Calculus on Manifolds (FA23)

Course Info:

- **Lectures:** Tuesday, Thursday, block 10A (10:10 am - 12:00 pm ET)
- **x-period:** Friday, block 10AX (3:30 - 4:20 pm ET); generally used for extra office hours
- **Room:** Kemeny 120
- **Instructor:** Alena Erchenko
- **Instructor office:** Kemeny 331
- **E-mail:** alena.erchenko@dartmouth.edu
- **Office hours:** Tuesday 12:10 - 1:10 pm and Friday 9-10am, or by appt
- **Prerequisites:** Math 11 or 13 and Math 22 or 24. If you are unsure about your preparation, please talk to the instructor!
- **Recommended Texts:**
  - James R. Munkres, Analysis on Manifolds. References in the schedule below are to this book.
  - Michael Spivak, Calculus on Manifolds: A modern approach to classical theorems of advanced calculus.
- **Grading:** Grades will be based on weekly homework (70%) and a final project (30%). Your lowest homework score will be dropped.

Homework:

Homework is due on Gradescope on the day indicated below before 11:59 pm ET. Please upload your solutions by following the instructions in this video. Feel free to submit handwritten or work typeset in LaTeX (Overleaf is a great resource and tool for the latter). If you are skipping a problem, it is easier for the grader if you write "Skip" and upload that as your solution to the problem. You are more than welcome to work with others on the homework problems. However, the solutions should be written up *on your own and reflect your understanding*.

Due Date	Homework	Solutions
9/15	Homework 0	
9/22	Homework 1	
9/29	Homework 2	
10/6	Homework 3	

10/13	Homework 4	
10/20	Homework 5	
10/27	Homework 6	
11/3	Homework 7	
11/10	Homework 8	

Schedule:

The specific topics covered in each class are tentative and will be updated as the semester progresses. Moreover, the notes posted for each lecture may contain slightly more content than the lecture and may bleed a bit into the next lecture. Let me know if you find any errors.

Date	Topic	References

Course Catalogue Description:

Manifolds provide mathematicians and other scientists with a way of grappling with the concept of “space” (from a global viewpoint). The space occupied by an object. The space that we inhabit. The space of solutions to a system of equations. Or, perhaps, the space of configurations of a mechanical system. While manifolds are central to the study of geometry and topology, they also provide an appropriate framework in which to explore aspects of mathematical physics, dynamics, control theory, medical imaging, and robotics, to name just a few. This course will demonstrate how ideas from calculus can be generalized to manifolds, providing a new perspective and toolkit with which to explore problems where “space” plays a fundamental role.

Learning Outcomes:

By the end of this course, you should be able to:

1. Understand the multivariable differentiable calculus and the concept of a manifold;
2. Solve mathematical problems: utilize abstraction and think creatively;
3. Write clear mathematical proofs: recognize and construct mathematically rigorous arguments.

Additional Pages:

1. *Academic Honor Principle*

   Cooperation on weekly homework is permitted (and encouraged), but you should write up the solution on your own. In other words, share your thoughts (say on a blackboard) to get started, but write up the solution afterwards using only your understanding. Please acknowledge any cooperative work at the end of each assignment.

   Plagiarism, collusion, or other violations of the Academic Honor Principle will be referred to the The Committee on Standards. If you have any questions as to whether some action would be acceptable under the Academic Honor Principle, please speak to me beforehand. For more information about standards of conduct, please see these resources.

2. *Expectations*

   Mathematics requires active participation.

   Before each class period, please read the assigned sections. Arrive to class ready to share what you have learned and also what remains confusing. Class meetings will involve some interactive lecture and other activities in a variety of formats; you will get the most out of each class day if you arrive ready to engage.

   In all settings, collaborate thoughtfully and ask questions respectfully: everyone should be able to freely participate.

