Code	MAT/09
Matter	Operations research
Main language of instruction	Italian
Head instructor	Valerio Marchisio
Introduction	The Operations Research course deepens into some of the topics studied in previous courses, such as calculus, analysing mathematical optimization in various contexts. In particular, case studies, real events of historical importance are considered in order to highlight how the development of this discipline is linked to the need to solve real problems in industrial and productive frameworks. The course also presents some techniques with Excel.
Objectives	The Operations Research course has the following educational objectives: • Understand how to formulate real problems in mathematical terms. • Acquire the theoretical and resolution bases of linear programming problems. • Understand the resolution techniques using the simplex method. • Acquire the basis for resolution in Excel. • Acquire the basic notions of graphs and optimization problems on graphs.
Competencies	*Knowledge and understanding* At the end of the course, the students must demonstrate to understand optimization problems and to be able to formulate the problem in mathematical terms. Furthermore, in solving optimization problems, the students must identify the applicable or most suitable technique, also in computational terms. Finally, the ability to use Excel in order to solve linear programming problems will be required. *Ability to apply knowledge and understanding* In general, the course and the knowledge learned are the basis of many optimization applications in different fields, from business production to finance, from management to application. Furthermore, the tools learned during the course may be of support in other courses and useful in working and professional life. *Communication skills* The students will be able to understand, describe in real and mathematical terms optimization problemas, starting from historical examples to case studies. The students will learn the specific terminologies in the field of operations research and the ability to describe the variables of each specific problem. *Learning ability* At the end of the course, the students will have the opportunity to use the topics studied to learn and understand the notions and concepts of the future courses, in particular in the field of optimization.
Syllabus	Introduction (Module 1) – (12 hours of study load - week 1). Introduction to operations research, general models and classical examples. Linear programming (Module 2) – (35 hours of study load – weeks 1-3). Definition and formulation of linear programming problems and examples. Objective function, choice variables, feasible region. Elementary problems and solution techniques in dimension 2. Non-elementary problems. Fundamental theorem of linear programming and related theoretical results. The simplex method (Module 3) – (32 hours of study load - weeks 3-5). Definition of the simplex algorithm and comparison with other techniques. The method for standard maximization and minimization problems with analysis of the different approach. Duality (Module 4) – (21 hours of study load - weeks 5-7). Definition and formulation of the dual problem. Duality theorems, relationship between choice variables and artificial variables between primal and dual problem. Interpretation of duality and sensitivity analysis.

	Excel solution (Module 5) – (14 hours of study load - week 8). Basic use of Excel. Use of the solver to solve linear programming problems. Sensitivity analysis as a tool integrated into Excel. Integer linear programming (Module 6) – (22 hours of study load - weeks 9-10. Definition and formulation of integer linear programming problems and examples. Different solution approaches. The branch and bound method and its application to some classical problems. Graphs (Module 7) – (24 hours of study load - weeks 11-12). Definitions and properties of graphs. Representations and notations. Flows and overview of optimization problems on graphs.
Evaluation system and criteria	The exam consists of a written test aimed at ascertaining the ability to understand, analyze and rework the concepts acquired or of an oral exam. The written test may include both open-ended and closed-ended exercises on the main topics of the course. The e-tivities do not contribute to the exam grade, but are a useful tool for verifying theown preparation.
Prerequisites	Calculus II, Geometry
Materials to consult	Lectures notes of the course Operations Research: Applications and Algorithms (2004), W. L. Winston