

Math.520.001 Introduction to Real Analysis 1

Fall 2011 Course Information

This is an overview. For more specifics see the [detailed information page](#).

Teacher Info

Dan Kalman

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Office Hours: MW 2 - 3PM, TuTh 12 - 2PM,
plus appointment or drop in. See schedule
at right.

*Feel free to phone my office anytime, make
an appointment, drop in, or send me an email*

Course Info

Text: [Elementary Analysis: The Theory of
Calculus](#) by Kenneth A. Ross, published by
Springer

Grades:

Final Exam - 20%,
2 in-class exams - 20% each,
course portfolio - 40%

Course Webpage: Go to www.dankalman.net
and click the link for *Introduction to
Analysis I*

Class Meets: MW 6:45 - 8:00 PM

Dan Kalman

Fall '11 Schedule

	MON	TUES	WED	THUR	FRI
12:00		Office Hours		Office Hours	
1:00		Office Hours		Office Hours	
2:00	Office Hours		Office Hours		
3:00				Seminars, Teas & Dept Meetings	
4:00	Math 154 Great Ideas		Math 154 Great Ideas	Math 154 Great Ideas	
5:00					
6:00					
7:00	Math 520 Intro to anal		Math 520 Intro to anal		
8:00					

Homework

Homework will be assigned for every class, and should be worked on before the next class. Do not postpone assignments! See the [detailed information page](#) for more specifics.

Exam Dates

Wednesday	9/28	First Midterm
Monday	10/31	Second Midterm
Monday	12/19	Final Exam (5:30PM)

Math 520 Intro to Analysis -- Fall 2011
Tentative Schedule

The schedule below shows what I tentatively plan to cover in class each day. Section numbers refer to the [text by Ross](#). As circumstances dictate, this schedule may change over the course of the semester, but it should serve as a guide to what we will be doing.

8/29	Sections 1&2, Natural and Rational Numbers	8/31	Section 3, Real Numbers
9/5	Labor Day - no class	9/7	Section 4, Completeness
9/12	Section 5, Infinity	9/14	Section 7 Limits of Sequences
9/19	Section 9, Limit Theorems	9/21	Section 10, Monotone and Cauchy Sequences
9/26	REVIEW	9/28	Exam 1
10/3	Section 11, Subsequences	10/5	Section 12, lim sup and lim inf
10/10	Section 13, Topology in Metric Spaces	10/12	Section 14, Series
10/17	Section 15, Alternating Series and Integral Tests	10/19	Section 17, Continuous Functions
10/24	Section 18, Properties of Continuous Functions	10/26	Review
10/31	Exam 2	11/2	Section 19, Uniform Continuity
11/7	Section 20, Limits of Functions	11/9	Section 23, Power Series
11/14	Section 24, Uniform Convergence	11/16	Section 25, More on Uniform Convergence
11/21	Sections 21 and 22, More on Metric Topology	11/23	Thanksgiving - no class
11/28	Sections 28 and 29, Differentiation	11/30	Sections 32 and 33, Integration
12/5	Sections 33 and 34, Integration and the Fundamental Theorem of Calculus	12/7	review, catch up, last class
12/12		12/14	
12/19	Final Exam: Monday, Dec 19, 5:30 - 8 PM	12/21	

COURSE INFORMATION DETAILS

Course Objectives

Real Analysis concerns functions whose domain and range are subsets of real numbers. The important concepts of calculus, namely limits, continuity, derivatives, and integrals, play a central role. However, in contrast to your past study of calculus, where the primary focus was on understanding and applying *procedures*, in this course the main focus is on the theory. Your goal will be to understand deeply what the real number system is, how important concepts are defined, what truths are known about them, and how we know they are true. Making the comparison in another way, in calculus you were expected to work out answers to quantitative questions by calculation and manipulation; here you will be expected to work out answers to theoretical questions by experimental investigation and logical deduction.

There are therefore two main objectives of this course:

1. learning the theoretical foundations of real analysis, consisting of definitions, theorems, and examples, and
2. successfully applying the techniques of analysis to answer (with logical proofs) theoretical questions about functions, limits, and so on.

These encompass

- knowing both the statements and the conceptual meaning of definitions and theorems,
- the ability to justify new conclusions (prove theorems),
- the ability to construct or cite examples that illustrate particular combinations of properties.

At the end of the course you should know the main definitions and the main theorems for the topics we cover, why the definitions and theorems are formulated in the way that they are, and what they mean. You should also know the proofs for the main theorems (or at least outlines of the key ideas for some proofs), as well as the kinds of reasoning that go into these proofs.

