

# ECE355H1F 2021 – Signal Analysis and Communications

**Description:** Efficient information processing is a core requirement of any complex engineering system. This course presents a mathematical framework for such analysis by introducing two key concepts: signals and systems. The topics include properties of signals and systems, processing of signals by linear systems, Fourier series and transforms, sampling, discrete-time processing of continuous-time signals, and application to communication systems.

**Textbook:** Alan V. Oppenheim, Alan S. Willsky, and S. Hamid Nawab, *Signals & Systems*, 2nd Ed., Prentice-Hall, 1996 (ISBN 0-13-814757-4).

## Instructor:

Prof. Ben Liang  
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Email: liang(AT)ece.utoronto.ca  
<http://www.comm.utoronto.ca/~liang>  
Office hours: TBD

## Lectures:

Mondays 12:00 - 14:00; ~~MC 254~~ pre-recorded  
Fridays 12:00 - 13:00; BA 1170

## Tutorials:

TUT01: Tuesdays 9:00 - 11:00; BA 1230  
TUT02: Tuesdays 9:00 - 11:00; BA 2185  
TUT03: Wednesdays 9:00 - 11:00; BA 2159

## Teaching Assistants:

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## Course Website:

The course website is at Quercus. Homework, handouts, grades, and announcements will be posted here. Students are required to check it regularly for new information. Please make sure you have a valid email address listed, since the professor and TAs may use it to contact you.

## Homework:

ECE355 is a course heavy in mathematics. New concepts are almost always built on those introduced earlier in the course. Therefore, to do well in this course you must ***keep up to date with the class material***. The best way to accomplish this is to practice early and often, through homework and other exercise problems. Homework problems will be assigned weekly, and they will be collected and graded. However, homework grading will be for effort only and not correctness. You are allowed to collaborate with your classmates on homework, but each student must write his/her own answers in the submitted work.

## Tutorials:

In tutorials, teaching assistants will cover homework assignment problems, take questions from students, and present extended examples or applications. Your learning experience will be much more productive if you attempt to solve the homework assignment problems *before* each tutorial.

**Tutorials begin in the week of September 20.**

## Grading Components:

Homework: 20%

Midterm Exam: 40% (evening of Friday, October 29)

Final Exam: 40%

## Online Homework Submission:

For homework and exams, you are required to submit your completed work as a PDF file. The following two options are recommended:

- a) Write on your screen directly and submit the resultant file in PDF;
- b) Write your answers on sheets of paper, scan all pages into one PDF file, and submit that PDF file.

Document scanning apps are available for most mobile phones (e.g., the scanning function built into the free Dropbox app). If you are not able to use either option above, please discuss with the instructor as soon as possible.

## Outline of Topics and Timing:

1. Signals and systems (Chapter 1, weeks 1 – 2)
2. Linear time-invariant systems (Chapter 2, weeks 3 – 5)
3. Fourier series (Chapter 3, weeks 6 – 7)
4. Continuous-time Fourier transform (Chapter 4, weeks 7 – 9)
5. Discrete-time Fourier transform (Chapter 5, weeks 9 – 10)
6. Sampling and reconstruction (Chapter 7, weeks 10 – 11)
7. Communication systems (Chapter 8, weeks 11 – 12)

## Tentative Lecture Schedule:

Week of Sep 6			Course Overview, Introduction to signals (ch 1.1)
Sep 13	Properties of signals (ch 1.2)	Exponential and sinusoidal signals (ch 1.3)	Unit impulse and step functions (ch 1.4)
Sep 20	Introduction to systems (ch 1.5)	Properties of systems (ch 1.6)	Discrete-time LTI systems (ch 2.1)
Sep 27	Continuous-time LTI systems (ch 2.2)	Interconnected LTI systems (ch 2.3)	Properties of LTI systems (ch 2.3)
Oct 4	Properties of LTI systems (ch 2.3)	Linear constant-coefficient differential/difference equations (ch 2.4)	Introduction to Fourier series (ch 3.2)
Oct 11	Thanksgiving Fourier series of periodic signals (ch 3.3)	Thanksgiving Convergence of Fourier series (ch 3.4)	Properties of Fourier series (ch 3.5)

