



# MATH 301: Real Analysis

Fall 2019

Mt. Holyoke College

## Course Information:

Lecture Times: MWF, 11:00 AM–12:15 PM

Lecture Location: 218 Clapp Lab

## Instructor:

Nathan Gray

Office: 417 Clapp Lab

Office Hours: TBA

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**Prerequisites:** Passing grades in MATH 211 and MATH 232—which includes previous exposure to reading and writing proofs—are required.

**Textbook (required):** *Understanding Analysis*, 2nd ed., Stephen Abbott, Springer, 2015.\* We plan to cover as much of chapters 1–6 (and hopefully 7) that time will permit.

**Course Description:** This course is an introduction to real analysis, a fundamental language for much of modern mathematics.

We will begin by exploring basic properties of the real numbers. We will assume only the most basic properties of the natural numbers (i.e., the numbers  $1, 2, 3, \dots$ ) and then extend things to the real numbers. After studying the handful of axioms that are needed in order to characterize the reals, we will turn to some fundamental notions of analysis, such as distance, neighborhoods, open sets, and closed sets. These notions will allow us to establish a rigorous idea of what it means for a function to have a limit or be continuous. Before discussing such aspects of functions, however, we will need to spend a few weeks studying sequences and series of real numbers.

After discussing continuity, we will then study differentiability as well as some related theorems often seen in first-semester calculus. Near the end of the semester, we will study sequences and series of functions (not numbers), and then (time permitting) we will define the Riemann integral and study its properties.

Even though much of the material will be familiar to students, we will study the material at a much deeper level, emphasizing mathematical rigor.

In summary, the course topics include: cardinality and countability; completeness of the real numbers; sequences and series of real numbers; continuity, uniform continuity, and differentiability of real-valued functions; sequences and series of real-valued functions. Time permitting, we will discuss the Riemann integral and metric spaces.

## Homework, Quizzes, Exams:

*Homework:* There will be (almost) weekly homework assignments. The two lowest homework grades will be dropped at the end of the semester.

Students are expected to complete the assignments on their own. However, collaboration with classmates *before the write-up* is acceptable and encouraged, as long as each student writes and submits their own work. Collaboration during the write-up stage of an assignment, or handing in an assignment that is identical to a fellow classmate's work, is cheating and may result in a grade of zero for the assignment.

\*A free PDF version of Abbott's book will be posted on the Moodle course site.

**Quizzes:** There will be an in-class quiz every Monday. Each quiz will cover definitions and named theorems from the previous week; any additional quiz topics will be mentioned in the previous lecture. The two lowest quiz grades will be dropped at the end of the semester.

**Exams:** There will be two midterm exams (part in-class, part take-home) and a final exam (part self-scheduled, part take-home). Rules regarding the take-home portions will be announced in lecture. The dates of the exams are:

- Exam 1: Friday, Oct. 11
- Exam 2: Friday, Nov. 15
- Final Exam: Thursday, Dec. 13–Monday, Dec. 17.

**Grading Policy:** Every student's grades are a reflection of the student's mastery of the course material and the student's ability to communicate that mastery through written work.

Course grades will be based on homework, quizzes, and exams. Table 1 gives the weights of these grade items. Students may check their grades on the course Moodle site throughout the semester. **Warning: The grades displayed on Moodle are raw scores.**

Earning 90%, 80%, and 70% of the total points in the course will result in course letter grades *no stricter than* A–, B–, and C–, respectively. The boundaries (cut-offs) between letter grades may be relaxed at the instructor's discretion, depending on the distribution of course numeric grades. This grading scheme rewards hard work, leaving little room for miraculous recovery.

**Table 1.** Course Grades

Category	Grade Basis	Weight (each)	Weight (total)
Homework	lowest two dropped		20%
Quizzes	lowest two dropped		15%
Exams (×2)		20%	40%
Final Exam		25%	25%

**Course Load:** Mt. Holyoke College complies with federal regulations defining a credit hour. For this course, MHC expects all students to have 12 hours per week of academic engaged time throughout the semester; besides lectures, this weekly time amounts to **9 hours of additional academic work**.

**Course Help:** Studying mathematics, especially at the 300-level, can be difficult. Here is some advice:

- Read the relevant material in the textbook before lecture. Try to read and understand every statement mentioned in all of the examples and proofs. Reread the same material after lecture. Then begin the homework assignment.
- Work on every homework assignment *on your own* for the first few days that it is assigned. During this period, you should not be discussing your solutions with others. Once you have completed all that you can, spend the last day or two discussing your solutions with one or more classmates to get further help. Your goal is to understand and write out every homework problem.
- **Do not search for homework solutions online.** This creates a dangerous habit; it also violates the MHC Honor Code.
- Attend office hours.
- Watch relevant videos online.\*

**Schedule:** A tentative schedule can be found on the course Moodle site. Students should consult the schedule and read the relevant material *before* it is presented in lecture. The schedule will be updated frequently.

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\*There are excellent video resources available for free.

**Attendance, Make-Up Policy:** Students should understand the importance of attending lectures and doing the assigned work. Some remarks:

- A student who misses a lecture is responsible for any announcements made during that time, and they should consult a classmate to determine what they missed. The instructor will *ignore* emails that are of the form, “I had to miss class today. What did you cover?”
- Late homework is *not* accepted.
- A legitimate absence due to a recognized MHC-related activity, a religious holiday, a verifiable illness, or an emergency will be reviewed on an individual basis. If a student must miss an exam, they must obtain permission from the instructor in advance.

**Electronics/Technology Policy:** All electronic devices are banned from use during quizzes and exams.

**Disability Accommodations:** Mt. Holyoke College is committed to providing equitable access to learning opportunities for all students. If you have a disability and seek accommodations, please make an appointment with the instructor within the first two weeks of the semester so that appropriate arrangements can be made; documentation from the AccessAbility Services Office is required. You can contact AccessAbility Services in Mary Lyon Hall, or at [accessability-services@mtholyoke.edu](mailto:accessability-services@mtholyoke.edu), or at (413) 538-2634.

**Scholastic Dishonesty:** This includes: cheating on exams or quizzes; taking or using past/present exam materials without instructor permission; submitting false or incomplete records of academic achievement; acting alone or in cooperation with another to falsify records or to obtain grades dishonestly. ***All students are expected to follow the Honor Code.*** If it is determined that a student has cheated, they may be given a grade of F for the course and may face additional sanctions from MHC.