

Geometry for teachers I
Course Outline
Course 7412074 Section 01, Spring 2022
Mondays 16:00 - 16:50, Thursdays 16:00 - 17:50, Room: E1-2 #306
Chungbuk National University

Instructor: Dr. Byungdo Park

Email: byungdo@g.cbnu.ac.kr

Office hours: By appointment.

Class webpage: Announcements, homework, exam schedules and other relevant information will be posted on the following webpage: https://byungdo.github.io/teaching/s2022_geom1.html which is also accessible via instructor's webpage: <https://byungdo.github.io/>

Textbook:

- C. G. Gibson, *Elementary Euclidean Geometry: An Undergraduate Introduction* 1st Edition (2004), Cambridge University Press, ISBN-13: 9780521834483

References:

- 이성현, *해석기하학*, 1963, 진명문화사, ISBN-13: 9788973390151.
- 이선홍, *해석기하학*, 초판(2019), 교우사, ISBN-13: 9791125103035
- George A. Jennings, *Modern Geometry with Applications* (Universitext), 2nd Edition (1997), Springer-Verlag Berlin, ISBN-13: 9780387942223

Prerequisites: Linear algebra materials from Calculus II. If you have learned geometry subjects in high school, that will help too.

Course description: This is a course on geometry of plane conics. Conics are important constituents in the standard secondary school curricula, but since it takes an analytic approach, many interesting algebraic and geometric aspects of the theory are often hidden under the rug. The aim of this course is to taste the richness of the theory of plane conics so that prospective teachers to grasp a firm handle on their teaching and research of geometry curricula.

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

- Understand plane conics in algebraic, geometric, and analytic perspectives and classify them.
- Create an online learning contents such as YouTube videos for sharing knowledge with a broader audience.
- Shape sophisticated knowledge in analytic geometry to teach it as a secondary school mathematics teacher.

Aspects on civic education: This course has been redesigned to incorporate strategies and goals of **The Project for Strengthening Civic Educational Competence in Teacher Training Colleges** (PI: Prof. Dr. Jongyeun Lee in the Department of Education) of the College of Education, Chungbuk National University. While the appreciation of plane conics will be tightly intertwined with civic educational themes, we shall follow the following specific weekly plans.

- **Week 1: The fairness.** The administrative introduction to this course is a great source to discuss values we strive in civic education. Using a carefully designed syllabus we shall look into details of the agreement between the instructor and students to see how everything coalesces to a single concept, the fairness. In addition, we shall add an aspect of character education on professional communication in electronic writing, such as how to compose an email to professionals for professional affairs.

Relevant items in Harmony-CHAMP abilities listing: C1, C2, C3, H1, H2, H3, P2, P3.

- **Week 2: Choices** While learning mathematics, it is important to distinguish between a canonical construction and a choice. Perhaps one of the most pervasive choice in mathematics would be that for the definition of an angle. In this week, we shall study basic constituents of Euclidean geometry. In our discussion about angles, we shall take a careful look at the definition of an angle and discuss mathematical consequences of the choice made. From this, we shall think about various social choices and agreements being a source of conflicts and making problems very difficult to solve, and it will naturally lead to an understanding that there is always a matter to do with choices.

Relevant items in Harmony-CHAMP abilities listing: C1, C2, C3, H2, H3, A1, A2, A3, M1, M2, M3, P3.

- **Week 14: Classification and violence** In mathematics, a theorem classifying mathematical objects always appreciated. One might argue that this reveals mathematicians' desire of control and possession, however, the logical value of classification theorems are self-evident (and we will see why). Nonetheless, one has to notice that, when it comes to the realm of the humanities, a classification itself can be a violence and itself is an origin of evil. Not only that, it leads you to perceive a situation or a matter in a guided way thereby limiting other perspectives or interpretations. We shall discuss various trivial and not-so-trivial social examples when a classification playing the role of violence, and by doing so, we shall be able to incorporate a respect toward the humanity so that our logical reasoning process won't be misled.

Relevant items in Harmony-CHAMP abilities listing: H1, H2, H3, A1, A2, A3, M1, M2, M3, P3.

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 midterm 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 NOT 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.

Homework submission guidelines: All the following requirements must be met.

- You should submit your homework to `byungdo@g.cbnu.ac.kr` (be sure not to use other email addresses of the instructor).
- Your email title should contain [기하학I과제], your CBNU ID, name, and homework number. An example: “[기하학I과제] 2021123456 홍길동 Homework #1 제출” Note that the instructor’s inbox has a filter and if you do not satisfy this requirement, your homework might get lost.
- Your email body should satisfy the email policy (see below).
- Your homework has to consist of a single PDF file. No other file formats are accepted.
- The file has to be attached to your email as a file and not as a download link; i.e., Large-size file attachments (대용량첨부) are not accepted. If your file size is too large, use freely available PDF compressor.
- Your homework has to be submitted before the deadline. Please do not send any homework past due because it won’t be read and it won’t be accepted. It will simply waste time for both you and your instructor.

Any homework that does not meet any one of the above requirements will not be accepted.

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.

Important dates:

- Thursday May 5th – Children’s day.
- Monday June 6th – Memorial day.

Weekly lesson plan:

Week 1: Vector structure, lines, zero loci, uniqueness of equations, parametrizations, pencils of lines (Sections 1.1–1.6)

Week 2: Scalar product, length, distance, angle, distance from a point to a line, circles as conics, general circles, uniqueness of equations (Sections 2.1–2.4, 3.1–3.3)

Week 3: Intersections with lines, pencils of circles, standard conics, parametrizing conics, matrices and invariants (Sections 3.4–3.5, 4.1–4.3)

Week 4: Intersections with lines, the component lemma, the concept of a centre, finding centres, geometry of centres (Sections 4.4–4.5, 5.1–5.3)

Week 5: Singular points, binary quadratics, reducible conics, pencils of conics, perpendicular bisectors (Sections 5.4, 6.1–6.4)

Week 6: Midpoint loci, axes, bisectors as axes, asymptotic directions, focal constructions (Sections 7.1–7.4, 8.1)

Week 7: Principles for finding constructions, constructions for parabolas, geometric generalities, constructions of ellipse and hyperbola, tangent lines, examples of tangents (Sections 8.2–8.5, 9.1–9.2)

Week 8: Leeway for catch-up. Midterm exam.

Week 9: Normal lines, the axis of a parabola, practical procedures, parametrizing parabolas (Sections 9.3, 10.1–10.3)

Week 10: Axes and vertices, rational parametrization, focal properties, asymptotes (hyperbolas) (Sections 11.1–11.3, 12.1)

Week 11: Parametrizing hyperbolas, focal properties of hyperbolas, the polars of a conic, the joint tangent equation (Sections 12.2–12.3, 13.1–13.2)

Week 12: Orthoptic loci, congruences, congruent lines, congruent conics (Sections 13.3, 14.1–14.3)

Week 13: The invariance theorem, rotating the axes, listing normal forms, some consequences, eigenvalues and axes (Sections 14.4, 15.1–15.4)

Week 14: Distinguishing classes, conic sections, conics within a class, proof of uniqueness, proof of invariance (Sections 16.1–16.3, 17.1–17.2)

Week 15: Leeway for catch-up. Final exam covers all sections we covered. PBL presentation.

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 accommodate 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.

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.

이메일 작성규칙: 담당교수에게 보내지는 모든 이메일의 제목에는 과목명, 신원, 요지가 포함되어 있어야 하며, 본문은 반드시 "OOO 교수님께"로 시작하여 인사, 신원, 용건을 간단 명료하고 예의 바르게 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.

English usage policies: 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.

영어 사용 정책: 본 강좌에서 강의는 한국어로 이루어지지만, 글의 경우 대부분 영어가 사용될 것입니다. 수업계획서, 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, 담당 교수에게 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.