



# MATH3909

## Real and Functional Analysis

Session 2, In person-scheduled-weekday, North Ryde 2023

*School of Mathematical and Physical Sciences*

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## General Information

Unit convenor and teaching staff

Convener/Lecturer

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Contact via Contact via Email

Please refer to iLearn

Lecturer

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Credit points

10

Prerequisites

((MATH2010 or MATH235) and (MATH2020 or MATH236)) or MATH3901 or MATH3902 or MATH3905 or MATH3906 or MATH331 or MATH332 or MATH335 or MATH336

Corequisites

Co-badged status

Unit description

This unit is concerned with a review of the limiting processes of real analysis and an introduction to functional analysis. Through the discussion of such abstract notions as metric spaces, normed vector spaces and inner product spaces, we can appreciate an elegant and powerful combination of ideas from analysis and linear algebra.

## Important Academic Dates

Information about important academic dates including deadlines for withdrawing from units are available at <https://www.mq.edu.au/study/calendar-of-dates>

## Learning Outcomes

On successful completion of this unit, you will be able to:

**ULO1:** demonstrate a well- developed knowledge of the principles, concepts and techniques of a broad range of areas in analysis and applied mathematics, with significant depth in analysis and functional analysis.

**ULO2:** demonstrate an understanding of the breadth of mathematics, the multi-disciplinary role of mathematics and the way it contributes the development in other related fields of study.

**ULO4:** formulate and model practical and abstract problems in mathematical terms using a variety of methods drawn from analysis and functional analysis.

**ULO3:** construct sustained logical, clearly presented and justified mathematical arguments incorporating deductive reasoning.

**ULO5:** apply mathematical principles, concepts, techniques and technology efficiently to solve practical and abstract problems across a range of areas in analysis and functional analysis.

**ULO6:** interpret mathematical information communicated in wide range of forms.

## General Assessment Information

**Requirements to Pass this Unit** To pass this unit you must achieve a total mark equal to or greater than 50%.

**Late Assessment Submission Penalty** Unless a Special Consideration request has been submitted and approved, a 5% penalty (of the total possible mark of the task) will be applied for each day a written report or presentation assessment is not submitted, up until the 7th day (including weekends). After the 7th day, a grade of '0' will be awarded even if the assessment is submitted. The submission time for all uploaded assessments is 11:55 pm. A 1-hour grace period will be provided to students who experience a technical concern. For any late submission of time-sensitive tasks, such as scheduled tests/exams, performance assessments/presentations, and/or scheduled practical assessments/labs, please apply for Special Consideration.

Assessments where Late Submissions will be accepted

- Assignment 1, Assignment 2 – YES, Standard Late Penalty applies
- Test 1, Test 2, Final Exam - NO, unless Special Consideration is granted

**Special Consideration** The Special Consideration Policy aims to support students who have been impacted by short-term circumstances or events that are serious, unavoidable and significantly disruptive, and which may affect their performance in assessment. If you experience circumstances or events that affect your ability to complete the assessments in this unit on time, please inform the convenor and submit a Special Consideration request through [ask.mq.edu.au](https://ask.mq.edu.au).

Written Assessments/Tests: If you experience circumstances or events that affect your ability to complete the written assessments in this unit on time, please inform the convenor and submit a Special Consideration request through [ask.mq.edu.au](https://ask.mq.edu.au).

## Assessment Tasks

Name	Weighting	Hurdle	Due
<a href="#">Test 1</a>	10%	No	Week 4
<a href="#">Assignment 1</a>	15%	No	Week 7
<a href="#">Test 2</a>	10%	No	Week 10
<a href="#">Assignment 2</a>	15%	No	Week 12
<a href="#">Final Exam</a>	50%	No	Exam period

### Test 1

Assessment Type <sup>1</sup>: Quiz/Test

Indicative Time on Task <sup>2</sup>: 5 hours

Due: **Week 4**

Weighting: **10%**

This will be a test held during the semester. It will test the ability of students to analyse and solve mathematical problems using concepts and techniques in real and functional analysis.

On successful completion you will be able to:

- demonstrate a well- developed knowledge of the principles, concepts and techniques of a broad range of areas in analysis and applied mathematics, with significant depth in analysis and functional analysis.
- demonstrate an understanding of the breadth of mathematics, the multi-disciplinary role of mathematics and the way it contributes the development in other related fields of study.
- formulate and model practical and abstract problems in mathematical terms using a variety of methods drawn from analysis and functional analysis.
- construct sustained logical, clearly presented and justified mathematical arguments incorporating deductive reasoning.
- apply mathematical principles, concepts, techniques and technology efficiently to solve practical and abstract problems across a range of areas in analysis and functional analysis.
- interpret mathematical information communicated in wide range of forms.

