

Instructor: Dr. Miriam Kuzbary
Time: TR 12:30-1:45PM
Classroom: Skiles 255
Email: kuzbary AT gatech.edu
Instructor Office: Skiles 014

Drop in office hours for students: T 10:30am-11:30am in Clough 248,
W 4pm on Zoom,
and by appointment through email.

Class Webpage: Canvas

You are responsible for all of the information in this syllabus, so please read it carefully and refer back to it regularly.

Course Description:

Welcome to Foundations of Mathematical Proof! Before this class, it is likely your mathematical education has focused on computation. In this course, you will begin your study of the reasons behind the computations, and build your skills in discovering those reasons for yourself. After this course, my hope is that you will be able to:

1. Construct a convincing mathematical argument which is well supported by definitions, axioms, and theorems,
2. Write a rigorous and logical proof reflecting a convincing mathematical argument,
3. Understand prerequisite material for upper level math coursework, such as MATH 4107: Abstract Algebra I and MATH 4317: Analysis I,
4. Develop your skills in learning difficult mathematics independently by reading texts and proving material for yourself.

The lectures and assignments of this course are all designed with these goals in mind.

Pre-Requisites:

MATH 1502, 1512, 1504, 1555 or equivalent.

Required Texts:

This course uses multiple textbooks, but all textbooks are available for free online with your GT login.

1. **Main textbook:** Book of Proof by Richard Hammack (3rd edition, 2018).
(Available at <http://www.people.vcu.edu/~rhammack/BookOfProof>)
2. **Analysis:** Elementary Analysis: The Theory of Calculus by Kenneth Ross (2013).
(Available through SpringerLink to GT students with login at <https://link.springer.com/book/10.1007/978-1-4614-6271-2>)

3. **Group Theory:** Theory and Applications by Thomas Judson (Annual Edition, 2019).
(Available at <http://abstract.pugetsound.edu/aata/aata.html>)
4. **Additional resource on set theory:** Naive Set Theory by Paul Halmos
(Available through SpringerLink to GT students with login at <https://link.springer.com/book/10.1007/978-1-4757-1645-0>)

Course Expectations:

Learning new mathematics takes a lot of work and often takes time to process and internalize. As this is an advanced mathematics course, you will be expected to write mathematics clearly and precisely. This is a physical skill that will take time and practice. As a result, it is extremely important to attend class regularly, carefully go through proofs we learn in class, and work on proofs and examples in real-time along with the lectures. It is your responsibility to check both your Georgia Tech email address and the course Canvas page to keep informed of any announcements, homework assignments, quizzes, syllabus adjustments, or policy changes made during scheduled classes.

During lecture we will have many conversations about what we are learning, so come to class expecting that you will be both contributing to the discussion and taking away something interesting to think about. We are creating this class together. There will be many opportunities to work with your peers in groups and your input will be regularly solicited both in the lecture chat and verbally. Our class time is your opportunity to think out loud, make mistakes, and ask questions! Here is some advice on how to effectively use our class lectures so we aren't wasting each other's time:

- **Eliminate distractions** as best you can while you participate in live lecture, read lecture notes from previous classes, or, if applicable, watch lecture recordings. For example, if you are scrolling TikTok on your phone during class, or are studying for another class while sitting in our class, you are getting less out of both activities than you would have otherwise.
 - Our brains are not usually physically able to “multitask,” i.e. do multiple things in parallel. Instead, our brains switch very quickly between tasks even if it may seem like they are doing many things at once. This means when you have multiple things going on when you are trying to learn a new thing, your brain cannot as easily internalize the thing you are trying to learn even though you are paying attention. For peer reviewed research about this in the study of cognition, see *Mayer and Moreno 2003*, *Junco 2012*, and *Junco and Cotten 2012*.
- **Ask questions during class, and please respond to questions I ask during class.** Our classroom is the time to explore ideas; it is reasonable and expected to participate in class discussions even if you do not yet feel comfortable with the material.
- **Work problems along with the lecture**, even if you are going through notes or recordings later. Math is not a spectator sport!

As with any proof-based math class, simply attending lectures will not be enough to succeed in the course. It is important you spend time outside of class actively reading the course textbooks and that you study regularly, regardless of whether you have an assessment looming on the horizon.

