MATH 311-01: REAL ANALYSIS (3 cr.)

SYLLABUS & COURSE POLICIES

DORDT UNIVERSITY

FALL 2023

Instructor:	Dr. Mike Janssen, Professor of Mathematics
Email:	`Mike.Janssen@dordt.edu`; I will endeavor to reply to every email within one school day.
Classroom:	SB 1637
Class time:	1:00–1:50 PM MWF
Office:	SB 1612
Office Phone:	(712) 722-6398
Student Hours:	By appointment: `https://fantastical.app/mkjanssen/student-hours`
Required Resources:	Access to our course notes: `https://prof.mkjanssen.org/ra/` Regular access to Overleaf.com for Written Work
Prerequisite:	Grade of C– or better in Math 212

Catalog course description: An introduction to the content and methods of single-variable real analysis: infinite sets, the real number system, sequences, limits, series, continuity, differentiation, and integration. Prerequisite: grade of C– or higher in Mathematics 212; or permission of instructor.

COURSE OVERVIEW

Welcome to Real Analysis! I am glad you are here. In this course, we will inquire about the nature of the real numbers, and functions which take one real value. Our goal is to deeply understand properties of continuous and differentiable functions, and we aim to prove the fundamental theorem of calculus by the end of the semester.

LEARNING OBJECTIVES

In this course, students will:

be *communicators* through regular presentations to the Math 311 learning community and growing fluency in the writing of mathematical proofs. (CD)

be *explorers* by engaging with in-class activities and regular work outside the classroom. (CD)

be *learners* by leveraging knowledge of logic, functions, and sets to explore foundational questions in the study of functions of one real variable. (CS)

be *ambassadors* of mathematics by reflecting on the ways the practice of mathematics can promote human flourishing. (RO, CD, CR)

COURSE LITURGIES

In this section, we briefly describe the basic rhythms of the course. It is a truism that the best way to learn mathematics is to *do* mathematics, and this course is designed with that in mind. There are two types of regular work in this course: daily work, and written work.

DAILY WORK

The work of the course will be primarily driven by you, the student.

PROBLEMS AND PRESENTATIONS

You will be assigned approximately three to five problems from the course notes to work on before coming to class. You may not use any outside resources to help you solve these problems–NO BOOKS, NO WEBSITES, NO FRIENDS WHO HAVE TAKEN THIS COURSE BEFORE. Using these resources will constitute plagiarism and will be reported to the Student Life Committee. You *may* work with others currently enrolled in the course, but you will need to ensure that you can completely understand and explain the solutions and proofs you come up with.

One of the main goals of this course is to improve your mathematical communication. Thus, the majority of each class period will be devoted to you PRESENTING YOUR WORK on these problems to the class. You should expect that approximately half of the typical class period will consist of presentations and discussion.

By 11:00AM before each class, you will claim on Canvas problems whose solutions you are willing to present. In general, you will be allowed to present at most one problem per class meeting. You will earn 0.1 daily work points per problem you sign up to present, even if you are not ultimately the person to present it.

You will be notified by 12:00pm on Canvas of any problems you are assigned to present.

You will then write the problem and solution up on the board, highlight the main points of the proof/solution, and generally lead the class discussion. THAT IS, MERELY WRITING THE SOLUTION ON THE BOARD WILL NOT BE SUFFICIENT TO EARN FULL CREDIT. The presenter will earn points as follows.

> 1 POINT. The solution/proof is correct and complete, the explanation clear, and all questions are answered.
>
> 1/2 POINT. The solution/proof was prepared, but there are gaps in the solution/explanation, and/or questions that are not satisfactorily answered.
>
> −0.1 POINTS. The solution/proof was either not prepared or is in completely the wrong direction.

SUPPORT

Of course, not everyone can be assigned the problems they sign up for. However, you may be assigned as *support* for a given problem, typically a problem you've indicated a willingness to present. Prior to the presentation, it is your job to make sure that the presenter's written proof is clear. During and following the presentation, it is your job to try to answer any questions alongside the presenter. Engaging as a problem support person will earn you half the credit of the presenter (1/2, 1/4, or −0.05 points).

SCRIBES

Each presented problem will also have a *scribe* assigned on Canvas. The first problems will be scribed (more or less) in alphabetical order by last name, and subsequent scribes will be assigned in ascending order from least daily work points to most.

The scribe will have the responsibility of taking notes on the presented proof and asking questions when something is not clear. They then will write up a formal version of the proof AND discussion and post it to our Overleaf document. The scribe will earn 1/4 point when a correct proof is submitted.

