Course guide
200161 - MD - Discrete Mathematics

Last modified: 01/06/2023

Unit in charge: School of Mathematics and Statistics
Teaching unit: 749 - MAT - Department of Mathematics.

Degree: BACHELOR'S DEGREE IN MATHEMATICS (Syllabus 2009). (Compulsory subject).

Academic year: 2023 **ECTS Credits:** 7.5 **Languages:** Catalan

LECTURER

Coordinating lecturer: JUAN JOSÉ RUE PERNA

Others: Segon quadrimestre:
GUILLEM PERARNAU LLOBET - M-A, M-B
JUAN JOSÉ RUE PERNA - M-A, M-B
LLUIS VENA CROS - M-A, M-B

PRIOR SKILLS

The student must have acquired the contents of the first term degree in mathematics.

DEGREE COMPETENCES TO WHICH THE SUBJECT CONTRIBUTES

Specific:
1. CE-2. Solve problems in Mathematics, through basic calculation skills, taking in account tools availability and the constraints of time and resources.
2. CE-3. Have the knowledge of specific programming languages and software.
3. CE-4. Have the ability to use computational tools as an aid to mathematical processes.

Generical:
4. CB-1. Demonstrate knowledge and understanding in Mathematics that is founded upon and extends that typically associated with Bachelor's level, and that provides a basis for originality in developing and applying ideas, often within a research context.
5. CB-2. Know how to apply their mathematical knowledge and understanding, and problem solving abilities in new or unfamiliar environments within broader or multidisciplinary contexts related to Mathematics.
6. CB-3. Have the ability to integrate knowledge and handle complexity, and formulate judgements with incomplete or limited information, but that include reflecting on social and ethical responsibilities linked to the application of their knowledge and judgements.
7. CG-1. Show knowledge and proficiency in the use of mathematical language.
8. CG-2. Construct rigorous proofs of some classical theorems in a variety of fields of Mathematics.
9. CG-3. Have the ability to define new mathematical objects in terms of others already know and ability to use these objects in different contexts.
10. CG-4. Translate into mathematical terms problems stated in non-mathematical language, and take advantage of this translation to solve them.
12. CG-6 Detect deficiencies in their own knowledge and pass them through critical reflection and choice of the best action to extend this knowledge.

Transversal:
11. SELF-DIRECTED LEARNING. Detecting gaps in one's knowledge and overcoming them through critical self-appraisal. Choosing the best path for broadening one's knowledge.

TEACHING METHODOLOGY

(Section not available)

LEARNING OBJECTIVES OF THE SUBJECT

(Section not available)

STUDY LOAD

Type	Hours	Percentage
Guided activities	7,5	4.00
Hours large group	45,0	24.00
Self study	105,0	56.00
Hours small group	30,0	16.00

Total learning time: 187.5 h

CONTENTS

1. Combinatorics enumerativa

Description:
1.1 Enumerative Combinatorics
Basic counting. Counting selections, words and distributions. Binomial numbers. Multinomial numbers. Pigeonhole principle, doubling coounting, Principle of inclusion and exclusion. Set partitions. Integer partitions. Asymptotics.

1.2 Recursions and Generating Functions
Solving recursions by induction and expansion. Sequences, formal power series and generating functions. Linear recurrence relations. Partitions and generating functions. Catalan numbers and bijections.

Full-or-part-time: 72h
Theory classes: 15h
Practical classes: 11h
Self study : 46h

2. Discrete Probability

Description:
Discrete probability spaces. Conditional probability and independent events. Discrete random variables. Discrete Random models. Expectation and variance. Markov and Chebyshev's and inequalities. Introduction to the probabilistic method.

