

MATH 4223
Differential Geometry
2026-27 Fall

https://canvas.ust.hk/courses/73428

Lecture

Time	Tuesdays and Thursday 3:00pm-4:20pm
Venue	Room 4579
Instructor	**Prof. Frederick Tsz-Ho FONG**
E-mail	frederick.fong@ust.hk
Office	Room 3425, Department of Mathematics

Tutorial

Time	Tuesdays 6:00pm-6:50pm
Venue	Room 6573
Teaching Assistant	**WU Sen-Yuk, Dormice**
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Course Description

Course outline: differential geometry of curves and surfaces in Euclidean spaces: curvature and torsion, Frenet-Serret frame, regular surfaces, first and second fundamental forms, curvatures, covariant derivatives, Theorema Egregium, Gauss-Codazzi equations, geodesics, Cartan's structural equations, Gauss-Bonnet theorem.

Credits: 3

Prerequisites: Multivariable Calculus (MATH 2024/2023/2011) and Linear Algebra (MATH 2121/2131).

Intended Learning Outcomes (ILOs)

Upon completion of this course, students are expected to:

(1) acquire workable knowledge on the fundamental concepts of regular curves and surfaces in Euclidean spaces;
(2) acquire necessary background for further studies in differential geometry, general relativity, and related fields;
(3) appreciate the beauty of differential geometry, especially the Gauss-Bonnet's Theorem.

Assessment, AI Policy, and Grading

AI Policy: You are very welcome to use AI tools (even including the current most powerful models ChatGPT 5.6 Sol, Claude Fable 5) in assisting your learning and problem-solving in this course, provided that it is used in an educational and honest way. Direct copying AI output into homework without careful and critical digestion is not encouraged. You are recommended to first try the homework problems by yourself without the help of AI tools, and only use AI tools to **ask for hints, ideas, suggested approaches** if you have no idea how to work out the problems. Before you finish the problem, you should **avoid asking AI for complete solutions** by carefully writing your prompts, such as:

- *"Can you teach me how to approach this attached problem, such as giving me some hint what theorems could I try without telling me the complete solution?"*
- Upload your partially completed solution, and ask AI: *"How is my progress so far? Am I on the right track? Can you give me some hints what to do next without telling me the complete solution?"*

Homework: There will be 5 problem sets. With the recent significant advancement of AI tools on solving mathematical problems, the percentage of the homework component in the course total score will be significantly reduced when compared to previous years. Furthermore, each homework will be marked on "1/0.5/0" basis, explained as follows:

- You are required to submit your homework in Canvas by the indicated deadline. No late homework will be accepted.
- After the due date of each homework, solution will be immediately released.
- Then, you are required to feed **(1) your own solution, and (2) the suggested solution** into an AI tool to **get feedback** of your work [Gemini free version would be good enough].
- Within one week after the homework due date, submit the **AI feedback** to Canvas.
- You will get 1 point if you submit both **your homework** by the due date, and the **AI feedback** within one week after the due date, as long as you have attempted $\geq 75\%$ of the problems.
- You will get 0.5 point if you have only submitted **your homework** (with $\geq 75\%$ completion rate) without the AI feedback.
- 0 point will be given if the homework is not submitted by the due date, or you have completed only $< 75\%$ of the problems.

You may write some "grading dispute" over AI's grading if you wish, but it is optional. You are also welcome to consult the instructor or TA if you have any doubt over "AI's grading". Instructor and TA will also do random check on your solution and AI's grading, yet it would not affect your homework scores.

Examinations: There will be a 2-hour midterm exam during Week 6-8 (exact date to be confirmed), and a 3-hour final exam arranged by ARO.

Make-up midterm policy:

- Under any circumstance (including sick leave), students who are unable to attend the midterm exam will **not** be offered a make-up test that takes place after the regular exam session.
- For students who have valid reasons of not being able to sit in the midterm (such as time crash with another midterm), the instructor may approve an early midterm, or assign the midterm marks according to the final exam performance.
- On the other hand, for students who miss the midterm without a valid reason, the midterm score will be regarded as 0. This includes self-claimed sickness without any medical statement.

Make-up final exam policy:

For final exams, the course will follow the make-up exam policy set by ARO. Approval from the instructor, the dean, and ARO will be needed for applying for a make-up final exam, and students need to complete the make-up final exam within 1 week after the approval decision from ARO. In any circumstance, the make-up final exam will use a different set of problems, and there is no guarantee that the level of difficulty remains the same as the regular sitting.

Oral Exam (optional, for A or A+ only): Students who aim at A or A+ should aim at getting $\geq 90\%$ in the course total. Additionally, they are required to attend a 30-minute oral exam which will test the deep understanding of the subject, including some detail steps of proofs (such as Gauss-Bonnet) discussed in the course. Students who do not pass the oral exam will have the letter grade capped by A-. For students who get below 90%, taking the oral exam is unnecessary and will not earn them bonus points.

The oral exam will take place in December. Detail logistics will be announced in due course.

Grading Scheme: This course will be assessed using **criterion-referencing**. It will not be graded on a curve, surface, nor manifold, but it will be graded on two schemes:

	Scheme A	Scheme B	Address ILOs
Homework	5%	5%	1, 2, 3
Midterm	45%	5%	1, 2, 3
Final	50%	85%	1, 2, 3
Course Total	100%	95%	

Your course total will be calculated by taking the **maximum of Scheme A and Scheme B**. Students should aim at getting a course total of 85% or above for A-/A/A+, and about 60% or above for B-/B/B+, and 40% or above for C-/C/C+.

Grade Descriptors:

Grades	Short Description A	Elaboration on subject grading description
A	Excellent Performance	The student has mastered almost all concepts and techniques of differential geometry taught in the course, has excellent understanding of the deepest content of the subject, and acquired workable knowledge for further studies of abstract manifolds, Riemannian geometry, general relativity, and related fields.
B	Good Performance	The student has mastered most computational techniques of differential geometry taught in the course, yet the understanding of some challenging concepts may not be deep enough for further studies on related advanced subjects.
C	Satisfactory Performance	The student meets the minimum expectation of the instructor, has acquired some basic computational techniques of the subject, yet some concepts were not clearly understood.
D	Marginal Pass	The student is only able to recall some fragments of topics and is able to complete some of the easiest computations.
F	Fail	The student does not have sufficient understanding of even some fragments of topics, and is not even able to complete some of the easiest computations.

Textbooks and References

References: The major reference is the instructor's lecture notes posted on the course website (only Part 1: Differential Geometry in Euclidean Spaces will be needed). In addition, the following reference books are recommended:

(1) *Differential Geometry: curves-surfaces-manifolds*, Third Edition by Wolfgang Kühnel
(2) *Differential Geometry of Curves and Surfaces* Manfredo P. do Carmo
(3) *A Comprehensive Introduction to Differential Geometry, Vol. 1*, Third Edition by Michael Spivak

Academic Integrity

Students are expected to adhere to the university's academic integrity policy. Students are expected to uphold HKUST's Academic Honor Code and to maintain the highest standards of academic integrity. The University has zero tolerance of academic misconduct.