UNSW Course Outline

MATH5605 Functional Analysis - 2024

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General Course Information

Course Code : MATH5605
Year : 2024
Term : Term 2
Teaching Period : T2
Is a multi-term course? : No
Faculty : Faculty of Science
Academic Unit : School of Mathematics & Statistics
Delivery Mode : In Person
Delivery Format : Standard
Delivery Location : Kensington
Campus : Sydney
Study Level : Postgraduate
Units of Credit : 6

Useful Links

Handbook Class Timetable

Course Details & Outcomes

Course Description

This course is an introduction to functional analysis. It is a proof-based course covering abstract topological vector spaces before specialising to Banach spaces (complete normed spaces). Students will prove several key results due to Banach and its school. The course also by

considers Hilbert spaces and decomposing compact operators acting on them.
This course is lecture based, with tutorials every week.

Course Aims

This course aims to develop the ability of the student to write proofs and to manipulate abstract objects.

Relationship to Other Courses

There are no formal prerequisites for this course, but we will assume that the student have a good understanding of linear algebra (such as MATH2601), analysis
and topology (such as MATH3611). This is an advanced proof based course. Postgraduate students who do not have a strong background in analysis should consider
doing MATH5705 Analysis first (or at least concurrently).

Course Learning Outcomes

Course Learning Outcomes
CLO1 : Construct arguments using concepts from a range of different areas of mathematics (e.g., analysis and linear algebra).
CLO2 : Understand proofs and adapt them to prove other statements in functional analysis.
CLO3 : Assess the appropriate tools to solve varying problems in functional analysis.
CLO4 : Use online tools to find information to solve problems in functional analysis.
CLO5 : Communicate ideas in functional analysis competently in written form.

Course Learning Outcomes	Assessment Item
CLO1 : Construct arguments using concepts from a range of different areas of mathematics (e.g., analysis and linear algebra).	• Short Assignment 1 • Short Assignment 2 • Short Assignment 3 • Final Exam
CLO2 : Understand proofs and adapt them to prove other statements in functional analysis.	• Short Assignment 1 • Short Assignment 2 • Short Assignment 3 • Final Exam
CLO3 : Assess the appropriate tools to solve varying problems in functional analysis.	• Short Assignment 1 • Short Assignment 2 • Short Assignment 3 • Final Exam
CLO4 : Use online tools to find information to solve problems in functional analysis.	• Short Assignment 1 • Short Assignment 2 • Short Assignment 3 • Final Exam
CLO5 : Communicate ideas in functional analysis competently in written form.	• Short Assignment 1 • Short Assignment 2 • Short Assignment 3 • Final Exam

Learning and Teaching Technologies

Moodle - Learning Management System

Learning and Teaching in this course

We believe that effective learning is best supported by a climate of inquiry, in which students are actively engaged in the learning process. Hence this course is structured with a strong emphasis on problem-solving tasks in assessment tasks, and students are

expected to devote the majority of their class and study time to the solving of such tasks.

Additional Course Information

To clarify: **This course is lecture based, and there will be tutorials every week.**

Assessments

Assessment Structure

Assessment Item	Weight	Relevant Dates
Short Assignment 1 Assessment Format: Individual	15%	Start Date: 06/06/2023 12:00 AM Due Date: 20/06/2023 12:00 AM Post Date: 17/06/2024 12:00 AM
Short Assignment 2 Assessment Format: Individual	15%	Start Date: 04/07/2023 12:00 AM Due Date: 18/07/2023 12:00 AM Post Date: 08/07/2024 12:00 AM
Short Assignment 3 Assessment Format: Individual	15%	Start Date: 21/07/2024 12:00 AM Due Date: 28/07/2024 12:00 AM Post Date: 28/07/2024 12:00 AM
Final Exam Assessment Format: Individual	55%	Start Date: After week 10 Due Date: Not Applicable

Assessment Details

Short Assignment 1

Assessment Overview

You will submit a written assignment in which you will present a number of proofs. You will be assessed on your ability to write a mathematical proof, including: clarity, presentation, and completeness of the mathematical argument.

Assignments will be released in Week 2 of Term and due Week 4 (exact deadlines to be provided in Term)

Written feedback will be provided to you along with the marked reports upon their return.

Course Learning Outcomes

- CLO1 : Construct arguments using concepts from a range of different areas of mathematics (e.g., analysis and linear algebra).
- CLO2 : Understand proofs and adapt them to prove other statements in functional analysis.
- CLO3 : Assess the appropriate tools to solve varying problems in functional analysis.
- CLO4 : Use online tools to find information to solve problems in functional analysis.
- CLO5 : Communicate ideas in functional analysis competently in written form.

