# Static and dynamic optimization

## Proff. Monica Bianchi, Andrea Calogero, Enrico Miglierina

***COURSE AIMS AND INTENDED LEARNING OUTCOMES***

The aim of the course is to give the basic mathematical tools to deal with the optimization problems that often arise from economic applications.

At the end of the course students should:

1. have acquired the knowledge and understanding of the main parts of the program and be able to apply the mathematical methods and techniques described in the program in order to solve problems and exercises.;
2. be able to translate problems deriving from concrete and real situations into mathematical models that are suitable to be faced and studied by means of the mathematical methods presented during the course;
3. have learned a rigorous and essential language that allows them to communicate the knowledge clearly and effectively;
4. be able to recognize links between the topics developed in the course and other issues addressed in the context of their study plan.

***COURSE CONTENT***

The course is divided into three parts: the first two parts will be in the first semester whereas the third one will be in the second semester:

*First part (Monica Bianchi – 20 hours – first semester)*. Static Optimization for real valued functions.

Introduction to a mathematical programming problem. Some references to unconstrained optimization. Convex function and optimization. Separation theorems. Constrained optimization (with equality and inequality constraints). Convex programming and sensitivity analysis.

*Second part (Enrico Miglierina – 20 hours – first semester).* Multiobjective optimization.

Introduction to the simultaneous optimization of more than one function. Some examples (location problem, mean-variance approach in portfolio selection, welfare theorems). Partially ordered vector spaces (cones and orders). Solutions of a vector optimization problem. Scalarization.

*Third part (Andrea Calogero – 20 hours – second semester).* Dynamic Optimization.

Some introductive problems. Statement of an optimal control problem. The simplest problem by variational approach: optimality conditions. Singular controls and bang-bang controls. More general optimal control problems: optimality conditions. Existence problems. Minimum time problems and infinite horizon problems.

***READING LIST***

The following texts are recommended and useful for further readings. The teachers will give detailed instructions about their use during lectures

**First Part**

O. Güler, *Foundations of Optimization,* Springer 2010

M. S. Bazaraa , H. D. Sherali , C. M. Shetty, *Nonlinear Programming,* John Wiley & Sons, 1993

L. Berkovitz, *Convexity and Optimization in Rn,* John Wiley & Sons, 2002

**Second Part**

M. Ehrgott, *Multicriteria Optimization,* Springer 2005

J. Jahn, *Vector Optimization,* Springer, 2011

**Third part**

A. Calogero, *Notes on Optimal Control Theory,* disponibile in rete.

L.C. Evans, *An Introduction to Mathematical Optimal Control Theory,* available on the web.

***TEACHING METHOD***

Classroom lectures or by means of e-learning tools (depending on the evolution of the health emergency)

***ASSESMENT METHOD AND CRITERIA***

Written exam concerning both theoretical and practical questions During the course will be possible to attend partial tests concerning the parts of the program. Each of them will contribute equally to the determination of the final mark.

For all three parts of the course, the effective achievement of the expected learning outcomes will be verified taking into account the following evaluation parameters: (i) understanding of the nature of the mathematical problem and ability to solve it; (ii) rigorous, clear and unambiguous exposition.

***NOTES AND PREREQUISITES***

***Prerequisites***

The student is assumed to know differential calculus in Rn, some basic notions of linear algebra and the Lebesgue integration.

Annoucements and additional material will be available on Blackboard

***Office hours:*** by appointment by contacting the teachers via e-mail:

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*Further information can be found on the lecturer's webpage at http://docenti.unicatt.it/web/searchByName.do?language=ENG or on the Faculty notice board.*