جامعة الملك فهد للبترول والمعادن
King Fahd University of Petroleum & Minerals

College of Computing and Mathematics
Department of Mathematics

MATH531 – Real Analysis

SYLLABUS

AY 2022-2023 **(Term 222)**

Instructor	Dr. Khairul Saleh	**Phone**	+966-13-860-7524
Office	Building 5 - Room 305	**E-mail**	khairul@kfupm.edu.sa
Office Hour	09:00 PM – 09:45 PM (Sun, Tue) 09:30 AM – 10:30 AM (Mon, Wed) and by appointment		

Textbook

Real Analysis by H.L. Royden and P.M. Fitzpatrick, Fourth Edition, Pearson

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.

Objectives

The course is designed to introduce graduate students to measure theory, which particularly focusing on the Lebesgue measure, integration, and the classical L^p spaces.

Learning Outcomes

Upon successful completion of this course, a student should be able to:

(1) *Identify the Lebesgue Measurable sets and describe basic properties of the Lebesgue measure.*
(2) *Perform operations on measurable functions.*
(3) *Use the Monotone Convergence Theorem, Fatou's Lemma, Fubini's Theorem, and the Dominated Convergence Theorem.*
(4) *Compare the Riemann integral and the Lebesgue integral.*
(5) *Distinguish different types of convergences.*
(6) *Identify functions of bounded variations and absolutely continuous functions.*
(7) *Use basic properties of the L^p spaces.*

Week	Date	Topic
1	15 – 19 Jan	2.1 Introduction 2.2 Lebesgue outer Measure 2.3 The σ-Algebra of Lebesgue Measurable sets
2	22 – 26 Jan	2.4 Outer and Inner Approximation of Lebesgue Measurable 2.5 Countable Additivity, Continuity, and the Borel-Cantelli Lemma
3	29 Jan – 2 Feb	3.1 Sums, Products, and Compositions 3.2 Sequential Pointwise Limits and Simple Approximation
4	5 – 9 Feb	3.3 Littlewood's Three Principles, Egoroff's Theorem, and Lusin's Theorem 4.1 The Riemann Integral
5	12 – 16 Feb	4.2 The Lebesgue Integral of a Bounded Measurable Function over a Set of Finite Measure 4.3 The Lebesgue Integral of a Measurable Nonnegative Function
6	19 – 21 Feb	4.4 The General Lebesgue Integral 4.5 Countable Additivity and Continuity of Integration
Saudi Founding Day (22 – 23 February 2023)		
Major Exam 1. Material: 2.1-4.4. Date: 26 February 2023. Time: TBA		
7	26 Feb – 2 Mar	4.6 Uniform Integrability: The Vitali Convergence 5.1 Uniform Integrability and Tightness: A General Vitali Convergence Theorem
8	5 – 9 Mar	5.2 Convergence in Measure 5.3 Characterizations of Riemann and Lebesgue Integrability
9	12 – 16 Mar	6.1 Continuity of Monotone Functions 6.2 Differentiability of Monotone Functions: Lebesgue's Theorem
10	19 – 23 Mar	6.3 Functions of Bounded Variation: Jordan's Theorem 6.4 Absolutely Continuous Functions
11	26 – 30 Mar	6.5 Integrating Derivatives: Differentiating Indefinite Integrals 6.6 Convex Functions
12	2 – 6 Apr	7.1 Normed Linear Spaces 7.2 The Inequalities of Young, Holder, and Minkowski
Major Exam 2. Material: 4.5-6.6. Date: 6 April 2023. Time: TBA		
13	9 – 13 Apr	7.3 L^p is Complete: The Riesz-Fischer Theorem 17.1 Measures and Measurable Sets
Eid Al-Fitr Holidays (16 – 27 April 2023)		
14	30 Apr – 4 May	17.2 Signed Measures: The Hahn and Jordan Decompositions 18.1 Measurable Functions
15	7 – 11 May	18.2 Integration of Nonnegative Measurable Functions Review
Final Exam: Comprehensive. Date: TBD		

Grading Policy:

- Major Exam 1 25%
- Major Exam 2 25%
- Homework Assignment 15%
- Final Exam (Comprehensive) 35%