Note: **This section is a pilot program for Math 1465: Intensive Mathematical Reasoning.**

Lecture: (Sec 02) Monday-Wednesday-Thursday, 1:35pm–2:40pm, Dodge Hall 430.
(Sec 14) Monday-Wednesday-Thursday, 4:35pm–5:40pm, West Village G 106.

Instructor: Evan Dummit, Lake Hall 571, edummit@northeastern.edu.

Office Hours: Monday noon–1pm + Monday-Thursday 3:00pm–4:00pm, or by appointment, via Zoom.

Course Webpage: https://web.northeastern.edu/dummit/teaching_fa23_1365.html.

Course Textbook: The instructor will write lecture notes for the course (in lieu of an official textbook) as the semester progresses. The course will roughly follow the presentation in Hammack's "Book of Proof", but it is **not** necessary to purchase the textbook for this course.

Course Philosophy: This course covers the basics of mathematical reasoning and problem solving, with a focus on writing logically sound mathematical arguments and analyzing such arguments. The goal is to provide an intensive preparation for subsequent theory-laden mathematics and science courses that involve proofs and rigor, such as group theory, real analysis, theoretical physics, and theoretical computer science.

Unlike most high-school courses, and unlike courses such as Math 1341-1342 (i.e., calculus courses), we spend very little time on mechanical algorithms to solve stereotyped problems (e.g., "differentiate this function", "graph that function", "solve this system of linear equations"). Rather, the goal is to explore the foundations of mathematical reasoning in scrupulous detail, and to help you develop mathematical intuition about the material that will allow you to solve a very wide variety of problems.

Due to the abstract nature of the material, Math 1365 is a proof-based course with a substantial emphasis on theory. The style of the lectures and of the assignments are a reflection of this philosophy: much of the lecture time in the course will be spent discussing the technical details and mechanics of proofs, along with examples that test our understanding of the underlying concepts. Correspondingly, many of the problems on the homework assignments and exams will ask for you to write proofs or explore unusual examples (or counterexamples).

At the end of the course, you should have a very solid understanding of a variety of foundational topics: in addition to learning fundamental details about logic, sets, functions, numbers, cardinality, and groups, you will know the ideas behind the proofs of the major results and how they can be used elsewhere; above all, you will have learned the language of rigorous mathematics. Success in this course thereby demands facility with the basic concepts and with the underlying theory.

Grades: Your course grade consists of **30% homework**, **30% midterms**, and **40% final exam**.

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

There are two 1-hour midterm exams, each contributing 15% of the total course grade, and a 2-hour final exam.

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+, 72% will be **at least** a C, and 70% 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 two 1-hour midterm exams, along with a 2-hour common final exam.

If you miss an examination for any reason, you will receive a 0; make-up exams will not be given other than in exceptional circumstances.

The midterms are in class and scheduled for Thursday, October 12th and Thursday, November 16th.

The final exam will occur during the final exam week, date and time TBA.

Homework Assignments: Written assignments will be assigned weekly and due by 11:59pm via Canvas, typically on Tuesdays. **It is highly recommended to start work on the assignments early**: many 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!

The lowest assignment grade is dropped, to provide you a cushion if an emergency arises and you cannot complete an assignment. For logistical reasons, extensions cannot be granted under any circumstances.

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. If you collaborated with any other students, write the names of all collaborators on the top of your assignment. **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 four chapters, as follows:

Weeks 1-3: Chapter 1 $\sim$ Proofs, Logic, and Sets: Basic concepts of mathematical proof, logic and proof techniques, conditionals, sets and set operations, Cartesian products, quantifiers and their applications.

Weeks 4-7: Chapter 2 $\sim$ Integers and Modular Arithmetic: The integers, induction, divisibility, GCDs and the Euclidean algorithm, primes and prime factorization, modular congruences and modular arithmetic.

Week 7: Midterm 1, covers chapters 1 and portions of chapter 2.

Weeks 7-11: Chapter 3 $\sim$ Relations, Orderings, and Functions: Relations, equivalence relations, partial and total orderings, functions, function composition, one-to-one and onto functions, inverse functions, bijections, cardinality of sets, countable and uncountable sets.

Week 11: Midterm 2, covers portions of chapters 2 and 3.

Weeks 12-14: Chapter 4 $\sim$ Elements of Algebra: Groups and symmetries, examples of groups, subgroups, orders of elements, Lagrange's and Cauchy's theorems, fields, the real numbers, the complex numbers.

Week 15: Final exam, covers all chapters.

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**. 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.**

Please also note that 70% of your course grade is determined by the exams, on which collaboration is not allowed.

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 to catch up, and you may also wish to obtain notes from another student. 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. Your instructor will work with you on alternative and reasonable arrangements for any time missed.

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 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 Classroom Behavior: Disruptive classroom behavior will not be tolerated.

In general, any behavior that impedes the ability of your fellow students to learn will be viewed as disruptive. Examples of disruptive behavior include, but are not limited to, ringing cell phones, listening to an audio player during class, constant talking, eating food noisily, or laptop usage (except for note-taking).

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.