

**Discrete Mathematics**

Code: 102772  
ECTS Credits: 6

Degree	Type	Year	Semester
2502441 Computer Engineering	FB	1	2

**Contact**

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**Use of Languages**

Principal working language: catalan (cat)  
Some groups entirely in English: No  
Some groups entirely in Catalan: Yes  
Some groups entirely in Spanish: No

**Teachers**

Joaquim Borges Ayats  
Joan Bartrina Rapesta  
Mercè Villanueva Gay  
Bernat Gaston Braso

**Prerequisites**

There are no prerequisites. However, students should be familiar with the most basic concepts of fundamental algebra, such as set theory and applications.

**Objectives and Contextualisation**

The course deals with topics included in the area of Discrete Mathematics focussing on the study of discrete objects. It begins with basic graph theory, path optimisation, algorithms in graphs and complexity of algorithms and problems.

**Competences**

- Acquire thinking habits.
- Have the capacity to understand and master the basic concepts of discrete mathematics, logic, computational algorithms and complexity, and their application to the resolution of engineering problems.
- Know the basic materials and technologies to enable the learning and development of new methods and technologies, as well as those that provide large-scale versatility to adapt to new situations.

**Learning Outcomes**

1. Calculate the computational complexity of graph algorithms.
2. Develop a mode of thought and critical reasoning.

3. Identify and recognise the basic algorithms of graph traversal.
4. Know and apply the mathematical methods of deduction and demonstration.
5. Recognise and identify the mathematical models of an engineering problem.
6. Show the capacity to apply the optimisation of graph traversal.
7. Understand and master discrete mathematics, logic and complexity from a mathematical point of view.
8. Understand the basic properties of directed and non-directed graphs.

## **Content**

### **1. Previous concepts: sets, functions and complexity of algorithms**

1. Sets and operations with sets
2. Cartesian product and binary relations
3. Combinatorial elements
4. Finite, infinite and numerable sets
5. Complexity of algorithms and problems
6. Functions of complexity. Polynomial and non-polynomial complexity

### **2. Fundamentals of graphs**

1. Definitions. Variants of graphs
2. Paths, circuits and distances
3. Degrees and handshaking lemma
4. Subgraphs and important types of graphs
5. Graphic sequences (Havel-Hakimi)
6. Graph representation

### **3. Optimal tours, paths and generating trees**

1. Exploration of graphs (DFS and BFS)
2. Minimum cost paths (Dijkstra, Floyd)
3. Characterization of trees
4. Optimal generating trees (Kruskal)

### **4. Planarity and colouring**

1. Basic results
2. Characterization of planar graphs
3. Colouring of planar graphs
4. Annex: chromatic polynomial

### **5. Eulerian and Hamiltonian graphs**

1. Eulerian paths and circuits
2. Fleury method (or Hierholzer)
3. Chinese postman problem
4. Hamiltonian path and circuits
5. Travelling salesman problem

### **6. Computational complexity**

1. Decision, calculation and optimization problems
2. Solvable and unsolvable problems
3. Complexity classes. NP-complete problems.
4. Other intractable problems

## **Methodology**

Theoretical content will be taught through lectures, although students will be encouraged to actively participate in the resolution of examples, complexity computation, etc. During problem sessions, a list of exercises will be resolved. Students are encouraged to solve the problems on their own in advance. Students will also be encouraged to present their own solutions in class. During seminar sessions, topics related to the lectures will be studied in depth. These include the presentation of real cases and the development of a project relating web pages and graph theory. Campus Virtual will be used for communication between lecturers and students (material, updates, announcements, etc.).

Annotation: Within the schedule set by the centre or degree programme, 15 minutes of one class will be reserved for students to evaluate their lecturers and their courses or modules through questionnaires.

## Activities

Title	Hours	ECTS	Learning Outcomes
Type: Directed			
Exercise-based classes	15	0.6	7, 8, 4, 6, 3, 5
Seminars	5	0.2	7, 8, 2, 3, 5
Theoretical classes / lectures	30	1.2	1, 7, 8, 4, 6, 3, 5
Type: Supervised			
Preparing exercises and seminars	12.5	0.5	1, 7, 8, 4, 6, 2, 3, 5
Tutoring and consultations	5	0.2	1, 7, 8, 4, 6, 2, 3, 5
Type: Autonomous			
Independent study	50	2	1, 7, 8, 4, 6, 3, 5
Preparing the final test	25	1	1, 7, 8, 4, 6, 3, 5

## Assessment

Continuous-assessment dates will be published on Campus Virtual. Specific programming may change when necessary. Any such modification will always be communicated to students through Campus Virtual, which is the usual communication platform between lecturers and students.

