Mathematical Methods and Techniques in Singal Processing

Aerospace Engineering

Instructor Name: Prof Shayan Srinivasa Garani
Institute: IISc Bangalore
Department: Electronics & Communication Engineering

About Instructor: Dr. Shayan Garani Srinivasa received his Ph.D. in Electrical and Computer Engineering from Georgia Institute of Technology â€“ Atlanta, M.S. from the University of Florida â€“ Gainesville and B.E. from Mysore University. Dr. Srinivasa has held senior engineering positions within Broadcom Corporation, ST Microelectronics and Western Digital. Prior to joining IISc, Dr. Srinivasa was leading various research activities, managing and directing research and external university research programs within Western Digital. He was the chairman for signal processing for the IDEMA-ASTC and a co-chair for the overall technological committee. He is the author of a book, several journal and conference publications, holds U.S patents in the area of data storage. Dr. Srinivasa is a senior member of the IEEE, OSA and the chairman for the Photonic Detection group within the Optical Society of America. His research interests include broad areas of applied mathematics, physical modeling, coding, signal processing and VLSI systems architecture for novel magnetic/optical recording channels, quantum information processing, neural nets and math modeling of complex systems.

Pre Requisites: : UG in Digital Signal Processing, familiarity with probability and linear algebra
Core/Elective: : Elective
UG/PG: : PG
Industry Support : Any company using DSP techniques in their work, such as, TI, Analog Devices, Broadcom and many more.

Course Intro: : â€¢ Review of basic signals, systems and signal space: Review of 1-D signals and systems, review of random signals, multi-dimensional signals, review of vector spaces, inner product spaces, orthogonal projections and related concepts. â€¢ Sampling theorems (a peek into Shannon and compressive sampling), Basics of multi-rate signal processing: sampling, decimation and interpolation, sampling rate conversion (integer and rational sampling rates), oversampled processing (A/D and D/A conversion), and introduction to filter banks. â€¢ Signal representation: Transform theory and methods (FT and variations, KLT), other transform methods inclusing convergence issues. â€¢ Wavelets: Characterization of wavelets, wavelet transform, multi-resolution analysis. â€¢ Statistical signal modeling: The least squares method, Padeâ€™s approximation, Pronyâ€™s method, Shanksâ€™ method, iterative pre-filtering, all-pole modeling and linear prediction, autocorrelation and covariance methods, FIR least squares inverse filter design, applications and examples. â€¢ Inverse problems (signal reconstruction): regularized methods, reconstruction from projections, iterative methods such as projection onto convex sets

COURSE PLAN

SL.NO	Week	Module Name
1	1	Review of vector spaces, inner product spaces, orthogonal projections, state variable representation
2	2	Review of probability and random processes
3	3	Signal geometry and applications

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4	4	Sampling theorems (Shannon sampling vs. compressive sampling overview), decimation and expansion (time and frequency domain effects)
5	5	Sampling rate conversion and efficient architectures, design of high decimation and interpolation filters. Multistage designs
6	6	Introduction to 2 channel QMF filter bank, M-channel filter banks, overcoming aliasing, amplitude and phase distortions.
7	7	Subband coding and Filter Designs
8	8	Introduction to multiresolution analysis and wavelets, wavelet properties
9	9	Wavelet decomposition and reconstruction, applications to denoising
10	10	Derivation of the KL Transform, properties and applications
11	11	Fourier expansion, properties, various notions of convergence and applications
12	12	Signal Modeling: Least squares technique, Pade approximation