Subject card

<table>
<tr><td>Subject name and code</td><td colspan="6">Mathematical Optimization and Applications, PG_00209690</td></tr>
<tr><td>Field of study</td><td colspan="6">Mathematics</td></tr>
<tr><td>Date of commencement of studies</td><td colspan="2">October 2026</td><td colspan="2">Academic year of realisation of subject</td><td colspan="2">2026/2027</td></tr>
<tr><td>Education level</td><td colspan="2">Master’s studies</td><td colspan="2">Subject group</td><td colspan="2">Obligatory subject group in the field of study
Optional subject group</td></tr>
<tr><td>Mode of study</td><td colspan="2">full-time studies</td><td colspan="2">Mode of delivery</td><td colspan="2">at the university</td></tr>
<tr><td>Year of study</td><td colspan="2">1</td><td colspan="2">Language of instruction</td><td colspan="2">English</td></tr>
<tr><td>Semester of study</td><td colspan="2">1</td><td colspan="2">ECTS credits</td><td colspan="2">5.0</td></tr>
<tr><td>Learning profile</td><td colspan="2">academic</td><td colspan="2">Assessment form</td><td colspan="2">credit</td></tr>
<tr><td>Conducting unit</td><td colspan="6"></td></tr>
<tr><td rowspan="2">Name and surname of lecturer (lecturers)</td><td colspan="2">Subject supervisor</td><td colspan="4">dr Felix Huber</td></tr>
<tr><td colspan="2">Teachers</td><td colspan="4"></td></tr>
<tr><td rowspan="3">Lesson types</td><td>Lesson type</td><td>Lecture</td><td>Tutorial</td><td>Laboratory</td><td>Project</td><td>Seminar</td><td>SUM</td></tr>
<tr><td>Number of study hours</td><td>30.0</td><td>30.0</td><td>0.0</td><td>0.0</td><td>0.0</td><td>60</td></tr>
<tr><td colspan="7">E-learning hours included: 0.0</td></tr>
<tr><td rowspan="2">Learning activity and number of study hours</td><td>Learning activity</td><td colspan="2">Participation in didactic classes included in study plan</td><td colspan="2">Participation in consultation hours</td><td>Self-study</td><td>SUM</td></tr>
<tr><td>Number of study hours</td><td colspan="2">60</td><td colspan="2">3.0</td><td>62.0</td><td>125</td></tr>
<tr><td>Subject objectives</td><td colspan="7">The aims of the course is to get an understanding of mathematical optimization. In particular so that the student knows the theory of convex optimization methods such as linear, quadratic, and semidefinite programming as well as their applications in theory and practise. The aim is also that the student will be confident in using numerical software packages.</td></tr>
<tr><td rowspan="3">Learning outcomes</td><td colspan="2">Course outcome</td><td colspan="3">Subject outcome</td><td colspan="2">Method of verification</td></tr>
<tr><td colspan="2">[MATMU2_W01] knows and understands in depth the theory of selected areas of mathematics or related fields, the complex relationships between them and their development trends</td><td colspan="3">Knows theory and applications of linear, quadratic, and semidefinite programming.</td><td colspan="2">[SW4] test/exam - oral or written</td></tr>
<tr><td colspan="2">[MATMU2_U05] is able to apply new or adapt existing methods and tools from a selected field of mathematics and information and communication technologies in related fields</td><td colspan="3">Knows how to use modern solvers, how to apply linear, quadratic, and semidefinite programming</td><td colspan="2">[SU5] implementation of a problem task</td></tr>
<tr><td>Subject contents</td><td colspan="7">1 Review of linear algebra (matrix decompositions, positive semidefinite matrices, convex geometry) 2 Linear programming (duality theory, Farkas lemma, maximum weight matching) 3 Second-order cone programming 4 Semidefinite Programming (infeasibility certificates, duality theory, Lovasz theta bound on independent set size, euclidean distance matrices) 5 Approximation algorithms and randomized rounding (quadratic binary optimization, Goeman-Williamson randomized rounding) 6 Non-negative polynomials and sum-of-square certificates (Motzkin Polynomial, Putinar Positivstellensatz) 7 Polynomial optimization (Lasserre hierarchy)</td></tr>
<tr><td>Prerequisites and co-requisites</td><td colspan="7"></td></tr>
<tr><td rowspan="3">Assessment methods and criteria</td><td colspan="2">Subject passing criteria</td><td colspan="3">Passing threshold</td><td colspan="2">Percentage of the final grade</td></tr>
<tr><td colspan="2">Working in classes</td><td colspan="3">51.0%</td><td colspan="2">20.0%</td></tr>
<tr><td colspan="2">Written or verbal exam</td><td colspan="3">51.0%</td><td colspan="2">80.0%</td></tr>
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Recommended reading	Basic literature	Lecture notes by Lovász, https://sites.math.washington.edu/~thomas/teaching/m514_web/Lovasz_semidef.pdf Blekherman et al, Semidefinite Optimization and convex algebraic geometry, https://www.mit.edu/~parrilo/sdocag/
	Supplementary literature	None.
	eResources addresses	
Example issues/ example questions/ tasks being completed	What is a Gram matrix? What is the Löwner order? Define convex cone, convex hull, dual cone, self-dual cone. Give examples of self-dual cones. Explain Farkas Lemma and its use. What is an approximation ratio? How is the Lovasz theta number defined as an SDP? Define indepedence number, chromatic number. What are their computational complexities? How does the Goeman-Williamon algorithm work? What is its approximation ratio? Formulate the primal and dual standard formulations of semidefinite programs. What are the problem parameters? Show weak duality.	
Work placement	Not applicable	