It is essential that you start your homework early enough to be able to ask questions about it in office hours and have conversations about it with your peers in class. Having made it this far in your undergraduate mathematics career, you certainly have your own tools for learning new mathematics. If you find yourself wanting to try more strategies, some things that may be helpful to you are:

- Come to office hours regularly, even if you don't have your own question! Someone else might ask a question that is relevant to you.
- Take notes during class, and after class summarize or outline the notes for yourself in a separate document.
- Summarize or outline the definitions, propositions, theorems, and conjectures for yourself while you are reading the text.
- Try to prove results from class for yourself without looking at the lecture notes, then, compare the proof you came up with to the proof we did together or you found in the book! Even if your proof is very different or you could not finish it your way, you will likely learn a lot from the experience.
- Discuss ideas from class with your peers in a respectful way, making sure everyone involved in the conversation is able to speak and work through problems together. Remember: a quick answer isn't necessarily a correct answer!
- Google strategies for succeeding in proof-based mathematics classes! There are many mathematicians in the world, and we all have different perspectives on how to effectively learn advanced mathematics and communicate it in a useful way.

Course delivery and illness policy: This course is scheduled to take place in person, but I will post materials from the class on Canvas and, if necessary, recordings from classes as well. Georgia Tech highly encourages all students, faculty, staff, and visitors to get COVID-19 vaccinations and additional boosters when necessary, and for the current University guidance see *the Stamps website*. The University System of Georgia encourages people to wear masks based on their preference and assessment of personal risk. If you are showing symptoms of a contagious illness and/or testing positive for COVID-19 on a regular class day, please follow the GT *isolation and quarantine guidelines* and do not come to class. If it is an exam day, please email me immediately to schedule a makeup exam.

Grading: Your final grade in the class will be computed as follows:

Homework	20%
Check-In Quizzes	6%
Proof Workshop Quizzes	6%
Midterm Exams 1, 2, and 3	18% each
Portfolio	14%
Participation	2% (extra credit)

There is no curving on individual assignments - all results are recorded as numerical scores. The final grade cutoffs will not be established until the end of the semester and they will be based on the overall score distribution, as well as historical grade distributions for the course. Cutoffs will not be set higher than the standard ones (90 for A, 80 for B, 70 for C, 60 for D), but they may be lowered, depending on the difficulty of the assignments.

Participation: There will be daily opportunities for participation in class, which both helps you engage with and retain the material better and helps me set the pace of the class. Please show courtesy to your fellow classmates and instructor by adhering to the following class rules:

- Be on time and on task during lecture; if you disrupt lecture with a device you are using such as a laptop, phone, or tablet, you will be asked to put it away or leave the classroom.
- Be respectful during class time; disruptive, harassing, and abusive behavior will result in being asked to leave the classroom.
- Please ask questions throughout class, however, if you are answering a question please raise your hand and wait for me to call on you. I make an effort to call on as many different people as possible during each lecture, and am happy to hear what all of you have to say.
- If you experience harassing or abusive behavior from another class member, please let the instructor know as soon as possible.

This term we will be using Piazza for class discussion. The system is highly catered to getting you help fast and efficiently from classmates and myself. Rather than emailing questions to me, I encourage you to post your questions on Piazza unless you would like to keep them private. It is possible to post anonymously to Piazza as well. If you have any problems or feedback for the developers, email team@piazza.com.

Find our class signup link at: <https://piazza.com/gatech/spring2023/math2106d>.

Homework: As the semester goes on, the homework will become longer and more difficult. There is homework due on January 19 and January 26, after that homework will be due approximately every two weeks (Feb 9, Feb 23, Mar 9, Mar 30, April 13, and April 25). You will earn 10% extra credit for each submission you typeset in \LaTeX . However, even with extra credit your homework grade for the semester cannot exceed 100%.

Homework will be assigned and collected on a regular basis, and a subset of the problems will be graded and returned with feedback. You will be graded not only on the mathematical content of your solutions, but also on the quality of your proofs.

While collaboration is encouraged, it is important that you try as many problems as you can by yourself before consulting other sources. Resist the urge to search the internet or ask your friends who have already taken the class for solutions; this is not the way to learn the material well. *Some struggle is expected and is necessary for learning mathematics.* You are welcome to discuss the problems and solutions with your classmates, but the work you submit should be your own. If you worked with other people on the homework and/or used other people's ideas, such as from an online source, state this clearly in the comments section when submitting your homework.

Finally, **do not give unsolicited answers to your classmates.** Again, part of the process of learning mathematics is the struggle itself, therefore 1) do not rob your colleagues of the opportunity to figure things out, 2) your solution may not actually be correct in the first place. The ideal

discussion of the homework is one where everyone involved has tried the problem already, and everyone in the discussion is given space to try out their ideas.

