



Universitat de Lleida

DEGREE CURRICULUM  
**DISCRETE MATHEMATICS.**

Academic year 2015-16

## Subject's general information

<b>Subject name</b>	Discrete Mathematics.
<b>Code</b>	102007
<b>Semester</b>	First semester.
<b>Typology</b>	Troncal
<b>ECTS credits</b>	6
<b>Groups</b>	The full group and three other small groups
<b>Theoretical credits</b>	3
<b>Practical credits</b>	3
<b>Office and hour of attention</b>	Tuesday from 10:00 to 12:00 am in office number 1.20 (EPS building)
<b>Department</b>	Matemàtica
<b>Modality</b>	Presencial
<b>Important information on data processing</b>	Consult <a href="#">this link</a> for more information.
<b>Language</b>	Spanish, catalan.
<b>Degree</b>	Degree in Computer Engineering/ Double degree GEIADE
<b>Distribution of credits</b>	Credits are distributed uniformly among theoretical credits and practical ones. The theoretical concepts are explained during the two hours devoted to the full group, meanwhile the exercises are played during the two hours in small groups.
<b>Office and hour of attention</b>	Tuesday from 10:00 to 12:00 am in office number 1.20 (EPS building)
<b>E-mail addresses</b>	nlopez@matematica.udl.es

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## Subject's extra information

Discrete mathematics is the study of mathematical structures that are fundamentally discrete rather than continuous. Mathematically speaking, the term discrete means that the elements are somehow split away between them. For instance, integers and discrete algebra are part of discrete mathematics (and they have been introduced in Algebra subject). Combinatorics and graph theory are also discrete mathematics and they are part of this subject. Besides, there are many others topics in discrete mathematics, like code theory, cryptography, etc. but they appear in other subjects of the degree. The main reason to put combinatorics and graph theory in this subject is because they have a lot of applications in computer science. This course is splitted in two parts: one devoted to several contents of Graph Theory and the second one devoted to a brief introduction to Combinatorics.

To follow this subject properly some previous knowledge on basic Algebraic group theory is recommended.

## Learning objectives

Utilization of graph representation to model problems.

Graph Isomorphism problem

Application of strategies depth first search and breadth first search.

Connectivity on graphs.

Distance on graphs and related concepts.

Short path algorithms

Eulerian and hamiltonian graphs

Trees and their elementary properties

Basic concepts about coloring and planarity of graphs

Elementary combinatorics.

## Competences

Strategic Competitions of the UdL according to the "Plan Director de la Docència" approved by the Government Council of UdL on July 10th, 2007.

- CT5. Acquire knowledge in scientific thinking.

Cross-disciplinary competences approved by the Plenary Commission of the Degrees of Industrial Engineering, Computer Engineering and Building Engineering, gathered on June 16th, 2008.

- EPS1. Capacity to solve problems and prepare and defence arguments inside the area of studies.
- EPS5. Capacity of abstraction and of critical, logical and mathematical thinking.

Specific competences that the students have to acquire in the degree in Computer Engineering set in the Royal decree 1393/2007, of October 29th

- GII-FB1. Capacity to solve mathematical problems arisen in the engineering field. Aptitude to apply knowledge on: linear algebra; differential and integral calculus; numerical methods; algorithmic, numerical; statistics and optimisation.
- GII-FB3. Capacity to understand and master the basic concepts of discreet mathematics, logical,

algorithmic and computational complexity, and its application to solve engineering problems.

