

Solid State Physics

Code: 100175
ECTS Credits: 6

2025/2026

Degree	Type	Year
Physics	OT	4

Contact

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Teachers

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Teaching groups languages

You can view this information at the [end](#) of this document.

Prerequisites

It is highly recommended to have basic notions of Quantum Physics and Thermodynamics.

Objectives and Contextualisation

This course deals with the study of some fundamental properties of the solid materials.

The interaction of two particles or one particle in an external potential is usually studied. In the real world there are almost never two particles, it is much more complex, there are many particles (on the order of Avogadro's number). But most of the things we handle are solid: mechanical tools, motors, radio, TV, mobile, etc. Although in principle, it would be enough to study these properties from the wave function solution of eq. Schrödinger, due to the high number of particles it is impossible and it is necessary to make approximations.

Solid State Physics is a very extensive subject, impossible to deal with in a subject of 6 credits, therefore, only the most basic properties of crystalline solids will be studied. They are fundamental for later studies or in many branches of research.

Competences

- Apply fundamental principles to the qualitative and quantitative study of various specific areas in physics
- Be familiar with the bases of certain advanced topics, including current developments on the parameters of physics that one could subsequently develop more fully
- Communicate complex information in an effective, clear and concise manner, either orally, in writing or through ICTs, and before both specialist and general publics
- Develop the capacity for analysis and synthesis that allows the acquisition of knowledge and skills in different fields of physics, and apply to these fields the skills inherent within the degree of physics, contributing innovative and competitive proposals.
- Formulate and address physical problems identifying the most relevant principles and using approximations, if necessary, to reach a solution that must be presented, specifying assumptions and approximations
- Know the fundamentals of the main areas of physics and understand them
- Make changes to methods and processes in the area of knowledge in order to provide innovative responses to society's needs and demands.
- Use critical reasoning, show analytical skills, correctly use technical language and develop logical arguments
- Work independently, have personal initiative and self-organisational skills in achieving results, in planning and in executing a project
- Working in groups, assume shared responsibilities and interact professionally and constructively with others, showing absolute respect for their rights.

Learning Outcomes

1. Apply the techniques studied in other disciplines such as crystallography and electron devices.
2. Communicate complex information in an effective, clear and concise manner, either orally, in writing or through ICTs, in front of both specialist and general publics.
3. Define useful approaches for studying superconductivity.
4. Describe Schrödinger's equation for a crystal.
5. Describe the approaches needed to solve Schrödinger's equation for a crystalline solid.
6. Distinguish quasicrystal glass on the basis of its properties.
7. Identify and understand the general properties of a crystal.
8. Identify situations in which a change or improvement is needed.
9. Predict electron dynamics from a semiclassical model.
10. Simplify and solve the approximate equations of a crystal.
11. Solve equations that describe ion vibrations.
12. Use approximations to calculate the energy of electrons.
13. Use critical reasoning, show analytical skills, correctly use technical language and develop logical arguments
14. Work independently, take initiative itself, be able to organize to achieve results and to plan and execute a project.
15. Working in groups, assume shared responsibilities and interact professionally and constructively with others, showing absolute respect for their rights.

Content

Topic 1: Crystal Lattices

- Crystal structure and classification
- Direct lattices and unit cells
- Reciprocal lattices and their relation to the direct lattice

Topic 2: Diffraction

- Principles of wave diffraction in crystal lattices
- Bragg's conditions and X-ray diffraction
- Interpretation of diffraction patterns

Topic 3: Cohesion

- Forces holding atoms together in a crystal
- Noble gas crystals and ionic crystals
- Cohesive energy and stability of crystal structures

Topic 4: Phonons. Classical Theory

- Vibrations in crystals and normal modes
- Phonons as quanta of crystal vibrations
- Classical theory of the harmonic oscillator

Topic 5: Phonons. Quantum Theory and Thermal Properties

- Quantum treatment of phonons
- Heat capacity and thermal conduction in crystals
- Bose-Einstein distribution and phonon statistics

Topic 6: Free Electrons. Drude and Sommerfeld Models

- Drude's classical model for electrons in metals
- Introduction to Sommerfeld's quantum theory
- Free electron Fermi gas and electrical properties

Topic 7: Electrons in Periodic Potentials. Bloch Functions and Energy Bands

- Periodic potential and Schrödinger equation solutions
- Bloch functions and basic concepts of band theory
- Origin of allowed and forbidden bands

Topic 8: Semiconductors

- Band structure in semiconductors
- Charge carriers: electrons and holes
- Basic electrical and optoelectronic properties

Topic 9: Superconductors

- Main characteristics of superconductors
- Superconducting phase transition
- Basic models of superconductivity (overview only)

Activities and Methodology

Title	Hours	ECTS	Learning Outcomes
Type: Directed			
Problem sessions	16	0.64	1, 2, 4, 5, 6, 7, 9, 13, 11, 10, 14, 15, 12
Theoretical sessions	32.75	1.31	1, 2, 3, 4, 5, 6, 7, 9, 13, 11, 10, 14, 15, 12
Type: Supervised			
survey of the subject	0.25	0.01	8, 13
Type: Autonomous			
Individual or group work	86	3.44	1, 2, 3, 4, 5, 6, 7, 9, 13, 11, 10, 14, 15, 12

In the theoretical sessions, the basic lines will be explained so that the student can work the subject in an efficient way, either individually or in groups.