3. *Student Accessibility Needs*

   Students requesting disability-related accommodations and services for this course are encouraged to schedule a phone/video meeting with me as early in the term as possible. This conversation will help to establish what supports are built into my online course. In order for accommodations to be authorized, students are required to consult with Student Accessibility Services (SAS; student.accessibility.services@dartmouth.edu; 603-646-9900) and to email me their SAS accommodation form. We will then work together with SAS if accommodations need to be modified based on the online learning environment. If students have questions about whether they are eligible for

accommodations, they should contact the SAS office. All inquiries and discussions will remain confidential.

4. *Mental Health*

   The academic environment at Dartmouth is challenging, our terms are intensive, and classes are not the only demanding part of your life. There are a number of resources available to you on campus to support your wellness, including your:
   - Undergraduate Dean (http://www.dartmouth.edu/~upperde/);
   - Counseling and Human Development (http://www.dartmouth.edu/~chd/); and the
   - Student Wellness Center (http://www.dartmouth.edu/~healthed/).

   I encourage you to use these resources to take care of yourself throughout the term, and to come speak to me if you experience any difficulties.

5. *Title IX*

   At Dartmouth, we value integrity, responsibility, and respect for the rights and interests of others, all central to our Principles of Community. We are dedicated to establishing and maintaining a safe and inclusive campus where all have equal access to the educational and employment opportunities Dartmouth offers. We strive to promote an environment of sexual respect, safety, and well-being. In its policies and standards, Dartmouth demonstrates unequivocally that sexual assault, gender-based harassment, domestic violence, dating violence, and stalking are not tolerated in our community.

   The Sexual Respect Website (https://sexual-respect.dartmouth.edu) at Dartmouth provides a wealth of information on your rights with regard to sexual respect and resources that are available to all in our community.

   Please note that, as a faculty member, I am obligated to share disclosures regarding conduct under Title IX with Dartmouth's Title IX Coordinator. Confidential resources are also available, and include licensed medical or counseling professionals (e.g., a licensed psychologist), staff members of organizations recognized as rape crisis centers under state law (such as WISE), and ordained clergy (see https://dartgo.org/titleix_resources). Should you have any questions, please feel free to contact Dartmouth's Title IX Coordinator or the Deputy Title IX Coordinator for the Guarini School. Their contact information can be found on the sexual respect website at: https://sexual-respect.dartmouth.edu.

6. *Religious Observances*

   Some students may wish to take part in religious observances that occur during this academic term. If you have a religious observance that conflicts with your participation in the course, please meet with me as soon as possible, or before the end of the second week of the term (at the latest) to discuss appropriate adjustments. Dartmouth has a

deep commitment to support students' religious observances and diverse faith practices.

7. *Additional Support for your Learning*

   The Academic Skills Center is open to the entire Dartmouth Community. Here are some common reasons why you might visit the ASC:
   - You're getting B's but you want to get A's
   - You don't feel comfortable talking in class
   - You're attending class regularly but you feel like you're missing important points
   - You feel like you're a slow reader
   - You're having trouble completing tests in the allotted time
   - You're spending hours studying for foreign language but still not "getting it"
   - You feel like you don't have enough time to get everything done
   - You're not sure how to take notes
   - You want to sign up for a tutor or study group
   - You're not sure if you should get tested for a learning disability

   See also the Tutor Clearinghouse if you would like to find a private one-on-one peer tutor. Tutors are recruited, having done well in the subject, and are trained by the Academic Skills Center. If a student receives financial aid the College will pay for three hours of tutoring per week. If you would like to have a tutor, please go to 301 Collis and fill out an application as early in the term as possible.

Additional Resources:

- It is highly recommended to solve as many exercises from the textbook or other resources as you have time for. This will be more useful than rereading your class notes or textbook as it will often force you to go back to look at the material anyway. The only way to truly learn mathematics is through practice. Feel free to ask about your solutions.

- There are many other textbooks and online materials that you can consult. If you have questions on whether a particular one might be useful, do not hesitate to reach out.