Bachelor in Physics
(Academic Year 2024-25)

Solid State Physics		Code	800515	Year	3rd	Sem.	2nd
Module	General Core	**Topic**	Quantum physics and statistics		**Character**		Obligatory

	Total	Theory	Exercises
ECTS Credits	6	3.5	2.5
Semester hours	55	30	25

Objetives of the course

- To understand the relationship between structure, bonding type, and the properties of solids.
- Assimilate the fundamental role played by electronic structure and its influence on transport properties.
- Understand vibration phenomena in crystal lattices and the models involved in their description.
- Understand the emergence of cooperative phenomena such as ferromagnetism and superconductivity.

Brief description of the content

Crystals, diffraction; bonding energy; vibrations in crystal lattices; electrons in solids, periodic potentials, and energy bands; cooperative phenomena in solids.

Essential previous courses

Quantum Physics 1 and Statistical Physics.

Teaching Coordinator:	Emilio Nogales Díaz		**Dept:**	FM
	Office:	02.211.0	**e-mail**	enogales@ucm.es

Theory/Problems – Schedule and Teaching Staff

Group	Lecture Room	Day	Time	Professor	Period/ Dates	Hours	T/E	Dept.
B	7	Tu Th	15:00 – 17:00 14:30 – 16:30	Charles Creffield	Full term	55	T/E	FM

*: T: theory, E: exercises, S: seminars

Office hours

Group	Professor	Schedule	E-mail	Location
B	Charles Creffield	M, V. 13:30-15:00 +3h On line	*c.creffield@ucm.es*	02.106.0

Course programme

1. Crystal structures. Crystalline and amorphous solids. Crystal structures. Monocrystals and polycrystals. Symmetries. Bravais lattices: centered lattices. Diffraction. Reciprocal lattice. Structure factor. Brillouin zones.

2. Crystal bond. Binding energy. Van der Waals bond. Repulsion energy. Ionic bond. Concepts of covalent bond and metallic bond.

3. Lattice vibrations. Adiabatic approximation. Harmonic potential. Vibrations in linear lattices. Acoustic and optical branches. Quantization of vibrations: phonons. Phonon spectroscopies: neutrons and Raman. Phonon density of states. Thermal properties in a lattice and specific heat.

4. Electrons in solids. Single electron approximation: momentum space. Energy bands. Fermi surface. Free electron model. Nearly-free electron models. Tight-binding approximation. Types of solids according to band structure. Electron dynamics: effective mass. Electrons and holes. Electric resistivity. Semiconductors.

5. Introduction to cooperative phenomena. Electron gas: plasmons. Ferro- and antiferromagnetism: Exchange interaction, spin waves. Superconductivity: phenomenology and basic notions, London equation, high-temperature superconductors.

Bibliography

- N.W. Ashcroft & N.D. Mermin, *Solid State Physics* (Thomson Press, India 2003)
- H. Ibach y H. Lüth , *Solid State Physics* (Springer, Berlin 1993)
- C. Kittel, Introduction to Solid State Physics 8th Edition (Wiley, New York 2005).

Internet resources

Methodology

The following educational activities will be performed:
- Theory lectures where the main concepts of the subject are explained.
- Practical problem-solving lessons and supervised activities.

Evaluation		
Examinations	**Weight:**	75%

A final examination will be given, which will be graded between 0 and 10. In addition, one or two voluntary partial exams could be given. These partial exams will normally take place in class hours. In case they are held out of the class schedule, students will be warned well in advance, and special care will be taken for all the students to be able to take these partial exams.

Other forms of evaluation	**Weight:**	25%

The professor may propose a number of activities that will be graded between 0 and 10. The score obtained will be kept until the final exam of the extraordinary call.

Problem sets will be issued for the students to solve and upload to the Campus Virtual.

Final classification

For in-person or partially in-person teaching, the final grade CF will be given by the formula:

$$CF = \max\{0.25*A + 0.75*E, E\}$$

where E is the final exam score and A the final score of other activities.