# GUJARAT TECHNOLOGICAL UNIVERSITY

**INSTRUMENTATION AND CONTROL (APPLIED INSTRUMENTATION) (03)**
ADVANCE SIGNAL PROCESSING AND ESTIMATION
**SUBJECT CODE:** 2720315
SEMESTER: II

**Type of course:** Major ElectiveIII

**Prerequisite:** Signals and Systems

**Rationale:** This course provides an overview and fundamentals of various types of filters design and various applications of DSP and study of various wavelet techniques.

**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) | | |
| | | | | | | ESE | OEP | PA | RP | |
| 3 | 2# | 0 | 4 | 70 | 30 | 30 | 0 | 10 | 10 | 150 |

**Content:**

| Sr. No | Topics | Teaching Hrs. | Module Weightage |
|---|---|---|---|
| 1. | **FIR and Adaptive FIR Filter Design**<br><br>Ideal Filter Requirements, FIR Filter Design Specifications, Classification of Linear Phase FIR Filters, Frequency Response of Linear-Phase Filters, Pole and Zero Plots For FIR Filters, Filter Design Techniques For Linear-Phase FIR Filters, FIR Filter Design Using Windowing, Gibbs Phenomenon, FIR Filter Design using Fourier Series Expansion Method, Use of Windowing, Comparison Of Different Window Functions, FIR Filter Design Using Frequency Sampling Method, Frequency Sampling Structures, FIR Differentiator Design, Design of FIR Hilbert Transformer, Adaptive FIR Filter Design, Method of Steepest Descent and Newton's Method, Least Mean Square Algorithm, Optimum Equiripple Design of FIR Filters: Alternation theorem, Applications Of Adaptive Filters, FIR System Structures, Direct-Form Realization, Cascade-Form Realization, Lattice Structure Realization | **15** | **25-30%** |
| **2.** | **IIR and Adaptive IIR Filter Design**<br><br>IIR Filter Design Using Impulse Invariance, Transformation or mapping function, IIR Filter Design Using Bilinear Transformation, Frequency Wrapping Function, IIR Filter Design Using Bilinear Transformation Method, Analog Filters-Butterworth Filters, Butterworth Filters (LPF), Butterworth Filters Design (LPF), Butterworth Filters (HPF), Butterworth | **10** | **25-30%** |

| | | | |
|---|---|---|---|
| | Filters(BPF and BRF), Calculation of the Order of Butterworth Filter from the given Filter Specifications, DT Butterworth Filter Design using Impulse Invariance Method, DT Butterworth Filter Design using BLT Method, Analog Filters-Chebyshev Filters and Elliptic Filters, Elliptic Filters, Adaptive IIR Filter Design, Pade Approximation Technique, Least Squares Design Methods, ,FIR Least Squares Inverse Filter (Wiener Filter), ,Recursive Least Squares Algorithm, IIR Filter Design in the frequency Domain (Deczkys Method), IIR Filter structures, Direct form realizations, cascade form Realization, Parallel structure realization, lattice structure realization, Quantization effects in IIR filters, Truncation and rounding, Input signal sample quantization, Co-efficient inaccuracy error, product round-off error, scaling considerations, limit cycle oscillations, Applications of FIR filters, Echoes and echo cancellation, multiple echoes, reverberation, digital music synthesis. | | |
| **3** | **Multirate DSP and Applications**<br><br>Decimation by inter Factor D, Interpolation by an inter factor I, Sampling rate conversion by a factor of I/D, Efficient implementation of decimator/Interpolator, Polyphase filter structures, Time variant filter structures, multistage filter design, sampling rate conversion of band pass signals, Sampling rate conversion by frequency conversion, sampling rate conversion using modulation free method, sampling rate conversion by arbitrary factor, Applications of multirate DSP, Design of phase shifter, Design of DFT filter bank, Design of QMFs, sub-band coding of speech signals, Over sampling ADC/DAC, Applications of Multirate DSP for image resizing. | **10** | **25%** |
| **4** | **DCT, WT, and Applications**<br><br>Discrete cosine transform and discrete sine transform, Karhunen-Loeve transform, Applications of DCT, Signal coding, signal filtering, sampling rate conversion and resizing, Feature extraction and recognition, Short time Fourier transform, Wavelet transform, Haar wavelet and multi resolution analysis, multi resolution analysis, Daubechies wavelets, matrix multiplication method for computation of WT, Number of operations, Time bandwidth product, some other standard wavelets, Mexican Hat functions, A modulated Gaussian, spline and battle-Lemerie wavelets, Bi-orthogonal wavelets, Cohen-Daubechies-Feauveau family of biorthogonal spline wavelets, wavelet packets, full wavelet packet decomposition, Applications of WT, Denoising using DWT, Signal compression, signal filtering, sampling rate conversion. | **10** | **25%** |

**Reference Books:**


1. Advanced Digital Signal Processing by Dr. Shaila D. Apte,Wiley India Pvt. Ltd.
2. Digital Signal Processing A Practical Approach Second Edition by Emmanuel C Ifeachor,Barrie W. Jervis,Prentice Hall India.
3. Digital Signal Processing by S.Salivahanan,A Vallavaraj,C. Gnanapriya, 2e,Tata Mcgraw Hill India.

**Course Outcome:**

After learning the course the students should be able to

1. Understand the structure of various types of filters
2. Design of different types of filters
3. Various Wavelet Techniques for different applications
4. Multirate DSP and its applications

**List of Tutorials:**

Student has to prepare computer programs and simulations for various Filter Design techniques covered in this course with any computing tools (,MatLab, Scilab, etc...).

Prepare research paper and submit report of various filter design methods covered in this course .

**Major Equipment:**

Computer Laboratory

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

- Matlab, Scilab
- NPTEL

**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.