Math 317: Analysis I

Fall 2017

1. Technical Information

Instructor: Josh Sabloff (jsabloff@haverford.edu)
Class Times: MWF 10:30–11:30 or MWF 11:30-12:30 and one (optional but highly recommended) discussion hour scheduled through the registrar.
Text: Abbott, *Understanding Analysis*, 2e.
Office Hours: M 1-3:30, Tu 1-4, F 1-2

2. Goals of the Course

When you first took calculus, there were probably many things that you understood at a mostly intuitive level — like limits[1] or the fact that a function with a positive derivative is increasing — or believed because your teacher or the book told you they were true — like the Mean Value Theorem[2] or the Fundamental Theorem of Calculus. In this course, you will take a more serious look at calculus, turning intuitive notions into rigorous definitions, proving theorems you had taken for granted, and building up an abstract framework in which to understand it all.

To this end, we will need to do two things. First, we will cover the following mathematical content:

- What are the real numbers, really? What is a limit? We will also apply this knowledge to infinite series.
- The topology of Euclidean space (the real line, the plane, 3-space, etc.) as a framework for understanding properties of functions.
- Continuous functions and their properties, especially the Extreme Value Theorem and the Intermediate Value Theorem.
- Differentiation and (Riemann) integration, including the Mean Value Theorem and the Fundamental Theorem of Calculus.

Second, in order to productively grapple with mathematical ideas, you need to learn how to better understand and use the language of mathematics. The process of internalizing this language and developing the skills necessary to shape it into correct and convincing proofs will be ongoing throughout your undergraduate career. We will explicitly discuss how to make sense of mathematical definitions and statements through careful analysis and construction of examples; we will also work through strategies and techniques by which proofs can be analyzed and constructed.

This will be a demanding course. Expect to spend ***at the very least*** *6–8 hours per week outside of class on homework.*

[1] Sure, you might have *seen* the definition of the limit, but you probably didn't work with it or seriously use it again later in the course.

[2] This seems to be vanishing from the calculus curriculum, but underlies much of analysis.

3. Course Structure

3.1. **Class Time and Reading Assignments.** I expect that you will have read the relevant section(s) of the text before coming to class. After every class, I will post the relevant sections for the next class along with a discussion question or two, which could range from a conceptual question about the material to a question about why the author chose to present the mathematics in a certain way.

Class time will be a mix of interactive lecture and discussion (some in small groups, some as a whole class). During the lecture portions, I will rely on the fact that you have read the section, but I will not assume that you have completely absorbed it.

3.2. **Weekly Problem Sets.** Weekly problem sets are due online by 10:30a on Wednesday. The problem sets are divided up into two parts; each should be turned in to separate "folders" on Moodle. Each part will have three problems; your assignment is to turn in *five of the six problems*. There will also be an occasional *challenge problem*. Each problem will be graded on a 4-point scale. The grading scale is:

- **4 points:** A completely correct solution of the problem. Exposition of the solution must be clear (the notation and logic in the details makes sense without too much effort on the reader's part) *and* well-structured (the reader is always aware what is being proven and how the details relate to the problem as a whole) *and* stylistically correct (a proof is a written argument, and as such, it should adhere to the rules of standard English grammar — in particular, this means that you should be writing in complete sentences!). You should aim the level of exposition so that a fellow-student can understand it.
- **3 points:** The solution demonstrates a good understanding of the problem, but some minor details are incorrect or missing *or* a completely correct solution of the problem whose exposition is lacking the elements discussed above.
- **2 points:** The solution is incorrect due to a significant error, but a not unreasonable strategy for solving the problem is in place.
- **1 points:** The beginnings of some good ideas are in the solution.
- **0 points:** No coherent or serious attempt at a solution given.

When available, you can replace one of the regular problems with a challenge problem. These problems will be graded on the same scale as the regular problems, but if you get all four points, you will get two bonus points that can be applied to offset points missed on the current homework assignment. However, you cannot get more than 20 points on any given problem set. Thus, attempting challenge problems is highly encouraged, but not strictly required.

There will also be a one-point bonus per problem set for using LaTeX to type your solutions. I will provide a LaTeX template for every problem set. Again, the bonus point can only compensate for missed points; that is, you cannot get over 20 points on a problem set.

The best way to do well in this course is to keep up with the reading and problem sets (even if you do not finish every problem). Nevertheless, your schedule can sometimes get crazy, so I will accept one late homework assignment up to the Friday after the original due date without penalty, so long as you inform me on Wednesday.[3] Other late homework will be subject to a 50% penalty. Solutions will be posted Monday afternoons, so I will not accept homework for grading after that (though I will be happy to comment on your problems).

3.3. **Collaboration.** Collaboration on homework — whether in the MQC, in office hours, or on your own — is encouraged, but should be approached carefully. There is a fine balance between learning from working with your fellow students and finding your own way through the material. You must indicate on your homework who your collaborators were (you may note different collaborators on different problems!), and you should follow these guidelines in your collaborations and write-ups:

- You must work on the problems on your own before talking with your collaborators. *Use white paper.*
- Bring your ideas to your collaborators. If you don't have any ideas to bring for a problem — though note that even knowing where to start, what you need to do to solve the problem, or having a vague idea about how the solution should go is an "idea" — then you should wait until you do before collaborating on that particular problem. *Use colored paper, a chalk board, or a white board; the same applies when you discuss problems with me.*
- The actual write-up of your homework assignment should be done with all colored paper put away and out of sight of any black/whiteboards used during collaboration so as to reflect your *own* understanding of the problem. If you cannot write up the solution without wanting to refer to your collaboration material, then you probably have not yet understood the problem. In that case, throw out your solution, work further on your own, and then start the collaboration process again.

So as to ensure productive collaborative work, you should not be working in groups larger than four people on any given problem at any given time. Two- or three-person groups are better than four. *Large groups of people "working together" are not really working together.*

Note that you are not allowed to use materials aside from the text, materials from Moodle, reserves in the library, and, of course, class notes in this course unless I give express permission.

4. Exams

There will be two midterm exams and a final exam. Each of the two midterms will be in place of a homework assignment, and will consist of two parts (one timed

[3]It is not necessary to use this extension when dealing with a *serious* illness (sniffles don't count), a family emergency, or a religious obligation. Please contact me as early as possible in case of any of these events.

and closed-book, one untimed and open book), with the second part weighted more heavily than the first.

The final exam will have a similar format, with Part I referring only to material since the second midterm and Part II being cumulative.

Of course, collaboration is not allowed on exams.

5. Grading

Your grade for the course is determined by:

Homework: 30%
Midterms (2): 20% each
Final: 30 %

6. Resources

Haverford College is committed to supporting the learning process for all students. Please contact me as soon as possible if you are having difficulties in the course. There are also many resources on campus available to you as a student, including the Office of Academic Resources (`https://www.haverford.edu/oar/`) and the Office of Access and Disability Services (`https://www.haverford.edu/access-and-disability-services/`). If you think you may need accommodations because of a disability, you should contact Access and Disability Services at `hc-ads@haverford.edu`. If you have already been approved to receive academic accommodations and would like to request accommodations in this course because of a disability, please meet with me privately at the beginning of the semester (ideally within the first two weeks) with your verification letter.