Math 44500: Foundations of Analysis II (Class No: 10009)

Meets: TuTh 4:30–5:45p in LD 002
Final Exam: Tuesday, May 5, 3:30–5:30p

Instructor: Carl Cowen **Office:** LD 224P **Phone:** 278-8846
Office Hours: TuTh 10:00-11:00, Th 3:00-4:00, or by appointment
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General Information and Goals

Math 44400 and Math 44500 together form a foundation for analysis, both as a rigorous treatment of many topics in calculus and as an introduction to the mathematical area of analysis generally and the analysis of real-valued functions of a real variable specifically. Many of the topics in these courses came about in response to deepening understanding of the subject over the course of the decades following the development of calculus to the formalization of many of the basic ideas at the end of the 19th century. This formalization formed an important backdrop and motivation for the changing view of rigor and the foundations of mathematics generally that were important in 20th century mathematics. Real analysis, including much of the material of these courses, is at the heart of much of modern mathematics and forms essential background for the understanding of these subjects and their applications in other parts of analysis, differential equations, probability and statistics, dynamical systems, mathematical physics, computational and applied mathematics, as well as subjects such as engineering, economics, physics, and biology that depend on mathematics. Math 44500 is a sequel to Math 44400; it is more abstract than Math 44400 and it both fills in some gaps and extends the ideas of Math 44400. Many graduate programs in mathematics or statistics, and sometimes other areas, expect students to know the material in both Math 44400 and 44500.

Math 44400 and 44500 form a *two-course sequence* and two such *two-course sequences* are required for both "Pure Math" and "Applied Math" majors, but there are about a dozen others that can be used also.

The official text will be either of the 3rd or 4th editions of

Text: *Introduction to Real Analysis*, by Robert G. Bartle and Donald R. Sherbert, Wiley, 2^{nd} Edition (1991), 3^{rd} Edition (2000), 4^{th} Edition (2011)

These can be purchased or ordered from the IUPUI bookstore, *Amazon*, or other booksellers. In addition, we will probably cover other topics not in either of these books on measure theory and the foundations of Lebesgue integration, topics studied in more depth in graduate courses in analysis in most mathematics graduate programs.

Reading and writing are important skills for life, including mathematics, and they will be important in this class as well. In your homework, your writing will be graded for spelling, grammar, and clarity of exposition as well as for mathematical correctness. In tests, writing is also important, but will not be as much of a focus as for the homework.

Reading will be an active part of this course as well. Reading assignments will be given and *your reactions to the reading assignments will be due by email by 3:00pm of the day specified in the assignment.* The tests and the final exam may also include readings that are related to the material of the course and questions concerning the readings will be part of the test.

Conversations about this mathematics will help facilitate your learning in the course, so occasional attendance at office hours is encouraged.

The topics covered in this course will be covered, although not necessarily in the same way or in the same depth, by almost any book whose title is "Real Analysis", for example, the books listed below. Those on reserve in the library are marked with "(∗)".

(∗) *Introduction to Real Analysis*, by Robert G. Bartle and Donald R. Sherbert, Wiley, 3^{rd} Edition (2000) and 1^{st} Edition (1982)

(∗) *The Elements of Real Analysis*, by Robert G. Bartle, Wiley, 2^{nd} Edition (1976)

(∗) *Real Analysis and Foundations*, by Steven G. Krantz, 3^{rd} Edition (2014)

(∗) *Real Analysis*, by H. L. Royden, 2^{nd} Edition (1988)

- *Closer and Closer: Introducing Real Analysis*, by Carol Schumacher, (2007)
- *Introduction to Real Analysis*, by William Trench, (2002) (Available FREE(!) on web)
- *Principles of Mathematical Analysis*, by Walter Rudin, 3^{rd} Edition (1976)
- *Understanding Real Analysis*, by Paul Zorn, (2010)

Homework, Test, Exam, and Grading Policies

In addition to the comprehensive Final Exam on May 5, there will be 2 tests during the semester.

Grades for the course will be based on the responses to the reading assignments (approximately 10%), written homework (approximately 20%), two midterm tests (approximately 20% each), and the comprehensive final examination (approximately 30%). Late homework assignments may be handed in for feedback if you wish, but they will be recorded in the gradebook as 0's and similarly, late reactions to the reading assignments will be read and may be commented on, but will be recorded as 0's. However, the lowest two homeworks and the lowest two reactions to the readings will be dropped before computing the final grades. Each homework assignment will be worth the same number of points and the reactions to the readings will be rated as *not returned or insubstantial response* (0 points), *fair* (1 point), or *good* (2 points).

