Math 4023, Introduction to Analysis

Syllabus: Online Section Summer 2019

Professor: Dr. Lisa Mantini, 410 Math Sciences, 405–744–5777

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▷ Course Times: This is an online course containing about 35 hours of pre-recorded video, available on Canvas, and associated assignments and exams.

▷ Instructor's office hours in 410 MSCS (in person or by telephone or video conference): Mondays and Thursdays from 3:00–4:30 PM and by appointment.

▷ Instructor will schedule additional virtual office hours in the conferencing system on Canvas, tentatively in early evenings on Tuesdays and Thursdays and by appointment.

Course Objectives: to study the theorems and proofs of calculus, aiming to

- help students become fluent in the ideas of beginning analysis including set theory, cardinality, properties of the real numbers, sequences and convergence, limits of functions, and continuity, so that students will be able to read and write arguments about topics in these areas.
- help students develop additional understanding of and fluency with the processes of pure mathematics itself including the role of definitions, the structure of proofs, logical reasoning, problem solving, and mathematical reading and writing.

Prerequisites: Calculus II (Math 2153), for computational experience with calculus, and Introduction to Abstract Algebra (MATH 3613), for familiarity with logic and mathematical proof. All prerequisite courses must be completed with grades of C or better. Students who have a prior familiarity with proof from other courses such as CS 3653 will probably be well prepared. I include enough material on logic and proof that well-motivated students who have not completed Math 3613 can be successful.

Required Text: *Analysis: With an Introduction to Proof*, fifth edition, by Steven R. Lay, ISBN 978-0-321-74747-1. The textbook on proof that would have been covered in Math 3613 is *How to Prove It: A Structured Approach*, second edition, by Daniel J. Velleman, ISBN 978-0-521-67599-4, chapters 1–3 and sections 4.1, 5.1 and 6.1.

Course Requirements: Students enrolled in this course will complete the following:

ITEM	DATES*	POINTS	WEIGHT
Homework	various	150 pts	23%
Worksheets	various	50 pts	8%
Exam 1	Friday–Saturday, June 28–29	150 pts	23%
Exam 2	Friday–Saturday, July 12–13	150 pts	23%
Exam 3	Friday–Saturday, August 2–3	150 pts	23%
TOTAL	For undergraduates:	650 pts	100%
Grad credit	various	50 pts	
TOTAL	For graduate students:	700 pts	100%

*Exam requirements and timing are discussed below.

Grading: Preliminary grade cutoffs for undergraduates, which may be curved very slightly if circumstances warrant, are:

- 585 points (90%) guarantees an A in the course;
- 520 points (80%) guarantees a B;
- 455 points (70%) guarantees a C;
- 390 points (60%) guarantees a D.
- Graduate students must complete three extra assignments for graduate credit, worth 15–20 points each, for a total of 50 additional points and a course total of 700 points. The percentages determining letter grades are the same as above.
- Undergraduates wishing to earn Honors credit will complete the same three extra assignments, but they will graded for completion only.

Course Components: The following paragraphs give further information about the various components of this course.

Course Structure The course is divided into ten Units. There is a homework assignment for each Unit, and some units also have 1–2 associated Worksheets covering preliminary material. Groups of three or four Units end in an Exam. There is also a Unit for Graduate and Honors students containing the additional assignments and related material for graduate and/or honors credit. The sections covered in each Unit and assignment due dates are given below.

Unit	Text Sections	Video Length (hours)	Assignment Due
1	1.1–1.4, 3.1	3.99	June 14
2	2.1, 2.2	3.07	June 19
3	2.3	2.75	June 21
4	2.4	3.64	June 26
Grad Asn 1	2.4	1.06	July 1
	Exam 1		June 28 (or 29)
5	3.2, 3.3	2.32	July 3
6	3.3, 3.4	2.65	July 5
7	3.4, 3.5	4.29	July 10
Grad Asn 2	3.5	.82	July 15
	Exam 2		July 12 (or 13)
8	4.1, 4.2, 4.4	3.38	July 19
9	4.2, 5.1, 4.3	4.62	July 26
10	5.2, 5.3, 4.3	4.37	July 31
Grad Asn 3	4.3	.65	August 2
	Exam 3		August 2 (or 3)

Lecture Video My lectures for this course have been recorded by one of our videographers here at OSU's Institute for Teaching and Learning Excellence (ITLE). There are numerous video clips for each section of the text. Video clips range from 3 minutes (for a single example) to 27 minutes (for a long proof) in length,

with the average video length about 13 minutes, and most videos running from 10 to 18 minutes in length. There are over 150 clips for the entire course, totalling about 35 hours of video (not including one very long proof which is optional). The lecture video clips are tied to the homework exercises to some extent, so a recommended procedure would be for you to

- watch a clip, working through the results,
- read the assignment to find the related homework problems, then
- complete those before going on to later video clips.

A standard pace would be for you to watch roughly 5 hours of video per week in summer school (equivalent to 2 weeks of a regular semester), but I am recommending approximately 7 hours of video during Week 1, to allow some extra time on the foundations of logic and mathematical proof. Assignment due dates are designed to correspond with this pace.

