

# ECE216: Signals and Systems

Winter 2022

Department of Electrical and Computer Engineering  
University of Toronto

## Course Description and Intended Learning Outcomes

Fundamental continuous-time and discrete-time signals, definition and properties of systems, linearity and time invariance, convolution, impulse response, differential and difference equations, Fourier analysis, sampling and aliasing, applications in communications. In the course laboratory, students will learn to apply the analysis techniques developed in the course using computational tools in MATLAB.

*Prerequisites:* ECE212 (Circuit Analysis), MAT188 (Linear Algebra), and MAT290 (Advanced Engineering Mathematics).

*Intended Learning Outcomes:* Upon completion of ECE216, students should be able to

- (i) identify key differences between continuous-time and discrete-time signals,
- (ii) analyze continuous-time and discrete-time signals in the frequency domain using Fourier series and Fourier transform methods,
- (iii) assess properties of continuous-time and discrete-time systems, including linearity, causality, and time-invariance, and
- (iv) analyze the responses of systems using convolution and frequency-domain methods.

**COVID-19:** Course delivery is synchronous online until January 30 and will return to in-person delivery from January 31, 2022. The schedule for lectures, tutorials, office hours listed is for online delivery (via Zoom) before January 31 and for physical in-person delivery after January 31. Please note that this may be subject to change depending on how the COVID-19 situation and the University of Toronto guidance changes.

## Instructors

Instructor	Section	Email	Office Hours
Andrew Romano	LEC0101	<a href="mailto:andrew.romano@mail.utoronto.ca">andrew.romano@mail.utoronto.ca</a>	TBD, by appoint.
Prof. L. Pavel ( <b>coordinator</b> )	LEC0102	<a href="mailto:pavel@ece.utoronto.ca">pavel@ece.utoronto.ca</a>	GB343A, Mon 3-4*
Prof. J. W. Simpson-Porco	LEC0103	<a href="mailto:jwsimpson@ece.utoronto.ca">jwsimpson@ece.utoronto.ca</a>	GB444, by appoint.
Prof. W. Wong	LEC0104	<a href="mailto:willy.wong@utoronto.ca">willy.wong@utoronto.ca</a>	BA7110, by appoint.

\* Online, before Jan 31. Zoom links provided on [Quercus](#) ->Office Hour Schedule.

## Lectures

\* Online, before Jan 31. Zoom links provided on [Quercus](#) ->Lecture Schedule.  
In-person, after Jan 31.

Section	Instructor	Mon.	Tues.	Wed.	Thurs.	Fri.
LEC0101	Romano	9-10 BA1160*	—	9-10 BA1160*	—	11-12 BA1160*
LEC0102	Pavel	1-2 MC254*	2-3 MC254*	—	1-2 MC254*	—
LEC0103	Simpson	4-5 BA1170*	5-6 BA1170*	—	4-5 BA1170*	—
LEC0104	Wong	2-3 SF1105*	—	2-3 SF1105*	2-3 MC254*	—

## Teaching Assistants

Teaching Assistants	Role	Email
Richard Perryman	Head Admin. TA	<a href="mailto:ece216admin@eecg.utoronto.ca">ece216admin@eecg.utoronto.ca</a>
Anurag Agarwal	Tutorial TA	<a href="mailto:ece216tutorialTAs@eecg.utoronto.ca">ece216tutorialTAs@eecg.utoronto.ca</a>
Hussein Ammar	Tutorial TA	—
Liang (Jeff) Chen	Tutorial TA	—
Aaron Curtis	Tutorial TA	—
Amr Mohamed	Tutorial TA	—
Youssef Al Falah	Tutorial TA	—
Reza Rafie Borujeny	Tutorial TA	—
Javane Rostampoor	Tutorial TA	—
Shiva Akbari	Lab TA	<a href="mailto:ece216labTAs@eecg.utoronto.ca">ece216labTAs@eecg.utoronto.ca</a>
Shahrzad Kianidehkordi	Lab TA	—
Alex Mertens	Lab TA	—
Ali Nasr Esfahani	Lab TA	—
Ali Parchekani	Lab TA	—
Majid Raeis	Marking TA	<a href="mailto:ece216admin@eecg.utoronto.ca">ece216admin@eecg.utoronto.ca</a>
SeyedMohammad Mortazavi	Marking TA	—
Paige Phillips	Marking TA	—
Hossein Yousefi	Marking TA	—

**E-mail policy:** If you would like to discuss an administrative aspect of the course (e.g., change of tutorial or section, re-grading, conflicts, etc.), please begin by sending an e-mail to the Head TA.

