

# GUJARAT TECHNOLOGICAL UNIVERSITY

## ELECTRONICS & COMMUNICATION (SIGNAL PROCESSING & COMMUNICATION) (41)

SIGNAL ANALYSIS AND TRANSFORM

**SUBJECT CODE: 2714107**

SEMESTER: I

**Type of course:** Analysis of Various Signals and Transformations, Theory with simulations.

**Prerequisite:** Advanced calculus, Signals and Systems

**Rationale:** The students need to learn fundamentals of discrete time signals, systems and modern digital processing algorithms and applications. The students need to know analysis of various signals and transformation methodology used for different applications in the area of signal and image processing. The purpose of transformation is to introduce the mathematical representation of signals, their properties and applications.

### Teaching and Examination Scheme:

Teaching Scheme			Credits C	Examination Marks						Total Marks
L	T	P		Theory Marks		Practical Marks				
			ESE (E)	PA (M)	PA (V)		PA (I)			
					ESE	OEP	PA	RP		
3	2#	2	5	70	30	20	10	10	10	150

### Content:

Sr. No.	Content	Total Hrs	% Weightage
1	<b>Signal and Signal Space</b> Size of a signal, Classification of Signals, Unit Impulse Signal, Signals versus Vectors, Correlation of Signals, Orthogonal Signal set, the concept of frequency in continuous time and discrete time signals, Discrete time signals and systems, Analysis of Discrete Time linear invariant systems, Correlation of discrete time systems, Z Transform, Analysis of Linear Time Invariant systems in the z domain.	<b>10</b>	21
2	<b>Analysis and Transmission of Signals</b> Frequency domain sampling, properties of DFT, Linear filtering methods based on the DFT, Fast Fourier transform, Applications of FFT Algorithms, Linear Filtering Approach for computation of the DFT, Quantization effects in the computation of the DFT, Signal Distortion over a Communication Channel, Signal Energy and Energy Spectral Density, Signal Power and Power Spectral Density.	<b>12</b>	25
3	<b>Signal Transforms</b> Introduction, Need for transform, Walsh Transform, Hadamard Transform, Haar Transform, Slant Transform, Discrete Cosine Transform, Karhunen-Loeve Transform, Singular Value Decomposition, Radon Transform, Hilbert Transform, Eigen values, Eigen vectors, Properties of Eigen values and Eigen vectors of Hermitian matrices	<b>15</b>	31
4	<b>Wavelet Transform</b>	<b>11</b>	23

	Introduction, Pyramids, Sub band coding, The Haar Transform, Multi Resolution Analysis, Continuous Wavelet Transform, Discrete Wavelet Transform, Fast Wavelet Transform, Multi Wavelet		
	<b>Total</b>	<b>48</b>	100

### Reference Books:

1. John G. Proakis, Dimitris G. Manolakis, “Digital Signal Processing – Principles, Algorithms and Applications”, PHI Publications
2. Athanasios Papoulis, “Signal Analysis”, McGraw Hill, New York, 1977.
3. Alexander D. Poularikas, “Transforms and Applications Handbook”, CRC Press, Taylor and Francis Group.
4. S Jayaraman, S Esakkirajan, T Veerakumar, “Digital Image Processing” , Tata McGraw Hill Education
5. Rafael C. Gonzalez, Richard E. Woods, “Digital Image Processing”, Pearson Publication.
6. B. P. Lathi, Zhi Ding, “Modern Digital and Analog Communication Systems”, International Fourth Edition, Oxford University Press

### Course Outcome:

After learning the course the students should be able to learn about basics of signals and systems, classification of signal, correlation and convolution of signals and its use in communication systems. The students should be able to solve numerical based on DFT, FFT and many other transformation and implementation on DSK 6713 kit. They will learn transformations and its use in signal, image and video processing algorithms. At the end they should be able to develop various applications using analysis and transformation of different signals.

### List of Simulation Studies and Implementation:

1. Representation and generation of basic signals
2. Discrete convolution and circular convolution
3. Correlation and Auto correlation
4. Effect of pole/zero on frequency response
5. Discrete time Fourier Transform and Discrete Fourier Transform
6. Fast Fourier Transform
7. Frequency response of LTI systems
8. Z Transform
9. Discrete Cosine Transform
10. Walsh Transform and Radon Transform
11. Wavelet Transform

### Major Equipments and Software:

1. High performance simulation software
2. Digital Signal Processing development board

### List of Open Source Software/learning website:

1. NPTEL website

### Design based Problems (DP)/ Open Ended Problem:

1. Consider a combination of two waveforms: 20 Hz sine wave and 50 Hz triangular wave and compute Fourier transform and DCT of the signals.

2. Compute DTFT of given signal, change window size and check the resolution of Fourier Transform. Also compute CWT and compare resolution (time and frequency) with DTFT.

$$s(t) = \begin{cases} \sin 2\pi 10t, & 0 < t < 0.5 \\ \sin 2\pi 20t, & 0.5 < t < 1 \\ \sin 2\pi 10t, & 1 < t < 2 \end{cases}$$

3. Generate a sine wave of 400 Hz with amplitude of 5 samples using 10 KHz sampling frequency; add a random noise to it. Compute 1<sup>st</sup> and 2<sup>nd</sup> level decomposition. Plot all the signals.
4. Take any two discrete signals and calculate Correlation and Auto correlation of those two signals.
5. Apply different transformations over a one dimensional signal and implement on DSP kit.
6. Take two dimensional matrix of random values and apply DFT and DCT transformation. Take a case study of Image Signal.