Course Title: Operational Research	**Number of Units:** 1
SSD: MAT09	**CFU:** 6

Course aims: The main objective of the course is the introduction of the students to the use of mathematical programming models and in particular to both linear and nonlinear optimization models (with both continuous and integer variables) and their applications in real world fields, including control, communications, logistics, services, and industrial production.
As concerns nonlinear programming models, the course aims at providing a comprehensive and rigorous treatment of classical topics, such as descent algorithms, Lagrange multiplier theory, and duality. In addition, some of the more sophisticated methods are also covered, such as interior point methods, penalty and barrier methods, least squares problems, and conditional gradient and subgradient optimization.

Course Description: **I**ntroduction to Operational Research and Optimization.Linear Programming (LP)**:** Introduction to LP and form of a LP problem; Geometry of continuous LP; The Simplex Method. Integer Linear Programming (ILP): Introduction to ILP; Linear Programming Relaxation; Special ILP problems with unimodular constraints matrix: the Transportation Problem, the Assignment Problem; Solution methods: Exact Methods: Branch & Bound; Cutting Planes, Dynamic Programming; Approximation Methods; Heuristic and Metaheuristic Methods; The 0/1 Knapsack Problem and the Fractional Knapsack Problem.Network flows and graph problems: The Minimum Vertex Cover Problem; The Minimum Spanning Tree Problem; Shortest Path Problems; Project Scheduling Problems: Critical Path Method (CPM); Path Evaluation and Review Technique (PERT); Post-optimization analysis.Nonlinear Optimization: Unconstraint Nonlinear Optimization: Optimality conditions; Gradient Methods: Convergence, Descent Directions and Stepsize Rules; Newton’s Method and Variations;Least Squares Problems: the Gauss-Newton Method, Incremental Gradient Methods; Coniugate Direction Methods; Quasi-Newton Methods; Nonderivative Methods. Optimization over a Convex Set; Lagrange Multiplier Theory; Lagrange Multipier Algorithms.

Assumed Background: Linear algebra: matrices, vectors, determinants, systems of linear equations. Vector analysis, eigenvalues and eigenvectors, quadratic forms and differential equations. Elements of convex analysis and optimality conditions.

Assessment methods: Written Test and Oral Exam