## Assignment 1

Assessment Type <sup>1</sup>: Problem set

Indicative Time on Task <sup>2</sup>: 10 hours

Due: **Week 7**

Weighting: **15%**

The assignment will include a set of questions with short answers involving proofs and calculations.

On successful completion you will be able to:

- demonstrate a well- developed knowledge of the principles, concepts and techniques of a broad range of areas in analysis and applied mathematics, with significant depth in analysis and functional analysis.
- demonstrate an understanding of the breadth of mathematics, the multi-disciplinary role of mathematics and the way it contributes the development in other related fields of study.
- formulate and model practical and abstract problems in mathematical terms using a variety of methods drawn from analysis and functional analysis.
- construct sustained logical, clearly presented and justified mathematical arguments incorporating deductive reasoning.
- apply mathematical principles, concepts, techniques and technology efficiently to solve practical and abstract problems across a range of areas in analysis and functional analysis.
- interpret mathematical information communicated in wide range of forms.

## Test 2

Assessment Type <sup>1</sup>: Quiz/Test

Indicative Time on Task <sup>2</sup>: 5 hours

Due: **Week 10**

Weighting: **10%**

This will be a test held during the semester. It will test the ability of students to analyse and solve mathematical problems using concepts and techniques in real and functional analysis.

On successful completion you will be able to:

- demonstrate a well- developed knowledge of the principles, concepts and techniques of a broad range of areas in analysis and applied mathematics, with significant depth in analysis and functional analysis.
- demonstrate an understanding of the breadth of mathematics, the multi-disciplinary role of mathematics and the way it contributes the development in other related fields of study.
- formulate and model practical and abstract problems in mathematical terms using a variety of methods drawn from analysis and functional analysis.
- construct sustained logical, clearly presented and justified mathematical arguments incorporating deductive reasoning.
- apply mathematical principles, concepts, techniques and technology efficiently to solve practical and abstract problems across a range of areas in analysis and functional analysis.
- interpret mathematical information communicated in wide range of forms.

## Assignment 2

Assessment Type <sup>1</sup>: Problem set

Indicative Time on Task <sup>2</sup>: 10 hours

Due: **Week 12**

Weighting: **15%**

The assignment will include a set of questions with short answers involving proofs and calculations.

On successful completion you will be able to:

- demonstrate a well- developed knowledge of the principles, concepts and techniques of a broad range of areas in analysis and applied mathematics, with significant depth in analysis and functional analysis.
- demonstrate an understanding of the breadth of mathematics, the multi-disciplinary role of mathematics and the way it contributes the development in other related fields of study.
- formulate and model practical and abstract problems in mathematical terms using a variety of methods drawn from analysis and functional analysis.
- construct sustained logical, clearly presented and justified mathematical arguments

incorporating deductive reasoning.

- apply mathematical principles, concepts, techniques and technology efficiently to solve practical and abstract problems across a range of areas in analysis and functional analysis.
- interpret mathematical information communicated in wide range of forms.

## Final Exam

Assessment Type <sup>1</sup>: Examination

Indicative Time on Task <sup>2</sup>: 15 hours

Due: **Exam period**

Weighting: **50%**

The final exam will cover all topics of the unit

On successful completion you will be able to:

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- demonstrate an understanding of the breadth of mathematics, the multi-disciplinary role of mathematics and the way it contributes the development in other related fields of study.
- formulate and model practical and abstract problems in mathematical terms using a variety of methods drawn from analysis and functional analysis.
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<sup>1</sup> If you need help with your assignment, please contact:

- the academic teaching staff in your unit for guidance in understanding or completing this type of assessment
- the [Writing Centre](#) for academic skills support.

<sup>2</sup> Indicative time-on-task is an estimate of the time required for completion of the assessment task and is subject to individual variation

## Delivery and Resources

### Classes

Lectures (beginning in Week 1): There is one 2-hour lecture each week.

SGTA classes (beginning in Week 2): There is one 1-hour SGTA class each week.

### Suggested textbooks

The following textbooks are useful as supplementary resources, for additional questions and explanations.

- Ross, Elementary Analysis, The Theory of Calculus, (Second Edition) (available as a free pdf download via the library)
- Lay, Analysis with an introduction to proof
- Gordon, Real Analysis, A First course
- Burkill, A First Course in Mathematical Analysis
- Young, An Introduction to Hilbert Space

**Methods of Communication** We will communicate with you via your university email or through announcements on iLearn. Queries to convenors can either be placed on the iLearn discussion board or sent to your lecturers from your university email address.

