Differential Geometry II
Course Outline
Course 7412006 Section 01, Fall 2020
Mondays 15:00 - 16:50, Tuesdays 12:00 - 12:50, Room: E1-1 #136
Chungbuk National University

Instructor: Dr. Byungdo Park

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Office hours: Mondays 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/f2020_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:

- 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*, translated in Korean by B. Kim (2002), Cheongmoongak, ISBN-13: 9788970881751

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 1 (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 egrigium (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.
- 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.

Grading policies: 75% from final exam, 17% from homework, and 8% from attendance.

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 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 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.

Weekly lesson plan:

Week 1: Review of concept of a surface (Parametrized regular surfaces) – *Online lectures using recorded videos*

Week 2: Review of concept of a surface (Simple surface, tangent planes, normal lines) – *Online lectures using recorded videos*

Week 3: The first and second fundamental forms (The 1st fundamental form and examples) – *Online lectures using recorded videos*

Week 4: The first and second fundamental forms (Normal curvature) – *Online lectures using recorded videos*

Week 5: The first and second fundamental forms (Principal curvature, principal directions, Gauss curvature, mean curvature) – *Online lectures using recorded videos*

Week 6: The first and second fundamental forms (Lines of curvature, Rodrigues' formula, asymptotic lines, conjugate families of curves.) – *Online lectures using recorded videos*

Week 7: Theory of surfaces (Gauss-Weingarten formula) – *Online lectures using recorded videos*

Week 8: Theory of surfaces (Gauss-Weingarten formula) – *Online lectures using recorded videos*

Week 9: Theory of surfaces (Gauss theorema egregium) – *Online lectures using recorded videos*

Week 10: Tensor analysis – *Online lectures using recorded videos*

Week 11: Intrinsic geometry (Geodesic curvature) – *Online lectures using recorded videos*

Week 12: Intrinsic geometry (Geodesics) – *Online lectures using recorded videos*

Week 13: Intrinsic geometry (Gauss-Bonnet formula)– *Online lectures using recorded videos*

Week 14: Intrinsic geometry (Gauss-Bonnet theorem) – *Online lectures using recorded videos*

Week 15: Make-up classes if nessary. 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.

Disclaimer: 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.

사전고지: 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, 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.

중요: 본 온라인강좌는 출석근거 및 과제물의 제출시한이 있습니다. 시한이 지난 출석인정신청 및 과제물은 접수하지 않습니다.

(1) 출석: 해당차시가 속한 주의 토요일 18:00.

(2) 과제물: 과제물별로 강좌 웹페이지에 게시된 제출시한 (이메일로만 과제물을 접수하며 학과 사무실 메일박스투입 등 불인정.)

Important: This course has a deadline for attendance claims and homework assignments. Any attendance claim and assignments that are past due will not be accepted.

(1) Attendance claims: Every Saturday 18:00 of the week that the video belongs.

(2) Assignments: Follows the deadline posted on the course webpage for each assignment. (Only email submission will be accepted, and no hard copies will be accepted.)

Policies on remote classes due to 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. Details of decisions made will be updated below in this document.

Tentative action plan as of 2020-06-20: If the university center decides to run classes remotely or if the status of new confirmed cases in Cheongju does not seem to be safe, stipulating that we follow policies and guidelines of the university center, we may choose to run this class remotely. The tentative action plan (which does not necessarily mean that we will be sticking to it) is as follows. Our remote classes will be 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. Of course the instructor does not wish to run this course remotely, and very much hopes that the current pandemic situation gets concluded as soon as possible.

Announcement of Remote classes as of 2020-07-20: As the primary rule, the university center has decided to run this course as a remote class for Fall 2020 semester. [학사지원과-6429 (2020.07.20.) 2020학년도 2학기 수업운영 방안 안내] Therefore, this course will go online throughout the semester. Please note the following:

- From the very first week of this course, 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 every Monday 15:00, you will be provided video recordings of lectures for 3 contact hours of that week. You will have to write an email to `byungdo@g.cbnu.ac.kr` with an answer key to the question (provided in the comment section of the video) for each contact hour. Please read the email (which will be sent nearing the first day of class) to learn more about attendance policies.