



Academic year	2014-15
Subject	11292 - Cooperative and Critical Phenomena
Group	Group 1, 1S
Teaching guide	A
Language	English

## Subject identification

<b>Subject</b>	11292 - Cooperative and Critical Phenomena
<b>Credits</b>	1.5 de presencials (37.5 hours) 4.5 de no presencials (112.5 hours) 6 de totals (150 hours).
<b>Group</b>	Group 1, 1S (Campus Extens)
<b>Teaching period</b>	1st semester
<b>Teaching language</b>	English

## Professors

Lecturers	Horari d'atenció als alumnes					
	Starting time	Finishing time	Day	Start date	Finish date	Office
Maximino San Miguel Ruibal <a href="mailto:msr260@uib.es">msr260@uib.es</a>	14:00h	15:00h	Wednesday	01/09/2014	19/07/2015	IFISC 213
Tomás Miguel Sintés Olives <a href="mailto:tomas.sintes@uib.es">tomas.sintes@uib.es</a>	09:30h	10:30h	Thursday	22/09/2014	24/07/2015	207 (Edifici Institut Universitari de Recerca)

## Contextualisation

The aim of this subject is to train potential researchers in the study of phase transitions, critical phenomena, kinetic lattice models and nonequilibrium growth processes by using the tools and methodologies of statistical physics and nonlinear dynamics.

Chapters 1-5: Prof. M. San Miguel is a Dr. in Physics and an international well recognized scientist due to his large number of contributions in different fields, particularly in the context of phase transitions and critical phenomena. Presently he is the director of the IFISC.

Chapters 5-8: Prof. T. Sintés is a Dr. in Physics with a broad experience in the study of growth processes out of equilibrium, aggregation and gelation in colloidal and polymer systems.

## Requirements





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## Recommendable

It is highly recommended that students have taken statistical physics courses during their undergraduate studies.

## Skills

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### Specific

- \* To understand the critical and cooperative phenomena from the perspective of cross-disciplinary physics and complex systems (E4).
- \* To understand the meaning of concepts like scaling laws, and to apply the techniques of the renormalization group (E5).
- \* To know the main concepts of non equilibrium statistical physics, including reticular models and growth (E7).
- \* To understand the main concepts and techniques of complex networks (E15).
- \* To understand the basic concepts of the classic and quantic information theory: Shanon entropy, complexity, colectivities, quantum entanglement (E18).

### Generic

- \* To acquire the capacity to develop a complete research plan covering from the bibliographic research and strategy to the conclusions (TG2).
- \* To write and describe rigorously the research process and present the conclusions to an expert audience (TG3).
- \* To acquire high power computation skills and advanced numerical methods capabilities in applications to problems in the context of complex systems (TG6).

### Basic

- \* You may consult the basic competencies students will have to achieve by the end of the Master's degree at the following address: [http://estudis.uib.cat/master/comp\\_basiques/](http://estudis.uib.cat/master/comp_basiques/)

## Content

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### Theme content

- Chapter 1. Introduction to phase transitions and critical phenomena
- Chapter 2. Reticular models and universality classes
- Chapter 3. The mean field approach. The Landau theory. The hamiltonian of Ginzburg-Landau
- Chapter 4. Scale Invariance and thenormalization group
- Chapter 5. Kinetic Ising models
- Chapter 6. Kinetics of self-aggregation and gelation. The DLA model
- Chapter 7. The percolation theory
- Chapter 8. Surface growth and the KPZ equation





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## Teaching methodology

### In-class work activities

Modality	Name	Typ. Grp.	Description	Hours
Theory classes	Theoretical Lectures	Large group (G)	The students will acquire the knowledge and methodologies to understand the basic concepts in the study of cooperative and critical phenomena.	37.5

At the beginning of the semester a schedule of the subject will be made available to students through the UIBdigital platform. The schedule shall at least include the dates when the continuing assessment tests will be conducted and the hand-in dates for the assignments. In addition, the lecturer shall inform students as to whether the subject work plan will be carried out through the schedule or through another way included in the Campus Extens platform.

### Distance education work activities

Modality	Name	Description	Hours
Group or individual self-study	Autonomous work	The students will apply the concepts and techniques learned during the lectures to solve a collection of specific theoretical problems proposed by the professor. This task will enforce the understanding of this subject.	45
Group or individual self-study	Autonomous work	The students will apply the concepts and techniques learned during the lectures to solve numerically a specific problem related to phase transition and critical phenomena (i.e. the 2d Ising model). The students will present the results obtained in a rigorous way and will be evaluated.	28
Group or individual self-study	Autonomous work	The students will practice the concepts and techniques learned during the lectures to numerically solve a specific problem related to growth processes out of equilibrium. Additional bibliography, such as, scientific journals, will be provided in order to enhance the student ability to follow the scientific language. The students will present the results obtained in a rigorous way and will be evaluated.	39.5

### Specific risks and protective measures

The learning activities of this course do not entail specific health or safety risks for the students and therefore no special protective measures are needed.

## Student learning assessment





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### Autonomous work

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Modality	Group or individual self-study
Technique	Papers and projects ( <b>non-retrievable</b> )
Description	The students will apply the concepts and techniques learned during the lectures to solve a collection of specific theoretical problems proposed by the professor. This task will enforce the understanding of this subject.
Assessment criteria	The students must solve a collection of specific problems related to the content of this subject and will be evaluated accordingly.

Final grade percentage: 40%

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### Autonomous work

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Modality	Group or individual self-study
Technique	Papers and projects ( <b>non-retrievable</b> )
Description	The students will apply the concepts and techniques learned during the lectures to solve numerically a specific problem related to phase transition and critical phenomena (i.e. the 2d Ising model). The students will present the results obtained in a rigorous way and will be evaluated.
Assessment criteria	Public presentation of the results of a selected project on phase transitions and critical phenomena (i.e. the 2d Ising model).

Final grade percentage: 25%

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### Autonomous work

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Modality	Group or individual self-study
Technique	Papers and projects ( <b>non-retrievable</b> )
Description	The students will practice the concepts and techniques learned during the lectures to numerically solve a specific problem related to growth processes out of equilibrium. Additional bibliography, such as, scientific journals, will be provided in order to enhance the student ability to follow the scientific language. The students will present the results obtained in a rigorous way and will be evaluated.
Assessment criteria	Public presentation of the results of a selected project in out of equilibrium growth processes.

Final grade percentage: 35%

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## Resources, bibliography and additional documentation

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### Basic bibliography

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1. J. M. Yeomans, "Statistical Mechanics of Phase Transitions". Oxford Sci. Pub (2002).
2. P. M. Chaikin and T. C. Lubensky, "Principles of Condensed Matter Physics". Cambridge Univ. Press (2000)
3. E. Stanley, "Introduction to Phase Transitions and Critical Phenomena". Oxford Sci. Pub (1987)
4. P. Meakin, "Fractals, scaling and growth far from equilibrium". Cambridge University Press, (1998).

