Kennesaw State University
College of Science and Mathematics
Department of Mathematics
Spring Semester 2023
MATH 4391 (Section 51): Complex Analysis

1. Basic Information

Instructor: Dr. Timothy Faver
Email: `tfaver1_AT_kennesaw.edu` (this is the best way to contact me)
Website: `https://tefaver.com/teaching/math-4391`
Lecture time/location: MWF 11:15 am–12:05 pm, Academic Building Room 320
Office: Mathematics Room 248
Office hours: (tentative) W 2:30 pm–3:30 pm, F 10:00 am–11:00 am

1.1. Learning outcomes. Upon successfully completing this course, you will be able to do the following:

1. Use properties of elementary functions (trigonometric, exponential, etc.) of a complex variable;

2. Determine if a given function of a complex variable is continuous, analytic, or integrable;

3. Differentiate and integrate functions of a complex variable; use Cauchy's integral theorem, Cauchy's integral formula, and the residue theorem to evaluate elementary contour integrals; prove related elementary theorems.

4. Perform elementary calculations with Taylor and Laurent series;

5. Apply techniques of complex analysis to solve certain applied problems (e.g., compute certain Riemann integrals, determine certain conformal maps or harmonic functions with given boundary values).

Informally, a complex number is an expression of the form $z = x + iy$, where x and y are real numbers and $i^2 = -1$. Making precise sense of the word "expression" and in particular the juxtaposition iy will be one of our first tasks. I see the course dividing into three phases; in each phase, we will see the recurring leitmotifs of *geometry*—the identification of complex numbers $x+iy$ with ordered pairs of real numbers (x, y)—and *algebra*—our ability to multiply complex numbers and get a new complex number.

The initial phase is precalculus: the arithmetic, algebra, and geometry of complex numbers and the definition and properties of fundamental functions defined on complex numbers (polynomials, exponentials, logarithms, and trigonometric functions). The intermediate phase is differential calculus: limits, continuity, and derivatives for functions of complex variables—the first two will proceed very much as they do in multivariable calculus, and the third definitely won't. The major phase, in which we'll spend most of the course, is integral calculus. The integral is *the* tool for extracting useful information about functions, and we will prove and apply many powerful results in the language of integrals.

Along the way, we'll develop a deeper understanding of and appreciation for topics in single and multivariable calculus. We'll even revisit some kindergarten geometry, as it turns out that circles and triangles are incredibly important shapes. While this is not a course in formal proof like your real analysis courses, we will nonetheless prove many results in rigorous detail (albeit with fewer ϵ–δ chasing); after all, a proof is just an argument that you're correct.

1.2. Course materials. We will closely follow the book *Complex Analysis with Applications* by Nakhlé Asmar and Loukas Grafakos for most topics, except when we won't, in which case I'll provide notes. The book is an incredibly rich source of examples and problems; I caution you that I will not do nearly enough examples, for your taste, or mine, in class, so ityou must develop a close relationship with this book.

• I will regularly provide readings from the book to complement our in-class discussions, and most of our problems will come from this book. A solutions manual for selected odd problems is on D2L.

• I will keep a daily calendar of what we covered on the course website. This calendar will include references to corresponding material from the textbook; to review material from class, or to catch up from an absence, you should consult this calendar and then the textbook. I may, from time to time, prepare custom lecture notes for material that is not explicitly covered in the textbook.

• There are many other good complex analysis books out there, so if you want some additional perspectives on a subject, let me know, and I can give you extra resources.

• The materials above are *required* or *recommended*. Here are some *prohibited* materials. Please remove AirPods and other listening devices during class. Please keep phones off your desks, and please do not take pictures of the board without my explicit permission.

2. Grading

Your final numerical grade will be based on your daily attendance, written problem sets, in-class quizzes, two in-class exams, a final exam, and a glossary project. The following weights will determine your final numerical grade.

Component	**Weight**
Attendance	5%
Problem Sets	35%
Glossary project	10%
Lowest exam score	15%
Middle exam score	15%
Highest exam score	20%

Your final letter grade will be determined by the interval to which your final numerical grade belongs.