In addition, there will a list of special problems, the *'A' List*, of longer, more interesting, and perhaps harder problems than those in the usual homework. Problems from this list may be handed in at any time before 5:00pm on May 7. The problems will be read and either accepted as correct or returned for rewriting and resubmission. Only one of these problems will be counted for credit but this problem will be worth the same number of points as two regular homework assignments. In order to receive an 'A' or 'A+' for the course, you must have one of the *'A' List* problems accepted as correct. Problems will be added to this list as the semester progresses.

General Academic Policies

The work you submit for homework, tests, and the final exam must be your own. During tests and the final exam, no electronic devices, including calculators and cell phones, may be powered up or even visible and no books or notes are permitted. The ending time for tests will be announced in advance; your test must be handed in when you first leave the test room or at the announced ending time, whichever is sooner.

For homework, you will probably find it beneficial to consult with other students about the material and this kind of conversation and collaboration is encouraged. At the end of the consultation, however, each participant should prepare their own summary of the discussion and their own solutions to the problems because that will be required on quizzes and tests. The policies for this class will be those derived from IUPUI's policies on academic conduct and adaptive services. More information about IUPUI course policies can be found at

`http://registrar.iupui.edu/course_policies.html` All students involved in a particular event of dishonesty will receive a zero on the item involved; a second infraction by an individual would usually mean receiving an 'F' for the course.

Students needing accommodations because of a disability will need to register with Adaptive Educational Services (AES) and complete the appropriate forms issued by AES before accommodations will be given. The AES office is located in Taylor Hall, UC 100. You can also reach the office by calling 274-3241. Visit `http://aes.iupui.edu/` for more information.

Administrative Withdrawal: A basic requirement of this course is that you will participate in all class meetings and conscientiously complete all required course activities and assignments. Keep in touch with me if you are unable to attend, participate, or complete an assignment on time. If you miss more than half of the required activities within the first 25% of the course without contacting me, you may be administratively withdrawn from this course. Example: Our course meets twice per week; thus if you miss more than four classes in the first four weeks, you may be withdrawn. Administrative withdrawal may have academic, financial, and financial aid implications. Administrative withdrawal will take place after the full refund period, and if you are administratively withdrawn from the course you will not be eligible for a tuition refund. If you have questions about the administrative withdrawal policy at any point during the semester, please contact me or check `http://registrar.iupui.edu/withdrawal-policy.html`.

This semester, I will be using the FLAGS System to provide real-time feedback on your performance in this course. Periodically throughout the semester I will be entering data on factors such as your class attendance, participation, and success with coursework, among other things. This information will provide feedback on how you are faring in the course and offer you suggestions on how you might be able to improve your performance. You will be able to access this information in the student center:

Onestart >Student Services page>Student Center>My Academics and Grades>My Grades

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Some Important Dates

January 12	First day of classes
January 18	Last day to withdraw with no record
January 19	Martin Luther King Day, no classes
March 15	Last day to withdraw with automatic "W" (with permission of advisor)
March 16-22	Spring Break!! no classes
April 17	Last day (5pm) to withdraw (requires permission of advisor and instructor)
April 30	Last Math 44500 class
May 5	Final Exam, 3:30p – 5:30p

Approximate Course Outline

Section numbers refer to *Introduction to Real Analysis* by Bartle & Sherbert, 4^{th} Edition.

Section	*Topic*	*Lectures*
4.3	Some extensions of the limit concept	3
6.3	L'Hôpital's Rules	1
7.1,2	Riemann integration	3
7.3	Fundamental Theorem of Calculus	2
7.5	Approximate Integration	2
	Midterm Test I (late February)	
8.1,2	Sequences of functions	3
8.3	Exponential and logarithmic functions	2
9.1-3	Infinite series	3
9.4	Series of functions, power series	1
	Midterm Test II (late March)	
9.4	Series of functions, power series	2
(hand-outs?)	Sets of measure zero	2
(hand-outs?)	Introduction to Lebesgue integration	2
	Review	1
	Final Exam (Tuesday, May 5, 3:30–5:30p)	