# Syllabus (2021-1)

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|---|---|---|---|
| Course Title | Real Analysis | Course No. | 35296-01 |
| Department/ Major | Mathematics | Credit/Hours | 3/3 |
| Class Time/ Classroom | Tuesday 3, Thursday 2 / Non face-to-face | | |
| Instructor | Name Chulkwang Kwak | Department Mathematics | |
| | E-mail ckkwak@ewha.ac.kr | Phone 4439 | |
| Office Hours/ Office Location | Any time via QnA in cyber campus or email | | |

## Ⅰ. Course Overview

### 1. Course Description

A measure on a set is a systematic way to understand a size of the set. Previously, we have learned similar concepts of length, area and volume, and thus the measure can be understood as its generalization. An important example is the Lebesgue measure on a Euclidean space, which assigns the conventional length, area, and volume of Euclidean geometry to suitable subsets of the n-dimensional Euclidean space $\mathbb{R}^n$.

This course covers basic measure theory on Euclidean space $\mathbb{R}^n$, particularly, including Set theory on $\mathbb{R}^n$, Lebesgue measure, Lebesgue integration, differentiation theorems and basic Banach spaces ($L^p$ space).

### 2. Prerequisites

-Advanced Calculus I, II.

-Topology I. (not required, but helpful)

### 3. Course Format

| Lecture | | | | |
|---|---|---|---|---|
| 100% | | | | |

(Instructor can change to match the actual format of the class.)

Explanation of course format: This course consists of two lectures and one recitation class per a week.

## 4. Course Objectives

The main aim in this course is to understand Lebesgue measure on $\mathbb{R}^n$, integration and differentiation, and conseqquently, is to constructan infinite dimensional complete normed function space.

## 5. Evaluation System

☐ Relative evaluation ☐ Absolute evaluation ☐ Others : ____________________

– Explanation of evaluation system:

Absolute evaluation

| Midterm Exam | Final Exam | Homeworks/Quizzes | | |
|---|---|---|---|---|
| 30% | 40% | 30% | | |

Ratio can be modified.

* Evaluation of group projects may include peer evaluations.

# Ⅱ. Course Materials and Additional Readings

## 1. Required Materials

Real Anlysis (H. L. Royden) Third edition

## 2. Supplementary Materials

## 3. Optional Additional Readings

Real Analysis (Elias M. Stein and Rami Shakarachi)

An introduction to measure theory (Terence Tao)

Real analysis (Barry Simon)

## Ⅲ. Course Policies

- The class style is Non face-to-face. All classes will be given as recorded videos in cyber campus.
- **Attendance will not be graded**, but "F" grade will be automatically given for absences more than 1/3 of all classes.
- All exams will be taken via zoom.
- **No final exam, no grade.**
- 3~6 homeworks will be given (tentative).

## Ⅳ. Course Schedule (15 credit hours must be completed.)

- Star(*) marked sections will be given in Korean and will not be included in ranges of midterm and final
- Appendices (A.1, A.2 and A.3) and all star marked sections will be given if time allows
- Course schedule can be modified

| Week | Date | Topics & Class Materials, Assignments |
|---|---|---|
| Week 1 | 3/2 | Orientation |
| | 3/4 | *1. Preliminaries<br>*1.1. Basic set theory |
| Week 2 | 3/9 | *1.2. Open, closed, and compact sets |
| | 3/11 | *1.3. σ-algebra and borel sets |
| Week 3 | 3/16 | 2. Lebesgue measure<br>*2.1. Cantor set |
| | 3/18 | 2.2. Measure of rectangles and cubes |
| Week 4 | 3/23 | 2.3. Measure of open and compact sets |
| | 3/25 | 2.4. Outer measure |
| Week 5 | 3/30 | 2.5. Measurable sets and Lebesgue measure |
| | 4/1 | 2.6. Measurable functions |
| Week 6 | 4/6 | *2.7. Non-measurable set and Littlewood's three principles |
| | 4/8 | 3. Lebesgue integral<br>3.1. Lebesgue integral of a bounded function |
| Week 7 | 4/13 | 3.2. Lebesgue integral of a nonnegative function |
| | 4/15 | 3.3. General Lebesgue measure |
| Week 8 | 4/20 | *3.4. Convergence in measure |
| | 4/22 | Midterm |
| Week 9 | 4/27 | 4. Differentiation and Integration<br>4.1. Differentiation of monotone functions |
| | 4/29 | 4.2. Functions of bounded variation |

| Week | Date | Topics & Class Materials, Assignments |
|---|---|---|
| Week 10 | 5/4 | 4.3. Differentiation of an integral |
| | 5/6 | 4.4. Absolute continuity |
| Week 11 | 5/11 | 4.5. Convex functions |
| | 5/13 | 5. The Classical Banach spaces<br>5.1. $L^p$ spaces |
| Week 12 | 5/18 | 5.2. Minkowski and Hölder inequalities |
| | 5/20 | 5.3. Convergence and completeness |
| Week 13 | 5/25 | 5.4. Approximation in $L^p$ |
| | 5/27 | 5.5 Bounded linear functional on $L^p$ |
| Week 14 | 6/1 | *A.1. Product measure |
| | 6/3 | *A.2. Fubini theorem |
| Week 15 | 6/8 | *A.3. Signed measure |
| | 6/10 | Final |
| Makeup Class | (mm/dd) | |

## Ⅴ. Special Accommodations

* According to the University regulation section #57-3, students with disabilities can request for special accommodations related to attendance, lectures, assignments, or tests by contacting the course professor at the beginning of semester. Based on the nature of the students' request, students can receive support for such accommodations from the course professor or from the Support Center for Students with Disabilities (SCSD). Please refer to the below examples of the types of support available in the lectures, assignments, and evaluations.

| Lecture | Assignments | Evaluation |
|---|---|---|
| · Visual impairment : braille, enlarged reading materials<br>· Hearing impairment : note-taking assistant<br>· Physical impairment : access to classroom, note-taking assistant | Extra days for submission, alternative assignments | · Visual impairment : braille examination paper, examination with voice support, longer examination hours, note-taking assistant<br>· Hearing impairment : written examination instead of oral<br>· Physical impairment : longer examination hours, note-taking assistant |

- Actual support may vary depending on the course.