MA 225: Foundations of Advanced Mathematics

Lecture details
Instructor: Ricky Liu
Lecture time/location: TH 3–4:15, Dabney 623
Office: SAS 3264
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Office Hours: TW 1–2, tentative

Course Description
Introduction to mathematical proofs with focus on properties of the real number system. Elementary symbolic logic, mathematical induction, algebra of sets, relations, functions, countability. Algebraic and completeness properties of the reals.

Prerequisite: MA 241

GEP Category: This course does not fulfill a General Education Program requirement.

Textbook: We will be using custom notes written by the instructor, available on the course website:

http://riliu.math.ncsu.edu/225/

Also available on the course website are notes prepared by Dr. Jo-Ann Cohen at NCSU, available free of charge.

An optional outside reference is How to Prove It: A Structured Approach by Daniel Velleman.

Learning Objectives/Outcomes: Students should demonstrate the ability to:

1. read, understand, and make informed judgments about mathematical arguments.
   - Students should be able to identify the basic methods of proof such as direct proofs, proofs by contradiction, and proofs using the Principle of Mathematical Induction and equivalent principles.
   - Students should be able to analyze and critique mathematical arguments. Students should be able to make a sound case as to the correctness of the argument, should be able to explain any problems that are found, and then should be able to suggest ways to remedy the problems.

2. generate clearly reasoned, convincing proofs.
   - Students should be able to construct proofs using direct arguments, contradiction, and the Principle of Mathematical Induction and equivalent principles.
   - Students should be able to move successfully from the discovery of a proof to the writing of a proof.
   - Students should be able to construct a proof in such a way that the reader can follow the steps logically from one to another and is convinced of the validity of the proof.
   - Students should be able to show that they possess a sound understanding of the underlying mathematics as revealed in the construction of proofs.

3. clearly communicate mathematics (in both written form and oral form) at the appropriate levels for the audience.

4. understand and use mathematical language and symbols.
• Students should be able to express mathematical concepts using precise mathematical symbols and prose.

5. explore examples and make conjectures.

6. understand the basic definitions and properties of selected mathematical concepts beyond calculus and high school material.

• Students should be able to use these definitions and properties in the construction of proofs.

Course Structure and Rules of Engagement: The lectures will be interspersed with small group activities. The course will be structured so that there is a lot of student interaction. In this class we will share ideas and learn from each other. It will be important for each of you to “try” on new ideas and to make conjectures even if you are not sure that you are correct. You will also be asked to critique the ideas and arguments of others. While it is OK to disagree with those ideas and arguments, it is not OK to make personal attacks.

Diversity and inclusivity are important to the success of our students at NC State. Everyone who comes to NC State enriches us through their varied perspectives, knowledge, and backgrounds. Our classroom is one in which every student is respected and feels heard.

Tentative Course Topics Schedule:

Preliminaries: 1-2 days
Language, Logic, Sets, and Methods of Proofs: 3-5 weeks
The Principle of Mathematical Induction: 2-3 weeks
Functions: 2-3 weeks
Equivalence Relations: 2 weeks
The Size of Sets: 1-2 weeks
Further Properties of the Integers: 1 week

Grading Policy:

The grading will be assigned on a 10-point scale: A: 90 – 100, B: 80 – 89, C: 70 – 79, D: 60 – 69, F: \leq 60. The cutoffs for the +/- grades are determined at the end of the semester. Your final grade in this course will be determined by marks earned on weekly homework assignments (10%), three midterms (20% each), and a final exam (30%).

Exams:

• Midterm 1: Tuesday, September 24
• Midterm 2: Thursday, October 24
• Midterm 3: Thursday, November 21
• Final exam date: Tuesday, December 10 at 1pm (at the usual classroom).

Requirements for Credit-Only (S/U) Grading: To receive a grade of S, students are required to take all exams and quizzes, complete all assignments, and earn a grade of C- or better. Conversion from letter grading to credit only (S/U) grading is subject to university deadlines. Refer to the Registration and Records calendar for deadlines related to grading. For more details refer to https://policies.ncsu.edu/regulation/reg-02-20-15/.

It is important that you consult with your advisor to see if the course will count towards your graduation requirements before taking this course as credit-only.
Incomplete Grades: Incomplete grades will be handled on an individual basis. Note, however, that if an extended
deadline is not authorized by an instructor or department, an unfinished incomplete grade will automatically
change to an F after either (a) the end of the next regular semester in which the student is enrolled (not
including summer sessions), or (b) the end of 12 months if the student is not enrolled, whichever is shorter.
Incompletes that change to F will count as attempted courses on transcripts. The burden of fulfilling an incomplete
grade is the responsibility of the student. The university policy on incomplete grades is located at https://
policies.ncsu.edu/regulation/reg-02-50-03/.

