

Math 9055A/4155A — Calculus on Manifolds

Fall 2024, Western University

- **Instructor:** Masoud Khalkhali, Professor of Mathematics UWO.

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Office hours: TBA, or by appointment.

- **Lectures:** TBA

- **Course outline**

The first main idea is to understand what a manifold is and how to differentiate and integrate a functions on a manifold, including Stoke's formula (the fundamental theorem of calculus for manifolds). We shall learn about differential forms and de Rham cohomology, and then tensor fields on a manifold in general. The course can be useful for students of pure and applied mathematics as well as physics. Topics will include: Manifolds (definition, examples, constructions), orientation, functions on manifolds, partitions of unity, tangent bundle, cotangent bundle, vector fields, integral curves, differential forms, integration, manifolds with boundary, Stokes' theorem, submersions, immersions, embeddings, submanifolds, Sard's theorem, Whitney embedding theorem.

- **Course Textbook:**

An Introduction to Manifolds by Loring Tu (2nd Edition, Springer Verlag). We shall start from Chapter 2, Manifolds.

- **Other useful references for you own self study:**

- Advanced Calculus by Loomis and Sternberg Manifolds, Tensors and Forms, by Renteln.
- Analysis on manifolds, by Munkres. A good text with many examples.
- Calculus on manifolds by Spivak. Excellent but mostly focused on Euclidean space.
- Introduction to Smooth Manifolds by John Lee. Excellent, comparable to our own textbook.
- Manifolds and Differential Geometry by Jeffrey Lee. It has some differential geometry too.
- Foundations of Differential Manifolds and Lie Groups by Frank Warner. Excellent resource (e.g. covers sheaf theoretic proof of de Rham theorem, and real Hodge theory).
- Differential and Riemannian Manifold by Serge Lang. Another good textbook. Covers infinite dimensional (Banach) manifolds, rarely covered elsewhere in textbooks!

Course evaluation: Evaluation: The evaluation will be based on

- 3 Homeworks: %45.
- Midterm (in class written exam): %20.
- Final Exam (Oral exam. Questions will be from a list of questions which will be shared with students long before the final exam.) : %35.
- **Conflict exams:** If you have a conflict with one of the exam times, please consult the Faculty of Science policy on missed course work. Based on that, if you think your situation qualifies you to take the conflict exam, please contact me as soon as possible, no later than a week before the exam in question.
- **Medical accommodations:** If you are unable to meet a course requirement due to illness or other serious circumstances, you must provide valid medical or other supporting documentation to the Dean's Office as soon as possible and contact me immediately. It is your responsibility to make alternative arrangements with me once the accommodation has been approved. In the event of a missed final exam,

a “Recommendation of Special Examination” form must be obtained from the Dean’s Office. For further information, please consult the University policy on medical accommodation.

- **Missed homework:** Late homework will not be accepted. Homeworks can always be submitted in advance. For extended absences or medical emergencies, these are handled the same way as for exams. In that case, a homework grade could be dropped; there will be no make-up homework.
- **Academic integrity:** Working on homework with your peers is allowed, in fact encouraged. However, each student must write their own solutions. Handing in suspiciously similar solutions will be considered an instance of cheating. Scholastic offences are taken seriously and will not be tolerated. For more information, please consult the University policy on scholastic discipline.
- **Accessibility:** Please consult Services for Students with Disabilities (SSD) regarding accessibility services on campus. Please contact me if you require material in an alternate format or other accommodations to make this course more accessible to you.