Math 311: Real Analysis Syllabus

Summer 2019 | Section T6

Instructor Information

Instructor	Email	Office Location & Hours
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Disclaimer: The material in this syllabus is subject to change, according to the instructor's discretion. The exam dates, however, will not change.

General Information

Description

This course is a first introduction to real analysis. In this course, we rigorously develop some of the main ideas of calculus (limits, continuity, and differentiability) starting from key properties of the real numbers. Unlike most standard math courses, this course is *flipped,* meaning that students' first exposure to course material is outside of class, while class time is spent deepening understanding through guided group work and other activities. For more details about what this looks like for this class, below.

Additionally, this course will use Canvas, rather than Sakai. To access this course page, visit canvas.rutgers.edu and log in using your NetID and password.

The official textbook for this course is Understanding Analysis, second edition, by Stephen Abbott, ISBN-13: 978-1493927111; ISBN-10: 1493927116. Students may access a PDF of the textbook for free from the university's libraries here: http://bit.ly/2IiOvPO. Additional resources will also be posted to the Canvas page.

This class meets Tuesdays and Thursdays 6-8:30pm in Tillett Hall 204.

Prerequisite

Students who take this course are required to have passed Math 300 with a C or better.

Learning Goals

1. Students will be able to apply major theorems in real analysis to prove or disprove mathematical statements.
2. Students will be able to provide examples to show that hypotheses of major theorems cannot be weakened.
3. Students will be able to translate between informal explanations and formal proofs of mathematical concepts.
4. Students will be able to generate examples of mathematical objects with specified properties or prove that such an example cannot exist.
5. Students will be able to identify whether a given example has a particular property and prove it.
6. Students will be able to typeset mathematics using LaTeX.
7. Students will be able to write clear and correct mathematical proofs. They use proper mathematical notation and precise language in their proofs.
8. Students will be able to connect pictures and computations in proofs.
9. Students will be able to read and gain insight from a mathematical text.

10. Students will be able to prove or provide counterexamples for conjectured relationships between properties of sequences, limits, and functions.
11. Students will be able to use definitions to prove true statements or provide counterexamples to false statements.

Flipped Format

This class is going to be run in a **flipped** model. To understand what that means, we first have to point out specific aspects of the traditional classroom.

In a traditional model, students typically first encounter a concept during lecture, where their instructor will introduce the topic and give some examples. The students will then go home to work on problems on their own to practice and deepen their understanding. If students run into questions while working on these problems, they have to email their instructor, go to office hours, find tutoring, or turn to less ideal resources such as Chegg.

A flipped model turns that sequence on its head. Students first encounter a concept *before* class, often through videos, readings, worksheets, discussion boards, etc. When they arrive in class, they are actively working on problems *while the instructor is there to answer questions*. Often there are some additional problems for the students to complete after class to solidify the understanding gained during class.

For a nice discussion of flipped classrooms and self-regulated learning (a concept related to flipped classrooms) listen to this podcast: https://teachinginhighered.com/podcast/self-regulated-learning-flipped-classroom/

Statement on Diversity

"The first question is: Can learning take place if in fact it silences the voices of the people it is supposed to teach? And the answer is: Yes. People learn that they don't count."

--Henry Giroux, Border Crossings: Cultural Workers and the Politics of Education

It is my intent that students from all diverse backgrounds and perspectives be well served by this course, that students' learning needs be addressed both in and out of class, and that the diversity that students bring to this class be viewed as a resource, strength, and benefit. It is my intent to present materials and activities that are respectful of diversity: gender, sexuality, ability, age, socioeconomic status, ethnicity, religion, race, and culture. To help accomplish this, I make the following commitments.

- All people have the right to be addressed and referred to in accordance with their personal identity. In this class, we will have the chance to indicate the name that we prefer to be called and, if we choose, to identify pronouns with which we would like to be addressed. I will do my best to address and refer to all students accordingly and support classmates in doing so as well.
- If you feel that your performance in the class is being impacted by your experiences outside of class, please don't hesitate to come and talk with me. I want to be a resource for you. The Canvas page will also include a tool to submit anonymous feedback.
- I (like many people) am still in the process of learning about diverse perspectives and identities. If something was said in class (by anyone) that made you feel uncomfortable, please talk to me about it. (Again, anonymous feedback is always an option).