ACADEMIC INTEGRITY

This course structure effectively models the way professional mathematicians conduct and share their research. Thus, we will abide by the Policy Statement on Ethical Guidelines[1] adopted by the American Mathematical Society, in particular Section I on mathematical research and its presentation. As this statement describes, "[t]he knowing presentation of another person's mathematical discovery as one's own constitutes plagiarism and is a serious violation of professional ethics. Plagiarism may occur for any type of work, whether written or oral and whether published or not." When you present your work in this class, both orally and in writing, you must cite ANY CONVERSATIONS you have had about your problem with ANYONE IN THE CLASS. Looking to ANY RESOURCE outside of the people in our class—including generative AI models like ChatGPT!—for information about the problems at hand constitutes plagiarism and will be reported to the Student Life Committee.

Daily work points will be monitored and factored into the final grade.

WRITTEN WORK

Roughly every other week (other than the weeks we have exams), you will be assigned three problems to solve, write up, and submit online by 11:59pm on **Sept. 6, 20; Oct. 4, 25; Nov. 8, 29**. These will be written in LaTeX, and will generally not be problems that have been presented in class (though they may have been assigned as daily work). Each problem will be graded on a four-level scale (each explained more fully on the proof rubric distributed on Canvas) as:

Exceeds expectations. Dr. Janssen would be happy to post this as the official class solution.

Meets expectations. The logic is generally correct and it is reasonably well written, but there is room for improvement.

Revision needed. Some major gaps in logic, misuse of notation, or unclear communication requires revision.

Not assessable. This is difficult to read, abuses notation, or contains significant mathematical flaws. Probably best to start over.

Writing proofs is as much art as science, and initially it can seem daunting and confusing. In order to aid your growth, you will have the opportunity to spend tokens (see below) to revise your work once after Dr. Janssen returns the graded version provided the work was (a) submitted on time (or extended using a token) and (b) received an initial assessment of R or higher.

In short, your submissions will go through the following workflow (with the number representing the number of days since the Wednesday submission):

Day 0: Initial submission due 5:00pm Wednesday

[1] See the AMS website for more: `http://www.ams.org/about-us/governance/policy-statements/sec-ethics`.

Day N: Initial assessment and feedback returned

Day $7+\mathrm{N}$, $1 \leqslant \mathrm{N} \leqslant 7$: Revised problems submitted to Dr. Janssen (using tokens as described below), to be graded within a week.

Your written work *must* include an acknowledgments section or it will be returned ungraded. You may work on this homework with others in the course, but if you discuss ANY mathematical content of any problem with another person, you *must* include their name in the acknowledgments, and ensure that your final writeup is completely your own. Looking to ANY RESOURCE outside of the people in our class for information about the problems at hand constitutes plagiarism. Failure to meet these criteria will constitute academic dishonesty and will be reported to the Student Life Committee.

Work submitted more than 24 hours late or work initially assessed at an N requires a meeting with Dr. Janssen and short accompanying reflection on why the work was assessed at an N and how such assessments will be avoided in the future. If earning an N becomes a regular occurrence on written assignments due to perceived lack of effort, you may lose the grace afforded by the revision process and only be allowed a single submission.

PROJECT

There are many fascinating historical vignettes in the development of real analysis which reveal both God's wondrous design in creation and the creativity exercised by humans as image-bearers. An example of this is Dedekind's work defining the real numbers themselves–how can one define a real number in such a way that the definition applies equally well to natural numbers, integers, rationals, and irrationals, all of which are reals? We will read some of Dedekind's *Continuity and Irrational Numbers* and complete a sequence of mathematical tasks which will help us explore his work. You'll submit your work on these tasks, along with an accompanying reflection, one week after we finish spending class time on it.

EXAMS

There will be two exams, the first the week of October 16, and the second during the last week of class/finals week. The first will be cumulative up to the previous class, and worth 50 points, while the second will be cumulative over the whole semester, but with an emphasis on Chapters 3-5, and worth 75 points. Both exams will be oral exams. Your exam average will be a major factor in your final grade.

OTHER POLICIES AND ADVICE

I am generally fairly accepting of late work, with a built-in 24-hour grace period for any non-classroom activities. Additional time beyond the 24-hour grace period must be approved ahead of time.

Student hours are your time to ask questions about all aspects of the class and college life. Please check online for an appointment. If you can't find one, send me an email! I will do my very best to accommodate your you.

Email Policy: I check my email twice per school day: once in the morning, where I'll deal with any emergencies, and once in the afternoon, when I'll respond to other emails (including any that have come in since the morning). If you require a more immediate response, you're welcome to come find me in my office.

Policy on Generative AI: Unless specifically permitted by Dr. Janssen in advance of student submission of work, any use of AI will be considered a breach of academic integrity. Suspected cases of misuse of AI tools will be treated as plagiarism and submitted to the Student Life Committee.

GRADING POLICY

In general, the **highest fully completed row** in Table 1 will determine your final grade[2].

