GUJARAT TECHNOLOGICAL UNIVERSITY

BRANCH NAME: INSTRUMENTATION & CONTROL ENGINEERING (17)
SUBJECT NAME: DIGITAL SIGNAL PROCESSING
SUBJECT CODE: 2171708
B.E. 7th SEMESTER

Type of course: Core Engineering

Prerequisite: Analog signal processing, differential equations, convolution, Fourier Transforms

Rationale: It is very important to understand the signal characteristics and system behaviour when the signals are digitized. Noises from the signals can be removed by designing filters using software. So, it is very important to understand the fundamentals of processing of complex signals. This subject will provide better understanding of discrete-time and digital signal in time and frequency domain. Students will also be able to design and implement FIR and IIR filters with different structures. Students will also be introduced to digital signal processor.

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks						Total Marks
L	T	P	C	Theory Marks			Practical Marks			
				ESE (E)	PA(M)		ESE (V)		PA (I)	
					PA	ALA	ESE	OEP		
3	0	2	5	70	20	10	20	10	20	150

Sr. No.	Course Content	Hrs.	Weightage %
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.	3	6
2	**DISCRETE TIME SIGNALS AND SYSTEMS** Discrete – Time Signal Discrete – Time Systems Analysis of Discrete Time Linear Time - Invariant Systems: Discrete Time Systems Described By Difference Equation Correlation of Discrete Time Signals	8	19
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	8	19

	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		
4	**STRUCTURES FOR DISCRETE TIME SYSTEMS** Block Diagram and signal flow diagram representations of Linear Constant-Coefficient Difference equations, Basic Structures of IIR Systems, Transposed forms, Direct and cascade form Structures for FIR Systems, Effects of Co-efficient quantization	5	12
5	**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 **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	8	19
6	**FAST FOURIER TRANSFORM** **Efficient Computation of DFT:(FFT Algorithm):** Direct computation of a DFT, divide & conquer approach to computation of DFT, radix2 and radix 4 FFT Algorithms	4	10
7	**Filter Design Techniques** Design of Discrete-Time IIR filters from Continuous-Time filters-Approximation by derivatives, Impulse invariance and Bilinear Transformation methods; Design of FIR filters by windowing techniques, Illustrative design examples of IIR and filters.	4	10
8	**Introduction of DSP processor architecture**	2	5

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
7	**21**	**14**	**21**	**7**	**0**

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.

Reference Books:

1. "Digital Signal Processing: Principles, Algorithm & Application",4th edition,Proakis, Manolakis, Proakis, Manolakis, Pearson

2. "Discrete Time Signal Processing":Oppeheim, Schafer, Buck Pearson education

publication, 2nd Edition, 2003.

3. Digital Signal Processing fundamentals and applications, Li Tan , Elsevier

4. .Digital Signal Processing, S.Salivahanan, A.Vallavaraj, C.Gnapriya TMH

Course Outcome:

After learning the course the students should be able to:

1. analyse the signals in both time and frequency domain
2. design FIR and IIR filters for signal pre-processing
3. implement and realize the filters using different structures.
4. explain the selection of DSP processor for signal processing applications.

List of Experiments:

1. To represent basic signals (Unit Step, unit impulse, ramp, exponential).
2. To represent sine, and cosine signals.
3. To develop program for discrete convolution.
4. To develop program for convolution without direct matlab command.
5. To develop program for discrete correlation.
6. (a) Determine the Impulse response for the system described by the second order difference equation ,$y(n) = x(n) + 0.6y(n-1) – 0.08y(n-2)$
   (b) Also obtain the Pole-Zero plot for the same and hence comment on the ROC and stability of the system.
   (c) Express following Z transform in factored form, plot its poles & zeros, and determine its ROCs.
7. To understand sampling theorem.
8. To design digital IIR filters
9. To design digital FIR filter

Design based Problems (DP)/Open Ended Problem:

1. Design a 25-tap Bandpass Filter for the following specifications:
Cut-off frequencies : 0.25pi and 0.75pi
Windowing: : Rectangular and Hamming, Order: : 25
Compare different Windowing Techniques and comment on the same.

2. Design Butterworth LPF for following specifications:

Passband Attenuation: 0.4dB, Stopband Attenuation: 35 dB
,Passband frequency : your Roll no + 400Hz,Stopband frequency : your Roll no + 800 Hz
,Sampling frequency : 3000 Hz

Major Equipment:

Computers, DSP kits, Simulation software like Scilab/ Matlab

List of Open Source Software/learning website:

NPTEL Website

MIT Open Course Ware (http://ocw.mit.edu/resources)

ACTIVE LEARNING ASSIGNMENTS: Preparation of power-point slides, which include videos, animations, pictures, graphics for better understanding theory and practical work – The faculty will allocate chapters/ parts of chapters to groups of students so that the entire syllabus to be covered. The power-point slides should be put up on the web-site of the College/ Institute, along with the names of the students of the group, the name of the faculty, Department and College on the first slide. The best three works should submit to GTU.