MA 511 B, Introduction to Analysis I
Syllabus, Fall 2024

Instructor: Margaret Beck (mabeck@bu.edu)	Meetings: TR 1130-1215, R 335-425
Book: Understanding Analysis by Abbott	Prerequisite: MA 225 or equivalent
Student Hours: M 1030-12 (drop in) and R 130-3 (appointments). I would love to see you there!	

Learning Goals and Objectives: In this course you will learn both content related to analysis and also skills connected with precise and logical thinking and communication. In particular:

- *Analysis Content:* You will obtain an understanding of analysis in the context of the real numbers, including basic properties of the real numbers; sequences and series of real numbers; basic topology of the real numbers; functional limits and continuity; derivatives; and sequences and series of functions.
- *Thinking and Communication:* You will develop your problem solving skills and your ability to communicate and to evaluate precise and logical mathematical arguments, both through writing, revising, and evaluating formal mathematical proofs, and through orally communicating mathematical ideas.

Assessment and Grading: Grades for this course will be determined as follows.

	Homework	Portfolio Proofs	Midterm and Final Oral Exams	Participation
A	All except 1	At least 6	Proficient on both exams	Positive Contribution
A-	All except 1	At least 5	Proficient on one exam, approaching proficiency on the other	Positive Contribution
B+	All except 2	At least 4	Approaching proficiency on both exams, or proficient on one exam	Positive Contribution
B	All except 2	At least 3	Approaching proficiency on one exam	Positive Contribution
B-	All except 2	At least 2	Not needed	Positive Contribution
C	All except 3	At least 1	Not needed	Positive Contribution

Other plus/minus grades (eg C+, C-) will be assigned to students who fall slightly short of the above grading standards. A grade of F may be assigned to any student who does not meet the requirements for a grade of C.

- **Participation**: Since we will regularly develop ideas together as a class, regular participation (which necessitates regular attendance) is essential. *If you need to miss a class, please email me to acknowledge your absence and to provide a brief explanation why.*
- **Homework:** Homework will be due on Monday of most weeks, via Blackboard. Your homework may be handwritten. (But if you want to type it in LaTeX, that's great!) Homework will be graded mostly for completion, and as long as you make a good-faith effort to solve all the problems in a given assignment, that assignment will be deemed complete. If there are N total assignments, then you need N-1 complete for a grade of A or A-, N-2 complete for a grade of B+, B, or B-, and N-3 complete for a grade of C. *You may submit homework late if needed, but each two late assignments will increase the number of required homeworks for a given grade by 1.* For example, if you submit one assignment late it will not impact the way your final grade is determined. But if you submit two assignments late, you will need N to be complete for a grade of A or A-, N-1 complete for a grade of B+, B, or B-, etc. *If you need to submit an assignment late, please email me to let me know and to provide a brief explanation why.*
- **Portfolio Proofs:** These will be opportunities for you to select an eligible problem from the homework assignments, revise it, and turn it into a final draft that you feel represents your best work. Portfolio proofs will be determined to be achieved or not yet achieved according to this rubric. Roughly speaking, a successful proof is one that provides a clearly written and logically convincing argument that the stated result is true. You may achieve at most one portfolio proof from any given homework assignment. You will have the opportunity to turn in up to two portfolio proofs on most Thursdays. You may revise and resubmit a given portfolio proof as many times as you want, subject to the constraint that at most two portfolio proofs may be submitted on each relevant Thursday. Portfolio proofs submissions must:
    - be typeset in LaTeX;
    - clearly list the HW number and problem number for each problem submitted;
    - include one copy of the rubric for each problem submitted;
    - include a statement that indicates (i) who you worked with on the assignment and what type of input you got from them, and (ii) what resources beyond the class book and notes you used (eg internet, AI, another book, etc) and how those resources were utilized;
    - be submitted via Blackboard as a single pdf file.

