MA 109C: INTRODUCTION TO GEOMETRY AND TOPOLOGY

SPRING 2024

Instructor: Seung-Yeon Ryoo (she/her, sryoo@caltech.edu)
Lectures: Monday, Wednesday, and Friday, 10:00 AM – 10:55 AM, Linde 387
Office hours: Monday 2:00 PM – 4:00 PM, Linde 258

Teaching Assistant: Chi Zhang (he/him, czhang5@caltech.edu)
Office hours: Tuesday 3:00 PM – 4 PM, Linde 306

Course Description: An introduction to differentiable manifolds. Transversality, differential forms, and further related topics.

Prerequisites: Ma 2 or equivalent, and Ma 108 must be taken previously or concurrently.

Main textbook: *Differential Topology* by Victor Guillemin and Alan Pollack, American Mathematical Society, 2010.

Supplementary textbooks:

- *Topology from the Differentiable Viewpoint* by John Milnor, Princeton University Press, 1997.
  - This gives a nice 'crash course' on differential topology. I recommend reading through this at the beginning of the course.
- *Calculus on Manifolds* by Michael Spivak, CRC Press, 1971.
  - This gives a systematic treatment on differentiation and integration and culminates in Stokes' theorem.
- *Differential Forms and Applications* by Manfredo do Carmo, Springer, 1994.
  - Reference for differential forms.
- *A Comprehensive Introduction to Differential Geometry, Volume 1* by Michael Spivak, Publish or Perish, 1999.
  - Refer to chapter 5 for differential equations on manifolds, and chapters 6 and 7.5 for the Frobenius integrability theorem.
- *Differential Topology* by Morris Hirsch, Springer, 1976.
  - A graduate level textbook on differential topology, which you can read for further studies after finishing this course.
- *Lectures on the h-Cobordism Theorem* by John Milnor, Princeton University Press, 1965.
  - As it is in the advanced graduate level, I do not expect you do read this from cover to cover during this quarter.

Problem sets: Problem sets will be assigned weekly, and posted on Canvas by Wednesday. Solutions must be submitted to Gradescope by the Friday of the following week. Each student will have an allowance of three late days. Collaboration with other students on the problem sets is allowed, though thinking about the problem sets on your own is the best way to understand the material. If you do discuss the problem set with others, please indicate clearly the names of the people with whom you collaborated, and write your solutions separately in your words while justifying all the claims and stating clearly all the previous results that you are using.

Midterm and Final exams: The midterm and final exams will be posted on Canvas, and the exact logistics will be announced later in the quarter. Collaboration with other students on the midterm and final exams is not allowed.

Grading scheme: Weekly problem sets (60%), midterm exam (20%) and final exam (20%). The lowest problem set grade will be dropped. I will not keep track of class attendance.

Tentative Course Schedule:

- Week 1 (4/1 - 4/5): Guillemin and Pollack Chapter 1.1 - 1.5.
- Week 2 (4/8 - 4/12): Guillemin and Pollack Chapter 1.6 - 1.8. Problem Set 1 due on 4/12.
- Week 3 (4/15 - 4/19): Guillemin and Pollack Chapter 2.1 - 2.3. Problem Set 2 due on 4/19.
- Week 4 (4/22 - 4/26): Guillemin and Pollack Chapter 2.4 - 2.6. Problem Set 3 due on 4/26.
- Week 5 (4/29 - 5/3): Guillemin and Pollack Chapter 3.1 - 3.4.
  Midterm examination period 5/1 - 5/7.
- Week 6 (5/6 - 5/10): Guillemin and Pollack Chapter 3.5 - 3.7.
- Week 7 (5/13 - 5/17): Guillemin and Pollack Chapter 4.1 - 4.5. Problem Set 4 due on 5/17.
- Week 8 (5/20 - 5/24): Guillemin and Pollack Chapter 4.6 - 4.9. Problem Set 5 due on 5/24.
- Week 9 (5/27 - 5/31): Additional topics. Problem Set 6 due on 5/31.
  Memorial day 5/27.
- Week 10 (6/3 - 6/7): Additional topics.
  Final exams for seniors (6/5 - 6/7)
- Week 11 (6/10 - 6/14)
  Final exams for undergraduates (6/12 - 6/14)

Additional topics may include differential equations on manifolds, the Frobenius integrability theorem, and the h-cobordism theorem.

(Last updated March 31, 2024)