Differential Geometry 2
Course Outline (updated)
Course 7412006 Section 01, Fall 2019
Mondays 15:00 - 15:50, Tuesdays 14:00 - 15:50, Room: E1-1 #306
Chungbuk National University

Instructor: Dr. Byungdo Park

Email: `byungdo@chungbuk.ac.kr`

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_dg2.html` which is also accessible via instructor's webpage: `http://newton.kias.re.kr/~byungdo/`

Textbook:

- Martin M. Lipschutz, *Schaum's Outline of Differential Geometry*, 1st Edition (1969), McGraw-Hill Education, ISBN-13: 9780070379855 (Korean translation of the same book is equally fine.)

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). 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: 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. Some of problems will be assigned as a team project, for which each student has to be belong to one of groups and collaboratively discuss and work on those problems. Each group has to give an in-class presentation on team project problems at least once.

Grading policies: 35% from midterm exam, 35% from final exam, 10% from homework, 10% from group presentation, and 10% 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. 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 group presentation: All group members in each group will receive the same score, with an exception that the student who gave the presentation will receive an additional 2%

of the total score subject to the same maximum. For example, if a group of student has obtained 9 out of 10% from the group presentation, the speaker will get full 10%.

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)

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: Team project presentation and midterm exam

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 nessary, team project presentation, and final exam.

Week 16: Make-up classes if nessary, team project presentation, and 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.