Basic/Essential Course Information	
Course title	Solid State Physics
Degree Course title	Physics
ECTS	6
Compulsory attendance	No
Course teaching language	ENGLISH

Teacher	Pietro Patimisco	pietro.patimisco@uniba.it

ECTS Details	**Disciplinary area/broad field:**	SSD	ECTS
	Characterizing	FIS/01	6

Time management and teaching activity type	Period	Year	lesson type
	2nd semester	1st	Lessons (40h) Exercises (15h)

Time management	Total hours	in-class/in-lab study hours	out-of-class study hours
	150	55	95

Course calendar	Starting date	Ending date
	First week of March	Last week of May

Syllabus	
Prerequisites	Background knowledge on quantum mechanics, statistical physics and semiconductor physics.
Expected learning outcomes (according to Dublin Descriptors)	**Knowledge and understanding** of crystal structure, electronic and vibrational properties of solid-state systems. Basic properties of metals, insulators and semiconductors. Semiconducting elements for the use in electronic devices. Low-dimensional semiconductors. **Applying knowledge and understanding.** Capability to apply quantum mechanics for theoretical and numerical calculations in solid state physics. Solve simple problems concerning different properties that result from the distribution of electrons and regular arrangement of atoms in crystals. **Making judgements.** Knowledge and skills acquired in this course will allow a greater level of autonomy in the evaluation of descriptions about theoretical models on electronic properties of materials and low dimensional systems. **Transferable Communication skills.** Enable transition from theoretical physical subjects towards the understanding of basic properties of solid-state matter and their technological applications.

	Lifelong learning skills. Follow the current progress and further prospects within the areas of solid-state physics. Discuss models and mechanics introduced in the course and assess the reliability of simple theoretically based relevant problems published in literature and technological documentation.
Course contents summary	Crystal Structure. Reciprocal Lattice. Band Structures. Semiconductor Structures. Low Dimensional Systems.
detailed syllabus	**Crystal Structure.** Periodic Array of Atoms. Lattice Translation Vectors. Primitive Lattice Cell. Fundamental Types of Lattices. Two-Dimensional Lattice Types. Three-Dimensional Lattice Types. Index Systems for Crystal Planes and Directions. Simple Crystal Structures. Sodium Chloride Structures. Cesium Chloride Structures. Diamond Structure. Zinc Blende Structure. Problems. **Reciprocal Lattice.** The Bragg Diffraction Law. Reciprocal Lattice. Fourier Analysis of Scattered Wave. Reciprocal Lattice Vectors. Diffraction Conditions. Laue Equations. Brillouin Zones. Reciprocal Lattice to Cubic Lattice. Reciprocal Lattice to Face-Centered Cubic Lattice. Reciprocal Lattice to Body-Centered Cubic Lattice. Fourier Analysis of the Basis. Structure Factor of Body-Centered Cubic Lattice. Structure Factor of Face-Centered Cubic Lattice. Atomic Form Factor. Problems. **Band Structures.** Introduction. Free Electron Fermi Gas. Single Electron Model. Fermi Sphere. Density of States. Fermi Distribution Non-Interacting Electrons in a Periodic Potential. Definition of Periodic Potential. Bloch Theorem. Band Index. Fermi Surface. Kronig-Penney Model. Energy Bands in 1D lattice. Nearly Free Electrons in a Weak Periodic Potential. General Approach to Schrodinger Equation. Energy Levels near a single Bragg Plane. Energy Bands in a 1D lattice. Tight-Binding Model. General Approach. Energy Bands in a 1D Lattice. Energy Bands in Three Dimensions. High Symmetry Points. Energy Bands in a Cubic Lattice. Energy Bands in a Body-Centered Cubic Lattice. Energy Bands in a Face-Centered Cubic Lattice. Orthogonalized Plane-Wave. Pseudopotential. **Semiconductor Structures.** Introduction. Silicon, Germanium and Gallium Arsenide. Covalent Bonding. Crystal Structure. Energy Bands. Band Gap. Motion of Electron Wave in an Energy band. Semiclassical Equations of Motion. Dynamical Effective Mass. Parabolic Approximation. Carrier Concentration at Thermal Equilibrium. Intrinsic Semiconductor. Donors and Acceptors. Extrinsic Carriers Concentration. Problems. **Low Dimensional Systems.** Introduction. 2D Quantum Heterostructures. Finite Quantum Well. Quantized Energy Levels. Density of States. Influence of Effective Mass. 2D Graphene. Crystal Structure. Brillouin Zones. Energy Bands. Density of States. Nanowires. Quantum dots.
books	N. W. Ashcroft and N. D. Mermin – *Solid State Physics*, Cencage. C. Kittel – *Introduction To Solid State Physics*, John Wiley & Sons Inc. S. M. Sze – *Physics of Semiconductor Devices*, Wiley-Interscience.
notes	Selected chapters

Teaching methods	Lectures in the teaching room with the aid of a laptop and a projector.
Assessment % of final mark	Oral exam (100%)
Evaluation criteria	Capability to discuss models and mechanics introduced in the course. Adequate comprehension and global knowledge of concepts and arguments described throughout the course.