M381 Advanced Calculus I – Fall 2020

Instructor information:

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Office hours: Monday 4:30 - 5:30; Wednesday 10 - 11; or by appointment.

Although our class will meet over Zoom (Meeting ID: 923 9798 0993, Password: Analysis), I will hold in-person office hours. While the weather permits, I'll hold office hours on the patio to the southeast of the Math building (above Urey Lecture Hall). However, I may wait in my office, rather than outside, until students arrive for office hours. So if you don't see me on the patio, come downstairs to my office!

Course description:

Welcome to Advanced Calculus. At other universities, this class is sometimes called "Real Analysis" and to be honest I think that's a better name.

While many of the topics we'll study in M 381 are familiar from calculus (limits, continuity, derivatives, integrals) the approach we take in M 381 is really very different. This class is all about applying your "but *why* is it true?" skills, that you've honed in M 307 and your other proof-writing classes, to things like the limit laws and differentiation rules. Plus, we'll see a lot of really cool and counterintuitive examples, like the Cantor set (it is as big as the real line, but has length zero) and a function which is continuous on [0,1] but is not differentiable at any point in [0,1].

The proofs in M 381 have a very different feel to them than the proofs in Number Theory or Abstract Algebra. Learning to think in this way is an important part of your mathematical training, and it will also be extremely helpful if you want to take a class like Complex Analysis or Introduction to Topology in the future. Plus, I think M 381 will be fun! I hope you do too.

Learning Outcomes:

Upon completion of this course, students will be able to:

1. Understand and use the precise definition of a limit for both sequences and functions;
2. Understand the proofs of the basic results from single variable calculus (e.g., limit laws, product rule, Fundamental Theorem of Calculus, etc.);
3. Read and write basic proofs in analysis;
4. Communicate mathematics orally and in writing.

Required textbook: Abbott, "Understanding Analysis," second edition.

Course Structure:

There will be weekly written homework, due on Wednesdays. We will also have two midterm exams and a final exam, all of which will be oral exams. The midterms are tentatively scheduled for the week of September 14 and October 19. Our final exam is scheduled for Tuesday, November 24, 1:10 – 3:10 PM.

On the **homework**, I encourage you to work together to figure out the solutions, but what you turn in should represent the understanding in your own brain. For that reason, please **use only your own brain** (and pencil/paper/LaTeX) to write up the homework solutions! Don't write the

homework up while you're in office hours or a group discussion – wait till later. Take notes on the results of the discussion, by all means, but try to **write the solution without consulting those notes** (or your textbook, or the internet, or a friend). If you get stuck, look at the notes/textbook/etc for a hint – but try to use as few hints as possible. This way, you will build up the "mental muscles" that will enable you to succeed in this course, and in particular on the exams (where you won't have notes/internet/friends helping you). You'll turn in the homework by uploading a PDF to Moodle.

Each week, (at most) one problem on the homework assignment will be **starred** (e.g. Chapter 6, problem 4*). These problems will usually be more challenging than the rest of the homework. The starred problem should be turned in on a separate page from the rest of the written homework. I will grade these problems on a credit/no credit basis (but with comments so that you know what you need to fix). If you receive a score of no credit, you can resubmit the problem the next week along with that week's homework assignment, and you can continue this process until you receive credit. The primary point of these problems is to make sure that everyone learns to write good proofs. The secondary point is to encourage you to solve problems which might require more than one week of thinking -- but not all of the starred problems will be that hard!

Reading the textbook will be another regular component of the course. Learning how to learn from the textbook will serve you well in any future math or science courses (or if you have to consult your old textbooks for a refresher!). Plus, reading the book gives you a model for how to write mathematics that will complement what I demonstrate in class, and which I hope you will incorporate into your homework assignments.

To that end, I will usually ask you to read a section of the textbook before class, and post a comment in the relevant Discussion forum in Moodle **by 12 noon**, one hour before class. I don't expect you to be able to understand everything in the textbook at the beginning of the semester -- this is the role of the Discussion forums, for you to tell me what you didn't understand from the textbook and what you want to focus on in class that day. However, I do expect you to **put serious effort** into the reading assignments, so that your ability to learn math from the textbook will improve over the course of the semester. We will spend time in class discussing strategies for reading a math textbook; one aspect of this is to **budget 10 minutes per page** for the reading assignments.

