Geometry and education
Course Outline (updated)
Course 7412062 Section 01, Fall 2019
Tuesdays 13:00 - 13:50, Wednesdays 10:00 - 11:50, Room: E1-1 #136
Chungbuk National University

Instructor: Dr. Byungdo Park

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Office hours: Mondays 16:00–17:00 at E1-1 #110 or by appointment.

Class webpage: Announcements, homework, exam schedules and other relevant information will be posted on the following webpage: http://newton.kias.re.kr/~byungdo/teaching/f2019_ge.html which is also accessible via instructor's webpage: http://newton.kias.re.kr/~byungdo/

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

Prerequisites: Differential Geometry I (7412005) and Differential Geometry 2 (7412006). Geometry for teachers 1 and 2 (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: There are two primary components in this course. First, 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. Another part of this course is a project-based learning (as known as PBL) for which each student will take initiatives for choosing and investigating a topic or a problem among advanced topics in geometry. 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 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.
- Know what else are out there as advanced topics of geometry and attempt to learn at least one of them.
- 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. In addition there are components of PBL that students will have to teach themselves. 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 20-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.

On every Tuesdays the instructor will give lectures on the material following the weekly lesson plan, which will be a problem-based discourse. Weeks 14, 15, and possibly 16 will be devoted to in-class presentations of students' PBL activities and/or lectures on advanced topics in geometry. We shall also watch several videos overarching the subject we study. Lectures on advanced topics might be carried out in a form of an invited lecture of an external scholar.

Grading policies: 70% from in-class quiz, 20% from term paper or an in-class presentation, and 10% from attendance.

Assessment through in-class quizzes: There will be total twelve 20-minute long in-class quizzes. Each quiz will consist of two problems and the style of questions will be similar to those of Public Secondary School Teacher Employment Exam. Three of your lowest quiz scores will be dropped, and the remainder will be used to calculate your quiz score. For those who participated in in-class presentation, 20% of the quiz score of that day will be given in extra with a maximum total score

100%. For example, if your quiz score of a day is 85% and you have presented your solutions, then your quiz score of that day will be 100%. If your score was 60% and have presented solutions, then it will become 80%.

Attendance policies: Attendance data will be collected in every class meeting and will be used for determining your final grade. Up to 3 total number of absence there is no penalty. After that, you lose 1% of total score for an absence to each 50-minute long class meeting with a doubled loss on each of the seventh to the ninth absence, with a maximum total loss 10% from your total score. If you have permissible reasons for your absence (for example illness), you won't get any penalty as long as you can justify by documenting (for example, a photo of your doctor's prescription of medicines or a detailed hospital receipt suffices for an illness cause).

Assessment of term paper/in-class presentation: There will be a list of topics that you can choose. Nearing the end of semester, you will have to write a term paper about what you have taught yourself. 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. Alternatively, you may choose to give a standard 50-minute in-class presentation, in which case your lecture will be assessed by the above-mentioned rubric and your term paper will be waived. Only one person will be accepted to speak for each topic in first come first served basis.

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 October 9th: No class — Holiday.
- Thursday October 31st: Deadline to apply for an in-class presentation.
- Saturday November 23th: Public Secondary School Teacher Employment Exam.

Weekly lesson plan:

Week 1: Weekly quiz and review. Basics on smooth curves.

Week 2: Weekly quiz and review. Torsion and curvature.

Week 3: Weekly quiz and review. Frenet formulae.

Week 4: Weekly quiz and review. Additional topics from curves.

Week 5: Weekly quiz and review. Basics of smooth surfaces, the Gauss map.

Week 6: Weekly quiz and review. The first and second fundamental forms.

Week 7: Weekly quiz and review. The normal curvature, principal curvatures.

Week 8: Weekly quiz and review. Gauss and mean curvatures

Week 9: Weekly quiz and review. The Gauss theorema Egregium.

Week 10: Weekly quiz and review. Geodesic curvature, geodesics.

Week 11: Weekly quiz and review. Gauss-Bonnet theorem.

Week 12: Weekly quiz and review. Final summary of topics we have learned.

Week 13: Problem-based review / watch a youtube video on history of geometry.

Week 14: Team project presentation (final exam).

Week 15: Make-up classes if nessary, team project presentation (final exam).

Week 16: Make-up classes if nessary, team project presentation (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. The minimum penalty for giving or receiving help on an exam is a grade of 0 on that test. 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. If your homework is identical to someone else's in the class, you will be summoned to explain your solution in front of the instructor. A failure in justifying your solution would lead score 0 to that homework. The abovementioned violation of academic integrity can be a subject of filing a report in accordance with the university policy.