

34955 - COMB - Combinatorics

Coordinating unit:	200 - FME - School of Mathematics and Statistics
Teaching unit:	749 - MAT - Department of Mathematics
Academic year:	2017
Degree:	MASTER'S DEGREE IN ADVANCED MATHEMATICS AND MATHEMATICAL ENGINEERING (Syllabus 2010). (Teaching unit Optional)
ECTS credits:	7,5
Teaching languages:	English

Teaching staff

Coordinator:	MARCOS NOY SERRANO
Others:	Segon quadrimestre: MARCOS NOY SERRANO - A ORIOL SERRA ALBO - A

Prior skills

Basic calculus and linear algebra. Notions of probability.

Degree competences to which the subject contributes

Specific:

1. RESEARCH. Read and understand advanced mathematical papers. Use mathematical research techniques to produce and transmit new results.
2. CALCULUS. Obtain (exact or approximate) solutions for these models with the available resources, including computational means.
3. CRITICAL ASSESSMENT. Discuss the validity, scope and relevance of these solutions; present results and defend conclusions.

Transversal:

4. 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.
5. EFFICIENT ORAL AND WRITTEN COMMUNICATION. Communicating verbally and in writing about learning outcomes, thought-building and decision-making. Taking part in debates about issues related to the own field of specialization.
6. THIRD LANGUAGE. Learning a third language, preferably English, to a degree of oral and written fluency that fits in with the future needs of the graduates of each course.
7. TEAMWORK. Being able to work as a team player, either as a member or as a leader. Contributing to projects pragmatically and responsibly, by reaching commitments in accordance to the resources that are available.
8. EFFECTIVE USE OF INFORMATION RESOURCES. Managing the acquisition, structure, analysis and display of information from the own field of specialization. Taking a critical stance with regard to the results obtained.

Teaching methodology

There will be a lecture each week, followed by a problem session.

Learning objectives of the subject

To use algebraic, probabilistic and analytic methods for studying combinatorial structures. The main topics of study are:



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partially ordered sets, extremal set theory, finite geometries, matroids, Ramsey theory and enumerative combinatorics.

Study load

Total learning time: 187h 30m	Hours large group:	60h	32.00%
	Self study:	127h 30m	68.00%

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Content

Partially ordered sets	Learning time: 24h 40m Practical classes: 4h Laboratory classes: 4h Self study : 16h 40m
Description: Sperner's theorem. LYM inequalities. Bollobás's theorem. Dilworth's theorem	
Extremal set theory	Learning time: 24h 40m Theory classes: 4h Laboratory classes: 4h Self study : 16h 40m
Description: Theorems of Baranyai, Erdos-de Bruijn and Erdos-Ko-Rado	
Linear algebra methods in combinatorics	Learning time: 18h 30m Theory classes: 3h Laboratory classes: 3h Self study : 12h 30m
Description: The polynomial method and applications. Fisher's theorem. Equiangular lines, sets with few differences	
Finite geometries	Learning time: 18h 30m Theory classes: 3h Laboratory classes: 3h Self study : 12h 30m
Description: q-anologs of extremal problems. Segre's theorem. Blocking sets, ovals and hyperovals.	

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Matroids	Learning time: 18h 30m Theory classes: 3h Laboratory classes: 3h Self study : 12h 30m
Description: Axioms. Transversal matroids. Greedy algorithms. The Tutte polynomial	
Probabilistic methods in combinatorics	Learning time: 18h 30m Theory classes: 3h Laboratory classes: 3h Self study : 12h 30m
Description: Permanents, transversals, hypergraph coloring. Monotone properties and threshold functions	
Ramsey theory	Learning time: 31h 40m Theory classes: 5h Laboratory classes: 5h Self study : 21h 40m
Description: Theorems of Ramsey and Hales-Jewett. Theorems of Schur, Van der Waerden and Rado.	
Enumerative combinatorics	Learning time: 32h 30m Theory classes: 5h Laboratory classes: 5h Self study : 22h 30m
Description: Symbolic and analytic methods. Symmetries and Pólya theory.	

Qualification system

Grading will be based on the solution of exercises. Eventually there will a final examination.

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Bibliography

Basic:

- Alon, Noga; Spencer, Joel H.; Erdős, Paul. The probabilistic method. 3rd ed. New York: Wiley, 2008. ISBN 0471535885.
- Bollobás, Béla; Andrew Thomason (eds.). Combinatorics, geometry, and probability : a tribute to Paul Erdos. Cambridge: Cambridge University Press, 1997. ISBN 0521584728.
- Lint, Jacobus Hendricus van; Wilson, R. M. A Course in combinatorics. 2nd ed. Cambridge: Cambridge University Press, 2001. ISBN 0521803403.
- Flajolet P.; Sedgewick R. Analytic combinatorics [on line]. Cambridge: Cambridge University Press, 2009 Available on: <<http://site.ebrary.com/lib/upcatalunya/docDetail.action?docID=10277515>>. ISBN 9780521898065.
- Graham, Ronald L.; Rotschild, B.; Spencer, J. Ramsey theory. 2nd ed. New York: John Wiley & Sons, 1990. ISBN 0471500461.
- Anderson, Ian. Combinatorics of finite sets. Mineola: Dover, 2002. ISBN 0486422577.
- Lovász, László. Combinatorial problems and exercises. 2nd ed. Amsterdam: North-Holland, 1993. ISBN 044481504X.
- Oxley, J. G. Matroid theory. 2nd ed. Oxford: Oxford University Press, 2011. ISBN 9780199603398.