COURSE DATA

DATA SUBJECT

Code: 46963
Name: Fundamentals of Quantum Technologies
Cycle: Master's Degree
ECTS Credits: 3
Academic year: 2025-26

STUDY (S)

Degree	Center	Acad. year	Period
2264 - Master's Degree in Quantum Technologies	Facultat de Física	1	First quarter

SUBJECT-MATTER

Degree	Subject-matter	Character
2264 - Master's Degree in Quantum Technologies	Fundamentos	COMPULSORY

COORDINATION

PEREZ CAÑELLAS ARMANDO

SUMMARY

This course establishes the mathematical foundations and physical motivations that support the development of quantum theory and its technological applications. It begins with the distinction between quantum theory (the abstract theory of probabilities that gives rise to quantum information theory using Hilbert spaces as a mathematical tool) and quantum mechanics (the physical theory that arises from applying quantum theory to physical systems such as atoms and photons).

PREVIOUS KNOWLEDGE

RELATIONSHIP TO OTHER SUBJECTS OF THE SAME DEGREE

There are no specified enrollment restrictions with other subjects of the curriculum.

COMPETENCES / LEARNING OUTCOMES

DESCRIPTION OF CONTENTS

Historical and conceptual introduction. 1st and 2nd quantum revolutions.

·Postulates of quantum theory and mathematical tools.

·Density operator. Pure states and mixing.

·Von Neumann entropy.

·Reversible transformations.

·Description of composite systems.

·Entangled states.

·Schmidt decomposition.

·Purification.

WORKLOAD

PRESENCIAL ACTIVITIES

Activity	Hours
Theory	30,00
Total hours	**30,00**

NON PRESENCIAL ACTIVITIES

Activity	Hours
Attendance at other activities	0,00
Individual or group project	0,00
Independent study and work	0,00
Preparation of lessons	0,00
Preparation for assessment activities	0,00
Resolution of case studies	0,00
Total hours	**0,00**

TEACHING METHODOLOGY

Masterclasses

Case study resolution

Presentations on project work or problem deliverables

Individual and/or group tutoring

EVALUATION

Assessment of participation in tutorials (minimum weighting: 0.0 and maximum weighting: 20.0)

Assessment of reports, practical exercises, and individual or group work (minimum weighting: 0.0 and maximum weighting: 40.0)

Assessment of the final oral or written exam (minimum weighting: 40.0 and maximum weighting: 100.0)

REFERENCES

L. E. Ballentine, Quantum Mechanics: A Modern Development (World Scientific, 2014).

M. Fayngold y V. Fayngold, Quantum Mechanics and Quantum Information (Wiley-VCH, 2013).

C. J. Isham, Lectures on Quantum Theory: Mathematical and Structural Foundations (Imperial College Press, 1995).

M. A. Nielsen e I. L. Chuang, Quantum Computation and Quantum Information (Cambridge University Press, 2000), Cap. 2.

J. Preskill, Lectures Notes on Quantum Computation (http://theory.caltech.edu/people/preskill/ph229/), Caps. 2-4.

V. Scarani, C. Lynn y L. S. Yang, Six Quantum Pieces: A First Course in Quantum Physics (World Scientific, 2010).

A. Peres, Quantum Theory: Concepts and Methods (Kluwer, 1993).

C. Cohen-Tannoudji, B. Diu y F. Laloe#, Quantum Mechanics. Volume 1: Basic Concepts, Tools, and Applications (Wiley, 2020).