MA4542: REAL ANALYSIS

Effective Term
Semester A 2023/24

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 Lp 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 app.)	DEC-A1	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 Lp 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 self-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.

Teaching and Learning Activities (TLAs)

	TLAs	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
1	Test	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 Lp 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. Test

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, Lp 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).