Universitat de Lleida

DEGREE CURRICULUM

DISCRETE MATHEMATICS

Coordination: DALFÓ SIMÓ, CRISTINA

Academic year 2020-21

DISCRETE MATHEMATICS 2020-21

Subject's general information

Subject name	DISCRETE MATHEMATICS
Code	102373
Semester	1st Q(SEMESTER) CONTINUED EVALUATION
Typology	

Degree	Course	Character	Modality
Bachelor's degree in Digital Interaction and Computing Techniques	2	COMMON	Attendance-based

Course number of credits (ECTS)	6
Type of activity, credits, and groups	

Activity type	PRAULA	TEORIA
Number of credits	3	3
Number of groups	1	1

Coordination	DALFÓ SIMÓ, CRISTINA
Department	MATHEMATICS
Teaching load distribution between lectures and independent student work	6 ECTS = 25x6 = 150 hours of work
Important information on data processing	Consult this link for more information.
Language	Catalan
Distribution of credits	3 credits of theory and 3 of exercises.

DISCRETE MATHEMATICS 2020-21

Teaching staff	E-mail addresses	Credits taught by teacher	Office and hour of attention
DALFÓ SIMÓ, CRISTINA	cristina.dalfo@udl.cat	6	

Subject's extra information

Discrete Mathematics studies the so-called discrete objects, which are formed by a finite (or numerable) number of elements. In mathematics, the discrete term, as opposed to continuing, means that it is composed of elements "well separated from each other". Among the discrete objects, we find the integers and the discrete algebraic structures, as well as combinatorics and graphs, which we will present in this subject. It must be said that there are many other issues of Discrete Mathematics, such as codes, cryptography and finite state machines, which appear in other subjects of the Degree in Techniques of Digital Interaction and Computation. The reason for their inclusion in these studies lies in the many applications they have in Computing, since computers store information and manipulated it in a discrete way ("through sequences of zeros and ones"). The program that we present to you consists of an approach to the Theory of Graphs and an introduction to the Combinatorial Enumeration.
Prerequisites: Mathematics of Computing (modular arithmetic and elementary group theory).

Learning objectives

- Modeling problems through graphs.
- Recognize the basic elements of a graph and its different representations.
- Determine if two small order graphs are or are not isomorphic.
- Distinguish between DFS and BFS strategies.
- Determine if a graph is connected.
- Know and apply different connectivity parameters.
- Calculate the metrics related to the distance.
- Use algorithms to calculate distances in weighted and unweighted graphs.
- Know different routes in a graph.
- Demonstrate if a graph is Eulerian and, if so, find a Eulerian circuit.
- Analyze the Hamiltonian character of a graph.
- Identify the trees and list their basic properties.
- Recognize in what situations the (optimal) graph coloring is required.
- Evaluate the efficiency of the different basic algorithms on graphs.
- Know the basic principles of combinatorial enumeration.
- Modeling some counting problems to solve with combinational techniques.
- Know the permutations, combinations, and variations.
- Apply the combinatorial formulas correctly.
- Know the principle of inclusion-exclusion.
- Recognize recurrence relationships.
- Resolve the recurrence equations of order two with constant coefficients.

Competences

Relation of the Strategic Skills of the UdL according to the Teaching Master Plan approved by the UdL Governing Council.
- CT5. Acquire essential notions of scientific thought.

Transversal competences approved by the Plenary Committee of the Degree in Techniques of Digital Interaction and Computation.
- EPS1. Ability to solve problems and elaborate and defend arguments within their area of study.
- EPS5. Capacity for abstraction and critical, logical and mathematical reasoning.

Specific skills that students must acquire in the Degree in Techniques of Digital Interaction and Computation.
- GII-FB1. Ability to solve mathematical problems that may arise in engineering. Aptitude to apply knowledge about: Linear algebra; differential and integral calculus; numerical methods; algorithmic
- GII-FB3. Ability to understand and master the basic concepts of discrete mathematics, logic, algorithmic and computational complexity, and its application to solve problems related to engineering.

Subject contents

I. INTRODUCTION TO ENUMERATIVE COMBINATORICS
1. Basic combinatorial principles and objects.
   1.0 Introduction.
   1.1 Basic enumeration principles.
   1.2 Sorted selections: permutations.
   1.3 Unordered selections: combinations.
   1.4 Binomial and multinomial coefficients.
   1.5 Principle of inclusion-exclusion.
2. Recurrence relations.
   2.0 Introduction.
   2.1 Basic terminology on recurrence relationships.
   2.2 Methods of resolution of recurrence relations.
   2.3 Resolution of linear recurrences of order two with constant coefficients.

