# Math 305: Real Analysis

**Course name**: Math 305 - Real Analysis.
**Instructor**: Danny Crytser
**Office**: Valentine 211
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**Office phone**: (315) 229-5672
**Meetings**: TTh 10:10-11:40 in Valentine 204
**Office hours**: Monday and Wednesday 10:30-11:30, Tuesday 1:30-2:30, and by appointment. If you can't make it to scheduled office hours, please email me.
**Textbook**: *Understanding Analysis* by Stephen Abbott, 2nd ed.
**Course contents**: Real analysis is the study of the real number system. We will try to learn as much as possible about this number system, including the axiom of completeness, cardinality of various subsets, sequences and series, topological properties like compactness and connectedness, as well as topics from calculus such as the derivative, Darboux's theorem, and (time permitting) the Riemann integral. Additionally, I hope that the course will serve to improve your proof-writing and problem-solving abilities. A solid introduction to analysis will help you to understand more advanced mathematics.
**Homework**: There are written assignments due to me at the beginning of clas every Thursday. They will be assigned on the previous Thursday. You will work on them in **pairs**: for each assignment I will provide you with someone else to work with, and you will submit a single jointly-prepared document. Homework is to be done in LaTeX (I will give you a two-week grace period to learn the basics of this system). Every week I will change your co-author randomly. Each week you will provide a confidential evaluation of your co-author as a collaborator (not an evaluation of their mathematical ability), and the sum of these evaluations will be used in determining course grades. Homework assignments will be posted as .pdf's to the course Sakai website.
**Exams**: Two midterms and a final. The midterms are on the weekly schedule on the next page. Please let me know if this schedule conflicts with any of your other commitments. Generally I will allow makeups for university-sanctioned activities and for medical/family emergencies, but not in any other case. You need to tell me ahead of time.

**Grading**: There are 1100 pts you can earn in this course. The total semester HW collaboration evaluation is worth 50 points, the midterms are worth 100 pts each, the final is worth 150 points, and each of the 14 assignments is worth 50 points. There *may* be opportunities for extra credit/bonus points throughout the term. (Don't count on it.)

**Grading scale**: Here is the conversion between percentage and four-point scale.

| | | | |
|---|---|---|---|
| 94-100 | 4.0 | 73-75 | 2.25 |
| 91-93 | 3.75 | 70-72 | 2.0 |
| 88-90 | 3.5 | 68-69 | 1.75 |
| 85-87 | 3.25 | 65-67 | 1.5 |
| 82-84 | 3.0 | 63-64 | 1.25 |
| 79-81 | 2.75 | 60-62 | 1.0 |
| 76-78 | 2.5 | 0-59 | 0 |

| Class | Section | Topics (TENTATIVE!) |
|---|---|---|
| Th 8/31 | 1.1 | Intro. Irrationality of $\sqrt{2}$. Proof review |
| T 9/5 | 1.2, 1.3 | Preliminaries. Sets theory. Axiom of completeness |
| Th 9/7 | 1.4 , 1.5 | Consequences of completeness axiom. Intro to cardinality |
| T 9/12 | 1.5, 1.6 | More cardinality. $\mathbb{R}$ is not countable |
| Th 9/14 | 2.2, 2.3 | Sequences and their limits |
| T 9/19 | 2.4, 2.5 | Subsequences. Bolzano-Weierstrass |
| Th 9/21 | 2.6 | Cauchy sequences. The Cauchy criterion for convergence |
| T 9/26 | 2.7 | Infinite series. Review |
| Th 9/28 | – | Exam 1 |
| T 10/3 | 3.2 | Open intervals, open sets. Limit points. Closed sets |
| Th 10/5 | 3.2, 3.3 | More on closed sets. Compact sets |
| T 10/10 | 3.3, 3.4 | More compactness. The Cantor set. Connectedness (skip perfect sets) |
| Th 10/12 | 3.4 | Intervals and connected sets coincide in $\mathbb{R}$ |
| T 10/17 | 4.2, 4.3 | The limit of a function at a point. Continuity |
| Th 10/19 | 4.3, 4.4 | Properties of continuous functions |
| T 10/24 | 4.4, 4.5 | Extreme and Intermediate value theorems. Types of discontinuities |
| Th 10/26 | 4.5 | Wrap up discontinuities. Review |
| T 10/31 | – | Exam 2 (Happy Halloween!) |
| Th 11/2 | 5.1 | What is the derivative? Differentiability and contuinity |
| T 11/7 | 5.2, 5.3 | Darboux/Rolle. Proving theorems from calculus |
| Th 11/9 | 5.4 | Constructing a non-differentiable function |
| T 11/14 | 7.1, 7.2 | What is an integral? Upper, lower Riemann sums |
| Th 11/16 | 7.2, 7.3 | Which functions can we integrate? Properties of the integral |
| T 11/28 | 7.4, 7.5 | More propertis. The fundamental theorem |
| Th 11/30 | 7.5 | The fundamental theorem |
| T 12/5 | 7.5 | Non-integrable functions. Lebesgue criterion |
| Th 12/7 | 7.5 | Every continuous function is integrable |
| T 12/12 | – | Construction of number systems, pt. I |
| Th 12/14 | – | Construction of number systems, pt. II |
| T 12/19 | – | **FINAL EXAM** : 1:30-4:30 PM |

**Academic honesty policy**: Click on the link to the pdf at
`http://stlawu.edu/academic-affairs/resource/academic-honor-policy`
In this course you are encouraged to collaborate on HW, but don't copy your the work of your friends, and never cheat on quizzes or exams. When in doubt, please email me and I'll be very happy to clarify things for you.