Complex Analysis II
Course Outline
Course 7412007 Section 01, Fall 2021
Mondays 15:00 - 15:50, Thursdays 15:00 - 16:50, Room: E1-1 #140
Chungbuk National University

Instructor: Dr. Byungdo Park

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Office hours: Thursdays 17:00–17:50 at E1-1 #110 or by appointment.

Class webpage: Announcements, homework, exam schedules and other relevant information will be posted on the following webpage: `https://byungdo.github.io/teaching/f2021_cv2.html` which is also accessible via instructor's webpage: `https://byungdo.github.io/`

Textbook:

- Joseph Bak and Donald Newman, *Complex Analysis*, 3rd Edition (2010), Springer, ISBN-13: 9781441972873.

References:

- Lars V. Ahlfors, *Complex Analysis*, 3rd Edition (1979), McGraw Hill Higher Education, ISBN-13: 9780070850088.
- Saeed Zakeri, *A Course in Complex Analysis*, 1st Edition (2021), Princeton University Press, ISBN-13: 9780691207582.
- Elias M. Stein and Rami Shakarchi, *Complex Analysis (Princeton Lectures in Analysis, No. 2)*, 1st Edition (2003), Princeton University Press, ISBN-13: 9780691113852.
- Saminathan Ponnusamy and Herb Silverman, *Complex Variables with Applications*, (2006) Birkhäuser, ISBN-13: 9780817644574.
- Otto Forster, *Riemannsche Flächen (Heidelberger Taschenbücher, Band 184)* 1. Edition (1977), Springer Berlin Heidelberg, ISBN-13: 9783540080343
- Bernard Maskit, *Kleinian Groups (Grundlehren der mathematischen Wissenschaften 287)* 1st Edition (1988), Springer Berlin Heidelberg, ISBN-13: 9783540177463

Prerequisites: Complex Analysis I (7412010). A solid coursework on calculus. Analysis I and II (7412029, 7412022) are recommended and results therein will not be repeated in this course but not strictly required. The instructor does not dissuade students without meeting the prerequisite criteria registering for this course at his/her own risk.

Course description: This is a the second-semester of a year-long course, "Complex Analysis." We will continue from where we stopped in Complex Analysis I (7412010) and study two main themes:

calculation techniques for various integrals and the Riemann mapping theorem. In the first-half, we shall begin with the complex logarithm. We will collect some important facts from the Cauchy theory such as classification of singularities, argument principle, and Rouché's theorem. After that we shall calculate various integrals which is of interest for scientists and engineers. In the second-half, we shall learn generalities on conformal mappings and build up foundations to eventually state and prove the Riemann mapping theorem. If time permits, we shall learn more topics of interest such as Phragmén–Lindelöf theorem, harmonic functions, and theorems on infinite products such as Weierstrass product theorem and Hadamard factorization theorem.
Course objectives: At the end of the course students should be able to:

- Explain the definition of complex logarithm and its meanings.
- Understand different kinds of singularities and theorems therein.
- Understand the concept of winding number as well as the argument principle and Rouché's theorem.
- Use the Residue theorem to compute various complex integrals.
- Apply techniques from complex integrals to evaluate definite integrals.
- Understand Möbius transformations and their importance in geometry.
- State and prove the Riemann mapping theorem.
- Create an online learning contents such as YouTube videos for sharing knowledge with a broader audience.
- Discuss various implications on civic education from mathematics we appreciate in this course.
- Shape an overarching perspective on teching complex numbers and the complex plane in secondary school mathematics curricular.

Details on problem solving: Problems arising in this course will be requiring proofs and calculations based on the mathematical discourse in class. Through dialogues and discussions during each lecture as well as the instructor's office hours, the instructor will guide students approaching to problems that they will have to address.

Details on class proceeding: The instructor will give lectures on the material following the weekly lesson plan and assign weekly homework problems. He will also encourage you to participate in a Project-Based Learning to strengthen your competence as a teacher also in online, remote setup.

Grading policies: 40% from miterm exam, 40% from final exam, 12% from homework, and 8% from attendance. Up to an additional 3% total score credit for your PBL project. Absolute evaluation [A: 100–90 points, B: 89.99–80 points, C: 79.99–70 points, D: 69.99–60 points, F: less than 60 points] with curving. Here the curving means a horizontal shift of the bell-shaped curve of %-score distribution in either directions using a rational constant which is determined at the discretion of

the instructor. Grading policies in the academic integrity policies are applied in higher priority than the above grading policies.

