Lecture: Monday-Wednesday-Thursday, 1:35pm–2:40pm, location TBA.

Instructor: Evan Dummit (he/him/his), Lake Hall 571, edummit@northeastern.edu.

Instructor Office Hours: Mon 12:05pm-1:05pm (shared) + Wed 3:00pm-4:00pm, Lake 571.

Problem Sessions: Tuesdays and Fridays, times and locations TBA.

Course Webpage: https://dummit.cos.northeastern.edu/teaching_sp25_3543.html.

Course Textbook: The instructor will write lecture notes for the course (in lieu of an official textbook) as the semester progresses. For students seeking additional reference, Devaney's "A First Course in Chaotic Dynamical Systems" is recommended.

Prerequisites: Calculus 2 (Math 1242 or 1342) or equivalent. Calculus 3 (Math 2321) and Introduction to Mathematical Reasoning (Math 1365/1465) recommended.

Course Topics: This course is an introduction to one-dimensional discrete dynamical systems on the real line and complex plane, with a focus on studying chaotic dynamics. The goal is to study the chaotic behaviors that can arise even from very simple systems and to seek patterns in the complicated and unpredictable behaviors of nonlinear systems arising from their sensitivity to initial conditions, using a variety of methods (analytical, topological, computational).

The course studies from both a theoretical and computational perspective the stability of orbits and periodic points, bifurcations in one-parameter families, symbolic dynamics, chaotic dynamics, fractals and dimension, and complex dynamics. Use of computing technology, primarily the computer algebra system Mathematica (available to all Northeastern students), is an integral component of this course.

Success in this course will require facility with both the theoretical concepts and with computational applications.

Grades: Your course grade consists of **40% homework** and **60% exams**. There are three exams each covering the material from one-third of the course.

The homework score consists of the average of the 11 written assignment scores, with the lowest score dropped.

The best two exams each contribute 2/5 of the exam score, while the remaining exam contributes 1/5.

An overall raw score of 92% will be **at least** an A, 90% will be **at least** an A-, 88% will be **at least** a B+, 82% will be **at least** a B, 80% will be **at least** a B-, 78% will be **at least** a C+, 70% will be **at least** a C, and 68% will be **at least** a C-.

If you feel that an assignment or exam has been misgraded, please talk to the instructor directly. Requests for regrading will not be considered more than two days past the date the assignment or exam was returned.

Exams: There will be three 65-minute exams, each covering one-third of the material from the semester. There is no comprehensive course exam.

If you miss an examination for any reason without scheduling a make-up or alternative exam modality with the instructor, you will receive a 0.

The first two exams will be held in class on Mon Feb 10th and Mon Mar 24th, while the third exam will be during the scheduled final exam time.

Homework: Written assignments will be assigned weekly and due via Gradescope on **Wednesdays by 11:59pm**. There is a **48-hour late period** during which assignments may still be submitted, possibly with a late penalty assessment (at the grader's sole and total discretion) that will represent at most 15% of the assignment maximum score.

Problem sessions will be held weekly on Tuesdays and Fridays. The problem sessions provide you a place to work collaboratively on the homework assignments with help from the TA. **It is highly recommended to start work on the assignments early**: computational problems may require you to do substantial experimentation and calculations before you can obtain the answers, while theoretical problems will require substantial thought and effort to solve even if the solution is ultimately fairly short. **Do not fall into the trap of only starting the assignment the evening before it is due!**

Written assignments should be organized carefully, neatly, and in complete sentences, with concise well-reasoned logical arguments. Cite any external resources used, and clearly label all problems. All electronic submissions are expected to be easily readable. **Failure to adhere to any of these guidelines may result in point deductions, at the grader's discretion.**

Course Schedule: The course and lecture notes are organized into five chapters, as follows:

Weeks 1-3: Introduction to Real Dynamics $\sim$ Dynamics, fixed points, orbits, periodic and preperiodic points, graphical analysis, attracting/repelling/neutral fixed points and cycles, basins of attraction, Newton's method.

