

Discrete Signals and Systems

----- 16 weeks (3 lectures, 1 exercise) -----

1 Introduction

2 Continuous-Time Signals

- 2.1 Overview
- 2.2 Signal Properties and Classification
- 2.3 Test Signals
- 2.4 Basic Signal Operations
- 2.5 Continuous-Time FOURIER Transform (CTFT)
- 2.6 HILBERT Transform

3 Continuous-Time Systems

- 3.1 System Definition and Properties
- 3.2 Time-Domain Representation
 - 3.2.1 Convolution Integral, Impulse Response
 - 3.2.2 Differential Equations
 - 3.2.3 State Space
- 3.3 Frequency-Domain Representation
- 3.4 HILBERT Transformer
- 3.5 LAPLACE Transform (LT)
 - 3.5.1 Definitions and Convergence
 - 3.5.2 Properties of the LAPLACE Transform
 - 3.5.3 Theorems of the Unilateral LAPLACE Transform
 - 3.5.4 Basic LAPLACE Transform Pairs
 - 3.5.5 Inverse LAPLACE Transform of Rational Functions
- 3.6 s -Domain Representation of LTI Systems
 - 3.6.1 System Function
 - 3.6.2 State-Space Representation in the s -Domain
 - 3.6.3 Time Domain Versus s -Domain of LTI Systems
 - 3.6.4 Frequency Response Derived from Pole-Zero Plot
 - 3.6.5 Allpass and Minimum-Phase Transfer Function
- 3.7 Block Diagram Representations

4 Discrete-Time Signals

- 4.1 Overview
- 4.2 Sampling and Reconstruction
 - 4.2.1 Impulse-Train Sampling
 - 4.2.2 Sampling with a Zero-Order Hold
 - 4.2.3 Sampling with a Linear Gate
- 4.3 Signal Notation and Properties
- 4.4 Test Sequences
- 4.5 Signal Operations
 - 4.5.1 Elementary Operations
 - 4.5.2 Convolution
 - 4.5.3 Sampling Rate Alteration
 - 4.5.4 Operations on Finite-Length Sequences
- 4.6 Discrete-Time FOURIER Transform (DTFT)
- 4.7 Discrete and Fast FOURIER Transform (DFT, FFT)

5 Discrete-Time Systems

- 5.1 System Definition and Properties
- 5.2 Time-Domain Representation
 - 5.2.1 Impulse and Step Response
 - 5.2.2 Convolution Sum
 - 5.2.3 Difference Equations
 - 5.2.4 State Space
- 5.3 Frequency-Domain Representation
- 5.4 z -Transform
 - 5.4.1 Definition and Convergence
 - 5.4.2 Basic z -Transform Pairs
 - 5.4.3 Properties of the z -Transform
 - 5.4.4 Theorems of the Bilateral z -Transform
 - 5.4.5 Inverse z -Transform
- 5.5 z -Domain Representation of LTI Systems
- 5.6 Transfer Function Classification
 - 5.6.1 Magnitude Based Classification
 - 5.6.2 Phase Based Classification
- 5.7 Block Diagram Representations

6 Applications

- 6.1 Time-Selective Filters
 - 6.1.1 Window Functions
 - 6.1.2 Properties
- 6.2 Frequency-Selective Filters
 - 6.2.1 Simple Digital Filters
 - 6.2.2 FIR Digital Filter Design
 - 6.2.3 FIR Filter Order
 - 6.2.4 Design Concepts
- 6.3 Control Systems
 - 6.3.1 Linear Feedback Systems
 - 6.3.2 Stabilization of Unstable Systems
 - 6.3.3 Sampled-Data Feedback Systems
 - 6.3.4 Root-Locus Analysis
 - 6.3.5 NYQUIST Stability Criterion

Appendix

- A Mathematical Basics
- B Transform Tables