1. OVERVIEW

Subject area	Experimental Project III
Degree	Bachelor's Degree in Physics
School/Faculty	School of Architecture, Engineering and Design
Year	4º
ECTS	6
Type	Compulsory
Language(s)	Spanish
Delivery mode	On campus
Semester	1º

2. INTRODUCTION

The subject area **Experimental Project III** is taught in the first semester of the fourth year of the Bachelor's Degree in Physics. It is the natural continuation of the subject areas *Experimental Project I* and *Experimental Project II*, which are studied in the second semester of the second year and the second semester of the third year, respectively.

The main aim of this subject area is to consolidate students' knowledge of the subject areas taught in this semester and in previous years. They will also learn to use the scientific instruments needed for the experiments to be performed in this subject area. As such, students will mainly consolidate their knowledge of **nuclear and particle physics**, **quantum mechanics** and **solid-state physics**, encountering different instrumentation systems, the key concepts of which should already be ingrained through the study of subject areas such as **Optics** or **Electromagnetism**.

Half of the subject area consists of regulated practical activities on the above-mentioned topics and the other half consists of a project based on scientific methodology. Students must complete this project individually under the professor's supervision. As in the subject area Experimental Project II, this project will be more complex and will require a higher level of scientific rigour. Students will also need to apply the theoretical and practical knowledge acquired during the degree programme.

By the end of the subject area, in addition to having consolidated the theoretical knowledge acquired in previous or parallel subject areas, students will have completed their own experiments and reached conclusions in a critical and rigorous manner.

The end goal of this subject area is for students to also be able to present and defend their findings in public, with the aim of demonstrating their acquired knowledge and their ability to summarise. In addition, they should be able to present and defend their findings in front of a critical audience, thereby complementing and completing the experimental learning objectives set for them on the Bachelor's Degree in Physics.

3. SKILLS AND LEARNING OUTCOMES

Basic skills and general skills (CB and CG, respectively, by their acronym in Spanish):

- **CB4 -** Students can communicate information, ideas, problems and solutions to both specialist and non-specialist audiences.
- **CB5** - Students have developed the learning skills necessary to undertake further study in a much more independent manner.
- **CG2** - Ability to plan and perform independent work when managing projects associated with different areas of physics.
- **CG4** - To convey knowledge, procedures, results and scientific ideas in the field of physics, both orally and in writing.

Cross-curricular skills (CT, by the acronym in Spanish):

- **CT1** - *Ethical values:* Ability to think and act in line with universal principles based on the value of individuals, contributing to their development and involving commitment to certain social values.
- **CT2 -** *Independent learning:* A range of skills in order to choose research, analysis, evaluation and information management strategies from different sources, as well as to learn and put into practice what has been learnt independently.
- **CT3** - *Teamwork:* Ability to integrate and collaborate actively with other people, areas and/or organisations to reach common goals.
- **CT4** - *Written communication/Oral communication:* Ability to communicate and gather information, ideas, opinions and viewpoints in order to understand and be able to act upon them, whether they are through spoken word and gestures, or through written word and/or visual aids.
- **CT5** - *Problem solving:* Be able to critically evaluate information, separate complex situations into their constituent parts, recognise patterns, and consider alternatives, different approaches and perspectives in order to find optimal solutions and negotiate efficiently.
- **CT6 -** *Adaptability:* Being able to accept, appreciate and integrate different positions, being able to adapt one's own approach as required by the situation, as well as working effectively in ambiguous situations.
- **CT7** - *Leadership:* To be able to direct, motivate and guide others, recognising their skills and abilities in order to effectively manage their development and common interests.
- **CT8** - *Entrepreneurial spirit:* Ability to take on and carry out activities that generate new opportunities, anticipate problems or bring about improvements.

Specific skills (CE, by the acronym in Spanish):

- **CE01** - To estimate orders of magnitude in order to interpret diverse phenomena.
- **CE04** - To understand the laws and principles of physics, to identify their logical and mathematical structure, their experimental basis and the phenomena described through them.
- **CE05** - To understand and know how to use the mathematical and numerical methods used in physics and in handling experimental data.
- **CE06** - To understand key experimental models and to perform experiments independently, describing, analysing and critically assessing experimental data.
- **CE07** - To use the most suitable electronic instruments and IT tools to study physical problems and search for solutions.

Learning outcomes (RA, by the acronym in Spanish):

- **RA1** - To follow measurement-taking protocols, especially those concerning the safety of the person conducting the experiment.
- **RA2** - To effectively manage the systematic and random errors that could affect an experiment.
- **RA3** - To understand the role of the measuring instruments, hardware and software used in different areas of physics, with the ability to calibrate and/or configure the corresponding systems.
- **RA4** - To understand the codes of ethics applicable to the process of science communication, ensuring the reproducibility and reliability of the data.
- **RA5** - To collaborate effectively as part of an experimental group to design and conduct a scientific/technical project.

