MATH 58T: Selected topics in differential forms
(Diferensiyel formlar ile ilgili seçme konular)
SYLLABUS

Course Description: This course will build on the work done in Math 58J and discuss more advanced topics in differential forms. In the first half of the course the instructor will cover the homotopy invariance properties of deRham cohomology and homological intersection theory of submanifolds using differential forms. In the second half the students will give presentations on the topics listed below. (3 Kredi TUL - 3+0+0 ECTS 8)

Prerequisites: Math 58J or instructor permission

Instructor: Umut Varolgunes
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Course Webpage: https://umutvg.github.io/BU.html

Lectures: In person, Monday 14:00-16:00 and Thursday 15:00-17:00, location: online for the time being

Grading: There will be weekly homework assigned in the first half of the course. The most important component of the grading will be the quality of student presentations. This includes participation as a listener as well. There will be a final take home exam the last week including the basic parts of the presentations.

Lecture notes and other resources: Lecture notes after each class in the first half and presentation materials in the rest will be posted to the course website. Other useful resources are listed in the course website.

Schedule: The course will consist of three parts:

- **Part I: Standard format** (4 weeks): Cartan's formula, Homotopy invariance in deRham theory, Compactly supported differential forms, Poincare duality, Thom isomorphism, Euler class, intersection theory, comparison of cup product and wedge product
- **Part II: Student presentations (short topics)** (3 weeks):
  1. Moser argument (volume, symplectic, contact)
  2. Lefschetz fixed point theorem (intuition using triangulations, proof via deRham theory)
  3. Cech-deRham complex (some sheaf theory needs to be introduced)
  4. Harmonic differential forms on Riemannian manifolds
- **Part III: Student presentations (longer topics)** (3 weeks):
  1. Complex manifolds, Hodge decomposition, Kahler manifolds
  2. Algebraic deRham theory
  3. Relationship with Morse theory (Witten's paper, rigorous comparison)
  4. Chern-Weil theory