

MIE1605H: Stochastic Processes

Fall 2026

Instructor	Prof. Vahid Sarhangian; Office: BA8108; Email: v.sarhangian@utoronto.ca
Teaching assistant	TBA
Office hours	TBA
Lectures	Thursdays, 9:00 a.m.–12:00 p.m., RS208; first class: September 10, 2026.
Tutorials	Wednesdays, 11:00–12:00 p.m., RS208; first tutorial: September 16, 2026.

Course description and prerequisites

This course is a graduate introduction to stochastic processes and their applications. The following topics will be covered:

- **Fundamentals of probability theory and calculus:** basic probability theory; conditional probability and expectation; bounded, finite, and infinite random variables; infinite series and limits; convergence theorems.
- **Discrete-time Markov chains:** recurrence and transience; communicating states and irreducibility; stationary distributions; Markov-chain convergence.
- **Martingales:** stopping times; the optional stopping theorem; Wald's theorem; martingale convergence.
- **Brownian motion:** construction of Brownian motion from a random walk; diffusion processes.
- **Poisson processes and continuous-time, discrete-space Markov processes:** definitions, constructions, and examples.

The concepts and methods will be illustrated through examples and applications, including:

- **Fundamental probabilistic models:** random walks; gambler's ruin; branching processes.
- **Financial applications:** geometric Brownian motion; option pricing in discrete and continuous time.
- **Simulation:** Markov Chain Monte Carlo (MCMC) algorithms.
- **Machine learning:** Gaussian processes.
- **Queueing networks and approximations:** simple birth-death queueing models; fluid and diffusion approximations of queueing networks (if time permits).

The course is designed for graduate research students, and mathematical rigour is emphasized throughout. MEng students are welcome to enrol but are expected to have a strong undergraduate, non-measure-theoretic background in probability at the level of MIE231, STA347, or an equivalent course, and ideally some knowledge of real analysis.

Textbook and additional references

Notes will be provided in class. The main reference for the course is:

- J. S. Rosenthal (2019), *A First Look at Stochastic Processes*. World Scientific Publishing Company, Singapore.

The book can be purchased from the [publisher's website](#) or [Amazon.ca](#).

Some topics and applications will be based on the following texts, which are also useful sources for supplementary reading:

- R. Durrett (2012), *Essentials of Stochastic Processes*. Springer, New York.
- J. S. Rosenthal (2006), *A First Look at Rigorous Probability Theory*. World Scientific Publishing Company, Singapore.
- H. Chen and D. D. Yao (2013), *Fundamentals of Queueing Networks: Performance, Asymptotics, and Optimization*. Springer Science & Business Media.

Durrett (2012) is available online on the [publisher's website](#) and [here](#). Additional resources and papers may be posted on Quercus.

Tutorials

There are no graded homework assignments. Instead, after most Thursday lectures, a set of practice questions will be posted on Quercus. Students are expected to make an independent attempt at the questions before the following Wednesday tutorial. The instructor or the teaching assistant will work through selected problems during the tutorial and answer questions.

Evaluation

Component	Weight	Format
Midterm 1	25%	Thursday, October 15, 2026, during the lecture time. Additional details to be announced.
Midterm 2	25%	Thursday, November 26, 2026, during the lecture time. Additional details to be announced.
Final examination	50%	Tentatively on December 11. Date and location to be announced.

Tentative weekly schedule

The schedule below is tentative. Topic coverage may be adjusted to reflect the pace and needs of the class. Any changes to assessment dates or coverage will be announced in class and on Quercus.

Week	Lecture date	Lecture topic or assessment	Tutorial
1	Sept. 10	Course introduction; probability and calculus review.	-
2	Sept. 17	Discrete-time Markov chains I	Tutorial 1
3	Sept. 24	Discrete-time Markov chains II	Tutorial 2
4	Oct. 1	Discrete-time Markov chains III	Tutorial 3

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Week	Lecture date	Lecture topic or assessment	Tutorial
5	Oct. 8	Discrete-time Markov chains IV	Tutorial 4
6	Oct. 15	Midterm 1 ; Martingales I	Tutorial 5
7	Oct. 22	Martingales II	Tutorial 5
8	Oct. 29	Fall Study Break	-
9	Nov. 5	Martingale convergence and applications.	Tutorial 6
10	Nov. 12	Brownian motion and diffusion models.	Tutorial 7
11	Nov. 19	Poisson processes and continuous-time Markov chains I.	Tutorial 8
12	Nov. 26	Midterm 2 ; continuous-time Markov chains II.	Tutorial 9
13	Dec. 3	Continuous-time Markov chains III and applications.	Tutorial 10

Policies & Statements

Use of Generative AI

You may use generative artificial intelligence tools (e.g., ChatGPT, Gemini, Claude, etc.) for learning and practicing the concepts in this course, but these tools may NOT be used for either midterm or the final examinations.