The following table shows how the skills developed in the subject area match up with the intended learning outcomes:

Skills	Learning outcomes
CB4, CB5, CG4, CT1, CT2, CT4, CT2, CE01, CE04, CE05, CE06	**RA1** - To follow measurement-taking protocols, especially those concerning the safety of the person conducting the experiment.
CB4, CB5, CG2, CG4, CT2, CT4, CT6, CT7, CT8, CE01, CE04, CE05, CE06	RA2 - To effectively manage the systematic and random errors that could affect an experiment.
CB5, CG4, CT3, CT2, CT3, CT6, CT7, CT8, CE04, CE06, CE07	**RA3** - To understand the role of the measuring instruments, hardware and software used in different areas of physics, with the ability to calibrate and/or configure the corresponding systems.
CB5, CG2, CT1, CT3, CT5, CT7, CT8, CE04, CE06, CE07	**RA4** - To understand the codes of ethics applicable to the process of science communication, ensuring the reproducibility and reliability of the data.
CB4, CG2, CG4, CT1, CT3, CT4, CT7, CT8	**RA5** - To collaborate effectively as part of an experimental group to design and conduct a scientific/technical project.

4. CONTENTS

This subject area is organised into three interrelated learning units:

- Nuclear and particle physics laboratory
- Quantum mechanics laboratory
- Integrative project

5. TEACHING/LEARNING METHODS

The types of teaching/learning methods are as follows:

- **Case studies**: Discussion of real cases that allow for practical application of the acquired theoretical knowledge.
- Collaborative learning: Students learn to collaborate with other people (classmates and professors) in order to find creative, comprehensive and constructive solutions to questions and problems that arise from the given case studies, using all relevant knowledge and material resources available.

- **Problem-based learning**: Students are given problems and asked to solve them, working individually or in groups.

- **Project-based learning**: Geared towards the completion of projects similar to those found in real work environments. This involves following a methodology to complete the project and choosing between different alternatives.

- **Lectures**: Presentations by the professor with the necessary technological tools to maximise comprehension of the learning content.

- **Workshop-based learning**: Students acquire knowledge through learning to use the tools and equipment needed in their profession. In other words, "learning by doing".

- **Guided academic activities:** Individual and group work that is more independent, including information searches, written summaries, debates and the public defence of projects.

6. LEARNING ACTIVITIES

The types of learning activities, plus the amount of time spent on each activity, are as follows:

On campus:

Learning activity	Number of hours
Lectures	20
Oral presentations of projects and debates	6
Report writing	40
Assessment	6
Practical activities (problems, written work, projects, workshops and/or lab work)	60
Tutorials	10
Independent working	28
TOTAL	**150**

7. ASSESSMENT

The assessment systems, plus their weighting in the final grade for the subject area, are as follows:

On campus:

Assessment system	Weighting
Submission of group reports (assessment system 1 or SE1, by its acronym in Spanish) Students will comment on each completed practical activity with their professor before starting the next activity. This is when they will be awarded 60% of the grade. Before returning to the laboratory, they must have uploaded the report on the previous practical activity, considering the professor's feedback during their commentary. This report accounts for the remaining 40% of the grade. The average of the grade for the practical activities will be the definitive grade, and it will account for 50% of the final grade.	50% (60% commentary + 40% report)
Oral defence (SE2) Students will give an oral presentation about one of their practical activities. The format of the presentation will be specified at the start of the subject area.	20%
Performance (SE3) The members of each group will assess between them the individual performance of each member. Based on this group assessment, the group members must assign grades to each member in such a way that the average of these grades is the group average. If it does not coincide or no grades are assigned, each student will be given the group grade minus two points.	30%

IMPORTANT: The lab-based activities are an essential part of the students' training, and the delivery mode is strictly on campus. As such, if students do not come to the laboratory to complete the practical activities, they will not achieve the minimum learning outcomes and, therefore, they will not pass the subject area. As such, **if any student misses more than two lab sessions without due cause (30% of the sessions), they can neither pass the subject area in the ordinary nor the extraordinary exam period.**

On the Virtual Campus, when you open the subject area, you'll find details of your assessable tasks, including the submission dates and assessment procedures for each task.

8. BIBLIOGRAPHY

The main bibliography for the subject area is as follows:

- H.D. Young, R.A. Freedman, F.W. Sears y M.W. Zemansky, **Física universitaria**, Vol. 1 y 2. 12ª ed. Pearson Education (2013).
- D. C. Giancoli, **Physics: Principles and applications**, 7ª ed. Pearson Education (2014).
- P.A. Tipler y G. Mosca, **Física para la Ciencia y la Tecnología**, Vol. 1 y 2. 6ª ed. Ed. Reverté (2010).
- M. Alonso y E.J. Finn, **Física**. Addison-Wesley Iberoamericana (1995).