## Subject contents

### I. BASICS ON GRAPH THEORY

1. Graphs and related objects.

1.0 Graph as mathematical models.

1.1 Definition of a graph.

1.2 Degree of a vertex. Hand shaking lemma.

1.3 Graph representations.

1.4 Graph isomorphism.

1.5 Main graph examples.

1.6 Operations with graphs.

1.7 Directed graphs

1.8 Modeling graph topology.

1.9 PageRank algorithm.

### 2. Connectivity and distances

2.1 Walks in graphs.

2.2 Connected graphs.

2.3 DFS algorithm and connectivity test.

2.4 Distances in graphs: eccentricity, radius and diameter.

2.5 Algorithms for distance computing in graphs.

### 3. Eulerian graphs and hamiltonian graphs

3.1 Eulerian graphs: characterization.

3.2 Hierholzer algorithm and Fleury algorithm.

3.3 Necessary and sufficient condition on hamiltonian graphs.

### 4. Trees.

4.1 Definition and basic properties.

4.2 Generating trees.

4.3 Kruskal algorithm.

4.4 Rooted trees.

4.5 Huffman codes.

5. Approaching other topics in graph theory

5.1 Planarity.

5.2 Coloration.

II. INTRODUCTION TO COMBINATORICS.

6. Elementary combinatoric topics.

6.0 Introduccion.

6.1 Basic principles in combinatorics.

6.2 Permutations

6.3 Combinations.

6.4 Binomial coefficients.

6.5 Special counting methods: Inclusion and Exclusion.

## Methodology

Graph Theory and Elementary combinatorics are the main structure of this subject, which is presented during the first semester of the second year with four hours of teaching (two in big group and the rest in small group). Some hours into small groups are devoted to solve problems by the students on their own.

## Development plan

Dates (Week number)	Activity	Description		
1-8	Master classes and problems resolution.	Contents of Section 1 and 2		
5	Evaluation exercise.	Solve a problem.		
9	Evaluation part.	Exam of contents of section 1 and 2.		
10-16	Master classes and problems resolution.	Contents of the other sections.		
12	Evaluation exercise.	Solve a problem.		
17-18	Evaluation part.	Exam of contents of the rest of sections.		
20	Recuperation	Exam.		

## Evaluation

The evaluation of discrete mathematics is as follows:

- First partial exam (week number 9), weighted on 4 points, where contents of sections 1 and 2 will be evaluated.
- Second partial exam (week number 17-18), weighted on 4 points, where the rest of the contents will be evaluated (also the basic results of the first two sections).
- Resolution of two problems either after and before the first partial exam, weighted on 1 point each.
- There is a recuperation exam, weighted en 10 punts, for those students whose qualification is lower than 5 with the sum of qualifications in the points given above.

## Bibliography

### Basic bibliography:

Related to combinatorics:

- Gimbert, J., Moreno R., Valls M., Notes sobre Combinatòria, Quadern EUP núm. 36, 2002. (In catalan)

Related to graph theory:

- Gimbert, J., Moreno, R., Ribó, J.M., Valls, M., Apropament a la Teoria de Grafs i als seus Algorismes, Edicions de la UdL, 1998. (In catalan).
- Bijedi, N., Gimbert J., Miret J.M., Valls M., Elements of Discrete Mathematical Structures for Computer Science, Univerzitetaska knjiga Mostar and Edicions de la UdL, 2007. (In english)

### Complementary bibliography:

- Anderson, I., Introducció a la Combinatoria. Vicens Vives, 1993.
- Brunat, J.M., Combinatòria i Teoria de Grafs. Edicions UPC, 1996.
- Biggs, N., Matemàtica Discreta. Vicens Vives, 1993.
- Comellas, F., Fàbrega, J., Sànchez, A., Serra, O., Matemàtica Discreta. Edicions UPC, 1994.
- García, F., Hernández, G., Nevot, A., Problemas resueltos de Matemática Discreta. Thomson, 2003.
- Trias, J., Matemàtica Discreta. Problemes resolts. Edicions UPC, 2001.
- Aldous, J.M., Wilson, R.J., Graphs and Applications: An introductory Approach. Springer, 2000.
- Basart, J.M., Grafs: Fonaments i Algorismes. Servei de Publicacions de la UAB, 1994.
- Chartrand, G., Lesniak, L., Graphs and Digraphs, third edition. Wadsworth and Brooks/Cole, 1996.
- Grimaldi, R.P., Matemàtica Discreta y Combinatoria. Addison Wesley Iberoamericana, tercera edició, 1997.
- Rosen, K., Matemàtica Discreta y sus Aplicaciones, quinta edició. McGraw- Hill, 2004.
- Daniel A. Marcus, Combinatorics: A problem oriented approach. The mathematical associations of america, 1998.