Syllabus

Subject

Subject / Group	11006 - Quantum Physics for Complex Systems / 1
Degree	Master's in Physics of Complex Systems
Credits	6
Period	2nd semester
Language of instruction	English

Professors

Lecturers	**Office hours for students**					
	Starting time	**Finishing time**	**Day**	**Start date**	**End date**	**Office / Building**
Llorenç Serra Crespí *Responsible* llorens.serra@uib.es	14:00	15:00	Monday	16/07/2019	31/07/2020	209, edifici Instituts
Roberta Zambrini -	16:00	17:00	Wednesday	01/10/2019	31/07/2020	Ed.inst.univ., despacho 206

Context

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.

Recommended

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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Syllabus

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.

Range of topics

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 fermions. Mean field symmetry breakings.

II.2. Symmetries and collective modes
Dynamical self-consistent fields. Independent particles, Tamm-Dancoff and RPA. Emergence of collective modes.

II.3. Examples
Metallic clusters. Quantum dots.

Teaching methodology

In-class work activities (1.36 credits, 34 hours)

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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

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 Aula Digital platform.

Distance education tasks (4.64 credits, 116 hours)

Modality	Name	Description	Hours
Individual self-study	Optional work	Written work on a specifically assigned subject. The LaTex editor must be used.	17
Individual self-study	Study	Assimilate new knowledge	67
Individual self-study	Problems	Solving problems	20
Individual self-study	Reading papers	Reading recommended papers	10
Individual self-study	Questionaires	Answer questionnaires (multiple option choice) using the UIB digital platform,	2

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

Frau en elements d'avaluació

In accordance with article 33 of Regulation of academic studies, "regardless of the disciplinary procedure that may be followed against the offending student, the demonstrably fraudulent performance of any of the evaluation elements included in the teaching guides of the subjects will lead, at the discretion of the teacher, a undervaluation in the qualification that may involve the qualification of "suspense 0" in the annual evaluation of the subject".

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Lectures

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

Final grade percentage: 5%

Problem solving classes

Modality	Practical classes
Technique	Observation techniques **(non-retrievable)**
Description	Solving exercises
Assessment criteria	Correction and clarity in solving problems. Written solutions must be handed in to the professors on specific dates. Specific problems are assigned to each student.

Final grade percentage: 15%

Optional work

Modality	Individual self-study
Technique	Papers and projects **(non-retrievable)**
Description	Written work on a specifically assigned subject. The LaTex editor must be used.
Assessment criteria	Individual written work. It is required to use the LaTex text editor. A specific work will be assigned to each student on request. This is an optional activity usually requiring reading papers and performing analytic and numerical calculations.

Final grade percentage: 20%

Questionaires

Modality	Individual self-study
Technique	Short-answer tests **(non-retrievable)**
Description	Answer questionnaires (multiple option choice) using the UIB digital platform,
Assessment criteria	Answer questionnaires using the UIB digital platform. The student has to choose among several options for each question. The test is randomly generated at each attempt. The test includes 30 questions to be answered in one hour on a specific day and time.

Final grade percentage: 60%

Resources, bibliography and additional documentation

Basic bibliography

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

Complementary bibliography

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Recommended papers.

Other resources

Lecture presentations.

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