Advanced Digital Signal Processing

Saturdays, 13:20 - 17:20, Room D0406

Lecturer: Dr. Phuong T. Tran

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Course Description: This is a graduate level course in digital signal processing, which covers advanced concepts in digital signal processing of deterministic and stochastic signals. Topics include discrete signals, systems, and transforms, linear filtering, fast Fourier transform, nonlinear filtering, spectrum estimation, linear prediction, adaptive filtering, and multirate signal processing.
Prerequisite(s): any undergraduate DSP course.
Credit Hours: 3

Text: *Digital Signal Processing: Principles, Algorithms, and Applications*, 4th Edition
Authors: J.G. Proakis and D.G. Manolakis; **ISBN-13:** 978-0131873742

References: *Foundations of Signal Processing*, 4th Edition
Author(s): M. Vetterli, J. Kovacevic, and V.K. Goyal; **ISBN-13:** 978-1107038608

Grade Distribution:

Assignments	10%
Tests	20%
Midterm Exam	20%
Final Exam or Final Project	50%

Course Policies:

- **Lecture**
  Active participation from the class as much as possible is highly encouraged. Please feel free to ask questions during the lecture. I will also be asking you some questions to stimulate your thinking at various points during the lecture.
- **Grades**
  If you dispute your grade on any exam or computer assignment, you have one week from the date that the graded paper was returned to you to request a regrade.
- **Assignments**
  - Regular homework will be assigned but not always be collected.

- There will also be assignments involving the use of a computer to simulate signals, perform digital filtering, spectral analysis, adaptive filtering, etc.
- **No late assignments will be accepted under any circumstances**.

- **Attendance and Absences**
  - Attendance is expected and will be taken each class. You are allowed to miss **1** class during the semester without penalty. Any further absences will result in point and/or grade deductions.
  - Students are responsible for all missed work, regardless of the reason for absence. It is also the absentee's responsibility to get all missing notes or materials.

Academic Honesty Policy Summary:

Introduction

In addition to skills and knowledge, UNIVERSITY aims to teach students appropriate Ethical and Professional Standards of Conduct. The Academic Honesty Policy exists to inform students and Faculty of their obligations in upholding the highest standards of professional and ethical integrity. All student work is subject to the Academic Honesty Policy. Professional and Academic practice provides guidance about how to properly cite, reference, and attribute the intellectual property of others. Any attempt to deceive a faculty member or to help another student to do so will be considered a violation of this standard.

Unauthorized/Excessive Assistance

Students are expected to work independently. **Offering** and **accepting** solutions from others is an act of **plagiarism**, which is a serious offense and **all involved parties will be penalized according to the University regulation**. Discussion amongst students is encouraged, but when in doubt, direct your questions to the lecturer.

Authorship

The student must clearly establish authorship of a work. Referenced work must be clearly documented, cited, and attributed, regardless of media or distribution. Even in the case of work licensed as public domain or Copyleft, (See: http://creativecommons.org/) the student must provide attribution of that work in order to uphold the standards of intent and authorship.

Declaration

Online submission of, or placing one's name on an exam, assignment, or any course document is a statement of academic honor that the student has not received or given inappropriate assistance in completing it and that the student has complied with the Academic Honesty Policy in that work.

Consequences

An instructor may impose a sanction on the student that varies depending upon the instructor's evaluation of the nature and gravity of the offense. Possible sanctions include but are not limited to, the following: (1) Require the student to redo the assignment; (2) Require the student to complete another assignment; (3) Assign a grade of zero to the assignment; (4) Fail the course. A student may appeal these decisions according to University Procedure. Multiple violations of this policy will result in a referral to the Disciplinary Board for possible additional sanctions.

Tentative Course Outline:

The weekly coverage might change as it depends on the progress of the class. However, you must keep up with the reading assignments.

Week	Content
Week 1	• Basic Sampling Theory and D/A Conversion • Signals as vectors; vector spaces • Hilbert spaces; approximation and projections; bases and frames • Discrete-Time Linear Systems (DT Convolution) – Autocorrelation, Cross-Correlation (VIP)
Week 2	• Z Transform • Discrete-Time Fourier Transform/Continuous Time Fourier Transform
Week 3	• Frequency Selective Linear Filtering • Multirate DSP – Efficient Upsampling/Downsampling – Multi-Stage Upsampling; Nobles Identities
Week 4	• Multirate DSP (cont.) – Digital Subbanding – M-Channel Perfect Reconstruction Filter Bank • Apps: CD/DVD Players, Radar, Wireless Comm: CDMA, OFDM.
Week 5	• Discrete Fourier Transform - Definition and Properties • Fast Fourier Transform Algorithms
Week 6	• FIR Filters Equiripple Designs – Common analog filters – Bilinear transformation – Frequency transformations via All-Pass Filters
Week 7	• Nonparametric methods of power spectrum estimation – Discrete random processes – Estimation of autocorrelation sequence • Stochastic processes and systems; MMSE and Wiener filters • Adaptive filters; LMS algorithm
Week 8	• Model-Based Spectrum Estimation – Autoregressive (AR) Modelling – Forward/Backward Linear Prediction – Levinson-Durbin Algorithm – Minimum Variance Method • Applications in Speech Processing, Communications, and Acoustics
Week 9	• Final Project presentation