Toronto Metropolitan University

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

Course Outline (W2024)

BME632: Signals and Systems II

Instructor(s)	Dr. Soosan Beheshti [Coordinator] Office: ENG425 Phone: (416) 979-5000 x 554906 Email: soosan@torontomu.ca Office Hours: Thursdays 10-11
Calendar Description	The topics covered in the course includes a general discussion on discrete signals (periodic signals, unit step, impulse, complex exponential), a general discussion on discrete systems, Discrete-Time Fourier Series (DTFS), Discrete-Time Fourier Transform (DTFT); analysis and synthesis, Fourier Spectra; continuous nature, periodicity, existence, Properties of the DTFT; linearity, conjugation, time/frequency reversal, time/frequency shifting, etc. LTI discrete time system analysis using DTFT, DTFT and Continuous-Time FT comparison and relation, DFT and FFT discussion and their relation to DTFT and CTFT, Discrete-Time Sampling, Z-Transform; generalization of the DTFT.
Prerequisites	BME 532, CEN 199
Antirequisites	ELE 632
Corerequisites	None
Compulsory Text(s):	1. B.P. Lathi, Linear Systems and Signals, 3rd edition, Oxford University Press, 2017.
Reference Text(s):	
Learning Objectives (Indicators)	At the end of this course, the successful student will be able to: 1. Learn how to represent, analyze, and perform operations on discrete-time signals and systems. Be able to understand the process of generating discrete-time signals and building simple discrete-time systems. (**1c**) 2. Be able to characterize input-output relationships in biomedical signals and systems using time, frequency (DTFT, DFT, FFT) and z-domains. Learn about signal generation (ECG, EMG, EEG), acquisition and analysis of complex biomedical signals and systems. (**1d**) 3. Describe differences between different evaluation methods and select and apply appropriate evaluation methods. Describe differences between methods, and use specified methods in hypothetical design situations. More specifically: learn frequency analysis of discrete-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 (**4b**) 4. Collect and analyze biomedical signals using a signal acquisition system and Matlab. Ensure signals are correctly acquired through visual and automated analysis, investigate physiological behaviour of signals, quantify performance of algorithms through various metrics in Matlab. (**5b**) 5. 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**)

6. Emphasis on bridging the medical and engineering uses of biomedical signals. Creating technologies that can make the job of the physician more accurate and efficient. (**9b**)
7. Ensure that data is collected and stored anonymously. (**10a**)
8. Students are referred to textbook, lab manual and other material to ensure labs and lecture material are learned. (**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

Khashayar Bayati, khashayar.bayati@torontomu.ca

Mathew Lam, matthew1.lam@torontomu.ca

Course Evaluation

Theory	
Midterm Exam	25 %
Quizzes (3 x 5%)	15 %
Final Exam	40 %
Laboratory	
Labs	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

Three Quizzes will be held on Tuesdays January 30, March 12 and April 2, 2024 (first hour of Lecture). Midterm will be held on Tuesday February 27, 2024. Final exam is during the exam period and covers all material from course. All exams are closed book.

Other Evaluation Information

NOTE: Students must pass both the lecture AND the laboratory components of the course, separately, to pass the course.

Other Information

Practice problems are provided on the course web page. You are strongly recommended to solve these and any additional problems from the textbook related to course material.

Lab experiments are to be completed in partners. Due dates and instructions will be discussed in lab sessions and posted on D2L. It is your responsibility to check these dates and submit your assignments online by the deadlines. Late labs will receive a 0 grade on that lab. For lab experiments, there is a data collection and a data analysis experiment. You will be required to demonstrate both components of these labs to your TA, in addition to a lab write-up.

Course Content

Week	Hours	Chapters / Section	Topic, description
1	3	Chapter 3 Sections 1-3	Introduction to discrete-time systems and signals.
2-3	6	Chapter 3 Sections 3	Time domain analysis of discrete time systems useful discrete-time signals.
4	3	Chapter 3 Sections 4-6	Classification of discrete systems, discrete system equations, system response to internal conditions.
5	3	Chapter 3 Sections 6-8	Unit impulse response, system response, BIBO stability criterion.
6	3	Chapter 3 Sections 8-10	Convolution and its properties LTI systems and impulse response.
--		--	READING WEEK
7	3		MIDTERM
8	3	Chapter 5 Sections 1-3	z-Transform properties inverse transform solution to difference equations. z-Transform system realization frequency response of discrete systems pole-zero analysis stability.
9	3	Chapter 8 Sections 1-6	Sampling theorem signal reconstruction. Spectral Sampling DFT properties and applications FFT.

10	3	Chapter 9 Sections 2-4	Properties of DTFT system analysis using DTFT digital filters.
11	3	Chapter 9 Sections 1-2	Fourier analysis of discrete systems DTFS periodic and aperiodic signal representation.
12	3	Chapter 9 Sections 5-6	DTFT connection with CTFT, DTFT and z-Transform.
13	3	Chapter 5 Section 4-6	System realization.

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

Week	L/T/A	Description
1	Lab 1 Intro	Lab 1: Introduction to Matlab DSP Toolbox (independent work - no lab session)
2	Lab 1	Lab 1: Pulse Oximetry & Blood Pressure Measurement
3	Lab 1	Lab 1: Pulse Oximetry & Blood Pressure Measurement
4	Lab 2	Lab 2: Electromyogram (EMG) Signals
5	Lab 2	Lab 2: Electromyogram (EMG) Signals
6	Lab 2	Lab 2: Electromyogram (EMG) Signals
--	--	Reading week
7	--	Midterm (no labs)
8	Lab 3	Lab 3: Electrocardiogram (ECG)

9	Lab 3	Lab 3: Electrocardiogram (ECG)
10	Lab 3	Lab 3: Electrocardiogram (ECG)
11	Lab 4	Lab 4: Electroencephalogram (EEG)
12	Lab 4	Lab 4: Electroencephalogram (EEG)
13	--	No labs

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.