

MATH 171: Fundamental Concepts of Analysis

SYLLABUS

Official Course Description: Recommended for Mathematics majors and required of honors Mathematics majors. Similar to 115 but altered content and more theoretical orientation. Properties of Riemann integrals, continuous functions and convergence in metric spaces; compact metric spaces, basic point set topology.

Teaching Staff:

Instructor: Dr. Laura Fredrickson
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WEBPAGE: web.stanford.edu/~ljfred4/
OFFICE: 380-382L
OFFICE HOURS: Tu 11:50-1:20pm

Course Assistant: Calista Bernard
E-MAIL: calista@stanford.edu
OFFICE: 380-380R
OFFICE HOURS: M 1:15-3:15pm; W 4-6pm.

Lecture: TuTh 10:30-11:50am | 380-380X

Exams: There will be one midterm exam, taken in class. The final is comprehensive.

Midterm: Tuesday, May 14 (in class)

Final: Monday, June 10 from 12:15-3:15pm in 380-380Y

Prerequisites: Math 61CM or 61DM or 115 or consent of the instructor

Textbook: (Required) *Foundations of Mathematical Analysis*, by Richard Johnsonbaugh and W.E. Pfaffenberger, Dover 2010 edition (ISBN: 0486477665)

I also recommend the following four references: Stephen Abbott's *Understanding Analysis* is well-written and typically a little easier than our textbook. Charles Pugh's *Real Mathematical Analysis* was written based on an honors real analysis course at UC Berkeley. Walter Rudin's *Principles of Mathematical Analysis* (colloquially called "Baby Rudin") is classic. Lastly, *Counterexamples in Analysis* by Gelbaum and Olmsted is a useful reference. If you're trying to understand why a hypothesis in a theorem is necessary, knowing a counterexample is illuminating. PDFs of these four texts are available legally online through the Stanford Library.

Course website: Course announcements, homework, solutions will be posted on Canvas. Additionally, the syllabus will be posted on my website <http://web.stanford.edu/~ljfred4/>.

Campuswire: We'll have a class discussion forum on [Campuswire](#). This is a great place to ask (and answer) questions about the homework. Generally, please post homework questions here (rather than e-mailing your Instructor or CA). A classmate of yours may have the same question as you, and another classmate might have an answer. Your CA and Instructor will check the site daily (Monday-Friday), and answer your questions (or endorse your answers).

Grading Policy: On all work, your grade will be computed as a percentage: the number of points

you earned divided by the number of points possible. The weekly homework and exams are weighted as follows:

- Homework: 30% (lowest score dropped)
- Writing Assignment: 10%
- Midterm: 25%
- Final: 35%

Your letter grade will be given based on your numerical average earned in the class, on a scale not stricter than the following: you are guaranteed a D for 60.0 or above, C- for 70.0 or above, C for 73.0 or above, C+ for 77.0 or above, B- for 80.0 or above, B for 83.0 or above, B+ for 87.0 or above, A- for 90.0 or above, and an A for 93.0 or above.

E-mail: If you send me an e-mail, you can expect 24-hour turn-around on school days.

Homework: Weekly homework assignments are due in class on Thursday. Alternatively, you can turn them in to the instructor's mailbox by **10:20am** on Thursday. The assignments will be posted on Canvas by the previous Wednesday.

The lowest score will be dropped to accommodate exceptional situations such as a serious illness. Because the lowest score is dropped, you can miss one assignment without penalty. No late homework will be accepted, and no make-up homework will be given.

You may hand write your solutions. However, you are encouraged to consider typing your solutions with LaTeX. (Note: You will be required to typeset the WIM assignment). Proofs should be readable and well-explained. E.g., you should try to use complete sentences, insert explanations, and err on the side of writing out "for all," etc. rather than using the symbol. Professor Keith Conrad at the University of Connecticut has written a helpful guide to common errors in mathematical writing: <http://www.math.uconn.edu/~kconrad/math216/mathwriting.pdf>.

I encourage you to form study groups and work together. A good strategy is to try each problem yourself first, then get together with others to discuss your solutions and questions, and finally *you should write up the solutions by yourself*. (The Honor Code applies to this and all other written aspects of the course.)

Writing Assignment: Clear writing is an important part of mathematical communication, and is an important part of our course. The broad idea of this assignment is to write a clear exposition of a specific mathematical topic detailed in the assignment beyond what we have covered in class, which is accessible to someone at a similar stage in a similar class. The writing assignment will be posted by the end of the fourth week, and is due at the beginning of the final exam.

Alternate Sitting for the Midterm Exam: In exceptional circumstances, and by *prearrangement only*, you may take the midterm exam at a fixed alternate time. The alternate sitting will always occur *before* the standard sitting for the exam. To arrange an alternate sitting you must e-mail me at least two weeks before the midterm.