Attendance Policy/Absence Policy/Late Assignments/Make-up Work: You are expected to attend all classes
on time. Late assignments and make-up work will only be allowed for excused absences. You should contact me
by email or in person before any anticipated excused absence. If you have an unanticipated excused absence (for
example, a medical emergency), you should contact me within one week of returning to class.

Academic Integrity Statement and Academic Dishonesty:
Both faculty and students at North Carolina State University have a responsibility to maintain academic integrity.
An informational brochure about academic integrity is available from the university and students are encouraged
to obtain a copy.

“Academic dishonesty is the giving, taking, or presenting of information or material by a student
that unethically or fraudulently aids oneself or another on any work which is to be considered in the
determination of a grade or the completion of academic requirements or the enhancement of that
student’s record or academic career.” (NCSU Code of Student Conduct)

Scholarly activity is marked by honesty, fairness and rigor. A scholar does not take credit for the work of others,
does not take unfair advantage of others, and does not perform acts that frustrate the scholarly efforts of others.
The violation of any of these principles is academic dishonesty. Penalties for a violation: For the first violation,
you will receive a zero for your work and be put on academic integrity probation for the remainder of your stay at
NCSU. The second violation may result in your suspension from NCSU. Both situations will involve the Office of
Student Conduct.

Electronically-Hosted Course Components: All reading materials, homework assignments, and handouts will
be available on the course website.

Cell Phone and Computer Use: Cell phones and computers should be turned off during class. But if you have
an emergency and need to keep your phone on during class, please let me know before class.

Accommodations for Disabilities: Reasonable accommodations will be made for students with verifiable disabil-
ities. In order to take advantage of available accommodations, students must register with the Disability Resource
Office at Holmes Hall, Suite 304, Campus Box 7509, 919-515-7653. For more information on NC State’s policy on
working with students with disabilities, please see the Academic Accommodations for Students with Disabilities
Regulation (REG02.20.01).

Non-Discrimination Policy: NC State prohibits discrimination, harassment, and retaliation that are based upon
a person’s race, color, religion, sex (including pregnancy), national origin, age (40 or older), disability, gender
identity, genetic information, sexual orientation, or veteran status (individually and collectively). If you feel that
you have been the subject of prohibited discrimination, harassment, or retaliation, you should contact the Office
for Institutional Equity and Diversity (OIED) at 919-515-3148.

NC State’s policies and regulations covering discrimination, harassment, and retaliation may be accessed at

Trans-Inclusive Statement: In an effort to affirm and respect the identities of transgender students in the
classroom and beyond, please contact me if you wish to be referred to using a name and/or pronouns other than
those listed in the student directory.
Basic Needs Security: Please notify me, if you are comfortable doing so, if you face challenges securing your food or housing or if you have other severe adverse experiences, and you believe your challenges may affect your performance in the course. Alternatively, you can contact the Division of Academic and Student Affairs to learn more about the Pack Essentials program (https://dasa.ncsu.edu/pack-essentials).

Supporting Fellow Students in Distress: As members of the NC State Wolfpack community, we each share a personal responsibility to express concern for one another and to ensure that this classroom (as well as the campus as a whole) remains a healthy and safe environment for learning. Occasionally, you may come across a classmate whose personal behavior concerns or worries you, either for your classmate's well-being, for your well-being or for the well-being of others. When this is the case, I would encourage you to report the behavior on the link located on NC State's Students of Concern website (http://go.ncsu.edu/NCSUcares).

List of Policies: Students are responsible for reviewing the NC State University PRRs (policies, rules and regulations) that pertain to their course rights and responsibilities:

- Equal Opportunity and Non-Discrimination Policy Statement
  https://policies.ncsu.edu/policy/pol-04-25-05/

- Code of Student Conduct
  https://policies.ncsu.edu/policy/pol-11-35-01/

- Grades and Grade Point Average
  https://policies.ncsu.edu/regulation/reg-02-50-03/

- Credit-Only Courses
  https://policies.ncsu.edu/regulation/reg-02-20-15/

- Audits
  https://policies.ncsu.edu/regulation/reg-02-20-04/