Toronto Metropolitan University

Department of Electrical, Computer, & Biomedical Engineering
Faculty of Engineering & Architectural Science

Course Outline (F2025)

ELE532: Signals and Systems I

Instructor(s)	Dr. Javad Alirezaie [Coordinator] Office: ENG452 Phone: (416) 979-5000 x 556092 Email: javad@torontomu.ca Office Hours: Thu. 11:00AM-12:00 PM Dr. Soosan Beheshti Office: ENG425 Phone: (416) 979-5000 x 554906 Email: soosan@torontomu.ca Office Hours: Mondays 11am-12pm
Calendar Description	This course deals with the analysis of continuous-time and discrete-time signals and systems. Topics include: representations of linear time-invariant systems, representations of signals, Laplace transform, transfer function, impulse response, step response, the convolution integral and its interpretation, Fourier analysis for continuous-time signals and systems and an introduction to sampling.
Prerequisites	CEN 199, COE 428, ELE 404, MTH 314
Antirequisites	None
Corerequisites	None
Compulsory Text(s):	1. B.P. Lathi, Linear Systems and Signals, 3rd edition, Oxford University Press, 2018. 2. Laboratory MATLAB assignment descriptions and procedures, and assignment problems are available from the course home page on D2L Brightspace via my.torontomu.ca.
Reference Text(s):	1. M. J. Roberts, Signals and Systems: Analysis Using Transform Methods and MATLAB, McGraw Hill, 2004. 2. Signals and Systems, A.V. Oppenheim, A.S. Willsky, S.H. Nawab, 2nd edition, Pearson, 1997.
Learning Objectives (Indicators)	At the end of this course, the successful student will be able to: 1. - Learn the properties of linear time-invariant (LTI) systems. - Learn time-domain and frequency-domain analysis of continuous-time signals and LTI systems. - Learn analog-to-digital and digital-to-analog conversion techniques. (**1b**) 2. - Learn mathematical foundations of frequency- domain analysis techniques (Fourier series, Fourier transform, Laplace transform) applicable to continuous-time signals and systems. (**1c**) 3. - Determine system output for a given input signal using time and frequency-domain techniques. - Learn to select the most appropriate and efficient solution technique based on

the information and mathematical models provided. - Identify system characteristics required to shape and modify signal characteristics such as in filtering and relate these characteristics to system parameters. (**2b**)

4. Learn frequency analysis of continuous-time signals and LTI systems and describe differences between Fourier transform and Fourier series analysis. Perform both Fourier transform and Fourier series in hypothetical design and analysis of signals and LTI systems. Analyze the result of the evaluation to detect if a continuous-time system is Linear Time-Invariant (LTI). To discern additional criteria. In case the system is LTI, an additional characteristic of the system (impulse response of the system) is calculated to facilitate calculation and evaluation of the system's output. (**4b**)
5. - Uses Matlab/Simulink as a signal analysis, simulation and visualization tool. - Generates system models using simulation tools to verify system properties and perform signal operations. (**5a**)
6. Read and appropriately respond to technical and non-technical written instructions. Cites evidence to construct and support an argument. Produce four lab reports using appropriate format, grammar, and citation styles for technical and non-technical audiences. (**7a**)
7. Illustrate concepts of continuous-time signals and systems through the graphical presentation of their properties. (**7c**)
8. Finding the relationship between signals, building a signal based on other existing bases, signal modulation, and its practical issues that can be well explained with the theory. (**12a**)

NOTE:*Numbers in parentheses refer to the graduate attributes required by the Canadian Engineering Accreditation Board (CEAB).*

Course Organization

3.0 hours of lecture per week for 13 weeks
2.0 hours of lab per week for 12 weeks
0.0 hours of tutorial per week for 12 weeks

Teaching Assistants

TBA

Course Evaluation

Theory	
Quizzes (2 X 7.5%)	15 %
Midterm Examination	25 %
Final Examination	40 %
Laboratory	
Laboratory Assignments (4 X 5%)	20 %
TOTAL:	100 %

Note: In order for a student to pass a course, a minimum overall course mark of 50% must be obtained. In addition, for courses that have both **"Theory and Laboratory"** components, the student must pass the Laboratory and Theory portions separately by achieving a minimum of 50% in the combined Laboratory components and 50% in the combined Theory components. Please refer to the **"Course Evaluation"** section above for details on the Theory and Laboratory components (if applicable).

