Math 105A-01 – Introduction to Real Analysis
MWF 9:20-10:25am
Engineering 2 - Room 192

Prof Name : Robert (Bob) Hingtgen
email address : rhingtge@ucsc.edu
Office Location : McHenry 4142
Office Hours: MWF 2:00-3:00pm, and by appointment

Phone: 831-459-1240

Schedule/Final Exam: Course schedule and final exam date are at the end of the syllabus.

Course Description: Math 105A is the first analysis course after Math 100 Introduction to Proofs. The course is heavily based on proof-writing rather than problem-solving. In short, this course is a rigorous construction of commonly used numbers systems, tools, and theorems from Calculus. While many students by this point have been exposed to the computational side of Calculus, our focus on proof instead of just finding an answer may present quite the culture shock. The analogue here would be the difference between riding a bike versus tearing down and rebuilding a bike before riding it, same end goal with a lot more work in between to build deeper understanding and intutition.

Our first goal will be to construct the real numbers from scratch via the study of sequences, and then study the topology of the real line (open/closed/compact sets). The next portion of the course will be devoted to the study of functions of a real variable, covering the concepts of limit, continuity, differentiability, and all the famous theorems enjoyed by functions as long as they are regular enough (IVT, EVT, MVT, InFT, etc.).

Prerequisite(s): MATH 22 or MATH 23B and either MATH 100 or CSE 101.

Course Goals:

- To reinforce your command of proof-writing, in particular manipulating sentences with multiple quantifiers, describing limiting processes.
- To probe the infinitely small and infinitely large with rigorous mathematical statements.
- To get a brief introduction to topological concepts via the study of the metric and topological properties of the real number line.
- To build the real number line and single-variable calculus from scratch, assuming nothing more than the existence of the field of rational numbers.
- To be exposed to more non-constructive proofs and counterexamples. By contrast to complex analysis (Math 103A), where functions tend to have friendly properties (a complex-differentiable function is automatically smooth) and the focus shifts on exploiting these properties (e.g. integrals by residue computations, construction of ad hoc conformal transformations), real analysis is rife with tricky counterexamples, be it at the level of set and sequence constructions, or functions with strange properties.

Text: *Principles of Mathematical Analysis*, (Not Required), Walter Rudin

Alternate Texts:

- *The Way of Analysis*, Robert Strichartz
- *Analysis, Vol. I*, Terrance Tao
- *Introduction to Real Analysis*, William Trench
- *Calculus*, Apostol
- *Mathematical Analysis I*, Vladimir A. Zorich
- *Understanding Analysis*, Stephen Abbott

Teaching Assistant: Cheyenne Dowd, email: cldowd@ucsc.edu

Sections: Sections begin 10/2/2024

Section	Day	Time	Room
A	Tues	11:40-12:45pm	McHenry 1267
B	Tues	1:00 - 2:05pm	McHenry 1267

Grade Distribution:

Average Definition Quiz Score	7.5%
Average Quiz Score	7.5 %
Average Homework Grade	20 %
Midterms	20 %
Final Exam	25 %

Grade Scale:

A+	96 - 100%	B	82 - 85%	C-	68 - 71%
A	93 - 96%	B-	78 - 82%	D +	65 - 68%
A -	89 - 93%	C+	75 - 78%	D	61 - 65%
B+	85- 89%	C	71 - 75%	D-	57 - 61%
				F	0 -57 %

Homework: Homework will be assigned (roughly) every week and due dates will be on each assignment. Late assignments will not be accepted without extenuating circumstances. These assignments you will submit in whatever format you please (handwritten, typed, etc.) However, this is a proof class, correctness is not the only goal of this course. Clarity and conciseness are also important. As such, understand that you will be graded on the quality of the content you submit in these three manners: correctness, clarity, and conciseness. 1 assignment may be dropped at the end of the course

Exams: There will be three exams during the course (Two midterms and a final). If cheating is suspected, the matter will be resolved following the guidelines of the university policy on academic misconduct. A review for each exam will be posted roughly a week before each corresponding exam (and may play an active role in the exam as well). The final exam will replace one midterm score at the end if it is an improvement. Makeup exams will not be given without pre-approved or approved reasons (depending on the context of the situation), and can not be guaranteed to exist. If you a miss an exam without reason or documentation, then the final will have to replace that specific exam.

Attendance: Attendance is expected and appreciated. If absent, students are responsible for all missed work, regardless of the reason for absence. It is also the absentee's responsibility to get all missing notes or materials.

