

# TRANSITION TO ADVANCED MATHEMATICS

FALL 2020

MATH 265-01

MWF

1:00 - 1:50 PM

CAE 208

## INSTRUCTOR

Dr. Lauren Williams  
Old Main 404  
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(814) 824-2226

## COURSE DESCRIPTION

This course is designed to facilitate the mathematics student's transition to courses requiring a higher level of mathematical maturity. Emphasis will be on the reading and writing of proofs, and on communicating mathematics both orally and in writing. Topics will include logic, set theory, functions, relations, and number theory.

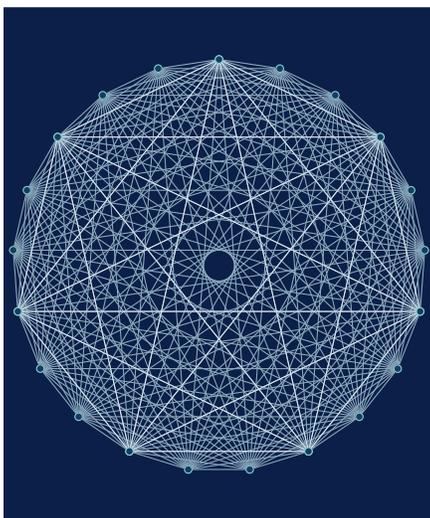
## COURSE OBJECTIVES

In this course, you will:

- learn to write using formal, mathematical language with correct notation;
- learn to construct direct proofs, proof by contradiction, and proofs by induction;
- learn to read mathematics critically, and be able to determine whether a proof is sound or flawed;
- define relations between sets of objects and the properties of those relations;
- learn the basic definitions and principles of logic, set theory, combinatorics, and number theory;
- be exposed to several different areas of mathematics, via direct study or within examples designed to clarify other topics;
- learn to apply new techniques of problem solving to challenging material, both in this course and in future study.

## PREREQUISITES

This course is intended for students pursuing a major or minor in mathematics. Calculus I and Linear Algebra, or instructor permission, are required.



## OFFICE HOURS

Monday 10:00 - 11:00  
Tuesday 3:00 - 4:00  
Wednesday 12:00 - 12:45  
Thursday 8:00 - 9:30  
Thursday 2:00 - 3:30  
*and by appointment*

WEBSITE: <https://www.integral-domain.org/lwilliams/>

## TEXTBOOK

*Book of Proof, 3rd Edition*, by Richard Hammack  
ISBN-10: 978-0-9894721-2-8

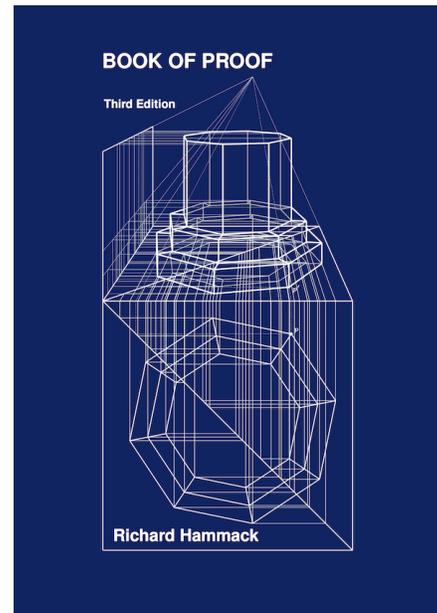
The textbook is available as a free PDF from the author's website:

<https://www.people.vcu.edu/~rhammack/BookOfProof/>

An older edition of the text is fine to use for class.

You will not be expected to bring the text to class, so the electronic version is all you'll need. However, inexpensive (~ \$15) paperback copies are available through the website above if you would prefer a hard copy.

You are strongly encouraged to read ahead in the text, and work on the practice problems at the end of each section after we've covered the topic in class. Solutions to many problems are at the end of the textbook. Your work on these problems will not be collected, but the questions may appear on exams.



## ADDITIONAL RESOURCES

There are several free textbooks and websites that you may find useful and inspiring while taking this course:

- The American Institute of Mathematics maintains a list of reviewed, open source textbooks, several of which focus on an introduction to proofs. There are also texts on prerequisite subjects, including calculus, linear algebra, and more.  
<https://aimath.org/textbooks/approved-textbooks/>
- CoCalc is a cloud based, online computing environment that allows you to write programs in SageMath, GAP, Maxima, R, Python, Julia, and many more. You can also learn and practice typesetting in  $\text{\LaTeX}$ , highly recommended for all mathematics students.  
<https://cocalc.com/>
- Cut the Knot features an enormous collection of interesting mathematics problems, puzzles, proofs, and games.  
<https://www.cut-the-knot.org/front.shtml>

## OTHER COURSE INFORMATION

- Be warned - you will struggle in this class! The material here is unlike anything you've seen before, and is not at all like a traditional math course. You'll be learning a new language along with some new abstract mathematics. Be prepared to spend plenty of time on the homework and reading.
- Please ask questions - in class or office hours - whenever you're stuck, but make an effort to find a solution or proof before seeking help. The process is more important than the result in this course, and the only way to become comfortable is to work through it on your own.
- I will attempt to answer email as quickly as possible, but please allow up to 24 hours for a response (particularly on weekends).

