Math*3200 – Real Analysis

Fall 2019

(Revision 0: August 23, 2018)

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1 Instructional Support

1.1 Instructor

Dr. Matt Demers
MACN 543, Extension 53079 mdemers@uoguelph.ca

Office Hours:
Thursdays 1 – 2 pm and 4 – 5 pm in MACN 543

1.2 Lab Technician

Not applicable.

1.3 Teaching Assistants

Liam Graham	lgraha07@uoguelph.ca

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2 Learning Resources

2.1 Course Website

Various resources, solutions, announcements and grades will be regularly posted to the Math*3200 Courselink page. It is your responsibility to log in and check the page every day.

2.2 Required Resources

The primary resource for the course will be the notes that we build together over the semester.

2.3 Recommended Resources

Closer and Closer – Introducing Real Analysis, by Carol S. Schumacher.

Most of the concepts, notes, and proofs from the course are derived from this book. While we will not totally adhere to it, this might give you a really useful extra source of examples and exercises.

2.4 Additional Resources

Lecture Information:

Class attendance is very important in this course, which focuses on theory, logic, and proof techniques. More than usual, the material in this course builds on itself and is essential for future concepts in the course. Therefore, missing class could leave you behind in a hurry – which may be challenging given the more abstract nature of the topics we cover.

Weekly Exercises:

A few extra problems may be posted to Courselink each week or recommended from the textbook. Even though they will not be for grades, these are there for you to practice with, beyond those that we cover in lectures and assignments. To gain the best understanding possible, I highly recommend that you attempt these as or soon after they are posted.

Other:

I might post some resources or provide links from time to time if I create something or come across something that I believe might be helpful to you. Anything like this would be posted to the Courselink site, so again, check it every day.

2.5 Communication & Email Policy

Please feel free to ask any questions during or just after lectures. Do not feel intimidated about contributing during class, because active learning is much more effective than just copying down notes! This is especially important in an abstract course like this: Remember, the material will be brand new (and challenging) to everybody in the room. If you can't ask me a question during or after class, there are still options for help:

- Come to my posted office hours. Don't ever hesitate to come by, even if you think you are behind in your studying. Getting you caught back up is **exactly** what those opportunities are there for!

- Send me an email (mdemers@uoguelph.ca). If you do this, it would be extremely helpful for you to *attach a picture of your work*, so I can easily see where you might be stuck and be able to help you more quickly.

3 Assessment

3.1 Dates and Distribution

"Your Turn" Class Assignments:
Worth 2% apiece up to a maximum of 20%

Rather than watch me prove stuff on the board all the time, it will be "your turn" to do some work and get in some practice. These will be short assignments that are given in the last part of each Thursday class. You will have the chance to complete the assignment either by yourself or in a group of up to three students, using any resources you like. I will be available to help you out as well. The material will be related to concepts recently covered in the course.

Take-Home Assignments:
Worth 2% apiece up to a maximum of 20%

Short take-home assignments will be given each week to help cement recent concepts. These will be given out (and posted) on Tuesdays, to be submitted on Thursday at the beginning of lecture. These will aim to help you describe definitions, provide examples (or counterexamples), and gain a better feel for some of the abstract concepts that we have covered. These will generally be only a question or two in length.

Tests:

Tuesday, October 8
2:30 – 3:50 pm
Worth 15% of your grade
MACN 118

Tuesday, November 5
2:30 – 3:50 pm
Worth 15% of your grade
MACN 118

Final Exam:
Thursday, December 12
8:30 – 10:30 am
Worth 30% of your grade, plus the remainder of any grades not obtained through "Your Turn" or take-home assignments.

Example 1: Raphael obtains 16.6/20 over the semester for in-class assignments, and 19/20 for take-home assignments. So, the final exam is worth 34.4% of his grade (30 as usual, plus 3.4 for the unclaimed in-class assignment grades, plus 1 for the unclaimed take-home assignment grades).

Example 2: Astra-Lynn does not submit any assignments of any kind over the whole semester (not advisable!). So, the final exam is worth 30 + 20 + 20 = 70% of their final grade.