Full-or-part-time: 25h
Theory classes: 6h
Practical classes: 4h
Self study : 15h

3. Graph Theory

Description:
3.1 Graphs
Definitions and examples. Isomorphism of graphs. Walks, trails and paths. Connected graphs. Distance in graphs.
3.2 Trees
Characterization of trees. Spanning trees. Enumeration of trees.
3.3 Eulerian and Hamiltonian Graphs
Eulerian circuits. Eulerian graphs. Characterization of Eulerian graphs. Hamiltonian cycles. Hamiltonian graphs. Some necessary and sufficient conditions for hamiltonicity.
3.4 Matchings, Colorings and Planarity
Matchings. Matchings in bipartite graphs. Graph coloring. Chromatic number.

Full-or-part-time: 64h
Theory classes: 16h
Practical classes: 10h
Self study : 38h

GRADING SYSTEM

Problem assignment/activities (PR, 10%), exam midterm (EP, 30%) and final exam (EF, 60%). The grade of the final exam will be considered if it is larger than the average of the course (see the following formula). The maximum of all possibilities will be considered:

MAX (EF, 0.7*EF+0.3*EP,0.9*EF+0.1*PR,0.6*EF+0.3*EP+0.1*PR)

Additionally, there will be an extraordinary exam during july for students who fail the course. In this case the continous evaluation will be not considered.

BIBLIOGRAPHY

Basic:
- Cameron, Peter J. Combinatorics : topics, techniques, algorithms. Cambridge: Cambridge University Press, 1994. ISBN 9780521457613.
- Comellas Padró, Francesc [et al.]. Matemàtica discreta [on line]. Barcelona: Edicions UPC, 2001 [Consultation: 22/05/2020]. Available on: http://hdl.handle.net/2099.3/36194. ISBN 8483014564.
- Matousek, J.; Nesetril, J. Invitación a la matemática discreta. Barcelona: Reverté, 2008. ISBN 9788429151800.
- West, Douglas Brent. Introduction to graph theory. 2nd ed. Upper Saddle River, NJ: Prentice Hall, 2001. ISBN 0130144002.
- Durrett, Rick. Elementary probability for applications [on line]. Cambridge: Cambridge University Press, 2009 [Consultation: 21/06/2023]. Available on: https://ebookcentral-proquest-com.recursos.biblioteca.upc.edu/lib/upcatalunya-ebooks/detail.action?pq-origsite=primo&docID=461127. ISBN 9780521867566.

Complementary:
- Bondy, J. A; Murty, U. S. R. Graph theory. New York: Springer, cop. 2008. ISBN 9781846289699.
- Loehr, Nicholas A. Bijective combinatorics. Boca Raton, FL: Chapman & Hall, 2011. ISBN 9781439848845.
- Biggs, Norman L. Matemática discreta. Barcelona: Vicens-Vives, 1994. ISBN 8431633115.
- Aigner, M.; Ziegler, G. M. El Libro de las demostraciones. Tres Cantos: Nivola, 2005. ISBN 8495599953.
- Brunat, Josep M. Combinatòria i teoria de grafs. 3a ed. Barcelona: Edicions UPC, 1997. ISBN 8483012162.
- Diestel, Reinhard. Graph theory. 3rd ed. Berlin: Springer, 2005. ISBN 3540261826.
- Graham, Ronald L.; Knuth, D. E.; Patashnik, O. Concrete mathematics : a foundation for computer science. 2nd ed. Reading, MA: Addison-Wesley, 1994. ISBN 0201558025.
- Lovász, L.; Pelikán, J.; Vesztergombi, K. Discrete mathematics: elementary and beyond [on line]. New York: Springer, 2003 [Consultation: 21/06/2023]. Available on: https://link-springer-com.recursos.biblioteca.upc.edu/book/10.1007/b97469. ISBN 0387955844.
- Mitzenmacher, M.; Upfal, E. Probability and computing: randomized algorithms and probabilistic analysis. Cambridge: Cambridge

University Press, 2005. ISBN 0521835402.
- Gimbert, Joan [et al.]. Apropament a la teoria de grafs i als seus algorismes. Lleida: Edicions de la Universitat de Lleida, 1998. ISBN 8489727651.