Linnæus University

Dnr: LNU-2024/2379

# Programme syllabus

## Faculty of Technology

## Matematikerprogrammet, 180 högskolepoäng
## Applied Mathematics Programme, 180 credits

**Level**
First cycle

**Date of Ratification**
Approved 2024-06-14.

The programme syllabus is valid from autumn semester 2025.

**Prerequisites**
General entry requirements and Mathematics 4/Mathematics D.

## Description of Programme

The Applied Mathematics Programme is a bachelor programme with mathematics as main subject.

The purpose of the programme is to give a broad education in pure and applied mathematics. An element of computer science gives knowledge and skills in programming and software systems intended for mathematics and its applications.

The students acquire basic knowledge, skills and approaches which are essential for professional activity in organizations and enterprises that use advanced mathematics, and for further studies on the advanced level in mathematics, computational science, statistics and finance mathematics.

Depending on the choices of elective courses, the programme can give competence for further studies on the master level in engineering, software technology, programmes based on statistics and actuary programmes. Knowledge in adjacent subjects and knowledge in applications of mathematics increase the attractivity of a mathematician on the job market.

Areas where mathematicians are in demand are for instance information security, artificial intelligence, manufacturing engineering, economy and operational research,

insurance policy analysis, design of experiments, and statistical surveys. It is also possible to continue study mathematics on a higher level and by extension to pursue an academic career.

## Objectives

*Knowledge and understanding*
For a Degree of Bachelor students must

- demonstrate knowledge and understanding in their main field of study, including knowledge of the scientific basis of the field, knowledge of applicable methods in the field, in-depth knowledge of some part of the field and a general sense of current research issues.

*Skills and abilities*
For a Degree of Bachelor students must

- demonstrate an ability to seek, gather and critically interpret information that is relevant to a problem and to critically discuss phenomena, issues and situations;
- demonstrate an ability to independently identify, formulate and solve problems and to perform tasks within specified time limits;
- demonstrate an ability to present and discuss information, problems and solutions in dialogue with different groups, orally and in writing; and
- demonstrate the skills required to work independently in the field that the education concerns.

*Judgement and approach*
For a Degree of Bachelor students must

- demonstrate an ability to make assessments in their main field of study, taking into account relevant scientific, social and ethical aspects;
- demonstrate insight into the role of knowledge in society and into people’s responsibility for how knowledge is used; and
- demonstrate an ability to identify their need of further knowledge and to upgrade their capabilities.

## Content

*Programme Overwiew*
The programme comprises 180 credits and includes a final Bachelor thesis of 15 credits.

The programme contains courses in mathematics, applied mathematics and computer science.

The programme gives space for six elective courses, during the second and final third year. The elective courses can be chosen from predefined alternatives, or otherwise after consulation with the programme director. In this way the students are given the opportunity to specialize in an area of application or in mathematics. The area can be mathematics, engineering mathematics, statistics, physics, computer science, machine

learning, electrical engineering, economy or a combination of these.

A Bachelor degree must contain at least 30 credits from other subjects than mathematics.

In several mathematics courses the students use mathematical software and work with problem solving and modelling in application areas which gives a deeper understanding of mathematics and its role in technology and social issues, and scientific development.

Mathematical communication is trained from the first semester in laborations, assignments and projects. During the programme, the progression of the students is followed up with respect to both individual courses, and the programme as a whole, and the progression is evaluated against the aims of the objectives.

Courses on the programme may be replaced by similar courses within the framework of the programme, in dialogue with the programme director. In particular credits may be transferred from earlier studies. In these cases the programme director checks that the learning outcomes of the programme are fulfilled. Prerequisites for courses and the local rules for degrees at Linnaeus University must be satisfied.

*Programme courses*

*=*Course in the main field of study*
Year 1 (Autumn term)

- *Basic Mathematics*, 7.5 credits (G1N)* The course is an introduction to the subject of mathematics and prepares for further studies in mathematics, programming and use of mathematical software. The course contains basic arithmetic and algebra, logic, set theory, number theory, relations, functions, recursion and induction, combinatorics. The students are trained in mathematical thinking for problem solving, writing and proofs.

- *Introduction to programming*, 7.5 credits (G1N) The course gives an introduction to computer science and programming in the language Python.

- *Programming and data structures*, 7.5 credits (G1F) Continuation of programming with focus on data structures and algorithms.

- *Calculus I*, 7.5 credits (G1N)* The course gives an introduction to limits, continuity, differential and integral calculus in one variable with applications. The students deepen their theoretical knowledge and skills in analysis. The theory is illustrated by examples from applications in e.g. physics, economy and biology. After the course students are expected to be able to show central theorems about limits, and differential and integral calculus.

Year 1 (Spring term)

- *Calculus II*, 7.5 credits (G1F)* The course gives deeper knowledge on integration and an introduction to series, generalized integrals, Taylor's formula, power series and differential equations in one variable. The students deepen their theoretical knowledge and skills in analysis. After the course students are expected to be able to show central theorems about series, generalized integrals,

power series, Taylor's formula and differential equations.

- *Linear algebra*, 7.5 credits (G1N)* The course gives an introduction to vectors, matrices and linear algebra in the plane and in three dimensions, and its applications in e.g. mechanics, electrical engineering and data fitting.

- *Numerical methods*, 7.5 credits (G1F)* The aim of the course is to introduce methods for numerical solution of mathematically formulated problems and to analyze their theoretical and computational properties. The course studies, among other things, error analysis, numerical linear algebra, approximation of functions, differentiation and integration, and numerical solution of differential equations.

- *Discrete mathematics*, 7.5 credits (G1F)* Deepens the knowledge from Basic Mathematics and gives an introduction to graph theory.