Your comments in the Discussion forums will be graded on a scale of 0 to 2, based on how well you convince me that you have read the section and thought about it, and I will drop your lowest 5 scores.

For example:

- You will receive a 0 if you don't post any comment.
- A comment like "Everything makes sense, I have no questions" will earn a score of 0. (Even if everything makes sense, I'm sure you can find something more specific to say! How does this section connect with other sections? What did you think was interesting? Was there any part of the section that didn't make sense at first? What was it that eventually made that part make sense?)
- If your comment asks a question that indicates to me that you only skimmed the textbook, you will earn a score of 1. For example: ``What is the set S in Example 1.2.7?'' (This is explained on page 10 of the textbook.)
- A comment such as ``I don't understand why Q doesn't satisfy the axiom of completeness. We know Q is a subset of R, and R satisfies it, so why doesn't Q?'' will earn a score of 2. This question demonstrates that its author read the section and thought about what s/he read.

You are welcome to consult other textbooks for the reading assignments, if you prefer. To facilitate this, in each Moodle discussion forum, I will describe the topic of the reading so that you can find the appropriate material in another textbook.

If you do consult other textbooks, please be careful to either use the notation from the course textbook on homework assignments and when posting in the Discussion forums, or to define the notation you use.

Course guidelines and policies:

Classroom and Course-related Behavior

University policy requires that all of us in the classroom treat each other with respect, and refrain from behavior that will disrupt the educational process. Please refrain from using any electronics during class that are not directly related to what we are doing.

I encourage you to ask questions at any time, and I will ask lots of questions of the class. To make sure that I haven't lost the majority of the class, I may call on people randomly to answer my questions. Saying "I don't know" is a perfectly acceptable answer! You are almost certainly not the only one who's confused, so this is a signal for me to try another explanation, or give some more details.

If you would prefer to be called by a different name, or gender pronoun, than is listed on the course roster, please let me know.

Digital Access

Digital devices (like laptops and cell phones) are becoming increasingly important to success in college. In this course, you may need digital devices to access readings, complete and submit written assignments, complete online quizzes, verify your attendance, take in-class polls, coordinate with other students regarding group projects, complete and submit group projects. I recognize that some students are unable to afford the cost of purchasing digital devices and that other students rely on older, more problem-prone devices that frequently break down or become unusable. I also recognize that those technology problems can be a significant source of stress for students. Given those challenges, please contact me if you experience a technology-related problem that interferes with your work in this course. I am more than happy to help you in accessing support.

Student Conduct Code

All students need to be familiar with the Student Conduct Code. You can find it at http://www.umt.edu/student-affairs/dean-of-students/default.php or by searching in the "A to Z Index" on the UM home page. In particular, discrimination and harassment are not tolerated at the University of Montana. If you feel that you have been subjected to discriminatory or harassing behavior, please contact the Office of Equal Opportunity and Affirmative Action at 243-5710 or http://www.umt.edu/policies/browse/personnel/discrimination-harassment-sexual-misconduct-stalking-and-retaliation for help in addressing the situation. You can also report the discrimination or harassment to me or to another faculty member you trust.

Academic Honesty

All students must practice academic honesty. Academic misconduct is subject to an academic penalty by the course instructor and/or a disciplinary sanction by the University.

Disability modifications

The University of Montana assures equal access to instruction through collaboration between students with disabilities, instructors, and Disability Services for Students. If you think you may have a disability adversely affecting your academic performance, and you have not already registered with Disability Services, please contact Disability Services in Lommasson Center 154

or call 406.243.2243. I will work with you and Disability Services to provide an appropriate modification.

Due Dates and Late Work

Unless stated otherwise, all assignments are due at the beginning of class on the day on which they are due. Late work will receive no credit. However, to give everyone a buffer for busy weeks, the Homework category will be graded out of 85 points, although there will be 100 possible points to earn (10 points for each of 10 assignments).

Except in exceptional circumstances, exams must be taken at their scheduled time. If you know you have a conflict with an exam, please contact me **early** to see what arrangements can be made.

Grading policy

Item	Percentage
Discussion posts (Reading reactions)	5%
Written Homework	40%
Starred Problems	10%
Midterm Exams (total)	25%
Cumulative final exam	20%