Homework policies: A list of homework problems will be posted on the class webpage roughly in weekly basis. Late homework will be accepted. The instructor will assign as many homework problems as it is needed to master the subject. The instructor will scan through each submitted homework and assign a score 2, 1, or 0 depending on quality of work. The homework score for the total grade will be calculated based on the following formula: $(\sum_{i=1}^{h} h_i \cdot n_i)/(\sum_{i=1}^{h} 2 \cdot n_i)$, where h is total number of homework assignment, h_i is the score for the i^{th} homework score, n_i is the number of problems in the i^{th} homework.

Attendance policies: Attendance data will be collected in every class meeting and will be used for determining your final grade. You will get a grade F if you have missed more than 25% of class meeting hours. Up to 3 hour of absence there is no penalty on your score. After that, you lose 1% of total score for an absence to each 50-minute long class meeting, with a maximum total loss 8% from your total score. If you have permissible reasons for your absence in accordance with the Regulation on Academic Management of the CBNU Article 52(1) (충북대학교 학사운영규정 제52조(공결승인) 제1항), you will need to contact the Department Assistant to follow the procedure for getting an approval on your absence bringing proper documentation as proof. That said, you have to fill out a form and submit it along with appropriate proofs before the absence or after seven days of the date of absence.

Assessment of Project-Based Learning (PBL): To submit your PBL project for an extra credit, you should record a 20-minute long video lecture about one of the following:

- A sample lecture on any topic listed on the syllabus of this course.
- A sample lecture on a concept from secondary school geometry curricular.

You should submit the video in a form of a YouTube video link by choosing the sharing option "unlisted(일부공개)." Your video will be disclosed to your classmates in this course as a part of a YouTube playlist. Registering to this course would mean that you accept sharing your video lecture with your classmates via YouTube. You may turn your video into "private" or even delete the video after your letter grade for this course is assigned. The assessment will be done as follows: 3/3 all in all good work. 2/3 lacking important examples, theorem, proofs or there are significant mathematical errors. 1/3 overall poor contents of the material. 0/3 no hand-in.

Assessment of learning: The assessment will be primarily done by the abovementioned grading policy. Nonetheless, the instructor will also take into account students' devotions and efforts for this course as well as their enthusiasm as a future educator so that those qualitative elements are not going to be neglected.

Weekly lesson plan:

Week 1: Introduction. Complex logarithm. [Section 8.2]

Week 2: Isolated singularities, Casorati-Weierstrass theorem, Laurent expansions. [Sections 9.1, 9.2]

Week 3: Laurent expansions, winding numbers [Sections 9.2, 10.1]

Week 4: Cauchy's residue theorem, meromorphic functions, argument principle, Rouché's theorem [Sections 10.1, 10.2]

Week 5: Hurwitz's theotem, applications of the Residue theorem: Definite integrals. [Sections 10.2, 11.1]

Week 6: Applications of the Residue theorem: Definite integrals (continued), estimations of sums [Sections 11.1, 11.2]

Week 7: Applications of the Residue theorem (wrap-up), Integral techniques: Shifting the contour integration [Sections 11.2, 12.1]

Week 8: Integral techniques (continued): An entire function bounded in every direction. [Sections 12.2], Midterm exam.

Week 9: Conformal mappings and conformal equivalences [Section 13.1]

Week 10: Special mappings [Section 13.2]

Week 11: Schwarz-Christoffel transformations [Section 13.3]

Week 12: Conformal mappings and hydrodynamics, *Civic education: The interpretation. [Section 14.1]

Week 13: The Riemann mapping theorem, mapping properties of holomorphic functions on closed domains [Sections 14.2, 14.3]

Week 14: Mapping properties of holomorphic functions on closed domains (continued), a general maximum modulus theorem [Sections 14.3, 15.1]

Week 15: The Phragmén-Lindelöf theorem [Section 15.2]; more topics will be covered if time permits. Final exam.

Make-up lesson plan during the teaching observation period: Most of students taking this course will be participating in the teaching observation around late October and early November. The instructor will make up lectures for those six 50-minute sessions on **Mondays, September 13, 27th October 4, 11, 18, 25th at 14:00–14:50**. Location is TBA. Since your teaching observation will be considered as absences in official causes, your attendance will not be collected for those make-up lectures, however, you are required to complete homework assignments from those. Also everything covered in those online video lectures will be included in the coverage of your final exam.

Accommodating disabilities in learning and assessment: The instructor is committed to providing access to all students. If you need accommodation in classroom or in assessment, you are encouraged to set up an appointment with the instructor at your soonest availability so that we can

figure out the best way to acoommodate you. Possible accommodations include, but not limited to, provision of materials from lectures, permission to hire an assistant for taking notes, audio-recording lectures, and aid/assistant devices, extension of due dates for assignments, alternative assessment for in-class presentations, extension of exam hours, and provision of an accommodating exam locations and exam sheets.

