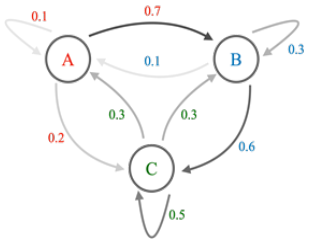
Department of Mathematics & Statistics
Concordia University

MAST 331
Mathematical Modelling
Winter 2026



Instructor: Dr. J. Bramburger
Email: jason.bramburger@concordia.ca

Lectures: Mondays & Wednesdays, 2:45-4:00 PM.
Note: There will be a mid-term break from March 2 to March 8.

Office Hours: Tuesdays, 12:00-3:00 in LB 759-06.
Virtual: by appointment only.

Course Website: Moodle.

Course Topics and Goals: The goal of this course is to provide opportunities for students to construct and analyze mathematical models that arise in the physical, biological, and social sciences. Course topics will be driven by the derivation of models that describe a wide variety of phenomena. In-depth mathematical methods will be presented that can be used to solve/analyze the derived models. The course is divided roughly into three modelling techniques: optimization, dynamical systems, and stochastic models. These methods will build upon each other as we progress through the course. Specific topics covered include linear programming, linear and nonlinear ordinary differential equations in 1 and 2 dimensions, construction of models from data, and Markov chains. We will use mathematical techniques from calculus, probability, and linear algebra.

Prerequisites: MAST 221, MAST 234 (or equivalent).

Textbook: This class does not have an assigned textbook. The professor will provide complete notes on course topics and questions will be provided on the assignment handout. Course will be based in part of *Mathematical Modeling*, 4th Edition, by Mark M. Meerschaert Elsevier Publishing.

Instruction: Lectures will be held in-person at the times stated above. I will also post lightboard video lectures to my Youtube channel that can be used to prepare for or review class material. If you are feeling ill in any way you are encouraged to stay home and use the lecture videos to keep up to date with the course. You are strongly encouraged to attend class as the videos are only meant to be supplementary material and therefore may not contain everything that is covered in lecture.

Assessment: Your grade on this course will be assigned according to the following system:

30% Final Exam
30% Midterm
40% Assignments

If the grading scheme for this course includes graded assignments, a reasonable and representative subset of each assignment may be graded. Students will not be told in advance which subset of the assigned problems will be marked and should therefore attempt all assigned problems.

Assignments: There will be weekly assignments. Assignments are very important; they indicate the level of difficulty of the problems that the students are expected to understand and solve. Therefore, every effort should be made to do and understand them *independently*. The assignments will be corrected and a representative sample graded (some problems may be not graded), with solution sets posted after the due date. Late assignments will **not** be accepted without a legitimate excuse and prior approval.

Tests: This course will have a midterm test and a final examination. The midterm will cover the first half of the course, while the final will cover the second half.

NOTE: It is the Department's policy that tests missed for any reason, **including illness,** cannot be made up. If you missed the midterm because of illness (to be confirmed by a **valid medical note)** the final exam will count for 60% of your final grade, and 40% will be contributed by the assignments.

PLEASE NOTE: Students are responsible for finding out the date and time of the final exam once the schedule is posted by the Examination Office. Any conflicts or problems with the scheduling of the final exam must be reported directly to the Examination Office, **not** to your instructor. **It is the Department's policy and the Examination Office's policy that students are to be available until the end of the final exam period. Conflicts due to travel plans will not be accommodated.**

Calculators: Electronic communication devices (including cell phones) are not permitted in examination rooms. Only calculators approved by the Department (with a sticker attached as proof of approval) are permitted for the class test and final examination. For a list of Approved calculators see https://www.concordia.ca/artsci/math-stats/services.html

Approximate Schedule:

Week	Sections Covered	Topics
1	1.1 - 1.4	Introduction, what is math modelling? Units and nondimensionalization.
2	2.1 (2.1.1 - 2.1.4)	Single variable optimization, sensitivity, and Newton's method.
3	2.2.1 - 2.2.2	Multivariable optimization and Lagrange multipliers.
4	2.2.3 - 2.2.5	Shadow pricing, multivariate Newton's method, linear programming.
5	3.1 - 3.2	Dynamic models: steady-states, phase lines, phase planes.
6	3.2 - 3.3	Phase plane sensitivity, difference equations, cobweb diagrams.
7	3.3.2	Planar difference equations and **MIDTERM 1**.
8	3.4.1	Linear dynamical systems and Romeo + Juliet.
9	3.4.2 - 3.4.4	Local linearization and Hartman–Grobman theorem.
10	3.5.1 - 3.5.3	Computational aspects of dynamic models.
11	4.1 - 4.2	Discrete and continuous probability models, intro to statistics.
12	4.3 - 4.5	Intro to statistics, diffusion models, and Markov chains.

