Winter 2021
Math 396: **HONORS ANALYSIS II**
MWF 2:30 – 3:50 PM,

Instructor: Zaher Hani, (*Office:* REMOTE!). *Website:* https://sites.lsa.umich.edu/zhani/. *Office hours:* Wednesday 4-6pm and by appointment via Zoom.

Teaching Assistants:

1. Fangu Chen (fangu@umich.edu) Office Hours: Wednesday and Thursday from 5-6pm.
2. Annie Xu (wanqiaox@umich.edu) Office Hours: TBD.

Prerequisites: MATH 395 or equivalent. In particular, a solid knowledge (proof-based) of linear algebra and multi-variable analysis is assumed.

Course Coordinates: MWF 2:30–3:50 pm via Zoom (**Meeting ID: 929 2700 4471**). Links to be provided in Canvas. You are encouraged to attend the lectures synchronously and participate actively in the class discussion. I will have lectures recorded and posted on Canvas.

Textbook: "Analysis on Manifolds" by Munkres, Westview Press.

Further Reference Here are some additional resources that could supplement your reading.

1. Lee, *Introduction to Smooth Manifolds*, Second Edition, Springer.
2. Spivak, *A comprehensive Introduction to Differential Geometry, vol. I*, by Spivak, Publish or Perish 3. ed. 1999
3. Do Carmo, *Differential Forms and Applications*, Universitext, Springer.

Homework: There will be (roughly) weekly homework sets.

Grading: homework, handouts, and discussion 60%, midterm 20%, final exam 20%; The exact format for the midterm and the final exams will be specified later.

Course Description: Math 396 is part of the math honors sequence Math 295-396 which offers a thorough preparation for any upper level and even beginning graduate course in mathematics, and other areas that use mathematics (in particular the sciences and engineering). In this forth course of the sequence, the aim is to move the study of analysis to the setting of manifolds. In the process, we will give an introduction to differentiable manifold theory, and hopefully a glimpse of Riemannian geometry as well. We shall see how adding various structures to the definition of topological manifolds (starting with a differential structure to obtain the notion of a differentiable manifold and later adding a metric structure to obtain Riemannian manifolds), will allow us to

go deeper in our understanding of the manifold and functions on it, as well as ask new kinds of questions of great interest.

Friday Discussion sessions and IBL: Typically, Friday's session will be a discussion session with several purposes including: a) Answering any questions related to the concepts arising in class and homework, b) group discussions of handouts with the aim of introducing some new concepts that branch and extend out of the main course material. As part of your homework, you will be responsible for writing up solutions of the handout problems after they have been discussed in class. They will be graded, for accuracy and good writing.

Testing and Disability: If you think you need an accommodation for a disability, please let me know as soon as possible. In particular, a Verified Individualized Services and Accommo dations (VISA) form must be provided to me at least two weeks prior to the need for a test/quiz accommodation. The Services for Students with Disabilities (SSD) Office VISA forms.

Rough Outline of main course: The following details the basic skeleton of the concepts that we will discuss. We might do a few digressions when needed depending on how our discussions evolve.

A) Introduction to Manifolds

- Manifolds in $\mathbb{R}^d$
- Topological and differentiable manifolds
- Tangent vectors
- Manifolds with boundary
- Orientable manifolds

B) Differential Forms

- Multilinear algebra and wedge products
- Differential forms
- Closed Forms and exact forms

C) Integration theory

- Integration on Manifolds
- Stokes' Theorem and applications

D) Additional topics

- Introduction to Riemannian manifolds
- The volume form
- Gauss Lemma
- The Gauss-Bonnet Theorem (time permitting).

Important Dates

January 20	First day of classes
Feb. 8	Drop and Add deadline
Feb 24	Well-being break-No Class
March 10	Midterm (tentative)
April 21	Last day of classes.