Course Description
ECE431 is an introductory course in digital filtering and applications and covers the following topics: 1) introduction to real world signal processing, 2) review of sampling and quantization of signals, 3) introduction to the discrete Fourier transform and its properties, 4) fast Fourier transform, 5) Fourier analysis of signals using the discrete Fourier transform, 6) structures for discrete-time systems, 7) design and realization of digital filters: finite and infinite impulse response filters, 8) DSP applications in areas such as communications, multimedia, video coding, human computer interaction and medicine.

Learning Objectives
Digital signal processing (DSP) is the mathematical manipulation of an information signal to enhance or simply modify it in some way. It is characterized by the representation of discrete time, discrete frequency, or other discrete domain signals by a sequence of numbers or symbols and the processing of these signals. The objective of this course is to introduce students to fundamental concepts of DSP, including sampling and reconstruction, the z-Transform, the Discrete Fourier Transform (DFT) and its implementation, finite impulse response (FIR) and infinite impulse response (IIR) digital filtering, multirate signal processing, and applications in digital media. The course includes weekly lectures (3 hours total), weekly 1-hour tutorials, and biweekly lab sessions.

- Understand fundamental concepts of DSP and the physical interpretation of its mathematical basis
- Understand tradeoffs in digital representation of signals: sampling rate, quantization
- Understand implementation of the fast Fourier transform
- Check stability of filters
- Analyze minimum phase, linear phase, and all-pass discrete-time systems
- Analyze and design filters based on pole/zero placement
• IIR filter design from continuous-time filters
• FIR linear-phase filter design
• Design filters using Matlab (via laboratory exercises)
• Implementation considerations
• Multirate processing and its application in efficient filtering, subband coding, communications, etc.
• Application of DSP to audio, image, and video processing

Textbook


Lectures

To ensure fair and safe learning for all students, pre-recorded videos of the week’s lectures will be available on BBCollaborate on the Sunday before the week commences. Students are expected to view these videos either during assigned lecture hours or on their own time *but before Thursday*. Every Thursday, we will conduct a synchronized Q&A session during the scheduled lecture time at 2:00 pm to answer questions from students on the week’s materials. The pre-recorded videos will be available for 7 days until the following Sunday, at which time lecture recordings for the week following will be posted.

<table>
<thead>
<tr>
<th>Day</th>
<th>Time</th>
<th>Location</th>
<th>Code</th>
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<tbody>
<tr>
<td>Monday</td>
<td>2:00 pm – 3:00 pm</td>
<td>Virtual</td>
<td>(LEC 01)</td>
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<tr>
<td>Wednesday</td>
<td>2:00 pm – 3:00 pm</td>
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<td>(LEC 01)</td>
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<tr>
<td>Thursday</td>
<td>2:00 pm – 3:00 pm</td>
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Tutorials

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<tr>
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<tr>
<td>Tuesday</td>
<td>5:00 pm – 6:00 pm</td>
<td>Virtual</td>
<td>(TUT 01)</td>
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Tutorials begin the week of September 14. Solutions to problem questions assigned the week before will be covered during the tutorial. A weekly short quiz based on the assignment questions will be given at the end of each tutorial.

Labs

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<td>Monday</td>
<td>3:00 pm – 6:00 pm</td>
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<tr>
<td>Specific Dates:</td>
<td>Sep 21, Oct 5, Oct 19, Nov 16, Nov 30</td>
<td>(PRA 01)</td>
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<td>Sep 28, Oct 12, Oct 26, Nov 23, Dec 7</td>
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The five laboratory sessions will cover the following:

- Exp01 – Sampling and Quantization
- Exp02 – Z-transform
- Exp03 – Fast Fourier Transform
- Exp04 – FIR Filters
- Exp05 – Multirate Processing
Composition of Final Mark

<table>
<thead>
<tr>
<th>Component</th>
<th>Mark</th>
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<tbody>
<tr>
<td>Labs</td>
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<tr>
<td>Quizzes</td>
<td>10%</td>
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<tr>
<td>Term tests x 2</td>
<td>30%</td>
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<tr>
<td>Final exam</td>
<td>40%</td>
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Syllabus

- Week 1: Introduction and review of Fourier series and Fourier transform
- Week 2: Discrete-time signals and systems (Oppenheim, §2).
- Week 3: Sampling of continuous-time signals (Oppenheim, §4).
- Week 4: z-Transform (Oppenheim, §3).
- Week 5: Discrete Fourier Transform and Fast Fourier Transform (Oppenheim, §8 & §9).
- Week 6: Transform analysis of linear time-invariant systems (Oppenheim, §5).
- Week 7: TERM TEST 1
- Week 8: Implementation for discrete-time systems (Oppenheim, §6).
- Week 9: Filter design (Oppenheim, §7).
- Week 10: Digital processing of analog signals, finite precision (Oppenheim, §4 & §6)
- Week 11: Multirate systems and wavelets (Oppenheim, §4)
- Week 12: Digital audio, image, and video processing
- Week 12: TERM TEST 2
- Week 13: Final exam review

Course Policies

- All tests and the final exam make use of a non-programmable (Type 2) calculator. No programmable calculators are allowed. The final exam is Type C (candidates may prepare, bring to the exam and use a single, double-sided standard aid sheet supplied by the registrar’s office).

- The Faculty’s policy on Petition for Consider in Course Work will be employed for missed tests and late assignments. Official supporting documentation must be provided and the completed petition must be filed with the EngSci office.

- Questions regarding marking must be written on a piece of paper and submitted with the associated test/assignment to the cognizant TA. There is a 48-hour limit (weekends and holidays excluded) from the time it is first returned in which you may request a recheck.

- Please note that late assignments (e.g., lab write-ups) will be deducted 15% per business day.

- Academic integrity is of utmost important. Any issues of plagiarism and inappropriate collaboration will be taken seriously and reported to the appropriate higher authority.

- Students with diverse learning styles and needs are welcome in this course. In particular, if you have a disability/health consideration that may require accommodations, please feel free to approach me and/or Accessibility Services at (416) 978 8060; [http://accessibility.utoronto.ca](http://accessibility.utoronto.ca).