GUJARAT TECHNOLOGICAL UNIVERSITY

Instrumentation and Control Engineering

B. E. SEMESTER: VII

Subject Name: **Digital Signals and Systems**
Subject Code: **171704**

Teaching Scheme				Evaluation Scheme			
Theory	Tutorial	Practical	Total	University Exam (E)		Mid Sem Exam (Theory) (M)	Practical (Internal)
				Theory	Practical		
4	0	0	4	70	0	30	50

Sr. No	Course Content	Total Hrs.
1.	**INTRODUCTION** Signals, System and signal processing, Classification of signals, Concept of frequency in continuous time and discrete time for sinusoidal signals, Analog to Digital and digital to analog conversion : Sampling theorem, Quantization, Coding of Quantized Samples, Analysis of digital signals and systems versus discrete – time signals and systems.	**4**
2.	**DISCRETE TIME SIGNALS AND SYSTEMS** **Discrete – Time Signal**: elementary discrete time signals, classification of discrete time signals, and simple manipulation of discrete time signal; **Discrete – Time Systems:** input – output description of systems, block diagram representation of discrete – time system, classification of discrete – time system, interconnection of discrete time system; **Analysis of Discrete Time Linear Time - Invariant Systems:** Techniques for the analysis of LTI systems, resolution of discrete – time signal into impulses, response of LTI systems to arbitrary inputs (the convolution sum), properties of convolution and the interconnection of LTI systems, Causal LTI systems, stability of LTI systems, system with finite duration and infinite duration impulse response; **Discrete time systems described by difference equation:** Recursive and non recursive discrete time systems, LTI Systems characterized by constant co-efficient difference equation, Solution of linear constant co-efficient differential equation, impulse response of LTI recursive system. **Implementation of discrete time systems:** Structures for realization of LTI systems, recursive and non-recursive realization of FIR system; **Correlation of Discrete Time Signals:** cross-correlation and auto-correlation sequences, properties of the autocorrelation and cross-correlation sequences.	**7**

3.	**Z -TRANSFORM AND ITS APPLICATION TO ANALYSIS OF LTI SYSTEMS** Direct z-transform and its properties; poles and zeros; pole location and time domain relation for causal signals; system function of LTI system; **Inverse z-transform:** by power series expansion and partial fraction expansion; **Analysis of Linear Time-Invariant System in the Z-domain:** Response of system with rational transfer function, transient and steady state response, causality and stability; pole zero cancellations, multiple order poles and stability, stability of second order system; **The One – Sided z – Transform:** Definition and properties, solution of difference equations, response of pole – zero systems with nonzero initial conditions.	**7**
4.	**FREQUENCY ANALYSIS OF SIGNALS:** **Frequency Analysis of Continuous – Time Signals:** The Fourier Series of continuous – time periodic signals, power density spectrum of periodic signals, The Fourier transform for continuous – time aperiodic signals; **Frequency Analysis of Discrete – Time Signals:** The Fourier series for discrete – time periodic signals, power density spectrum of periodic signals, the Fourier transform of discrete – time aperiodic signals, convergence of the Fourier transform, energy density spectrum of aperiodic signals, relationship of the Fourier transform to the z – transform, the cepstrum, the Fourier transform of signals with poles on the unit circle, frequency domain classification of signals (the concept of bandwidth), the frequency ranges of some natural signals; Frequency – Domain and Time – Domain Signal Properties; Properties of the Fourier Transform for Discrete – Time Signals: symmetry properties of the Fourier transform, Fourier transform theorems and properties	**7**
5.	**FREQUENCY – DOMAIN ANALYSIS OF LTI SYSTEMS** **Frequency – Domain Characteristics of LTI systems:** Response to complex exponential and sinusoidal signals, steady state and transient response to sinusoidal input signals, steady state response to periodic input signals, response to aperiodic input signals; **Frequency Response of LTI Systems:** frequency response of a system with a rational system function, computation of the frequency response functions; Correlation Functions and Spectra at the Output of LTI Systems: input – output correlation functions and spectra, correlation functions and power spectra for random input signals; **LTI as Frequency Selective Filter:** Ideal filter characteristics, low-pass filter, high-pass filter, band-pass filter, digital resonators, notch filter, comb filter, all-pass filters, digital sinusoidal oscillators; **Inverse Systems and Deconvolution:** invertibility of LTI systems, minimum-phase systems, maximum – phase systems, mixed-phase systems, system identification and decobvolution, homomorphic	**7**

	deconvolution	
6.	**SAMPLING AND RECONSTRUCTION OF SIGNALS** ***Ideal Sampling and Reconstruciton of Continuous – Time Signals; Discrete – Time Processing of Continuous – Time Signals; Analog – to – Digital and Digital – to – Analog Converters:*** quantization and coding, analysis of quantization errors; **Sampling and Reconstruction of Continuous – Time Band-pass Signals**: first order sampling, interleaved or non-uniform second order sampling, band-pass signal representation, sampling using band-pass signal representation; **Sampling of Discrete – Time Signals**: sampling and interpolation of discrete – time signals, representation and sampling of band-pass discrete – time signals; **Oversampling A/D and D/A Converters**	**7**
7.	**DISCRETE FOURIER TRANSFORM :** **ITS PROPERTIES AND APPLICATION** Frequency –Domain Sampling (The Discrete Fourier Transform): frequency domain sampling and reconstruction of discrete – time signals, discrete Fourier transform (DFT), the DFT as a linear transformation, relationship of the DFT with other transformation; Properties of the DFT: periodicity, linearity, symmetry, multiplication of two DFTs and circular convolution, additional DFT properties; Linear Filtering Methods Based on the DFT: use of DFT in linear filtering, filtering of long data sequence; Frequency Analysis of Signals Using the DFT; The Discrete Cosine Transform: forward DCT, Inverse DCT, DCT as an orthogonal transform.	**7**
8.	**IMPLEMENTATION OF DISCRETE TIME SYSTEMS** Structures for realization of discrete time systems; Structures for FIR systems: direct-form structure, cascade-form structures, frequency sampling structure, lattice structure; Structures for IIR systems: direct form, signal flow graph and transposed structure, cascade – form structure, parallel – form structures, lattice and lattice ladder structure for IIR systems;	**8**

Reference Books:

1. Digital Signal Processing: Principles, Algorithms, and Applications by John G. Proakis, Dimitris G. Manolakis; Pearson Publication
2. Discrete – Time Signal Processing by Alan V. Oppenheim, Ronald W. Schafer, and John R. Buck; Pearson Publication
3. Digital Signal Processing: A Computer Based Approach by Sanjit K. Mitra; McGraw Hill Publication
4. Digital Signal Processing: A Practical Approach by Emmanuel Ifeachor and Barrie W. Jervis; Pearson Publication