3.2 Course Grading Policies

Missed Assessments:
If you are unable to attend any tests due to medical, psychological, or compassionate

reasons, please email me. See below for details and consult the undergraduate calendar for information on regulations and procedures for Academic Consideration:

https://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-ac.shtml

Accommodation of Religious Obligations:
If you are unable to meet an in-course requirement due to religious obligations, please email me within two weeks of the start of the semester to make alternate arrangements. See the undergraduate calendar for information on regulations and procedures for Academic Accommodation of Religious Obligations:

https://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-accomrelig.shtml

Passing grade:
You must receive a final grade of 50% or greater in order to pass this course. In addition, you cannot pass by virtue of the assignments alone. *For this course, that means you must pass at least one of the tests or the final exam, or else your final grade will be capped at 48%.*

Missed Tests:
If you miss a test due to acceptable grounds for granting accommodation, the weight of the missed assessment will be added to the final exam. There will be no makeup midterm tests. If you know in advance that you have a conflict for a test, provide me with at least two weeks of notice. I will try to schedule an alternative writing time *ahead* of the scheduled assessment (but for clarity, I cannot guarantee that such an arrangement will be possible). Only in very exceptional circumstances will I allow for an alternative time that is afterward.

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4 Aims, Objectives & Graduate Attributes

4.1 Calendar Description

4.2 This course provides a basic foundation for real analysis. The rigorous treatment of the subject in terms of theory and examples gives students the flavor of mathematical reasoning and intuition for other advanced topics in mathematics. Topics covered include the real number line and the supremum property; metric spaces; continuity and uniform continuity; completeness and compactness; the Banach fixed-point theorem and its applications to ODEs; uniform convergence and the rigorous treatment of the Riemann integral.
Prerequisite Courses: Math*2000, Math*2210, One of Math*1160 or Math*2160

4.3 Course Aims

This course is taught with the goal of continuing to develop the logical, problem-solving, creative, and abstract thinking skills that students have first encountered in Math*2000. Many of the concepts presented will provide a deeper and more rigorous treatment of material that

students will already be familiar with. So, it is hoped that students will emerge from this course with a greater appreciation for concepts involving the real number line, real functions, sets, proof techniques, and more; while extending to new ideas that set the stage for more advanced analysis courses.

4.4 Learning Objectives

At the successful completion of this course, the student will have demonstrated the ability to:

1. Explain various properties of the real number line by building from basic field axioms toward more sophisticated results.
2. Define metric spaces.
3. Discern between open and closed sets; finite, countable, and infinite sets; interior, boundary, and limit points, and the closure of a set.
4. Work with sequences in a variety of contexts, and explain convergence of sequences and uniform convergence of functions.
5. Rigorously define familiar topics such as limits, continuity, and the Riemann integral.
6. Understand the importance of completeness, compactness, and the Heine-Borel theorem.
7. Calculate fixed points for various functions or operators and understand various consequences of Banach's Fixed Point Theorem.

4.5 Instructor's Role and Responsibility to Students

As your instructor, I pledge to:

1. Come prepared to each lecture and deliver course material in a professional way that facilitates learning for a variety of students and learning styles.

2. Respond to you. This includes, as time permits, questions during or after lectures, during office hours, or through email. You are more than welcome to contact me at any time through these means if you have questions or concerns about the course or new concepts.

3. Evaluate you fairly, providing prompt feedback on your performance and justification for any grades you are given. I must provide academic consideration, where appropriate, as described in Section 3.

4.6 Students' Learning Responsibilities

As a member of this class, you are expected to:

1. Take advantage of the learning opportunities provided during lectures and assignments, and through Courselink.
2. Treat myself and other students with dignity whenever you address them, in-class or online.

3. Genuinely try all homework in a timely manner and make the effort of attempting optional practice questions, especially if you have faced some trouble with math courses in the past.
4. Seek help if you have tried the homework and are still having difficulty with the course content. This means talking to me! Contact me through email or in office hours (*not* just at the last minute!) and possibly consider other resources as I recommend them to you.
5. Check all of your posted grades with tests that have been returned to you, to verify that the correct mark has been recorded. If not, then for tests, get in touch with me right away in person or through email, and we will figure things out. For lab assignments, contact your TA and they will do the same.
6. Notify me, as described in Section 3, in the case that there are academic conflicts that are known in advance. If illness, work, or extra-curricular activities are causing you to struggle, you are advised to keep me up-to-date on your progress, so that I can be more helpful to you.

4.7 Relationships with other Courses & Labs

Math*2000, Math*2210, Math*1160 or Math*2160. These courses provide some fundamental tools that will be helpful in understanding new concepts introduced in this course.

