Mathematics major plus

Offered by: Mathematics
Language: Dutch or English
Primarily interesting for: Bachelor Applied Mathematics
Prerequisites: First and second year Applied Mathematics
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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 2WAF0 (Functional 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.

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<td>2WF70</td>
<td>Algorithmic algebra and number theory</td>
<td>Q1, E</td>
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<td>2WO20</td>
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<td>2WF60</td>
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Course descriptions

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 algorithms that are important for solving discrete optimization problems. Topics include linear inequalities, the separation theorem for convex sets, Farkas’ lemma, and the duality theorem for linear optimization. Polyhedra and polytopes are treated, as well as the simplex method for linear programming, convex functions and positive definite matrices, Diophantine linear equations, integer programming and the branch-and-bound algorithm. The computer package AIMMS is used in practical assignments.

**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).

**Functional analysis**
Functional analysis is the name for a group of abstract techniques for the concrete analysis of differential and integral equations. By viewing function spaces as scaled linear spaces, many existence and uniqueness results can be directly derived from abstract theorems.

**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.

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). The other courses in this elective package are level 3 courses.