Examinations

- Quizzes are scheduled on Week 3, 5, 10 and 12, approximately 50 minutes, during the regular lecture hours (the first hour): Quiz 1 on September 19, Quiz 2 on October 3, Quiz 3 on November 7 Quiz 4 on November 21.

- Midterm Exam is in Week 7, on Thursday October 17, two and half hours, problem-solving, during the regular lecture hours (covers Weeks 1-6 of lecture notes).

	- Final Exam is scheduled during the Fall 2025 term undergraduate exam period (covers Weeks 1-13 with emphasis on Weeks 6, 8-13 of lecture notes).
Other Evaluation Information	- Practice Problems/Assignments: Assignment problems and solutions will be provided on D2L.The assignments will neither be collected nor graded; they are provided only as a study guide. You are strongly recommended to attempt to solve the problems on your own without looking at the solutions first. If you have any questions about an assignment problem or its solution, please consult the course instructor or the teaching assistant during their consulting hours. - The lab marks are based on attendance, successful completion of pre-lab problems, participation, and completion of experiment steps, lab interviews, and lab reports. Students will have the responsibility to achieve a working knowledge of the software packages that will be used in the lab. Students will work in groups of two.
Teaching Methods	In person lectures are in ENG103 Thursdays 3-6pm
Other Information	None

Course Content

Week	Hours	Chapters / Section	Topic, description
1 & 2	6		Signals and Systems Representations Size of a signal: signal energy and power useful signal operations: time-shifting, time scaling, time reversal, combined operations, classification of signals: linear systems, time-invariant systems, linear and time-invariant continuous-time (LTIC) systems, useful signal models: unit step function, unit impulse function, exponential function, even and odd functions, continuous-time systems, classification of systems, internal and external descriptions of a system. (Reference: Chapter 1 Sections 1.1-1.7)
3-5	9		Time-Domain Analysis of Continuous-Time Systems System response to internal conditions: the zero-input response, the unit impulse response, system response to external response: zero-state response, the convolution integral, interconnected systems, total system response, classical solution to differential equations: forced responsethe method of undetermined coefficients, system stability: internal (asymptotic) stability, BIBO stability, criterion relationship between BIBO and asymptotic stability, intuitive insights into system behavior. (Reference: Chapter 2 Sections 2.1-2.6 and 2.8-2.9)

7	3		Midterm Exam
6 & 8	6		Continuous-Time Signal Analysis: The Fourier Series Periodic signal representation by trigonometric Fourier series existence and convergence of Fourier series exponential Fourier series LTIC system response to periodic inputs. (Reference: Chapter 6 Sections: 6.1-6.4)
9 & 10	6		Continuous-Time Signal Analysis: The Fourier Transform Aperiodic signal representation by Fourier integral Fourier transforms of some useful functions properties of the Fourier transform signal transmission through LTIC systems ideal and practical filters signal energy application to communications. (Reference: Chapter 7 Sections 7.1-7.9)
11	3		Sampling: Discrete-Time Signals Introduction to Sampling theorem signal reconstruction. (Reference: Chapter 8 Sections 8.1-8.2)
12 & 13	6		The Laplace Transform The Laplace transforms, properties of the Laplace transform, solution of differential equations: zero-state response, stability, inverse systems, analysis of electric networks, block diagrams, system realizations, application to feedback and control, the frequency response of an LTIC system. (Reference: Chapter 4 Sections 4.1-4.2 & 4.4-4.6)

Laboratory(L)/Tutorials(T)/Activity(A) Schedule

Week	L/T/A	Description
2	L/T	Lab0: Tutorial Introduction to Matlab It is very important to attend the Matlab tutorial scheduled for Week 2.
3 &4	L/T	Tutorial & Lab Experiment 1: Signal and System Representations In this experiment you will work with simple Matlab functions and will explore some signals properties

5 & 6	L/T	Tutorial & Lab Experiment 2: Time-Domain Analysis of Continuous-Time Systems. In this experiment you will learn how to use M-files in Matlab and exercise convolution and system properties
7	T	Tutorial Problems from course textbook and quizzes will be discussed.
8 & 9 &10	L/T	Tutorial & Lab Experiment 3: The Fourier Series The purpose of this experiment is to investigate the Fourier Series while continuing to learn how to use Matlab effectively. General Fourier series characteristics will be investigated and Matlab functions that work with Fourier series will be developed. Also the effects on the Fourier series coefficients due to changing the period of a periodic signal will be investigated along with the effects of series truncation on signal reconstruction.
11 & 12	L/T	Tutorial & Lab Experiment 4: The Fourier Transform In this experiment you will investigate properties of the Fourier transform. You will use Fourier Transform to analyze dual-tone multi frequency (DTMF) signals used in telephone signalling.
13	T	Tutorial: Problems from course textbook and quizzes will be discussed

University Policies & Important Information

Students are reminded that they are required to adhere to all relevant university policies found in their online course shell in D2L and/or on the Senate website

Refer to the Departmental FAQ page for furhter information on common questions.

