Bachelor in Physics
(Academic Year 2022-23)

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

Teaching Coordinator:	Miguel Ángel González Barrio		Dept:	FM
	Office:	116	e-mail	mabarrio@fis.ucm.es

Theory/Practicals/Seminars - Lecturer and timetable details

Group	Room	Day	Timetable	Lecturer	Period/ Dates	Hours	T/P/S*	Dept.
B	4ª	Tu Th	15:00-17:00 14:30-16:30	Fernando Sols Lucia Charles E. Creffield	Dates will be alternated throughout the semester	14 41	T/P	FM

*: T: theory, P: practicals, S: seminars

Tutorials - Lecturer and timetable details

Group	Professor	Timetable	e-mail	Place
B	Fernando Sols Lucia	L, X, V. 11:00-13:00	f.sols@fis.ucm.es	Office 108 2nd floor
	Charles E. Creffield	L, X, V. 14:30-16:00 +3h telematic	c.creffield@fis.ucm.es	Office 106 2nd floor

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.

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 1 and 10. In addition, one or two voluntary partial exams could be given, liberatory for the final exam. These partial exams will normally take place in class hours. In case they be held out of the class schedule, students will be warned well in advance, and special care will be taken for all the students be able to take these patial exams.

Other forms of evaluation	Weight:	25%

The professor may propose a number of activities that will be graded between 1 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.