Oct 18	Continuous-time Fourier transform (ch 4.1)	Continuous-time Fourier transform (ch 4.1, 4.2)	Properties of CTFT (ch 4.3)
Oct 25			Midterm Q&A
Nov 1	Convolution and multiplication (ch 4.4, 4.5)	LCCDE and Fourier Transform (ch 4.7)	Discrete-time Fourier series (ch 3.6, 3.7)
Nov 8	Fall Study Break		
Nov 15	Discrete-time Fourier transform (ch 5.1, 5.2)	Properties of DTFT (ch 5.3)	Properties of DTFT (ch 5.4 - 5.8)
Nov 22	Sampling theorem (ch 7.1)	Sampling and reconstruction (ch 7.2)	Under sampling and aliasing (ch 7.3)
Nov 29	Sampling of DT signals (ch 7.5)	Amplitude modulation (ch 8.1)	AM demodulation, FDM (ch 8.2, 8.3)
Dec 6	Single-sideband AM, pulse-train AM, TDM (ch. 8.4, 8.5)	Angle modulation (ch. 8.7), digital modulation	

### Inclusivity Statement:

You belong [here](#). The University of Toronto commits to all students, faculty and staff that you can learn, work and create in a welcoming, respectful and inclusive environment. In this class, we embrace the broadest range of people and encourage their diverse perspectives. This team environment is how we will innovate and improve our collective academic success. You can read the evidence for this approach [here](#).

We expect each of us to take responsibility for the impact that our language, actions and interactions have on others. Engineering denounces discrimination, harassment and unwelcoming behaviour in all its forms. You have rights under the [Ontario Human Rights Code](#). If you experience or witness any form of harassment or discrimination, including but not limited to, acts of racism, sexism, Islamophobia, anti-Semitism, homophobia, transphobia, ableism and ageism, please tell someone so we can intervene. Engineering takes these reports extremely seriously. You can talk to anyone you feel comfortable approaching, including your professor or TA, an [academic advisor](#), our [Assistant Dean, Diversity, Inclusion and Professionalism](#), the [Engineering Equity Diversity & Inclusion Action Group](#), any staff member or a [U of T Equity Office](#).

You are not alone. [Here](#) you can find a list of clubs and groups that support people who identify in many diverse ways. Working together, we can all achieve our full potential.

### Syllabus Statement on Accommodations:

The University of Toronto supports accommodations for students with diverse learning needs, which may be associated with mental health conditions, learning disabilities, autism spectrum, ADHD, mobility impairments, functional/fine motor impairments, concussion or head injury, blindness and low vision, chronic health conditions, addictions, deafness and hearing loss, communication disorders and/or temporary disabilities, such as fractures and severe sprains, or recovery from an operation.

If you have a learning need requiring an accommodation the University of Toronto recommends that students register as soon as possible with Accessibility Services at <https://studentlife.utoronto.ca/service/accessibility-services-registration-and-documentation-requirements/>.

Phone: 416-978-8060

Email: [accessibility.services@utoronto.ca](mailto:accessibility.services@utoronto.ca)

### **Mental Health Statement:**

As a university student, you may experience a range of health and/or mental health challenges that could result in significant barriers to achieving your personal and academic goals. Please note, the University of Toronto and the Faculty of Applied Science & Engineering offer a wide range of free and confidential services that could assist you during these times.

As a U of T Engineering student, you have an [Academic Advisor](#) (undergraduate students) or a [Graduate Administrator](#) (graduate students) who can support you by advising on personal matters that impact your academics. Other resources that you may find helpful are listed on the [U of T Engineering Mental Health & Wellness webpage](#), and a small selection are also included here:

- [Accessibility Services](#) & the [On-Location Advisor](#)
- [Graduate Engineering Council of Students' Mental Wellness Commission](#)
- [Health & Wellness](#) and the [On-Location Health & Wellness Engineering Counsellor](#)
- [Inclusion & Transition Advisor](#)
- [U of T Engineering Learning Strategist](#) and [Academic Success](#)
- [My Student Support Program \(MySSP\)](#)
- [Registrar's Office](#)
- [SKULE Mental Wellness](#)
- [Scholarships & Financial Aid Office & Advisor](#)

If you find yourself feeling distressed and in need of more immediate support resources, consider reaching out to the counsellors at [My Student Support Program \(MySSP\)](#) or visiting the [Feeling Distressed webpage](#).

### **Land Acknowledgment Statement:**

We wish to acknowledge this land on which the University of Toronto operates. For thousands of years it has been the traditional land of the Huron-Wendat, the Seneca, and most recently, the Mississaugas of the Credit River. Today, this meeting place is still the home to many Indigenous people from across Turtle Island and we are grateful to have the opportunity to work on this land.