DIGITAL SIGNAL PROCESSING

VI Semester: ECE

Course Code	Category	Hours / Week			Credits	Maximum Marks		
		L	**T**	**P**	**C**	**CIA**	**SEE**	**Total**
AEC012	**Core**	3	1	-	4	30	70	100

Contact Classes: 45	Tutorial Classes: 15	Practical Classes: Nil	Total Classes: 60

I. COURSE OVERVIEW:

The course is intended to provide representation of discrete-time signals and systems, and their analysis using Fourier and z-transforms. The notion of discrete Fourier transform is introduced, followed by an overview of fast algorithms for its computation. The methods for spectral analysis of discrete-time signals are discussed next, principal methods for design of FIR and IIR filters, followed by multi-rate signal processing and finite word length effects. While this course deals largely with the theory of DSP, we will use a powerful software package, MATLAB, to look at applications of this theory, particularly Fourier analysis and digital filter design.

II. OBJECTIVES:

The course should enable the students to:

I	To provide background and fundamental material for the analysis and processing of digital signals and to familiarize the relationships between continuous-time and discrete-time signals and systems.
II	To study fundamentals of time domine, frequency domine and z-domine analysis and to discuss the inter-relationships of these analytic method and to study the designs and structures of digital (IIR and FIR) filters from analysis to synthesis for a given specifications.
III	To acquaint in FFT algorithm, multi-rate signal processing techniques and finite word length effects. To introduce a few real-world signal processing applications.

III. COURSE OUTCOMES:

After successful completion of the course, students should be able to:

CO 1	**Illustrate** the realization of LTI systems using discrete time signals and systems	Understand
CO 2	**Construct** the decimation-in-time and decimation-in-frequency fast fourier transforms for reducing computational complexity of DFT.	Apply
CO 3	**Implement** FIR and IIR filters using digital filter transformation techniques.	Apply
CO 4	**Analyze** the performance characteristics of IIR and FIR filters using MATLAB.	Analyze
CO 5	**Interpret** the multi rate signal processing methods for interfacing the digital systems with different sampling rates.	Understand
CO 6	**Examine** errors in analog to digital conversion for tolerating finite word length effects.	Analyze

IV. SYLLABUS:

UNIT-I	REVIEW OF DISCRETE TIME SIGNALS AND SYSTEMS	Classes: 10

Discrete time signal definition; Signal classification; Elementary signals; Transformation of elementary signals; Concept of digital frequency; Discrete time system definition; System classification; Linear time invariant (LTI) system; Properties of the LTI system; Time domain analysis of discrete time systems; Impulse response; The convolution sum; Methods of evaluating the convolution sum; Filtering using overlap-save and overlap-add method; Realization of digital filters: Concept of IIR and FIR filters; Realization structures for IIR and FIR filters using direct form-I and direct form-II, cascade, lattice and parallel.

UNIT-II	DISCRETE FOURIER TRANSFORM AND EFFICIENT COMPUTATION	Classes: 08

Introduction to discrete time Fourier transform (DTFT); Discrete Fourier transform (DFT) definition; Properties of DFT; Linear and circular convolution using DFT; Fast-Fourier-transform (FFT): Direct computation of DFT; Need for efficient computation of the DFT (FFT algorithms); Radix-2 FFT algorithm for the computation of DFT and IDFT using decimation-in-time and decimation-in-frequency algorithms; General Radix-N FFT.

UNIT-III	STRUCUTRE OF IIR FILTERS	Classes: 08

Analog filters: Butterworth filters; Chebyshev type-1 & type-2 filters; Analog transformation of prototype LPF to HPF/BPF/BSF.

Transformation of analog filters into equivalent digital filters using impulse invariant method and bilinear transform method; Matlab programs of IIR filters.

UNIT-IV	SYMMETRIC AND ANTISYMMETRIC FIR FILTERS	Classes: 09

Design of linear phase FIR filters windowing and frequency sampling methods; Equiripple linear phase FIR filters; Parks-McClellan algorithm and remez algorithm; Least-mean-square error filter design; Design of FIR differentiators; Matlab programs of FIR filters; Comparison of FIR & IIR.

UNIT-V	APPLICATIONS OF DSP	Classes: 10

Multirate signal processing; Decimation; Interpolation; Polyphase structures for decimation and interpolation filters; Structures for rational sampling rate conversion; Applications of multirate signal processing for design of phase shifters, interfacing of digital systems with different sampling rates, sub band coding of speech signals. Analysis of finite word length effects: Representation of numbers; ADC quantization noise, coefficient quantization error, product quantization error, truncation & rounding errors; Limit cycle due to product round-off error; Round-off noise power; Limit cycle oscillations due to overflow in digital filters; Principle of scaling; Dead band effects.

Text Books:

1. John G. Proakis, Dimitris G. Manolakis, "Digital signal processing, Principles, Algorithms and Applications", Prentice Hall, 4th Edition, 2007.
2. Sanjit K Mitra, "Digital signal processing, A computer base approach", McGraw-Hill Higher Education, 4th Edition, 2011.
3. Emmanuel C, Ifeacher, Barrie. W. Jervis, "DSP-A Practical Approach", Pearson Education, 2nd Edition, 2002.
4. A.V. Oppenheim, R.W. Schaffer, "Discrete Time Signal Processing", PHI, 2nd Edition, 2006.

Reference Books:

1. Li tan, "Digital signal processing: fundamentals and applications" Elsevier Science &. Technology Books, 2nd Edition, 2008.
2. Robert J.schilling, Sandra. L.harris, "Fundamentals of Digital signal processing using Matlab", Thomson Engineering, 2nd Edition, 2005.
3. Salivahanan, Vallavaraj, Gnanapriya, "Digital signal processing", McGraw-Hill Higher Education, 2nd Edition, 2009.

Web References:

1. https://www.coursetalk.com/providers/coursera/courses/digital-signal-processing
2. https://www.edx.org/course/discrete-time-signal-processing-mitx-6-341x-1
3. https://www.mooc-list.com/course/digital-signal-processing-coursera

E-Text Books:

1. http://www.dspguide.com/pdfbook.htm
2. http://dspguru.com/dsp/books/favorites
3. http://onlinevideolecture.com/ebooks
4. http://www.freebookcentre.net/SpecialCat/Free-Signal-Processing-Books

Course Home Page: