Geometry for teachers
Course Outline (Updated)
Course 7412647 Section 01, Spring 2024
Wednesdays 14:00 - 14:50, Thursdays 13:00 - 14:50, Room: E1-1 #140
Chungbuk National University

> *This document prevails whenever interpretations of the course syllabus (the version in 개신누리) and that of this document conflict. This document contains terms and conditions on how this class will be administered throughout the semester. Registering for this class means you agree on plans, policies, and details in this document. You MUST drop this course if you disagree with any item listed in this document.*

Instructor: Dr. Byungdo Park

Email: byungdo@chungbuk.ac.kr

Office hours: Wednesdays 15:00–15:50 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/s2024_geom1.html` which is also accessible via instructor's webpage: `https://byungdo.github.io/`

Textbook:

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

References:

- 이성헌, <u>해석기하학</u>, 1963, 진명문화사, ISBN-13: 9788973390151.

- 이선홍, <u>해석기하학</u>, 초판(2019), 교우사, ISBN-13: 9791125103035

- George A. Jennings, <u>Modern Geometry with Applications</u> (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 the subtle difference between zero sets of lines and conics and their equations. (Convergent Major Competency)

- Explain when three non-parallel lines are concurrent and three distincts points are collinear. (Comprehensive Thinking and Creative Problem-Solving Competency)

- Understand the role of a pencil of lines, circles, and conics as well as the behavior of its constituents. (Convergent Major Competency)

- Know what radical axes and center lines are and how they are related. (Comprehensive Thinking and Creative Problem-Solving Competency)

- Understand and use the trace invariant, the delta invariant, and the discriminant. (Comprehensive Thinking and Creative Problem-Solving Competency)

- Find the center of conics understand the criteria for existence of centers. (Convergent Major Competency)

- Understand properties of singular conics; particularly how singularity and reducibility are related to the degeneracy of a conic and find perpendicular bisectors of reducible conics. (Comprehensive Thinking and Creative Problem-Solving Competency)

- Find axis of symmetry of conics and how it is related to an eigenvalue problem in linear algebra. (Convergent Major Competency)

- Find foci, directrices, tangent lines, and normal lines to a conic. (Comprehensive Thinking and Creative Problem-Solving Competency)

- Understand parametrizations of non-degenerate conics and their meanings as well as possible applications. (Convergent Major Competency)

- Understand what poles, polar lines, orthoptic loci are as well as their meanings. (Comprehensive Thinking and Creative Problem-Solving Competency)

- State and prove the invariance theorem and understand how conics are classified using invariants. (Comprehensive Thinking and Creative Problem-Solving Competency)

- Create an online learning contents such as YouTube videos for sharing knowledge with a broader audience. (Self-Management Competency)

- Shape sophisticated knowledge in analytic geometry to teach it as a secondary school mathematics teacher. (Global Competency)

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: 46% from 100-minute midterm exam, 46% from 100-minute final exam, 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. The only exception (that is unlikely to happen) to the absolute evaluation: If your total score is less than 60 points after curving <u>and</u> greater than or equal to 60 points before curving, then D is assigned instead of F. Grading policies in the attendance policies, academic integrity policies, and classroom attitude policies are applied in higher priority (in this order) than the above grading policies. Those who are in their final semester and have to show up to work during the semester, special rules apply in accordance with the university policies (cf. 충북대학교 학칙 제34조의2, 학사운영규정 제86조의3).

Homework policies: A list of homework problems will be posted on the class webpage roughly in weekly basis. The instructor will assign as many homework problems as it is needed to master the subject. However, homework will not be collected, will not be graded, and will not be used as a constituent of your final score. Instead, some of your exam problems will be identical to your homework problems.

Classroom attitude policies: The instructor may apply up to 5 points per day (up to 10 points per day for repeated cases) of deduction of your total score against any of your attitude which the instructor views it inappropriate. The sum of total score deduction due to these policies may not exceed 20 points throughout the semester. Inappropriate attitudes are (i) anything you do in the classroom that disturbs and/or distracts the instructor or other students or (ii) disturbing and/or distracting the instructor from administering this class. If you violate, you will be notified via email registered in 개신누리 and it gets confirmed if you do not dispute in a written form in 7 days.

Attendance policies: (1) 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.

(2) 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 your department secretary 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.

(3) If you responded to an attendance call and leave the classroom (even if you come back later) while the lecture is still going on, you will be considered to be absent for that attendance call *if you report later to the instructor that you left during the class within that day's class*. If you don't report and your arbitrary and sudden leave gets caught, you will be considered to be absent for that day's class and it will be treated as a violation of classroom attitude policies.

(4) Any dispute about in-class attendance records must be made before the instructor physically leaves the classroom after that day's class meeting.

Makeup exam policies: If you could not take any exam and would like to take a makeup exam to the missing exam, you must follow the following guideline:
https://byungdo.github.io/teaching/makeup.pdf

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 or a reuse of recording submitted to the instructor in the past.

Program Learning Outcomes Assessment: This course contributes to the following major competencies and learning outcome indicators:

1. Convergent Major Competency
   - Indicator 1-1 (Convergent Course Completion):
   * Integration of geometry, algebra, and analysis through conic sections
   * Assessment: Performance in theoretical problem-solving during exams
   - Indicator 1-2 (Mathematical Software Utilization):
   * Use of mathematical software for conic section visualization and analysis
   * Assessment: Application of software tools in geometric investigations

2. Comprehensive Thinking and Creative Problem-Solving Competency
   - Indicator 2-1 (Teaching Demonstration Assessment):
   * Development of teaching demonstrations incorporating geometric concepts
   * Assessment: Evaluation through PBL presentations of analytic geometry concepts
   - Indicator 2-2 (Teaching Plan Assessment):
   * Creation of lesson plans connecting analytic geometry to secondary mathematics
   * Assessment: Quality of teaching materials developed during problem sessions

3. Self-Management Competency
   - Indicator 3-1 (Participation in Extracurricular Programs):
   * Creation of educational YouTube videos as PBL projects
   * Assessment: Quality and effectiveness of produced video content (additional credit)

- Indicator 3-2 (Study Group Activities):
* Participation in problem sessions and peer discussions
* Assessment: Active engagement in collaborative learning activities

4. Global Competency
   - Indicator 4-1 (English-Medium Course Completion):
   * Use of English textbook and mathematical terminology
   * Assessment: Understanding of technical terms demonstrated in exams

The assessment results for each indicator will be primarily evaluated through midterm and final exams (92%), attendance (8%), and PBL project (3% additional credit), reflecting students' comprehensive understanding of analytic geometry and their ability to connect it with secondary mathematics education. The results will be submitted to the Department Performance Management Committee, and reflected in the course CQI report.

Important dates:

- Wednesday April 10th – National election day. Make-up date: TBA

- Wednesday May 15th – Buddha's birthday. Make-up date: TBA

- Thursday June 6th – Memorial day. Make-up date: TBA

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.

Dispute policies: (1) The instructor will announce a date and an interval of time for you to see (and dispute if you wish) your graded papers. For that you have to respond and set up an appointment by email until the specified deadline. If you respond, the instructor will give you a specified date, time, and location for you to show up. There will be an option to give up your rights to dispute and just get notified your scores by email.

(2) If the specified date and an interval of time in the announcement conflicts with your other classes or other equivalently official schedules, you may request a rescheduling by attaching your time table or a relevant document showing that you have other official matters.

(3) If you do not respond by the deadline in each announcement, the instructor will have to assume that you give up your right to dispute and the grading is flawless. For example, if you inquire after your letter grade is assigned, the instructor will only look into whether there is any error in entering your final grade and will dismiss all inqueries on the raw data.

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. If you violate any of these policies, you receive score zero to that exam at the discretion of the instructor. In addition,

your case will be handled through the standard procedure of the university. Note that a use of your smartphone during an exam is simply a cheating.

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 이루어집니다만, 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.