1. BASIC INFORMATION

Course	Quantum Physics II
Degree program	Degree in Physics
School	School of Science, Engineering and Design
Year	3
ECTS	6
Credit type	Mandatory
Language(s)	English
Delivery mode	In-person
Semester	6
Academic year	2024-2025
Coordinating professor	Joaquín Santos Blasco
Professor	Joaquín Santos Blasco

2. PRESENTATION

The course "Quantum Physics II" is a mandatory subject within the curriculum of the Physics Degree at the European University of Valencia. This course is a continuation of Quantum Physics I and introduces students to more advanced concepts, such as the general theory of angular momentum in quantum mechanics, scattering theory, perturbative methods, and the concept of identical particles.

Throughout the course, students are expected to gain knowledge about the differences between Quantum Mechanics and Classical Mechanics and their range of validity. This course, along with Quantum Physics I and Nuclear and Particle Physics, is essential for studying the basic structure of matter and opens the door to research and technological development in material science, nuclear physics, and advanced fundamental physics.

3. COMPETENCIES AND LEARNING OUTCOMES

Core competencies:

- CB1. Knowing the most important concepts, methods, and results of the various branches of Physics, along with a certain historical perspective of their development.
- CB3 - Students should have the ability to gather and interpret relevant data (usually within their field of study) to make judgments that include reflection on relevant social, scientific, or ethical issues.
- CB5 - Students should have developed the learning skills necessary to undertake further studies with a high degree of autonomy.

Cross-curricular Competencies:

- CT4 - Written/Oral Communication: The ability to convey and receive data, ideas, opinions, and attitudes to achieve understanding and action, with oral communication involving words and gestures, and written communication involving writing and/or graphic supports.
- CT5 - Problem Analysis and Resolution: The ability to critically evaluate information, break down complex situations into their constituent parts, recognize patterns, and consider alternative approaches, perspectives, and solutions to find optimal outcomes and efficient negotiations.

Specific Competencies:

- CE2 - Describe and analyze physical systems, identifying the fundamental concepts and principles to make the necessary approximations that allow for the construction of a simplified model.
- CE4 - Understand and explain the laws and principles of Physics, identify their logical and mathematical structure, their experimental support, and the phenomena they describe.
- CE5 - Understand and know how to use the mathematical and numerical methods applied in Physics and in handling experimental data.

Learning Outcomes:

- RA1 - Understand the problem of indistinguishability in Quantum Mechanics and its consequences in the study of systems of many identical particles.
- RA2 - Use approximate methods for the analysis of quantum systems that cannot be solved exactly.
- RA3 - Apply collision theory in Quantum Mechanics to simple scattering models.

The following table shows the relationship between the competencies developed during the course and the learning outcomes pursued:

Competencies	Learning outcomes
CG1, CB3, CB5, CT1, CT5, CE2	RA1 - Understand the problem of indistinguishability in Quantum Mechanics and its consequences in the study of systems of many identical particles.
CB3, CB5, CT1, CT5, CE2, CE5	RA2 - Use approximate methods for the analysis of quantum systems that cannot be solved exactly.
CB3, CB5, CT1, CT5, CE2, CE4, CE5	RA3 - Apply collision theory in Quantum Mechanics to simple scattering models

4. CONTENT

1. General Angular Momentum
2. Spin Angular Momentum
3. Identical Particle Systems
4. Approximation Methods
5. Introduction to Quantum Scattering Theory

5. TEACHING-LEARNING METHODOLOGIES

The types of teaching-learning methodologies used are indicated below:

- Cooperative Learning: Students learn to collaborate with others (peers and teachers) to creatively, integratively, and constructively solve the questions and problems identified from the presented cases, using the available knowledge and material resources.

- Problem-Based Learning: Problems will be presented with the goal of having students solve them, either working in teams or individually.
- Lectures: Presentations by the professor using the necessary technological tools to ensure maximum understanding of the concepts taught.
- Directed Academic Activities: More autonomous work, both individual and group-based, involving information search, written synthesis, debates, and public defense of work.

