Mathematics for quantum mechanics

Academic Year: (2023 / 2024) **Review date: 21-04-2023**

Department assigned to the subject: Mathematics Department

Coordinating teacher: LLEDO MACAU, FERNANDO

Type: Electives ECTS Credits : 3.0

Year : 2 Semester : 1

REQUIREMENTS (SUBJECTS THAT ARE ASSUMED TO BE KNOWN)

Linear algebra, analysis and quantum physics.

OBJECTIVES

According to the master's documentation the students will obtain in this course the following basic, general and specific competences (see additional documentation in the application "Reina").

CB6, CB9, CB10

CG2, CG4, CG5,
CG6, CG7

CE1, CE2, CE3, CE4,
CE5, CE6, CE7, CE8,
CE9, CE10, CE11,

DESCRIPTION OF CONTENTS: PROGRAMME

The present course aims at complementing the mathematical bases in relation to fundamental aspects of quantum theory putting particular emphasis to the infinite-dimensional case and in relation to relevant aspects of quantum theory. The course will develop the following contents:

1. Recap of basic notions: Hilbert spaces, operators and states. Tensor product structure. Examples.

2. The emergence of infinite dimensions: Canonical (anti)commutation relations. Finite versus infinite dimensions. Spectral theorem. Types of spectrum. Measurements. Operator algebas.

3. Symmetries in quantum physics: Unitary representation of groups. Time evolution.

LEARNING ACTIVITIES AND METHODOLOGY

The following lessons (12 theory and 10 excercise sessions) will be devoted to the following activities:ç

i) The teacher will present the main topics and techniques of the course using the necessary informatic support. The necessary bibliography will be presented in order to complement the students background. Along the lectures the students will be tutorized to achieve the objectives mentioned above.

ii) Critical reading of texts and scientific article recommended by the teacher. This will support the scientific background of students.

iii) Solutions of practical exercises and problems by the teacher and studens (individually or in groups).

In addition there will be two hours per week of personal tutorships where the students can ask for support for understanding of the lectures, solve the exercises or prepare little projects.

ASSESSMENT SYSTEM

According to the master's documentation, the final grade will be assigned in view of the students¿ performance in two kinds of assessments: continuous evaluation (40%) consisting of problems solved by the students and/or a partial examination and a final evaluation (60%) consisting of a final exam and/or some projects distributed during the course.

% end-of-term-examination:	60
% of continuous assessment (assigments, laboratory, practicals…):	40

BASIC BIBLIOGRAPHY

- B.C. Hall Quantum Theory for Mathematicians, Springer, New York., 2013

- G. Mackey Mathematical Foundations of Quantum Mechanics, Dover, 2004

- M. Reed and B. Simon Methods of Modern Mathematical Physics. Vol. 1. Functional Analysis , Academic Press, San Diego, 1980.

- M. Ziman and T. Heinosaari Guide to Mathematical Concepts of Quantum Theory, Acta Physica Slovaca 58 (2008) 487-674, 2008

ADDITIONAL BIBLIOGRAPHY

- J. von Neumann Mathematical Foundations of Quantum Mechanics, Princeton University Press , 1955.

- V. Moretti Spectral Theory and Quantum Mechanics, Springer , 2013.