CSXX0262 : Digital Signal Processing

L_T_P (3-0-0) Credits: 3

Duration: 14 Weeks (42 Lectures) Target Audience: B.Tech.
Prerequisites: Signals and Systems, Basic Calculus, Linear Algebra

Course Objectives:

To introduce the fundamentals and mathematical tools of Digital Signal Processing.
To understand the design and analysis of digital filters.
To learn efficient algorithms for computing Fourier transforms.

Course Outcomes (COs) and Bloom's Taxonomy Levels:

CO No.	Course Outcome	Bloom's Taxonomy Level
CO1	Understand the representation of discrete-time signals and systems	Understand (Level 2)
CO2	Analyze discrete systems using z-transform and frequency-domain methods	Analyze (Level 4)
CO3	Compute DFT/FFT and interpret frequency components of signals	Apply (Level 3)
CO4	Design and implement FIR and IIR digital filters	Create (Level 6)
CO5	Evaluate effects of finite word length in digital filter implementation	Evaluate (Level 5)
CO6	Multirate Signal Processing Concepts	Create (Level 6)

UNIT 1: Discrete-Time Signals and Systems [5 Lectures]

Basic elements of DSP, advantages of digital over analog processing. Classification of discrete signals and systems. Linear Time-Invariant (LTI) systems and its properties. Convolution, correlation. Stability and causality.

CO1, Bloom's Level: 2 (Understand)

UNIT 2: z-Transform and Analysis of LTI Systems [5 Lectures]

z-Transform and its ROC. Properties of z-transform. Inverse z-transform techniques.System function, stability, and causality in z-domain.

CO2, Bloom's Level: 4 (Analyze)

UNIT 3: Discrete Fourier Transform (DFT) and FFT [7 Lectures]

DTFT, DFT and its properties. Linear convolution using DFT. Filtering of long data sequences using DFT: overlap save method,overlap add method. Fast Fourier Transform (FFT) algorithms: Radix-2 DIT & DIF. FFT computational complexity. Goertzel algorithm.

CO3, Bloom's Level: 3 (Apply)

UNIT 4: FIR Filter Design [5 Lectures]

Characteristics of FIR filters, phase delay and group delay ,linear-phase filter, Frequency response of linear phase FIR filters, FIR filter design using Window method, Frequency sampling method.

CO4, Bloom's Level: 6 (Create)

UNIT 5: IIR Filter Design [6 Lectures]

IIR vs FIR filters. IIR filter design (Using Butterworth approximation , Chebyshev approximation) ,Elliptic Filter, Impulse invariant and bilinear transformation methods. warping effect. Frequency transformation in digital domain.

CO4, Bloom's Level: 6 (Create)

UNIT 6: Realization of Digital Filters [4 Lectures]

Structures for FIR systems: Direct form, cascade, lattice structures.

Structures for IIR systems: Direct form, parallel, cascade, lattice , lattice ladder structure

Signal flow graph

CO4, Bloom's Level: 6 (Create)

UNIT 7: Finite Word Length Effects [5 Lectures]

Quantization errors. Limit cycles in recursive filters. Overflow and scaling. Effect of coefficient quantization on filter performance.

CO5, Bloom's Level: 5 (Evaluate)

UNIT 8: Multirate Signal Processing [5 Lectures]

Multirate Signal Processing. Introduction to multirate DSP. Decimation and interpolation. Sampling rate conversion. Polyphase decomposition Application: subband coding.

CO6, Bloom's Level: 6 (Create)

Textbooks:

1. Tarun Kumar Rawat , Digital Signal Processing, Oxford University Press India
2. A.V. Oppenheim and R.W. Schafer, Discrete-Time Signal Processing, Pearson Education.

Reference Books:

1. S.K. Mitra, Digital Signal Processing: A Computer-Based Approach, McGraw Hill.
2. J.G. Proakis and D.G. Manolakis, Digital Signal Processing: Principles, Algorithms, and Applications, 4th Edition, Pearson Education.
3. R. Rabiner and B. Gold, Theory and Application of Digital Signal Processing, Prentice Hall.
4. P. P. Vaidyanathan, Multirate Systems and Filter Banks, Pearson.

Assessment Structure:

Assignments/Quizzes: 10%

Mid-Semester Exam: 30%

End-Semester Exam: 60%