Weeks 4-6: One-Parameter Families $\sim$ One-parameter families, bifurcation diagrams, saddle-node and period-doubling bifurcations, Schwarzian derivatives, critical points and attracting cycles, orbit diagrams of families.

Weeks 7-9: Chaotic Dynamics $\sim$ Symbolic dynamics on sequence spaces, itineraries, equivalence of dynamical systems, sensitive dependence, transitivity, Devaney's definition of chaos, Sarkovskii's theorem.

Weeks 10-11: Fractals $\sim$ Classical fractals (Cantor sets, the Koch curve, the Sierpinski triangle and carpet), topological dimension, box-counting dimension, iterated function systems and self-similarity, the chaos game.

Weeks 12-14: Introduction to Complex Dynamics $\sim$ Complex-valued functions, complex dynamical systems, Julia sets, the Mandelbrot set.

Collaboration Policy: Mathematics is fundamentally a collaborative endeavor, and discussing the course material with others is an excellent way to solidify your own understanding. However, it is critical not to outsource your learning! You cannot expect to retain knowledge if you do not solve your homework problems yourself, whether because you relied on other people to explain to you how to do the problems, or because you relied too heavily on technological assistance.

On written assignments, you may work together with other people, **but you must write up your work independently**.

Please also note that 60% of your course grade is determined by the exams, on which collaboration is not allowed.

External Resources Policy: If you use **any** external resources (e.g., wikipedia, stackexchange, other books beyond the course text or notes, other people, etc.) you must say **what results you are citing and where they are from**. If you happen to find a solution to an assigned problem online or elsewhere, it is plagiarism to present it as your own work without attribution of its source. **In particular, solutions to some homework problems from previous years may be available online: copying from these solutions is prohibited and will be treated as an academic honesty violation.**

Use of generative AI / large language models (e.g., ChatGPT, Copilot) or similar technology, is **expressly prohibited in this course. Submitting answers generated by such models constitutes plagiarism and will receive an automatic zero on the assignment**. Additionally, students are highly discouraged from attempting to check their solutions using generative AI, as the responses are not typically accurate enough to learn effectively from: instead, ask questions on the course Piazza, or speak to the TAs or instructor.

Attendance Policy: It is expected that you will attend every class. This course moves very fast, and it is quite possible to fall behind even if you only miss one day. If you miss class for any reason, it is highly advisable to consult the course lecture notes and to watch the recording of the lecture you missed. It is your responsibility to be aware of all information announced in class, including modifications to the course syllabus or schedule, even if you are absent.

If you will be absent from a class activity due to a religious observance or practice, or for participation in a university-sanctioned event (e.g., university athletics), it is your responsibility to inform the instructor during the first week of class and provide appropriate documentation if required.

Statement on Academic Integrity: A commitment to the principles of academic integrity is essential to the mission of Northeastern University. Academic dishonesty violates the most fundamental values of an intellectual community and undermines the achievements of the entire University. Violations of academic integrity include (but are not limited to) cheating on assignments or exams, fabrication or misrepresentation of data or other work, plagiarism, unauthorized collaboration, and facilitation of others' dishonesty. Possible sanctions include (but are not limited to) warnings, grade penalties, course failure, suspension, and expulsion.

Statement on Accommodations: Any student with a disability is encouraged to meet with or otherwise contact the instructor during the first week of classes to discuss accommodations. The student must bring a current Memorandum of Accommodations from the Office of Student Disability Services.

Statement on Inclusivity: Faculty are encouraged to address students by their preferred name and gender pronoun. If you would like to be addressed using a specific name or pronoun, please let your instructor know.

Statement on Evaluations: Students are requested to complete the TRACE evaluations at the end of the course.

Miscellaneous Disclaimer: The instructor reserves the right to change course policies, including the evaluation scheme of the course. Notice will be given in the event of any substantial changes.