherent detection of signals in noise. Correlation receiver and matched filter receiver.

UNIT II DIGITAL MODULATION
Probability of error and receiver implementation of BPSK, BFSK, QPSK, MSK, Mary PSK and Mary FSK.
UNIT III: DEMODULATION OF SIGNALS
Union bound approximation for the probability of error. Detection of signals with unknown phase
Spectra of digitally modulated signals. Carrier and clock recovery methods.

UNIT IV: ERROR CONTROL CODES
Error control coding: Linear block codes: Generator and parity check matrices. Syndrome
calculation. Error detection and error correction using block codes. Conventional codes:
Generator and transfer function matrices.

UNIT V: CONVENTIONAL CODES
State and trellis diagrams. Maximum likelihood decoding of conventional codes: The Viterbi
algorithm. Trellis coded modulation.

TOTAL: 45 PERIODS

OUTCOMES:
- Fundamental signal representation in information coding
- Various modulation techniques in order to develop the similar techniques
- Has knowledge in error detection and correction methods information coding and various
  method of coding

REFERENCES
   TECHNIQUES” Signalling and detection practice wall India, New Delhi 195
   2002.