McGill UNIVERSITY

MATH 326/376 **NONLINEAR DYNAMICS AND CHAOS** **Winter 2018**

COURSE OUTLINE

Instructor: Prof. Jean-Philippe Lessard
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Lectures: Tuesdays & Thursdays 10:05 – 11:25, Rutherford Physics Building 118
Office hours: Tuesdays & Thursdays: 11:30 – 12:30 (at Burnside 1119)

- **Description:** This is an introductory course on dynamical systems mainly concerned with linear systems, low-dimensional nonlinear systems of differential equations, and iterations of low-dimensional maps. We will investigate how to determine the qualitative behaviour of the solutions of these differential equations, without having to determine the actual solutions explicitly (most interesting equations do not have neat closed form solutions). This is an applied mathematics course, and the main focus of the course will be on understanding and explaining the behaviour of solutions to differential equations, as opposed to a pure mathematics course where the focus might be more on stating and proving theorems. The honours version of the course will contain more analytical questions.

  Topics will include: *Linear systems of differential equations, linear stability theory. Nonlinear systems: existence and uniqueness, numerical methods, one and two dimensional flows, phase space, limit cycles, Poincare-Bendixson theorem, bifurcations, Hopf bifurcation, the Lorenz equations and chaos.*

- **Differences in the courses:** MATH-326 is intended primarily for students in Majors programs. MATH-376 is intended for students in Honours programs. The courses share the same lectures, but the assignments, midterm and final exam for MATH-376 will be at a higher level of difficulty and depth. In addition, MATH-376 Students will have a take-home project to complete.

- **Textbook:** *Nonlinear Dynamics and Chaos, Second Edition*, by Steven H. Strogatz.

  We will largely follow the text in order, covering most of the the first 8 chapters with selected topics from the rest of the book. Assignments will be set from the questions in the book, so you will need access to a copy of the text. *Note:* an *eBook* version is available from McGill University Library.

- **Prerequisites:** The course is intended for all students with an interest in nonlinear dynamics, and sufficient mathematical grounding. In the past students have been drawn from across science and engineering as well as mathematics. To that end the prerequisites are

  - Math 222 or equivalent (Taylor's theorem in particular)
  - Math 223 (non-math students), Math 236 (math students), or equivalent (Eigenvalues/eigenvectors in particular).

  Although there is no computer programming prerequisite, some examples will be supplied in MATLAB, and students are expected to make some use of computing software such as MATLAB.

- **Assignments**

  There will be regular assignments (about 7 in the semester). For MATH-326 students these will count for 20% of the final mark. For MATH-376 students these will count for 10% of the final mark.

- **Project (MATH-376 only)**

  A take-home project will be assigned to MATH-376 students and will be worth 10% of the final grade.

- **Midterm**

  The midterm will be a closed-book exam in class on (provisionally, subject to room availability) Thursday 25th October, and will be worth 30% of the final mark.

- **Final Exam**

  There will be a formal 3 hours final closed-book exam which will count 50% of the final mark.

- **Policies**

  - Make up tests will not be given, and late homework will not be accepted, except for an absence approved in advance by the instructor.
  - Important announcements (including posting of assignments and due dates) will be made to registered students by e-mail (via MyCourses) and/or posted on MyCourses.
  - I attempt to reply to e-mail in a timely fashion, but do not expect immediate responses. I usually will not reply to email sent the day before a test.

- **Copyright**

  Instructor generated course materials (e.g., handouts, notes, summaries, exam questions, etc.) are protected by law and may not be copied or distributed in any form or in any medium without explicit permission of the instructor. Note that infringements of copyright can be subject to follow up by the University under the Code of Student Conduct and Disciplinary Procedures.

- **Academic Integrity**

  The work you hand in should be your own effort; any collaboration must be acknowledged.

  McGill University values academic integrity. Therefore all students must understand the meaning and consequences of cheating, plagiarism and other academic offences under the Code of Student Conduct and Disciplinary Procedures (see www.mcgill.ca/students/srr/honest/ for more information).

- **Language**

  In accord with McGill University's Charter of Students' Rights, students in this course have the right to submit in English or in French any written work that is to be graded.