Prerequisites

Math 503 is a prerequisite for this course. Students will be assumed to know the names, notations, and properties of important number systems (natural numbers, integers, rational numbers, and real numbers), basic properties and operations of sets and functions, the logical structure of definitions and proofs, including correct use and interpretation of quantifiers, and proof schemes such as proof by induction, direct proof, proof by contradiction, proof by contrapositive, and if and only proofs. A [separate handout](#) provides a sample of statements you should be able to prove.

Grades

Grades will depend on exams and a portfolio of course work. The portfolio is required, and counts for 40% of your grade. You will be adding work to your portfolio throughout the semester, so it is important that you understand at the beginning what is expected. See a separate handout called [Course Portfolio](#).

Tentative Schedule

A tentative schedule showing what topics are planned for each class meeting is available [here](#).

Makeup Policy

If you are forced to miss an in-class exam for reasons beyond your control (such as an illness, family emergency, etc.), a makeup may be arranged, **but ONLY if I am informed in advance**. I will **NOT** approve requests to reschedule an exam for reasons of convenience. For example, if you plan to travel during a school break, that is not a valid reason to reschedule an exam. Similarly, avoidable conflicts for recreational, entertainment, social, or work activities are generally not valid reasons to miss an exam. You have received a schedule indicating the dates of the exams; please plan other activities around them.

Attendance Policy

Class participation in this course is important. Although I will not keep track of days you miss class, or impose specific

penalties for missing class, I do expect you to attend and participate in each class meeting, unless you are ill or have unavoidable conflicts.

Homework

Homework will be assigned for every topic we cover. You should make it a practice to work on homework after every class. Assignments will be posted online and announced via blackboard and email. .

One or more problems in each set of problems to hand in is designated as a *plus* problem (marked with a + symbol on the assignment sheet. These problems have a special significance as explained in the [Portfolio](#) handout. For one thing, all *plus* problems will be collected and graded twice - once as part of a daily assignment, and a second time as part of a collection of *plus* problems. Consider the first time you hand a *plus* problem in to be a rough draft, and use the comments you receive to correct and polish your presentation.

In some cases you may not complete an entire problem set, either because you do not understand all of the questions, or because you run out of time. In all cases, hand in as much of the assignment as you have completed when it is due. Some of the students have had classes from me in the past, in which I was pretty lax on homework deadlines. Because of my other obligations, this semester I am going to be pretty strict on the deadlines. Late work will only be accepted in cases of illness or genuine emergency situations. Since the problem sets will have a significant impact on your grade, it is important to complete and hand in on time as much of each assignment as possible. Any problems you are unable to complete by the deadline should be completed as you have time and added to your portfolio. But I will not collect or grade these problems.

Collaboration

You may work together on some problems, but you should work alone on a significant part of each assignment. When you do work with others, observe the following guidelines. First, each student should be actively involved in working on problems. It is not of much value to copy the work of others, nor does it help someone to copy your work. Second, each student should write up his or her own version of the solution to each problem. It is fine to work together to understand what method to use, or how to approach a problem, but when it comes to actually writing up the solutions, work separately. Your solution to each problem should be something you understand for yourself and can explain in your own words. This is the most effective way to use the practice problems to help learn the material.

You should not get help from other students (or anyone else) when you develop final drafts of *plus* problems. Please consult only with me for any questions that you have on these final drafts.

The guidelines and rules for collaboration are explained in greater detail in a separate handout on [Academic Integrity Rules](#).

FORMAT: Homework should be done on 3 ring loose leaf binder paper. Leave a wide margin on the left side of the page for any comments I want to make. Do not jam all of your work together, leave space between successive problems. Please staple the pages of your assignment. [Here is a sample](#) showing the preferred format. This format should be used for both regular assignments and final drafts of *plus* problems. A special formatting requirement for final drafts is that each problem should begin on a separate sheet of paper, and should be clearly labeled. A clear statement of what is to be proven should appear first, followed by your solution. You may wish to organize your work by proving lemmas that you can cite in the main proof. In this case, each lemma should have a clear statement and proof separate from the main question.

Your work will be easier to read and easier to correct if you prepare it using a word processor. This is particularly encouraged (but not required) for *plus* problems. Suggestions about mathematical word processing are provided [here](#).

For work prepared with a word processor, it is even more important to leave space for my comments. Be sure to leave a generous margin on the left, and also leave some extra space after each problem.

Course Portfolio

In this course, 40% of your grade will be based on a portfolio of your work. The portfolio is your opportunity to document the quality and quantity of your work. It should be a finished product in which you can take pride. That means it should be neat, attractive, well organized, and assembled with some care. It should not be thrown together at the last minute.