II. THE THEORY OF GRAFS
1. Graphs: basic concepts.
   1.0 Graphs as mathematical models: historical examples and current applications.
   1.1 Definition of a graph.
   1.2 Degree of a vertex. Handshake Lemma.

1.3 Representation of a graph.
1.4 Isomorphism of graphs.
1.5 Important examples of graphs.
1.6 Operations with graphs.
1.7 Directed graphs.
2. Connection and distances.
2.1 Routes in a graph.
2.2 Connected graphs: Definition and properties. DFS algorithm.
2.3 Connectivity.
2.4 Distances in a graph. Algorithm BFS.
2.5 Trees. The problem of the minimum connector.
3. Hamiltonian and Eulerian graphs.
3.1 Eulerian graphs: Definition and characterization.
3.2 Construction of a Eulerian circuit: Hierholzer algorithm and Fleury algorithm.
3.3 Hamiltonian graphs: Definition, necessary conditions, and sufficient conditions.

Methodology

Theory lessons (3 credits):
Theoretical part: classes supported by notes and material available on the virtual campus.
Part of practical exercises: Always working with examples and exercises. There is a collection of problems, of which solutions the students are provided throughout the semester.

Problem lessons (3 credits):
Guided classes and problem-solving tracking.

Autonomous work:
It is recommended that the students solve on their own the problems of the collection of problems that are not solved in class, in order to complete theoretical and practical knowledge.

The lecture sessions will be done through the videoconference of the Virtual Campus and the problem-solving sessions will be face-to-face.

Development plan

Dates (weeks)	Description	Activity Theory Group	Activity Exercises Group	Self-Study
Weeks 1-8	Contents of block I	Lectures and exercises	Exercises Resolution	Study and solve exercises
Week 4	Control Exam 1	Evaluation Exam	Evaluation Exam	Study and solve exercises
Week 9	Exam block I	Evaluation Exam	Evaluation Exam	Study and solve exercises
Weeks 10-16	Contents of block II	Lectures and exercises	Exercises Resolution	Study and solve exercises
Weeks 14	Control Exam 2	Evaluation Exam	Evaluation Exam	Study and solve exercises
Weeks 17-18	Exam block II	Evaluation Exam	Evaluation Exam	Study and solve exercises
Week 20	Reevaluation Exam	Evaluation Exam	Evaluation Exam	Study and solve exercises

Evaluation

- Control Exam 1: 10%

- Partial Exam 1: 40%.

- Control Exam 2: 10%.

- Partial Exam 2: 40%.

To pass this subject, there is no minimum mark for the control exams, the partial exams have 2.5 as a minimum mark (over 10).

Partial Exams 1 and 2 (80%) can be recovered with the Reevaluation Exam.

It is mandatory to carry out the four evaluation exams (it is necessary to present them and develop them).

Bibliography

Material in the Virtual Campus:
Material of Combinatorics:
- Joan Gimbert, Ramiro Moreno, Magda Valls, Notes sobre Combinatòria, Quadern EUP núm. 36, 2002.

Material of Graphs:
- Joan Gimbert, Ramiro Moreno, Josep Maria Ribó, Magda Valls, Apropament a la Teoria de Grafs i als seus Algorismes, Edicions de la UdL, 1998.

Exams Compilation:
- Joan Gimbert, Nacho López, Ramiro Moreno, Magda Valls, Recull d'Exàmens de Matemàtica Discreta.

Basic Bibliografhy

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THEORY BOOKS (with exercises):

- Ian Anderson, Introducción a la Combinatoria. Vicens Vives, 1993.
- Josep Maria Brunat, Combinatòria i Teoria de Grafs. Edicions UPC, 1996.
- Norman Biggs, Matemàtica Discreta. Vicens Vives, 1993.

BOOKS OF SOLVED EXERCISES:

- Nina Bijedi, Joan Gimbert, Josep Maria Miret, Magda Valls, Elements of Discrete Mathematical Structures for Computer Science, Univerzitetska knjiga Mostar and Edicions de la UdL, 2007.
- Félix García, Gregorio Hernández, Antonio Nevot, Problemas resueltos de Matemática Discreta. Thomson, 2003.
- Joan Trias, Matemàtica Discreta. Problemes resolts. Edicions UPC, 2001.