ACE Network Subject Information Guide

MATH4313: Functional Analysis

Semester 1, 2021

Administration and contact details

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Host institution	The University of Sydney
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Subject details

Handbook entry URL	https://www.sydney.edu.au/units/MATH4313
Subject homepage URL	https://www.maths.usyd.edu.au/u/UG/HM/MATH4313/
Honours student hand-out URL	https://canvas.sydney.edu.au/courses/31411
Start date:	1 March 2021
End date:	4 June 2021
Contact hours per week:	3 lectures and 1 tutorial (13 Weeks)
Lecture day(s) and time(s):	Lectures Mon 09:00 – 11:00 and Wed 09:00 – 10:00, Lectures will be recorded and available through Canvas. Tutorial Wed, 10:00 – 11:00
Description of electronic access arrangements for students (for example, WebCT)	Access to Canvas to be arranged

Subject content

1. **Subject content description**

Functional analysis is one of the major areas of modern mathematics. It can be thought of as an infinite-dimensional generalisation of linear algebra and involves the study of various properties of linear continuous transformations on normed infinite-dimensional spaces. In this unit you will start with a review of the topology of metric spaces, and then move on to cover topics that include normed vector spaces, Banach and Hilbert spaces; bounded and closed linear operators; abstract Fourier series; uniform boundedness, closed graph and the open mapping theorem; dual spaces and the Hahn-Banach theorem as well as spectral theory. If time permits the unit will cover the spectral theory of compact operators. While the unit constitutes a self-contained introduction to functional analysis, we will also be looking at some more concrete applications, particularly in tutorials.

2. Week-by-week topic overview

Tentative Schedule:
Week 1: Review of the topology of metric spaces, compactness and continuity
Week 2: Normed linear spaces and basic properties of linear operators
Week 3: Finite and infinite dimensional Banach spaces
Week 4: Banach algebras and the Stone-Weierstrass Theorem
Week 5: Hilbert spaces, orthonormal systems, projection theorem, abstract Fourier series
Week 6: Baire's theorem and the open mapping theorem
Week 7: The closed graph theorem, the uniform boundedness theorem
Week 8: Closed operators
Week 9: Duality and the Hahn-Banach theorem
Week 10: Weak convergence
Week 11: Duality in Hilbert spaces and the Lax-Milgram Theorem
Week 12: Basics of spectral theory, ascent and descent of linear operators
Week 13: The spectrum of compact operators

3. Assumed prerequisite knowledge and capabilities

Working knowledge in abstract linear algebra and analysis, including working with inner products on real or complex vector spaces, the Euclidean norm, supremum and infimum and basic point set topology. Some knowledge of metric spaces and Lebesgue integration is an advantage but not required.

4. Learning outcomes and objectives

See https://www.sydney.edu.au/units/MATH4313 (follow the link to Semester 1, 2121)

AQF specific Program Learning Outcomes and Learning Outcome Descriptors (if available):

AQF Program Learning Outcomes addressed in this subject	Associated AQF Learning Outcome Descriptors for this subject
Insert Program Learning Outcome here	Choose from list below
Insert Program Learning Outcome here	Choose from list below
Insert Program Learning Outcome here	Choose from list below
Insert Program Learning Outcome here	Choose from list below
Insert Program Learning Outcome here	Choose from list below
Insert Program Learning Outcome here	Choose from list below
Insert Program Learning Outcome here	Choose from list below

Learning Outcome Descriptors at AQF Level 8

Knowledge

K1: coherent and advanced knowledge of the underlying principles and concepts in one or more disciplines

K2: knowledge of research principles and methods

Skills

S1: cognitive skills to review, analyse, consolidate and synthesise knowledge to identify and provide solutions to complex problem with intellectual independence

S2: cognitive and technical skills to demonstrate a broad understanding of a body of knowledge and theoretical concepts with advanced understanding in some areas

S3: cognitive skills to exercise critical thinking and judgement in developing new understanding

S4: technical skills to design and use in a research project

S5: communication skills to present clear and coherent exposition of knowledge and ideas to a variety of audiences

Application of Knowledge and Skills

A1: with initiative and judgement in professional practice and/or scholarship

A2: to adapt knowledge and skills in diverse contexts

A3: with responsibility and accountability for own learning and practice and in collaboration with others within broad parameters

A4: to plan and execute project work and/or a piece of research and scholarship with some independence

5. Learning resources

Daniel Daners, Introduction to Functional Analysis (Lecture Notes, University of Sydney, 2021, will be made available as a PDF).

6. Assessment

Exam/assignment/classwork breakdown					
Exam	70 %	**Assignment**	3 x10%	**Class work**	
Assignment due dates		23 March 2021	29 April 2021	27 May 2021	
See also https://www.sydney.edu.au/units/MATH4313 (follow the link to Semester 1, 2121)					
Approximate exam date				Exam period 15-26 June	

Institution honours program details

Weight of subject in total honours assessment at host department	One out of four coursework units
Thesis/subject split at host department	50% + 50%
Honours grade ranges at host department	
H1	80 – 100%
H2a	75 – 79%
H2b	70 – 74%
H3	65 – 69%

Institution masters program details

Weight of subject in total masters assessment at host department	This is one of 6 coursework units in the 2 year masters of mathematical science program
Thesis/subject split at host department	2/3 coursework and 1/3 thesis (2 year program)
Masters grade ranges at host department	
H1	Enter range %
H2a	Enter range %
H2b	Enter range %
H3	Enter range %