Quizzes: A quiz will be given each week (after week 1) relating the topics we are working on at that time. 2-3 lowest quiz scores will be dropped at the end of the quarter. Make-up quizzes will not be given without reason or documentation explaining one's absence. These quizzes will be given on canvas.

Section / Definition Quizzes: A definition quiz will be given each week (after week 1) during section covering definitions. In a proof class it is important to know your definitions exactly with no vagueness in the definition or understanding. Section will also be a valuable time to work on worksheets to gain better understanding of topics and have time to ask the teaching assistant questions about homework or the course in general. 2-3 lowest definition quiz scores will be dropped at the end of the quarter.

Academic Accommodations (DRC): UC Santa Cruz is committed to creating an academic environment that supports its diverse student body. If you are a student with a disability who requires accommodations to achieve equal access in this course, please affiliate with the DRC. I encourage all students to benefit from learning more about DRC services to contact DRC by phone at 831-459-2089 or by email at drc@ucsc.edu. For students already affiliated, make sure that you have requested Academic Access Letters, where you intend to use accommodations. You can also request to meet privately with me during my office hours or by appointment, as soon as possible. I would like us to discuss how we can implement your accommodations in this course to ensure your access and full engagement in this course.

Inclusivity Statement: We understand that our members represent a rich variety of backgrounds and perspectives. UCSC is committed to providing an atmosphere for learning that respects diversity. While working together to build this community we ask all members to:

- share their unique experiences, values and beliefs
- be open to the views of others
- honor the uniqueness of their colleagues
- appreciate the opportunity that we have to learn from each other in this community
- value each others opinions and communicate in a respectful manner
- keep confidential discussions that the community has of a personal (or professional) nature
- use this opportunity together to discuss ways in which we can create an inclusive environment in this course and across the university community

A note on AI: In this class, I ask that you complete your work without using AI-generated sources to augment, think through, or write your assignments.

There is one exception: you are welcome to use AI tools for pre-submission editing (spell-check and grammar-check) as long as you do not use them for thinking or drafting.

If you submit work that appears to have been written using AI sources, I will ask you to meet with me to discuss your thinking and writing process. If, after our conversation, I conclude its more likely than not that you did not personally complete an assignment you submitted under your name, I may refer you to your college provost for further conversation.

If you have questions about AI use and/or proper attribution of other peoples work, please come ask me!

Email: A small note. I will check my email rougly 2 times a day. I will try to answer as many questions as I can there. Do understand that math questions are better answered in person and so I will ask you to attend office hours or schedule a meeting. Common questions that come up often may be put in a FAQ on Canvas, and I may refer you to there. Due to the nature of email, I can not guarantee immediate communication.

Final Note: I will also give X% amount of extra credit

- To ALL students, if there is a 75% or higher response rate to the SETS at the end of the quarter.
- To EACH student that picks up every paper of theirs from me by the end of the quarter.

Tentative Course Plan: This is the projected plan for the course.

Date	Event
9/27	Syllabus, Intro to Course, Number Systems, Countability
9/30	Uncountability & Field Axioms
10/2	Triangle Inequality, Archimedean Property, Supremum & Infimum
10/4	Sequences - Convergence & Orders
10/7	Algebraic Limit Rules, Subsequences
10/9	Subsequences, Cauchy sequences
10/11	Constructing R
10/14	Field Structure of R
10/16	Order Structure of R, Density & Archimedean Principle
10/18	Completeness of R
10/21	Sequences Reprise
10/23	Monotone Convergence Theorem
10/25	**Midterm 1**
10/28	Bolzano-Weierstrass Theorem, Series
10/30	Series of Nonnegative Terms, Convergence Tests
11/1	Absolute & Conditional Convergence
11/4	Topology of R, open sets
11/6	Closed sets, boundary, Density
11/8	Compact sets
11/11	Veterans Day (Holiday)
11/13	Compact & Connected sets
11/15	Limits of Functions
11/18	Continuity, Extreme Value Theorem
11/20	Uniform Continuity, Intermediate Value Theorem
11/22	**Midterm 2**
11/25	Differentiability
11/27	Local Extrema, Mean Value Theorem
11/29	Thanksgiving (Holiday)
12/2	Inverse Function Theorem

Date	Event
12/4	Second Derivatives & Convexity
12/6	Taylor's theorem, L'hopital's Rule
12/11	**Final Exam** 12-3pm