Detailed Assessment Description

You will submit a written assignment in which you will present a number of proofs. You will be assessed on your ability to write a mathematical proof, including: clarity, presentation, and completeness of the mathematical argument.
Assignments will be released in Week 2 of Term and due 2 to 3 weeks later (exact deadlines to be provided in Term)
Written feedback will be provided to you along with the marked reports upon their return.

Assessment Length

N/A

Submission notes

Tex software

Assessment information

Further instructions are provided in class and in assessment sheets.

UNSW standard late submission penalty applies of: 5% per day, for all assessments where a penalty applies, capped at five days (120 hours) from the assessment deadline, after which a student cannot submit an assessment, and no permitted variation.

Assignment submission Turnitin type

Not Applicable

Short Assignment 2

Assessment Overview

You will submit a written assignment in which you will present a number of proofs. You will be assessed on on your ability to write a mathematical proof, including: clarity, presentation, and completeness of the mathematical argument.
Assignments will be released in Week 5 of Term and Week 8 (exact deadlines to be provided in Term).
Written feedback will be provided to you along with the marked reports upon their return.

Course Learning Outcomes

- CLO1 : Construct arguments using concepts from a range of different areas of mathematics (e.g., analysis and linear algebra).
- CLO2 : Understand proofs and adapt them to prove other statements in functional analysis.
- CLO3 : Assess the appropriate tools to solve varying problems in functional analysis.
- CLO4 : Use online tools to find information to solve problems in functional analysis.

- CLO5 : Communicate ideas in functional analysis competently in written form.

Detailed Assessment Description

You will submit a written assignment in which you will present a number of proofs. You will be assessed on on your ability to write a mathematical proof, including: clarity, presentation, and completeness of the mathematical argument.
Assignments will be released in Week 5 of Term and due 1 to 2 weeks later (exact deadlines to be provided in Term).
Written feedback will be provided to you along with the marked reports upon their return.

Assessment Length

N/A

Submission notes

Latex

Assessment information

Further information provided in class and in assegnment sheets.

UNSW standard late submission penalty applies of: 5% per day, for all assessments where a penalty applies, capped at five days (120 hours) from the assessment deadline, after which a student cannot submit an assessment, and no permitted variation.

Assignment submission Turnitin type

Not Applicable

Short Assignment 3

Assessment Overview

You will submit a written assignment in which you will present a number of proofs. You will be assessed on your ability to write a mathematical proof, including: clarity, presentation, and completeness of the mathematical argument.
Assignments will be released in Week 9 of Term and in Week 10 (exact deadlines to be provided in Term)
Written feedback will be provided to you along with the marked reports upon their return.

Course Learning Outcomes

- CLO1 : Construct arguments using concepts from a range of different areas of mathematics (e.g., analysis and linear algebra).
- CLO2 : Understand proofs and adapt them to prove other statements in functional analysis.

- CLO3 : Assess the appropriate tools to solve varying problems in functional analysis.
- CLO4 : Use online tools to find information to solve problems in functional analysis.
- CLO5 : Communicate ideas in functional analysis competently in written form.

Detailed Assessment Description

Details will be provided in class and in assignment sheets.

Assessment Length

N/A

Submission notes

Latex

Assessment information

More information will be provided in class.

UNSW standard late submission penalty applies of: 5% per day, for all assessments where a penalty applies, capped at five days (120 hours) from the assessment deadline, after which a student cannot submit an assessment, and no permitted variation.

Assignment submission Turnitin type

Not Applicable

Final Exam

Assessment Overview

In person, two hour long final exam. You will be assessed on all mathematical content of the course, mathematical reasoning and writing abilities.

Course Learning Outcomes

- CLO1 : Construct arguments using concepts from a range of different areas of mathematics (e.g., analysis and linear algebra).
- CLO2 : Understand proofs and adapt them to prove other statements in functional analysis.
- CLO3 : Assess the appropriate tools to solve varying problems in functional analysis.
- CLO4 : Use online tools to find information to solve problems in functional analysis.
- CLO5 : Communicate ideas in functional analysis competently in written form.

Detailed Assessment Description

Duration: Two hours. Weighting: 55% of your final mark.
Further details about the final examination will be available in class closer to the time.

Assessment Length

N/A

Submission notes

Hand written only.

Assessment information

Exam will be in person with an exam invigilator present. The duration is 2-2.5 hours. No late submissions will be accepted.

