



GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Master of Engineering

Level: PG

Branch: Applied Instrumentation

Subject Code : ME02067021

Subject Name : Advance Signal Processing & Estimation

WEF Academic Year :	2024-25
Semester :	2
Category of the Course :	Professional Core Course

Prerequisite :	Digital Signal Processing
Rationale :	This course provides an overview and fundamentals of various types of filters design and various applications of DSP along with estimation techniques.

Course Scheme:

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

Course Content:

Sr. No.	Course Content	No. of Hours	% of Weightage
1	DESIGN OF DIGITAL FILTERS: Causality and Its Implications. Characteristics of Practical Frequency-Selective Filters. Design of FIR Filters Symmetric and Antisymmetric: FIR Filters, Design of Linear-Phase FIR Filters Using Windows, Design of Linear-Phase FIR Filters by the Frequency-Sampling Method, Design of Optimum Equiripple Linear-Phase FIR Filters, Design of FIR Differentiators, Design of Hilbert Transformers, Comparison of Design Methods for Linear-Phase FIR Filters, Design of IIR Filters From Analog Filters, IIR Filter Design by Approximation of Derivatives. IIR Filter Design by Impulse Invariance. IIR Filter Design by the Bilinear Transformation, The Matched-; Transformation, Characteristics of Commonly Used Analog Filters. Some Examples of	16	35



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	<p>Digital Filter Designs Based on the Bilinear Transformation. Frequency Transformations in the Analog Domain, Frequency Transformations in the Digital Domain.</p> <p>Design of Digital Filters Based on Least-Squares Method: Pade approximation, FIR Least-Squares Inverse (Wiener) Filters, Design of IIR Filters in the Frequency Domain.</p>		
2	<p>MULTIRATE DIGITAL SIGNAL PROCESSING</p> <p>Decimation by a Factor D, Interpolation by a Factor I, Sampling Rate Conversion by a Rational Factor I/D</p> <p>Filter Design and Implementation for Sampling-Rate Conversion: Direct-Form FIR Filter Structures, Polyphase Filter Structures, Time-Variant Filter Structures. Multistage Implementation of Sampling-Rate Conversion, Sampling-Rate Conversion of Bandpass Signals, Decimation and Interpolation by Frequency Conversion, Modulation-Free Method for Decimation and Interpolation.</p> <p>Applications of Multirate Signal Processing, Design of Phase Shifters. Interfacing of Digital Systems with Different Sampling Rates, Implementation of Narrowband Lowpass Filters, Implementation of Digital Filter Banks. Subband Coding of Speech Signals. Oversampling A/D and D/A Conversion</p>	12	27
3	<p>LINEAR PREDICTION AND OPTIMUM LINEAR FILTERS</p> <p>Innovations Representation of a Stationary Random Process, Rational Power Spectra, Relationships Between the Filter Parameters and the Autocorrelation Sequence, Forward and Backward Linear Prediction, Forward Linear Prediction, Backward Linear Prediction.</p> <p>Wiener Filters for Filtering and Prediction. FIR Wiener Filter, Orthogonality Principle in Linear Mean-Square Estimation, IIR Wiener Filter. Noncausal Wiener Filter.</p>	7	16
4	<p>POWER SPECTRUM ESTIMATION</p> <p>Estimation of Spectra from Finite-Duration Observations of Signals, Computation of the Energy Density Spectrum. Estimation of the Autocorrelation and Power Spectrum of Random Signals: The Periodogram. The Use of the DFT in Power Spectrum Estimation</p> <p>Non parametric Methods for Power Spectrum Estimation The Bartlett Method: Averaging Periodograms, The Welch Method: Averaging Modified Periodograms, The Blackman and Tukey Method: Smoothing the Periodogram, Performance Characteristics of Nonparametric Power Spectrum Estimators</p> <p>Parametric Methods for Power Spectrum Estimation Relationships</p>	10	22



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Between the Autocorrelation and the Model Parameters, The Yule-Walker Method for the AR Model Parameters, The Burg Method for the AR Model Parameters, Unconstrained Least-Squares Method for the AR Model Parameters, Sequential Estimation Methods for the AR Model Parameters, Selection of AR Model Order, MA Model for Power Spectrum Estimation, ARMA Model for Power Spectrum Estimation.		
Total	45	100

Reference Book:

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:

After Completion of the Course, Student will able to:

No	Course Outcomes	RBT Level*
01	Design of different types of filters	AP
02	Design of Multirate DSP and its applications	AP
03	Understand sampling and reconstruction of the signal	UN
04	Analyze and design optimal filters	AN
05	Apply and evaluate various power spectrum estimation techniques	EL

*RM: Remember, UN: Understand, AP: Apply, AN: Analyze, EL: Evaluate, CR: Create

Suggested Course Practical List:

1. Design a low-pass FIR filter using different windowing techniques
2. Design a high pass FIR filter using different windowing techniques
3. Design FIR BPF using frequency sampling.
4. Design LPF DT Butterworth filter using BLT method.



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5. Design a low pass IIR filter.
6. Design a high pass IIR filter.
7. Design multirate filter using Decimation by a Factor D, Interpolation by a Factor I, Sampling Rate Conversion by a Rational Factor I/D.
8. Apply multirate filter on one of the application for signal processing.
9. Apply Wiener Filters for Filtering and Prediction Wiener estimation
10. Apply parametric methods for power spectrum estimation
11. Apply non parametric methods for power spectrum estimation

List of Laboratory/Learning Resources Required:

1. NPTEL
2. Virtual Laboratory (vlab.co.in)

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