

# Math 4/5880, Spring 2015

## Complex Variables

### Instructor: Paul Hewitt

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Office: UH 4080c      Hours: Monday, Wednesday, Friday, 12:30–1:50pm

At the times listed above you can call or stop by without an appointment. Feel free to ask for appointments at other times if you cannot make it to my regular office hours. My email address is simply paul.hewitt@utoledo.edu, which is often the best way to contact me. If you call me when I am not in my office then you can leave a voice mail message and I will get back to you as soon as I can.

Course info will be posted on the UT BlackBoard site <https://blackboard.utd1.edu/>. Please check frequently for announcements, changes, due dates, solutions, scores, and other goodies.

### Course overview

Welcome to Complex Variables! This is a beautiful subject developed over the years in an ongoing collaboration between mathematicians, physicists, and engineers. Despite the unfortunate name complex analysis is far simpler and more elegant than real analysis. As is clear from their many real-world applications complex numbers are just as real as any other kind.

### Course calendar

Monday, 19 January	<i>Martin Luther King Jr Day</i>
Friday, 13 February	Exam 1: Chapters 2–4
Monday–Friday, 9–13 March	<i>Spring Break</i>
Friday, 27 March	Exam 2: Chapters 5–7
Friday, 27 March	<i>Last Day to Withdraw</i>
Friday, 1 May	Exam 3: Chapters 8–10
2:45–4:45pm, Tuesday, 5 May	Comprehensive Final Exam

### Contingencies

I reserve the right to adjust the course content and calendar as need arises due to unforeseen circumstances.

### Catalog description and prerequisites

Analytic functions; Cauchy’s theorem; Taylor and Laurent series; residues; contour integrals; conformal mappings, analytic continuation and applications. Prerequisite: MATH 2860 (MATH 3860)

### Text and other resources

We will use *Complex Analysis*, by John Howie. This textbook is one of the most readable I have seen at this level, and is well regarded for self study. I expect you to peruse it. Reading math textbooks is not easy, but it is enjoyable and rewarding, especially for this beautiful subject.

Chapters 2–10 form the core material. Chapter 1 is a review of prerequisite material. We will not cover this material in class, altho I will assign exercises from this chapter. We will cover some or all of the material in chapters 11–12 as time permits.

In addition to the material in the text you should consult the biographies and historical sketches at the admirable MacTutor site <http://www-history.mcs.st-and.ac.uk/history/>, especially for those mathematicians footnoted in our text.

## Quizzes

There will be eight 10-point quizzes. I will not announce the dates of the quizzes beforehand. Your 5 best quiz scores will count towards your final grade. Some of the quiz questions will be multiple choice; some will be computational; some will require answers in complete sentences.

## Assignments

There will be eight 10-point exercise sets. I will post the problems and due dates as the semester progresses. I expect your solutions to be mathematically correct but also clear and well-written. I expect complete sentences, correct notation, and accurate diagrams. You will not get credit for a solution if you are vague or if you omit important details. Your 5 best homework scores will count towards your final grade.

After I grade your assignments you will have the opportunity to redo your solutions and present your work at the blackboard. I will schedule special office hours for these presentations. You must first turn in your written solutions to be able to take advantage of this opportunity to raise your homework scores.

Before you turn in your homework, fold the papers lengthwise and write on the outside

*your name, Math 4/5880, Spring 2015 assignment number, due date*

## Exams

There will be three 100-point midterm exams and an optional comprehensive final exam. The exam dates are listed on the calendar above. Some of the exam questions will be multiple choice; some will be computational; some will require answers in complete sentences.

## Academic dishonesty

The UT policy on academic dishonesty can be found at [www.utoledo.edu/dl/students/dishonesty.html](http://www.utoledo.edu/dl/students/dishonesty.html). I encourage you to work together. Studies show that students who work together consistently out-perform those who do not. However, your own work must be written in your own words. Do not “divide up the labor”. Do not turn in work that is not your own. Copying is cheating. This includes copying from another student or copying from a book or website. Any act of academic dishonesty will result in a 0 on the assignment, quiz, or exam in question. A second incident will result in an F for the course.

## Missed class policy

The UT Missed Class Policy can be found at [www.utoledo.edu/facsenate/missed\\_class\\_policy.html](http://www.utoledo.edu/facsenate/missed_class_policy.html). If circumstances governed by this policy result in you missing a quiz, assignment, or exam then you must contact me immediately, either by email, phone, or in person, and provide official documentation to justify your absence and arrange to make up the missed work as soon as you return. If you fail to show up for a quiz or exam and do not contact me about it until afterwards then you will get a 0 for that item.

## Grades

Your final grade will be determined from your total points earned, based on the following scale: 90% earns an A; 80% earns a B; 70% earns a C; 60% earns a D. I give grades such as A- and C+ sparingly. Scores and final grades will be posted on the UT BlackBoard page for this class.

Faculty cannot initiate a withdrawal. If you are still registered after the 10th week you will get a grade in this course, whether or not you have stopped attending.

## Learning objectives

Upon successful completion of this class you should demonstrate knowledge of and facility with the following.

- *Historical development:* Cardano's Formulas and Bombelli's formal methods; the historical role of complex analysis in physics and engineering; the many contributions of Cauchy to the subject; Riemann's strategy for the Prime Number Theorem.
- *Algebra of complex numbers:* arithmetic operations; complex conjugation and reciprocal; De Moivre's theorem and Euler's formula in the evaluation of exponential and the extraction of complex roots.
- *Geometry of the complex plane:* the Argand-Wessel representation; conversion between polar and rectangular coordinates; equations and inequalities expressed using the modulus and argument; stereographic representation, the Riemann sphere, and fractional linear transformations.
- *Convergence, limits, topology:* sequential and functional limits; Bachmann-Landau " $O$  and  $o$ " notation; continuity and removable singularities; interior point, boundary point, and closure; uniform convergence.
- *Differential calculus of complex functions:* differentiation formulas; differential as a linear approximation; Cauchy-Riemann equations; branch cuts; harmonic functions; conformality.
- *Integration of complex functions:* parametrization of curves; definition and basic properties of integration along piece-wise smooth contour; path independence and antiderivatives; estimation of integrals; the Cauchy-Goursat Theorem; behavior of integrals under deformation of contour.
- *Series representations of complex functions:* Taylor series and Laurent series, disk and annulus of convergence; classification of isolated singularities; analytic continuation.
- *Applications of Cauchy's Theorem:* Cauchy Integral Formula; Residue Theorem; Liouville's Theorem; Morera's Theorem; evaluation of real integrals.

## Nondiscrimination policy

The University of Toledo is committed to a policy of equal opportunity in education, affirms the values and goals of diversity.

## Students with disabilities

The University will make reasonable academic accommodations for students with documented disabilities. Contact Student Disability Services (RH1820; 419.530.4981; [studentdisabilitysvs@utoledo.edu](mailto:studentdisabilitysvs@utoledo.edu)) as soon as possible for more information and/or to initiate the process for accessing academic accommodations. For the full policy see: [www.utoledo.edu/offices/student-disability-services](http://www.utoledo.edu/offices/student-disability-services).

## Student privacy

Federal law and university policy prohibits instructors from discussing a student's grades or class performance with anyone outside of university faculty/staff without the student's written and signed consent. This includes parents and spouses. For details, see the Confidentiality of Student Records (FERPA) section of the UT Policy Page at [www.utoledo.edu/policies/academic/undergraduate/index.html](http://www.utoledo.edu/policies/academic/undergraduate/index.html).