Assignment submission Turnitin type

Not Applicable

General Assessment Information

Assessment in this course will consist of three assignments (15% each) and a final exam (55%). Assignments will be paired with authentication procedure fixed by the course authority (possibly student's interview regarding their submitted essay). It is preferred that assignments are written in Latex.

Grading Basis

Standard

Requirements to pass course

Achieve a composite mark of at least 50 out of 100.

Course Schedule

Teaching Week/Module	Activity Type	Content
Week 1 : 27 May - 2 June	Lecture	Normed and Banach spaces.
Week 2 : 3 June - 9 June	Lecture	Bounded linear operators. Hahn-Banach theorem.
Week 3 : 10 June - 16 June	Lecture	Baire's category theorem. The uniform boundedness principle.
Week 4 : 17 June - 23 June	Lecture	The open mapping theorem. The closed graph theorem.
Week 5 : 24 June - 30 June	Lecture	Hilbert spaces.
Week 7 : 8 July - 14 July	Lecture	Linear functionals and operators on Hilbert spaces.
Week 8 : 15 July - 21 July	Lecture	Spectrum of an operator. Positive operators.
Week 9 : 22 July - 28 July	Lecture	Compact operators.
Week 10 : 29 July - 4 August	Lecture	Spectral theory for compact operators.

Attendance Requirements

Students are strongly encouraged to attend all classes and review lecture recordings.

General Schedule Information

Chapter 1. Normed and Banach spaces.

Chapter 2. Bounded linear operators.

Chapter 3. The dual space and the Hahn-Banach theorem.

Chapter 4. Principles of functional analysis.

Chapter 5. Hilbert spaces.

Chapter 6. Linear functionals and linear operators on Hilbert spaces.

Chapter 7. The spectrum of an operator and functional calculus.

Chapter 8. Compact operators.

Course Resources

Prescribed Resources

A complete set of lecture notes will be available on moodle with exercises in it. Those notes may be updated: the core of the notes will remain unchanged but additional examples, remarks, exercises may be added during the term.

Recommended Resources

We will not follow any textbook. The course notes provided on moodle are self-contained and sufficient for validating and following the whole course. We provide here a non-exhaustive list of books that students may want to use as a complement. None of them are compulsory.

1. John Conway. A course in functional analysis.
2. Walter Rudin. Functional analysis.
3. M. Reed and B. Simon: Methods of Modern Mathematical Physics. Vol.1 Functional Analysis.
4. K. Yosida: Functional Analysis.

Additional Costs

None

Course Evaluation and Development

The School of Mathematics and Statistics evaluates each course each time it is run. We carefully consider the student responses and their implications for course development. It is common practice to discuss informally with students how the course and their mastery of it are progressing.

Staff Details

Position	Name	Email	Location	Phone	Availability	Equitable Learning Services Contact	Primary Contact
Convenor	Fedor Sukochev		Anita Lawrence Building, East wing, level 5, room: 5109	-	upon request	No	Yes

Other Useful Information

Academic Information

Upon your enrolment at UNSW, you share responsibility with us for maintaining a safe, harmonious and tolerant University environment.

You are required to:

- Comply with the University's conditions of enrolment.
- Act responsibly, ethically, safely and with integrity.
- Observe standards of equity and respect in dealing with every member of the UNSW community.
- Engage in lawful behaviour.
- Use and care for University resources in a responsible and appropriate manner.
- Maintain the University's reputation and good standing.

For more information, visit the UNSW Student Code of Conduct Website.

Academic Honesty and Plagarism

Referencing is a way of acknowledging the sources of information that you use to research your assignments. You need to provide a reference whenever you draw on someone else's words, ideas or research. Not referencing other people's work can constitute plagiarism.
Further information about referencing styles can be located at https://student.unsw.edu.au/referencing

Academic integrity is fundamental to success at university. Academic integrity can be defined as a commitment to six fundamental values in academic pursuits: honesty, trust, fairness, respect, responsibility and courage. At UNSW, this means that your work must be your own, and others' ideas should be appropriately acknowledged. If you don't follow these rules, plagiarism may be detected in your work.
Further information about academic integrity, plagiarism and the use of AI in assessments can be located at:

- The Current Students site,
- The ELISE training site, and
- The Use of AI for assessments site.

The Student Conduct and Integrity Unit provides further resources to assist you to understand your conduct obligations as a student: https://student.unsw.edu.au/conduct

Submission of Assessment Tasks

Penalty for Late Submissions

UNSW has a standard late submission penalty of:

- 5% per day,
- for all assessments where a penalty applies,
- capped at five days (120 hours) from the assessment deadline, after which a student cannot submit an assessment, and
- no permitted variation.