Grade	DW Points	WW (M/E)	WW E	Exam Average	Project
A	23	17/18	13	87%	90%
A–	22	16/18	11	84%	87%
B+	21	15/18	9	80%	84%
B	20	14/18	8	77%	80%
B–	19	13/18	7	74%	77%
C+	18	12/18	6	70%	74%
C	16	11/18	4	67%	70%
C–	14	10/18	2	64%	67%
D	12	9/18	0	55%	60%

Table 1: The Final Grade table.

REVISIONS

Each Written Work assignment submitted no more than 24 hours late may be revised *once*. In order to revise it, you must have banked at least one token; the cost to revise the assignment will be one token *per problem revised*. You'll begin the semester with one token, and may earn more by signing up to present daily work problems. You may earn additional tokens as follows:

- You'll earn one additional token *per ten daily work problems you sign up to present*.
- You can earn one token each time you attend a Pizza and a Presentation, 11:00am in CL 1321 on Sept 8, Sept 22, Oct 13, Nov 3, Nov 17, and Dec 1.

Written Work assignments submitted more than 24 hours late will be assessed at one token/completed problem and no additional submissions will be allowed.

Note: this means that you may not be able to revise all of your Written Work problems! Thus it is important to ensure that you are giving your best effort with your first submission. You are welcome to come to my office, work with others, etc., to ensure that your first submission is as good as possible.

Tokens which are not used by the end of the semester are used by Dr. Janssen and disappear. This leads to a great increase in metaphysical understanding which has no practical relevance.

TENTATIVE SCHEDULE

As the course will be driven by your work and interests, it is difficult to predict the amount of time that will be spent in each chapter. However, here is my best guess.

- Chapter 1: Preliminaries and Review: August 29–September 13
- Chapter 2: Point Sets and Sequences: September 15–October 13
- *Interlude*: Dedekind Cuts: October 16–20
- Chapter 3: Continuity: October 23–November 10

[2]The **A**-level for Daily Work was obtained thusly: 70% of 120 daily work signups (8.4 points), scribing your share of daily work (2.15 points), and presenting your share of daily work (including support; 12.85 points): $\lfloor 8.4 + 2.15 + 12.85 \rfloor = 23$.

- Chapter 4: Differentiation: November 13–November 29
- Chapter 5: Integration: December 1–December 13

INSTITUTIONAL POLICIES

DORDT UNIVERSITY STUDENT'S RIGHT TO ACCOMODATIONS POLICY

Dordt University is committed to providing reasonable accommodations for students with documented qualifying disabilities in accordance with federal laws and university policy. Any student who needs access to accommodations based on the impact of a documented disability should contact the Coordinator for Service for Students with Disabilities: Sharon Rosenboom, Academic Enrichment Center, 712 (722-6490), Email: Sharon.Rosenboom@dordt.edu.

DORDT UNIVERSITY ACADEMIC HONESTY POLICY

Dordt University is committed to developing a community of Christian scholars where all members accept the responsibility of practicing personal and academic integrity in obedience to biblical teaching. For students, this means not lying, cheating, or stealing others' work to gain academic advantage; it also means opposing academic dishonesty. Students found to be academically dishonest will receive academic sanctions from their professor (from a failing grade on the particular academic task to a failing grade in the course) and will be reported to the Student Life Committee for possible institutional sanctions (from a warning to dismissal from the college).

Dordt University continues to monitor developments in the use of AI. For the Fall 2023 semester, follow your instructor's AI-related policies and procedures.

Appeals in such matters will be handled by the student disciplinary process. For more information, see the Student Handbook at https://www.dordt.edu/student-life/residential-life/student-services/student-handbook.

DORDT UNIVERSITY ATTENDANCE POLICY

As we begin the 2023-2024 school year, class attendance policies and procedures as outlined in the Student Handbook are in place. To paraphrase the Student Handbook, Dordt University as an institution remains committed to in person instruction for face-to-face courses. As a result, you are expected to be present for every class period and laboratory period. Should you need to miss class for any reason, contact your instructor as soon as possible (either prior to the absence or immediately following). Absences for Dordt-sponsored curricular or co-curricular activities will be communicated by the activity sponsor and are considered excused.

You are responsible to contact your instructor to make arrangements for missed work. Your instructor is not required to provide real time (synchronous) learning for you should you be absent for class for any reason (ex. Zooming into your real time class). Your instructor is also not required to provide asynchronous virtual learning materials for you (ex. recordings of missed classes, powerpoints, other materials on Canvas). While some instructors might utilize some of the synchronous/asynchronous methods of making up work on occasion, you should not expect all instructors to provide these experiences automatically. Methods of making up missed work might include: contacting a fellow student to get notes from class, extensions on assignments or labs, or other methods as determined by your instructor. Making arrangements for missed class work is your responsibility!

Please see your instructor's specific attendance policy.

I reserve the right to make changes to this document as the need arises.