Approval: 6th Senate Meeting

Course Name : Digital Signal Processing
Course code : EE-305
Credits : 3-1-0-4
Prerequisites : IC-260 - Signals and Systems
Elective/Core : Elective
Semester : Even

Preamble: The course covers some fundamental aspects of discrete-time signals and systems, their time-domain and frequency domain analysis, and applications. It is an important building block in communication engineering, and for various computational areas involving signal analysis.

Course Outline:

- Introduction to discrete time signals and systems, their properties and representations
- Discrete time signal transforms: Fourier transform and Z-transform, and their properties
- Sampling, Nyquist theorem, processing continuous and discrete signals, multi-rate sampling
- Introduction to filtering of signals, filter structures, and types of filters
- Discrete Fourier transform (DFT), its analysis and properties, its efficient computation, and analysis of signals using DFT

Modules:

Unit 1: Discrete time signals and systems: (4 hours)
Types of systems, LTI systems and their properties, impulse response and convolution, Difference equations, Eigen-functions of LTI systems

Unit 2: Discrete time signal transform: (4 hours)
Discrete time Fourier Transform (DTFT) and examples, Properties, Convergence of signals, Z-transform and examples, Properties, Difference equation representation, Inverse Z-transform

Unit 3: Sampling: (10 hours)
Time domain and frequency domain representation, Nyquist theorem, Signal reconstruction, Discrete-time processing of continuous-time signals, Continuous-time processing of discrete-time signals, Changing the sampling rate, Multi-rate signal processing, Sub-Nyquist sampling and its applications

Unit 4: Filtering and Frequency response of LTI systems (10 hours):
Discrete-time frequency selective filtering, Phase distortion and delay, Characterization with difference equations, Stability and Causality, Frequency response of rational system functions, All pass and minimum-phase systems, Basics of filter design, Z-transform characterization of IIR filters, Window functions for FIR

filters, Filter structures for IIR and FIR filters,

Unit 5: Discrete Fourier transform (DFT): (10 hours)
Discrete Fourier series and its properties, Fourier transform of periodic signals, Sampling the Fourier transform, DFT and its properties, Linear and circular convolution, Efficient computation of DFT using the Fast Fourier transform (FFT)

Unit 6: Fourier analysis of signals using the DFT: (4 hours)
Pipeline for analyzing continuous time signals, Effect of windowing, Effect of spectral sampling

Text books:

1. Text for Unit 1 to Unit 6: Alan V. Oppenheim, Ronald W. Schafer, John R. Buck., "Discrete-Time Signal Processing," Second edition, Pearson, 1999.

Additional reference:

1. John G. Proakis, Dimitris G. Manolakis., "Digital Signal Processing – Principles, Algorithms, and Applications," Fourth Edition, Pearson 2007.