Homework will be due on Thursdays on Gradescope through Canvas at the beginning of class (12:30pm). All homework must be uploaded electronically. Please make sure your uploads are legible, and do not label your homework with your name anywhere on the page. I will not post solutions to homework problems.

I will accept late homework with a penalty of 25% for each late day without proper documentation. I will not accept homework later than two days except for in exceptional circumstances.

Check-in quizzes: There will be a short, straightforward quiz on Canvas due Tuesday every week except for the weeks directly following exams. The quiz will be open book and open note, and its purpose is to help you check in on how you are keeping up with the new material. You are bound by the honor code to not share questions with other students who have not taken the quiz yet; please do not discuss the quiz until after it is due. I will drop a total of four check-in quizzes, and I will not give makeup quizzes.

Proof workshop quizzes: There will be four in-class proof workshop quiz rounds during the semester. The structure of each round is as follows:

1. In class on January 24, February 21, March 28, and April 18 you will take a **proof quiz** be given a set of statements and asked to prove a subset of them for a quiz grade.
2. After class, you will have five days to typeset your quiz submission in \LaTeX and submit online in Canvas WITHOUT YOUR NAME ON IT. I will be able to see you submitted it, but your submission will appear anonymous to someone who only has the document.
3. In class on January 31, February 28, April 4, and April 25 we will have a **proof workshop** where we spend 30 minutes of class time in pre-assigned groups discussing anonymously written proofs (note that no group will be assigned proofs a member of that group has written). Each group will submit a feedback form for the quiz submissions they were assigned, and I will distribute the feedback to the original authors.
4. Using this feedback, you will be able to submit quiz corrections by the last day of class (April 25). You will not receive credit on ANY quiz correction unless you participate in at least **three** of the four workshop rounds (which includes both submitting your anonymous typeset work and engaging in discussion of others' work with your group).

Exams:

All exams are closed book, closed note, and taken in class. If you have accommodations through ODS, please contact me with documentation during the first week of class. Make-up exams will be allowed only in the case of a documented medical or personal emergency. If an exam conflicts with a holiday you observe, please let me know before the end of the first week of classes.

Portfolio: You will write many proofs throughout the semester. The portfolio gives you a chance at the end of the semester to show me your best proofs of the semester. More specific information will follow later, but the idea is that during the semester you will periodically go back and improve proofs you have submitted for homework, quizzes, or exams to add to your portfolio. Note that

any proof you have seen full solutions for is not eligible for your portfolio. Partial portfolios will be submitted on Thursday, February 16 and Thursday, April 13. The final portfolio is due Monday, May 1 at 11:20am.

Your grade on the portfolio will be determined by:

- First partial portfolio: 10%
- Second partial portfolio: 15%
- Final portfolio: 75%

CIOS: If at least 85% of students submit CIOS, I will drop one homework grade.

Attendance:

- You are responsible for all material covered in class and are encouraged to attend every class ready to participate to get the most out of this course.
- As our class is discussion-based, much of the value in the course involves regularly coming to lecture. Even for students who prefer to learn material on their own, it usually takes much longer to do so without having come to lecture as well.
- I will only take attendance on proof workshop days.

Academic Dishonesty:

Georgia Tech aims to cultivate a community based on trust, academic integrity, and honor. Students are expected to act according to the highest ethical standards. For information on Georgia Tech's Academic Honor Code, please visit <http://www.catalog.gatech.edu/policies/honor-code/> or <http://www.catalog.gatech.edu/rules/18/>. All students must be aware of their individual responsibilities under the Georgia Tech Academic Honor Code, which will be strictly adhered to in this class. Any evidence of cheating or other violations of the Georgia Tech Honor Code (e.g. using other people's work on homework without giving proper credit) will be submitted to the Dean of Students.

Cheating includes, but is not limited to:

- Copying directly from any source, including friends, classmates, tutors, internet sources, or a solutions manual.
- Allowing another person to copy your work.
- Taking a test in someone else's name or having someone else take a test in your name.
- Asking for a regrade of a paper that has been altered from its original form.
- Fraudulently asking for an extension or make-up.
- Using software to automatically generate proofs.

Accommodations:

If you are a student with learning needs that require accommodations, contact the Office of Disability Services at (404)894-2563 or <http://disabilityservices.gatech.edu/>, as soon as possible to make an appointment to discuss your needs and to obtain an accommodations letter. Please also e-mail me as soon as possible in order to set up a time to discuss your learning needs.