Final Exam Policy: (See registrar.stanford.edu/students/final-exams.)

- Students must not register for classes with conflicting end-quarter exams.
- Alternative arrangements for the final may only be made for the following unforeseen circumstances: illness, personal emergency, or the student's required participation in special events (for example, athletic championships) approved as exceptions by the Committee on Undergraduate Standards and Policy (C-USP).

Schedule: This course is structured with the expectation that you will attend every lecture. Of course, sometimes an absence is necessary. In such a situation, you should contact a classmate to get notes and other information for the class you missed.

We will have 18 lectures in total. We will cover approximately chapters I-X of the book. Thematically, the content we will cover falls into three areas:

- **Real numbers, sequences, limits, series, functions.** Much of this will be familiar to you already, and we will not cover it in detail.
- **Metric spaces.** Completeness, compactness. Introduction to topological spaces.
- **Integration.** The Riemann integral. Introduction to the Lebesgue integral.

Here is a tentative schedule, which may be adjusted as the quarter goes on.

4/2, 4	Real numbers and the axioms; sequences, limits, the relation between monotonicity, boundedness and convergence; Bolzano-Weierstrass Theorem; lim sup and lim inf. (JP Section 3-6, 10-21, S-pre Chap 1-2)
4/9, 11	Countable and uncountable sets; series; tests for convergence; absolute convergence versus conditional convergence; rearrangement of series. (JP Section 9, 22-28, S-pre Chap 3, 6)
4/16, 18	Power series and their radius of convergence; tests for convergence; Cauchy sequences in \mathbb{R} ; continuity of functions; introduction to metric spaces. (S-pre Chap 4-5, S-pre 30-33, 35)
4/23, 25	Examples of metric spaces; sequences in metric spaces; open and closed sets; continuous functions on metric spaces. (JP 36-40)
4/30, 5/2	Continuous functions on metric spaces; relative metrics. (JP 40-41)
5/7, 9	Compactness; Heine-Borel theorem on \mathbb{R} ; real-valued continuous functions on compact spaces; sequential compactness; equivalence of norms on \mathbb{R}^n ; Continuous functions on compact spaces; image and inverse (if it exists). (JP 42-44, JP 34)
5/14	Midterm
5/16	Complete metric spaces. (JP 46)
5/21, 23	Relations between compact/closed/completeness; step functions, Lebesgue measure zero sets; Lebesgue integral. (JP 57, 87-88, S-int 1,3)
5/28, 30	Convergence of step functions; Lebesgue integrals; convergence theorems. (S-int 3-4), Construction of L^1 and L^2 space; completeness; review. (S-int 5)
6/4	Review

(JP refers to our textbook. “S-pre” and “S-int” refer respectively to lecture notes by Prof. Leon Simon which are posted on Canvas as “Simon-preliminary.pdf” and “Simon-integration.pdf.”)

Students with Documented Disabilities: Students who may need an academic accommodation based on the impact of a disability must initiate the request with the Office of Accessible Education

(OAE). Professional staff will evaluate the request with required documentation, recommend reasonable accommodations, and prepare an Accommodation Letter for faculty dated in the current quarter in which the request is made. Students should contact the OAE *by the end of the first week of the quarter*, since timely notice is needed to coordinate accommodations. The OAE is located at 563 Salvatierra Walk (723-1066, studentaffairs.stanford.edu).

Textbook and other Resources: The primary textbook is *Foundations of Mathematical Analysis*, by Johnsonbaugh and Pfaffenberger. The textbook is of high quality, and you should read it. This does not mean that it is “easy” to read. Math books are quite demanding on the reader, owing to the intrinsic difficulty of the material, so do not be surprised if you have to go slowly.

You are encouraged to attend the office hours provided by the instructor and course assistant.

Another resource which may be of use is Counseling and Psychological Services. See vaden.stanford.edu/caps-and-wellness.

Academic Integrity: The Honor Code articulates Stanford University’s expectations of students and faculty in establishing and maintaining the highest standards in academic work. Examples of conduct that have been regarded as being in violation of the Honor Code (and are most relevant for this course) include copying from another’s examination paper or allowing another to copy from one’s own paper; plagiarism; revising and resubmitting an exam for regrading, without the instructor’s knowledge and consent; representing as one’s own work the work of another; and giving or receiving aid on an academic assignment under circumstances in which a reasonable person should have known that such aid was not permitted. See communitystandards.stanford.edu for more information on the Honor Code.

Important Dates:

First Day of Classes	April 1, 2019
Add/Drop Deadline	April 19
Midterm Exam (in class)	May 14
Course Withdrawal & Change of Grading Basis Deadlines	May 24
Last Day of Classes, Last Day to Arrange an Incomplete	June 5
Final Exam	Monday, June 10 (12:15-3:15pm)