

## Quantum Physics

Academic Year: ( 2024 / 2025 )

Review date: 12-02-2024

Department assigned to the subject: Physics Department

Coordinating teacher: SANCHEZ FERNANDEZ, LUIS RAUL

Type: Compulsory ECTS Credits : 6.0

Year : 2 Semester : 1

## REQUIREMENTS (SUBJECTS THAT ARE ASSUMED TO BE KNOWN)

It is highly recommended that students have successfully passed the following first-year subjects:

Physics I, Physics II, Calculus I, Calculus II, Algebra & Programming.

## SKILLS AND LEARNING OUTCOMES

CB1. Students have demonstrated possession and understanding of knowledge in an area of study that builds on the foundation of general secondary education, and is usually at a level that, while relying on advanced textbooks, also includes some aspects that involve knowledge from the cutting edge of their field of study.

CB2. Students are able to apply their knowledge to their work or vocation in a professional manner and possess the competences usually demonstrated through the development and defence of arguments and problem solving within their field of study.

CB3. Students have the ability to gather and interpret relevant data (usually within their field of study) in order to make judgements which include reflection on relevant social, scientific or ethical issues.

CB4. Students should be able to communicate information, ideas, problems and solutions to both specialist and non-specialist audiences.

CB5. Students will have developed the learning skills necessary to undertake further study with a high degree of autonomy.

CG1. Analyze and synthesize basic problems related to physics and engineering, solve them and communicate them efficiently.

CG2. Learn new methods and technologies from basic scientific and technical knowledge, and being able to adapt to new situations.

CG3. Solve problems with initiative, decision making, creativity, and communicate and transmit knowledge, skills and abilities, understanding the ethical, social and professional responsibility of the engineering activity. Capacity for leadership, innovation and entrepreneurial spirit.

CG5. Use the theoretical and practical knowledge acquired in the definition, approach and resolution of problems in the framework of the exercise of their profession.

CE13. Understand and handle solid state physical principles relevant to engineering and, in particular, semiconductors for application in electronic and photonic components, as well as the fundamentals and applications of analog and digital electronics and microprocessors.

CE17. Understand and handle the fundamental concepts of Quantum Physics, its relationship with Classical Physics, and its application to the understanding of the physics of atoms and molecules, as well as solving simple one- and three-dimensional quantum problems and applying approximate resolution methods.

CT1. Work in multidisciplinary and international teams as well as organize and plan work making the right decisions based on available information, gathering and interpreting relevant data to make judgments and critical thinking within the area of study.

RA1. To have acquired sufficient knowledge and proved a sufficiently deep comprehension of the basic principles, both theoretical and practical, and methodology of the more important fields in science and technology as to be able to work successfully in them.

RA2. To be able, using arguments, strategies and procedures developed by themselves, to apply their knowledge and abilities to the successful solution of complex technological problems that require creating and innovative thinking.

RA3. To be able to search for, collect and interpret relevant information and data to back up their

conclusions including, whenever needed, the consideration of any social, scientific and ethical aspects relevant in their field of study.

RA6. To be aware of their own shortcomings and formative needs in their field of specialty, and to be able to plan and organize their own training with a high degree of independence.

## DESCRIPTION OF CONTENTS: PROGRAMME

1. Foundation of Quantum Mechanics. Black body spectrum and Planck's postulate. Einstein's theory of the photoelectric effect. The Compton effect. De Broglie principle and the wave-particle duality. Rutherford and Bohr atomic models.
2. Schrödinger's equation. Wave functions. Born interpretation: probability density. Expected values and measurement. Energy, position and momentum. Uncertainty principle.
3. Time-independent Schrödinger equation. Energy quantization. Bounded and unbounded states.
4. Unidimensional problems. Free particle solution. Potential steps, wells and barriers. The harmonic oscillator. Quantum tunnelling.
5. Three-dimensional problems. Central potentials. The Schrödinger equation in spherical coordinates.
6. Solution of the Hydrogen atom.

## LEARNING ACTIVITIES AND METHODOLOGY

AF1. THEORETICAL-PRACTICAL CLASSES. Knowledge and concepts students must acquire. Receive course notes and will have basic reference texts. Students partake in exercises to resolve practical problems

AF2. TUTORING SESSIONS. Individualized attendance (individual tutoring) or in-group (group tutoring) for students with a teacher. Subjects with 6 credits have 4 hours of tutoring/ 100% on-site attendance.

AF3. STUDENT INDIVIDUAL WORK OR GROUP WORK. Subjects with 6 credits have 98 hours/0% on-site.

AF8. WORKSHOPS AND LABORATORY SESSIONS. Subjects with 3 credits have 4 hours with 100% on-site instruction. Subjects with 6 credits have 8 hours/100% on-site instruction.

AF9. FINAL EXAM. Global assessment of knowledge, skills and capacities acquired throughout the course. It entails 4 hours/100% on-site

AF8. WORKSHOPS AND LABORATORY SESSIONS. Subjects with 3 credits have 4 hours with 100% on-site instruction. Subjects with 6 credits have 8 hours/100% on-site instruction.

MD1. THEORY CLASS. Classroom presentations by the teacher with IT and audiovisual support in which the subject's main concepts are developed, while providing material and bibliography to complement student learning

MD2. PRACTICAL CLASS. Resolution of practical cases and problem, posed by the teacher, and carried out individually or in a group

MD3. TUTORING SESSIONS. Individualized attendance (individual tutoring sessions) or in-group (group tutoring sessions) for students with teacher as tutor. Subjects with 6 credits have 4 hours of tutoring/100% on-site.

MD6. LABORATORY PRACTICAL SESSIONS. Applied/experimental learning/teaching in workshops and laboratories under the tutor's supervision.

## ASSESSMENT SYSTEM

**% end-of-term-examination:** 60

**% of continuous assessment (assignments, laboratory, practicals...):** 40

1) Laboratory sessions (20% of final mark)

Attendance to the laboratory sessions is compulsory to pass this course.

The mark of the reports takes into account attendance, quality of reports, etc. The mark is usually shared by the members of the lab group, except when explicitly stated.

2) Assessment during the course (20% of final mark)

- Midterm exams

3) Final exam (60% of final mark)

The exam is made at the end of the semester and it is the same for all the students

Contents:

- Problems to be solved covering the topics of the program

The minimum required grade in the final exam is 3/10.

#### BASIC BIBLIOGRAPHY

- D.J. Griffiths Introduction to Quantum Mechanics. , Ed. Prentice Hall., 1995

#### ADDITIONAL BIBLIOGRAPHY

- Anthony Levi Applied Quantum Mechanics for Engineers and Physicists, Cambridge University Press, 2006

- David Miller Quantum Mechanics for Scientists and Engineers, Cambridge University Press, 2007