Make-Up Exams:

In the event of an absence due to an institute sponsored event, such as an intercollegiate sports competition, please notify me at least two weeks in advance to arrange an early test or other alternative. If you miss an exam due to family or medical emergency, please bring me a note from the Office of the Dean of Students.

Regrade Requests: Any regrading request should be submitted to me through the mechanism in Gradescope within one week of the date the assessment has been returned to the class.

Digital Learning Day: In the case of inclement weather to the point that Georgia Tech has declared a digital learning day, and I have an internet connection and power, lecture will be online on Zoom with participation through chat and breakout rooms. The lecture will also be recorded and posted online.

Student-Faculty Expectations Agreement: At Georgia Tech we believe that it is important to strive for an atmosphere of mutual respect, acknowledgment, and responsibility between faculty members and the student body. See <http://www.catalog.gatech.edu/rules/22/> for an articulation of some of the basic expectations we have for each other.

As a member of the Georgia Tech community, I am committed to creating a learning environment in which all of my students feel safe and included. Because we are individuals with varying needs, I am reliant on your feedback to achieve this goal. To that end, I invite you to enter into dialogue with me about the things I can stop, start, and continue doing to make my classroom an environment in which every student feels valued and can engage actively in our learning community.

Campus Resources for Students

In your time at Georgia Tech, you may find yourself in need of support. Below you will find some resources to support you both as a student and as a person.

Academic Support

- Center for Academic Success <http://success.gatech.edu>
 - 1-to-1 tutoring <http://success.gatech.edu/1-1-tutoring>
 - Peer-Led Undergraduate Study (PLUS) <http://success.gatech.edu/tutoring/plus>
 - Academic coaching <http://success.gatech.edu/coaching>

- Residence Life's Learning Assistance Program <https://housing.gatech.edu/learning-assistance-program>
- OMED: Educational Services (<http://omed.gatech.edu/programs/academic-support>)
 - Group study sessions and tutoring programs
- Communication Center (<http://www.communicationcenter.gatech.edu>)
 - Individualized help with writing and multimedia projects
- Academic advisors for your major

Personal Support

- The Office of the Dean of Students: <http://studentlife.gatech.edu/content/services>; 404-894-6367; Smithgall Student Services Building 2nd floor
 - You also may request assistance at https://gatech-advocate.symplicity.com/care_report/index.php/pid383662?
- Counseling Center: <http://counseling.gatech.edu>; 404-894-2575; Smithgall Student Services Building 2nd floor
 - Services include short-term individual counseling, group counseling, couples counseling, testing and assessment, referral services, and crisis intervention. Their website also includes links to state and national resources.
 - Students in crisis may walk in during business hours (8am-5pm, Monday through Friday) or contact the counselor on call after hours at 404-894-2204.
- Students' Temporary Assistance and Resources (STAR): <http://studentlife.gatech.edu/content/need-help>
 - Can assist with interview clothing, food, and housing needs.
- Stamps Health Services: <https://health.gatech.edu>; 404-894-1420
 - Primary care, pharmacy, gender-inclusive health care, psychiatry, immunization and allergy, health promotion, and nutrition
- OMED: Educational Services: <http://www.omed.gatech.edu>
- Women's Resource Center: <http://www.womenscenter.gatech.edu>; 404-385-0230
- LGBTQIA Resource Center: <http://lgbtqia.gatech.edu/>; 404-385-2679
- Veteran's Resource Center: <http://veterans.gatech.edu/>; 404-385-2067
- Georgia Tech Police: 404-894-2500

Important Dates

January 9	First Day of Classes
January 24	Proof Quiz 1
January 31	Midterm Exam 1 review and Quiz 1 Workshop
February 2	<i>Midterm Exam 1</i>
February 16	<i>Partial Portfolio Due</i>
February 21	Proof Quiz 2
February 28	Midterm Exam 2 review and Quiz 2 Workshop
March 2	<i>Midterm Exam 2</i>
March 20-24	Spring Break
March 28	Proof Quiz 3
April 4	Midterm Exam 3 review and Quiz 3 Workshop
April 6	<i>Midterm Exam 3</i>
April 13	<i>Partial Portfolio Due</i>
April 18	Proof Quiz 4
April 25	Quiz 4 Workshop on last day of class
May 1	Final Portfolio Due

**This syllabus provides a general plan for the course;
deviations may be necessary.**