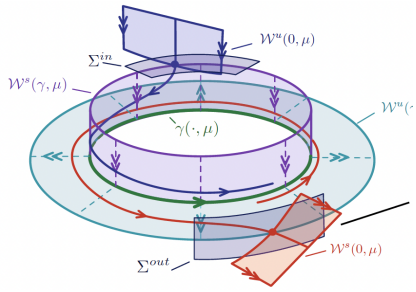
MAST 680 / 837: Advanced Differential Equations (Fall 2024)

Instructor:	Jason Bramburger
Email Address:	jason.bramburger@concordia.ca
Instructor Office:	LB 901-21
Lectures:	Wednesday/Friday 11:45 am - 1:00 pm
Office Hours:	Thursday 1:00 - 3:30 pm in LB 759-06
	Virtual: by appointment only
Course Website:	Moodle



Course Topics and Goals

This course will cover the theory of differential equations from a rigorous graduate mathematics perspective. Topics related to ordinary differential equations to be covered include proving existence and uniqueness for nonlinear systems, examining linear systems, fundamental solutions, equilibria, periodic solutions, stability, invariant manifolds, and hyperbolic theory. We will be introduced to important theorems that underscore the discipline such as Floquet's theorem, the Hartman-Grobman theorem, and the stable and centre manifold theorems. The final weeks of the course will be dedicated to boundary value problems and Sturm-Liouville theory.

Prerequisites

For undergraduates at Concordia: MATH 370, or equivalent. For graduate students: Courses at the undergraduate level in ordinary differential equations and real analysis are necessary.

Textbook

There is no required textbook as lectures will provide all relevant material and separate assignments with problems will be provided on Moodle. However, the majority of the course content can be found in the following books:

- *Ordinary Differential Equations*, Wolfgang Walter, Springer.
- *Differential Equations and Dynamical Systems*, Lawrence Perko, Springer.

Additional resources can be suggested by the instructor based on the interests of the student.

Assessment

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

35% Final Exam
25% Midterm
40% Assignments

Assignments

There will be a total of five assignments over the semester. 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 reason 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 all material from the entire course.

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 can count for 60% of your final grade, and 40% will be contributed by the assignments.

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, 1.2, 2	Introduction, geometric interpretation, tools from functional analysis.
2	2, 3.1	Tools from functional analysis, existence and uniqueness
3	3.2, 3.3, 4.1, 4.2	Continuous dependence of solutions, analysis of IVPs, linear systems
4	4.2, 4.3	Linear systems, matrix exponentials
5	4.4, 4.5, 4.6	Non-constant linear systems, linearization, hyperbolic equilibria
6	4.6, 4.7	Hyperbolic + non-hyperbolic equilibria and **MIDTERM**
7	4.7	Non-hyperbolic equilibria and the centre manifold theorem
8	4.8, 4.9	Limit sets, Poincaré maps, Floquet theory
9	4.9, 4.10.1	Floquet theory, Lyapunov functions
10	4.10.2, 4.10.3, 4.10.4	Dulac's Criterion, Poincaré–Bendixson theorem, averaging
11	5, 5.1	Boundary value problems, Sturm–Liouville problems
12		