## COURSE COMPONENTS

### Homework

There will be homework assignments given regularly throughout the semester. Most collected problems will not be from the textbook, so these assignments are considered to be in addition to recommended problems from the book.

For collected problems, you are expected to submit your final work. Problems involving calculations should include work and an explanation of the steps used to arrive at your answer. Proofs should use formal language and notation, as covered in class. Work should be clear and neatly written.

You should expect to spend a fair amount of time on each assignment - don't wait until the night before it's due to get started! You are free to work together on your assignments, but everyone must submit their own work, in their own words. Late homework will be accepted with a 2 point per day penalty, until the graded assignment is returned to class.

This semester, I will be unable to collect your homework on paper. You can submit a clear scan or photo of your work through Blackboard. If you're familiar with the  $\text{\LaTeX}$ typesetting language, this would be a great time to use those skills!

### Exams

We will have three midterm exams. These exams will be based on homework problems and the suggested textbook problems that do not need to be turned in.

Each exam will have an "in class" and a "take home" portion. The in class part will focus on definitions and basic calculations.

## GRADING

Your final grade will be calculated as follows:

Component	Value	Total Points
Homework (10 best)	20 points each	<b>200 points</b>
Exams (3)	100 points each	<b>300 points</b>
		<b>500 points</b>

Your letter grade will be based on the total number of points you earn throughout the semester:

Grade	Percentage	Points Needed
A	90	<b>448</b>
B+	87	<b>433</b>
B	80	<b>398</b>
C+	77	<b>383</b>
C	70	<b>348</b>
D+	67	<b>333</b>
D	60	<b>298</b>

## COVID-19 INFORMATION

This is sure to be an unprecedented semester! While we cannot know what the next few months will bring, we must all work together to keep our campus community safe and healthy.

This page features information regarding policies of the University (in italics) as well as comments, suggestions, and requests that pertain to our class specifically.

### Face Masks

*As per the COVID-19 Prevention, Mitigation, and Response Policy, Mercyhurst University is requiring that all members of the campus community wear a cloth or disposable face covering over their nose and mouth when on campus. Please refer to the policy for specific details as to where and when face coverings are required. Students may use their own face coverings or those provided by the University. A student in need of a face covering should email covid19@mercyhurst.edu or call 814-824-3600 to find the nearest location where face coverings are available. The University's Mask/Face Coverings Policy will be enforced in this class.*

I will have a few disposable masks with me in case you need to borrow one, but please understand that these supplies are limited.

### Sanitation and Safety

*In keeping with the COVID-19 Prevention, Mitigation, and Response Policy, students are expected to use hand sanitizer and to wipe down their desks using disinfectant wipes when they enter and exit the classroom. Classrooms have been provided with sanitizer and disinfectant wipes for student and faculty use.*

### Eating and Drinking in the Classroom

*In light of the COVID-19 situation, Eating is not permitted in classrooms, labs, or other academic spaces. A water bottle or cup with a lid, and straw preferably, is permitted to be used in classrooms and labs to help prevent a student from becoming uncomfortably parched. Masks should be pulled only slightly away from the bottom of the face to take a quick drink and immediately replaced to covering the mouth and nose.*

### Class Dismissal, Congestion Prevention

*In keeping with the COVID-19 Prevention, Mitigation, and Response Policy, faculty members and students should take steps to avoid crowding outside of classrooms, in hallways, and any enclosed area in university buildings. All rooms will be designated with signs indicating maximum capacity for specific instructional use. These must always be adhered to. Students waiting to enter classrooms or exiting classrooms should always maintain a minimum of 6 feet of distance from others. Class time endings may be adjusted when necessary to minimize overcrowding or congestion.*

### Seating Chart

*In compliance with federal and state regulations, the University must be able to conduct contact tracing if there is a positive test or an outbreak; therefore, seating charts are mandatory for all in-person classes. Students will be required to sit in the same seat in the classroom each time they attend class. The seating chart will be available for review for purposes of contact tracing.*

## COVID-19 INFORMATION, CONTINUED

### Paper Sharing Policy

*We will not be exchanging paper this semester. Supplemental materials will be distributed and made available electronically. Assignments and exams will be submitted electronically as well. You are welcome to bring your own paper to class to take notes, but you may not pass paper to a classmate or to me.*

### Attendance, Missed Class

*Attendance at all classes is expected. However, it is important that students and course instructors adhere to the university's COVID-19 mitigation policies and strategies. As such, a student who misses class due to illness or suspected illness within the context of those policies will not be penalized and will be provided sufficient means to make up any missed course content or work and remain actively engaged in the class.*

The word “attendance” has a broader definition than usual this semester. While attending class is certainly preferred, please do not feel obligated to come if you have any potential symptoms. I plan to record all class meetings via Zoom, and those recordings will be available on Blackboard throughout the semester. You can also join and participate in the live Zoom meeting. If you're not up to joining in, watch the meeting and the associated pre-recorded video lectures when you're able to.