  The deadlines for portfolio proof submission are firm. If you miss the deadline in a given week, you must wait until to the following week to submit your proofs, and thus lose two opportunities to submit proofs.
- **Midterm and Final Oral Exams:** The midterm oral exams will take place during the weeks of October 21 and October 28, and the final oral exams will take place during Dec 11-13 and Dec 16-17. On each exam you will receive an assessment level of proficient, approaching proficiency, or needs improvement. These exams are optional, but they are required for anyone wishing to earn a grade of B or higher. Each exam will be 30 minutes long and audio recorded, and they will be scheduled at a time that is mutually

convenient for me and the student. More details about the format of the exams will be given closer to the exam dates.

How to succeed in this course: Each of you is capable of succeeding in this course. Here are some suggestions for how to do that.

- **Embrace productive struggle.** The easy thing to do is to give up, but we rarely learn from things that are easy. Find ways to make the struggle productive. Do not immediately resort to asking someone, or the internet, for help. Your experience in the course will be much more meaningful if you figure things out on your own, and you will internatilize the knowledge much more deeply. It does not matter how quickly you learn something, but whether you ultimately get there in the end.
- **Collaborate.** Talk with your friends and classmates. Work together. Collaborating with someone who is approaching the problem in a different way can deepen your own understanding. If you are stuck, hearing someone else's perspective can often unstick you, even if they don't directly tell you the answer, and even if they are stuck too. And if you feel you understand something, it is not a waste of time to help someone else who is stuck. Teaching others is a way to check whether or not you truely understand something.
- **Ask for help when you need it.** It is ok to need help, especially after you have tried to embrace the productive struggle. We all need help sometimes. Ask your friends and classmates for help. Be kind to yourself and each other. Come to office hours; I want you to have a good experience in this course and I would be happy to help.
- **Don't wait until the last minute.** The material we discuss will build progressively throughout the semester. If you are confused about a topic we discuss, sort that confusion out soon, ideally before we move too far forward on to additional topics. Also, don't wait until the end of the semester to start submitting portfolio proofs, because then you lose valuable opportunities for feedback and revision.
- **Some advice from students who have taken MA 511 in the past:** "Make sure you pay close attention to what definitions are saying in the beginning of the semester. A lot of analysis depends on understanding earlier concepts taught in the course." "Initially learning the 'language' of proofs is going to be hard, but trust yourself to keep trying and going at it until it clicks." "Stay positive and try to force yourself to develop your way of proving a problem before seeking for help from professor/tutors/peers." "Stay on top of the homeworks and regularly review old content. Going over old stuff often leads to deeper understandings."

What to do when you don't know what to do: If you are feeling stuck, here are some suggestions for working productively through your struggle.

- **Work out some examples**. If the problem is asking you to prove an abstract result, make it more concrete. If it is asking you to prove something about a bounded set, try to first consider the case of an interval of the form [a,b]. If the result is about a sequence that satisfies some general assumptions, write down a specific example sequence that

satisfies the assumptions. Why is the result true for that example sequence? Once you understand some examples, you can return to thinking about the general case or more abstract setting.

- **Have you see a similar problem?** If the result is asking you to prove something in an abstract setting, have you already proven something similar for a particular example? Or maybe you have essentially thought about the problem in calculus, and now what you need to do is to make that calculus calculation rigorous.
- **Do some calculations; focus on your intuition.** Temporarily forget about writing a proof. Just think about why the result should (or shouldn't) be true. What steps have lead you to that conclusion? Once you have an outline of the key steps, you can go back and work on making them rigorous, and turn your outline into a formal proof (or into a counterexample).
- **Talk with someone.** Collaborate, and ask for help when you need it.

Classroom environment: I hope that all students in this course feel it is in an environment in which they can productively learn. Diversity of background (including, but not limited to: race, gender, ethnicity, sexual orientation, age, socioeconomic status, religion, ability) is an asset. Diversity of ideas makes our ability to do mathematics stronger. See this article, which shows that "Being around people who are different from us makes us more creative, more diligent and harder-working." It is extremely important that all members of our classroom community feel welcomed and respected. If there are any ways I can help facilitate this, I welcome that feedback. I hope that each student feels comfortable letting me know if they feel that their learning is being adversely affected by any experiences, inside or outside of class.