In the problem classes, the difficulties encountered by the students when solving the exercises proposed will be solved.

Annotation: Within the schedule set by the centre or degree programme, 15 minutes of one class will be reserved for students to evaluate their lecturers and their courses or modules through questionnaires.

Assessment

Continuous Assessment Activities

Title	Weighting	Hours	ECTS	Learning Outcomes
First part test	35%	2.5	0.1	1, 2, 3, 4, 5, 6, 7, 8, 9, 13, 11, 10, 14, 15, 12
Moodle short tests	30%	10	0.4	1, 3, 4, 5, 6, 7, 9, 13, 11, 10, 14, 12
Second part test	35%	2.5	0.1	1, 2, 3, 4, 6, 7, 13, 11, 10, 15, 12

Continuous Assessment

- First partial exam covering the content studied up to that point: 35% of the final grade.
- Submission of practical assignments and Moodle quizzes related to the course material: 30% of the final grade.
- Second partial exam covering all the content of the course related to the topics in the second half of the term: 35% of the final grade.

To be able to average and compute all activities, the student must obtain a minimum grade of 3.0 in each of the evaluable parts.

Furthermore, to pass the course, the weighted average of the three activities must be at least 5.0.

The recovery exam will consist of two parts, corresponding to each of the partial exams taken. The student will only have to retake the part in which they obtained less than a 3.0. The submission of practical assignments and Moodle quizzes is not recoverable.

Students who have not participated in any of the partial exams, recovery exams, or the submission of practical assignments and quizzes will receive a final grade of "Not Evaluable."

There will be no grade improvement exam for students who have already passed the course.

Single Assessment

Students who have opted for the single assessment modality must take a final exam consisting of:

- First partial exam covering the content studied up to that point: 35% of the final grade.
- Second partial exam covering all the content of the course related to the topics in the second half of the term: 35% of the final grade.
- Submission of practical assignments and Moodle quizzes completed during the course (30% of the final grade).

These exams will take place on the same day, time, and place as the second partial exams of the continuous assessment modality.

To be able to average, the student must obtain at least a 3.0 in each part, and to pass the course, the weighted average of the three activities must be at least 5.0 out of 10.

If the final grade does not reach 5, the student will have another opportunity to pass the course through a recovery exam, which will be held on the date set by the degree coordination. In this exam, it will be possible to recover 70% of the grade corresponding to the partial exams. The part corresponding to practical assignments and quizzes is not recoverable.

Bibliography

Basic

Theory

1. N.W. Ashcroft and N.D. Mermin, ***Solid State Physics***. (Saunders Collegue, 1976) ISBN 0-03-083993-9 (Collegue Edition), 0-03-049346-3 (International Edition)
2. C. Kittel, ***Introducción a la Física del Estado Sólido***. (Reverté, 3a. edición, 1998). ISBN 84-291-4317-3
3. J. Maza, J. Mosqueira y J.A. Veira, *Física del estado sólido*, (Universidade de Santiago de Compostela, 2008; Manuais Universitarios, n. 8). ISBN 978-84-9750-906-0
4. J.M. Ziman, *Principios de la Teoría de Sólidos*. (Selecciones Científicas, 1969)

Problems

1. H.J. Goldsmid, *Problemas de Física del Estado Sólido* (Reverté, 1975). ISBN 84-291-4037-9
2. L. Mihaly and M.C. Martin, *Solid State Physics* (Jonh Wiley & Sons, Inc., 1996). ISBN 0-471-15287-0
3. J. Piqueras y J.M. Rojo, *Problemas de Introducción a la Física del Estado Sólido* (Alhambra, 1980). ISBN 84-205-0670-2

Avanced

J. Callaway, *Quantum Theory of the Solid State*. (Academic Press, Inc. 2on edition, 1991). ISBN 0-12-155203-9

Software

No special program is used.

Groups and Languages

Please note that this information is provisional until 30 November 2025. You can check it through this [link](#). To consult the language you will need to enter the CODE of the subject.

Name	Group	Language	Semester	Turn
(PAUL) Classroom practices	1	Catalan	first semester	morning-mixed
(TE) Theory	1	Catalan	first semester	morning-mixed