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M 551.01: Real Analysis

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Math 551 - Real Analysis

Fall 2018

Course Instructor: Dr. Elizabeth Gillaspy

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Lecture hours and Venue: MWF 11:00 a.m. - 11:50 a.m., MATH 108

Office Hours: Monday 2-3 PM; Tuesday 11-12 AM; or by appointment.

Course Prerequisites: Math 473 (Real Analysis) or Math 472 (Complex Analysis)

Textbook: David Bressoud, *A Radical Approach to Lebesgue's Theory of Integration*.

1 Course Contents

Welcome to Math 551, Real Analysis!

The name of this course can be a bit misleading; its focus is on the alternative approach to integration which was introduced by Henri Lebesgue in his PhD thesis in 1902. Lebesgue's integral can be applied in a much broader setting than the Riemann integral you remember from calculus; we will start to investigate that generality at the end of the semester. At the beginning, however, we'll focus on the development of Lebesgue theory for the real line.

One goal of this class is to prepare you for the graduate comp/prelim exam in Analysis. Approximately one-third of the problems on this exam will be based on material from M 551.

Another goal is for you to gain some historical perspective on the development of analysis. Analysis is full of elegant, beautiful ideas and theorems – and messy, intricate proofs. Without the historical perspective, it's hard to imagine how someone came up with these messy proof techniques in the first place. Sometimes it's even hard to see why anyone would bother.

Finally, a third goal is for you to improve your ability to read and communicate mathematics.

2 Course Structure

If you have not yet passed your prelim/comp exams, your grade in this course will be based on:

- Reading assignments/Discussion posts (10%)
- Midterm exam [Friday, October 12, in class] (10%)
- Final exam [Friday, December 14, 8-10 AM] (15%)
- Weekly Homework (65%)

If you have passed your prelim/comp exams, you may choose to take the midterm and final exams, and your grade will be determined by the above rubric. Alternatively, you can choose

to give a 50-minute presentation on a topic related to Lebesgue theory; your presentation will count 25% of your grade and will replace the two exam scores.

Please inform me of your choice **by Friday, Sept 21**. We will finalize the date and topic of your presentation later in the semester.

2.1 Reading assignments/Discussion posts

In every class I teach, I want students to improve their ability to communicate math, not just to enhance their mathematical knowledge. One aspect of this is improving your ability to read math. 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 **10 AM** the morning 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.

The discussion posts are a means for you to synthesize what you've learned by reading the textbook, connect the material to previous sections, and let me know what you still need some help with. 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 does the author mean by the intermediate value property?”
(This is explained on page 16 of the textbook.)
- A comment such as “What's an example of a function for which the upper and lower Darboux sums can never be realized by a Riemann sum? What makes this possible?” 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 Bressoud's book on homework assignments and when posting in the Discussion forums, or to define the notation you use.

2.2 Presentations

If you have passed your prelim/comp exams and you choose not to take the midterm and final exams in this class, I will instead ask you to give a 50-minute presentation on some topic related to Lebesgue theory. You can base this presentation on a section of the textbook that we haven't covered in class, or on material from another textbook or a paper.

Please let me know as soon as you have an idea for a presentation topic. Then we can fine-tune the choice of topic and source materials together, and schedule your presentation so that it fits well with the arc of the course and with your own schedule. At the very latest, you should **meet with me before Thanksgiving** to confirm your presentation topic and schedule your presentation.

2.3 Homework

The majority of your grade will be based on the weekly written homework assignments, which will be due on Wednesdays at the beginning of class. Each of the 13 homework assignments will be graded out of 20 points, but the total number of points in the "Homework" category of your grade will be 200, to give you a buffer for busy weeks.

I encourage you to discuss the homework problems together, but **you must write up your solutions on your own**, and acknowledge, in your write-ups, any sources (human or otherwise) that you consulted, other than me or the course textbook. During discussions with classmates (or with me) about the homework problems, feel free to take a few notes, but you should not write up the solutions during this discussion period. Waiting to write up the solutions until you're in the privacy of your home or office confirms that the solutions you write up reflect your own understanding of the problem.

Indeed, when writing up your homework, please **consult your notes, and any other resources, as minimally as possible**. Before writing the proof, think through the argument. How do all the pieces fit together? What's the best order to explain things? Then, once you start writing, do your best to write the solution without reference to your notes or the textbook. If you have to look up a reference more than 2 or 3 times during the writing, you don't fully understand the solution yet. If this happens, I suggest you stop working on the final draft; work through again (using notes) how the argument should go; and take a break, perhaps by moving on to another problem. When you come back to the tricky problem later, you should have a better, deeper understanding of how the proof works.

Failure to follow these guidelines may result in homework solutions that are uncomfortably close to plagiarism. Plagiarism (copying solutions from a source other than your own brain) constitutes academic misconduct, and will result in a loss of credit for the assignment and/or disciplinary sanctions.

3 Course Policies

3.1 Asking and Answering Questions

It's important to me that our class is paced for everyone, not necessarily the pace of the most vocal students. I want to make sure that everyone's questions are heard. So, if you have a question, feel free to ask it at any time; if I have a question for the class, I will choose who to ask at random. Please feel free to say "I don't know;" that tells me that I need to try a different explanation. Almost always, if you're confused, there are at least one or two other people in the class with the same confusion!

3.2 Student 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. In particular, I expect that you will **focus your attention on M 551 during class time!** For example, please refrain from cell phone use (including texting), computer use (unless you take notes on your computer), or working on homework for another class. I know from experience how easy it is to think "I know this material, it's a good time to take 10 seconds and check my email" – only to surface a full minute later, having missed something important.

In my turn, I promise to treat all of you with respect. For example, if you would prefer me to call you by a different name, or gender pronoun, than is listed on the course roster, please let me know and I'll be happy to oblige.

3.3 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. Turning in an assignment 5 minutes after the start of class is acceptable (unless it becomes a habit); handing in an assignment 20 minutes late is **not**.

3.4 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 have a disability that adversely affects your academic performance, and you have not already registered with Disability Services, please contact Disability Services in Lommasson Center 154 or 406.243.2243. I will work with you and Disability Services to provide an appropriate modification.

3.5 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.

3.6 Religious Holidays and Absences from Classes and/or Exams

If a religious observance or other obligation conflicts with a scheduled exam or other course activity, please let me know ASAP, preferably **during the first two weeks of the semester**, so that we can make alternate arrangements.

3.7 Student Conduct Code

All students need to be familiar with the Student Conduct Code. You can find it 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, I’m very sorry to hear it; please contact the Office of Equal Opportunity and Affirmative Action at 243-5710 or <http://www.umt.edu/eo/equalop/harassment.php> for help in addressing the situation. You can also report the discrimination or harassment to me or to another faculty member you trust.