

Differential Geometry II
Course Outline
Course 7412006 Section 01, Fall 2021
Mondays 16:00 - 17:50, Thursdays 14:00 - 14:50, Room: E1-1 #136
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_dg2.html which is also accessible via instructor's webpage: <https://byungdo.github.io/>

Textbook:

- Martin M. Lipschutz, *Schaum's Outline of Differential Geometry*, 1st Edition (1969), McGraw-Hill Education, ISBN-13: 9780070379855. **Caution:** The main textbook for this course is the English version. The instructor **does not** recommend using Korean translation of the main textbook for this course, and will neither accommodate nor understand users of a Korean-translated textbook. It must be at your own risk if you want to use it. All your exam problems will be given in English, so if you use a Korean-translated textbook, it might act toward your disadvantage in exams.

References:

- Richard S. Millman and George D. Parker, *Elements of Differential Geometry*, 1st Edition (1977), Pearson, ISBN-13: 9780132641432
- 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
- Manfredo P. do Carmo, *Differential forms and applications*, Springer-Verlag Berlin, ISBN-10: 3540576185
- Shoshichi Kobayashi, *Differential Geometry of Curves and Surfaces*, 1st Edition translated in English (2019), Springer-Verlag, ISBN-13: 9789811517389

Prerequisites: Differential Geometry I (7412005). It is desirable to take this course after taking the following list of courses. You may still take this course and master materials successfully if you look up and teach yourself necessary concepts and results from the following list of courses.

- Geometry for teachers I, II (7412074, 7412075).
- Linear Algebra and Mathematics Education I , II (7412068, 7412069).
- Functions of Several Variables (7412065).
- General Topology I (7412016).

The instructor does not dissuade students without meeting the prerequisite criteria registering for this course at his/her own risk.

Course description: As a continuation of Differential Geometry I (7412005), we study the surface theory of Gauss. We shall begin with a definition of surface in \mathbb{R}^3 , learn how to analyze and classify curved surfaces locally. It will then lead us to Gauss' theorema egregium (an awesome theorem), and the course will reach at its climax by stating and proving the Gauss-Bonnet theorem bridging two totally different kinds of mathematics in one equation.

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

- Know what a surface in \mathbb{R}^3 means and give parametrizations to a few typical examples.
- Understand the meaning of normal curvature and principal curvatures as its extrema.
- Calculate Gauss and mean curvatures and analyze the meaning of numbers obtained.
- Extract geometric meanings from Gauss' equation.
- Understand the contents of Gauss' theorema egregium.
- Appreciate the statement and proof of Gauss-Bonnet theorem.
- Create an online learning contents such as YouTube videos for sharing knowledge with a broader audience.
- Shape an overarching perspective on secondary school geometry, vectors, and calculus curricula.

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. 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).

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.

Important dates:

- Monday September 20th – Chuseok holiday.

Weekly lesson plan:

Week 1: Review of concept of a surface (Parametrized regular surfaces)

Week 2: Review of concept of a surface (Simple surface, tangent planes, normal lines)

Week 3: The first and second fundamental forms (The 1st fundamental form and examples)

Week 4: The first and second fundamental forms (Normal curvature)

Week 5: The first and second fundamental forms (Principal curvature, principal directions, Gauss curvature, mean curvature)

Week 6: The first and second fundamental forms (Lines of curvature, Rodrigues' formula, asymptotic lines, conjugate families of curves.)

Week 7: Theory of surfaces (Gauss-Weingarten formula)

Week 8: Midterm Exam. Theory of surfaces (Gauss-Weingarten formula)

Week 9: Theory of surfaces (Gauss theorema egregium)

Week 10: Tensor analysis

Week 11: Intrinsic geometry (Geodesic curvature)

Week 12: Intrinsic geometry (Geodesics)

Week 13: Intrinsic geometry (Gauss-Bonnet formula)

Week 14: Intrinsic geometry (Gauss-Bonnet theorem)

Week 15: Make-up classes if necessary. 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 two-week period by providing online video lectures on CBNU eCampus. Since your teaching observation will be considered as absences in official causes, your attendance will not be collected for those video 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 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.

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.