Joint Faculties of Humanities and Theology

ÄMAA01, Mathematics 1 for Subject Teachers: Analysis in One Variable, 13 credits

Matematik 1 för ämneslärare: Envariabelanalys, 13 högskolepoäng

First Cycle / Grundnivå

Details of approval

The syllabus was approved by The Education Board of Faculty of Science on 2024-11-27. The syllabus comes into effect 2024-11-27 and is valid from the autumn semester 2025.

General information

The course is a included in the teacher education programme at Lund University.

Language of instruction: Swedish and English
The lectures are given in English, while the seminars are taught in Swedish.

Main field of study	*Specialisation*
Mathematics	G1N, First cycle, has only upper-secondary level entry requirements

Learning outcomes

The overarching goal of the course is for the student to develop understanding of central concepts, results and methods of analysis in one variable, and to apply these methods to solve standard calculus problems for functions in one variable. The course aims for the student to develop the ability to communicate mathematics in speech and writing, as well as reading mathematical texts. The course aims additionally to prepare the student for further studies in mathematics and the practice-based part of the education as well as for their future profession as subject teachers.

Knowledge and understanding

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

- state and outline the relations between the most important concepts and results included in the course, and illustrate these with examples

- explain how the most important concepts and results of the course are related to methods for solving problems in single variable calculus
- explain how standard concepts of calculus are related to convergence and quantitative estimates with given error bounds.

Competence and skills

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

- within the framework of the course with confidence be able to handle elementary functions of one variable, including limits, derivatives and integrals of such functions
- demonstrate a good computational proficiency
- use the methods included in the course to solve problems in single variable calculus
- use the methods included in the course to make quantitative approximations within given error bounds
- present solutions to problems in single variable calculus in speech and in writing, logically coherent and with adequate terminology
- derive basic relations between key concepts, and reproduce proofs of the most important results included in the course.

Judgement and approach

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

- argue for why proofs are necessary when developing a mathematical theory
- account for the most important concepts of the course are related to quantitative approximations
- analyse critically other students' solutions and presentations and evaluate alternative solutions in relation to their own solutions
- argue for the importance of mastering mathematical analysis for their future profession.

Course content

The course treats:

- The real numbers: axioms, examples of proofs of basic arithmetical rules.
- The elementary functions, polynomials, rational functions, the exponential function and the natural logarithm, the trigonometric functions and the inverse trigonometric functions; definitions, basic properties, and quantitative approximations using representations in terms of areas and arclengths.
- Sequences of numbers and their limits: formal definition of the limit, examples of proofs of their computational rules, visual representation of convergence of recursive sequences, quantitative approximations.
- Infinite series: applications and proofs of convergence tests, absolute convergence, quantitative approximations using partial sums and tail estimates.

- Functions and their limits: formal definition of the limit, proofs and applications of their computational rules, indeterminate forms and asymptotes.
- Continuity: continuity of elementary functions, the intermediate value theorem and the min-max theorem.
- Derivatives: definition, proofs and applications of computational rules, differentiation formulas for elementary functions, Rolle's lemma, the mean value theorem and L'Hopital's rule.
- Applications of the derivative: optimisation and graph sketching, techniques for establishing identities and inequalities.
- Indefinite integrals: proofs and applications of basic computational rules and integration methods, such as change of variables, partial integration and use of partial fraction decomposition.
- Definite integrals: Darboux integrability of monotone functions and functions with bounded derivative with related error estimates, the fundamental theorem of calculus, applications to arclength, rotational volumes and surfaces, numerical approximations of definite integrals.
- Improper integrals: convergence criteria for improper integrals for positive functions, absolute convergence, comparison to infinite series.
- Differential equations: direction fields, analytic solution methods for separable and linear first order differential equations, solution method for linear higher-order differential equations with constant coefficients, numerical approximations of solutions of initial value problems using Euler's method.
- Taylor expansions: Taylor's formula with Lagrange's formula for the error term, uniqueness theorem for Taylor polynomials, numerical approximations of function values and integrals using Taylor polynomials.

In addition, materials on sets, functions and relations, induction, the binomial theorem, as well as variables, for-loops and if-statements in Python are covered at the beginning of the course.

Course design

The teaching consists of lectures, seminars, exercise classes and mentoring sessions. An essential element of the seminars is training in problem solving and mathematical communication and assumes students' active participation. Several compulsory computer-based tests are given during the course.

The first part of the course is taught jointly with *Mathematics 1 for Subject Teachers: Algebra and Vector Geometry* and *Computational Programming in Python,* where material on sets, induction, the binomial theorem, functions and relations, as well as variables, for-loops and if-statements in Python, are covered.

Assessment

The examination consists of the following parts:

- computer based tests (1 credit)
- mid-term written examination (4.5 credits)
- final written examination with an optional oral examination (7.5 credits)

The optional oral examination is offered only to students who obtained at least 70% of the maximum number of the marks in the final written examination and it is required to obtain the grade Pass with distinction on the whole course.

Students who fail the ordinary written examinations are offered a resit examination during 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 grading scale for the computer-based tests and the mid-term examination is Fail, Pass.

The written examination, possibly together with the optional oral examination, is graded according to the scale Fail, Pass, Pass with Distinction. To achieve the grade Pass with distinction, it is required to obtain at least 70% of the maximum number of the marks in the written examination and demonstrate satisfactory performance at the oral examination.

For a Pass grade on the whole course, the student must have Pass grades on the oral presentation, the computer-based tests and on both written examinations.

The final grade is determined by the grade on the final written examination including the optional oral examination.

Entry requirements

General requirements and studies equivalent of courses Mathematics 4 (or older course Mathematics D) and English 6/B from Swedish Upper Secondary School.

Further information

The course is given jointly with the Bachelor's programme in mathematics at the Faculty of Science.

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