

**Mathematics W4081y**  
**Differentiable Manifolds**  
**Spring 2014**

**Instructor:** Prof. Michael Thaddeus    **Classroom:** 417 Mathematics  
**Office:** 414 Mathematics            **Lectures:** M.W. 1:10–2:25  
**Office hours:** Th. 11 am – noon, or by appointment.

**Home page:** [www.math.columbia.edu/~thaddeus/manifolds.html](http://www.math.columbia.edu/~thaddeus/manifolds.html)

**Text:** Michael Spivak, *Calculus on Manifolds*, Westview Press. Readings and much of the assignments will be drawn from this text. It has been placed on reserve in the Mathematics Library.

**Course outline:** The great nineteenth-century theorems of Green, Gauss, and Stokes on line and surface integrals were generalized in the twentieth century to arbitrary dimensions. The domain of integration is then a *differentiable manifold*, while the integrand is a *differential form*. We will define and explore these concepts, then prove the generalized Stokes's theorem subsuming and extending the classical theorems. In other words, we will study multivariable calculus in higher dimensions. We may follow Spivak's book fairly closely. If time permits, we may study how differential forms are used to prove that two manifolds are not differentially equivalent, by computing their *de Rham cohomology* groups.

**Prerequisites:** Linear Algebra (V2010) and either Topology (W4051) or Modern Analysis I (W4061). Students lacking these prerequisites must seek my explicit permission.

**Contacting me:** By e-mail at [thaddeus@math.columbia.edu](mailto:thaddeus@math.columbia.edu), or, preferably, by telephone at 4–4308, or, even more preferably, in office hours, Th. 11 am – noon in 414 Mathematics. Or knock on my office door at any time.

**Teaching assistant:** Kyeongsu Choi [kschoi@math.columbia.edu](mailto:kschoi@math.columbia.edu).

**Assignments:** To learn a subject like this one thoroughly, practical experience is essential, so a written assignment will be given each week. It will be posted on the course home page. You can learn as much from your fellow students as from lectures, so I encourage you to discuss the problems with each other, subject to the following ground rules: (1) make a serious effort to think through each question for yourself first; (2) list the names of all collaborators at the head of each assignment; (3) do not exchange any written work with others; (4) do not consult any Internet sources except Wikipedia; (5) write up every problem in your own words.

Assignments are due on Mondays at 5 pm, starting February 3, in the collection box outside 417 Mathematics. Late assignments will be penalized by 10% of their point value for each day they are late. Warning: the building may be locked outside of library hours.

On each assignment, the use of a staple or paper clip is absolutely, positively, utterly compulsory! (Tip: look behind the blue sheet on the door of the collection box.) Also, each assignment must be submitted as a single document, not piecemeal. Addenda to your assignment will not be graded. And, unfortunately, electronic submission of assignments (e.g. by fax or e-mail) cannot be accepted. Only a physical copy in the collection box will do. If you must be out of town, please ask a fellow student to print out and submit your assignment.

**Exams:** The midterm exam will be Wednesday, March 12 in lecture. The final exam is tentatively scheduled for Monday, May 12 from 1:10 to 4 pm. There will not normally be a makeup exam for the midterm or final; instead, you may be given an oral exam covering the same material. Since the dates of these exams cannot be changed, please make your travel plans for the spring and summer breaks early!

**Devices:** All electronic devices must be turned off (*not* set to vibrate) during class. Exception: laptops may be used in the front row only.

**Grading:** Assignments 35%, midterm 25%, final 40%.

**The fine print:** If you foresee an exam conflict such as a religious holiday, notify me at least two weeks in advance. Otherwise, you may be excused from an exam only for incapacitating illness, a serious family emergency, or situations of comparable gravity. In the first case you must have a note from a doctor; in the other cases, from your dean. In any case you must notify me before the exam if at all possible. Incompletes may be granted only by your dean and only in the above circumstances.