

GUJARAT TECHNOLOGICAL UNIVERSITY



Program Name: Master of Engineering

Level: PG

Branch: Electronics & Communication (Communication System Engineering)

Course / Subject Code: ME01000311

Course / Subject Name : Advanced Digital Signal Processing

| | |
|-------------------------|--------------------------|
| w. e. f. Academic Year: | 2024-25 |
| Semester: | 1 st Semester |
| Category of the Course: | PCC |

| | |
|----------------------|--|
| Prerequisite: | Signals and Systems, Digital Signal Processing |
| Rationale: | PG Students of EC Engineering need to possess good understanding of the fundamentals and applications of Digital filters, predictive filters, Adaptive systems and multirate DSP including estimation theory and random variables for implementing changing real world into DSP system. They are expected to be able to design Adaptive Digital filters and process real world signals as per desired communication applications. They will be guided in designing Adaptive Filters using various Algorithms using MATLAB/Scilab/CCS software. |

Course Outcome:

After Completion of the Course, Student will able to:

| No | Course Outcomes | RBT Level |
|----|---|-----------|
| 01 | Understand theory of different filters and algorithms | U |
| 02 | Understand theory of multirate DSP, solve numerical problems and write algorithms | A |
| 03 | Understand theory of prediction and solution of normal equations | U |
| 04 | Apply DSP algorithms to solve signal analysis and design problems | N |
| 05 | Design digital filters for specific applications | C |

**Revised Bloom's Taxonomy (RBT)*

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Teaching and Examination Scheme:

| Teaching Scheme (in Hours) | | | Total Credits L+T+ (PR/2) | Assessment Pattern and Marks | | | | Total Marks |
|-------------------------------|---|----|---------------------------------|------------------------------|----------------|-----------|----------------------|-------------|
| L | T | PR | | C | Theory | | Tutorial / Practical | |
| | | | ESE (E) | | PA / CA (M) | PA/CA (I) | ESE (V) | |
| 3 | 0 | 2 | 4 | 70 | 30 | 20 | 30 | 150 |

Course Content:

| Unit No. | Content | No. of Hours | % of Weightage |
|----------|---|--------------|----------------|
| 1. | Introduction: Overview of DSP, Characterization in time and frequency, FFT Algorithms, Digital filter design and structures: Basic FIR/IIR filter design & structures, design techniques of linear phase FIR filters, IIR filters by impulse invariance, bilinear transformation, FIR/IIR Cascaded lattice structures, and parallel realization of IIR. | 9 | 20 |
| 2. | Multi rate DSP: Decimators and Interpolators, Sampling rate conversion, multistage decimator & interpolator, poly phase filters, QMF, digital filter banks, Applications in sub-band coding. | 9 | 20 |
| 3. | Filters: Linear prediction & optimum linear filters, stationary random process, forward-backward linear prediction filters, solution of normal equations, AR Lattice and ARMA Lattice-Ladder Filters, Wiener Filters for Filtering and Prediction. | 9 | 20 |
| 4. | Adaptive Filters: Applications, Gradient Adaptive Lattice, Minimum mean square criterion, LMS algorithm, Recursive Least Square algorithm | 9 | 20 |
| 5. | Spectral Estimation: Estimation of Spectra from Finite-Duration Observations of Signals. Nonparametric Methods for Power Spectrum Estimation, Parametric Methods for Power Spectrum Estimation, Minimum-Variance Spectral Estimation, Eigen analysis Algorithms for Spectrum Estimation. | 9 | 20 |



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| | | | |
|--|--------------|-----------|------------|
| | Total | 45 | 100 |
|--|--------------|-----------|------------|

Suggested Specification Table with Marks (Theory):

| Distribution of Theory Marks (in %) | | | | | |
|-------------------------------------|---------|---------|---------|---------|---------|
| R Level | U Level | A Level | N Level | E Level | C Level |
| 10 | 20 | 20 | 30 | 10 | 10 |

Where R: Remember; U: Understanding; A: Application, N: Analyze and E: Evaluate C: Create (as per Revised Bloom's Taxonomy)

References/Suggested Learning Resources:

(a) Books:

1. J.G.Proakis and D.G.Manolakis "Digital signal processing: Principles, Algorithms and Applications", 4th Edition, Pearson.
2. S.Haykin, "Adaptive Filter Theory", 4th Edition, Pearson.
3. D.G.Manolakis, V.K. Ingle and S.M.Kogon, "Statistical and Adaptive Signal Processing", McGraw Hill.

(b) Open source software and website:

- Scilab
- <https://nptel.ac.in>
- Rahul Dubey, "An Introduction to Internet of Things: Connecting Devices, Edge Gateway, and Cloud with Applications", Cengage India Publication
- Raj Kamal, "Internet of Things: Architecture and Design Principles, Mc Graw Hill Education Hanes et al "IoT Fundamentals",
- Cisco Press Vijay Madisetti and Arshdeep Bahga, "Internet of Things (A Hands-on-Approach)", Paperback, 2015.
- McEwen, H. Cassimally, "Designing the Internet of Things", Wiley, 2013. Yashwant Kanetkar, "21 Internet of Things Experiments", Kindle edition Adeel Javed, "Building Arduino projects for Internet of Things", Apress publication Donald Noris,
- "The Internet of Things: Do it yourself Projects with Arduino, Raspberry PI and BeagleBone Black" Mc Graw Hill Publication Adrian McEwen & Hakim Cassimally, "Designing the Internet of things", Willey publication Rahul Dubey,
- "An Introduction to Internet of Things: Connecting Devices, Edge Gateway, and Cloud with Applications", Cengage India Publication Raj Kamal, "Internet of Things: Architecture and Design Principles, Mc Graw Hill Education Hanes et al "IoT Fundamentals",



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- Cisco Press Vijay Madisetti and Arshdeep Bahga, “Internet of Things (A Hands-on-Approach)”, Paperback, 2015.
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- “An Introduction to Internet of Things: Connecting Devices, Edge Gateway, and Cloud with Applications”, Cengage India Publication

Suggested Course Practical List: (30 Hours)

1. Basic Signal Representation
2. Correlation Auto And Cross
3. Stability Using Hurwitz- Routh Criteria
4. Sampling FFT of Input Sequence
5. Butterworth Lowpass and Highpass Filter Design
6. Chebychev Type I, II Filter
7. State Space Matrix from Differential Equation
8. Normal Equation Using Levinson Durbin
9. Decimation and Interpolation Using Rationale Factors
10. Maximally Decimated Analysis DFT Filter
11. Cascade Digital IIR Filter Realization
12. Convolution and M Fold Decimation & PSD Estimator
13. Estimation of PSD
14. Inverse Z-Transform
15. Group Delay Calculation
16. Seperation of Time/Frequency
17. Parallel Realization of IIR filter



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List of Laboratory/Learning Resources Required: MATLAB, Signal Processing and Filter Design Toolbox, DSP hardware kits based on DSP Processors.

Suggested Project List: Filter design problem for Digital Communication application

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