MTH 401 :: Real Analysis

Fall 2024

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Welcome!

Before we get into the details of the course, I want to share with you a few thoughts about my general approach to teaching and learning. My main goal as the professor in this course is to help you succeed in not just learning the material but in growing as a learner. Learning takes effort, a willingness to try something that may not work, and the ability to use feedback to refine your understanding. My job is to foster an environment in which each and every one of you are supported in these aspects.

Much of the work for this course will be done within class or small group discussions for which we will rely on everyone in this class as a source for feedback and support. Because of this, it's important that we create an inclusive community that is respectful of our differences and offers space for the boundary-setting necessary for positive relationships to form. Our diversity is reflected by differences in race, gender, sexuality, ability, class, religion, nationality, and other cultural identities and material circumstances.

I am looking forward to getting to know each of you and it is my sincere goal to make our time together (in class and out) productive and engaging. I want you to feel comfortable coming to me with any questions or concerns that arise, mathematical and otherwise. If you encounter any issues that interfere with your learning, whether they are physical, mental, emotional, economic, or otherwise, or if you experience discrimination or mistreatment of any sort, please contact me immediately. Other resources for support include the Chair of the Math Department or the CAS Dean of Students.

1 At a Glance

Schedule

Tue-Thur, 9:45-11:10 DB 230

Instructor

Chris Hallstrom, PhD (he / him / his). My office is Buckley Center 270.

Email

hallstro@up.edu. Email is the best way to contact me. I will do my best to get back to you as soon as I can, but please be aware that I typically do not check my email in the evenings or on weekends.

Webpage

All course content will be posted on our class Moodle page

Zoom

In addition to stopping by my office for questions, I am also available (by prior arrangement) via zoom. Here is my personal zoom link.

Calendly

To schedule a meeting (in-person or virtual), you can check my Calendly scheduluer. If you would like to meet at time that you don't see available on Calendly, please feel free to check with me via email!

2 Course Description

In this course, we will revisit many of the fundamental concepts from Calculus I with the goal of understanding better how the basic theorems and results follow from definitions. We will consider the question of how we can make these concepts precise – or what that term even means in the context of calculus – as well as how we can communicate our mathematical ideas clearly. Specific topics that we will cover include a formal definitions of the limit, continuity, and the derivative as well as various properties and theorems involving those concepts.

We will use a method of instruction often called Inquiry Based Learning (IBL) which is designed to engage and foster skills and habits that working mathematicians use regularly; you will be asked to solve problems, make conjectures, experiment, explore, create, collaborate, and communicate your work with your peers. Rather than giving you facts to memorize or showing you clear paths to solutions, my role is to guide you via a sequence of carefully chosen problems through a journey of mathematical discovery.

Throughout the semester, you will receive lists of definitions to interpret and make sense of, as well as exercises and theorems which you and your classmates will answer or prove. There will be very little traditional lecture. Instead, class time will consist of student presentations of new material. For best results, you should come to class prepared to share your work or ideas about that day's problems. This method of inquiry does not work nearly as well if you're looking at a problem for the first time in-class.

You will be asked to share your solutions in class regularly. You will also be encouraged to critique the problems (reformulating them if needed), to generate examples and counterexamples to theorems or conjectures, to conjecture new theorems based on what you've learned, and to prove or disprove these conjectures. When observing another student's presentation, it is your responsibility to follow their argument closely and decide if they have seems reasonable. If you cannot follow their logic, or have questions about their solution, it is your responsibility to ask!

⚠ A key feature of the IBL method is student **discovery** and therefore **outside resources are not allowed.** This means that you should not consult texts (other than the one handed out in class), the internet, students not currently enrolled in the course, or faculty other than myself. Consulting outside resources will only deprive yourself of opportunities to engage with the material. You are encouraged to work with your classmates on the problems, although for best results you should get as far as you can on your own before collaborating. It's important that you do not feel overwhelmed – so please let me know if you're stuck on a problem and I'll be happy to give you hints.

3 Learning Outcomes

It will be helpful to organize the course content into

3.1 Course Learning Outcomes

1. (LO1) I can communicate mathematics orally in a clear and complete manner
2. (LO2) I can write correct and complete mathematical proofs of Real Analysis results using the conventions of mathematical writing
3. (LO3) I can independently develop correct and complete proofs of Real Analysis results
4. (LO4) I can demonstrate an understanding of the nature, approaches, and domain of mathematical inquiry.

3.2 Fundamental Learning Outcomes

- (FPT1) I can prove a result involving a supremum or infimum.
- (FPT2) I can prove a finite limit statement using the precise definition.
- (FPT3) I can prove an infinite limit statement using the precise definition.
- (FPT4) I can prove a finite limit result using the precise definition.
- (FPT5) I can prove an infinite limit result using the precise definition.
- (FPT6) I can prove a result involving a limit superior or limit inferior.

4 Student Support

Throughout the semester, I expect that you will have questions that might not get answered in class. This could happen while doing homework or reviewing your notes, for example. Or perhaps you have a question about the material that did not get fully resolved in class. For these reasons, it's important that you know how to get help outside of class.

> ⚠ Because of the inquiry method of the class, it's important that you **do not** seek assistance from outside resources – including and especially the internet!

4.1 Drop-In Student Hours

I have set aside the following specific times during the week that I am available for drop-in help. You do not need to let me know you're coming – just stop by my office (BC 270). Many students find these drop-in hours can be particularly helpful if you are working together with classmates. You can work together at one of the tables down the hall from my office and just pop in when you have questions.

- Mon, Wed 10:00-11:00
- T-Th 2:30-4:00

> ℹ Note: since I'm setting these times before the semester actually begins, these times may change if my schedule changes. If it turns out that I need to adjust them, I will let you know!

4.2 Sign-Up Hours

I recognize that your schedule might not allow you to stop by during all the posted drop-in hours. Or you might simply find it more convenient to meet with me at a different time. If you go to my Calendly scheduler, you can sign-up for a time slot to meet, either in-person or via zoom. If there is a specific time that works for you and you don't see it available on the Calendly scheduler, please reach out to me via email and we will find a time that works for your schedule.

4.3 Open Door

I have the scheduled drop-in hours simply to give you some times when you know that I'll be available – but you are **always** welcome to stop by my office **at any time**. Unless I'm in class or in a meeting, I will generally be available to meet with you!