Numerical grade	**[90,100]**	**[80,90)**	**[70,80)**	**[60,70)**	**[0,60)**
Letter grade	A	B	C	D	F

2.1. Attendance (5%). *Regular and engaged attendance is essential for your learning; failures in my classes are strongly correlated with low attendance or attendance with weak engagement.* I will take attendance on each of the days that we meet and do not have an exam. Each day that you are present will add a point to your final attendance score. I may determine attendance by checking the class roster or collecting some in-class work (which I will not grade for correctness, just engagement). At the end of the term, your attendance grade will be determined by

$$\min\left\{100 \times \frac{\text{Total number of attendance points}}{\text{Total number of meetings} - 6}, 100\right\}.$$

This allows you to miss several classes without penalty, including the first week if you join the course after the term begins.

An absence may or may not be "excused." Important family commitments, religious obligations, feeling ill, COVID exposure/infection, emergency car trouble, legal issues, an essential work commitment, and university-sponsored athletics, trips, or programs are all sufficient reasons for an excused absence. Making up work in another class, oversleeping, traffic, and vacations (. . .early spring break. . .) are not.

If you feel that your absence merits an excuse, please read the material covered in the textbook that day and then email me (1) the reason for your absence and (2) a question about something that you don't understand from that day's discussion or, if you feel that you understand everything, a comment about something that seems interesting, or frustrating, or weird, or anything that evokes an emotional reaction in you. To receive the attendance credit, you need to send the email before you next return to class. An excused absence will not receive attendance credit without the component (2).

2.2. Problem sets (35%). *Regular work on problem sets will strengthen your understanding of course concepts and techniques. Success in this class will be impossible without diligent, thorough completion of the problem sets.* There will be 11 problem sets assigned on Fridays and due throughout the term at 11:59 pm on the following Fridays; see the calendar (Section 4) for the exact dates. You will submit your solutions to the appropriate slot on D2L, and it is your responsibility to ensure that your D2L submissions are correctly formatted and organized according to the submission instructions. In particular, your work must be clearly typed or scanned (not photographed). I will drop your lowest 3 problem set scores, so that your the problem set component of your final grade will be the average of your 8 best problem set scores. You are most welcome to consult with me throughout the week about the preparation of your problem sets; see Section 3.2 for advice on office hours and Section 3.3 for email policy. I will typically not be available for last-minute help on Friday afternoons, but we can and should talk throughout the week as you need to.

You may push back two assignments from their Friday due date until the following Monday. For example, if you wish to push Problem Set 1 back, you would have until Monday, January 23, at 11:59 pm to submit it. You do not need to provide any reason for a pushback. However, you must request a pushback no later than 5 pm on the Thursday

before the assignment is due. For example, if you wish to push Problem Set 1 back, you would have until Thursday, January 19, at 5 pm to tell me that you want to do so. The point of this condition is to ensure that you have started your assignment in a timely fashion and have been thinking about it throughout the week; leaving problem sets for Friday afternoons is dangerous and deleterious both for your learning and your peace of mind. Once you have used your two pushbacks, I will typically not allow any more, outside of absolutely exceptional circumstances. Also, once you have pushed a problem set back, I will not accept it late beyond the Monday deadline. There is no reward or extra credit for *not* using your pushbacks.

2.3. Glossary project (10%). *If we don't know what the words mean, we won't be able to do anything worthwhile.* Complex analysis (like most of math!) is highly dependent on specialized, technical vocabulary. You will prepare a detailed glossary—definitions, examples, nonexamples, pictures, commentary—of what *you* think are the 10 most important words that we use throughout the term; one goal of this project is not merely your deep, precise understanding of these words but also an articulation of why they matter in *your* increasingly educated opinion. Further instructions are available in the separate glossary description on the course website; note that you will submit drafts along with your exam reflections.

2.4. Exams (50%). *Exam preparation will help you connect discrete course topics; completing an exam under time constraints is one way of evaluating your fluency with course material and your intellectual independence.* There will be two in-class exams (Exams 1 and 2) during the term and a cumulative final exam. The final exam will only be given at the university-specified time, which cannot be changed. See the calendar (Section 4) for the exam dates. I will provide a detailed study guide at least a week in advance of each exam; typical problems will ask you to state definitions and give (non)examples, prove theorems that we have studied in class, and present detailed calculations. You will earn 5 points on each exam from a reflection activity that you will do based on the study guide; you can earn the other 95 points on the actual exam. I will ask for updates on your glossary project in each reflection, too. Your reflection responses will guide our in-class review; you are welcome to consult with me individually before exams, though I discourage waiting until the last minute.