If you have a personal issue that requires attention, please contact the course coordinator. Please place “ECE216” in the subject header of all e-mail correspondence, and use **only** your University of Toronto e-mail account.

## Courseware and Supplementary References

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There is no required textbook. Partially filled course notes are available via the course [Quercus](#) website.

Useful supplementary references on signals and systems include:

- *Signals and Systems* by Oppenheim, Willsky, and Nawab. Advanced level.
- *Signal Processing and Linear Systems* by B. P. Lathi. Beginner and intermediate level.
- *ECE216 Signals and Systems* by Stark Draper (available for download on [Quercus](#)). Notes used in previous years. Some overlap with current course, but coverage is different.

## Detailed Course Outline

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- Fundamentals of Continuous and Discrete-Time Signals; signal properties: support, energy, power, periodicity
- Sinusoidal signals, complex numbers, CT and DT complex exponential signals
- The continuous-time Fourier series (CTFS); CTFS properties & Parseval’s relation
- The discrete-time Fourier series (DTFS) and DTFS properties
- The continuous-time Fourier transform (CTFT); CTFT properties & Parseval’s relation
- Inverse CTFT; the discrete-time Fourier transform (DTFT)
- Sampling, Aliasing, and Interpolation: the sampling function; sampling theorem for band-limited signals
- Fundamentals of Continuous-Time (CT) Systems: properties: linearity, time-invariance, causality, stability
- LTI systems: the impulse response and the convolution integral; combinations of LTI systems; differential equations and CT LTI systems
- Analysis of CT Systems using the Fourier Transform: frequency response and complex exponential inputs
- Response of a LTI system to a periodic input; filtering in the frequency domain using LTI systems
- Analysis of CT Systems using the Laplace Transform: response of a causal LTI system to a right-sided signal; frequency response: steady-state response to harmonic inputs
- Fundamentals of Discrete-Time(DT) Systems: properties; LTI systems: the impulse response and the convolution sum
- Finite impulse response (FIR) systems; difference equations and DT LTI systems

## Course Website

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The course website is hosted via [Quercus](#). If you encounter access issues, please contact the Head TA. The course website will be available from the first day of class until the final exam is given.

**All lectures, lab office hours, tutorials and office hours are synchronous online until January 30 and in-person from January 31, 2022.** Administrative aspects of the course will be discussed on Quercus. For questions and discussion of technical course material you will have plenty of opportunities to ask questions directly from your instructors and TAs during/after lectures, tutorials, lab as well as during instructor and tutorial/lab TA office hours. You should take full advantage of these opportunities.

## Tutorials

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The table below displays the times for tutorials. Please consult the Course Finder for the most up-to-date tutorial schedule. **Note:** There will be no tutorials in Week 1.

Section	Mon.	Tues.	Wed.	Thurs.	Fri.
TUT0101	—	—	3-5 GB304*	—	—
TUT0102	—	—	3-5 GB303*	—	—
TUT0103	9-11 MY380*	—	—	—	—
TUT0104	9-11 SF2202*	—	—	—	—
TUT0105	—	3-5 GB244*	—	—	—
TUT0106	—	—	3-5 BA1200*	—	—
TUT0107	—	—	—	—	4-6 SF3201*
TUT0108	—	—	9-11 SF3201*	—	—

\* Online, before Jan 31. Zoom links provided on [Quercus](#) -> Tutorial Schedule.  
In-person, after Jan 31.

## Homework

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There will be 10 homework sets assigned for practice. Homework problems are posted on the [Quercus](#) course website with solutions. The homework is good preparation and allows you to keep on top of the material covered. Homework will not be collected or graded. The midterms and final will assume that you have completed and understood all assigned homework problems.

## Laboratory Information

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There will be three MATLAB-based labs, with due dates listed below. The lab documents are posted on the [Quercus](#) course website.