### COVID Information

For the latest information on the University's response to COVID-19, please refer to the Coronavirus infection page on the Macquarie website: <https://www.mq.edu.au/about/coronavirusfaq>. Remember to check this page regularly in case the information and requirements change during semester. If there are any changes to this unit in relation to COVID, these will be communicated via iLearn.

### Student Experience & Feedback

We value student feedback to be able to continually improve the way we offer our units. As such we encourage students to provide constructive feedback via student surveys, to the teaching staff directly, or via the FSE Student Experience & Feedback link in the iLearn page. Student feedback from the previous offering of this unit was very positive overall, with students pleased with the clarity around assessment requirements and the level of support from teaching staff. As such, no change to the delivery of the unit is planned, however we will continue to strive to improve the level of support and the level of student engagement.

## Unit Schedule

Real Analysis



01	The real number system	
02	Sequences	
03	Topology of Real Numbers	
04	Continuity	Test 1: Real Analysis
05	Sequences of Functions	
06	Uniform Limits	Assignment 1: Real Analysis
<b>Functional Analysis</b>		
07	Metric spaces	
08	Normed vector spaces, Banach spaces	
09	Lebesgue integral	
10	Inner product spaces, Hilbert spaces	Test 2: Functional Analysis
11	Linear functionals	
12	Dual space.	Assignment 2: Functional Analysis
13	Review	

## Policies and Procedures

Macquarie University policies and procedures are accessible from [Policy Central \(https://policies.mq.edu.au\)](https://policies.mq.edu.au). Students should be aware of the following policies in particular with regard to Learning and Teaching:

- [Academic Appeals Policy](#)
- [Academic Integrity Policy](#)
- [Academic Progression Policy](#)
- [Assessment Policy](#)
- [Fitness to Practice Procedure](#)
- [Assessment Procedure](#)
- [Complaints Resolution Procedure for Students and Members of the Public](#)
- [Special Consideration Policy](#)

Students seeking more policy resources can visit [Student Policies \(https://students.mq.edu.au/support/study/policies\)](https://students.mq.edu.au/support/study/policies). It is your one-stop-shop for the key policies you need to know about throughout your undergraduate student journey.

To find other policies relating to Teaching and Learning, visit [Policy Central \(https://policies.mq.edu.au\)](https://policies.mq.edu.au) and use the [search tool](#).

## Student Code of Conduct

Macquarie University students have a responsibility to be familiar with the Student Code of Conduct: <https://students.mq.edu.au/admin/other-resources/student-conduct>

## Results

Results published on platform other than [eStudent](#), (eg. iLearn, Coursera etc.) or released directly by your Unit Convenor, are not confirmed as they are subject to final approval by the University. Once approved, final results will be sent to your student email address and will be made available in [eStudent](#). For more information visit [ask.mq.edu.au](http://ask.mq.edu.au) or if you are a Global MBA student contact [globalmba.support@mq.edu.au](mailto:globalmba.support@mq.edu.au)

## Academic Integrity

At Macquarie, we believe [academic integrity](#) – honesty, respect, trust, responsibility, fairness and courage – is at the core of learning, teaching and research. We recognise that meeting the expectations required to complete your assessments can be challenging. So, we offer you a range of resources and services to help you reach your potential, including free [online writing and maths support](#), [academic skills development](#) and [wellbeing consultations](#).

## Student Support

Macquarie University provides a range of support services for students. For details, visit <http://students.mq.edu.au/support/>

## The Writing Centre

[The Writing Centre](#) provides resources to develop your English language proficiency, academic writing, and communication skills.

- [Workshops](#)
- [Chat with a WriteWISE peer writing leader](#)
- [Access StudyWISE](#)
- [Upload an assignment to Studiosity](#)
- [Complete the Academic Integrity Module](#)

The Library provides online and face to face support to help you find and use relevant information resources.

- [Subject and Research Guides](#)
- [Ask a Librarian](#)

## Student Services and Support

Macquarie University offers a range of [Student Support Services](#) including:

- [IT Support](#)
- [Accessibility and disability support](#) with study

- Mental health [support](#)
- [Safety support](#) to respond to bullying, harassment, sexual harassment and sexual assault
- [Social support including information about finances, tenancy and legal issues](#)
- [Student Advocacy](#) provides independent advice on MQ policies, procedures, and processes

## Student Enquiries

Got a question? Ask us via [AskMQ](#), or contact [Service Connect](#).

## IT Help

For help with University computer systems and technology, visit [http://www.mq.edu.au/about\\_us/offices\\_and\\_units/information\\_technology/help/](http://www.mq.edu.au/about_us/offices_and_units/information_technology/help/).

When using the University's IT, you must adhere to the [Acceptable Use of IT Resources Policy](#). The policy applies to all who connect to the MQ network including students.