In order to be excused from an exam, you must (1) notify me before the start of the exam (or as soon after as the circumstances allow) and (2) provide official documentation (a doctor's note, a quarantine notice or proof of COVID test, a note from your employer, etc.) excusing your absence in a timely manner. If your absence from an exam is excused, then you will take a make-up exam within a week of returning to class. Valid (and invalid) reasons for missing an exam are, in general, the same as for missing class. In general, I will not permit a make-up if you notify me of your absence *after* the class has taken exam, barring exceptional circumstances that make prior communication absolutely impossible.

2.5. Midterm grades. I will submit midterm grades by March 7 to help you assess your progress in the course. I am required to include the following remarks in this syllabus: *A midterm grade will be assigned by the midterm grade due date identified on the Spring 2023 academic calendar. This midterm grade is for assessing mid-semester performance prior to the last day to withdraw without academic penalty. You may view your midterm grade in*

Owl Express. Note that only your final grade will be officially recorded on your academic transcript.

Your midterm numerical grade will be determined by the following breakdown:

$$10\% \text{ attendance} + 50\% \text{ problem sets} + 40\% \text{ Exam 1}.$$

I will not drop any absences, problem sets, or quizzes in this calculation. Note that the weights here are, overall, quite different from what will determine your final grade; a good midterm grade is not a promise of a good final grade, but a bad midterm grade should serve as a warning that something is amiss in your current approach to the course. Midterm letter grades will follow the numerical correspondence for your final grade.

2.6. Incomplete grades. The catalogue specifies that an "incomplete grade may be awarded only when the student was doing satisfactory work prior to the last two weeks of the semester but for nonacademic reasons beyond the student's control, was unable to meet the full requirements of the course." I define "satisfactory work" to mean that it is mathematically possible for you to obtain a score on your remaining work that will allow you to pass the class.

The catalog subsequently states that a "grade of 'I' must be removed by completing the course requirements within one calendar year from the end of the semester in which the 'I' was originally assigned. In addition, should the student enroll in classes at KSU during the calendar year, the grade of 'I' must be removed by the end of the first semester of enrollment during that calendar year."

If you are awarded an incomplete for this course, it will be to your advantage to complete all remaining work as soon as possible. Based on your circumstances, we will agree on a mutually convenient and appropriate timeline for completing your work. Failure to follow this timeline without a justifiable excuse may result in failing grades for the missed work and possibly the course. Ideally, you would complete all work by the end of May 2023.

3. Strategies for Success and/or Failure

3.1. Attendance, participation, and independent work. Failures in my classes are strongly correlated with low attendance *or* attendance with minimal engagement; students who both attend class regularly and engage with me in and/or outside class tend to succeed.

3.2. Office hours. During office hours, we can discuss specific examples, problems, or techniques from class, the lecture notes, or the textbook. More broadly, we can talk about your study habits, time management, and mathematical reading skills. Before coming to office hours, think carefully about what you want to discuss so that we use our time well.

If my office hours conflict with your other classes, we can make an appointment for a different time. If the currently scheduled office hours conflict with the availability of students who most frequently want to see me, I may change the weekly hours to accommodate the preferences of the majority.

An online option via Teams will always be available for office hours. The Teams link will be on D2L. I will attempt to hold office hours in person (I encourage masking).

3.3. Email communication. You are welcome to email me questions about any aspect of the course at any time. Feel free to send a photo or scan of work and indicate where you're stuck. A short hint from me can make a big difference for you.

Please include the words "Math 4391" in the subject of your email. I filter emails and may not respond to your message promptly, or may miss it entirely, without these key words. Please use your "students" email, not D2L email.

Please begin your email with a salutation (e.g., "Hi, Dr. Faver") before the body of text; this is simply good manners (and will put me in a good mood, which will be helpful for you). Please also address me by my name ("Dr. Faver," not just "Professor").

I will (typically) respond to email within 24 hours, but I cannot guarantee a response to questions about problem sets or exams late on Thursday evenings. Those final hours before an exam or quiz need to be about perfecting what is already good in you, not about learning it for the first time.

3.4. Reading assignments and recommended problems. It is quite likely, and wholly natural, that you will not fully understand the material that we cover in class. Readings from the textbook(s) will offer different perspectives that may be more conducive to your personal engagement with Math 4391. Part of your mathematical education is developing your reading comprehension; be prepared to invest time, and struggle, with the course's *written* materials before seeking outside help or alternate media.

