Toronto Metropolitan University

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

Course Outline (W2024)

ELE635: Communication Systems

Instructor(s)	Dr. Lian Zhao [Coordinator] Office: ENG434 Phone: (416) 979-5000 x 556101 Email: l5zhao@torontomu.ca Office Hours: Tuesdays, 12:30-1:30 pm Dr. Alagan Anpalagan Office: ENG447 Phone: (416) 979-5000 x 556079 Email: alagan@torontomu.ca Office Hours: Tuesdays 12 noon -1 pm
Calendar Description	This course studies basic principles of communication theory as applied to the transmission of information. The course topics include: baseband signal transmission, amplitude, phase and frequency modulation, modulated waveform generation and detection techniques, effects of noise in analog communication systems, frequency division multiplexing. Digital Signals: sampling, aliasing, quantization and introduction to pulse code modulation. (3 hr. Lab every other week)
Prerequisites	ELE 532 and MTH 514 and CEN 199
Antirequisites	None
Corequisites	None
Compulsory Text(s):	1. Lecture Notes and Lab Assignments available from course home page on D2L.
Reference Text(s):	1. B.P. Lathi and Zhi Ding, Modern Digital and Analog Communication Systems, 5th edition, Oxford University Press, 2019
Learning Objectives (Indicators)	At the end of this course, the successful student will be able to: 1. Learn mathematical analysis of non-linear modulated signals (e.g. frequency and phase modulated signals) using Bessel functions and series expansions to estimate their spectra. Learn mathematical formulation and analysis of stochastic signals. (**1b**) 2. Study characteristics of communication channels. Learn basic modulation techniques for efficient transmission of signals over communication channels. Learn modulation techniques to counteract frequency-dependent limitations of transmission (attenuation, frequency-selective fading). Learn effects of noise on systems and signals. (**1c**) 3. Learn to model complete communication systems including transmitter and receiver structures. Study bandwidth efficient communication techniques. Learn to formulate and analyze effects of noise on model communication systems and signal propagation. (**2b**) 4. Learn how to use the measurements of AM and FM signals to extract signal characteristics (e.g., modulation indices), so that signal characteristics can be modified to conform to

regulatory conditions. (**3b**)
5. Study different amplitude- and frequency modulation systems, study their characteristics, power efficiency and limitations. Learn coherent and non-coherent coherent communication systems. (**3a**)
6. Learn to conduct lab experiments with specialized test and measurement equipment to measure modulated signal characteristics in time- and frequency domains. Learn to measure modulation indices of modulated signals. (**5b**)

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 1.5 hours of lab per week for 12 weeks 0.0 hours of tutorial per week for 12 weeks
Teaching Assistants	TBA

Course Evaluation

Theory	
Midterm Exam	25 %
Final Exam	45 %
Laboratory	
Experiments (4 labs)	24 %
Formal Report	6 %
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	Midterm exam: Tuesday, Date TBD, 9:00-11:00am, closed-book, problem solving. Final exam, during the exam period, three hours, closed-book, problem solving.
Other Evaluation Information	Students must achieve passing grades in both the lecture and the laboratory components of the course in order to pass the course.
Other Information	Assignments: There are four assignments, which include problems selected from the course reference text. These questions and their respective solutions are available from the course home page on D2L. These assignments will neither be collected nor graded; they are provided only as a study guide. You are strongly recommended to attempt to solve the assignment problems on your own without looking at the solutions first. If you have any questions about an assignment problem or its respective solution, please consult the course instructor or the teaching assistant during their consulting hours.

Course Content

Week	Hours	Chapters / Section	Topic, description
1	3	Chp 1-2	Introduction Representation of signals and systems.
2	3	Chp 3 Sect 1-3	Analysis and transmission of signals.
3	3	Chp 3 Sect 4-8	Analysis and transmission of signals.
4	3	Chp 4 Sect 1-4	Amplitude modulation.
5	3	Chp 4 Sect 1-4	Amplitude modulation (cont'd).
6	3	Chp 4 Sect 1-4, Sec. 8	Amplitude modulation (cont'd).
7			Midterm exam
8	3	Chp 4 Sect 5-7, 10-11	Phase-locked loop and applications
9	3	Chp 4 Sect 5-7	Angle modulation
10	3	Chp 4 Sect 4-5	Angle modulation (cont'd).

11	3	Chp 4 Sect 5-7	Angle modulation (cont'd).
12	3	Chp 8 Sect 1-3 5-6	Random processes, Lowpass and Bandpass noise processes, Transmission of noise Processes over LTI systems
13	3	Lecture Notes	Effects of noise on AM signals.

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

Week	L/T/A	Description
3-4	Lab 1	Spectral Analysis
7-8	Lab 2	Amplitude modulation
9-10	Lab 3	Frequency modulation
11-12	Lab 4	Software defined radio

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.