Geometry and education
Course Outline
Course 7412062 Section 01, Fall 2021
Wednesdays 15:00 - 17:50, Room: E1-1 #140
Chungbuk National University

Instructor: Dr. Byungdo Park

Email: `byungdo@chungbuk.ac.kr`

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_ge.html` which is also accessible via instructor's webpage: `https://byungdo.github.io/`

References on geometry general:

- Claire F. Adler, *Modern Geometry : an integrated first course*, 2nd Edition (1967), McGraw-Hill, ISBN-13: 9780070004214

- Marvin J. Greenberg, *Euclidean and Non-Euclidean Geometries: Development and History*, 4th st Edition (2007), W. H. Freeman, ISBN-13: 9780716799481

- Robin Hartshone, *Geometry: Euclid and Beyond* (Undergraduate Texts in Mathematics), 1st Edition (2005), Springer New York, ISBN-13: 9780387986500

- Shoshichi Kobayashi, *From Euclid geometry to modern geometry*, translated in Korean by D. Won (1999), Cheongmoongak, ISBN-10: 8970881816

References on differential geometry:

- Martin M. Lipschutz, *Schaum's Outline of Differential Geometry*, 1st Edition (1969), McGraw-Hill Education, ISBN-13: 9780070379855

- Barrett O'Neill, *Elementary Differential Geometry*, Revised 2nd Edition (2006), Academic Press, ISBN-13: 9780120887354

- Manfredo P. do Carmo, *Differential Geometry of Curves and Surfaces: Revised and Updated Second Edition* (Dover Books on Mathematics) Updated, Revised Edition (2016), Dover Publications, ISBN-13: 9780486806990

References on complex analysis:

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

- Saminathan Ponnusamy and Herb Silverman, Complex Variables with Applications, (2006) Birkhäuser, ISBN-13: 9780817644574.

- Lars V. Ahlfors, <u>Complex Analysis</u>, 3rd Edition (1979), McGraw Hill Higher Education, ISBN-13: 9780070850088.

- Elias M. Stein and Rami Shakarchi, <u>Complex Analysis (Princeton Lectures in Analysis, No. 2)</u>, 1st Edition (2003), Princeton University Press, ISBN-13: 9780691113852.

- Saeed Zakeri, <u>A Course in Complex Analysis</u>, 1st Edition (2021), Princeton University Press, ISBN-13: 9780691207582.

Prerequisites: Differential Geometry I and II (7412005, 7412005). Complex Analysis I and II (7412010, 7412007), Geometry for teachers I and II (7412074, 7412075) are recommended. The instructor does not dissuade students without meeting the prerequisite criteria registering for this course at his/her own risk.

Course description: We shall review differential geometry of curves and surfaces through problems while revisiting also Euclidean, non-Euclidean, and projective geometry. Seeking connections between differential geometry and classical geometry as well as a reflection to secondary school geometry curricula is of particular interest. While doing so, we shall train ourselves for an ability of lucidly explaining and communicating logical thoughts on given problems to amplify teaching skills.In modern mathematics, understanding the intimate connection between geometry and complex analysis is very important particularly nowadays complex differential and algebraic geometries are important constituents of modern geometry. Therefore we would like to take a brief excursion to the land of complex geometry at least looking at phenomena near one point of a complex curve. If time permits we would like to expand our discussions to include more of panoramas in contemporary geometries such as Riemannian, symplectic, metric, and complex geometries. The overall goal is to help students to get armed with a strength in microscopic details as well as a bird-eye view of the subject.

Course objectives: At the end of the course students should be able to:

- Solve problems in differential geometry and complex analysis precisely and promptly.

- Clearly communicate ideas and logic for addressing given problems.

- Understand where to fit each topic learned in geometry courses (including this one) in historical timeline.

- Create an online learning contents such as YouTube videos for sharing knowledge with a broader audience.

- Think about topics learned in geometry courses (including this one) in connection to the curricula in secondary mathematics education.

Details on problem solving: Problems arising in this course will be requiring proofs and calculations based on the mathematical discourse in class and/or the subjects students are supposed to know already. 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: On every Wednesdays, there will be a 25-minute quiz and followed by a discussion on quiz problems. Students should be able to present their solutions and logically communicate. We shall exchange helpful feedback to improve teaching skills of all of us. Since the national exam usually takes places around November 20th, the instructor will set up a plan that everything we do in this course will be lined up with students' success in the national exam. Details about it will be discussed on the first day of class. In a situation that this course has to run online, then every class meeting will consist of the following components.

- An introductory lecture followed by an in-class problem session (Problem session: 25-minute long).

- Going over the problems from the problem session.

- An in-class quiz (25 minutes).

- Going over the quiz problems from the previous day.

Grading policies: 92% from in-class quiz 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. Those who are in their final semester and have to show up to work during the semester, special rules applies in accordance with the university policies (cf. 충북대학교 학칙 제34조의2, 학사운영규정 제86조의3).

Assessment through in-class quizzes: There will be total fifteen 25-minute long in-class quizzes on differential geometry in some weeks and on complex analysis in some other weeks. Each quiz will consist of two problems and the style of questions will be similar to those of Public Secondary School Teacher Employment Exam. For each student, the instructor will count only 5 highest scores of quizzes on differential geometry and the rest of quiz scores will be dropped. For those who participated in an in-class presentation will get 2 out of 6 points of extra credit for that day's quiz.

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 the number of absent hours will be counted but there will be no penalty on your total score. After that, you lose 1% of total score for an absence of 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.

Important dates:

- Wednesday September 22nd: Chuseok holidays

Weekly lesson plan:

Week 1: Weekly quiz and review. [DG] Basics on smooth curves. Lengths.

Week 2: Weekly quiz and review. [CV] Holomorphic functions.

Week 3: Weekly quiz and review. [DG] Frenet formulae.

Week 4: Weekly quiz and review. [CV] Some theorems arising in Cauchy theory: Liouville's theorem, identity theorem, maximum modulus principle, open mapping theorem, and etc.

Week 5: Weekly quiz and review. [DG] Congruence of curves.

Week 6: Weekly quiz and review. [CV] Residue theorem and integration techniques I

Week 7: Weekly quiz and review. [DG] Local theory of surfaces I

Week 8: Weekly quiz and review. [CV] Residue theorem and integration techniques II

Week 9: Weekly quiz and review. [DG] Local theory of surfaces II

Week 10: Weekly quiz and review. [CV] Möbius transformations

Week 11: Weekly quiz and review. [DG] Geodesic curvature, geodesics.

Week 12: Weekly quiz and review. [DG] Gauss-Bonnet theorem.

Week 13: Weekly quiz and review. [DG] Gauss-Bonnet Formula.

Week 14: Weekly quiz and review. [DG] Gauss map, The Gauss theorema Egregium.

Week 15: Weekly quiz and review. [DG] Weingarten map.

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 간단 명료하고 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.