Faculties of Humanities and Theology

ÄMAD01, Mathematics with Didactics 1, 30 credits

Matematik med ämnesdidaktik 1, 30 högskolepoäng

First Cycle / Grundnivå

Details of approval

The syllabus was approved by Study programmes board, Faculty of Science on 2016-10-19 and was last revised on 2020-06-14. The revised syllabus applies from 2020-06-14, autumn semester 2020.

General Information

The course is a component of the teacher education programme at Lund University.

Language of instruction: Swedish and English
The lectures in the subject modules are in English. The subject teaching seminars and the teaching sessions in the subject modules are in Swedish.

Main field of studies	*Depth of study relative to the degree requirements*
Mathematics	G1N, First cycle, has only upper-secondary level entry requirements

Learning outcomes

The overall aim of the course is for students to acquire a solid theoretical foundation in one variable analysis, linear algebra and scientific computing with Python and to link this knowledge to basic methodology for teaching mathematics in upper-secondary school.

Knowledge and understanding

On completion of the course, the students shall be able to

- use calculation rules for and theorems on limits, derivatives and integrals to carry out calculations on number sequences, elementary functions, differential equations and series
- use algebra to express different geometrical concepts in three-dimensional space and derive relevant algebraic relationships and formulas

- account for basic programming concepts, data structures, control theorems
- use Python as a programming language and independently write their own calculation programs
- account for mathematical concepts and methods of importance to other subject areas and for the future teaching profession
- account for basic learning processes with regard to mathematical concepts of relevance to upper secondary school
- account for the mathematics curriculum in upper secondary school and for summative and formative forms of evaluation

Competence and skills

On completion of the course, the students shall be able to

- apply different methods and techniques to solve mathematical problems
- visualise, interpret and critically analyse numerical results
- present mathematical arguments, solutions to problems and numerical results in speech, writing and graphical form
- plan and carry out pupil activities linked to upper-secondary school mathematics
- assess and grade the mathematical knowledge of upper-secondary school pupils.

Judgement and approach

On completion of the course, the students shall be able to

- critically analyse the solutions and presentations of other students and assess solutions alternative to their own solutions
- explain the purpose of mathematical argumentation and discuss the value and applicability of mathematics in other fields
- deal with issues of teaching related to mathematical analysis, linear algebra and programming
- evaluate knowledge and expertise in mathematical analysis, linear algebra and programming

Course content

The course consists of the modules:

- Analysis in One Variable (13 credits)
- Linear Algebra 1 (6 credits)
- Scientific Computing with Python (6 credits)
- Subject Didactics (5 credits)

Analysis in One Variable (13 credits):

- The real numbers: axiomatic description and proofs of basic arithmetical rules.
- Limits of number sequences: formal definition, proofs and use of arithmetical rules, the Bolzano-Weierstrass theorem.
- Limits of functions: formal definition of limits of functions, proofs of the rules of differentiation.
- Continuity: definition and basic properties of continuous functions, the intermediate value theorem, the extreme value theorem for continuous functions, uniform continuity.
- Derivatives: definition, proof and applications of computational rules for derivatives, the mean value theorem, optimisation, curve sketching, proof techniques for identities and inequalities.
- Primitive functions: proof and applications of basic computational rules and integration methods such as change of variables, partial integration and

integration of elementary functions (trigonometric integrals, rational integrals, partial fraction decomposition).
- Definite integrals: definition, integrability of monotonous functions and continuous functions, proof for the main clause of the analysis and applications.
- Differential equations: direction field, solution methods for first-order linear or separable differential equations and higher-order linear differential equations with constant coefficients.
- Taylor expansions: Taylor's formula, proof and applications, and error term estimates.
- Series: proof and use of convergence criteria for positive and alternating series.
- Improper integrals: proof and use of convergence criteria for generalised integrals of positive functions.

Linear Algebra 1 (6 credits):

- Analytical geometry in two and three dimensions: vectors, base and coordinates, equations for lines and planes, inner product, calculation of distances and angles, vector and volume product and calculation of area and volume.
- Systems of linear equations: Gauss elimination, solvability.
- Matrices and determinants.
- Introduction to linear spaces and reproductions.

Scientific Computing with Python (6 credits):

- Basic programming concepts, data structures, control theorems, functions and classes.
- Problem-solving using some basic numerical methods linked to mathematics and physics.
- The basic functions and data types of the Python programming language: arithmetical operations, arrays for vectors, matrices, graphic functions, lists, tuples, dictionaries, file management.
- Representation of floating point numbers and their implications for arithmetic.
- Syntax: [for], [if-else], [while], list comprehensions, generators.
- Built-in functions, individually defined functions and modules.
- Classes and inheritance applied to mathematical objects.
- Tests and profiling.

Subject Didactics (5 credits):

- The learning processes and concept formation of pupils in the field of analysis and algebra.
- Planning of activities for pupils, interactive and dynamic mathematics using digital aids.
- Communication and group dynamics in teaching contexts.
- The upper secondary school curriculum in mathematics, evaluation in mathematics teaching, links between the content of the parallel modules and mathematics teaching in upper secondary school.

Course design

All modules are taught in consultation with the students and based on the outcome of evaluation of previous course occasions.
The teaching consists of lectures and teaching of smaller student groups in the form of lessons, calculation exercises, computer exercises and a didactics seminar series.Problem-solving and oral communication of mathematics are essential features

of the group tuition in the form of lessons, calculation exercises and computer exercises.The didactics seminar series is included in the module *Subject Didactics* and aims toprepare students for the placement component of the teacher education programme.

Assessment

The assessment is based on the following components of the different modules:

- Single Variable Calculus: written exam, 13 credits
- Linear Algebra 1: written exam, 6 credits
- Calculation Programming with Python: presentation of project work, 6 credits
- Subject Didactics: presentation of written assignments, written, oral and through video, 5 credits.

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.

Subcourses that are part of this course can be found in an appendix at the end of this document.

Grades

Marking scale: Fail, Pass, Pass with distinction.
The grades awarded on all assessed components are Pass or Fail.

The results of written exams are given as exam credits, where the total number of credits per exam is proportional to the number of credits for the respective modules. For a grade of Pass on each written exam, the student must have achieved at least 50% of the total available number of credits.

For a grade of Pass on the whole course, the student must have been awarded this grade on all assessed components. For a grade of Pass with Distinction, the student must have passed all components and the total number of exam credits awarded for the written exams must total at least 75%.

Entry requirements

General and courses corresponding to the following Swedish Upper Secondary School Programs: Civics 1b/1a1+1a2 and Mathematics 4. English 6

Further information

The course is coordinated with MATA21 Mathematics: Analysis in One Variable, 15 credits, MATA22 Mathematics: Linear Algebra 1, 7.5 credits, and NUMA01 Computational Programming with Python, 7.5 credits, and may not be included in a degree together with these courses.

Subcourses in ÄMAD01, Mathematics with Didactics 1

Applies from H16

1601 Linear Algebra 1: written examination, 6,0 hp
Grading scale: Fail, Pass
1602 Analysis in One Variable: written examination, 13,0 hp
Grading scale: Fail, Pass
1603 Computational Programming with Python: project, 6,0 hp
Grading scale: Fail, Pass
1604 Didactics: assignments, 5,0 hp
Grading scale: Fail, Pass