Department of Mathematics, University of Utah

Applied Complex Variables and Asymptotic Methods
Math 6720 – Section 001 – Spring 2024
Course Information and Syllabus
Updated January 9, 2024

Instructor:	Akil Narayan
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Phone:	801-581-8984
Office:	WEB 4666, LCB 116
Office hours:	Wednesday 11am-12pm, LCB 116
	Thursdays 1pm-2pm, WEB 4666

Class type: In Person

Class time and location: MWF, 9:40am-10:30am, LCB 323
Virtual: Zoom, by request

Attendance policy: Attendance during lectures is *not* a part of your grade. However, I strongly recommend that you attend the lectures; attendance is an essential ingredient for success in this course.

Section webpage: http://www.sci.utah.edu/~akil/math6720
Note: Scores for graded assignments will be posted on Canvas.

Course Information: This is a 3-credit course.

Learning objectives: The course will cover central topics from complex variables and asymptotic methods. The course serves as preparation for the second part of the Applied Mathematics Qualifying exam. Topics include Cauchy-Riemann equations, Cauchy inte- gral formulas, Taylor and Laurent series, multivalued functions, branch points and cuts, analytic continuation, Jordan's lemma, evaluation of real integrals; conformal mapping, Fourier and Laplace transforms, asymptotic analysis of integrals, Laplace's method, Watson's lemma, method of steepest descents.
Prerequisites: "C" or better in Math 5210 AND Math 5410.

Course description: This course is an introduction to the theory of complex variables and its applications and to asymptotic methods.

Text: Required: *Complex Variables: Introduction and Applications*, M. J. Ablowitz & A. S. Fokkas, Second edition, Cambridge University Press (2003); ISBN 0-521-53429-1, 978-0-521-53429-1. We will primarily cover chapters 1-6.
Class lectures will be *heavily* based on textbook material. The textbook provides additional details and alternative interpretations that cannot be covered in class due to time constraints. Homework will be assigned mostly from problems in the textbook. Access to the textbook is mandatory for success in this class.

The following *optional* and supplementary texts may prove useful, but they are not required:

- *Principles of Applied Mathematics*, J.P. Keener; Perseus Books 2000; ISBN 0-7382-0129-4; Chapters 6, 7.2, 7.5, 10.
- *Advanced Mathematical Methods for Scientists and Engineers*, C. M. Bender and S. A. Orszag; Chapter 6.
- *Functions of One Complex Variable I*, J. B. Conway, Chapters 1, 3, 4.2-4.6, 5.

Class meetings: This class meets in person thrice per week. Class meetings will primarily be lecture-based, which will include a discussion of theory and practice examples. I encourage you to participate in class, in particular with questions and related discussions.

Homework: Problem sets will be announced in-class and subsequently posted on the course website. Homework will be assigned approximately every 2 weeks and collected online. Late homework assignments will be accepted, but with a 10% penalty per day late. This penalty will be enforced on Canvas, and can be waived if you submit to me documentation demonstrating extenuating circumstances.

Each homework assignment is worth equal weight and your lowest homework score over the semester will be dropped. You are welcome (and encouraged) to work on the homework assignment in groups, but each student must submit individual work.

Exams: This course will have 1 in-class midterm exam, and 1 in-class comprehensive final exam. The midterm exam will be held in class on March 1.

The final exam is a cumulative exam in the same format as the midterm exams. Per university policy, the final exam will be held on Thursday, April 25 from 8:00-10:00am.

Unless otherwise specified, **neither calculators or notes of any kind are allowed on either of the exams**. The homework assignment problems can (and should) be completed without resorting to a calculator.

Grading: Your course grade will be computed as follows.

