Syllabus: MATH 531 Real Analysis (3-0-3)

Winter 2025

Department of Mathematics

Logistics

- **Instructor:** Nika Salia
- **Email:** nika.salia@kfupm.edu.sa
- **Office Hours:** By appointment & UTR 10:00-10:50
- **Lecture Times:** UTR 09:00-10:00, Building 4, Room 100
- **Textbook:** *Real Analysis* by H.L. Royden and P.M. Fitzpatrick, 4-th edition.

Course Description

Lebesgue measure and outer measure. Measurable functions. The Lebesgue integral. Lebesgue Convergence Theorem. Differentiation and integration. L^p spaces. Riesz Representation Theorem. Introduction to Banach and Hilbert spaces. Product spaces, Fubini's Theorem.

Course Objectives

1. Define Lebesgue measure on the real line.
2. Explain the convergence theorems, Lusin's theorem, Egorov's theorem.
3. Discuss functions of bounded variation, absolutely continuous functions, and the Lebesgue differentiation theorem.
4. Explain the different properties of L^p spaces.
5. Define general measure theory and discuss some of its properties.
6. Discuss the permutation of integrals.

Learning Outcomes

Upon successful completion of this course, students will:

CLO1. Define the Lebesgue measure on the real line and its properties.

CLO2. Explain the convergence theorems, Lusin's theorem, and Egorov's theorem.

CLO3. Discuss concepts of bounded variation and absolute continuity.

CLO4. Explain properties and applications of L^p spaces.

CLO5. Understand the basics of general measure theory.

CLO6. Apply integration techniques over general measure spaces.

Assessment Plan

- **Homework:** Two Comprehensive Homework 20%
- **Major Oral Exam 1:** Week 7, Wednesday 15:00-18:00, February 24 20%
- **Major Exam 2:** Week 11, Wednesday 15:00-17:00, April 9 20%
- **Final Exam:** Week 16+, TBA 40%

Weekly Schedule

Week 1: Lebesgue Measure

Week 2: Lebesgue Measure (Continued)

Week 3: Lebesgue Measure (Continued)

Week 4: Lebesgue Measurable Functions

Week 5: Lebesgue Measurable Functions (Continued)

Week 6: Lebesgue Integration

Week 7: Lebesgue Integration (Continued)

Week 8: Lebesgue Integration (Continued)

Week 9: Differentiation and Integration

Week 10: Differentiation and Integration (Continued)

Week 11: L^p Spaces: Completeness and Approximation

Week 12: L^p Spaces: Completeness and Approximation (Continued)

Week 13: General Measure Spaces: Properties and Construction

Week 14: General Measure Spaces: Properties and Construction (Continued)

Week 15: Integration Over General Measure Spaces

The Study Cycle

To learn and apply mathematics you must internalise it – it should become part of you and your thinking process. You must own the material. This can be achieved through a conscious effort. Learning mathematics – just as learning a foreign language or learning to dance or to swim – is a very personal experience and cannot be achieved by simply watching someone else do it.

Here is a possible way of structuring your study process:

1. Take notes!
2. After class review and rework the class notes. If you get stuck, ask me!
3. Attend the tutorial!
4. On the weekend review (rework) the class notes for the week. Solve the Problem Set. You should devote at least six hours per week to this. If you get stuck during the weekend, ask me on Sunday.
5. Repeat the following week.

Course Policies

Classroom Etiquette: Students are expected to attend class regularly, arrive on time, and participate actively. Electronic devices should be used only for academic purposes.
Academic Integrity: Collaboration on assignments is encouraged, but each student must submit their own work. Cheating will result in a failing grade and disciplinary action.