

## 34957 - GT - Graph Theory

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:	ORIOL SERRA ALBO
Others:	Primer quadrimestre: ANNA LLADO SANCHEZ - A ORIOL SERRA ALBO - A

### Prior skills

Elementary Calculus and Linear Algebra; basic notions and abilities in combinatorics and 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

Sessions of presentation of material alternate with sessions with student presentations of problems and specific topics. The active participation of students is a requirement for the evaluation of the course.

### Learning objectives of the subject

Application of spectral techniques to the study of graphs.



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Application of the probabilistic method.  
Properties of almost all graphs.  
Properties of Cayley and vertex symmetric graphs.  
Graphs on surfaces.  
Minors.

### Study load

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

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### Content

#### Spectral techniques in Graph Theory

Learning time: 1h

Theory classes: 1h

Description:

Adjacency and Laplacian matrix. Spectral properties. Cosppectral graphs. Graph invariants and spectral properties: chromatic number, Cheeger constant, expansion properties, maxcut, bisection width. The matrix tree theorem. Random walks in graphs. Shannon capacity.

Specific objectives:

Computation of spectra. Circulant graphs. Spectra and graph operations. Obtention of spectral bounds for graph invariants.

#### Symmetries in graphs

Learning time: 1h

Theory classes: 1h

Description:

#### Minors and treewidth

Degree competences to which the content contributes:

#### Graphs on surfaces

Degree competences to which the content contributes:

#### Graph homomorphisms

Degree competences to which the content contributes:

#### Random graphs

Degree competences to which the content contributes:

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Extremal Graph Theory	Learning time: 75h Theory classes: 24h 10m Practical classes: 24h 10m Assessment sessions: 3h Self study (distance learning): 23h 40m
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### Qualification system

The evaluation of the course is based on the weekly work on problems proposed in the presentation sessions. There will be a final comprehensive exam based on the problem sessions during the course.

### Regulations for carrying out activities

The active participation in the course is a requirement for the evaluation of the final exam.

### Bibliography

#### Basic:

- Biggs, Norman L. Algebraic graph theory. 2nd ed. New York: Cambridge University Press, 1993. ISBN 0521458978.
- Kolchin, V. F. Random graphs. Cambridge: Cambridge University Press, 1999. ISBN 0521440815.
- Chung, Fan R. K. Spectral Graph Theory. Providence: American Mathematical Society, 1997. ISBN 0821803158.
- Diestel, Reinhard. Graph theory. 3rd ed. Berlin: Springer, 2005. ISBN 3540261826.
- Hell, Pavol; Nešetřil, Jaroslav. Graphs and homomorphisms. Oxford: Oxford University Press, 2004. ISBN 0198528175.