

Academic year	2016-17
Subject	11006 - Quantum Physics for Complex Systems
Group	Group 1, 2S
Teaching guide	A
Language	English

Subject identification

Subject	11006 - Quantum Physics for Complex Systems
Credits	1.52 de presencials (38 hours) 4.48 de no presencials (112 hours) 6 de totals (150 hours).
Group	Group 1, 2S (Campus Extens)
Teaching period	Second semester
Teaching language	English

Professors

Lecturers	Horari d'atenció als alumnes					
	Starting time	Finishing time	Day	Start date	Finish date	Office
Llorenç Serra Crespi llorens.serra@uib.es	15:00	16:00	Monday	06/02/2017	19/06/2017	despatx 209 IFISC
Roberta Zambrini -	You need to book a date with the professor in order to attend a tutorial.					

Contextualisation

This is a compulsory subject of the basic module of the master in complex systems. It is taught in the second semester of the academic year. It provides the basics to understand complex quantum systems, both as closed and open systems.

Requirements

There are no specific requirements for the course. However, a basic knowledge of quantum physics at the undergraduate level is assumed.

Recommendable

A basic command of scientific English is highly recommended

Skills

Specific

- * E14 To understand the concept of symmetry breaking.
- * E16: To be able to identify characteristic properties of quantum systems including nonlinear effects.
- * E17: To be able to identify and model dissipation and decoherence effects in physical systems coupled to environments.

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Generic

- * TG1: To be able to describe, both mathematically and physically, complex systems in different situations.
- * TG2: To acquire the capacity to develop a complete research plan covering from the bibliographic research and strategy to the conclusions..
- * TG4: To acquire the ability to ask questions, read and listen critically and participate actively in seminars and discussions..

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/

Content

The course is divided into two parts, for closed and open quantum systems, respectively.

Theme content

1. Statistics and quantum mechanics: second quantization
Formalism of identical particles for states, operators and fields.

Part I. Open quantum systems

- I.2. Master equation
Derivation of master equations in weak coupling limit
- I.1. Motivation and system-bath theories
Introduction and overview of different approaches to open systems
- I.3. Damped oscillators
Description of decoherence with damped oscillators. Phase-space representations.
- I.4. Brownian motion
- I.5. Spin-boson model

Part II.. Closed quantum systems

- II.1. Non linearity in mean field
Static Hartree and Hartree-Fock models for bosons and fermions. Mean field symmetry breakings.
- II.2. Symmetries and collective modes
Dynamical self-consistent fields. Appearance of collective modes.
- II.3. Examples
Quantum dots. Bose-Einstein condensates. Numerical simulations.

Teaching methodology

In-class work activities

Modality	Name	Typ. Grp.	Description	Hours
Theory classes	Lectures	Large group (G)	Presentation of the course contents	24
Practical classes	Problem solving classes	Medium group (M)	Solving exercises	10
Practical classes	Work presentations	Medium group (M)	Presentation of the individual works to the class	4

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
Individual self-study	Problems	Solving problems	20
Individual self-study	Reading papers	Reading recommended papers	20
Individual self-study	Study	Assimilate new knowledge	55
Individual self-study	Work	Writing final work and preparing its presentation	17

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

Lectures

Modality	Theory classes
Technique	Short-answer tests (non-retrievable)
Description	Presentation of the course contents
Assessment criteria	Relevance of questions posed by the students and clarity in answers.

Final grade percentage: 30%



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Problem solving classes

Modality	Practical classes
Technique	Observation techniques (non-retrievable)
Description	Solving exercises
Assessment criteria	Correction and clarity in solving problems

Final grade percentage: 40%

Work presentations

Modality	Practical classes
Technique	Observation techniques (non-retrievable)
Description	Presentation of the individual works to the class
Assessment criteria	Quality of written work and clarity on its exposition

Final grade percentage: 30%

Resources, bibliography and additional documentation

Basic bibliography

Modern Many Particle Physics, Enrico Lipparini, World Scientific
Quantum dissipative systems, Ullrich Weiss, World Scientific

Complementary bibliography

Recommended papers.

Other resources

Lecture presentations.