Student Services
You may wish to access the many services available to you as a Concordia student. An overview of these resources can be found here: https://www.concordia.ca/students/services.html

Academic Integrity and the Academic Code of Conduct
This course is governed by Concordia University's policies on Academic Integrity and the Academic Code of Conduct as set forth in the Undergraduate Calendar and the Graduate Calendar. Students are expected to familiarize themselves with these policies and conduct themselves accordingly. "Concordia University has several resources available to students to better understand and uphold academic integrity. Concordia's website on academic integrity can be found at the following address, which also includes links to each Faculty and the School of Graduate Studies: https://www.concordia.ca/conduct/academic-integrity.html" *[Undergraduate Calendar, Sec 17.10.2]*

Behaviour
All individuals participating in courses are expected to be professional and constructive throughout the course, including in their communications.

Concordia students are subject to the Code of Rights and Responsibilities which applies both when students are physically and virtually engaged in any University activity, including classes, seminars, meetings, etc. Students engaged in University activities must respect this Code when engaging with any members of the Concordia community, including faculty, staff, and students, whether such interactions are verbal or in writing, face to face or online/virtual. Failing to comply with the Code may result in charges and sanctions, as outlined in the Code.

Intellectual Property
Content belonging to instructors shared in online courses, including, but not limited to, online lectures, course notes, and video recordings of classes remain the intellectual property of the faculty member. It may not be distributed, published or broadcast, in whole or in part, without the express permission of the faculty member. Students are also forbidden to use their own means of recording any elements of an online class or lecture without express permission of the instructor. Any unauthorized sharing of course content may constitute a breach of the Academic Code of Conduct and/or the Code of Rights and Responsibilities. As specified in the Policy on Intellectual Property, the University does not claim any ownership of or interest in any student IP. All university members retain copyright over their work.

Extraordinary circumstances
In the event of extraordinary circumstances and pursuant to the Academic Regulations the University may modify the delivery, content, structure, forum, location and/or evaluation scheme. In the event of such extraordinary circumstances, students will be informed of the change.

Accommodations for Students with Disabilities
If you need accommodations for classes, assignments, or exams, please contact me and the Access Center for Students with Disabilities. Website: https://www.concordia.ca/students/accessibility.html

Counselling and Psychological Services
Counselling and Psychological Services offers short-term counselling to register Concordia students who are in Quebec. Appointments can be either virtual and in-person. Website: https://www.concordia.ca/health/mental-health/counselling.html

Diversity and Inclusion Statement
Concordia University is an intentionally inclusive community that promotes and maintain an equitable and just work and learning environment. We welcome and value individuals and their differences including race, economic status, gender expression and identity, sex, sexual orientation, ethnicity, national origin, first language, religion, age and disability. I invite and respect any concerns about inequitable access or treatment in this course.

I strive to create a learning environment for you that supports a diversity of thoughts, perspectives, and experiences, and honours your identities. To help accomplish this:

- If you have a name and/or set of pronouns that differ from those that appear in your official Concordia records, you are encouraged to let me know.
- If you feel your performance in the course is being impacted by your experiences outside of class, please come talk to me.
- I am still in the process of learning about inclusion, diverse perspectives and identities. If something was said in class (by anyone, including me) that made you feel uncomfortable, please talk to me about it.
- As a participant in course discussion and problem-based sessions, you should strive to honour the diversity of your classmates.

Additional Course Policies

- No cell phones or computers are allowed during class time.
- All announcements will be posted on Moodle. Be sure your Moodle notifications are turned on, and you check it regularly.
- I am here to facilitate your learning; let me know if you have questions! I can always be reached by e-mail and can schedule additional office hours should you need them.