- Homework 45%
- Midterm exam 25%
- Final exam 30%

Final letter grades will be assigned based on the following scheme:

- 92% - 100% — A
- 90% - 91% — A−
- 88% - 89% — B+
- 82% - 87% — B
- 80% - 81% — B−
- 78% - 79% — C+
- 72% - 77% — C
- 70% - 71% — C−
- 68% - 69% — D+
- 62% - 67% — D
- 60% - 61% — D−
- 0% - 59% — E

Qualifying exams: (For mathematics graduate students only) To earn a "high-pass" in this class you need a A. To earn a "pass" you need a A- or B+. Earning a "pass" or "high-pass" in this class means you will earn that grade for the qualifying exam associated with this class (without having to take the qualifying exam). For more details, please see the graduate bulletin

at `http://www.math.utah.edu/dept/gradbull.pdf`, which is the authoritative document on this matter.

Important dates:

Jan 19		Last day to add, drop, elect CR/NC or audit classes
Mar 1		Midterm 1
Mar 1		Last day to withdraw from classes
Apr 19		Last day to reverse CR/NC option
Apr 24		Reading Day
Apr 25	**8:00am**	Final exam

Class communication: An email list is set up with which I shall send out information not communicated during class. This email list will also be used to communicate class information in the case of unusual circumstances affecting the the logistics of the class. If you are not officially registered for the class but wish to be on the roster, please discuss it with me.

If you are registered for the course, but do not receive the course email announcements to your University of Utah email address, please notify me immediately. You can forward your Utah emails to other email addresses. (Navigate to `http://www.cis.utah.edu`, login, and change your UMail settings.)

The section website will be used to communicate more technical matter of the class (e.g. problem sets, lecture summaries, etc.).

In the event of a major campus emergency, course requirements, deadlines and grading percentages are subject to change that may be necessitated by a revised semester calendar or other circumstances. The above two methods, in addition to the coursewide website, are reliable means of getting information about changes to the course.

Communication with the instructor: The most reliable and preferred means of contacting me is via email, and I typically respond in less than 24 hours. Communication through the messaging system in Canvas will also work, but possibly with a slightly longer response time. One-on-one meetings can also be set up with me outside of office hours; please set up such meetings with me via email.

Student responsibilities and integrity: All students are expected to maintain professional behavior in the classroom setting, according to the Student Code, spelled out in the Student Handbook. Students have specific rights in the classroom as detailed in Article III of the Code. The Code also specifies proscribed conduct (Article XI) that involves cheating on tests, plagiarism, and/or collusion, as well as fraud, theft, etc. Students should read the Code carefully and know they are responsible for the content. According to Faculty Rules and Regulations, it is the faculty responsibility to enforce responsible classroom behaviors, and I will do so, beginning with verbal warnings and progressing to dismissal from and class and a failing grade. Students have the right to appeal such action to the Student Behavior Committee.
`http://regulations.utah.edu/academics/6-400.php`

Inclusivity: It is my intent that students from all diverse backgrounds and perspectives be well served by this course, that students' learning needs be addressed both in and out of class, and that the diversity that students bring to this class be viewed as a resource, strength and benefit. It is my intent to present materials and activities that are respectful of diversity: gender, sexuality, disability, age, socioeconomic status, ethnicity, race, and culture. Your suggestions are encouraged and appreciated. Please let me know ways to improve the effectiveness of the

course for you personally or for other students or student groups. In addition, if any of our class meetings conflict with your religious events, please let me know so that we can make arrangements for you.

Discrimination and Harassment: If you or someone you know has been harassed or assaulted, you are encouraged to report it to the Title IX Coordinator in the Office of Equal Opportunity and Affirmative Action, 135 Park Building, 801-581-8365, or Office of the Dean of Students, 270 Union Building, 801-581-7066. To report to the police, contact the Department of Public Safety, 801-585-2677(COPS). Please see Student Bill of Rights, section E `http://regulations.utah.edu/academics/6-400.php`. I will listen and believe you if someone is threatening you.

