THE GEORGE WASHINGTON UNIVERSITY
School of Engineering and Applied Science
Department of Electrical Engineering and Computer Science

ECE 211 Signals and Transforms in Engineering Analysis

Fall 2006

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Texts
(N) Notes
(**OW**) Alan V. Oppenheim and Alan S.Willsky, with S.Hamid Nawab, "Signals and systems", (Second Edition) Prentice Hall (1997)

References
(P) Athanasios Papoulis, "The Fourier integral and its applications", McGraw Hill (1962)

COURSE OUTLINE

1 (6 Sept.) **Signals and their representations**
Signal spaces and the approximation problem, inner product, norm in function space, functions in finite and infinite dimensional spaces; LMS approximation and the normal equations, geometrical interpretation in terms of the projection theorem, orthogonal functions, generalizations of the normal equations (**N)**
2 (13 Sept.) **Signals and their representations**
LMS approximation problem in terms of the Singular Value Decomposition (SVD), examples of finite orthogonal systems, the Gram Schmidt orthogonaliztion procedure (**N)**
3 (20 Sept.) **Signals and their representations**
Pointwise convergence of infinite orthogonal function sets, the delta function and other singularity functions, completeness of orthogonal systems. Examples of complete orthogonal systems: trigonometric functions, orthogonal polynomials (**N**), (**P:** pp. 269-281**), (OW:** Sec. 2.5**)**
4 (27 Sept.) **Fourier Series**
Fourier series, convergence properties, completeness, Fejer summation and spectral smoothing, relationships between frequency and time domain representations, symmetries, cosine and sine series, interpolation with sinusoids (**N**), (**OW**: Sec. 3.0-3.5)
5 (4 Oct.) **The Fourier Integral**
LMS approximation by sinusoids spanning a continuum, transition to infinite intervals : The Fourier Transform, completeness and relationship to Fourier Series,

convergence issues and use of CPV integrals, FT of canonical signals, basic properties of the FT, convergence at discontinuities, Fejer summation techniques, Hilbert transform and analytic signal theory (N) (OW 4.1-4.8)

6 (11 Oct.) **Linear Systems: I/O Description**
Causality, linearity, passivity, impulse response, response to general excitations, BIBO stability; time varying and LTI systems, frequency domain representation.
(**N**), (**P:** pp. 81-92), (**OW:** Sec. 2.2-2.3**)**

7 (18 Oct.) **Linear Systems: DE description**
Representation of linear systems by differential equations, time varying and LTI systems (**N**) (**OW**: Sec. 2.4.1)

8 (25 Oct.) **MIDTERM EXAM**

9 (1 Nov.) **Laplace transforms**
Theory of the single- sided Laplace transform, analytic properties; double-sided Laplace transform and relationships to the FT, evaluation of using the calculus of residues, applications to the analysis of LTI systems (N) (OW: Sec 9.0-9.9)

10 (8 Nov.) **Sampling and the discrete Fourier transform**
Bandlimited functions, the sampling theorem, signal reconstruction and interpolation, aliasing, sampling in the frequency and time domains, impulse sampling, zero-hold sampling and reconstruction, sampling of periodic signals; the discrete FT, applications. (**N) (OW:** Sec. 7.1-7.5)

11 (15 Nov) **Discrete-time Linear Systems**
Fundamental properties, representation in terms of difference operators, solutions using the DFT, (**N**), (**OW**: Sec. 2.4.2, 5.2-5.8)

12 (22 Nov.) **The Z- Transform**
Transition from Fourier series to the double-sided z-transform, the inversion formula, regions of convergence, properties of the z-transform.**(N),** (**OW:** Sec. 10.1-10.6**)**

13 (29 Nov.) **Discrete Linear Systems**: **Solutions by Z- transforms**
Analysis and characterization LTI systems using z-transforms, analytical properties of transfer functions, digital filters. (**N),** (**OW**: 10.7-10.9)

14 (6 Dec. **) The Wavelet Transform**
Fundamental properties of wavelets, representation of signals, frequency /time representation of signals, applications to signal analysis (N)

15 (20 Dec.) **FINAL EXAM**