ECE 603: Statistical Digital Signal Processing

Department of Electrical and Computer Engineering
University of Waterloo
Spring 2020

Course details

Course description

This is a course on statistical digital signal processing. In particular, as opposed to a first course on digital signal processing which deals with deterministic signals, this course aims to present methods by which to design signal processing techniques in the presence of uncertainty. This will usually involve some form of the least squares methods in the context of signal processing and second order statistics will play an important role in some components.

Course schedule/staff

- Lectures are online
- **Instructor**: Oussama Damen, `mdamen@uw`, Office
- **Office hours:** By email appointment
- **Course website:** On LEARN

Marking scheme

- Midterm (in the form of three quizzes spaced over the term): $3 \times 20 = 60\%$
- Project: 40%
- Assignments are not graded but are essential to after exam happiness
- If you miss the exams, we need official papers to justify a supplementary exams or deferral
- **No alternative marking scheme on a case by case basis.** But the instructor reserves the right to change the marking scheme for all if judged beneficial
- Requirements for auditing: (1) register for the course; (2) attend every class; and (3) complete all assignments.

Course info

Required textbook

Statistical Digital Signal Processing and Modeling by Monsoon H. Hayes

Reference

- Adaptive Filter Theory by Simon Haykin.
- An Introduction to Statistical Signal Processing by Robert M. Gray and Lee Davisson (available online: https://ee.stanford.edu/~gray/sp.pdf).

Prerequisite

- Probability theory and elementary stochastic processes (will do a short review on those but you are required to review your probability notes)
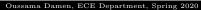- Signals and systems (Fourier analysis, Z-transform, etc.)

Covered material

The following material will be covered from the textbook.[1]

1. Background review of linear Algebra: vectors and matrices operations, Toeplitz and circulant matrices, eigen and singular values decompositions, optimization theory.

2. Review of random processes: autocorrelation and autocovariance matrices, filtering; spectral factorization; special types of random processes.

3. Linear prediction and optimum linear filters: Levinson recursion; lattice filters; Wiener filtering and Kalman filtering.

4. Adaptive filtering: Least Mean Squares (LMS) algorithm; recursive least squares (RLS); decision feedback equalizers.

5. Spectrum estimation: non-parametric methods; minimum variance; maximum entropy; parametric methods; frequency estimation.

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[1] The lectures will closely follow the textbook but not verbatim, additional examples, explanations, interpretations will be given when necessary.

- The exams are closed-book
- If you miss the exams without a verifiable and valid reason you will receive a 0 on that exam
- Solutions to assignments will be available on Waterloo LEARN

Required inclusions

- Academic integrity: In order to maintain a culture of academic integrity, members of the University of Waterloo community are expected to promote honesty, trust, fairness, respect and responsibility.

- Grievance: A student who believes that a decision affecting some aspect of his/her university life has been unfair or unreasonable may have grounds for initiating a grievance. Read Policy 70, Student Petitions and Grievances, Section 4. When in doubt please be certain to contact the department's administrative assistant who will provide further assistance.

- Discipline: A student is expected to know what constitutes academic integrity to avoid committing an academic offence, and to take responsibility for his/her actions. A student who is unsure whether an action constitutes an offence, or who needs help in learning how to avoid offences (e.g., plagiarism, cheating) or about "rules" for group work/collaboration should seek guidance from the course instructor, academic advisor, or the undergraduate Associate Dean. For information on categories of offences and types of penalties, students should refer to Policy 71, Student Discipline. For typical penalties check Guidelines for the Assessment of Penalties.

Required inclusions (continued)

- Appeals: A decision made or penalty imposed under Policy 70 (Student Petitions and Grievances) (other than a petition) or Policy 71 (Student Discipline) may be appealed if there is a ground. A student who believes he/she has a ground for an appeal should refer to Policy 72 (Student Appeals).

- Note for students with disabilities: The AccessAbility Services, located in Needles Hall, Room 1132, collaborates with all academic departments to arrange appropriate accommodations for students with disabilities without compromising the academic integrity of the curriculum. If you require academic accommodations to lessen the impact of your disability, please register with the AccessAbility Services at the beginning of each academic term.