

MA4542: REAL ANALYSIS

Effective Term

Semester A 2024/25

Part I Course Overview

Course Title

Real Analysis

Subject Code

MA - Mathematics

Course Number

4542

Academic Unit

Mathematics (MA)

College/School

College of Science (SI)

Course Duration

One Semester

Credit Units

3

Level

B1, B2, B3, B4 - Bachelor's Degree

Medium of Instruction

English

Medium of Assessment

English

Prerequisites

MA2508 Multi-variable Calculus

Precursors

Nil

Equivalent Courses

Nil

Exclusive Courses

Nil

Part II Course Details

Abstract

This course aims to provide an introduction of some fundamental topics on real analysis, for example, set theory, Lebesgue measure, Lebesgue integrals and L_p spaces. It will help students extend their knowledge about analysis taught in basic calculus courses and make them ready for further studies in advanced numerical analysis and functional analysis.

Course Intended Learning Outcomes (CILOs)

CILOs		Weighting (if DEC-A1 app.)		DEC-A2	DEC-A3
1	explain at high level concepts from set theory.	10	x		
2	understand the basic properties of Lebesgue measure, measurable sets and measurable functions.	30	x	x	
3	understand the definition and properties of the Lebesgue integral, and recognize its difference with the Riemann integral.	30	x	x	
4	explain clearly basic concepts of L_p spaces, and prove rigorously their elementary properties.	20	x	x	
5	understand basic integration theory on measure spaces.	10	x	x	

A1: Attitude

Develop an attitude of discovery/innovation/creativity, as demonstrated by students possessing a strong sense of curiosity, asking questions actively, challenging assumptions or engaging in inquiry together with teachers.

A2: Ability

Develop the ability/skill needed to discover/innovate/create, as demonstrated by students possessing critical thinking skills to assess ideas, acquiring research skills, synthesizing knowledge across disciplines or applying academic knowledge to real-life problems.

A3: Accomplishments

Demonstrate accomplishment of discovery/innovation/creativity through producing /constructing creative works/new artefacts, effective solutions to real-life problems or new processes.

Learning and Teaching Activities (LTAs)

LTAs		Brief Description	CILO No.	Hours/week (if applicable)
1	Lectures	Learning through teaching is primarily based on lectures.	1, 2, 3, 4, 5	39 hours in total
2	Take-home assignments	Learning through take-home assignments helps students understand basic concepts of real analysis.	1, 2, 3, 4	after-class
3	Math Help Centre	Learning activities in Math Help Centre provides students extra help.	1, 2, 3, 4	after-class

Assessment Tasks / Activities (ATs)

ATs		CILO No.	Weighting (%)	Remarks (e.g. Parameter for GenAI use)
1	Quizzes/Test/Midterm	1, 2	30	Questions are designed for the first part of the course to see how well students have learned the concepts from set theory and Lebesgue measure.
2	Hand-in assignments	1, 2, 3, 4	10	These are skills based assessment to help students understand properties of set theory, Lebesgue measure, Lebesgue integrals and L_p spaces.
3	Formative take-home assignments	1, 2, 3, 4	0	The assignments provide students chances to demonstrate their achievements on real analysis learned in this course.

Continuous Assessment (%)

40

Examination (%)

60

Examination Duration (Hours)

2

Additional Information for ATs

40% Coursework

60% Examination (Duration: 2 hours, at the end of the semester)

For a student to pass the course, at least 30% of the maximum mark for the examination must be obtained.

Assessment Rubrics (AR)**Assessment Task**

1. Quizzes/Test/Midterm

Criterion

Understanding of main concepts and results

Excellent (A+, A, A-)

Excellent

Good (B+, B, B-)

Good

Fair (C+, C, C-)

Fair

Marginal (D)

Marginal

Failure (F)

Not even reaching marginal levels

Assessment Task

2. Hand-in assignments

Criterion

Understanding of main concepts and results

Excellent (A+, A, A-)

Excellent

Good (B+, B, B-)

Good

Fair (C+, C, C-)

Fair

Marginal (D)

Marginal

Failure (F)

Not even reaching marginal levels

Assessment Task

3. Formative take-home assignments

Criterion

Ability to write a rigorous proof for a mathematical statement in real analysis

Excellent (A+, A, A-)

Proofs are complete and rigorous

Good (B+, B, B-)

Proofs contain unjustified steps which can be fixed without too much extra work

Fair (C+, C, C-)

Proofs contain serious errors which would require substantial extra work to fix

Marginal (D)

The student solution is far from a correct proof, but it contains some relevant logical steps toward a proof

Failure (F)

Not even reaching marginal levels

Assessment Task

4. Examination

Criterion

1. Understanding of main concepts and results

2. Ability to write a rigorous proof for a mathematical statement in real analysis

Excellent (A+, A, A-)

1. Excellent
2. Proofs are complete and rigorous

Good (B+, B, B-)

1. Good
2. Proofs contain unjustified steps which can be fixed without too much extra work

Fair (C+, C, C-)

1. Fair
2. Proofs contain serious errors which would require substantial extra work to fix

Marginal (D)

1. Marginal
2. The student solution is far from a correct proof, but it contains some relevant logical steps toward a proof

Failure (F)

Not even reaching marginal levels

Part III Other Information

Keyword Syllabus

Measurable sets, Measurable functions, Lebesgue measure, Lebesgue integrals, L_p spaces, integration on measure spaces.

Reading List

Compulsory Readings

Title	
1	Lecture notes provided by the instructor

Additional Readings

Title	
1	Royden H.L., Fitzpatrick P.M.: Real Analysis, Pearson, 2010 (or previous editions 1963, 1968, 1988 by Royden only)
2	Stein E.M., Shakarchi S.: Real Analysis: Measure Theory, Integration, and Hilbert Spaces, Princeton University Press, 2005.
3	Philippe Ciarlet, Linear and Nonlinear Functional Analysis with Applications, Chapters 1 and 2, SIAM, 2010.
4	Lawrence C. Evans et Ronald F. Gariepy, Measure Theory and Fine Properties of Functions, CRC Press, 1992.
5	Walter Rudin, Real and Complex Analysis, McGraw-Hill, 1987 (or 1966, 1974).