HOMEWORK In this course you will complete about 5 worksheets worth 10 points each, and 10 written assignments worth 15 points each, that cover computational and theoretical aspects of our content. Worksheets and assignments are provided in pdf form with blank space left for your solutions to the problems. Most of the time, enough space will be available once you understand the proof and can write it up neatly and concisely (or you may add additional pages if needed).

▷ Please hand write your solutions neatly in the space available as much as is possible, create a *single pdf* of your assignment. To do this, you may use a copy machine, or you may use an app on your phone (such as Turboscan or Tinyscanner). Name your file with the Course number, the Assignment, and Your Last Name:

$$4023\_\text{Asn}0n\_\text{LastName.pdf},$$

and upload to the appropriate dropbox in Canvas, attached to the assignment itself.

▷ Assignments are due at 11:59 PM on the due date. Assignments due on a Friday generally have a grace period until 5:00 PM the following Saturday. Late assignments will still be accepted until the time of the next exam but may accrue small point deductions.

▷ We will release my typed solutions to students who have submitted the assignment. Reading my solutions is a good idea, as I expect you to know their content on exams.

DISCUSSION BOARDS Every unit in this course is accompanied by a Discussion Board on which students can post questions or discuss course content with each other. I will try to check these periodically to give replies to questions. These are optional and are not graded. (Students may also discuss questions directly with me, in person, by email, or in a virtual conference.)

EXAMS Exams in this course are done on paper with pencil (or pen), supervised by an approved proctor, and are to be completed in 90 minutes. Distance students will have two days in which to schedule the exam, and must find a suitable proctor and

submit a signed proctor agreement. Local students may use the testing centers on campus, such as in UAT or in the Wes Watkins Center (for a fee), or may use the test proctoring provided by the Department of Mathematics without charge. The times at which I will proctor our exams are as follows:

Exam	Time	Location
Exam 1	Friday, June 28, 10:30 AM	514 MSCS
Exam 2	Friday, July 12, 10:30 AM	514 MSCS
Exam 3	Friday, August 2, 10:30 AM	514 MSCS

Additional proctoring times may be available in the OSU Math Department by private arrangement with the office staff.

▷ All students must complete the Math 4023 Exam Proctor Agreement and return it to me by **Monday, June 17, 2019**.

GRADUATE CREDIT Graduate students wishing to earn Graduate credit, or honors students wishing to earn Honors credit for the course, must complete three extra assignments, one for each part of the course. These are graded out of 15–20 points each. For Honors students, the assignments are graded for completion only. For graduate students, the 50 points earned count towards their course total of 700 points. These assignments go into a bit more depth on topics we do not have time to investigate during the course itself. They are also supported by a few additional video clips. The selected topics are listed below.

Grad Asn 1: This assignment accompanies section 2.4 and leads the student through a proof of the Cantor-Schröder-Bernstein Theorem, a wonderful result in set theory that says that if you have an injective function $f : S \to T$ and another injective function $g : T \to S$, for some sets S and T, then you can construct a bijective function $h : S \to T$. Using the notation of set theory, we are in fact proving that if $|S| \leq |T|$ and $|T| \leq |S|$, then $|S| = |T|$.

Grad Asn 2: This assignment accompanies section 3.5 and deals with the construction of the Cantor Set, the first known fractal. It is a wonderful application of the notion of compactness and the Nested Intervals Theorem, and it is an uncountable set that contains no intervals! As a preliminary, we introduce binary (base 2) and tertiary (base 3) expressions for real numbers.

Grad Asn 3: This assignment accompanies section 4.3 and deals with the construction of the number e. You may recall from calculus the limit $e = \lim_{n\to\infty}(1 + \frac{1}{n})^n$. In fact, in a rigorous presentation of the subject, this is the *definition* of the number e. This assignment shows why this limit comes up in reference to a function whose derivative is itself, and then uses the binomial theorem and the monotone convergence theorem to prove the existence of the limit above.

Deadlines: See the Syllabus Attachment for deadlines for dropping or withdrawing from the course and other important information.

Special Accommodations: If you have a qualified disability and need special accommodations, you should notify me as soon as possible and request verification of eligibility for accommodations from the Office of Student Disability Services.

Academic Integrity: Oklahoma State University is committed to the maintenance of the highest standards of integrity and ethical conduct of its members. This level of ethical behavior and integrity will be maintained in this course. Participating in a behavior that violates academic integrity will result in your being sanctioned. These behaviors include, but are not limited to, unauthorized collaboration or plagiarism, cheating on examinations, or helping another person cheat. Violations may subject you to disciplinary action including the following: receiving a failing grade on an assignment, examination or course, receiving a notation of a violation of academic integrity on your transcript (F!), or being suspended from the University. Sanctions are much more severe for graduate students — see academicintegrity.okstate.edu.

- ▷ With regard to the homework in this course, I encourage the formation of study groups and the discussion of homework solutions. However, you must write up your homework solutions and other assessments *yourself* unless an assignment is specifically listed as a group assignment. You must never claim ideas that are not your own as your own.
- ▷ If you don't understand it or could not explain it to me, don't write it down!
- ▷ You may certainly help your classmates but you should not show your written solutions to other students.
- ▷ Any published, reputable sources that you consult other than our textbook must be cited (include a comment in parentheses giving the author's name and title of book or URL). Material influenced by sources other than our textbook should not be copied verbatim but should be written in your own words.