Faculty of Science

MATC61, Mathematics: Optimization, 7.5 credits

Matematik: Optimering, 7,5 högskolepoäng

First Cycle / Grundnivå

Details of approval

The syllabus was approved by Study programmes board, Faculty of Science on 2021-05-28 and was last revised on 2021-08-31. The revised syllabus applies from 2021-08-31, autumn semester 2021.

General Information

The course is an elective course at upper basic level for a Bachelor or Master of Science degree in mathematics.

Language of instruction: English

Main field of studies	*Depth of study relative to the degree requirements*
Mathematics	G2F, First cycle, has at least 60 credits in first-cycle course/s as entry requirements

Learning outcomes

The overall purpose of the course is that the students after completing the course should have acquired knowledge of basic optimization theory and have an overview of the most important methods and their practical use.

Knowledge and understanding

On completion of the course, the student should be able to:

- describe the optimization algorithms, for problems with and without constraints, encountered in the course, and their properties,
- give an account of the theory of convex sets and convex functions, and be able to state and derive the most important theorems on convexity,
- make use of convexity in the treatment of an optimization problem,
- explain how the duality theory can be used in the treatment of an optimization problem,

- give an account of Karush-Kuhn-Tucker theory and be able to state and derive the most important theorems therein.

Competence and skills

On completion of the course, the student should be able to:

- solve optimization problems within the framework of the course,
- handle optimization problems using a computer,
- derive simple results not previously encountered in the course, in the context of problem solving,
- describe the connections between different concepts in the course, with proper terminology and in a well structured and logically consistent manner,
- with proper terminology, suitable notation, in a well structured way and with clear logic describe the solution to a mathematical problem and the theory within the framework of the course.

Judgement and approach

On completion of the course, the student should be able to:

- give arguments for and explain why convex optimization problems have better properties than others.

Course content

The course treats:

- Quadratic forms and matrix factorisation
- Convexity
- Separating planes and Farkas' Lemma
- The theory of optimization with and without constraints: Lagrange functions, Karush-Kuhn-Tucker theory
- Duality
- Introduction to methods for optimization without constraints: line search, steepest descent, Newton methods, conjugate directions, non-linear least squares optimization
- The Nelder-Mead search algorithm without derivatives
- Introduction to methods with constraints: linear optimization, quadratic programming, penalty and barrier methods

Course design

The teaching consists of lectures, seminars, exercises, computer exercises and a programming assignment that should be completed during the course. The programming assignment consists of a couple of given optimization problems that the student must solve by writing a computer program. The student must present and evaluate the results in a written report. Participation in computer exercises and programming assignment and thereby integrated teaching is compulsory.

Assessment

The examination takes place in the form of a written exam covering theory and problems at the end of the course, two compulsory computer exercises during the course and a programming assignment with an appurtenant written report.

For students who have not passed the ordinary written examination, an additional examination opportunity is offered during the scheduled re-examination period.

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 grading scale for the computer exercises and the programming assignment is Fail, Pass.

The grading scale for the written examination includes the grades Fail, Pass, Pass with Distinction. For the grade Pass with Distinction on the written examination, at least 75% of the total number of points is required.

For the grade Pass on the entire course, passed computer exercises, passed written examination and passed written report of the programming assignment are required. The final grade is determined by the grade on the written exam.

Entry requirements

For admission to the course, at least 60 credits in mathematics and numerical analysis are required, including the courses MATB22 Linear algebra 2, 7.5 credits, MATB21 Multivariable analysis 1, 7.5 credits, NUMA01 Computational Programming with Python, 7.5 credits, or equivalent.

Further information

The course cannot be included in a degree together with MATC51 Optimization 7.5 credits. The course is given jointly with the course FMA061 Optimization, 7.5 credits, at the Faculty of Engineering, and can not be part of a degree together with this course. The examination of the course is scheduled in accordance with the examination schedule at the Faculty of Engineering.

Subcourses in MATC61, Mathematics: Optimization

Applies from H21

2104 Optimization, written examination, 6,0 hp
Grading scale: Fail, Pass, Pass with distinction
2105 Computer Exercises, 0,0 hp
Grading scale: Fail, Pass
2106 Programming Assignment, 1,5 hp
Grading scale: Fail, Pass