Lab	Topic	Due Date
1	Signal Processing in MATLAB	Fri, Jan 28, 2022 11:59pm
2	Response of RLC Circuits	Fri, Feb 18, 2022 11:59pm
3	Music Synthesis	Fri, Mar 18, 2022 11:59pm

The labs must be completed in groups of two, which will be established via [Quercus](#). You will join a group by using the group self sign-up feature found in [Quercus](#)->People. The group members do *not* need to be in the same practical section. Please sign-up by January 18, 2022, 11:59pm, or you will be randomly assigned a lab partner. If needed, you may e-mail the Head TA for assistance in group pairing. Both group members are expected to contribute equally to the lab completion; they will get identical marks, unless special circumstances occur.

Each lab group will work remotely. Completed lab sheets will be submitted via [Quercus](#). Late submissions will not be accepted. For general lab questions, please contact the Head Lab TA.

During the week each lab is due, there are **five 2-hour lab office-hour slots**, open to students in **all sections**. A number of lab TAs will be answering your questions and clarifications. Lab TAs will not be able to answer questions sent via email, so these lab office hours will be your only opportunity to seek help and clarifications on the labs. As they are open to all sections, take advantage of them and go to as many lab office hours as you need.

#### Lab Office-Hour Slots Schedule

Lab	Mon.	Tues.	Wed.	Thurs.	Lab Due Date
LAB1	9-11 Jan 24*	9-11 Jan 25*	6-8 Jan 26*	9-11 Jan 27*	Jan 28
		1-3 Jan 25*			
LAB2	9-11 Feb 14	9-11 Feb 15	6-8 Feb 16	9-11 Feb 17	Feb 18
	SF1013	SF1013	SF1012	SF1013	
		1-3 Feb 15 SF1012			
LAB3	9-11 Mar 14	9-11 Mar 15	6-8 Mar 16	9-11 Mar 17	Mar 18
	SF1013	SF1013	SF1012	SF1013	
		1-3 Mar 15 SF1012			

\* Online, before Jan 31. Zoom links at [Quercus](#) ->LAB Office-Hour Slots Schedule.

## Late Submission Policy

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We do not accept late online submissions, under any circumstance. We do not accept submissions via email. This policy is strictly enforced. A late submission will receive a mark of 0. If you deem it unavoidable to submit a deliverable after the deadline, you need to contact the Head TA before the deadline, explain the circumstances surrounding the expected delay, and check whether or not he/she gives you permission to submit late. In the absence of such an advance permission, the policy above applies.

## Assessment Dates and Grading Scheme

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Item	Allocation	Due Date
Lab 1	5%	Jan 28 2022 11:59pm
Midterm 1	20%	Feb 8 2022 6-7:30pm
Lab 2	5%	Feb 18 2022 11:59pm
Lab 3	5%	Mar 18 2022 11:59pm
Midterm 2	25%	Mar 22 2022 6-7:30pm
Final	40%	Date/time to be announced

**Midterms and Final:** There will be two midterms and one final exam.

Each midterm will be 1.5 hours in length and the exam is 2.5 hours long.

**Midterm 1** is held on Tuesday, Feb 8, 6-7:30pm. Location will be announced via [Quercus](#).

**Midterm 2** is held on Tuesday, Mar 22, 6-7:30pm. Location will be announced via [Quercus](#).

To help in your preparation during the week preceding each of the two midterms and the final exam there will be several tutorial TA office hours. In all there will be **eight 2 hour-slots of tutorial office-hours** open to students in **all sections**. Times and room location will be announced via the course website. Take full advantage of these sessions to ask directly your questions on the course material. Additionally, take advantage of synchronous/in person delivery and ask questions from your instructors during/after the lectures and during their office hours.

**Regrading procedure:** Please contact the Head TA via e-mail with all requests for regrading, and include a clear and concise statement indicating (i) which questions were graded incorrectly and (ii) why you deserve more points. Regrade requests will only be accepted within two weeks following the return of an assessment. The instructors reserve the right to fully regrade any assessment, and as such regrading may result in a lower overall grade.

## Land Acknowledgement

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I (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.

## Inclusivity, Accommodations and Mental Health Support

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**Statement on Inclusivity** 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 and 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.

**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](#).

Phone: 416-978-8060

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

**Statement on Mental Health** 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.