Academic integrity: It is expected that you will complete all exams without giving or receiving help from anyone. Electronic devices are not allowed in any in-class exam. You may talk to other students about the homework but you must then complete the homework yourself. The grader will trust students and will not apply any prejudice. However, if the grader has found an evidence that you have violated those policies, the grader reserves the right to investigate by summoning you to come in to his office, reproduce and explain your own solutions in front of the chalkboard. If you cannot provide a coherent and consistent explanation to your own solution to a problem or do not show up to the investigation without a documented official cause and/or an emergency, the minimum punishment would be score zero to that problem and lowering your letter grades by 2 letters. (For example, if you were to receive A+, it will become C+.) In addition to that, your other homework solutions may possibly be a subject of investigation. The investigation session will be both video and audio recorded, and the result of the investigation (including video/audio recording of the investigation) can be reported to the department or the university center. You MUST drop this course if you cannot comply with this policy.

Disclaimer: (1) Email policies: All emails addressed to the instructor should have a title containing the course title, name, and a brief summary as well as a body starting with "Dear Professor Last name" and ending with "Sincerely, Your full name", which contains greetings, your name and department, a brief and clear purpose written politely. Any email deviating from this format will not be accepted and will be dismissed without any rejection reply. The corresponding disadvantages are solely and entirely on the student.

(2) Lectures in this course will be given in Korean, but most of written materials will be in English. For example, the course syllabus, most of boardwork, exam problems, homework, solutions to exams, course webpage, announcements, but not limited to those. English sentences to be used in this course should be understandable enough based on the regular Korean public high school curriculum. Nonetheless if your English skill is not competent enough to follow this course or understanding announcements, it is your responsibility to ask the instructor to also provide an explanation in Korean. The instructor will take those questions under an attitude of helping students' understanding, but taking into account the contents of each question, he may reject the question or advise the questioner to visit him during his office hour to ask the question about Korean translation.

(3) No homework past due will be accepted or reviewed for any reasons.

사전고지: (1) 이메일 작성규칙: 담당교수에게 보내지는 모든 이메일의 제목에는 과목명, 신원, 요지가 포함되어 있어야 하며, 본문은 반드시 "OOO 교수님께"로 시작하여 인사, 신원, 용건을 간단명료하고 예의바르게 기술한 후 "OOO 올림" 또는 "OOO 드림"으로 끝나야 합니다. 이 형식에 어긋난 이메일은 접수하지 않으며, 반려회신 없이 종결합니다. 이에 따른 불이익은 전적으로 학생의 단독

책임입니다.

(2) 본 강좌에서 강의는 한국어로 이루어집니다만, 글의 경우 대부분 영어가 사용될 것입니다. 수업 계획서, 칠판 판서의 대부분, 시험문제, 숙제, 시험문제에 대한 풀이, 강좌의 웹페이지, 공지사항 등이 예가 될 수 있으며, 이상 열거한 것들로 한정되지 않습니다. 본 강좌에서 사용될 영어 문장들은 한국의 공립 고등학교 정규 교과과정을 기초로 할 때 충분히 이해될 수 있어야 합니다만, 만약 수강생 본인의 영어실력이 본 강좌를 따라오거나 공지사항을 이해하기에 충분치 못하다면, 담당교수에게 한국어로 추가 설명을 요청하는 것은 학생 본인의 몫입니다. 담당 교수는 학생들의 이해를 도우려는 자세로 질문을 받을 것이지만, 질문의 내용에 따라 답을 하지 아니할 수도 있고, 면담시간에 개별 방문하여 질문하도록 안내할 수도 있습니다.

(3) 제출기한이 지난 과제물은 어떤 이유로도 접수 및 검토하지 않습니다.

General plans and outlook concerning the new Corona virus (SARS-CoV-2) outbreak: The class will follow the instructions from the university center regarding class operation policies due to the current Corona virus pandemic situation. Based on [학사지원과-4977 (2021.06.21) 2021 학년도 2학기 수업운영 계획 송부] we shall **meet in-class** however if the class cannot meet in-class for any reasons, we will follow the following action plan.

- **Remote classes using Youtube videos:** We shall have remote classes using **video-recorded lectures** posted on Youtube. The **platform** will be CBNU e-Campus (Blackboard) wherein you will be able to find Youtube video links. By the class meeting time of each day, you will be provided video recordings of lectures for that day's class meeting. Your attendance will be collected by using the online system implemented on e-Campus, while you will be provided a google form to submit in case the e-Campus system does not recognize your watching activities correctly. The instructor recommends watching youtube videos while logged into your own google account so that youtube can record your history in your account. You must complete watching video lectures within the specified period, which normally ends on Saturday of the week each lecture belongs.
- **Collecting assignments:** Hand-in your homework via email to `byungdo@g.cbnu.ac.kr` by scanning it or using smart phone scanner apps. You have to hand-in your homework by the due date. A late submission will not be accepted for any reasons.