CMPE 362, Introduction to Signal Processing for Computer Engineers

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Catalog Description

Introduction to discrete and continuous time signals and systems with computer engineering applications. Time-
domain signal representations, impulse response of linear time-invariant systems; convolution. Fourier series. Spectrum
representation. Discrete Fourier transform. Algorithms for signal processing, fast Fourier transform. Floating point
and quantization errors. Exercises with applications in audio and image processing, matlab/octave programming.

Course Description

Signal Processing is the study of computational techniques for analysis, synthesis and manipulation of time series data
obtained via sensors. The data can come from diverse phenomena, such as biological, medical, financial, behavioral,
seismological, communication networks, multimedia (music, audio, speech, video, images, text).

With the increasing computational power, there has been a significant growth of information processing applications
that require signal processing. Today, signal processing is not only needed in classical subjects such as communications
or control, but also in machine learning, artificial intelligence, information retrieval, bioinformatics, human computer
interaction, computer vision, machine listening, robotics, computer systems security or computer games.

The purpose of this introductory course is to provide the students with an understanding of the basic theory, as
well as working skills for solving practical problems. Apart from rudiments of algebraic and symbolic manipulations
involving matrices and symbolic sequences, a significant part of the course deals with computational experiments using
the matlab programming language.

Essentially, this course is a basic signals and systems course but deviates from the traditional EE treatment in
some ways. Our primary goal is to equip the computer science and engineering students with the fundamentals of
signal processing concepts for scientific computation and machine learning.

Topics

1. Introduction, Motivations, Applications of Signal Processing, Systems (McClellan)
2. Sinusoids, Complex Exponentials and Phasors (McClellan), Proof of Euler’s Identity (McClellan,Smith)
3. Geometric Signal Theory, Vector/ Matrix Representations, Block diagrams, (Smith, Handouts)
4. Spectrum Representation, the Discrete Fourier Transform and Spectrogram (McClellan)
5. FIR Filters, Linear Time Invariant Systems (McClellan)
6. Transfer Function Analysis, z-transform (McClellan, Smith)
7. IIR Filters, Matlab Filter Analysis, Analysis of a Digital Comb Filter, Time Domain Representations, Matrix
   Representations of Digital Filters (Smith,McClellan)
8. State Space Representations (Smith)
9. Vandermonde Matrices, The DFT Derived, Fourier Theorems for the DFT, DFT Applications, (Handouts,
    Smith)
10. Fast Fourier Transform FFT, The Kronecker Product (handouts (van Loan))
11. Quantization, Sampling, Aliasing, Floating point representations (McClellan)
12. Least Squares and Singular Value Decomposition (SVD) (Handouts)

Schedule and Assignments
TBA

Main Textbook

Additional Online Material
- Mathematics of the Discrete Fourier Transform (DFT), Second Edition
  Julius O. Smith III
  http://ccrma.stanford.edu/~jos/mdft/
- Introduction to Digital Filters with Audio Applications,
  Julius O. Smith III
  http://www.dsprelated.com/dspbooks/filters/
- Handouts

Prerequisite
MATH 202

Administrative (Tentative)
- Grading
  - % 20 Midterm I
  - % 20 Midterm II
  - % 20 Midterm III
  - % 30 Final
  - % 10 Quizes (Assignment questions)
  - Assignments will be given but not graded. Testing via Exams and Quizzes.
- Total Credits 3