Mathematics Major Plus

Mathematics Major Plus	
Offered by	Department of Mathematics
Language	English
Primarily interesting for	Bachelor Applied Mathematics students
Prerequisites	Required courses: First and second year Applied Mathematics courses
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Content and composition

Within the Applied Mathematics major, choices have to be made between courses in the third year. But maybe you prefer not to choose. Then the Mathematics Major Plus elective package is the choice for you!

In the first quarter of the third year of the bachelor Applied Mathematics, a choice between the courses 2WF70 (Algorithmic algebra and number theory) and 2WO20 (Linear Optimization) has to be made. In the second quarter of the third year, there is a choice between the three courses 2WS40 (Linear Statistical Models), 2WF60 (Graph Theory and Combinatorics) and 2WA80 (Complex Analysis). If you do not want to miss any of these subjects in your curriculum, simply take all five courses: two of them are part of your major program, and the remaining three constitute the coherent elective package Mathematics Major Plus. Also a choice of any two from the remaining three courses is regarded as a coherent elective package (of 10 ECTS).

The coherent elective package Mathematics Major Plus is an advanced package meant for bachelor students with a major in Applied Mathematics. With your choice for the elective package Mathematics Major Plus you should clearly indicate of which courses this package is composed. Obviously, the courses contained in the Mathematics Major Plus elective package cannot be part of your major program anymore.

You should be aware that taking the full elective package of 15 ECTS as well as the major courses during the third year leads to a study load of 20 ECTS in the second quarter. A possible alternative planning would be to take the course 2WF60 already in the second year of the bachelor.

Course code	Course name	Level classification
2WF70	Algorithmic algebra and number theory	3
2WO20	Linear optimization	3
2WS40	Linear statistical models	3
2WA80	Complex analysis	2
2WF60	Graph theory and combinatorics	2

Graph theory and combinatorics is a level 2 course, which means that it can be taken in the second year of the bachelor applied mathematics (the only prerequisites are first year bachelor courses). Also the course Complex analysis is a level 2 course, but it has Analysis 3 (2WA60) as a prerequisite so it not possible to take this course in the second year of the bachelor.

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EINDHOVEN UNIVERSITY OF TECHNOLOGY

Course description

Algorithmic algebra and number theory
The algorithmic algebra part shows how Gröbner bases and an algorithm to compute them are used in several applications of algebra. The algorithmic number theory part treats methods and techniques from number theory that are mainly important in cryptography. Consequently, this course prepares for a master with focus on discrete mathematics and algebra.

Linear optimization
This course treats a key method for solving (discrete) optimization problems. Linear optimization is deciding the values of several unknown quantities, so as to maximize a given linear function of these unknowns, subject to given linear inequalities. There are outstanding algorithms for solving problems of this type. Many real-life problems can be cast as a linear optimization problem and solved as such. On the theoretical side, it is taught how to attain certainty about the optimality of solutions of linear optimization problems. This involves studying linear inequalities, the separation theorem for convex sets, Farkas' lemma, and the duality theorem for linear optimization. We describe the simplex method for solving linear optimization problems, and we prove that it works. Finally, we discuss two extensions of linear optimization: convex optimization and integer linear optimization. On the practical side, you will learn how to model real-world problems as linear optimization problems and to use existing solvers for evaluating the resulting models.

Linear statistical models
In this course we will cover linear statistical models as a direct extension of the models of the course Mathematical Statistics (2WS30) to higher dimensions. You will learn how linear algebra supports statistics in a most efficient and elegant way. In this course we will not only treat in detail theoretical aspects like constructing estimators, confidence intervals and statistical tests but also practical applications. The computer package R is used for analysing data with the help of linear models (both for homework assignments and a modelling assignment with a practical data set).

Complex analysis
The theory of complex functions is a very rich and classical part of applied analysis with important applications in many areas of physics and geometry. Considered will be: holomorphic (analytic) functions, curve integrals, theorems of Cauchy and Liouville, Taylor and Laurent series, complex logarithm, residue calculus and its applications, Fourier and Laplace transformation and their applications. For students interested in mathematical physics, spectral theory, control theory, differential geometry or random matrix theory, this course is crucial.

Graph theory and combinatorics
In the combinatorics part subjects include counting problems, generating functions, recurrence relations and analysis of sorting algorithms. In the graph theory part, first structural properties of graphs are studied, and then several (algorithmic) graph problems are considered, such as Euler tour, Hamilton circuit, graph coloring, graph search, the shortest path problem, the minimum spanning tree problem, the maximum flow problem, and the maximum (weight) bipartite matching problem. There is also some attention for (computer) representations of graphs and for competitive analysis of graph algorithms.