1. OVERVIEW

Subject area	Solid-State Physics
Degree	Bachelor's Degree in Physics
School/Faculty	Architecture, Engineering and Design
Year	3
ECTS	6
Type	Compulsory
Language(s)	Spanish
Delivery mode	On campus
Semester	1

2. INTRODUCTION

Solid-state physics (SSP) is the most important branch of what is known today as **condensed matter physics**; which, in turn, is the branch of physics that studies the properties of condensed matter and is the biggest field of study in modern physics (a large percentage of the Nobel Prizes in Physics awarded to date are directly or indirectly linked to breakthroughs in this area). **SSP** focuses on the **study of solid-state matter and, more specifically, on crystalline solids**, where it is easiest to apply the different physical models used to study their properties.

SSP is a **key subject area** (and, therefore, a compulsory one) on the Bachelor's Degree in Physics for the following **educational, scientific and technological reasons**:

- From an **educational** perspective, students will acquire a general overview of the study of solid bodies, of how physical models are proposed and how the principles of quantum mechanics and statistical physics are used in these models. They will also build a foundation from which to study any derived branch of condensed matter physics in greater depth.

- From a **scientific** and **technical** perspective, students will easily see the connection between **SSP** and other disciplines and its potential uses in the latest technology. This makes the subject area especially important as it equips students with the tools that they will need in their future careers, whether in a scientific or technological field.

Although this subject area is a block in itself, students are advised that a **basic understanding of mechanics and waves, electromagnetism, quantum physics and statistical physics is recommended**.

For students **interested in broadening** their **SSP** studies, **we recommend** taking the subject areas **Materials Physics**, **Introduction to Nanotechnology**, **Physical Electronics** and **Photonics**.

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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.
- **CG1**. To understand key concepts, methods and findings in the different branches of physics while gaining a historical perspective of their development.
- **CG5**. To understand diverse phenomena that, despite being physically different, share certain similarities, allowing known solutions to be applied to new problems.

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

- **CT5**. Problem solving: the ability to critically assess 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.

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

- **CE01**. To estimate orders of magnitude in order to interpret diverse phenomena.
- **CE02**. To describe and analyse physical systems, identifying fundamental concepts and principles to make the approximations needed to build a simplified model.
- **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.
- **CE09**. To understand the processes for obtaining materials and the physical fundamentals and uses of materials.

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

- **RA1**. To identify the physical phenomena associated with the vibrations of atoms in crystalline networks and their modelling.
- **RA2**. To analyse the most common defects seen in crystals and their connection to some of the physical properties of the crystals.
- **RA3**. To explain the properties of insulators, conductors and semiconductors, and the phenomena of ferromagnetism and superconductivity.

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

Skills	Learning outcomes
CB4, CB5, CG1, CG5, CT5, CE01, CE02, CE04	**RA1**. To identify the physical phenomena associated with the vibrations of atoms in crystalline networks and their modelling.
CB4, CB5, CG1, CG5, CT5, CE01, CE02, CE04	**RA2**. To analyse the most common defects seen in crystals and their connection to some of the physical properties of the crystals.
CB4, CB5, CG1, CG5, CT5, CE01, CE02, CE04	**RA3**. To explain the properties of insulators, conductors and semiconductors, and the phenomena of ferromagnetism and superconductivity.

4. CONTENTS

The subject is organised into five learning units:

- **Unit 1. Bonding and crystal structure.**
- **Unit 2. Reciprocal lattice and X-ray diffraction.**
- **Unit 3. Thermal properties of solid bodies.**
- **Unit 4. Electronic properties of solid bodies.**
- **Unit 5. Magnetism and superconductivity.**

5. TEACHING/LEARNING METHODS

The types of teaching/learning methods are as follows:

- **Lectures**: Presentations by the professor with the necessary technological tools to maximise comprehension of the learning content.
- **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 available resources.
- **Problem-based learning**: Students are given problems and asked to solve them, working individually or in groups.
- **Guided academic activities:** Individual and group work that is more independent, including information searches, written summaries and 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	18
Asynchronous lectures	12
Oral presentations of projects and debates	6
Report writing	18
Assessment	6
Practical activities (problems, projects, lab work)	30
Tutorials	10

Independent working	50
TOTAL	**150**

7. ASSESSMENT

The assessment systems as well as their weight with regard to the total grade are listed:

On campus:

Assessment system	Weighting
Knowledge tests (assessment system 1 or SE1) Students will sit two exams in the ordinary exam period with theoretical/practical questions and/or problems: one midterm exam and one final exam. The weighting of the midterm exam is 15% and the weighting of the final exam is 35%. In the extraordinary exam period, there is only one exam, covering all previous exams, with a weighting of 50%.	50%
Submission of group and/or individual exercises (SE2) Students will complete individual and/or group exercises that will be discussed and resolved in the problem-solving sessions.	30%
Oral defence of problems (SE3) Students must solve a problem in class during a problem-solving session. *This grade will only be awarded if the student has attended over 50% of the classes, whether on campus or online during class hours, and if the student is present when the problem is solved.*	10%
Performance observation (SE4) This is a subjective grade that is based on attendance, attitude towards the subject area, collaboration with classmates and respect for others in the classroom.	10%

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 reference material for the subject area is as follows:

- Hook, J.R. y Hall, H.E.: ***Solid State Physics (2nd edition)***. Wiley-VCH (1991)
- Hofmann, P.: ***Solid State Physics: An introduction (2nd edition)***, Wiley-VCH (2015)
- Simon, S.H.: ***The Oxford Solid State Physics***, Oxford University Press (2013)
- Omar, M.A.: ***Elementary Solid State Physics: Principles and Applications***. Addison-Wesley (1975)
- Ashcroft, N. y Mermin, D.: ***Solid State Physics***. Brooks/Cole (1976)

The recommended bibliography is indicated below:

- Kittel, C.: ***Introduction to Solid State Physics (8th edition)***. Wiley-VCH (2018)

- Yung-kuo, L.: ***Problems and Solutions on Solid State Physics, Relativity and Miscellaneous Topics***. World Scientific (1995)
- Mihály L. y Martin M.C.: ***Solid State Physics: Problems and Solutions***. Wiley (1996)