Universitat Autònoma de Barcelona

2021/2022

Solid State Physics

Code: 100175
ECTS Credits: 6

Degree	Type	Year	Semester
2500097 Physics	OT	4	1

The proposed teaching and assessment methodology that appear in the guide may be subject to changes as a result of the restrictions to face-to-face class attendance imposed by the health authorities.

Contact

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Use of Languages

Principal working language: catalan (cat)
Some groups entirely in English: No
Some groups entirely in Catalan: Yes
Some groups entirely in Spanish: No

Prerequisites

It is highly recommended to have basic notions of quantum physics.

Objectives and Contextualisation

Introduction to the most basic properties of crystalline solids. First, it is necessary to know what is a crystal, and then study its fundamental properties, as well as the behavior of phonons and electrons.

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 Schrödingers equation for a crystal.
5. Describe the approaches needed to solve Schrödingers 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

1. Symmetries and crystals.

2. Diffraction by a crystal.

3. Crystal Hamiltonian.

4. General properties.

5. Electronic models.

6. Experimental implications of the electronic structure.

7. Lattice vibrations: classical theory.

8. Lattice vibrations: quantum formulation.

Methodology

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.

Activities

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	90	3.6	1, 2, 3, 4, 5, 6, 7, 9, 13, 11, 10, 14, 15, 12

Assessment

a) Evaluation

- 4 short tests after chapters 2, 4, 6 and 8. The maximum score is 1,1 per test.

- 4 partial summaries of the subject after chapters 2, 4, 6 and 8. The maximum score is 0,4 per summary.

- Written final test (maximum score of 4), of the whole program.

All scores will be added, P.

To pass the subject you only have to have a score (P) equal to or greater than 5. It is not necessary to obtain a minimum score in any test.

b) Resit exam

There will be a written resit exam of the whole subject with a maximum of 10 points.

The student can submit to the resit whenever he/she has submitted to a set of activities that represent at least two thirds of the total grade of the subject, and that has a score of the continuous evaluation, P, equal or superior to 2,5.

c) Special qualifications

Who during the course (the resit exam is not included) only presents 2, or less, written tests of continuous evaluation, will have a grade of "Not gradable".

Assessment Activities

Title	Weighting	Hours	ECTS	Learning Outcomes
4 short tests	1,1 points each test	2	0.08	1, 3, 4, 5, 6, 7, 9, 13, 11, 10, 14, 12

4 summaries	1,6 points	4	0.16	1, 2, 8, 13, 14, 15
Final test	4 points	2.5	0.1	1, 2, 3, 4, 5, 6, 7, 9, 13, 11, 10, 14, 15, 12
exam resit	10 points	2.5	0.1	1, 2, 3, 4, 5, 6, 7, 9, 13, 11, 10, 14, 15, 12

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.