

Teacher(s)	Glineur François ;Nunes Grapiglia Geovani ;
Language :	English > French-friendly
Place of the course	Louvain-la-Neuve
Prerequisites	A basic optimization course (such as LINMA1702) and basic knowledge in real analysis and linear algebra (such as provided by LEPL1101 and LEPL1102)
Main themes	Linear optimization, convex optimization (including structured conic optimization) ; duality and applications ; interior-point methods ; first-order methods ; trust-region methods ; use of a modeling language.
Learning outcomes	At the end of this learning unit, the student is able to : Learning outcomes: • AA1.1, AA1.2, AA1.3 • AA2.1, AA2.2, AA2.4, AA2.5 • AA5.3, AA5.5 More specifically, at the end of the course the student will be able to : • recognize the possibility of formulating or converting a problem into a linear, convex or conic optimization program; • exploit the concept of duality in order to understand a problem, produce optimality or impossibility certificates, carry out sensitivity analysis or formulate robust problems; • describe, analyze and implement advanced algorithms to solve linear, convex or non-linear optimization problems; • use a modeling language to formulate and solve optimization problems, while understanding and exploiting the formal separation between model, data and resolution algorithm. Transversal learning outcomes : • Use a numerical/computational software tool such as MATLAB, or a modeling language such as AMPL. • Formulate, analyze and solve optimization models, in a small group. • Write a report about the formulation, analysis and resolution of optimization models, in a small group.
Evaluation methods	Students are assessed individually with a written exam organized during the session, based on the learning outcomes listed above. In addition, students complete one or several homework assignments, alone or in small groups, during the first term. Homework assignments are assessed through the submission of a written report and all codes used, as well as through an individual written examination. The final grade for each session is awarded on the basis of the homework assignments (6 points out of 20) and the exam (14 points out of 20). The grade of the homework is acquired for all the sessions of the academic year (it is not possible to redo the homework assignments in the second session). In the event of a technical problem or suspected irregularity, an additional oral examination may be requested in addition to an assessment. All external sources of information used in the writing of assignments must be cited in accordance with bibliographic referencing standards. The use of generative artificial intelligence is allowed according to the EPL guidelines, in particular with regard to transparency. Authors remain responsible for the content of their work.
Teaching methods	The course is comprised of lectures, exercise sessions and computer labs, as well as a series of homework assignments to be carried out in small groups.
Content	Models: Advanced modeling techniques for linear and convex optimization ; structured conic optimization ; convex duality with applications (alternatives, sensitivity analysis and robust optimization) ; Lagrangian duality Methods: path-following interior-point methods for convex optimization (self-concordant barriers) ; first-order methods for convex and non-convex optimization (including stochastic methods) ; algorithmic complexity and convergence rates ; introduction to the AMPL modeling language. Applications in various domains, such as data analysis, machine learning, finance, shape or structural optimization (mechanics), telecommunications, etc.
Inline resources	https://moodle.uclouvain.be/course/view.php?id=1415

Bibliography	• <i>Convex Optimization</i> , Stephen Boyd et Lieven Vandenberghe, Cambridge University Press, 2004. • <i>Lectures on Modern Convex Optimization: Analysis, Algorithms, and Engineering Applications</i> , Aharon Ben-Tal, Arkadi Nemirovski, SIAM 2001. • <i>Interior point methods for linear optimization</i> , Cornelis Roos, Tamas Terlaky, Jean-Philippe Vial, Springer, 2006. • <i>Introductory Lectures on Convex Optimization: A Basic Course</i> , Yurii Nesterov, Kluwer, 2004. • <i>Lectures on Convex Optimization</i> , Y. Nesterov, Springer, 2018
Faculty or entity in charge	MAP

Programmes containing this learning unit (UE)				
Program title	Acronym	Credits	Prerequisite	Learning outcomes
Master [120] in Biomedical Engineering	GBIO2M	5		
Master [120] in Mathematics	MATH2M	5		
Master [120] in Computer Science and Engineering	INFO2M	5		
Master [120] in Computer Science	SINF2M	5		
Master [120] in Mathematical Engineering	MAP2M	5		
Master [120] in Data Science Engineering	DATE2M	5		
Master [120] in Data Science: Information Technology	DATI2M	5		