Your portfolio should be a **three ring binder** with **separate sections** as described below. Note that there are different criteria of evaluation for the different sections. In particular, the material in your **Polished Work** section should be high quality finished products. In contrast, the section of your homework assignments should include all of your problem sets. These should be neat, legible, and mathematically complete and correct, but will not be held to as high a standard as the polished work. These ideas are presented in greater detail below.

Your portfolio is **not** the same as a course notebook. In particular, the following items should **not** be in your portfolio: assignment sheets, handouts with information about the course, class notes.

Each of the following sections describes a section that should be in your portfolio. The heading for each section is the title you should use for the corresponding section of the portfolio.

Problem Sets Handed In

This section should include all of the problem sets that have been handed in and returned. Include a cover sheet showing which problems were turned in from each assignment, and any late problems you have added that were not turned in. Problem sets will be assigned and collected weekly. All problem sets should be included in your portfolio. Each problem set should have a heading on the first page indicating the section of the text to which it corresponds. Please follow the format guidelines from the detailed course instructions handout.

Polished Work (+ Problems)

Approximately one problem in each set will be marked with a + on the assignment sheet. These are *plus* problems. The recommended approach to these problems is to treat the solutions handed in with homework as rough drafts. Based on further thought, class discussion, or comments on your returned homework paper, you will the opportunity to prepare a second, polished draft, with the same standards of neatness and format that you would follow for a term paper. Periodically, I will collect all the second drafts of + problems, and give you a second set of comments, and a grade. This graded draft should be placed in the *Polished Work* section of the portfolio.

The polished version of each problem should begin on a separate sheet of paper, and should be clearly labeled. A clear statement of what is to be proven should appear first, followed by your solution. You may wish to organize your work by proving lemmas that you can cite in the main proof. In this case, each lemma should have a clear statement and proof separate from the main question.

<>Your polished versions of these problems should be logically correct(!) and explanations should be clear and in correct English prose: complete sentences, correct punctuation, etc. You are encouraged (but not required) to type these, following the style conventions of the text: variables in italics, centered equations, etc. Additional details about this format and suggestions about mathematical word processing are provided in separate handouts.

The polished work is supposed to be your own work. As discussed elsewhere, you may sometimes work with other students on homework problems the first time you do them. But you should not work with anyone else on polished drafts of + problems. If you have questions about those, please consult only me.

If you wish, you may include polished versions of additional problems in this section. This may be appropriate to document significant additional work that you wish to highlight, particularly if you have received assistance with many of the assigned problems for the Polished Work Section.

Exams and Corrections

After an exam has been returned, you are expected to find and correct all errors. Make your corrections on separate sheets of paper, not on the exam itself, and indicate briefly why each error occurred. This work is not expected to be polished - apply the same standards as for the homework. Include the corrections and the exams in this section of the portfolio.

Exam corrections will influence my assessment of your portfolio at the end of the course. Errors on exams show some amount of misunderstanding of the material, and corrections are your chance to learn the ideas you missed. If your exam corrections do not show that you have learned this material, for example because you still have incorrect answers to some of the exam items, that indicates to me that you do not care very much about whether you understand the missed items. To make sure you understand your errors and the needed corrections, **feel free to talk with classmates, tutors, other students, or me.**

Rules for Academic Integrity

To avoid any confusion, here are the rules under which students in this class are expected to operate. Violations of these rules will be considered to be instances of academic dishonesty. For more information on academic integrity, see <http://www.american.edu/academics/integrity/>.

1. **Handed in Problem Sets: guidelines.** Collaboration with others on assigned problems is permitted, but you should get into the habit of doing a substantial part of each assignment independently. I suggest reserving about half of each assignment to do on your own. For those problems you should only get help from other students if you are really stuck.
2. **Handed in Problem Sets: rules.** If you have worked with other students this must be indicated on the turned in homework assignment. Just note at the top something like this: *worked with Joe and Molly on 12, 13, and 14. Problems 20 - 22 were done on my own.* It is not permitted to copy the work of others, nor to allow someone to copy your work. Each student should write up his or her own version of the solution to each problem. Students may work together to understand what method to use, or how to approach a problem, but when it comes to actually writing up the solutions, work separately. Your solution to each problem should be something you understand for yourself and can explain in your own words. In particular, your solution should not be a word-for-word match (or nearly a match) to anyone else's solution.
3. **Polished Work (+ Problems).** You may *not* consult with anyone except me (the instructor) in developing final drafts of + problems. Do not discuss these problems with other students, professors, or anyone else.
4. **Examinations.** On examinations you may not copy work from anyone, nor allow anyone to copy your work. You may not consult with anyone except me. This is true for both in-class and take-home examinations.
5. **Exam Corrections.** Follow the same rules as for Practice Problem Sets.