



**LUNDS UNIVERSITET**  
Lunds Tekniska Högskola

*Course syllabus*

# **Funktionalanalys och harmonisk analys**

## **Functional Analysis and Harmonic Analysis**

**FMAN80, 7,5 credits, A (Second Cycle)**

**Valid for:** 2023/24

**Faculty:** Faculty of Engineering, LTH

**Decided by:** PLED F/Pi

**Date of Decision:** 2023-04-18

### **General Information**

**Elective for:** F5, F5-tf, F5-bs, F5-ss, Pi4-bs, Pi4-ssr, MMSR2

**Language of instruction:** The course will be given in English on demand

### **Aim**

Functional analysis and harmonic analysis are fundamental tools in many mathematical applications, e.g., in field theory, solid mechanics, control theory, signal processing and in mathematical statistics and numerical analysis. The aim of the course is to convey knowledge about basic concepts and methods in the subject, and to give the ability, both to follow discussions where these are used and to independently solve mathematical problems which arise in the applications. An important goal of the course is also to develop a power of abstraction which makes it easier to see analogies between problems from apparently different fields.

### **Learning outcomes**

*Knowledge and understanding*

For a passing grade the student must

- have knowledge of different common norms and their usefulness in different applications.
- be familiar with the meaning of the concepts of completeness and compactness, and be aware that the choice of norm has an impact on these properties of a space. In particular, the student should have a good understanding of the difference between the infinite and the finite dimensional case.
- be familiar with the basic properties of the dual space of a normed space.
- be familiar with the most common classes of linear and bounded operators, and have an

understanding of how spectral theory provides information on the properties of a linear operator.

- be familiar with how the properties of a function are reflected in its Fourier transform.
- be able to explain the basic theory in an oral examination.

#### *Competences and skills*

For a passing grade the student must

- with access to literature independently be able to integrate methods and approaches from different parts of the course in order to solve problems and answer questions within the framework of the course.
- in writing and orally, with proper terminology and clear logic be able to explain the solution to a mathematical problem within the course.
- be able to translate concrete mathematical problems into the abstract language of the course.

## Contents

*Functional analysis:* norms and approximation, completeness, compactness, function spaces, Hilbert spaces, orthogonality and orthogonal systems. Linear operators, compact operators and self-adjoint operators. Spectral theory. Dual spaces and Hahn-Banach's theorem.

*Harmonic analysis:* The Fourier transform. Sobolev spaces and the Sobolev embedding theorem.

## Examination details

**Grading scale:** TH - (U,3,4,5) - (Fail, Three, Four, Five)

**Assessment:** Take-home exam followed by an oral exam.

The examiner, in consultation with Disability Support Services, may deviate from the regular form of examination in order to provide a permanently disabled student with a form of examination equivalent to that of a student without a disability.

## Admission

**Assumed prior knowledge:** FMAN55 Applied Mathematics and FMAN70/FMAN71 Matrix Theory.

**The number of participants is limited to:** No

**The course overlaps following course/s:** FMA260

## Reading list

- Renardy & Rogers: An Introduction to Partial Differential Equations. Springer, 2004, ISBN: 0-387-00444-0.
- Material produced at the department.

## Contact and other information

**Course coordinator:** Studierektor Anders Holst, Studierektor@math.lth.se

**Teacher:** Pelle Pettersson, pelle@maths.lth.se

**Course homepage:** <https://canvas.education.lu.se/courses/20321>