# Course guide
# 300257 - OPTIM - Optimization for Applied Engineering Design

**Last modified:** 11/05/2026

**Unit in charge:** Castelldefels School of Telecommunications and Aerospace Engineering
**Teaching unit:** 744 - ENTEL - Department of Network Engineering.

**Degree:** MASTER'S DEGREE IN APPLIED TELECOMMUNICATIONS AND ENGINEERING MANAGEMENT (MASTEAM) (Syllabus 2015). (Compulsory subject).

**Academic year:** 2026 **ECTS Credits:** 3.0 **Languages:** English

## LECTURER

**Coordinating lecturer:** Cristina Cervelló-Pastor

**Others:** Cristina Cervelló-Pastor

## DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

**Specific:**
05 MTM. (ENG) Resolver problemas de optimización en el ámbito de las redes de comunicación.

**Transversal:**
03 TLG. THIRD LANGUAGE. Learning a third language, preferably English, to a degree of oral and written fluency that fits in with the future needs of the graduates of each course.

**Basic:**
CB6. Possess and understand knowledge that provides a basis or opportunity to be original in the development and/or application of ideas, often in a research context.
CB10. Students will acquire learning skills that allow them to continue studying in a way that will be largely self-directed or autonomous.

## TEACHING METHODOLOGY

* Laboratory learning sessions
- Individual work delivered at the end of the session. Laboratory learning
- activities linked to the concepts of the slides.
- Reinforce the concepts using computer tools: problems solved at the laboratory.
- Lab sessions provide students with the opportunity to analyse, discuss, and solve problems, in addition to fostering the development of practical, technical and engineering skills.
- Students have to read and study the corresponding slides before coming to the lab.

* Project lab sessions
- Individual work delivered at the end of the session.
- Development of one project throughout the course.

## LEARNING OBJECTIVES OF THE SUBJECT

The Optimization for Applied Engineering Design course is aimed at providing the participants with knowledge in applied optimization, with focus on the application of theory and methods in deterministic optimization and heuristic techniques for modeling and solving optimization problems originating from the area of communication and others areas.

## STUDY LOAD

| Type | Hours | Percentage |
|---|---|---|
| Hours medium group | 27,0 | 36.00 |
| Self study | 48,0 | 64.00 |

**Total learning time:** 75 h

## CONTENTS

### Introduction to Optimization

**Description:**
Definition of an Optimization Problem. Unconstrained and Constrained Optimization.

**Specific objectives:**
* Definition of an Optimization Problem
- Components of an Optimization Problem

* Unconstrained Optimization
- Statement of an Optimization Problem
- Concepts
- Concavity and Convexity
- Conditions for local optimizers: Interior and Boundary cases

* Equality Constrained Optimization
-Conditions for local optimizers

* Inequality and Equality Constrained Optimization
- Conditions for local optimizers

**Related activities:**
Problems resolution
Control

**Full-or-part-time:** 15h
Practical classes: 5h
Self study : 10h

**Part I: Optimization with Engineering Applications**

**Description:**
Network Optimization
Mixed Integer Programming
Multi-Objective Optimization

**Specific objectives:**
* Network Optimization
- Special type of linear Programming
- Continuous and Discrete Models

* Mixed Integer Programming
- Common IP Problems
- Technique for formulating CO problems as ILP
- Linearizing nonlinear functions

* Multi-Objective Optimization
- Definition of a MOP
- Pareto Optimal Solutions
- Solving Multi-objective Optimization Problems

**Related activities:**
Lab learning sessions
laboratory Project sessions
Control

**Full-or-part-time:** 48h
Practical classes: 18h
Self study : 30h

**Part II: Metaheuristics Optimization Algorithms**

**Description:**
Introduction
Analysis of different algorithms

**Specific objectives:**
* Introduction

* Analysis of different algorithms depending on the progress of the course
- Evolutionary Algorithms
- Genetic Algorithms
- Differential Evolution Algorithms
- Ant Colony Optimization
- Particle Swarm Optimization
- Biogeography-based Optimization

**Related activities:**
Lab learning session
Laboratory Project session

**Full-or-part-time:** 12h
Laboratory classes: 4h
Self study : 8h

## 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**.

Lab Learning Sessions: 20%
Laboratory Project: 20%
Mid-course control: 20%
Final exam: 40%

## BIBLIOGRAPHY

**Basic:**
- Oki, Eiji. Linear programming and algorithms for communication networks : a practical guide to network design, control, and management. First edition. Boca Raton: CRC Press, [2012]. ISBN 9781138034099.
- Chong, Edwin Kah Pin; Zak, Stanislaw H. An Introduction to optimization [on line]. 4th ed. Hoboken, N.J.: Wiley-Interscience, 2013 [Consultation: 23/10/2026]. Available on: https://learning-oreilly-com.recursos.biblioteca.upc.edu/library/view/an-introduction-to/9781118515150/. ISBN 9781118279014.

**Complementary:**
- Guenin, B. A Gentle introdution to optimization. Cambridge: Cambridge University Press, 2014. ISBN 9781107053441.
- Deb, Kalyanmoy. Multi-objective optimization using evolutionary algorithms. Chichester ; New York: John Wiley & Sons, 2001. ISBN 9780470743614.
- Simon, Dan. Evolutionary optimization algorithms : biologically inspired and population-based approaches to computer intelligence. New Jersey: John Wiley, 2013. ISBN 9780470937419.
- Rao, S. S. Engineering optimization : theory and practice. 4a ed. Hoboken, New Jersey: John Wiley & Sons, cop. 2009. ISBN 9780470183526.
- Hart, William E. Pyomo – Optimization modeling in Python. Second edition. New York [etc]: Springer, [2017]. ISBN 9783319588193.