Differential Geometry I
Course Outline
Course 7412005 Section 01, Spring 2022
Mondays 14:00 - 14:50, Fridays 11:00 - 12:50, Room: E1-1 #136
Chungbuk National University

Instructor: Dr. Byungdo Park

Email: byungdo@g.cbnu.ac.kr

Office hours: By appointment.

Class webpage: Announcements, homework, exam schedules and other relevant information will be posted on the following webpage: https://byungdo.github.io/teaching/s2022_dg1.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 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.

Supplementary textbooks:

- Barrett O'Neill, Elementary Differential Geometry, Revised 2nd Edition (2006), Academic Press, ISBN-13: 9780120887354

- Serge Lang, Linear Algebra, 3rd edition, Springer-Verlag Berlin, ISBN-10: 0387964126

- Jerrold Marsden and Anthony Tromba, Vector Calculus, 6th Edition, W. H. Freeman, ISBN-10: 1429215089

- Manfredo P. do Carmo, Differential forms and applications, Springer-Verlag Berlin, ISBN-10: 3540576185

You do not have to buy supplementary textbooks, but expected to make yourselves photocopies of chapters and sections to be used from the library.

References:

- Richard S. Millman and George D. Parker, Elements of Differential Geometry, 1st Edition (1977), Pearson, ISBN-13: 9780132641432

- 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

- Shoshichi Kobayashi, <u>Differential Geometry of Curves and Surfaces</u>, translated in Korean by B. Kim (2002), Cheongmoongak, ISBN-13: 9788970881751

Prerequisites: A solid coursework on calculus and linear algebra will help. 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.

Corequisites: None. The instructor highly recommends taking "Functions of Several Variables (7412065)" along with this course.

Course description: This is the first semester course of an year-long course "Differential Geometry" consisting of Differential Geometry 1 (7412005) and Differential Geometry II (7412006). We shall study a local theory of curves as well as their invariants curvatures and torsions, Frenet formulae, tangent maps, isometries in $\mathbb{R}^3$, congruence of curves, as well as basic concepts of differential forms and the second derivative tests using Hessian.

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

- Write an arc-length parametrization of a regular curve.

- Compute curvature and torsion at a point of a given curve in both unit-speed and arbitrary-speed cases.

- Say when two given curves are congruent.

- Explain precisely what a differential form is.

- Know how to carry out the second derivative test for 2-variable functions.

- 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 miterm 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.

Homework policies: A list of homework problems will be posted on the class webpage roughly in weekly basis. Late homework will NOT 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 ith homework score, n_i is the number of problems in the ith homework.

Homework submission guidelines: All the following requirements must be met.

- You should submit your homework to byungdo@g.cbnu.ac.kr (be sure not to use other email addresses of the instructor).

- Your email title should contain [미분기하학I과제], your CBNU ID, name, and homework number. An example: "[미분기하학I과제] 2021123456 홍길동 Homework #1 제출" Note that the instructor's inbox has a filter and if you do not satisfy this requirement, your homework might get lost.

- Your email body should satisfy the email policy (see below).

- Your homework has to consist of a single PDF file. No other file formats are accepted.

- The file has to be attached to your email as a file and not as a download link; i.e., Large-size file attachments (대용량첨부) are not accepted. If your file size is too large, use freely available PDF compressor.

- Your homework has to be submitted before the deadline. Please do not send any homework past due because it won't be read and it won't be accepted. It will simply waste time for both you and your instructor.

Any homework that does not meet any one of the above requirements will not be accepted.

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 제52 조(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 June 6th – Memorial day.

Weekly lesson plan:

Week 1: Concept of a curve (regular representations, regular curves, orthogonal projections, arc-length)

Week 2: Concept of a curve (arc-length parametrization), Curvature and torsion (tangent vectors, tangent line and normal plane, curvature)

Week 3: Curvature and torsion (curvature, principal normal vectors, normal line and osculating plane, binormal vectors, Frenet frame fields)

Week 4: Curvature and torsion (torsion, spherical indicatrices, general helices, Frenet formulae)

Week 5: The theory of curves (intrinsic equations, funamental existence and uniqueness theorem, canonical representation of a curve)

Week 6: The theory of curves (involutes and evolutes)

Week 7: Leeway for the theory of curves

Week 8: Midterm exam. Linear algebra review.

Week 9: Linear algebra review

Week 10: Linear algebra review, continuity and limits, differentiable functions

Week 11: Directional derivatives, chain rule, inverse function theorem

Week 12: The dual of a vector space (Lang, Section V.6.), differential forms (do Carmo, Chapter 1)

Week 13: A crash course on the second derivative test (Marsden and Tromba, Section 3.3.) [Digital classroom environment]

Week 14: Isometries and their derivatives, congruence of curves(O'Neill Chapter 3)

Week 15: In-class final exam. PBL presentation.

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. 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.

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.