Your suggestions are encouraged and appreciated. Please let me know ways to improve the effectiveness of the course for you personally or for other students or student groups.

Rutgers University Office of Diversity and Inclusion: https://odi.rutgers.edu/

Rutgers University Cultural Collaborative: http://culturalcollaborative.rutgers.edu/

Rutgers University Office of Disability Services: https://ods.rutgers.edu/

Academic Integrity

Copying, collaborating, and getting help are all *very* different things. Understanding the distinctions is crucial for students in this and all other university classes.

Copying means taking work from the internet (including anything on Chegg), another student, or any other source at face value and submitting it as your own. Copying constitutes a violation of the academic integrity policy and will be reported to the proper Rutgers offices.

Collaborating means working with classmates on a problem assigned as group work, such as workshops. Students might also collaborate while working through the online homework. In fact, in this class you will spend a lot of time working in groups. However, you will still receive you own grade for the course and will therefore need to do your own work. So, how do you know when the group work must stop, and the individual work begins? Follow the **"Sauna Rule"**: If you work out problems with other students, do not copy the answers. Instead, go take a 30-minute sauna, and then write up the answer on your own without the aid of group work. Copying work that is not yours is plagiarism, even if the work was done as part of a group discussion of a problem.

Getting help from someone who is more familiar with the material than you are **may also constitute copying**. Of course, if you come to office hours or ask me (the instructor) questions, I know what level of help you've received and can structure the conversation to avoid the question of plagiarism. If, however, you get help from a tutor (including online tutoring platforms like Chegg), a friend, or anyone else that isn't the instructor of this course, you should again follow the Sauna Rule to avoid potential violations of the academic integrity policy.

Internet Searches and Other Sources

You may not search anything for this class on the internet. You may not use any resources outside of those posted on the Canvas page. You are expected to make mistakes on your homework problems, and the grading policy is designed to compensate for that. I have plenty of office hours where you can ask questions. Searching the internet will often lead you to solutions which are misleading at best. I have posted a lot of resources which you may use, and of which I have confirmed the accuracy. I also have plenty of availability to meet in office hours if you have questions.

There is one very important exception to this policy: you may (and in fact are encouraged to) search the internet for anything about working in LaTeX. I will not in any way test you on memorization of LaTeX. Professional mathematicians routinely search the internet for help with typesetting, and it would therefore be unreasonable (and quite frankly, pointless) for me to stop you from searching for typesetting help.

If at any point you have questions about academic integrity and the policies enforcing it, please don't hesitate to ask. You should also familiarize yourself with the official Rutgers policy:
http://academicintegrity.rutgers.edu/academic-integrity-policy

Disabilities Statement

Rutgers University welcomes students with disabilities into all of the University's educational programs. In order to receive consideration for reasonable accommodations, a student with a disability must contact the appropriate

disability services office at the campus where you are officially enrolled, participate in an intake interview, and provide documentation: https://ods.rutgers.edu/students/documentation-guidelines.

If the documentation supports your request for reasonable accommodations, your campus's disability services office will provide you with a Letter of Accommodations. Please share this letter with your instructors and discuss the accommodations with them as early in your courses as possible. To begin this process, please complete the Registration form on the ODS web site at: https://ods.rutgers.edu/students/registration-form.

Course Assignments

Pre-Class Worksheets

Before class, students will work to complete a pre-class worksheet that is designed to introduce students to that day's topics. Sometimes these worksheets will ask students to read posted material and answer questions about it. Some of the worksheets will be self-contained with all definitions and examples students need to complete them. In same cases, the worksheet will provide a proof (or a sketch of a proof) of a major theorem and ask questions about the proof to help students develop deeper understanding of it, rather than encouraging rote memorization. These pre-class assignments, as the name suggests, are due before class, scanned and submitted to Canvas.

