MAT 531: Topology&Geometry, II
Spring 2011
Course Information

Course Instructor

Name: Aleksey Zinger *Office Hours:* W 9-10:30am in P-143, 10:30am-12noon in 3-111
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Teaching Assistant

Name: Alexandra Popa *Office Hours:* 3:30-4:30pm in 3-105, 5-6 in MLC
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Please do not hesitate to ask her any questions related to the course, including about the homework. All issues concerning homework grading should be resolved with her.

Course Website

All homework assignments and various updates (including changes in office hours) will be posted on the course website,

`http://math.sunysb.edu/~azinger/mat531-spr11`.

Please visit this website regularly.

Grading and Exams

Problem Sets 30%, *Midterm* 25%, *Final 45%*
The midterm will be in class, likely on Tuesday, March 22. The final exam is scheduled for Friday, May 20, 11:15am-1:45 pm, but it can be moved to a different day/time if there is consensus (the final exams in the other core courses are scheduled for May 17, 18, and 19).

Text

The textbook, which you need to acquire, is *Foundations of Differentiable Manifolds and Lie Groups*, GTM 94, by Frank Warner; we will cover the entire book, except for Chapter 3. Additional notes will be provided (either available from the course website or distributed in class).

Some of the notation used in the textbook is not the most standard. Here are some examples:

object	*book's notation*	*standard notation*
tangent space of manifold M at $m \in M$	M_m	T_mM
cotangent space of manifold M at $m \in M$	M_m^*	T_m^*M
tangent bundle of manifold M	$T(M)$	TM
cotangent bundle of manifold M	$T^*(M)$	T^*M

Some of the book's notation is actually more consistent with other conventions than the standard notation. For example, the dual of a vector space or a vector bundle V is normally denoted by V^*. So, in the standard notation $T_m^*M = (T_mM)^*$ and $T^*M = (TM)^*$. However, in lecture the standard notation will generally be used.

About the Course

This is one of the seven core graduate mathematics courses; it continues MAT 530 and has some connections with the other five core courses. It studies smooth (or differentiable) manifolds, one of the most central objects in mathematics. Manifolds will be defined intrinsically, rather than as subsets of $\mathbb{R}^n$. Chapters 1, 2, and 4 are the foundations of differential geometry and essentially extend concepts from calculus on $\mathbb{R}^n$ to smooth manifolds. Chapters 5 and 6 introduce sheaf and Hodge theories, respectively, that have found many applications in geometry, including algebraic geometry and geometric analysis. Some of the applications that we will see are the *de Rham theorem* (the de Rham and singular cohomologies of a manifold are isomorphic) in Chapter 5 and the *Poincare duality* (the p-th and $(n-p)$-th cohomology groups of a compact oriented n-manifold are duals of each other) and finite-dimensionality of cohomology groups of compact manifolds in Chapter 6.

Homework Assignments

You should do all of the exercises at the end of each chapter. However, only the exercises and the additional problems specified on the website should be handed in for grading. These will be posted roughly once a week and will generally be due in class the following week, usually on Thursday. *Late problem sets will not be accepted.*

The clarity and completeness of your written work will influence its evaluation. This in no way means that you should turn two-line proofs into multi-page expositions. Try to be clear and concise, without omitting any details. Occasionally this may be achievable in a couple of lines; sometimes this may require a couple of pages. In addition, please write legibly; if the grader is unable to read your solutions, with reasonable ease, you may receive no credit.

The daily reading assignments from the textbook will also be posted on the course webpage. In addition, you should read all notes posted on the website, including the solutions to the homework problems (which will generally be more detailed that yours are expected to be) and *Notes on Vector Bundles* (these are not really covered in the book). Please take the time to do the reading assignments carefully, preferably before the lecture and certainly before attempting the homework problems. *You will be responsible for the material contained in the reading assignments, whether or not it is directly covered in lecture.*

You are encouraged to discuss any aspect of this class, including the material covered in lectures, the readings, and the homework problems, with anyone, including other students in or outside of the class. You can also consult any source that may help you with the class in general and the homework problems in particular. You may (and in fact should) compare your homework solutions with each other. However, you *must* write your own solutions to the problem sets. You should also try to do all of the problems yourself first and should be able to do most of them without any help.

Finally, please do not fall behind; it will be much harder to catch up later. Chapters 5 and 6 are mutually independent; distributions do not appear after Chapter 2 (but may appear in exercises and on the exams, including the comps). Other than that, all new material will be building up on the previous topics.