

Differential Geometry

Lia Vas

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Office: BL 228

Website: <http://liavas.net> (class material)

Class times, Fall 2026: M and W 12:20 – 1:35.

Class meeting location, Fall 2026: BL 221 (HH campus)

Office hours, Fall 2026 are by appointment: email me and we will find a time for us to meet. I will be glad to answer all of your questions about the course material, go over some problems together with you, check your assignment work, review together for an exam, or discuss any course content you may have questions about.

Text: No textbook is required. Handouts with new material and practice problems are available on my website. The textbooks used for the class preparation include the following.

- **Richard L. Faber**, Differential Geometry and Relativity Theory
- **Richard Millman, George Parker**, Elements of Differential Geometry.

Topics covered:

1. Curves: parametrization, tangent (velocity) vector, arc length, acceleration vector, curvature, normal and binormal vector, torsion, Frenet-Serret apparatus. (Exam 1)
2. Surfaces: tangent plane, curvature, Theorema Egregium.
3. Surfaces: coordinate patches, the First Fundamental Form. (Exam 2)
4. Surfaces: the Second Fundamental Form, the Gauss curvature, geodesics, curvature tensor, manifolds. (Exam 3)

Tentative Exam Schedule, Fall 2026:

Exam 1. During week 5 (Sept 23)

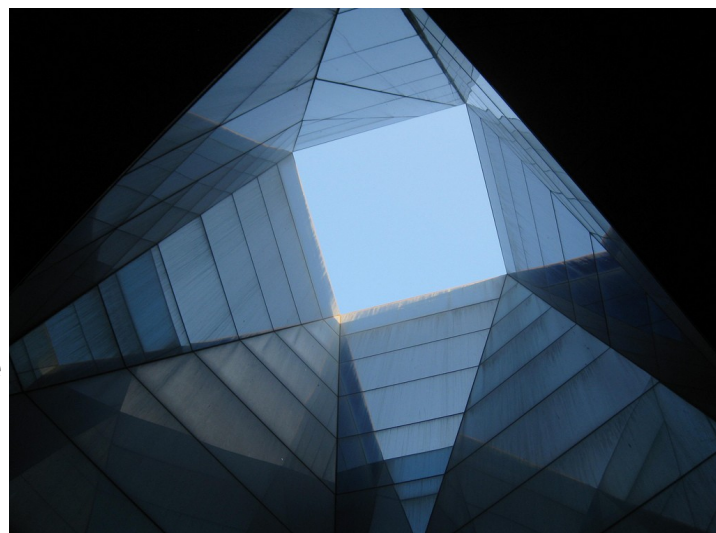
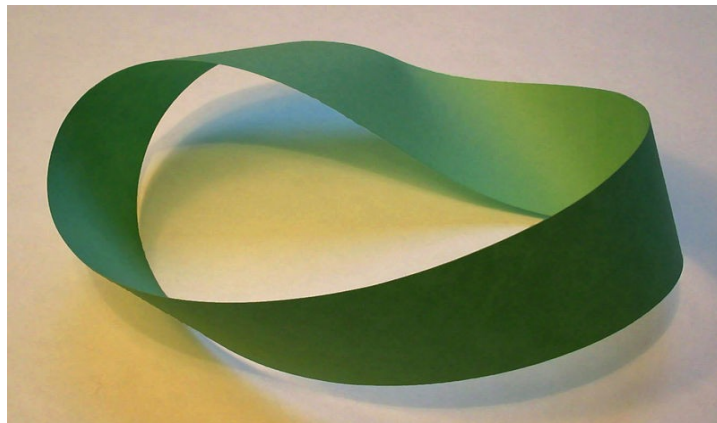
Exam 2. During week 9 (Oct 21)

Exam 3. During week 15 (Dec 7)

Grading:

Exam 1	26%
Exam 2	26%
Exam 3	26%
Project	22%
TOTAL	100%

Grades are computed according to the following system:



letter grade	A	A-	B+	B	B-	C+	C	C-	D+	D	F
number grade	93 to 100	90 to 92	87 to 89	83 to 86	80 to 82	77 to 79	73 to 76	70 to 72	67 to 69	60 to 66	0 to 59

Relevant Course Elements.

Number of Credits: 3

Prerequisites: Calculus 3 or permission of instructor.

Attendance: The class lectures will be delivered on campus (at the times listed above). To stay on track, it is highly recommended that students attend all classes. I will be available to any student who misses a class and has questions.

Students are responsible for all material covered in class, even if attendance is not checked or assignments collected.

Exams and assignments: There will be **three exams** and **one student project** during the semester. Exams turned in after their due date will receive an automatic reduction in grade. No exam grade will be dropped.

More on course topics:

- The course will start with a review of Multivariable Calculus. The course can be considered a continuation of Calculus 3 course and the next step in deepening the students understanding of calculus and its use.
- The review of multivariable calculus will morph into the study of differential geometry - a mathematical discipline that uses methods of multivariable calculus to study geometrical features, such as shape and curvature, of objects. The **curvature** measures the extend of bending of a curve, a surface, a space or their generalizations to any dimension, the manifolds. Studying ways of describing such an extent of bending is one of the central ideas of the course and enables one to understand concepts like the expansion rate of the universe.
- Differential Geometry is used in natural sciences, especially in physics and computational chemistry.
- The course provides students interested in continuing their education at a graduate level with mathematical techniques that certain graduate programs use.

Course Objectives.

- Identify situations that require the use of vector calculus and differential geometry.
- Solve certain classes of problems related to vector calculus and differential geometry.
- Understand and write mathematical proofs using formal mathematical reasoning.
- Present solutions on a computer or in a written form.

University Student Learning Outcome 2.

- Critical Thinking and Inquiry: Students will be able to critically analyze and/or construct arguments to support their positions using skills appropriate to the context, such as deductive reasoning, scientific inquiry, quantitative reasoning, aesthetic judgment, and/or critical examination of form, style, content, and/or meaning.

Course specific learning outcomes. Students will:

- develop understanding of basics of differential geometry,

- be able to understand and solve problems which require the use of differential geometry,
- know how to use formal mathematical reasoning and write mathematical proofs when necessary,
- demonstrate ability to cover a topic independently and to present their results in a written report.

Academic Integrity Statement: Saint Joseph's University encourages the free and open pursuit of knowledge; we consider this to be a fundamental principle and strength of a democratic people. To this end, SJU expects its students, its faculty, its administrators, and its staff to uphold the highest standards of academic integrity. The University expects all members of the University community to both honor and protect one another's individual and collective rights.

Students with Disabilities Statement: Reasonable accommodations are provided to eligible students by the Office Student Disability Services (SDS). For more information, please contact SDS at sds@sju.edu or 610.660.1774, or visit the website at www.sju.edu/sds.

Class Recording: Be advised that by taking this course, you consent to some or all class sessions being recorded by the instructor (and in some cases with assistance from the SJU Office of Information Technology). Recordings are intended to focus on the instructor, but the voices or likenesses of other individuals in the class may also be recorded. Video or sound recordings will be used only for educational or academic purposes, e.g., to allow for remote learning for those students not physically present in class or unable to attend a synchronous class session. If you have questions about the use of such technology or you do not consent to being recorded, you must discuss and resolve your concerns with your instructor before the end of the drop/add period.

Statement on AI use: The assignments in this course should be completed without any use of artificial intelligence platforms. Note that students will not have access to such platforms on in-class exams.