

\*\*\*Fall 2020\*\*\*  
\*\*Math 395: HONORS ANALYSIS I\*\*  
MWF 1:00 – 2:30 PM,

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**Instructor:** Zaher Hani, (*Office:* REMOTE!). *Website:* <https://sites.lsa.umich.edu/zhani/>. *Office hours:* TBA via Zoom.

**Teaching Assistants:** TBA

**Prerequisites:** MATH 295, 296 or equivalent. In particular, a solid knowledge (proof-based) of linear algebra and single-variable analysis is assumed.

**Course Coordinates:** MWF 1:00–2:30 pm via Zoom. Links to be provided in Canvas. You are encouraged to attend the lectures synchronously and participate actively in the class discussion. My plan is to have lectures recorded and posted on Canvas.

**Textbook:** “Analysis on Manifolds” by Munkres, Westview Press.

**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 395 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 third course in the sequence, we will build on the single-variable analysis studied in Math 295/296 in order to generalize the concepts of differentiability and integration to functions of several variables. A lot of new concepts emerge in the process of this generalization, and new doors are opened leading to geometry, measure theory, probability, functional and harmonic analysis. The purpose of this course is to develop rigorously and deeply the analysis of functions of several variables, as well as explore and cultivate its connections to other areas of pure mathematics and possibly theoretical physics.

**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 from 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. 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 Accommodations (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 build. Some of this outline (especially the later parts) might spill over into Math 396 next semester. Not included in this outline is the material that will be developed through group learning on Fridays. This will likely cover concepts from measure theory (the problem of measure) and Fourier series and transforms, and applications.

A) Preliminaries:

- Metric spaces, topology in  $\mathbb{R}^d$ , normed vector spaces.
- Introduction to topological spaces

B) Differentiation in higher dimensions

- Definitions, chain rule.
- The inverse function theorem
- The implicit function theorem

C) Integration in higher dimensions

- Generalizing the Riemann Integral, existence and basic properties
- change of variables formula.

D) Manifolds in  $\mathbb{R}^d$

- Definitions, charts, atlases.
- Differential forms

E) Calculus on manifolds

- Integration on Manifolds
- Stokes' Theorem and applications
- Closed Forms and exact forms

### Important Dates

|                |                               |
|----------------|-------------------------------|
| August 31      | First day of classes          |
| September 7    | Labor Day - No Class          |
| October 21     | Midterm (format TBD)          |
| November 21-30 | Thanksgiving recess- No Class |
| Dec 7          | Last day of classes.          |