

# GUJARAT TECHNOLOGICAL UNIVERSITY

## MECHATRONICS (47) MECHATRONICS SIGNAL PROCESSING SUBJECT CODE: 2724707 M.E. 2<sup>ND</sup> SEMESTER

**Type of course:** Engineering Science

**Prerequisite:** NA

**Rationale:** This subject deals with fundamentals of Signal Processing and its applications, which are useful for Mechatronics engineers.

### Teaching and Examination Scheme:

Teaching Scheme			Credits C	Examination Marks						Total Marks
L	T	P		Theory Marks		Practical Marks				
			ESE (E)	PA (M)	ESE (V)		PA (I)			
					ESE	OEP	PA	RP		
3	0	2#	4	70	30	20	10	10	10	150

### Content:

Sr. No	Contents	Teaching Hrs	Weightage (%)
1	<b>Introduction:</b> Signals, systems and signal processing, classification of signals, elements of digital signal processing system, concept of frequency in continuous and discrete time signals, Periodic Sampling, Frequency domain representation of sampling, sampling low pass signals, sampling bandpass signals, spectral inversion in bandpass sampling, general applications of DSP	<b>05</b>	<b>12</b>
2	<b>Discrete-Time Signals and Systems:</b> Discrete-Time Signals, Discrete-Time Systems, LTI Systems, Properties of LTI Systems, linear convolution and its properties, Linear Constant Coefficient Difference equations.	<b>05</b>	<b>12</b>
3	<b>The Z- Transform and its Application in to Analysis of LTI System:</b> Z-Transform, Properties Z-transform, Rational Z-transform, the inverse Z-transform methods, Analysis of LTI systems in Z domain	<b>06</b>	<b>14</b>
4	<b>Discrete-Fourier Transform and Fast Fourier Transform:</b> Discrete Fourier transform and its properties, Inverse DFT, Fourier Transform of Periodic Signals, Linear Convolution using DFT, efficient computation of DFT:FFT, Frequency analysis of continues and discrete time signal, Properties of discrete time Fourier Transform, and correlation of signals, Fourier Transform Theorem	<b>08</b>	<b>18</b>
5	<b>Filter Design Techniques:</b> 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	<b>07</b>	<b>16</b>
6	<b>Signal Processing Techniques for Mechatronics Engineers :</b> Envelope Analysis, Adaptive Filters, Introduction of random signal, Correlation functions, Spectral density function.	<b>07</b>	<b>16</b>
7	<b>Introduction:</b> Signals, systems and signal processing, classification of signals, elements of digital signal processing system, concept of frequency in continuous and discrete time signals, Periodic Sampling, Frequency	<b>05</b>	<b>12</b>

	domain representation of sampling, sampling low pass signals, sampling bandpass signals, spectral inversion in bandpass sampling, general applications of DSP		
	<b>TOTAL</b>	<b>43</b>	<b>100</b>

**Reference Books:**

1. “Digital Signal Processing: Principles, Algorithm & Application”,4th edition,, Proakis, Manolakis, Pearson
2. “Understanding Digital Signal Processing”, 2nd edition, Richard G Lyons, Pearson Education
3. Digital Signal Processing: A Computer-Based Approach, S K Mitra, McGraw-Hill
4. Discrete Time Signal Processing, Oppenheim, Schaffer, Buck Pearson education publication, 2nd Edition, 2003.
5. Fundamentals of Signal Processing for Sound and Vibration Engineers, Kihong ShinJoseph K. Hammond John Wiley & Sons, Ltd

**Course Outcomes:**

After learning the course the students should be able to

- Represent discrete-time signals analytically and visualize them in the time domain.
- Understand the meaning and implications of the properties of systems and signals.
- Understand the Transform domain and its significance and problems related tocomputational complexity.
- Specify and design any digital filters using MATLAB.

**List of Practicals**

The experiments will be carried out using MATLAB /Labview software. Experiments will be based on

1. Signal generation :Periodic Signal generation and Random signal generation
2. Discretisation of signals
3. Z transform of signal
4. DFT of signal
5. Study of DFT properties
6. FFT of signal
7. FIR and IIR filters
8. Signal capturing from actual system and processing
9. Adaptive filtering
10. Envelope analysis of actual signal

**Design based/open ended problem**

Student may be given a task to exhibit the knowledge of the course studied during the academic year.

**Major Equipment:**

MATLAB /Labview software

**Review Presentation (RP):** The concerned faculty member shall provide the list of peer reviewed Journals and Tier-I and Tier-II Conferences relating to the subject (or relating to the area of thesis for seminar) to the students in the beginning of the semester. The same list will be uploaded on GTU website during the first two weeks of the start of the semester. Every student or a group of students shall critically study 2 papers, integrate the details and make presentation in the last two weeks of the semester. The GTU marks entry portal will allow entry of marks only after uploading of the best 3 presentations. A unique id number will be generated only after uploading the presentations. Thereafter the entry of marks will be allowed. The best 3 presentations of each college will be uploaded on GTU website.