



COURSE DESCRIPTION

Approval: 24th Senate Meeting

Course Number : EE 620

Course Name : Advanced Digital Signal Processing

Credits : 3-0-0-3 (L-T-P-C)

Prerequisites : Digital Signal Processing (EE305), Linear algebra (MA512 or IC 111)/Matrix Theory (EE522).

Intended for : UG /MS/MTech (CSP)/PhD/M.Sc (Applied Mathematics)

Distribution : Specialization course for MTech (CSP), Elective for B.Tech. EE III/IV year, MS, Ph.D.

Semester : Even/Odd

Comments: The syllabus for EE 620 has been revised. The revised syllabus as recommended by 33rd BOA, held on 31st January 2020 and approved by 24th Senate meeting held on 13th February is as mentioned below.

Preamble

Digital signal processing has advanced quite a lot over the past few years branching out into multiple paths which differ in the underlying approach. This course is focused on the extension of Fourier methods and moves to time-frequency localization with an extensive coverage of wavelets and filter banks. Students are expected to have an undergraduate level expertise in continuous and discrete time Fourier analysis and exposure to digital filter design.

Course modules with Quantitative lecture hours:

Review: Signal spaces: $L_1(\mathbb{R}), L_2(\mathbb{R}), l_1(\mathbb{Z}), l_2(\mathbb{Z})$. finite dimensional vector spaces. Filter design: FIR, IIR and all pass filter design. Biorthogonal basis. Bounded linear operators (on Hilbert spaces). Convergence and regularity of functions.

(9 hours)

Multirate systems: decimation, interpolation, fractional sampling rate, digital filter bank, multirate filters, Noble identities. Polyphase representation, efficient structures for interpolation, decimation filters.

(7 hours)

Haar and sinc expansion of discrete-time signals. Two channel filter banks – time, modulation and polyphase domain analysis and relation between the three representations. Perfect reconstruction and approximate reconstruction – alias-free reconstruction, QMF. Orthogonal FIR filter banks. Linear phase FIR filter banks. IIR filter banks. Tree-structured and multichannel filter banks, modulated filter banks – STFT and cosine modulated filter banks.

(10 hours)

Series (Fourier and sinc) expansion of signals and their time frequency resolution. Haar expansion. Multiresolution analysis and construction of the wavelet. Construction of wavelets using Fourier techniques. Wavelets from iterated filter banks and regularity. Wavelet series.

(10 hours)

Applications: *Choice of applications is left to the instructor.* Example: signal compression and subband coding.

(6 hours)



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Textbook:

1. Martin Vetterli and Jelena Kovacevic, Wavelets and Subband Coding, Prentice Hall PTR, 2007.

Reference books:

1. Vetterli M., Kovacevic J., Goyal V.K., Fourier and Wavelet Signal Processing, Cambridge University Press, 2013.
2. P.P. Vaidyanathan, Multirate Systems And Filter Banks, Prentice Hall, 1993.
3. Stephen Mallat, A Wavelet Tour of Signal Processing The Sparse Way, Elsevier 2009.

Similarity Content Declaration with Existing Courses:

Nil

Justification for new course proposal if cumulative similarity content is > 30%: NA