Universidad Zaragoza

Academic Year/course: 2023/24

26926 - Solid State I

Syllabus Information

Academic year: 2023/24
Subject: 26926 - Solid State I
Faculty / School: 100 - Facultad de Ciencias
Degree: 447 - Degree in Physics
ECTS: 6.0
Year: 4
Semester: First semester
Subject type: Compulsory
Module:

1. General information

This subject is the first part of the Solid State Physics module of the degree in Physics. It will be completed with the Solid State II subject in the second semester. For this reason, one of its objectives is to provide the student with some basic tools with which to approach the study of crystalline solids. From these tools the student will learn how different microscopic models can be used to determine macroscopic properties and will apply it to problems such as the calculation of the modes of vibration of the lattices, the calculation of different contributions to the heat capacity or transport phenomena associated with the application of temperature gradients, electric or magnetic fields. Specifically, the following points will be covered:

Crystalline solids. structures. crystal bond.

Lattice dynamics. Specific heat of the network. thermal properties.

Electronic states: free electrons and band approximation. Fermi surface. Electrical and thermal conductivities associated with electrons.

These approaches and objectives are aligned with the following Sustainable Development Goals (SDG) of the United Nations 2030 Agenda (https://www.un.org/sustainabledevelopment/), in such a way that the acquisition of the results of subject learning provides training and competence to contribute to some extent to its achievement: Goal 4: Quality education.

2. Learning results

The Solid State Physics is a fundamental discipline for the acquisition by the student of the competences of the Degree in Physics since in it the student learns to propose microscopic models for solids and apply said models to the calculation of macroscopic properties. This type of relationship between the models and the phenomena to which they are applied is of great importance so that the student obtains fundamental competences in the approach and resolution of the problems that arise within the Degree in Physics.

Upon passing this subject, the student will acquire the following learning outcomes:

- Knowledge of Bravais lattices in real and reciprocal spaces. Description of crystalline structures. Determination of structures based on diffraction measurements.
- Description of the different types of bonding in crystals. Evaluation of cohesion energies in crystals with different types of bonds.
- Determination of the dynamics of crystalline latttices: phonons. Calculation of the contribution to the heat capacity and thermal conductivity of the lattice.
- Knowledge of the different models to obtain electronic states in solids: free electrons, energy bands. Theoretical and experimental determination of the Fermi surface.
- Calculation of some properties associated with electrons: electronic contribution to the heat capacity of solids, thermal and electrical conductivities associated with electrons, Hall effect.

3. Syllabus

0. INTRODUCTION

CRYSTRAL STRUCTURE. DIFFRACTION. COHESION
1. Crystal structure
2. Determination of crystal structures
3. Crystal binding

PHONONS. THERMAL PROPERTIES
4. Lattice dynamics
5. Lattice thermal properties

ELECTRONS. ELECTRONIC TRANSPORT
6. Drude and Sommerfeld theories
7. Electrons in a periodic potential
8. Semiclassical dynamics of Bloch electrons

4. Academic activities

This 6 ECTS course includes the following learning tasks:

- Lectures (4.5 ECTS: 45 hours).
- Interactive solving problems sessions (1 ECTS: 10 hours).
- Laboratory sessions (simulations in computer lab, 0.5 ECTS: 5 hours).

5. Assessment system

Realization of problems and questions on the different topics of this subject. The score of these hand-outs will be the average value of those obtained (scored from 0 to 10) and will constitute 20% of the final grade. The professor will assign them throughout the semester and students must present their solutions in writing. A minimum of 3.0 out of 10 is required to average with the rest of the activities. Otherwise, the student will be evaluated only by a final comprehensive exam.

Result of the exam that will constitute 80% of the overall result. The exam will consist of two parts, one of theoretical questions, and another of problems. Each of them will be scored between 0 and 10. The final score of the exam will be the average of the two parts. Results below 30% will not be averaged in any of the parts, in which case the subject will be considered failed. The student will be able to obtain 100% of the final grade through these activities. Said final qualification will be made public at the end of the academic period.

Passing the subject through a single global examination:

The evaluation will be obtained directly from a written exam that will consist of two parts: one of theoretical questions and another of problems. Each of these parts will be scored between 0 and 10. The final result will be the average of the two evaluations. Results below 30% will not be averaged in any of the parts, in which case the subject will be considered failed. This exam may be different from the progressive assessment one, in order to obtain a more complete information on the skills acquired by the student in the subject.