Post-Class Worksheets

Students will be given worksheets after each class to complete for the following week. These assignments are to be completed using LaTeX and the resulting PDF is to be uploaded to Canvas for the homework grader to grade. One workshop session at the start of the semester will be devoted to introducing students to type-setting in LaTeX.

Workshops

During the last 40 minutes of each class, students will work through worksheets guiding them through topics at a deeper level than the core course content. Examples of the topics include sequences of functions, series, the Cantor set, and L'Hôpital's rule (Boas, 1986). In each worksheet, students will work through selected examples to develop and understand definitions and theorems within the topic. Students will also conjecture and prove some statements about that topic. The purpose of these worksheets is to encourage students to take the skills and ideas they learn in the core course content and apply them in this new setting. This is not only a useful skill on its own, but it will also help students to deepen their understanding of the core course content. Students will submit the completed worksheets the following week. Students are encouraged, but not required, to type the solutions to these worksheets.

Exams and Assessment

This class will have four exams: three midterms and one final. Each midterm will last 80 minutes in the normal class time and location, with a workshop-like activity scheduled for afterwards. The final exam will be 3 hours during the last day of class.

Midterm Rewrites

After each midterm, students will receive scans of their submissions with a mark next to each one indicating if the solution is completely correct, has a very minor error, or has a more than a minor error. For all cases except when the problem is completely correct, students have the option to submit rewrites of their solutions. They must not only provide correct solutions but also explain what was wrong with their original solution. By submitting these

rewrites, students can earn back up to half of the points they missed in their original exam submission. More details about this will be given out just before the first midterm.

Missing Exams

No makeup midterms will be offered. If a student misses a midterm for any unavoidable reason, then the final exam grade will replace that midterm in the final course grade calculation. It is a matter of department policy that you may not be excused from the final exam. **You must take the final exam.**

Quizzes

Each class day will include a 10-15 minute quiz part of the way through class. This quiz will mostly be based on the pre-class material, but will also include any material covered at the start of class.

Course Grade Breakdown

Course Component	Percentage of Final Course Grade
Quizzes	10
Pre-Class Worksheets	5
Post-Class Assignments	10
Workshops	10
Midterm 1	13
Midterm 2	13
Midterm 3	13
Final Exam	26
Total	100

Course Schedule

Date	Topic	Workshop Topic
Tuesday, May 28	Definition of Convergent Sequences	Introduction to the Course
Thursday, May 30	Proving Convergence and Other Properties	Introduction to LaTeX
Tuesday, June 4	Necessary Conditions for Convergence	A Mathematician's Lament
Thursday, June 6	Sufficient Conditions for Convergence	Convergence of Series
Tuesday, June 11	Algebraic and Order Limit Theorems	Rearrangement of Series
Thursday, June 13	**Exam 1**	Cardinality
Tuesday, June 18	Supremums and Infemums	Limit and Accumulation Points
Thursday, June 20	Open and Closed Sets	Limsup and Liminf
Tuesday, June 25	Open Covers	The Cantor Set
Thursday, June 27	Compact Sets and Heine Borel	The Real Numbers
Tuesday, July 2	**Exam 2**	General Topology
Thursday, July 4	**Holiday: No Class**	
Tuesday, July 9	Discovering Continuity and Functional Limits	Halmos's Essay
Thursday, July 11	Delta-Epsilon Functional Limits	Sequences and Functional Limits
Tuesday, July 16	Properties of Continuous Functions	Domains that are Proper Subsets of $\mathbb{R}$
Thursday, July 18	Uniform Continuity	Sequences of Functions
Tuesday, July 23	Intermediate and Extreme Value Theorems	Monotone Functions
Thursday, July 25	**Exam 3**	Fourier Series
Tuesday, July 30	Derivatives and Calculus Rules	L'Hopital's Rule
Thursday, August 1	Rolle's Theorem and Mean Value Theorem	Directional Derivatives and Holomorphic Functions
Tuesday, August 6	Weierstrass Function	Final Review
Thursday, August 8	Final Review	
Tuesday, August 13	**Final Exam**	