



Faculty of Health, Science and Technology
Mathematics

Syllabus

Selected Topics in Functional Analysis and Applications

Course Code: 7MAT006
Course Title: Selected Topics in Functional Analysis and Applications
Utvalda delämnena i funktionsrum och tillämpningar
Subject: Mathematics
Credits: 7.5 ECTS
Degree Level: Doctoral

Course Approval

The syllabus was approved by the Faculty of Health, Science and Technology, 22 March 2023 and is valid from the spring semester 2023.

Language of instruction

Teaching is in English.

Prerequisites

The course is primarily for PhD students at Karlstad University, secondly for PhD students accepted at other universities and thirdly for others with equivalent knowledge.

Learning Outcomes

For a Pass grade, the doctoral student must be able to:

- Identify the main theorems of the course, describe the main ideas and carry out the steps in their proofs.
- Give examples of non-trivial situations where these theorems apply.
- Integrate knowledge from various parts of the course and use appropriate methods in connection with problem solving.
- Identify situations where the methods apply and use these in applications, such as for differential equations and operator theory.
- Explain the solution in speech and writing.

Course Content

The course is based on an individual study of course literature on selected key topics in function spaces. This course covers selected examples of infinite-dimensional function spaces. The course can be seen as a course in two parts, the first part will include the same core material for all students, and in the second part, the student studies selected topics and applications.

The first part of the course consists of studies of the functional properties of Banach, Hilbert, and Lebesgue spaces and their properties. This part includes boundedness and compactness of operators, densities, embeddings, inequalities, duals and adjoints, and various modes of convergence.

The content of the second part will be tailored to the research interest and topics of the student. This part may include deeper studies on, various function spaces for example, Besov spaces, general and fractional Sobolev spaces, Hölder spaces, Lebesgue spaces, Lorentz, Cesaro, Morrey-Campanato spaces, and their properties; interpolation between function spaces; and applications, for example, in regularity theory for partial differential equations, Fourier analysis.

The course includes ongoing discussions with the instructor.

Reading List

See separate document.

Examination

For a Pass grade, doctoral students are required to study the course literature and discuss the content with the instructor(s). The student must also give a presentation that summarises the studies and the key theorems at a seminar.

Grades

One of the grades Fail (U) or Pass (G) is awarded in the examination of the course.

Quality Assurance

The course convenor has a duty to encourage a continuous dialogue on learning processes and goal fulfilment. A written evaluation is carried out at the conclusion of the course combined with a joint student-teacher discussion of all aspects commented on. The result of the evaluation is collated and made available in accordance with *The Higher Education Ordinance*, Chapter 1, § 14.

Course Certificate

Course certificate is issued on request.

Goal matrix

Goals that, after completing the course, are fulfilled for the doctoral or licentiate degree are marked with an X.

	Doctoral			Licentiate	
	Knowledge and understanding			Knowledge and understanding	
1a	- demonstrate broad knowledge and systematic understanding of the research field and	x		1a demonstrate knowledge and understanding in the field of research including	x
1b	advanced and up-to-date specialised knowledge in a limited area of this field, and	x		1b current specialist knowledge in a limited area of this field as well as	x
1c	familiarity with research methodology in general and the methods of the specific field of research in particular.	x		1c specialised knowledge of research methodology in general and the methods of the specific field of research in particular	x
	Competence and skills			Competence and skills	
2a	- demonstrate capacity for scholarly analysis and synthesis as well as			2a demonstrate the ability to identify and formulate issues with scholarly precision critically, autonomously and creatively and to	
2b	to review and assess new and complex phenomena, issues and situations autonomously and critically			2b plan and use appropriate methods to undertake a limited piece of research and other qualified tasks within predetermined time frames in order to contribute to the formation of knowledge	
3a	- demonstrate the ability to identify and formulate issues with scholarly precision critically, autonomously and creatively, and to			2c as well as to evaluate this work	
3b	plan and use appropriate methods to undertake research and other qualified tasks within predetermined time frames and to review and evaluate such work			3a demonstrate the ability in both national and international contexts to present and discuss research and research findings in speech and writing and in dialogue with the academic community and	
4	- demonstrate through a dissertation the ability to make a significant contribution to the formation of knowledge through his or her own research			3b society in general	

5a	- demonstrate the ability in both national and international contexts to present and discuss research and research findings authoritatively in speech and writing and in dialogue with the academic community and	x	4	demonstrate the skills required to participate autonomously in research and development work and to work autonomously in some other qualified capacity.
5b	society in general			
6	- demonstrate the ability to identify the need for further knowledge and	x		
7	- demonstrate the capacity to contribute to social development and support the learning of others both through research and education and in some other qualified professional capacity.			
Judgement and approach				Judgement and approach
8a	- demonstrate intellectual autonomy and disciplinary rectitude as well as		5	demonstrate the ability to make assessments of ethical aspects of his or her own research
8b	the ability to make assessments of research ethics, and		6	demonstrate insight into the possibilities and limitations of research, its role in society and the responsibility of the individual for how it is used
9	- demonstrate specialised insight into the possibilities and limitations of research, its role in society and the responsibility of the individual for how it is used.		7	demonstrate the ability to identify the personal need for further knowledge and take responsibility for his or her ongoing learning.