Important Resources Available at Toronto Metropolitan University

- The University Libraries provide research workshops and individual consultation appointments. There is a drop-in Research Help desk on the second floor of the library, and students can use the Library's virtual research help service to speak with a librarian, or book an appointment to meet in person or online.
- Student Life and Learning Support offers group-based and individual help with writing, math, study skills, and transition support, as well as resources and checklists to support students as online learners.
- You can submit an Academic Consideration Request when an extenuating circumstance has occurred that has significantly impacted your ability to fulfill an academic requirement. You may always visit the Senate website and select the blue radio button on the top right hand side entitled: Academic Consideration Request (ACR) to submit this request.

  For Extenuating Circumstances, Policy 167: Academic Consideration allows for a once per semester ACR request without supporting documentation if the absence is less than 3 days in duration and is not for a final exam/final assessment. Absences more than 3 days in duration and those that involve a final exam/final assessment, always require documentation. Students must notify their faculty/contract lecturer once a request for academic consideration is submitted. See Senate Policy 167: Academic Consideration.

Longer absences are not addressed through Policy 167 and should be discussed with your Chair/Director/Program to be advised on next steps.
- FAQs Academic Considerations and Appeals
- Information on Copyright for Faculty/Contract Lecturers and students.

Lab Safety (if applicable)

Students are to strictly adhere and follow:

a. The Lab Safety information/guidelines posted in the respective labs,
b. provided in their respective lab handouts, and
c. instructions provided by the Teaching Assistants/Course instructors/Technical Staff.

During the lab sessions, to avoid tripping hazards, the area around the lab stations should not be surrounded by bags, backpacks etc, students should place their bags, backpacks etc against the walls of the labs and/or away from their lab stations in such a way that it avoids tripping hazards.

Accessibility

- Similar to an accessibility statement, use this section to describe your commitment to making this course accessible to students with disabilities. Improving the accessibility of your course helps minimize the need for accommodation.
- Outline any technologies used in this course and any known accessibility features or barriers (if applicable).
- Describe how a student should contact you if they discover an accessibility barrier with any course materials or technologies.

Academic Accommodation Support

Academic Accommodation Support (AAS) is the university's disability services office. AAS works directly with incoming and returning students looking for help with their academic accommodations. AAS works with any student who requires academic accommodation regardless of program or course load.

- Learn more about Academic Accommodation Support.
- Learn how to register with AAS.
- Learn about Policy 159: Academic Accommodation of Students with Disabilities

Academic Accommodations (for students with disabilities) and Academic Consideration (for students faced with extenuating circumstances that can include short-term health issues) are governed by two different university policies. Learn more about Academic Accommodations versus Academic Consideration and how to access each.

Wellbeing Support

At Toronto Metropolitan University, we recognize that things can come up throughout the term that may interfere with a student's ability to succeed in their coursework. These circumstances are outside of one's control and can have a serious impact on physical and mental well-being. Seeking help can be a challenge, especially in those times of crisis.

If you are experiencing a mental health crisis, please call 911 and go to the nearest hospital emergency room. You can also access these outside resources at anytime:

- **Distress Line:**24/7 line for if you are in crisis, feeling suicidal or in need of emotional support (phone: 416-408-4357)
- **Good2Talk:**24/7-hour line for postsecondary students (phone: 1-866-925-5454)
- **Keep.meSAFE:** 24/7 access to confidential support through counsellors via My SSP app or 1-844-451-9700

If non-crisis support is needed, you can access these campus resources:

- **Centre for Student Development and Counselling:** 416-979-5195 or email csdc@torontomu.ca

- **Consent Comes First - Office of Sexual Violence Support and Education:** 416-919-5000 ext 3596 or email osvse@torontomu.ca
- **Medical Centre:** call (416) 979-5070 to book an appointment

We encourage all Toronto Metropolitan University community members to access available resources to ensure support is reachable. You can find more resources available through the Toronto Metropolitan University Mental Health and Wellbeing website.