

Digital Signal Processing

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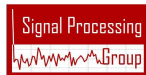
http://sp.utcluj.ro/Teaching_IVTST.html

October 4th, 2016



<http://etti.utcluj.ro>

Faculty of Electronics,
Telecommunications
and Information Technology



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Course contents

Ch. I **Discrete-time signals and systems**

- **Signals and systems:** Concept of frequency in continuous-time and discrete-time signals; Discrete angular frequency; Alias effect
- **Discrete-time signals:** Some elementary discrete-time signals; Classification of discrete-time signals; Simple manipulations of discrete-time signals
- **Discrete-time systems:** Block diagram representation of discrete-time systems; Classification of discrete-time systems; Interconnection of discrete-time systems

Course contents (cont.)

Ch. II **Analysis of discrete-time linear time-invariant systems (LTIS)**

- Convolution sum and impulse response sequence
- Causal LTIS
- Stability of LTIS
- **Finite impulse response (FIR) and infinite impulse response (IIR) systems:** Recursive and nonrecursive discrete-time systems; Forced and free response; LTIS characterized by constant-coefficient difference equations; IIR systems – solution of linear constant-coefficient difference equations; Impulse response of an LTI recursive system
- **Correlation of discrete-time signals:** Crosscorrelation sequence; Autocorrelation sequence; Properties of the autocorrelation and crosscorrelation sequences; Correlation of periodic sequences
- **Implementation of discrete-time systems – direct-forms:** IIR systems; FIR systems

Course contents (cont.)

Ch. III Frequency analysis of discrete-time signals and systems

- Fourier series – discrete-time periodic signals
- Fourier transform – discrete-time aperiodic signals: Definition; Properties
- Frequency-domain characteristics of LTIS

Ch. IV Discrete Fourier transform

- Sampling in time and frequency-domain
- Discrete Fourier transform (DFT): Definition; Properties; DFT as a linear transformation; Relationship of DFT to other transforms
- Applications of DFT: Linear filtering methods based on DFT; Frequency analysis of signal using DFT

Ch. V Fast Fourier transform

- Discrete Fourier transform – remarks
- Fast Fourier transform (FFT) – radix algorithms: Radix-2 FFT algorithms: decimation-in-time; Radix-2 FFT algorithms: decimation-in-frequency; Split-radix FFT algorithms

Course contents (cont.)

Ch. VI **z -Transform and its applications to the analysis of LTIS**

- z -Transform: definition, convergence
- Inversion of z -transform
- Properties of z -transform
- Rational z -transform: Poles and zeros; System/transfer function of an LTIS
- One-sided z -transform
- Analysis of LTIS in z -domain: Response of systems with rational system functions; Causality and stability; Schür-Cohn stability test

Ch. VII **Implementation of discrete-time systems**

- Introduction
- Structures for FIR systems: Direct-form structure; Cascade-form structure; Frequency-sampling structure; Lattice structure
- Structures for IIR systems: Direct-form structures; Cascade-form structure; Parallel-form structure; Lattice and lattice-ladder structures

Course contents (cont.)







Ch. VIII Design of digital filters

- **Design of filters in frequency-domain:** General considerations; Characteristics of practical frequency-selective filters; Relationships between system function and frequency response function; LTIS as frequency-selective filters
- **Design of FIR filters:** Linear-phase FIR filters; Design of linear-phase FIR filters using windows; Design of linear-phase FIR filters by frequency sampling method; Design of optimum equiripple linear-phase FIR filters
- **Design of IIR filters:** Design of IIR filters from analog filters; Frequency transformations; Design of digital IIR filters in discrete-domain

Laboratory contents

- 1 Introduction to MATLAB
- 2 Discrete-time signals
- 3 Sampling of analog signals
- 4 Discrete-time LTIS
- 5 Discrete Fourier transform
- 6 Linear and circular convolution
- 7 *Practical exam 1*
- 8 FIR filters. Design methods
- 9 Discrete-time LTIS as frequency selective filters
- 10 IIR filters. Indirect design methods
- 11 IIR filters. Direct design methods
- 12 Structures for the realization of FIR systems
- 13 Structures for the realization of IIR systems
- 14 *Practical exam 2*. Questions

References

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-  [Sanjit K. Mitra.](#)
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Teaching WEB page

- http://sp.utcluj.ro/Teaching_IVTST.html
 - Course contents
 - Slides
 - Laboratory contents
 - Examples (implemented in MATLAB)
 - Exercises (must be implemented in MATLAB – practical exams)
 - References
 - Solved problems
 - Proposed problems
 - Miscellanea

Grading

- ① Written exam (**WE**): 1 ÷ 10 points – 2 hours
 - 3 problems
- ② 2 practical exams
 - Practical exam 1 (**PE1**): 1 ÷ 10 points – 30 minutes
 - 7th week of the semester – November 17, 2016 (at the laboratory class)
 - 2 exercises (must be implemented in MATLAB) – from laboratory exercises
 - Practical exam 2 (**PE2**): 1 ÷ 10 points – 30 minutes
 - 14th week of the semester – January 19, 2017 (at the laboratory class)
 - 2 exercises (must be implemented in MATLAB) – from laboratory exercises

Final mark = $0,6 \cdot WE + 0,2 \cdot PE1 + 0,2 \cdot PE2$

if $WE \geq 4$ and $0,6 \cdot WE + 0,2 \cdot PE1 + 0,2 \cdot PE2 \geq 4,5$

Where can we meet?

- ① **Course:** Room P01 (G. Barițiu street)
- ② **Laboratory:** Room 307 (Observatorului street)
- ③ **Contact:** Lacrimioara.Grama@bel.utcluj.ro