SUBJECT TEACHING GUIDE

G1999 - Solid State Physics

Double Degree in Physics and Mathematics
Degree in Physics

Academic year 2022-2023

1. IDENTIFYING DATA					
Degree	Double Degree in Physics and Mathematics Degree in Physics			Type and Year	Compulsory. Year 3 Compulsory. Year 3
Faculty	Faculty of Sciences				
Discipline	Subject Area: Quantum Physics and the Structure of Matter Central Module				
Course unit title and code	G1999 - Solid State Physics				
Number of ECTS credits allocated	6	Term		Semester based (2)	
Web					
Language of instruction	Spanish	English Friendly	No	Mode of delivery	Face-to-face

Department	DPTO. CIENCIAS DE LA TIERRA Y FISICA DE LA MATERIA CONDENSADA
Name of lecturer	FERNANDO RODRIGUEZ GONZALEZ
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Office	Facultad de Ciencias. Planta: + 2. DESPACHO PROFESORES (2008)
Other lecturers	JESUS MARIA RODRIGUEZ FERNANDEZ LUIS FERNANDEZ BARQUIN FRANCISCO JAVIER JUNQUERA QUINTANA

3.1 LEARNING OUTCOMES

- Understand the microscopic origin of the physical properties of solid materials. Principles governing the existence of different phases depending on temperature and pressure. Vibrational excitations: influence of the structure of the solid. Specific heat: origin of the universal laws. Electronic bands: origin. Electronic excitations: conditions for the existence of metals, semiconductors and insulators. Microscopic origin of the resistivity in metals and semiconductors. Dynamics of electrons in electric and magnetic fields: semiclassical model. Semiconductors: Fundamentals and applications (p-n junctions, transistors, LEDs, solar cells,...). Magnetic properties of ions in crystalline lattices. Magnetic ordering: ferromagnetism and antiferromagnetism.

4. OBJECTIVES

Understand the microscopic origin of electronic bands in periodic solids, using nearly free electron model (that is, starting from a free electron model). Understand the influence of electronic bands on the properties of materials. Understand the differences between metals, insulators and semiconductors. Understand the importance of Bloch's theorem and the origin of electrical resistance. Understand the dynamics of electrons under electric and magnetic fields using a semiclassical model. Understand the importance of electronic excitations in specific heat. Understand the importance of pure and doped semiconductor materials, analyzing their fundamental properties, as well as their basic applications (pn junction diodes, npn transistors, photoelectric cells, etc.). Understand the quantum origin of diamagnetism, paramagnetism and magnetic orders (ferromagnetism and antiferromagnetism). To know the basic phenomenology of superconducting materials, as well as the phenomenological models of London and Ginzburg-Landau and the foundations of the BCS theory.

6. COURSE ORGANIZATION

CONTENTS	
1	Historical introduction. Solids, liquids and gases. Phases.
2	Free electron models: classical (Drude) and quantum (Sommerfeld). Fundamentals of band theory. Bloch theorem and consequences. Electron in periodic potentials: Quasi-free electron and Tight binding models
3	Electron dynamics under external fields. Semiconductors: fundamentals and applications. Junction diodes and transistors.
4	Ferroelectricity
5	Electrical conductivity in metals. Magnetic properties: Types of magnetism. Magnetic sub-lattices and exchange interactions.
6	Superconductivity: phenomenology, phenomenological models and fundamentals of the microscopic BCS theory.
7	Partial exam 1: Proof on blocks 1-2
8	Partial exam 2: Proof on block 3
9	Final exam: proof on blocks 4-6 plus blocks failed in previous proofs (partial exams).

7. ASSESSMENT METHODS AND CRITERIA

Description	Type	Final Eval.	Reassessn	%
Ordinary final exam: written proofs on blocks 1-6	Written exam	Yes	Yes	33,33
Extraordinary final exam: written proofs on blocks 1-6	Written exam	Yes	No	0,00
Partial exam 1: written proofs on blocks 1-2.	Written exam	No	Yes	33,33
Partial exam 2: written proofs on block 3.	Written exam	No	Yes	33,34
TOTAL				100,00

Observations

Ordinary final exam on the three blocks including block 4-6. Each passed block corresponds to 33.3% of the grade.
Extraordinary final exam on the three blocks. Each passed block corresponds to 33.3% of the grade.

Observations for part-time students

8. BIBLIOGRAPHY AND TEACHING MATERIALS

BASIC

N. W. Ashcroft, N. D. Mermin, Solid State Physics (Holt, Rhinehart and Winston, 1976).
C. Kittel. Introducción a la Física del Estado Sólido (Reverté, 1993).