Subject outline - 2.163J/6.455J (Fall 2006)

Lecture 1 (9/6/06) - Administrative information, overview of subject content

Lecture 2 (9/11/06) - Data acquisition - theory and practice, review of sampling theory, Nyquist rates and aliasing, antialias filters, analog to digital conversion - dynamic range and precision, quantization, dynamic range, precision and digitizing noise

Lecture 3 (9/13/06) - Modulation and demodulation, quadrature components, narrow band signals, complex envelopes for narrowband signals and systems, magnitude and phase, phase and group delays for LTI systems with narrowband inputs, multichannel issues

Lecture 4 (9/18/06) - Sonar/radar model for signals reflected from slow, point targets, narrowband models and doppler shifts, correlation receivers and matched filters, range/doppler plane

Lecture 5 (9/20/06) - Ambiguity functions, examples of pulsed, coded (M-sequences) and FM signals, time-bandwidth issues

Lecture 6 (9/27/06) - Properties of ambiguity functions, detection and range/doppler estimation, resolution accuracy, sidelobes and global errors

Lecture 7 (10/2/06) - Reverberant environments, multipath and time varying scattering, range and doppler spread channel models, scattering functions, dispersion effects, examples from sonar, radar and seismic propagation

Lecture 8 (10/04/06) - Multidimensional random variables and random vectors, mean vectors, correlation and covariance matrices, multidimensional characteristic and moment generating functions

Lecture 9 (10/06/06) -Gaussian random vectors, linear transformations of Gaussian vectors, product-moment theorem, covariance matrix diagonalization

Lecture 10 (10/11/06) - Introduction to random processes, sample functions and ensembles, complete and partial representations, 1st and 2nd moment descriptions, correlation functions

Lecture 11 (10/16/06) - **Quiz No. 1, in class, covers material through lecture 8**

Lecture 12 (10/18/06) - Power density spectra, examples from wave spectra and ambient acoustic noise, input/output properties for correlation functions and spectra through linear, time invariant systems

Lecture 13 (10/23/06) - Estimation of power density spectra (I), indirect or Blackman-Tukey methods, performance, windows and bias/variance tradeoffs

Lecture 14 (10/25/06) - Estimation of power density spectra (II), frequency domain methods, tapering, segmenting and overlapping effects, resolution and variance tradeoffs, confidence intervals

Lecture 15 (11/01/06) - Estimation of power density spectra (III), estimation cross spectra and coherence functions, performance

Lecture 16 (11/06/06) - Estimation of power density spectra (IV), autoregressive methods (maximum entropy), Wiener-Levinson recursion and Burg methods

Lecture 17 (11/08/06) - Estimation of power density spectra (V), adaptive methods-maximum likelihood, Prony, root loci methods

Lecture 18 (11/13/06) - Deconvolution and whitening filters, minimum phase signals, correlation functions and reflection coefficient estimation methods, examples from seismic data

Lecture 19 (11/15/06) - Space/time random processes, spectral covariance functions, frequency-wavevector and directional spectra, examples of space/time processes using ambient noise and directional wave spectra

Lecture 20 (11/20/06) - Arrays, beam patterns and spatial filters, i/o properties of arrays, resolution, narrowband and broadband issues

Lecture 21 (11/20 - Tapering and sidelobe control, wavevector space interpretations

Note that this will be a three hour lecture from 2:30 to 5:30 to make up for cancelling class on the following Weds.

11/22/06 - class cancelled
Take home quiz covering material up to lecture 18 distributed.

Lecture 22 (11/27/06) - Directivity indices and array gain, sensitivity to gain/phase errors, superdirectivity

Lecture 23 (11/29/06) - Wavefront curvature array processing, matched field methods

12/1/06 **Take home quiz due!**

Lecture 24 (12/04/06) - Synthetic aperture radars and sonars, intro to space-time array processing

Lecture 25 (12/06/06) - Seismic array processing (I) Near field processing, wavefront curvature, RMS models

Lecture 26 (12/11/06) - Seismic array processing (II) common depth point stacking, velocity spectra

Lecture 27 (12//06) - **Quiz No. 3, in class, covers material through lecture 22**