Course Outline (W2024)

ELE532: Signals and Systems I

Instructor(s)	Dr. Alagan Anpalagan [Coordinator] Office: ENG447 Phone: (416) 979-5000 x 556079 Email: alagan@torontomu.ca Office Hours: Tuesdays 12 noon -1 pm
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
Corequisites	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	Iqbal Banwait (iqbal.banwait@torontomu.ca@torontomu)

Course Evaluation

Theory	
Quizzes (3 X 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 as indicated on the course webpage or course management sheet during the lab hours. Duration is 30 minutes. Closed-book/notes. - Midterm Exam will be held as indicated on the course webpage or course management sheet, during the regular lecture hours. It is closed-book/notes 2.5 hour exam, problem-solving. - Final Exam is scheduled during the Winter 2024 term undergraduate exam period. It is cumulative. it is a closed-book/notes 3-hour exam. An aid sheet will be provided.
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, i.e., MATLAB. Students will work in groups of two. - Lab assignments (1-4) are available in Labs folder in D2L. - Lab reports (pdf file) should be submitted (one per group) in Assessments->Assignments folder before the deadline. - Quizzes will be held on the announced date approximately during the last 30 minutes.
Teaching Methods	The weekly lecture time will be dedicated to introducing and discussing in detail the concepts, and providing live examples of the theoretical materials in the posted lecture notes.
Other Information	PDF version of the lecture notes will also be posted.

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			Study Week (No lectures, No labs)
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	3		Midterm Exam
10 & 11	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)
12	3		Sampling: Discrete-Time Signals Introduction to Sampling theorem signal reconstruction. (Reference: Chapter 8 Sections 8.1-8.2)
13 &14	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 and 4.6)

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

Week	L/T/A	Description
2	L	LAB 0: Matlab Introduction
3	L	Lab1: Working with Matlab Functions, Visualization of Signals, and Signal Properties
4	L/T	Lab1 / Tutorial QUIZ #1 Lab Assignment #1 Due
5	L	Lab2: System Properties & Convolution

6	L	Lab2
8	L/T	Lab2 / Tutorial QUIZ #2 Lab Assignment #2 Due
9	L	Lab3: Fourier Series Analysis using Matlab
10	L	Lab3
11	L/T	Lab3 / Tutorial Lab Assignment #3 Due
12	L	Lab4: Fourier Transform: Properties and Applications
13	L	Lab4 Quiz #3
14	L	Lab4 Lab Assignment #4 Due

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 Library provides research workshops and individual assistance. If the University is open, there is a Research Help desk on the second floor of the library, or students can use the Library's virtual research help service to speak with a librarian.
- 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, require documentation. Students must notify their instructor once a request for academic consideration is submitted. See Senate Policy 167: Academic Consideration.

- If a student is requesting accommodation due to a religious, Aboriginal and/or spiritual observance, they must submit their request via the online [Academic Consideration Request (ACR) system](#) **within the first two weeks of the class or, for a final examination, within two weeks of the posting of the examination schedule**. If the required absence occurs within the first two weeks of classes, or the dates are not known well in advance as they are linked to other conditions, these requests should be submitted with as much lead time as possible in advance of the required absence.

- If taking a remote course, familiarize yourself with the tools you will need to use for remote learning. The [Remote Learning Guide](#) for students includes guides to completing quizzes or exams in D2L Brightspace, with or without [Respondus LockDown Browser and Monitor, using D2L Brightspace,](#) joining online meetings or lectures, and collaborating with the Google Suite.
- Information on Copyright for [Faculty](#) and [students](#).

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](#).

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.