Wellness and Mental Health Support

As a university student, you may experience a range of health and/or mental health challenges that could result in significant barriers to achieving your personal and academic goals. The University of Toronto and the Faculty of Applied Science & Engineering offer a wide range of free and confidential services that could assist you during these times.

As a U of T Engineering student, you have a [Departmental Undergraduate Advisor](#) or a [Departmental Graduate Administrator](#) who can support you by advising on personal matters that affect your academics. Other resources that you may find helpful are listed on the [U of T Engineering Mental Health & Wellness webpage](#), and a small selection is included here:

- [U of T Engineering's Mental Health Programs Officer](#)
- [Accessibility Services](#) & the [On-Location Advisor](#)
- [Health & Wellness](#) and the [On-Location Health & Wellness Engineering Counsellor](#)
- [Graduate Engineering Council of Students' Mental Wellness Commission](#)
- [SKULE Mental Wellness](#)
- [U of T Engineering's Learning Strategist](#) and [Academic Success](#)
- [Registrar's Office](#) and [Scholarships & Financial Aid Office & Advisor](#)

We encourage you to access these resources as soon as you feel you need support; no issue is too small.

If you find yourself feeling distressed and in need of more immediate support, consider reaching out to the counsellors at [U of T Telus Health Student Support](#) or visiting U of T Engineering's [Urgent Support – Talk to Someone Right Now](#).

Accommodations

The University of Toronto supports accommodations for students with diverse learning needs, which may be associated with mental health conditions, learning disabilities, autism spectrum, ADHD, mobility impairments, functional/fine motor impairments, concussion or head injury, visual impairments, chronic health conditions, addictions, D/deaf, deafened or hard of hearing, communication disorders and/or temporary disabilities, such as fractures and severe sprains, or recovery from an operation.

If you have a learning need requiring an accommodation, the University of Toronto recommends that students [register with Accessibility Services](#) as soon as possible.

We know that many students may be hesitant to reach out to Accessibility Services for accommodations. The purpose of academic accommodations is to support students in accessing their academics by helping to remove unfair disadvantages. We can assess your situation, develop an accommodation plan with you, and support you in requesting accommodation for your course work. The process of accommodation is private; we will not share details of your needs or condition with any instructor.

If you feel hesitant to register, we encourage you to reach out for further information and resources on how we can support you. It may feel difficult to ask for help, but it can make all the difference during your time here. Phone: 416-978-8060; Email: accessibility.services@utoronto.ca

Equity, Diversity and Inclusion

Looking for community? Feeling isolated? Not being understood or heard?

You are not alone. You can talk to anyone in the Faculty whom you feel comfortable approaching, at any time: professors, instructors, teaching assistants, [first-year](#) or [upper-year](#) academic advisors, student leaders, or the Assistant Dean of Diversity, Inclusion and Professionalism.

You belong here. In this class, the participation and perspectives of everyone are invited and encouraged. The broad range of identities and the intersections of those identities are valued and create an inclusive team environment that will help you achieve academic success. You can read the evidence for this approach [here](#).

You have rights. The [University Code of Student Conduct](#) and the [Ontario Human Rights Code](#) protect you against all forms of harassment or discrimination, including but not limited to acts of racism, sexism, Islamophobia, antisemitism, homophobia, transphobia, ableism, classism, and ageism. Engineering denounces unprofessionalism or intolerance in language, actions, or interactions, in person or online, on- or off-campus. Engineering takes these concerns extremely seriously, and confidential disclosures can be made through [the Faculty disclosure process](#) or by email at disclosure@engineering.utoronto.ca.

Resource List:

- [Engineering Equity, Diversity & Inclusion Groups, Initiatives & Student Resources](#)
- [Engineering Positive Space Resources](#)
- Request a religion-based accommodation [here](#)
- Make a confidential disclosure of harassment, discrimination, or unprofessionalism [here](#), email disclosure@engineering.utoronto.ca, or call 416-946-3986
- Email the Engineering Society Equity & Inclusivity Director at equity@g.skule.ca
- [U of T Equity Offices & First Nations House Resources](#)

University Land Acknowledgement

I wish to acknowledge this land on which the University of Toronto operates. For thousands of years, it has been the traditional land of the Huron-Wendat, the Seneca, and the Mississaugas of the Credit. Today, this meeting place is still the home to many Indigenous people from across Turtle Island, and we are grateful to have the opportunity to work on this land.

Learn more about Canada's relationship with Indigenous Peoples [here](#).

Indigenous students at U of T are invited to visit First Nations House's Indigenous Student Services for culturally relevant programs and services. For information on Indigenous-specific funding opportunities, cultural programs, traditional medicines, academic support, social events, or the weekly newsletter, visit the [First Nations House website](#) or email fnh.info@utoronto.ca.