

Syllabus
AQM1142E Mathematical Optimization
Prof. Dr. Thilo Klein
Summer Semester 2024

Level	Bachelor	
Credits	3	
Student Contact Hours	2	
Workload	90 hours, thereof 22,5 for lectures, 6 hours for exercises and 61,5 hours for preparation and review	
Prerequisites	AQM1043E Analysis and Linear Algebra	
Time	Fridays, 12:00 – 13:30	
Room	W2.3.01	
Start Date	22.03.2024	
Lecturer	Name	Prof. Dr. Thilo Klein
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Summary

The course covers basic methods for Mathematical Optimization from Operations Research and applications to practical questions from business administration and practice. In this course, students learn to abstract problems from real contexts, translate them into mathematical models and solve them with appropriate procedures and algorithms.

This includes, in particular, the mastery of linear programming, formulation of tasks, algorithmic solving using algorithms such as Dantzig's Simplex and the interpretation of the most important quantities, including duality. Course participants also know the most important types of assignment problems and algorithms (serial dictatorship; top-trading-cycles) and understand the game-theoretic properties of matching algorithms (Gale-Shapley deferred acceptance and immediate acceptance algorithm), including strategy-proofness, stability and efficiency.

Outline of the Course

- Linear Programming
 - Formulation of an LP
 - Graphical interpretation and solution
 - Simple algorithm (primal, dual)
 - Duality
 - Software (Interpretation of solution reports)
- Network problems
 - Graphs
 - Transportation problems
 - Assignment problems
- Project networks (Project management)
 - Activity lists
 - Time scheduling
 - Capacity and cost planning

Course Intended Learning Outcomes and their Contribution to Program Intended Learning Outcomes / Program Goals

Program Intended Learning Outcomes	Course Intended Learning Outcomes	Assessment Method
After completion of the program the students will be able...	After completion of the course the students will be able...	Written Exam
		100%
		Individual
1 Expert Knowledge		
1.4 ...to solve business problems based on profound data research skills and by applying quantitative methods.	... to apply the algorithms, learned in the course, to business administration problems and to implement the necessary linear algebra and mathematical basics.	X
2 Digital Skills		
2.1 ...to know and understand relevant IT software tools used in business and their features and have a solid understanding of digital technologies.	... to apply, understand and interpret basic algorithms with common optimization software. The focus is also on learning the basic syntax.	X
3 Critical Thinking and Analytical Competence		
3.1 ...to implement adequate methods in a competent manner and to apply them to complex problems.	... to accompany quantitative decisions in companies and to participate in decision support.	X
4 Ethical Awareness		
5 Communication and Collaboration Skills		
5.1 ...to express complex issues effectively in writing.	... to describe the operational problems in exact mathematical notation and to verbalize them in the exam depending on the context.	X
6 Internationalization		

Teaching and Learning Approach

The lecture is given to students from different study programs. To prepare for the exam and to get familiar with the provided content, exercise sheets will be additionally provided during the semester. Details will be provided in the lecture. "Mathematical Optimization" is a classical lecture with the idea of the methods, the methods itself and applications of the methods. The content of the lecture is built upon the previous lecture "Analysis and Linear Algebra".

Due to the quantity and details of the topics discussed in the lecture, it is strongly recommended to keep track of the lecture by working through the hand-outs / slides and the corresponding chapters in the books during the term. The primary approach to the course will be analytical/logical. It is important to understand why and how the methods are used rather than just being able to get the correct answer.

Some mathematics, however, will be necessary to understand course content. Students are expected to attend all classes, arriving on time and staying until dismissed. You are also expected to participate actively in all class discussions and activities. It is very important that students ask and answer questions during the class. This will greatly help to understand the material better. The spoken word of the lecturer prevails.

Literature and Course Materials

Hillier, F. and G. Liebermann (2014): Introduction to Operations Research, McGraw-Hill, New York.

Nickel, S., O. Stein and K. Waldmann (2014): Operations Research, Springer Gabler, Heidelberg.

Lecture slides and exercise sheets for the tutorials are provided in Moodle.

Assessment

For the course, participants have to pass a written exam (60 minutes). For the exam, the following scheme of grades will be applied: 'very good' corresponds to an outstanding performance which is clearly above the average. 'good' corresponds to good performance being above the average. 'satisfactory' corresponds to an average performance with some deficits. 'sufficient' corresponds to a performance below the average with clearly deficits. 'insufficient' corresponds to performance clearly below the average with deficits being not acceptable.

Additional Information

A total of five exercises are offered in this course. The dates for the exercises will be visible in the LSF. Participation in the exercises is voluntary and cannot replace attending the lecture or a detailed study of the literature, but it does facilitate efficient self-study. Sample solutions to the exercise sheets are not provided. The students are advised to work through all the tasks on the exercise sheets before the exercise in order to be able to ask specific questions.