

# Introduction to Complex Variables (Math 419)

Fall 2024

## Technicalities

**Instructor:** Dr. Clayton Shonkwiler ([clayton.shonkwiler@colostate.edu](mailto:clayton.shonkwiler@colostate.edu))

**Office:** Weber 206C

**Course web page:** <https://col.st/WDZ01>

**Text:** *A First Course in Complex Analysis*, by Matthias Beck, Gerald Marchesi, Dennis Pixton, and Lucas Sabalka, which is available free online at <https://matthbeck.github.io/complex.html>

**Time/Location:** 11:00–11:50 MWF, Engineering B2.

**Office Hours:** 1:00–2:00 Wednesday, 2:00–3:00 Thursday.

## Course Content

### Part I: Differentiation and Integration – 6 weeks

- (Chapter 1) Algebra, geometry, and topology of complex numbers
- (Chapter 2) Limits, differentiation, holomorphic functions, Cauchy–Riemann equations
- (Chapter 3) Möbius transformations, the cross ratio, stereographic projection, exponentials, logarithms, and trigonometric functions
- (Chapter 4) Integration, antiderivatives, Cauchy’s theorem, Cauchy’s integral formula
- **Midterm 1:** Sept. 27–Oct. 4.

### Part II: Consequences and Residues – 7 weeks

- (Chapter 5) Derivative formulas, Morera’s theorem, Fundamental Theorem of Algebra, Liouville’s theorem,
- (Chapter 6) Harmonic functions and PDEs, the maximum principle
- (Chapter 7) Power series and convergence
- (Chapter 8) Analytic functions, classification of zeros, identity principle, maximum-modulus theorem, Laurent series
- (Chapter 9) Classification of singularities, residues, meromorphic functions, argument principle, Rouché’s theorem,
- **Midterm 2:** Nov. 15–Nov. 22.

### Part III: Applications – 2 weeks

- (Chapter 10) Residues and counting, gamma and eta functions
- Fluid flows

## Prerequisites

Students are expected to have a solid grounding in multivariable calculus, equivalent to the content offered in MATH 261. Line integrals are particularly relevant to this course. Students without experience in proof-based courses (e.g., MATH 317 or MATH 366) may struggle.

## Course Goals

Students will develop a deep understanding of the complex numbers, complex functions, and their connections to different areas of mathematics. This will require a synthesis of geometric visualization, symbolic and numerical calculation, and rigorous reasoning and communication.

## Assignments

It is impossible to *learn* mathematics without actually *doing* mathematics. The goal of the assignments is to deepen your understanding of the concepts, tools and techniques discussed in class, as well as to give you the opportunity to practice explaining your mathematical thinking. The importance of effective communication is vital: knowledge without the ability to communicate that knowledge is of limited value. As such, to get full credit on a problem your solution must be clear and well-written.

### Reading Assignments

You will be assigned to read relevant sections from the text before the material is discussed in class. Although it is impossible (at least absent some pretty intrusive surveillance) to check whether you are doing this reading, you will also be expected to do a short online reading comprehension quiz on Canvas for each reading assignment. This quiz will not be graded for correctness, only for whether you made an honest attempt at each problem.

### Homework

Homework will be collected every week or two.

Homework must be stapled with your name clearly written at the top. What you turn in should be a final copy: it should be neat, legible, and well-organized. If I can't read or understand your work you won't receive any credit.

Late homework will not be accepted, so you should turn in whatever you have completed on the due date in order to get credit for it.

I strongly encourage you to work on solving homework problems with your fellow classmates. However, the work you turn in must reflect your own knowledge and understanding and not that of anyone else. Therefore, you *must* write up your solutions by yourself.

### Exams

There will two take-home midterm exams. You will have approximately 1 week to do each of the take-home midterms; the first will be due on **October 4** and the second on **November 22**.

No make-up examinations will be given in the course.

### Final Project

As a final project, you will create a poster for the math department poster session. The poster session will be held on Thursday, December 5. A list of potential project ideas will be circulated; you are also very welcome to develop your own. The following are deadlines for various milestones along the way:

**Sept. 27:** Project proposal  
**Oct. 25:** Two-page project description  
**Nov. 15:** Poster rough draft  
**Dec. 5:** Poster final draft

You may work on your poster in groups of up to three people.

## Attendance

You are expected to attend class every day, to participate in class, to read the textbook, and to do the homework.

## Grading

Your final grade in the course will be determined by:

**Homework and Class Participation:** 40%

**Exams:** 40%

**Final Project:** 20%

Here's how the grading process works. First, I compute an overall course grade for you on a scale of 0–100 by combining your exam and homework grades using the weights above. Then, I rank everybody in the class in order by their score and assign cutoffs for 'A', 'B', 'C', and 'D'. Generally these are somewhat lower than the traditional 90, 80, 70, and 60. When setting the cutoff I consider the students immediately above and below the line and try to take into account improvement and other circumstances. That being said, the list is never, ever reordered. Regardless of other circumstances, a better score in the class should always earn at least as good a letter grade. Ultimately, I can only grade the course based on what you have actually done.

## Policies

The Department of Mathematics has a set of policies which cover topics ranging from cell phones to alternate exams. These are available at

<https://mathematics.colostate.edu/undergraduate-students/departmental-class-policies> and it is your responsibility to read them.

Likewise, the Institute for Learning and Teaching provides policies relevant to this course and resources to help you with various challenges you may encounter at <https://col.st/2FA2g>

Some particular issues of interest:

## Academic honesty

Colorado State University has an Academic Integrity Policy (<https://catalog.colostate.edu/general-catalog/policies/students-responsibilities>) and a Student Conduct Code (<https://resolutioncenter.colostate.edu/conduct/>). These will be enforced in Math 419. Briefly, while you are encouraged to seek out help, including from your peers, for homework assignments, all work on any exam must be your own. Cases of flagrant academic dishonesty will be referred to Student Conduct Services.

## **Student Disability Center**

Colorado State University is committed to providing reasonable accommodations for all individuals with disabilities; the Student Disability Center (<https://disabilitycenter.colostate.edu>) coordinates the necessary support systems.

If you need accommodation, especially for exams, it is up to you to work with the Student Disability Center to make suitable arrangements; the sooner you do this, the better.

## **Additional help**

If I were a perfect teacher, you could learn everything you need to know just by going to class and doing the assignments. Unfortunately, I am not a perfect teacher, so there's a good chance that, at some point, you'll find yourself confused, stuck or otherwise frustrated by the material or the course. If you do, ask for help! Come to office hours, send me email, ask me questions after class.

Also, your fellow classmates are a great resource! Odds are that, for any question you have, there's someone in the class who can answer it, so don't be afraid to ask. Even the simple process of explaining why you're stuck to someone who is just as confused as you is often enough to make things clearer. Just be sure to return the favor when you get the chance to help someone else.

If you need additional help or outside resources, please ask and I will be happy to try to give suggestions.

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## **Disclaimer**

The course syllabus is a general plan for the course; deviations announced in class may be necessary.