SUBJECT TEACHING GUIDE

356 - Combinatorial Optimisation

Master's Degree in Mathematics and Computing

Academic year 2026 - 2027

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	DAVID IGNACIO ALCANTARA GARCIA

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. COURSE ORGANIZATION	
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. Linerar programming interpretation.
4	Integer linear programming. Totally unimodular matrices. Cut hyperplanes.

7. ASSESSMENT METHODS AND CRITERIA				
Description	Type	Final Eval.	Reassessment	%
The student will write the solutions to some problemas and hand them to the professor.	Work	No	Yes	60,00
Final exam.	Written exam	Yes	Yes	40,00
TOTAL				100,00
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
BASIC
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, https://homepages.cwi.nl/~lex/files/dict.pdf