Any variations to the above will be explicitly stated in the Course Outline for a given course or assessment task.

Students are expected to manage their time to meet deadlines and to request extensions as early as possible before the deadline.

Special Consideration

If circumstances prevent you from attending/completing an assessment task, you must officially apply for special consideration, usually within 3 days of the sitting date/due date. You can apply by logging onto myUNSW and following the link in the My Student Profile Tab. Medical documentation or other documentation explaining your absence must be submitted with your application. Once your application has been assessed, you will be contacted via your student email address to be advised of the official outcome and any actions that need to be taken from there. For more information about special consideration, please visit: https://

student.unsw.edu.au/special-consideration

Important note: UNSW has a "fit to sit/submit" rule, which means that if you sit an exam or submit a piece of assessment, you are declaring yourself fit to do so and cannot later apply for Special Consideration. This is to ensure that if you feel unwell or are faced with significant circumstances beyond your control that affect your ability to study, you do not sit an examination or submit an assessment that does not reflect your best performance. Instead, you should apply for Special Consideration as soon as you realise you are not well enough or are otherwise unable to sit or submit an assessment.

Faculty-specific Information

Additional support for students

- The Current Students Gateway
- Student Support
- Academic Skills and Support
- Student Wellbeing, Health and Safety
- Equitable Learning Services
- UNSW IT Service Centre
- Science EDI Student Initiatives, Offerings and Guidelines

School-specific Information

School of Mathematics and Statistics and UNSW Policies

The School of Mathematics and Statistics has adopted a number of policies relating to enrolment, attendance, assessment, plagiarism, cheating, special consideration etc. These are in addition to the Policies of The University of New South Wales. Individual courses may also adopt other policies in addition to or replacing some of the School ones. These will be clearly notified in the Course Initial Handout and on the Course Home Pages on the Maths Stats web site. Students in courses run by the School of Mathematics and Statistics should be aware of the School and Course policies by reading the appropriate pages on the web site starting at: The School of Mathematics and Statistics assessment policies

The School of Mathematics and Statistics will assume that all its students have read and understood the School policies on the above pages and any individual course policies on the Course Initial Handout and Course Home Page. Lack of knowledge about a policy will not be an excuse for failing to follow the procedure in it.

Special Consideration - Short Extension Policy

The School of Mathematics and Statistics has carefully reviewed its range of assignments and projects to determine their suitability for automatic short extensions as set out by the UNSW Short Extension Policy. Upon comprehensive examination of our course offerings that incorporate these types of assessments, we have concluded that our current deadline structures already accommodate the possibility of unexpected circumstances that may lead students to require additional days for submission. Consequently, the School of Mathematics and Statistics has decided to universally opt out of the Short Extension provision for all its courses, having pre-emptively integrated flexibility into our assessment deadlines. The decision is subject to revision in response to the introduction of new course offerings. Students may still apply for Special Consideration via the usual procedures.

Computing Lab

The main computing laboratory is room G012 of the Anita B.Lawrence Centre (formerly Red Centre). You can get to this lab by entering the building through the main entrance to the School of Mathematics (on the Mezzanine Level) and then going down the stairs to the Ground Level. A second smaller lab is Room M020, located on the mezzanine level through the glass door (and along the corridor) opposite the School's entrance.

For more information, including opening hours, see the computing facilities webpage. Remember that there will always be unscheduled periods when the computers are not working because of equipment problems and that this is not a valid excuse for not completing assessments on time.

School Contact Information

Please visit the School of Mathematics and Statistics website for a range of information.

For information on Courses, please go to “Student life & resources” and either Undergraduate and/or Postgraduate and respective "Undergraduate courses" and "Postgraduate courses" for information on all course offerings.

All school policies, forms and help for students can be located by going to the "Student Services" within “Student life & resources” page. We also post notices in "Student noticeboard" for your information. Please familiarise yourself with the information found in these locations. If you cannot find the answer to your queries on the web you are welcome to contact the Student Services Office directly.

Undergraduate

E: ug.mathsstats@unsw.edu.au

P: 9385 7011 or 9385 7053

Postgraduate

E: pg.mathsstats@unsw.edu.au

P: 9385 7053

Should we need to contact you, we will use your official UNSW email address of in the first instance. **It is your responsibility to regularly check your university email account. Please use your UNSW student email and state your student number in all emails to us.**