

## Advanced Calculus II

Math 5053.1 ES 213A MWF 10:30 – 11:20

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The textbook is *Calculus on Manifolds* by Michael Spivak. We shall attempt to cover the entire book, as well as several supplementary topics. The first chapter is largely a recapitulation of various topics that were covered in greater generality in Advanced Calculus I, and so we shall go through this chapter rather quickly. In addition to this Advanced Calculus I background, it will be assumed that everyone in the class has reasonable facility with the basics of Linear Algebra, including the algebra of matrices, linear maps, inner products, norms, subspaces, and determinants. More advanced Linear Algebra topics, including dual spaces, Euclidean tensors, and exterior algebra, are developed in the textbook as needed.

The purpose of the course is to provide a rigorous treatment of calculus on Euclidean spaces (Chapters 1 – 3), to introduce the modern language of differential forms, chains, and the exterior derivative on Euclidean spaces (Chapter 4), and then to explain how this material is globalized in the context of embedded manifolds (Chapter 5). The last two chapters are substantially more abstract than the first three.

It will be essential to read the textbook thoroughly. *Calculus on Manifolds* is written in the style that is standard for much advanced mathematical writing. One requires a specific set of skills to read material written in this style. You should expect to read actively, initially with a pencil and paper at hand. When Spivak writes that a certain fact “follows easily,” you should ensure that you have a complete proof for the fact before reading on. You will normally need to read the longer proofs several times, since it is essential to understand the overall strategy, the details of each step, the role of each hypothesis, and ways in which the proof could be modified to prove related statements. You need to become completely familiar with every definition in the book, and be comfortable with chains of definitions with many links. You also need to practice providing examples and, particularly, counterexamples. You should read each section at least once before it is discussed in lectures.

Grades in the course will be based on homework (50%) and two preliminary exams (25% each). Near the end of the semester, I will tell you your overall grade based on these components. An optional final exam will be offered to anyone who wishes to try to improve this grade. If you elect to take the final exam then it will count for 100% if this improves your grade; otherwise, it will make no difference.

Since this is a double-numbered course, with one number having graduate credit and the other not, I am required to specify the extra feature of the graduate-level course. It is this: I will hold those enrolled in the graduate-level number to a slightly higher standard of precision in logic and written expression in homework solutions. I may ask you to revise your homework solutions if they do not initially meet this standard.