



GUJARAT TECHNOLOGICAL UNIVERSITY

Master of Engineering

Subject Code: 3720312

ADVANCE SIGNAL PROCESSING AND ESTIMATION

SEMESTER: II

Type of course: Core IV

Prerequisite: Signals and Systems

Rationale: This course provides an overview and fundamentals of various types of filters design and various applications of DSP and study of various wavelet techniques.

Teaching and Examination Scheme:

Teaching Scheme			Credits C	Examination Marks				Total Marks
L	T	P		Theory Marks		Practical Marks		
				ESE (E)	PA (M)	ESE (V)	PA (I)	
3	0	2	4	70	30	30	20	150

Content:

Sr. No	Topics	Hours
1.	FIR and Adaptive FIR Filter Design Ideal Filter Requirements, FIR Filter Design Specifications, Classification of Linear Phase FIR Filters, Frequency Response of Linear-Phase Filters, Pole and Zero Plots For FIR Filters, Filter Design Techniques For Linear-Phase FIR Filters, FIR Filter Design Using Windowing, Gibbs Phenomenon, FIR Filter Design using Fourier Series Expansion Method, Use of Windowing, Comparison Of Different Window Functions, FIR Filter Design Using Frequency Sampling Method, Frequency Sampling Structures, FIR Differentiator Design, Design of FIR Hilbert Transformer, Adaptive FIR Filter Design, Method of Steepest Descent and Newton's Method, Least Mean Square Algorithm, Applications Of Adaptive Filters, FIR System Structures, Direct-Form Realization, Cascade-Form Realization, Lattice Structure Realization	15
2.	IIR and Adaptive IIR Filter Design IIR Filter Design Using Impulse Invariance, Transformation or mapping function, IIR Filter Design Using Bilinear Transformation, Frequency Wrapping Function, IIR Filter Design Using Bilinear Transformation Method, Analog Filters-Butterworth Filters, Butterworth Filters (LPF), Butterworth Filters Design (LPF), Butterworth Filters (HPF), Butterworth	10



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	Filters(BPF and BRF), Calculation of the Order of Butterworth Filter from the given Filter Specifications, DT Butterworth Filter Design using Impulse Invariance Method, DT Butterworth Filter Design using BLT Method, Adaptive IIR Filter Design, Pade Approximation Technique, Least Squares Design Methods, IIR Filter structures, Direct form realizations, cascade form Realization, Parallel structure realization, lattice structure realization, Quantization effects in IIR filters, Truncation and rounding, Input signal sample quantization, limit cycle oscillations, Applications of FIR filters, Echoes and echo cancellation, multiple echoes, reverberation, digital music synthesis.	
3	Multirate DSP and Applications Decimation by inter Factor D, Interpolation by an inter factor I, Sampling rate conversion by a factor of I/D, Efficient implementation of decimator/Interpolator, multistage filter design, sampling rate conversion by arbitrary factor, Applications of multirate DSP, Design of phase shifter, Design of DFT filter bank, Design of QMFs, sub-band coding of speech signals, Over sampling ADC/DAC, Applications of Multirate DSP for image resizing.	10
4	DCT, WT, and Applications Discrete cosine transform and discrete sine transform, Karhunen-Loeve transform, Applications of DCT, Signal coding, signal filtering, sampling rate conversion and resizing, Feature extraction and recognition, Wavelet transform, Haar wavelet and multi resolution analysis, multi resolution analysis, Daubechies wavelets, matrix multiplication method for computation of WT, Biorthogonal wavelets, wavelet packets, full wavelet packet decomposition, Applications of WT, Denoising using DWT, Signal compression, signal filtering, sampling rate conversion.	10

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
15	25	15	15	15	15

Legends: R: Remembrance; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create and above Levels (Revised Bloom's Taxonomy)

Note: This specification table shall be treated as a general guideline for students and teachers. The actual distribution of marks in the question paper may vary slightly from above table.



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Reference Books:

1. Advanced Digital Signal Processing by Dr. Shaila D. Apte, Wiley India Pvt. Ltd.
2. Digital Signal Processing A Practical Approach Second Edition by Emmanuel C Ifeachor, and Barrie W. Jervis, Prentice Hall of India.
3. Digital Signal Processing Principles, Algorithms, and Applications, Fourth Edition by John G. Proakis and Dimitris G. Manolakis, Prentice Hall of India.
4. Digital Signal Processing by S.Salivahanan, A Vallavaraj, C. Gnanapriya, 2e, Tata Mcgraw Hill India.

Course Outcome:

Sr. No.	CO statement	Marks % weightage
CO-1	Understand the structure of various types of filters	25
CO-2	Design of different types of filters	25
CO-3	Various Wavelet Techniques for different applications	25
CO-4	Multirate DSP and its applications	25

List of Practical:

Student has to prepare computer programs and simulate them for various filter design techniques covered in this course with any computing tools (MATLAB, Scilab, etc...).

1. Designing a low-pass FIR filter using rectangular window. Plot its magnitude and phase response.
2. Plot different window functions like Blackman, Hamming, Hanning, Bartlett, and Kaiser window.
3. Designing a high-pass FIR filter using blackman/Hamming/Hanning/Bartlett/Kaiser/Rectangular windows. Plot their magnitude and phase response.
4. Design 7 coefficient FIR BPF using frequency sampling method and plot its magnitude and phase response.
5. Design 7 coefficient FIR differentiator using rectangular window and Hamming window. Plot their magnitude responses. Compare the effect of windowing.
6. Design 7 coefficient FIR Hilbert transformer using rectangular window and Hamming window. Plot their magnitude responses. Compare the effect of windowing.
7. Design LPF DT Butterworth filter using BLT method. Plot its magnitude and phase response.
8. Perform filtering of speech signal using FIR-LPF and decimating it by factor of 2. Plot original, filtered and decimated speech signal.
9. Using DCT and perform compression of the image. Display original and compressed image.
10. Perform resizing of an image by a downsampling factor of 2 and 4.
11. Apply low pass filtering on an image using wavelet transform.
12. Detect the edge in the image using wavelet transform.

Major Equipment: Computer Laboratory

List of Open Source Software/learning website:

- Matlab, Scilab
- NPTEL