MAST 331: Mathematical Modeling (Winter 2023)

Instructor:	Jason Bramburger	
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Instructor Office:	LB 901-21	
Lectures:	Monday/Wednesday 2:45 - 4:00 pm	
Office Hours:	Tuesday 1:00 - 4:00 pm in LB 759-06	
	Virtual: by appointment only	
Course Website:	Moodle	
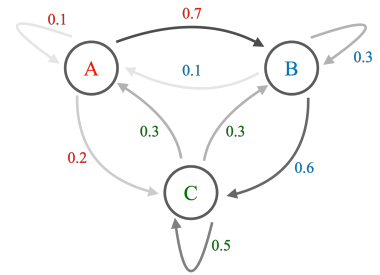
Course Topics and Goals

The goal of this course is for 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. We will primarily consider *dynamic* models, meaning they are changing in time, with time being either continuous or discrete depending on the application. We will learn how to analyze Markov chains, interpret and solve linear and nonlinear ordinary differential equations in 1 and 2 dimensions, and construct models from data. 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 notes will be based in part on *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 in this course will be assigned according to the following system:

30% Final Exam
30% Midterm
40% Assignments

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 final examination. The midterm will cover the first half of the course, while the final will cover the second half. The final will also be held on the last day of class instead of during the

scheduled exam period.

Calculators
Electronic communication devices (including cell phones) are not permitted in examination rooms. Only "Faculty Approved Calculators" (**SHARP EL-531** or **CASIO FX-300MS**) are allowed in examination rooms during midterm and final examinations.

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 registered Concordia students who are in Quebec. Appointments can be either virtual and in-person. Website: https://www.concordia.ca/health/mental-health/counselling.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. Concordias website on academic integrity can be found at the following address, which also includes links to each Faculty and the School of Graduate Studies: concordia.ca/students/academic-integrity." [Undergraduate Calendar, Sec 17.10.2]

Diversity and Inclusion Statement
Concordia University is an intentionally inclusive community that promotes and maintains 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 with 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 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.

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 - 4.4	Intro to statistics and diffusion models.
13	4.5	Markov chains and **MIDTERM 2**