Faculty of Science

MATB34, Mathematics: Linear Analysis, 7.5 credits

Matematik: Lineär analys, 7,5 högskolepoäng

First Cycle / Grundnivå

Details of approval

The syllabus was approved by The Education Board of Faculty of Science on 2024-12-03. The syllabus comes into effect 2024-12-03 and is valid from the autumn semester 2025.

General information

The course is an alternative-compulsory course at upper-basic level for a Bachelor of Science in Mathematics.

Language of instruction: English

Main field of study	*Specialisation*
Mathematics	G1F, First cycle, has less than 60 credits in first-cycle course/s as entry requirements

Learning outcomes

The overarching goal of the course is that the student develop an understanding of fundamental concepts, results, and methods in Fourier analysis, and the ability to apply these to describe, analyze, and solve relevant problems related to linear analysis. The course aims to develop the students' ability to communicate mathematics orally and in writing and to read mathematical texts. It also aims to prepare the student for further studies in mathematics, science, and technology.

Knowledge and understanding

On completion of the course, the student shall be able to:

- give an account of the relationships between the main concepts and results included in the course and illustrate these with examples.
- explain how the main concepts and results of the course are related to solution methods for relevant problems in linear analysis.

- explain how relevant linear structures are fundamentally important for certain problems in mathematical analysis.

Competence and skills

On completion of the course, the student shall be able to:

- confidently apply basic methods to solve relevant calculation tasks within the course content
- demonstrate good calculation skills
- present solutions to relevant calculation tasks orally and in writing, logically coherent, and with appropriate terminology
- derive basic relationships between key concepts and reproduce proofs for the main results included in the course.

Judgement and approach

On completion of the course, the student shall be able to:

- evaluate available solution methods in problem-solving and choose an appropriate solution method
- critically analyze their own and other students' solutions and evaluate solution alternatives in relation to each other
- argue for the value of mathematical theory in problem-solving
- argue for the value of mathematical analysis in other sciences.

Course content

The course treats:

- Basic properties of Fourier series of functions in one variable. Exponential form and trigonometric form. Riemann-Lebesgue lemma. Elementary conditions for pointwise and uniform convergence. Gibbs phenomenon.
- Basic properties of convolutions of periodic functions in one variable. Interaction with Fourier series. Convolution kernels and their applications in summing Fourier series. Fejér's theorem and Weierstrass approximation theorem.
- Linear spaces and examples of linear operators. Vector norm, inner product, and Cauchy-Schwarz inequality. Hilbert space, minimum distance to closed convex sets, projection theorem. Orthonormal systems, Bessel's inequality, and Parseval's identity. Completeness of the Fourier system.
- Basic properties of Fourier transforms of functions in one variable. Interaction with translation, modulation, scaling, differentiation and convolution. Laplace transforms. Elementary conditions for pointwise convergence of the inverse Fourier transform. Some information on Schwartz functions and Plancherel's identity.

- Applications towards classical partial differential equations such as the heat equation, wave equation, and Dirichlet problem in simple domains. Method of separation of variables.

During the course, notation for Lebesgue spaces naturally occurs. Properties of these can be briefly discussed but are not included in the course content that is part of the examination. For a rigorous presentation, refer to courses in Integration Theory.

Course design

The teaching consists of lectures and seminars. The seminars are based on selected exercises and require active student participation, including preparation. During the course, one of the exercises must be presented in writing. The written presentation must first be peer-reviewed and then, after possible correction, approved by the teacher.

Assessment

The examination consists of the following parts:

- Written presentation of an exercise and completed peer review (0.5 credits)
- Written examination, possibly with a supplementary oral examination (7 credits).

The supplementary oral examination is offered only to students who have achieved at least 75% of the maximum number of points on the written exam. The supplementary oral examination is voluntary but required for the grade "Pass with Distinction."

For students who did not pass the regular written examinations, additional examination opportunities are offered during the scheduled re-examination period.

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.

Grades

Grading scale includes the grades: Fail, Pass, Pass with distinction
The written assignment is graded on the scale Fail, Pass. The grade is based on the quality and correctness of the solution. To achieve the grade Pass, the student must also have reviewed another student's submitted assignment.

The written examination, together with the supplementary oral examination, is graded on the scale Fail, Pass, Pass with Distinction. To achieve the grade Pass, the student must obtain at least 50% of the maximum points on the written examination. To achieve Pass with Distinction, the total points from the written and oral examinations must be at least 75% of the maximum points. The maximum points for the written and oral examinations are weighted in a ratio of three to one.

To achieve the grade Pass for the entire course, a passing grade on the written assignment and the written examination is required. The final grade is determined by the grade on the written examination together with the supplementary oral examination.

Entry requirements

The course requires basic knowledge in analysis in one and several variables and linear algebra, corresponding to, for example:

- MATA31Analysis in One Variable, 15 credits
- MATA32 Algebra and Vector Geometry, 7,5 credits
- MATB21 Analysis in Several Variables, 7,5 credits
- MATB32 Linear Algebra, 7,5 credits

Additionally, knowledge equivalent to MATB33 Mathematics: Introduction to Higher Analysis, 7.5 credits, or FYSB21 : Mathematical Methods for Vibrations, Waves and Diffusion, 7.5 credits, is required.

Further information

The course cannot be credited together with the courses MATB24 Linear Analysis, 7.5 credits.

The course is given at the Centre for Mathematical Sciences, Lund University.