

## SUBJECT TEACHING GUIDE

### 356 - Combinatorial Optimisation

#### Master's Degree in Mathematics and Computing

Academic year 2024-2025

1. IDENTIFYING DATA					
Degree	Master's Degree in Mathematics and Computing			Type and Year	Compulsory. Year 1
Faculty	Faculty of Sciences				
Discipline					
Course unit title and code	356 - Combinatorial Optimisation				
Number of ECTS credits allocated	3	Term	Semester based (1)		
Web					
Language of instruction	Spanish	English Friendly	Yes	Mode of delivery	Face-to-face

Department	DPTO. MATEMATICAS, ESTADISTICA Y COMPUTACION				
Name of lecturer	FRANCISCO SANTOS LEAL				
E-mail	francisco.santos@unican.es				
Office	Facultad de Ciencias. Planta: + 3. DESPACHO PROFESORES (3013)				
Other lecturers	LUIS CRESPO RUIZ				

### 3.1 LEARNING OUTCOMES

- To get acquainted, understand, and be able to apply, techniques of discrete combinatorial optimization and understand their role within mathematics and computer science.

**4. OBJECTIVES**

Techniques and algorithms for optimization in discrete problems will be studied. Goals are:

- that students understand the mathematical foundations (geometric, algebraic, and combinatorial) behind the problems being treated.
- that students understand the algorithms that solve these problems optimally, as well as (a first approximation to) their computational complexity.
- that students understand that in certain problems it is too expensive to apply exact algorithms, so approximation algorithms need to be studied.

**6. SUBJECT PROGRAM**

CONTENTS

1	Polyhedral combinatorics and linear programming (polytopes and polyhedra, Farkas Lemma, linear programming, duality).
2	Matchings in bipartite and non-bipartite graphs (Hall and Gallai theorems, augmenting paths, the matching polytope).
3	Flows in graphs. The max-flow-min-cut Theorem. Linear programming interpretation.
4	Integer linear programming. Totally unimodular matrices. Cut hyperplanes.

**7. ASSESSMENT METHODS AND CRITERIA**

Description	Type	Final Eval.	Reassessn	%
The student will write the solutions to some problems and hand them to the professor.	Work	No	Yes	60,00
Final exam.	Written exam	Yes	Yes	40,00
<b>TOTAL</b>				<b>100,00</b>
Observations				
Observations for part-time students				
The evaluation method will be essentially the same, but deadlines for the different tasks can be adapted to the student's needs.				

**8. BIBLIOGRAPHY AND TEACHING MATERIALS**

<b>BASIC</b>
Lee J. A first course in combinatorial optimization (Cambridge University Press, 2004)
Alexander Schrijver, A Course in Combinatorial Optimization. Libro disponible en la página web del autor, <a href="https://homepages.cwi.nl/~lex/files/dict.pdf">https://homepages.cwi.nl/~lex/files/dict.pdf</a>