

MATH 230A: DIFFERENTIAL GEOMETRY

Fall 2022

Instructor:	Fan Ye	Time:	10:30-11:45 am, T-Th
Email:	fanye@math.harvard.edu	Place:	SC 221.

Course Page: <https://scholar.harvard.edu/fanye/classes/math230a-differential-geometry>

Course Assistant: Keeley Hoek, khoek@math.harvard.edu

Office Hours: Fan Ye, SC 505H, Tuesday 1:30-3:20 pm.

Keeley Hoek, SC 333G, Thursday 2:00-3:00 pm.

Main Reference: Differential Geometry: Bundles, Connections, Metrics and Curvature, Chapters 1-16, by Clifford H. Taubes.

Other suggested references:

1. An Introduction to Differentiable Manifolds and Riemannian Geometry, William M. Boothby
2. Foundations of differentiable manifolds and Lie groups, Frank W. Warner
3. Differential forms in algebraic geometry, Raoul Bott and Loring W. Tu
4. Vector bundles & K-theory, Allen Hatcher

Prerequisites: An undergraduate-level understanding of manifolds. An undergraduate may look at the first chapter of Cliff's book for preparation.

Tentative Course Outline: Notes will be posted on the course page after the classes.

- Weeks 1-2 (Sept. 1-8): smooth manifolds and Lie groups [Taubes, Chapters 1-2]
- Weeks 3-4 (Sept. 13-22): vector bundles [Taubes, Chapters 3-6]
- Weeks 5-6 (Sept. 27-Oct. 6): metrics and geodesics [Taubes, Chapters 7-9]
- Weeks 7-8 (Oct. 11-20): de Rham cohomology and covariant derivative [Taubes, Chapters 12]
- Weeks 9-10 (Oct. 25-Nov. 3): Levi-Civita connections and Riemann curvature tensors [Taubes, Chapters 15, 14.1]
- Weeks 11-13 (Nov. 8-22): characteristic classes and principal bundles [Taubes, Chapters 14, 10-11]
- Week 14 (Nov. 29-Dec. 1): Yang-Mills equation and applications.

Grading Policy: Homework (60% = 5 × 12%) and Final exam (40%).

Homework: There will be 6 assignments, posted on the course page every two weeks, which are related to the materials in the next two weeks. The first assignment will be posted on Sept. 1. The homework should be submitted via Canvas (see Important Dates for the exact dates). Late homework is accepted only by my permission. LaTeX, scanned copies, photos of writings, and any other types of writings are accepted if they are clear and understandable. The lowest homework score will be dropped and it is allowed to only finish and submit homework for 5 times.

Final Exam: There will be a take-home final exam, posted on the course page on Dec. 1. It should be submitted via Canvas before Dec. 5.

Collaboration: Discussion and collaboration are encouraged for homework but students should write up their own solutions. It is good to write the names of collaborators on the first page of the homework. Collaboration on the final exam is prohibited.

Important Dates:

Sept. 1, Thu	Assignment 1 will be posted
Sept. 15, Thu	Assignment 2 will be posted
Sept. 22, Thu, 11:59 pm	Deadline of Assignment 1
Sept. 29, Thu	Assignment 3 will be posted
Oct. 13, Thu	Assignments 4,5 will be posted
Nov. 3, Thu, 11:59 pm	Deadline of Assignments 2,3,4
Nov. 10, Thu	Assignment 6 will be posted
Nov. 17, Thu, 11:59 pm	Deadline of Assignment 5
Nov. 23-25, Wed-Fri	Thanksgiving break
Dec. 1, Thu, 11:59 pm	Deadline of Assignment 6
Dec. 1., Thu	Final exam will be posted
Dec. 5, Mon, 11:59 pm	Deadline of final exam