Follow-On Courses
Math*4200 (Advanced Analysis), Various Topics in Mathematics courses.
Many senior courses will come with the expectation that students have a grasp of many of the fundamental concepts from this course. Real Analysis also provides some important background for many research areas, for those students interested in pursuing graduate studies.

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5 Teaching and Learning Activities

5.1 Timetable

Lectures:
Tuesdays and Thursdays, 2:30 – 3:50 pm in MACN 118

5.2 Lecture Schedule – (Please note that the timing may vary slightly)

Lecture(s)	Topic	Text Chapter	Learning Outcomes
Lectures 1-4	Basics of the Real Number Line	1	LO 1
5	Metric Spaces	2	LO 2
6-9	Open Sets, Closed Sets, Sequences	3	LO 3,4
10	Test #1		
11-12	Real Functions, Limits, and Continuity	4, 5	LO 5

13-14	Completeness and Compactness	6, 7	LO 6
15-16	Fixed Points and Banach's Fixed Point Theorem	10	LO 7
17	Test #2		
18-19	Iterated Function Systems and Fractals	- - -	LO 7
20-22	Integration of Real Functions	11	LO 5
23-24	Uniform Convergence of Functions	12	LO 4

5.3 Drop Date

Students will have until the last day of classes to drop courses without academic penalty. The deadline to drop two-semester courses will be the last day of classes in the second semester. This applies to all students (undergraduate, graduate and diploma) except for Doctor of Veterinary Medicine and Associate Diploma in Veterinary Technology (conventional and alternative delivery) students. The regulations and procedures for course registration are available in their respective Academic Calendars.

Undergraduate Calendar - Dropping Courses
https://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-drop.shtml
Graduate Calendar - Registration Changes
https://www.uoguelph.ca/registrar/calendars/graduate/current/genreg/genreg-reg-regchg.shtml
Associate Diploma Calendar - Dropping Courses
https://www.uoguelph.ca/registrar/calendars/diploma/current/c08/c08-drop.shtml

5.4 Other Important Dates

Thursday, September 5: First day of classes
Monday, October 14: Thanksgiving Day (no classes scheduled)
Tuesday, October 15: Fall Study Break Day (no classes are scheduled)
Thursday, November 28: Tuesday class schedule is in effect
Friday, November 29: Last day of classes; Monday class schedule is in effect

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6 Academic Misconduct

The University of Guelph is committed to upholding the highest standards of academic integrity and it is the responsibility of all members of the University community faculty, staff, and students to be aware of what constitutes academic misconduct and to do as much as possible to prevent academic offences from occurring. University of Guelph students have the responsibility of abiding by the University's policy on academic misconduct regardless of their location of study; faculty, staff and students have the responsibility of supporting an environment that discourages misconduct. Students need to remain aware that instructors have access to and the right to use electronic and other means of detection.
Please note: Whether or not a student intended to commit academic misconduct is not relevant for a finding of guilt. Hurried or careless submission of assignments does not excuse students from responsibility for verifying the academic integrity of their work before submitting it.

Students who are in any doubt as to whether an action on their part could be construed as an academic offence should consult with a faculty member.

6.1 Resources

The Academic Misconduct Policy is detailed in the Undergraduate Calendar: https://www.uoguelph.ca/registrar/calendars/undergraduate/current/c08/c08-amisconduct.shtml

A tutorial on Academic Misconduct produced by the Learning Commons can be found at: https://academicintegrity.uoguelph.ca/

7 ACCESSIBILITY

The University of Guelph is committed to creating a barrier-free environment. Providing services for students is a shared responsibility among students, faculty and administrators. This relationship is based on respect of individual rights, the dignity of the individual and the University community's shared commitment to an open and supportive learning environment. Students requiring service or accommodation, whether due to an identified, ongoing disability for a short-term disability should contact Student Accessibility Services as soon as possible.

For more information, contact SAS at 519-824-4120 ext. 56208 or email sas@uoguelph.ca or see the website: https://wellness.uoguelph.ca/accessibility/

8 RECORDING OF MATERIALS

Presentations which are made in relation to course work—including lectures—cannot be recorded or copied without the permission of the presenter, whether the instructor, classmate or guest lecturer. Material recorded with permission is restricted to use for that course unless further permission is granted.

9 RESOURCES

The Academic Calendars are the source of information about the University of Guelph's procedures, policies and regulations which apply to undergraduate, graduate and diploma programs: https://www.uoguelph.ca/registrar/calendars