

EE 8301: Linear Systems and Modern Control Theory

Fall 2026, Sec 1

Monday, 12 noon – 3 pm, VIC503

Instructor Information

- **Instructor Name:** Dr. Mohamad T. Shahab
- **Office Location:** ENG451
- **Office Hours:** Tuesdays and Wednesdays, 1-2 pm (or other times by appointment)
- **Phone:** (416) 979 – 5000, ext. 556686
- **Course Website:** D2L course shell on <https://courses.torontomu.ca/>
- **Email Address:** mshahab@torontomu.ca

Email Policy: In accordance with university policies ([Policy 157](#)), Toronto Metropolitan University (TMU) requires that any electronic communication by students to TMU faculty or staff be sent from their official university email account.

Course Description

Calendar Description: The course introduces linear system theory with focus on applications to modern control theory. Emphasis is on state-space approach to both continuous and discrete dynamic systems. Topics include: state-space modelling, linearization, stability, controllability, observability, state feedback, output feedback, controller and observer design, regulation and tracking, introduction to optimal control, and linear quadratic regulator (LQR).

Prerequisites: none.

Recommended background: Undergraduate linear algebra, undergraduate course on control systems.

Course Details

Teaching Methods

- The class consists of a weekly 3-hour lecture held in-person at the designated lecture room.
- During lectures, slides will be expanded with additional notes.
- Announcements will be made during lectures and posted to the course website.
- Problem sets will be provided.

Course Materials

Main textbook reference:

- C.-T. Chen, *Linear System Theory and Design*, 3th ed, Oxford University Press, 1999.

Note: Access to the e-book version of the book is available at no cost via TMU library; check the course website on how to access it.

Additional (optional) book references:

- J.P. Hespanha, *Linear Systems Theory*, 2nd ed, Princeton University Press, 2018.
- W.J. Rugh, *Linear System Theory*, 2nd ed, Prentice Hall, 1996.
- P.J. Antsaklis, and A.N. Michel, *A Linear Systems Primer*, Birkhäuser, 2007.
- D.S. Naidu, *Optimal Control Systems*, 1st ed, CRC Press, 2003.
- R.L. Williams, and D.A. Lawrence, *Linear State-space Control Systems*, John Wiley & Sons, 2007.
- S. Axler, *Linear Algebra Done Right*, 4th ed, Springer, 2024.

Other course material:

- Slides and other course material will be posted on the course website.
- [MATLAB](#) may be needed for coursework. Check the following webpage on accessing MATLAB using TMU account: <https://www.ee.torontomu.ca/matlab/>

Course Learning Outcomes

By the end of this course, a successful student will be able to:

- Have a solid understanding of linear system theory.
- Develop linear state-space system models for multi-input multi-output dynamic systems.
- Find realizations and solutions of linear systems.

- Analyze properties of linear systems, including stability, controllability and observability.
- Design state feedback controllers and state estimators/observers according to given specifications.
- Find solutions to the output regulation and the linear quadratic regulation problems.

Academic Integrity

TMU's [Policy 60 - Academic Integrity policy](#), applies to all students at the University. Note however, that expectations for graduate students are set to higher levels. If there is a finding of academic misconduct, *the minimum penalty for misconduct with respect to work submitted in a course by a graduate student is a grade of “zero” (0) on the work.* Graduate students who are found to have committed academic misconduct may also have a Disciplinary Notation (DN) placed on their academic record, *which will exclude them to be eligible for any scholarships and/or awards.* In addition, they may be assigned one or more of the penalties ranging from *a grade of “F” in the course, to DA (Disciplinary action), DA-S (Disciplinary action with suspension), (DW) Disciplinary withdrawal, up to an expulsion or even revocation of a degree.*

Forms of academic misconduct include plagiarism, cheating, supplying false information to the University, and other acts. The most common form of academic misconduct is plagiarism. Plagiarism is a serious academic offence, and penalties can be severe. In any academic exercise, plagiarism occurs when one offers as one's own work the words, data, ideas, arguments, calculations, designs, or productions of another without appropriate attribution or when one allows one's work to be copied.

Furthermore, the unauthorized use of intellectual property of others, including your professor, for distribution, sale, or profit is expressly prohibited. Intellectual property includes, but is not limited to: slides, lecture notes, presentation materials used in and outside of class, lab manuals, course packs, exams, etc.

All academic work must be submitted using the citation style approved by the instructor. Students may refer to the TMU Library's list of [Citations and Style Guides](#) for more information.