With this in mind, I would like to acknowledge and emphasize:

- As Francis Su eloquently put it in The Lesson of Grace in Teaching, each of you is a valuable human, regardless of what your accomplishments may or may not be.
- Frederico Ardila's Axioms: Axiom 1) Mathematical potential is distributed equally among different groups, irrespective of geographic, demographic, and economic boundaries. Axiom 2) Everyone can have joyful, meaningful, and empowering mathematical experiences. Axiom 3) Mathematics is a powerful, malleable tool that can be shaped and used differently by various communities to serve their needs. Axiom 4) Every student deserves to be treated with dignity and respect.
- Labels like "good at math" are problematic. Each of us is capable of learning analysis in a deep and meaningful way. As explained in The Secret to Raising Smart Kids by Carol S. Dweck, "a focus on 'process' - not on intelligence or ability - is key to success."

You are always welcome to tell me your preferred name and/or pronouns at any time.

Accessibility Resources and Other Types of Support: A variety of support resources exist on BU's campus.

- **Accessibility:** BU's Disability and Access Services can provide services and support to ensure that students are able to access and participate in the opportunities available at Boston University. Please reach out to them if you need any additional support or accommodations. Please also feel free to reach out directly to me with requests for support and accommodation, regardless of whether or not you are in touch with the Disability and Access Services office.
- **Student hours:** Please come to student hours! I welcome the opportunity to get to know students outside of class. I want you to have a great experience in this course and I am happy to help.
- **Tutoring Room in the Department of Mathematics and Statistics:** The tutoring room is staffed by graduate students and provides drop-in help for students enrolled in any of our courses. Different tutors have different backgrounds and areas of expertise, so I recommend that you consult not only the schedule but also the list of tutoring expertise to find a time when a tutor with an appropriate background in analysis will be available.
- **Peer tutoring at the Educational Resource Center (ERC):** The ERC Peer Tutoring program provides BU students an opportunity to meet with a fellow student and ask questions related to their course material. These services are free to all BU students.
- **Mental Health and Wellness:** Additional types of support that you may find helpful can be found on the Academic Help and Wellness page of the Department of Mathematics and Statistics.

Academic Integrity and Tech Policies: I trust that you are all aware of BU's academic conduct code. I hope and expect that you will all uphold it. I would like to highlight two key expectations I have for each student.

- Be honest with yourself and others about when you do not understand something. There is no shame in needing help with any aspect of this course.
- Do not present the work of anyone else (human or otherwise) as your own. It is natural in mathematics to collaborate with others, but you must acknowledge your collaborators, only write up ideas that you genuinely understand yourself, and those ideas should be written in your own words.

Regarding the use of AI, like ChatGPT, and the use of other online resources like Chegg, MathOverflow, etc: Using these services to directly complete your work for this course will significantly compromise your learning. However, there are productive ways to utilize online resources. Here are some examples:

- Looking up definitions, theorems, etc, if for some reason you are not able to access our book in that moment, or if you would like a complementary persepctive on the topic.
- Looking up LaTeX commands and debugging LaTeX code. You can even ask things like ChatGPT to generate LaTeX code for you. Just be aware that the code it generates might not be very good. But, nevertheless, it could be a good starting point for you.
- Asking things like ChatGPT to prove results that we have already proven in class, or results for which a proof exists in the book, and then trying to determine yourself if the proof is correct. This is a great way to practice your ability to detect errors or logical

inconsistencies in proofs. Some proofs I've tried in this way come out essentially perfect, but sometimes there are unexpected, and often interesting, errors.

Regarding the use of cell phones, tablets, and laptops in class: Although there are many positive ways to use these devices (like note taking, typing up work in LaTeX, etc), there are also studies that show that using such devices for non-academic purposes leads to reduced long-term retention of in-class material, such as lower performance on exams. So I strongly encouage you to limit your device use to only academic purposes that are necessary for our class.