2017/2018

Digital Signal Processing

M. Sc. (COMPUTER SCIENCE)

An Introductory Course

By

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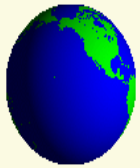
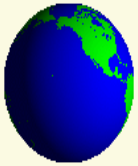
The objective of this course



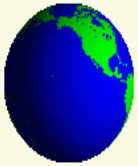
- Is to provide a basic introduction to the theory of **digital signal processing (DSP).** We assume a familiarity with the **Fourier transforms** and concepts such as **linearity** and **shift invariance** that are used in the description and analysis of linear analog systems. Much of what we do extends these ideas to the field of **discrete time systems**. Major parts of the course will concentrate on signal analysis using ***Fourier transforms***, ***linear system analysis, Filter design*** and a few more advanced topics. We will study the discrete Fourier transform and its properties. We will also study the ***sampling theorem*** and the relationship between **continuous** and **discrete time transforms**. We will see how discrete time, linear shift invariant systems can be characterized using **linear difference equations** and the **impulse response** and show how tools such as the ***z-transform and discrete Fourier transform*** can be used in the design and analysis of such systems. We will then study the design and implementation of **digital filters**. We will also include some topical material: what is **bandpass sampling**? what are **polyphase filters** and f**ilterbanks**?, what are **adaptive filters**? While this course deals largely with the theory of DSP, we will use a powerful software package, **MATLAB**, to look at **applications** of this theory, particularly Fourier analysis and digital filter design.

Outline



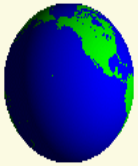
- I. **Introduction to discrete linear systems**
  - ***Discrete time signals.***
  - ***Special sequences.***
  - ***Shift invariance.***
  - ***Stability and causality.***
  - ***Impulse response.***
  - ***Difference equations.***

Outline



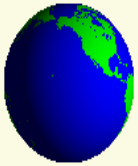
- II. **Discrete-Time Fourier Transform and Linear Time Invariant Systems**
  - ***Transform definitions.***
  - ***Theorems.***
  - ***Frequency response of linear time invariant systems.***
  - ***Phase and group delays.***
  - ***Matlab computations***

Outline



- III. **Fourier transforms, sampling**
- ***Fourier transform review.***
- ***Sampling continuous-time signals: the sampling theorem.***
- ***Aliasing.***
- ***Re-sampling digital signals.***
- ***A/D conversion and quantization***
- ***D/A conversion***
- ***Polyphase decomposition***
- ***Polyphase DFT filterbanks***
- ***Bandpass sampling***

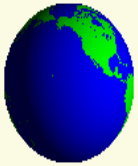
Outline



- IV. **The discrete Fourier transform**

  - ***Definition of DFT.***
  - ***Properties of the DFT.***
  - ***Linear and periodic convolution using the DFT.***
  - ***Zero padding, spectral leakage, resolution and windowing in the DFT.***

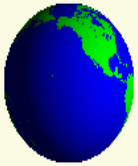
Outline



- V. **The Z transform**

- ***Z-transforms by summation of left, right, and two-sided sequences.***
- ***Regions of convergence and Z-transform properties.***
- ***Inverse Z-transform.***

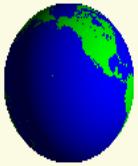
Outline



VI. **Properties of digital filters**

- ***Averaging filter.***
- ***Recursive smoother.***
- ***First-order notch filter.***
- ***Second-order unity gain resonator.***
- ***All-pass filters.***
- ***Comb filters.***
- ***Equalization filters.***
- ***Group delay, linear phase, all-pass, minimum phase***

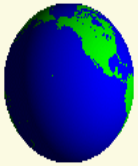
Outline



- VII. **Finite impulse response (FIR) filters**

  - ***Window design techniques.***
  - ***Kaiser window design technique.***
  - ***Equiripple approximations.***

Outline



- VIII. **Infinite impulse response (IIR) filters**

  - ***Bilinear transform method.***
  - ***Examples of bilinear transform method.***

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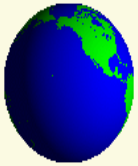
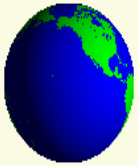


- IX. **Structures and properties of FIR and IIR filters and review**

- ***IIR - Direct, parallel and cascaded realizations.***
- ***FIR – Direct and cascaded realizations.***
- ***Coefficient quantization effects in digital filters***
- ***Final review.***

Texts and References



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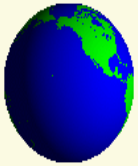

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