Doing the problem sets *alone* probably will not provide you with enough exposure to course material outside of class. Instead, you should attempt a variety of problems from the "Recommended Problems" lists that I provide each week; challenge yourself to do a certain number of these each week along with the problem sets. Recommended problems will also serve as additional, essential practice and review for exams. You should skim the textbook's problems that I don't assign, as well, and attempt some of them as you study.

3.5. How to fail. The following strategies have helped prior students fail my classes.

1. Don't come to class regularly; in particular, show up only for exams.

2. Be physically present but intellectually disengaged in class. Avoid talking with me.

3. Don't do the problem sets or any recommended practice problems.

4. Save all your Math 4391 work for only one day each week. Even better, do all problem sets and exam reviews on Thursday evenings only.

5. Ask for, but then completely ignore, my advice on improving your course performance.

6. Think about the course as an obstacle, not an opportunity. Definitely don't look for beauty, surprises, or things that might fill you with wonder and curiosity.

4. Calendar

You are responsible for knowing all of the due dates for assignments and scheduled dates for quizzes and exams listed below. All submissions to D2L are due at 11:59 pm on the stated day. If class is canceled on the day of a quiz or exam, we will take that quiz or exam during our next meeting, unless I specify otherwise.

F January 20:	Problem Set 1 due on D2L
F January 27:	Problem Set 2 due on D2L
F February 3:	Problem Set 3 due on D2L
F February 10:	Problem Set 4 due on D2L
M February 13:	Exam 1 reflection due on D2L
F February 17:	Exam 1 in class
F February 24:	Problem Set 5 due on D2L
F March 3:	Problem Set 6 due on D2L
M March 6:	No class—Spring Break
T March 7:	Midterm grades due
W March 8:	No class—Spring Break
F March 10:	No class—Spring Break
T March 14:	Last day to withdraw without academic penalty (11:45 pm)
F March 17:	Problem Set 7 due on D2L
F March 24:	Problem Set 8 due on D2L *and* Exam 2 reflection due on D2L
F March 31:	Exam 2 in class
F April 7:	Problem Set 9 due on D2L
F April 14:	Problem Set 10 due on D2L
F April 21:	Problem Set 11 due on D2L
W April 26:	Final exam reflection due on D2L
F April 28:	Glossary project due on D2L
M May 1:	Last day of class
W May 3:	Final exam in class, 10:30 am–12:30 pm

5. University Policies and Formal Matters

5.1. Federal, BOR and KSU Student Policies. You should be familiar with the policies detailed via the link below.

`https://cia.kennesaw.edu/instructional-resources/syllabus-policy.php`

5.2. KSU student resources. You should be familiar with the resources and rights available to you as detailed in the link below.

`https://cia.kennesaw.edu/instructional-resources/syllabus-resources.php`

5.3. Academic integrity statement. Every KSU student is responsible for upholding the provisions of the Student Code of Conduct, as published in the Undergraduate and Graduate Catalogs. Section 5c of the Student Code of Conduct addresses the university's policy on academic honesty, including provisions regarding plagiarism and cheating, unauthorized access to university materials, misrepresentation/falsification of university records or academic work, malicious removal, retention, or destruction of library materials, malicious/intentional misuse of computer facilities and/or services, and misuse of student identification cards. Incidents of alleged academic misconduct will be handled through the established procedures of the Department of Student Conduct and Academic Integrity (SCAI), which includes either an "informal" resolution by a faculty member, resulting in a grade adjustment, or a formal hearing procedure, which may subject a student to the Code of Conduct's minimum one semester suspension requirement.

5.4. Course catalogue description.
3 Class Hours 0 Laboratory Hours 3 Credit Hours
Prerequisite: MATH 2203
This course is an introduction to the basic concepts of complex analysis, its beautiful theory and powerful applications. Topics covered will include the algebra and geometry of the complex plane, properties of elementary functions of a complex variable, analytic and harmonic functions, conformal mappings, continuity, differentiation, integration (Cauchy integral theory), singularities, Taylor and Laurent series, residues and, time permitting, their applications.

5.5. COVID-19 statements. You should be familiar with the most recent university policies and resources regarding COVID-19 as detailed in the link below.

`https://www.kennesaw.edu/coronavirus`