Classroom Social Equity: Canvas allows students to change the name that is displayed AND allows them to add their pronouns to their Canvas name. Class rosters are provided to the instructor with the student's legal name as well as "Preferred first name" (if previously entered by you in the Student Profile section of your CIS account, which managed can be managed at any time). While CIS refers to this as merely a preference, I will honor you by referring to you with the name and pronoun that feels best for you in class or on assignments. Please advise me of any name or pronoun changes so I can help create a learning environment in which you, your name, and your pronoun are respected. If you need any assistance or support, please reach out to the LGBT Resource Center: `https://lgbt.utah.edu/campus/faculty_resources.php`

English Language Learners: If you are an English language learner, please be aware of several resources on campus that will support you with your language and writing development. These resources include: the Writing Center (`http://writingcenter.utah.edu/`); the Writing Program (`http://writing-program.utah.edu/`); the English Language Institute (`http://continue.utah.edu/eli/`). Please let me know if there is any additional support you would like to discuss for this class.

Undocumented Student Support: Immigration is a complex phenomenon with broad impact—those who are directly affected by it, as well as those who are indirectly affected by their relationships with family members, friends, and loved ones. If your immigration status presents obstacles to engaging in specific activities or fulfilling specific course criteria, confidential arrangements may be requested from the Dream Center. Arrangements with the Dream Center will not jeopardize your student status, your financial aid, or any other part of your residence. The Dream Center offers a wide range of resources to support undocumented students (with and without DACA) as well as students from mixed-status families. To learn more, please contact the Dream Center at 801-213-3697 or visit `dream.utah.edu`.

Veterans: If you are a student veteran, the University of Utah has a Veterans Support Center located in Room 161 in the Olpin Union Building. Hours: M-F 8-5pm.Please visit their website for more information about what support they offer, a list of ongoing events and links to outside resources: `http://veteranscenter.utah.edu/`.

The Americans with Disabilities Act: The University of Utah seeks to provide equal access to its programs, services and activities for people with disabilities. If you will need accommodations in the class, reasonable prior notice needs to be given to the Center for Disability & Access, 162 Olpin Union Building, 801-581-5020, `https://disability.utah.edu`. CDA will work with you and the instructor to make arrangements for accommodations. All written information in this course can be made available in alternative format with prior notification to the Center for Disability & Access.

Student wellness: Personal concerns such as stress, anxiety, relationship difficulties,depression,

cross-cultural differences, etc., can interfere with a student's ability to succeed and thrive at the University of Utah. For helpful resources contact the Center for Student Wellness at www.wellness.utah.edu or 801-581-7776.

University Counseling Center (UCC): The UCC staff is committed to supporting the mental health needs of our campus community. Their phone number is 801-581-6826. Their hours are Monday-Friday, 8:00am-5:00pm. For after-hours emergencies, contact the 24/7 Crisis Line: 801-587-3000 . More information is at https://counselingcenter.utah.edu/. **Student Success Advocates:** The mission of Student Success Advocates is to support students in making the most of their University of Utah experience (ssa.utah.edu). They can assist with mentoring, resources, etc. Any student who faces challenges securing their food or housing and believes this may affect their performance in the course is urged to contact a Student Success Advocate for support (https://asuu.utah.edu/displaced-students).

Addressing Sexual Misconduct: Title IX makes it clear that violence and harassment based on sex and gender (which includes sexual orientation and gender identity/expression) is a Civil Rights offense subject to the same kinds of accountability and the same kinds of support applied to offenses against other protected categories such as race, national origin, color, religion, age, status as a person with a disability, veteran's status or genetic information. If you or someone you know has been harassed or assaulted on the basis of your sex, office for equal opportunity and affirmative action including sexual orientation or gender identity/expression, you are encouraged to report it to the University's Title IX Coordinator; Director, Office of Equal Opportunity and Affirmative Action, 135 Park Building, 801-581-8365, https://oeo.utah.edu/contact-us/index.php or to the Office of the Dean of Students, 270 Union Building, 801-581-7066, https://deanofstudents.utah.edu. For support and confidential consultation, contact the Center for Student Wellness, 426 SSB, 801-581-7776. To report to police, contact the Department of Public Safety, 801-585-2677(COPS), https://police.utah.edu.