It is assumed that all examinations and work submitted for evaluation and course credit will be the product of individual effort, except in the case of group projects arranged for and approved by the course instructor. Submitting the same work to more than one course, without instructor approval, is also considered a form of plagiarism.

When an instructor has not indicated that a plagiarism detection service will be used, or when a student has opted out of the plagiarism detection service, if the instructor has reason to suspect that an individual piece of work has been plagiarized, the instructor is permitted to submit that work in a non-identifying way to any plagiarism detection service.

For more detailed information on these issues, please refer to the full online text for the [Toronto Metropolitan University Senate Policy 60: Academic Integrity](#). For more information on how to avoid academic misconduct situations, for clues and tips, visit the Academic Integrity website.

Generative AI Course Policy:

Students may use Generative AI (GenAI) tools (e.g. such as ChatGPT, Grammarly, Perplexity, Gemini, Claude) **only** for minor grammar correction; this includes translating individual words and correcting spelling, punctuation and basic grammar issues. GenAI tools **may not** be used to create any submitted work or make substantial revisions such as edits to style, tone, content nor rewrite phrases. Failure to stay within these limits will be considered a breach of Policy 60.

Topics and Course Schedule (tentative)

Week	Date	Topic	Readings
-	07 Sep	<i>No lecture (Labour Day)</i>	
1-2	14 Sep 21 Sep	Introduction to Linear Systems, State-space System Models	Ch1-2, Lecture slides & notes
3	28 Sep	Linear Algebra Review	Ch3, Lecture slides & notes
4	5 Oct	Solutions of State-space Models	Ch4, Lecture slides & notes
-	12 Oct	<i>No lecture (Thanksgiving)</i>	
5	19 Oct	Stability	Ch5, Lecture slides & notes
6-7	26 Oct 2 Nov	Controllability and State Feedback	Ch6, Ch8, Lecture slides & notes
8-9	9 Nov 16 Nov	Observability and State Estimation	Ch6, Ch8, Lecture slides & notes
10	23 Nov	Regulation and Tracking	Lecture slides & notes
11-12	30 Nov 7 Dec	Linear Quadratic Regulation (LQR), and other topics as time allows	Lecture slides & notes

Evaluation

- Assignments: 10%
- Research project: 20%
- Midterm exam: 20%
- Final exam: 50%

Exams:

- Midterm exam: Held during **the week of 26-30 October**. Exact date, time and location will be confirmed later. Exam duration is 90 minutes and covers course material up to the week of the exam.
- Final exam: Held during the university's final examination period. Check the final exam schedule one month prior to final examination period for details. Exam duration is 3 hours and covers all course material.
- All exams are closed book, but a handwritten cheat sheet (letter-size) is allowed.

Assignments:

- There are two (2) homework assignments in this course. Assignment problems and due dates will be posted on the course website in due course.
- Submissions must be handwritten, unless otherwise indicated (e.g. for computer simulations), and handed in to the instructor during lecture time by the due date. Late submissions will incur a penalty.
- Graded assignments will be returned to the student within approximately one week.

Research Project:

- Project goal: explore and explain a topic of interest, relate it to course concepts, methods and applications, reproduce key results from relevant literature, and/or suggest a better solution.
- Both a final written report and an in-class presentation are required.
- Topic selection (subject to instructor approval):
 - Option 1: pick from provided list on the course website, or
 - Option 2: a topic of the student's choosing.
- Selected topic and a brief proposal must be submitted for approval **by 12 October**.
- The presentation schedule and final report due date will be announced later in the term.
- More details about the project requirements, deliverables and rubrics will be posted on the course website.

University Policies

Students must be 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](#).

For information on academic policies pertaining to issues such as course management, grading practices, and appeals, students are to refer to the TMU Senate Policies: [Policy 170\(b\) \(Formerly #164\) – Graduate Status, Enrolment, and Evaluation](#), [Policy 166 – Course Management](#), and [Policy 167 – Academic Consideration](#).

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 instructor once a request for academic consideration is submitted. See Senate [Policy 167: Academic Consideration](#).

- Information on Copyright for [Faculty](#) and [students](#).
- Information on Academic Integrity for [Faculty](#) and [students](#).

Accessibility

Commitment to providing accessible learning spaces for students is essential to the delivery of this course. Feedback regarding any accessibility barriers with any course materials or technologies can be addressed to the instructor by phone, by email, or in person.

Please check the Toronto Metropolitan University's Accessibility [website](#) for the university's statement on accessibility.

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 any time:

- **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)
- [GuardMe Student Support Program \(GMSSP\)](#): 24/7 access to confidential support through counsellors via the [Student Support 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.