Academic subject:

Degree Class: LM-40 (Mathematics)		**Degree Course:** Mathematics	**Academic Year:** 2018/2019
		Kind of class: (inserire mandatory o optional) optional	**Year:** second / **Period:** second semester
			ECTS: 7 divided into **ECTS lessons: 6.5** **ECTS exe/lab/tutor: 0.5**

Time management, hours, in–class study hours, out–of–class study hours

lesson: 52 exe/lab/tutor: 8 in–class study: 60 out–of–class study:113

Language: Italian	**Compulsory Attendance:** no		
Subject Teacher: Nicoletta Del Buono	**Tel:** +39 0805442711 **e–mail:** nicoletta.delbuono@uniba.it	**Office:** Department of Mathematics Room 24, Floor Second	**Office days and hours:** Tuesday 10:00-11:00 a.m. Other days: on appointment

Prerequisites:
General knowledges related to first degree in Mathematics (L-35 Mathematics) with particular emphasis to Numerical Methods and Multivariable Mathematical Analysis

Educational objectives:
Acquisition of basic numerical techniques for treating optimization problems involving nonlinear multivariate functions and for solving linear programming problems

Expected learning outcomes (according to Dublin Descriptors)

Knowledge and understanding:
Acquiring the main techniques for treating continuous-optimization problems.
Ability to design efficient numerical codes implementing standard optimization techniques

Applying knowledge and understanding:
Theoretical and practical knowledge acquired would be used on applied mathematical fields and for solving real problems.

Making judgements:
Ability to identify the right numerical techniques which are able to address and solve numerically optimization problems arising in real-life applications.

Communication:
Acquiring the advanced mathematical language and formalism required for the consultation and comprehension of technical texts, exposing the acquired knowledge, describing, analyzing and solving problems in real applications.

Lifelong learning skills:
Learning an appropriate studying methodology, supported by text consultation and implementation of the techniques proposed during the course.

Course program

- Classification of optimization problems. Examples: Steiner problem. Portfolio optimization. A production problem.
- Nonlinear programming: possible directions, I and II order conditions for local minimum, Convex differentiable functions, their characterizations and sufficient conditions for minimum points. Unimodal functions of R in R: Method of bisections, method of golden section, parabolic interpolation, Newton method, secant method.
- Descent Methods: exact line search, inexact line search methods: rule of Armijo and Wolfe conditions. Steepest descent method applied to the case of quadratic function. Convergence theorems of steepest descent method. Newton's method in several variables, theorems of convergence in the quadratic case. Trust region methods.

- Conjugate directions method for quadratic functions their properties.
- Quasi-Newton methods, convergence for quadratic functions, modified Newton method, construction of the inverse Hessian. Correction of rank one method. Davidon-Fletcher-Powell (DFP) and BFGS method. Convergence in a finite number of steps and preservation of defined positive, "scaling" to reduce the ill-conditioning, notes on the family Broyden methods.
- Constrained optimization: theoretical conditions and KKT conditions. Penalty and barrier methods for constrained problems, convergence theorems, exact penalty functions. Introduction to the method of gradient projection.
- Linear programming: definition of a PL in general, canonical and standard forms, Equivalence of these definitions, basic solutions and associated definitions, Matrices E_{rs} and related pivot operation, Simplex method and related entries (test optimality, etc.). Simplex Lemmas Degeneration, method of the two phases, geometric interpretation of a PL by means of convex sets, revised simplex algorithm, updating of the base by means of the LU factorization, Dual simplex method, method of Gomory problems for PL to variables totally and partially whole, definition of the problem dual of a PL, weak and strong duality theorem, existence theorem of solutions, waste and complementary applications.

Teaching methods:
Lectures session and exercises in computer lab

Auxiliary teaching:
Notes available at the web page http://www.dm.uniba.it/~delbuono

Assessment methods:
Oral examination

Bibliography:
D.G.LUENBERGER, " Linear and nonlinear Programming" (Second Edition)
J. NOCEDAL-S.J. WRIGHT, " Numerical Optimization", Springer
V. DE ANGELIS, "Metodi Matematici di Ottimizzazione", La Goliardica