Campus Safety: The University of Utah values the safety of all campus community members. To report suspicious activity or to request a courtesy escort, call campus police at 801-585-COPS (801-585-2677). You will receive important emergency alerts and safety messages regarding campus safety via text message. For more information regarding safety and to view available training resources, including helpful videos, visit safeu.utah.edu.

Office of the Dean of Students: The Office of the Dean of Students is dedicated to being a resource to students through support, advocacy, involvement, and accountability. It serves as a support for students facing challenges to their success as students, and assists with the interpretation of University policy and regulations. To contact the Office of the Dean of Students, please email deanofstudents@utah.edu or call 801-581-7066. There is more information at https://deanofstudents.utah.edu.

Semester calendar

(Subject to change!)

Day	Date	Text Section(s)	Topic
Monday	January 8, 2024		Hello
Wednesday	January 10, 2024	1.1	Complex numbers
Friday	January 12, 2024	1.2	Elementary functions
Monday	January 15, 2024		No class: Margin Luther King Jr. Day
Wednesday	January 17, 2024	1.3	Limits and differentiation
Friday	January 19, 2024	2.1	Analytic functions
Monday	January 22, 2024	2.2	Multi-valued functions and branches
Wednesday	January 24, 2024	2.4	Complex integration
Friday	January 26, 2024	2.4	Complex integration
Monday	January 29, 2024	2.5	Cauchy's Theorem
Wednesday	January 31, 2024	2.5	Cauchy's Theorem
Friday	February 2, 2024	3.1	Sequences and series
Monday	February 5, 2024	3.2	Taylor series
Wednesday	February 7, 2024	3.3	Laurent series
Friday	February 9, 2024	3.5	Singularities
Monday	February 12, 2024	3.5	Singularities
Wednesday	February 14, 2024	4.1	Cauchy Residue Theorem
Friday	February 16, 2024	4.1	Cauchy Residue Theorem
Monday	February 19, 2024		No class: Presidents Day
Wednesday	February 21, 2024	4.2	Evaluation of definite integrals
Friday	February 23, 2024	4.3	Indented Contours
Monday	February 26, 2024	4.3	Indented Contours
Wednesday	February 28, 2024		Review
Friday	March 1, 2024		**Midterm Exam**
Monday	March 4, 2024		No class: Spring break
Wednesday	March 6, 2024		No class: Spring break
Friday	March 8, 2024		No class: Spring break
Monday	March 11, 2024	4.4	Argument Principle
Wednesday	March 13, 2024	4.5	Fourier and Laplace Transforms
Friday	March 15, 2024	5.1	Conformal Mappings
Monday	March 18, 2024	5.1	Conformal Mappings
Wednesday	March 20, 2024	5.4	Physical applications
Friday	March 22, 2024	5.4	Physical applications
Monday	March 25, 2024	5.7	Bilinear transformations
Wednesday	March 27, 2024	5.7	Bilinear transformations
Friday	March 29, 2024	6.1	Asymptotic expansions
Monday	April 1, 2024	6.2	Laplace-type integrals
Wednesday	April 3, 2024	6.2	Laplace-type integrals
Friday	April 5, 2024	6.3	Fourier-type integrals
Monday	April 8, 2024	6.3	Fourier-type integrals
Wednesday	April 10, 2024	6.3	Fourier-type integrals
Friday	April 12, 2024	6.4	Method of steepest descent
Monday	April 15, 2024	6.4	Method of steepest descent
Wednesday	April 17, 2024	6.4	Method of steepest descent
Friday	April 19, 2024	6.5	Applications
Monday	April 22, 2024		Review
Wednesday	April 24, 2024		Reading day
Thursday	April 25, 2024	8:00am-10:00am	**FINAL EXAM**