# SUBJECT TEACHING GUIDE

## G101 - Discrete Mathematics

## Double Degree in Physics and Mathematics
## Degree in Mathematics

Academic year 2016-2017

| 1. IDENTIFYING DATA | | | | | |
|---|---|---|---|---|---|
| Degree | Double Degree in Physics and Mathematics<br>Degree in Mathematics | | | Type and Year | Compulsory. Year 3<br>Compulsory. Year 3 |
| Faculty | Faculty of Sciences | | | | |
| Discipline | Third Year Subjects<br>Subject Area: Computational Mathematics<br>Module: Compulsory Subjects | | | | |
| Course unit title and code | G101 - Discrete Mathematics | | | | |
| Number of ECTS credits allocated | 6 | Term | Semester based (1) | | |
| Web | | | | | |
| Language of instruction | English | English Friendly | No | Mode of delivery | Face-to-face |

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|---|---|
| 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 | MONICA BLANCO GOMEZ |

| 3.1 LEARNING OUTCOMES |
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| - To know and be able to interpret and apply in concrete examples basic concepts of graph theory. |
| - To know and be able to apply in concrete examples several graph theory algorithms |
| - To learn basic counting principles and some elements of combinatorial structures |
| - To be able to compute exactly and/or approximately the number of objects of several types. |
| - To be able to solve linear recurrence relations and understand the asymptotic behavior of the sequences they define. |
| - To know how to construct certain linear codes and analyze their error-correcting capacity. |

| 4. OBJECTIVES |
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| Discrete mathematics is in increasingly important branch of mathematics, both pure and applied. This course intends to give an overview of it focusing on two topics: graph theory, which models many networks, processes, diagrams or relations among discrete objects, and enumerative combinatorics, that is to say, techniques to count the number of elements in a finite set, and the applications this has. As an example of algebraic techniques in combinatorics linear error-correcting codes are studied. These codes are used in digital data transmission and storage. |

| 6. COURSE ORGANIZATION | |
|---|---|
| | CONTENTS |
| 1 | Combinatorics.<br><br>Lesson 6: Introduction to combinatorics. Factorial and binomial numbers. Binomial theorem. Inclusion-exclusion principle.<br><br>Lesson 7: Generating functions. Formal power series and generating functions. Homogeneous linear recurrences. Fibomacci and Catalan numbers. Partitions of a positive integer. |
| 2 | Coding Theory.<br><br>Lesson 8: Codes. Words, codes, and errors. Hamming distance. Correcting capacity of a code. Minimum distance decoding.<br><br>Lesson 9: Linear codes. Linear codes over finite fields. Syndrome decoding. Examples: Hamming, Golay, and Reed-Muller codes. |
| 3 | Graph Theory:<br><br>Lesson 1: Graphs. Gepresentation of graphs. Isomorphism. Paths and cycles. Eulerian and Hamiltonian graphs.<br><br>Lesson 2: Trees and search algorithms. Spanning trees. Depth first search and breadth first search. Dijkstra's algorithm. Rooted trees. Binary trees.<br><br>Lesson 3: Bipartite graphs. Matchings, maximal and perfect matchings. Augenting path algorithm. Hall's theorem.<br><br>Lesson 4: Digraphs and networks. Directed graphs. Networks. Flows and cuts. Max-flow-min-cut algorithm.<br><br>Lesson 5: Planar graphs. Kuratowski's Theorem. Euler's formula. Four color theorem. Graph coloring. |
| 4 | Preparation and realization of midterm and final exam. |

## 7. ASSESSMENT METHODS AND CRITERIA

| Description | Type | Final Eval. | Reassessn | % |
|---|---|---|---|---|
| Problem sheets. Every couple of weeks the students will hand in two or three problems to be graded by the professor. | Work | No | Yes | 15,00 |
| Oral exam: During the last month of teaching, the students will do an oral exam (about half an hour), solving in the blackboard several problems taken from the problem sheets. | Oral Exam | No | Yes | 15,00 |
| Partial exam: Written exam covering the first half of the course, to be taken around the 8th week of class. | Written exam | No | Yes | 35,00 |
| Partial exam: Written exam covering the second half of the course, to be taken in the last week of class. | Written exam | No | Yes | 35,00 |
| Final exam: An exam of the whole course for students that did not pass the partial exams. | Written exam | Yes | No | 0,00 |
| TOTAL | | | | 100,00 |

**Observations**

The continuous evaluation (problem sheets and oral exam) will be in English. Students not doing it satisfactorily will have to do the final exam in English.

**Observations for part-time students**

These students can choose between the evaluation system of regular students and one in which they only need to do the final exam and receive its grade as their final grade.

## 8. BIBLIOGRAPHY AND TEACHING MATERIALS

**BASIC**

N. Biggs: Discrete Mathematics, Revised edition, Clarendon Press, Oxford, 1989.

J. Matousek, J. Nesetril, Invitation to Discrete Mathematics, Clarendon Press, Oxford, 1998.