Year 2 (Autumn term)

- *Multivariable calculus and vector valculus*, 7.5 credits (G1F)* The course gives an introduction to calculus in several variables and vector calculus, which concerns differential and integral calculus in several variables. Theory and methods are illustrated by examples from applications in physics. The course prepares for further studies in optimization methods, probability and statistics, Fourier methods and complex analysis, ordinary and partial differential equations, and physics.

- *Algebraic structures I*, 7.5 credits (G2F)* The course introduces algebraic structures such as groups, rings and fields as well as proof techniques in algebra.

- *Optimization methods*, 7.5 credits (G2F)* The course treats methods from optimization and operational analysis that are used in computer science, engineering and economy. Real life problems are formulated and modelled so that they can be used by students in their future work. In particular optimization problems relevant for sustainable development and economy of resources are studied. Problem solving with mathematical software is an element of the course. Mathematical modelling and report writing is trained in project assignments.

- *Linear algebra advanced course*, 7.5 credits (G1F)* The course treats among other things vector spaces, function spaces, scalar product, orthogonality, the least squares method, eigenvalues, the spectral theorem, quadratic forms and matrix norms.

Year 2 (Spring term)

- *Fourier methods and complex analysis*, 7.5 credits (G2F)* The course concerns introductory complex analysis, Fourier series, the Laplace transform, the Fourier transform, and their applications. The theory is illustrated by examples from wave propagation and heat propagation. The course is a prerequisite for further studies in analysis, stochastic processes and time series analysis.

- *Mathematics, science and society*, 7.5 credits (G2F)* The course gives basic knowledge of the philosophy of science, mathematical philosophy of science,

ethical problems in mathematics and sustainability. The students are trained in mathematical writing and presentation skills.

- *Ordinary differential equations*, 7.5 credits (G2F)* The course provides theory and methods for solving and analyzing systems of ordinary differential equations and their applications in mathematical modeling of physics, population biology and meteorology. Students deepen their knowledge and skills in analysis and learn theorems about the existence and uniqueness of solutions to ordinary differential equations. Through compulsory project work, students get the opportunity to deepen their knowledge in some area of application.

- *Probaility and statistics*, 7.5 credits (G1F)* The course gives an introduction to probability theory and statistical methods. Problem solving and modeling with random models is studied, and the use of data observations for inference. Theory and methods are illustrated by examples from data analysis, quality technology, economy and operational research. There is an element of visualization and problem solving using mathematical software. In the course there is a project and report writing.

Year 3 (Autumn term)

- *Calculus advanced course*, 7.5 credits (G2F)* The aim of the course is to provide in-depth knowledge in multivariable analysis regarding convergence, differential calculus, integration and vector calculus. The course also introduces some basic concepts in topology and measure theory.

- *Stochastic processes*, 7.5 credits (G1F)* The course provides in-depth knowledge of theoretical concepts and methods in probability theory, especially Markov processes in discrete and continuous time, queueing theory, branching processes, time series and spectral density. Emphasis is placed on the formulation, modeling and simulation of real problems so that the participants can later use the methods in working life. The content is illustrated through examples and problem solving from applications in technology, computer science, population dynamics, and economics. Problem solving and simulation with mathematical software is an element of the course.

- Elective courses, 15 credits

Year 3 (Spring term)

- *Degree project in mathematics at Bachelor level*, 15 credits (G2E)* The purpose of the degree project is for the student to apply their acquired knowledge to the study of a problem in pure or applied mathematics.

- Elective courses, 15 credits.

The timing of the courses with respect to year and study period is subject to possible changes.

*Societal relevance*

All students are offered contacts with mainly the local business community. These contacts consist of study visits, project work, seminars etc. The seminars are mainly of a contact-seeking nature where business problems are in focus but also general issues occur. In addition to contacts with the business community, students also gain insight into mathematical work in the public sector. For some students, contact is made with potential employers within the final degree project, for many this is designed as a bridge to a future professional activity in business or the public sector.

*Internationalization*

Parts of the programme can, after consultation with the programme director, be conducted at foreign universities. This can be done in year two or year three. The programme director decides whether the foreign courses are relevant to the program and can in such a case approve that these replace certain courses in the program.

*Scope of Programme*

Mathematics is particularly suitable for internationalization. Mathematics is an international language.
Sustainability perspectives are included in compulsory courses such as Optimization methods and Mathematics, science and society.
In the mathematics courses, students are trained to make reasonableness assessments of results from calculations and problem solving. In courses in mathematical statistics, students are trained in discovering pitfalls in statistical analysis and evaluating statistical significance in data analysis.
In the course Mathematics, science and society, students get to examine and evaluate ethical aspects of development in technology, data management and artificial intelligence.

## Quality Development

The programme has a programme director who has overall responsibility for the programme and the contact with its students. Students are involved in both programme and course evaluations. The programme director meets regularly with all students and discusses courses and helps to choose elective courses. Compilations of course and programme evaluations are archived by the department.

## Degree

After having completed their studies in accordance with the requirements stated in the Qualification Ordinance of the Higher Education Ordinance and in Linnaeus University’s local qualification ordinance, the student may apply for the award of a qualification. Students who have completed the Applied Mathematics Programme may obtain the following qualification:

Filosofie kandidatexamen
Huvudområde: Matematik

Bachelor of Science in Mathematics
Main field of study: Mathematics

The degree certificate is issued in two languages (Swedish and English) and is accompanied by a diploma supplement in English.

## Other Information

Language:
The program is given in English.

In the event of any discrepancies between the Swedish and the English version of this programme syllabus, the Swedish version shall prevail.