6. LEARNING ACTIVITIES

Listed below are the types of learning activities and the number of hours the student will spend on each one:

Campus-based mode:

Learning activity	Number of hours
Lectures	22
Oral presentations and debates	13
Report writing	10
Formative assessment	5
Practical activities (problems, assignments, projects, workshops and/or laboratories)	20
Tutorials	6
Autonomous work	74
TOTAL	**150**

7. ASSESSMENT

Listed below are the assessment systems used and the weight each one carries towards the final course grade:

Campus-based mode:

Assessment system	Weight
In-person individual knowledge tests, being theoretical and/or practical	50%
Submission of reports/assignments/projects and group and/or individual exercises	30%
Oral Defense	10%
Performance Observation	10%

When you access the course on the *Campus Virtual*, you'll find a description of the assessment activities you have to complete, as well as the delivery deadline and assessment procedure for each one.

7.1. First exam period

To pass the course in the first exam period, you must obtain a final course grade of at least 5 out of 10 (weighted average).

In any case, you will need to obtain a grade of at 5.0 in the final exam in order for it to count towards the final grade along with all the grades corresponding to the other activities.

To be eligible to take the first period evaluation exam, attendance at in-person classes must be 50% or higher. Attendance must be in person. Synchronous virtual attendance via HyFlex is only counted in cases that are approved and justified by the university.

7.2. Second exam period

To pass the course in the second exam period, you must obtain a final grade of at least 5 out of 10 (weighted average).

In any case, you will need to obtain a grade of at 5.0 in the final exam in order for it to count towards the final grade along with all the grades corresponding to the other activities.

The student must deliver the activities not successfully completed in the first exam period after having received the corresponding corrections from the professor, or those that were not delivered in the first place.

8. SCHEDULE

This table shows the delivery deadline for each assessable activity in the course:

Assessable activities	Deadline
Exercise 1	Week 2
Exercise 2	Week 5
Exercise 3	Week 8
Partial exam	Week 9
Exercise 4	Week 11
Exercise 5	Week 13
Oral exposition/workshop	Week 15
First term exam	Weeks 18-19

This schedule may be subject to changes for logistical reasons relating to the activities. The student will be notified of any change as and when appropriate.

9. REFERENCES

The main reference work for this subject is:

- Kok, P. (2018). *A First Introduction to Quantum Physics*. Springer.

The recommended Bibliography is:

- Griffiths, D. J.; Schroeter, D. F. (2018) - *Introduction to Quantum Mechanics* (3rd edition). Cambridge University Press.
- Sakurai, J. J.; Napolitano, J. (2020). *Modern Quantum Mechanics* (3rd edition.). Cambridge: Cambridge University Press.
- Trachanas, S.;, Antonoyiannakism M.; Tsetseris, L. (2018). *An Introduction to Quantum Physics_ A First Course for Physicists, Chemists, Materials Scientists, and Engineers*. Wiley-VCH.

10. EDUCATIONAL GUIDANCE DIVERSITY AND INCLUSION UNIT

From the Educational Guidance, Diversity and Inclusion Unit we offer support to our students throughout their university life to help them reach their academic achievements. Other main actions are the students' inclusions with specific educational needs, universal accessibility on the different campuses of the university and equal opportunities.

From this unit we offer to our students:

1. Accompaniment and follow-up by means of counselling and personalized plans for students who need to improve their academic performance.
2. In terms of attention to diversity, non-significant curricular adjustments are made in terms of methodology and assessment for those students with specific educational needs, pursuing an equal opportunity for all students.
3. We offer students different extracurricular resources to develop different competences that will encourage their personal and professional development.
4. Vocational guidance through the provision of tools and counselling to students with vocational doubts or who believe they have made a mistake in their choice of degree.

Students in need of educational support can write to us at:
orientacioneducativa.uev@universidadeuropea.es

11. ONLINE SURVEYS

Your opinion matters!

The Universidad Europea encourages you to participate in several surveys which help identify the strengths and areas we need to improve regarding professors, degree programs and the teaching-learning process.

The surveys will be made available in the "surveys" section in virtual campus or via e-mail.

Your assessment is necessary for us to improve.

Thank you very much for your participation.