Subject assessment (out of 10 points) will be carried out as follows:

- Two individual partial tests, 6 points (3 points each). As part of continuous assessment, the first test will take place during lectures; the second will take place on the date specified by coordination. The first partial test will be given at the end of the first three chapters of the course; the second partial test will be given on finishing all the chapters of the course. These individual tests will consist mostly of exercises in the style of those worked on during the course; a smaller part will consist of more theoretical questions. A minimum of 1 point (of the 3 points) in each partial test is required to pass the course.
- Exercise resolutions, 1.5 points. As part of continuous assessment, activities must be carried out or exercises must be solved by applying the given algorithms (via online quizzes, for example). The non-online activities or exercises will take place during the exercise sessions.
- Continuous assessment for seminars, 2.5 points. The activities developed in a tutored way in these seminars will be evaluated. Students will be required to present their exercises done in group during the sessions. A minimum of 1 point (of the 2.5 points) is required to pass the course.
- Finalexam, 6 points. Those who have not passed the subject through the individual partial tests will have the option to take final exam as a re-assessment grade to compensate the individual partial tests. There is therefore no separate re-assessment for partial tests; this exam covers material from the entire

course. It will consist mainly of exercises in the style of those worked on during the course; a smaller part will consist of more theoretical questions. A minimum of 2 points (of the 6 points) is required to pass the course.

Notwithstanding other disciplinary measures deemed appropriate, and in accordance with the academic regulations in force, assessment activities will receive a zero whenever a student commits academic irregularities that may alter such assessment. Assessment activities graded in this way and by this procedure will not be re-assessable. If passing the assessment activity or activities in question is required to pass the subject, the awarding of a zero for disciplinary measures will also entail a direct fail for the subject, with no opportunity to re-assess this in the same academic year. Irregularities contemplated in this procedure include, among others:

- the total or partial copying of an evaluation activity;
- allowing others to copy;
- presenting group work that has not been done entirely by the members of the group;
- presenting any materials prepared by a third party as one's own work, even if these materials are translations or adaptations, including work that is not original or exclusively that of the student;
- having communication devices (such as mobile phones, smart watches, etc.) accessible during theoretical-practical assessment tests (individual exams).

To pass the course it is necessary that the mark of each one of the parts exceeds the minimum required and that the overall grade is 5.0 or higher. If you do not pass the course because some of the assessment activities do not reach the minimum mark required, the mark in the Transcript of Records will be the lowest value between 4.5 and the overall average grade. A "non-assessable" grade cannot be assigned to students who have participated in any of the individual partial tests or the final exam. No special treatment will be given to students who have completed the course in the previous academic year, except that the seminar grade previously obtained can be assigned to this course gradebook. In order to pass the course with honours, the final grade must be a 9.0 or higher. Because the number of students with this distinction cannot exceed 5% of the number of students enrolled in the course, this distinction will be awarded to whoever has the highest final grade. In case of a tie, partial-test results will be taken into consideration.

In the case of tests based on exercise resolutions, a review may be requested after the date of the activity or the date of closure of the quiz. For all other assessment activities, a place, date and time of review will be indicated allowing students to review the activity. If students do not take part in this review, no further opportunity will be made available.

To consult the academic regulations approved by the Governing Council of the UAB, please follow this link: [http://webs2002.uab.es/afers\\_academics/info\\_ac/0041.htm](http://webs2002.uab.es/afers_academics/info_ac/0041.htm)

## Assessment Activities

Title	Weighting	Hours	ECTS	Learning Outcomes
Group tests in seminar classes	25%	4	0.16	7, 8, 2, 3, 5
Tests based on exercise resolutions in exercise-base classes	15%	0.5	0.02	7, 8, 4, 6, 3, 5
Two partial tests	60%	3	0.12	1, 7, 8, 4, 6, 3, 5

## Bibliography

- J.M. Basart. *Grafs: fonaments i algorismes*. Manuals de la UAB, 13. Servei de publicacions de la UAB, 1994.
- C. Berge. *Graphs*. North-Holland, 1991.
- N.L. Biggs. *Matemàtica discreta*. Vicens-Vives, 1994.
- N. Christofides. *Graph theory, an algorithmic approach*. Academic Press, 1975.

- M.R. Garey, D.S. Johnson. *Computers and intractability. A guide to the theory of NP-Completeness*. W.H. Freeman, 1979.
- F.S. Roberts. *Applied combinatorics*. Prentice-Hall, 1984.
- J. Gimbert, R. Moreno, J.M. Ribó, M. Valls. *Apropament a la teoria de grafs i als seus algorismes*. Eines 23, edicions de la UdL, 1998.

## **Software**

No se utiliza ningún software.