If you are unable to attend class (or join the live Zoom meeting) for more than a few days, please let me know as soon as possible. I am happy to work with you in building a plan that allows you the time off you need without risking your academic progress.

### Potential Class Changes

Mathematics students are a rare breed, which this semester is a good thing: it means that our class is small enough to safely meet in person! It is my hope that we remain able to meet in person as scheduled for the entire semester. However, there is a very good chance that our plans will change, and without much notice.

If we are unable to continue meeting in person, you will still have the opportunity to “attend” class via Zoom during our regularly scheduled times. The video content on Blackboard was created specifically for this semester, to help fill in any unexpected gaps in meetings or attendance.

Our highest priority (even above learning about determinants and vector spaces) is to remain healthy and safe. We will all need to remain responsible, flexible, and understanding to make this semester a success, and I have full confidence that we will be able to achieve that goal.

## **ADA AND LEARNING DIFFERENCES**

Mercyhurst University is committed to making reasonable accommodations for qualified students, and employees with disabilities as required by law. Individuals seeking an accommodation for a disability must submit a written request outlining the specific accommodation request being made. Supporting documentation may also be required. To request an accommodation, contact Alice Agnew, Director of Equal Opportunity Programs, 311 Egan Hall, aagnew@mercyhurst.edu, 814-824-2362.

## **TITLE IX INFORMATION**

Mercyhurst is committed to providing an environment free from sex discrimination, including sexual harassment and sexual violence. Please refer to the Title IX – Sexual Respect button on the HUB for more information. If you would like to file a sexual misconduct complaint, please contact Mercyhurst Title IX Coordinator Alice Agnew, 311 Egan Hall, aagnew@mercyhurst.edu, 814-824-2362. Please be aware that in compliance with Title IX educators must report incidents of sexual assault/harassment, stalking, and domestic/dating violence. If you disclose any of these situations in class, in papers, or to me personally, I am required to report it to the Title IX Coordinator (or any of the Deputy Title IX Coordinators).

## **ACADEMIC HONESTY**

Students are required to uphold academic integrity throughout the course. In particular, plagiarism of any sort, unauthorized collaboration on exams, quizzes and other assignments, and other incidences of academic dishonesty will be handled according to the policies set forth in the Student Handbook.

## **COURSE EVALUATIONS**

Near the end of the semester, you will be asked to complete an online course evaluation. The evaluation will be completed in class during the last two weeks of the semester using any laptop, tablet, or mobile device. The response tool allows you to note aspects of the course that helped you learn, as well as aspects that might be modified to help future students learn more effectively. You will receive an email letting you know when the evaluation window for our class is open. Please note that these course evaluations are anonymous and instructors do not see the results until after the grades for the course are submitted.

## COURSE SCHEDULE

Aug	19	Class Introduction
	21	Intro to Sets, Cartesian Product
	24	Set Operations, Venn Diagrams
	26	Subsets, Power Sets
Sep	28	Indexed Sets, Number Systems
	31	Statements, And, Or, Not
	2	Conditional and Biconditional Statements
	4	Truth Tables, Logical Equivalence
	7	Truth Tables, Logical Equivalence
	9	Quantifiers
	11	Symbolic Logic
	14	Negation
	16	Review/Catch Up
	18	<b>Exam I</b>
Oct	21	Factorials, Counting Subsets
	23	The Binomial Theorem
	25	Theorems and Definitions
	28	Proof Writing Basics
	30	Direct Proof
	2	Direct Proof
	5	Proof by Cases
	7	Contrapositive Proofs
	9	Proof by Contradiction
	12	Combining Techniques
	14	Biconditional Proofs, Equivalent Statements
	16	Biconditional Proofs, Equivalent Statements
	19	Existence and Uniqueness
21	Review/Catch Up	
23	<b>Exam II</b>	
Nov	26	Set Equality
	28	Proofs Involving Sets
	30	Counterexamples and Disproof
	2	Proof by Induction
	4	Relations
	6	Equivalence Relations
	9	Equivalence Classes and Partitions
	11	Integers Modulo $n$
	13	Functions
	16	Injective and Surjective Functions
	18	Injective and Surjective Functions
20	Inverse Functions	
23	<b>Exam III</b>	
25	<i>No Class - Thanksgiving Break</i>	
27	<i>No Class - Thanksgiving Break</i>	

## OTHER IMPORTANT DATES

August 31  
Add/Drop Deadline

October 14  
Advising Day

November 10  
Withdrawal Deadline

November 23  
Fibonacci Day

December 16  
Pythagorean Triple Day

### IMPORTANT NOTE:

Due to the current COVID-19 pandemic, it is more likely than usual that our semester plans will be altered. While I will attempt to follow this schedule as closely as possible, please make a note of any announced changes to important dates in class or on Blackboard.