Course guide
205115 - 205115 - Combinatorial Optimisation in Logistics

Last modified: 19/06/2026

Unit in charge: Terrassa School of Industrial, Aerospace and Audiovisual Engineering
Teaching unit: 715 - EIO - Department of Statistics and Operations Research.
732 - OE - Department of Management.

Degree: MASTER'S DEGREE IN TECHNOLOGY AND ENGINEERING MANAGEMENT (Syllabus 2016). (Optional subject).

Academic year: 2026 **ECTS Credits:** 7.5 **Languages:** English

LECTURER

Coordinating lecturer: Maria Albareda Sambola

Others: José María Sallán Leyes

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
CE03-MEM. The ability to optimise problems and systems using mathematical models and make decisions in conditions of uncertainty.
CE05-MEM. The ability to analyse the need for physical and financial resources in process and project management in technological settings.
CE06-MEM. The ability to optimally assign physical and financial resources in process and project management in technological settings.

Transversal:
CT1a. ENTREPRENEURSHIP AND INNOVATION: Being aware of and understanding how companies are organised and the principles that govern their activity, and being able to understand employment regulations and the relationships between planning, industrial and commercial strategies, quality and profit.

CT2. SUSTAINABILITY AND SOCIAL COMMITMENT: Being aware of and understanding the complexity of the economic and social phenomena typical of a welfare society, and being able to relate social welfare to globalisation and sustainability and to use technique, technology, economics and sustainability in a balanced and compatible manner.

CT3. TEAMWORK: Being able to work in an interdisciplinary team, whether as a member or as a leader, with the aim of contributing to projects pragmatically and responsibly and making commitments in view of the resources that are available.

Basic:
CB6. Knowledge and understanding that provides a basis or opportunity for originality in the development and/or application of ideas, often in a research context.
CB7. METMF_The ability to apply the knowledge and problem-solving skills acquired in new or unfamiliar environments within wider (or multidisciplinary) contexts related to the area of study.
CB8. METMF_The ability to integrate knowledge and deal with the complexity of making judgements on the basis of information that, albeit incomplete or limited, includes thoughts on the role played by social and ethical responsibility in the application of knowledge and judgement.
CB9. METMF_The ability to communicate conclusions, and the knowledge and reasons that ultimately sustain these conclusions, to specialised and lay audiences in a clear and unambiguous way.
CB10-METP. Learning abilities that will enable students to keep studying in a largely self-directed or independent manner.

TEACHING METHODOLOGY

Lecture: Lecturers present concepts, principles and techniques, with the active participation of students.
Problem Based Learning: Lecturers and students resolve exercises and standard problems through specific techniques related to the theoretical contents and principles of the course.
Project Based learning: Students resolve complex problems through specific techniques related to the theoretical contents and principles of the course.
Self-study: Students diagnose their learning needs, in collaboration with the lecturers, and plan their own learning process.

LEARNING OBJECTIVES OF THE SUBJECT

The goal of this course is to introduce the main techniques used for solving combinatorial optimization problems that arise in logistics. These problems usually consist of making restricted choices from discrete sets with the goal of minimizing the associated total cost. The course includes integer programming formulations, finding upper bounds through heuristics and finding lower bounds to assess the quality of solutions. Prospective students can take advantage of the linear programming module of Tools for Decision Making to follow this course.

STUDY LOAD

Type	Hours	Percentage
Hours large group	30,0	16.00
Hours medium group	30,0	16.00
Self study	127,5	68.00

Total learning time: 187.5 h

CONTENTS

Module 1: Problems and formulations

Description:
This module has two main goals. The first one is to identify classical combinatorial optimization problems within realistic situations. The second one is to develop good skills in developing mathematical programming formulations, and get some insight in what characteristics distinguish a good formulation form a correct one. Special emphasis will be put in network flow problems and their special properties.

Related activities:
Deliverable individual tasks
Group project (First part)
Final exam

Full-or-part-time: 80h 30m
Theory classes: 15h
Practical classes: 15h
Self study : 50h 30m

Module 2: Upper bounds: heuristics

Description:
The goal of this module is to overview different techniques that allow identifying good solutions in reasonable times, in situations where exact methods based on mathematical programming are not affordable, because of the instance size or the problem complexity. In particular, the course covers some heuristics designed ad-hoc for specific combinatorial optimization problems, as well as general metaheuristics that need to be adapted for each particular problem.

Related activities:
Deliverable individual tasks
Group project (Second part)
Final exam

Full-or-part-time: 54h
Theory classes: 7h
Practical classes: 8h
Self study : 39h

Module 3: Lower bounding techniques

Description:
The use of lower bounds is crucial both, to speed up exact solution methods and to assess the quality of heuristic solutions. This module covers different methods for obtaining such bounds, ranging from combinatorial lower bounds, which are specifically designed for some classical combinatorial optimization problems, to general methods such as linear or Lagrangean relaxations.

Related activities:
Deliverable individual tasks
Group project (Third part)
Final exam

Full-or-part-time: 53h
Theory classes: 8h
Practical classes: 7h
Self study : 38h

GRADING SYSTEM

Any academic fraud, plagiarism or use or possession of unauthorised means in an assessment activity leads to a mark of zero (0) for the affected test or assignment. Furthermore, in accordance with the University's regulations, if disciplinary proceedings are initiated the subject is recorded as "Pending Assessment" until a decision is reached. These incidents are managed in accordance with the **Action Framework for Academic Integrity in Assessment at the UPC**.

The final grade depends on the following three elements:

* 30%, Deliverable individual tasks
* 40%, Group project (report and dissertation)
* 30%, Final exam

BIBLIOGRAPHY

Basic:
- Nemhauser, G.L.; Wolsey, L.A. Integer and combinatorial optimization. New York: John Wiley and Sons, cop. 1999. ISBN 047182819x.
- Wolsey, Laurence A. Integer programming. New York [etc.]: John Wiley & Sons, cop. 1998. ISBN 0471283665.
- Ahuja, R.K.; Magnanti, T.L.; Orlin, J.B. Network flows: theory, algorithms, and applications. Harlow: Pearson, 2014. ISBN 9781292042701.