MASTER

Physique fondamentale
et applications

SCIENCES SORBONNE UNIVERSITÉ

M1 – Course description MU4PYA11

Course: Condensed Matter Physics	Code Apogée UE : MU4PYA11 Nombre d'ECTS : 6	
Course coordinators:	Sorbonne Université Name: **Nathalie JEDRECY** Adress : T 22-12, s. 309 Phone : 01 44 27 39 63 Email : nathalie.jedrecy@sorbonne-universite.fr	Université de Paris Name: **Edouard BOULAT** Adress : Bât. Condorcet, b. 640B Phone : 01 57 27 62 38 Email : edouard.boulat@univ-paris-diderot.fr
Number of hours:	30 h CM (lecture) - 30 h TD (tutorials)	
Semester :	**S2**	
Lecture localization:	Campus Jussieu (Sorbonne Université) – Université de Paris	
Laboratories:	None	
Objectives:	The course has two objectives: (1) making a link between microscopic properties of solids and macroscopic physical phenomena, (2) becoming familiar with the models used for the interpretation of the latter. Different fields of application of the physics of materials will be presented.	
Prerequisites:	Quantum physics: Schrödinger equation, vector spaces, harmonic oscillator. Statistical physics: Fermi-Dirac and Bose-Einstein distributions.	
Topics/program:	Introduction to condensed matter physics: cohesion in ordered solids (from metal to insulator); basic properties. Atoms vibrations (network dynamics): normal modes of oscillation of a linear (1D) monoatomic or diatomic chain, dispersion relation, limit conditions and frequency quantification. Generalization to the 2D and 3D cases. Sound propagation. Thermal energy treatment - Phonons: the linear chain of atoms viewed as quantum harmonic oscillators, phonons, Einstein and Debye models, thermal capacity. Thermal conductivity, interaction with light or particles. Crystalline structures: Bravais network and symmetries. Reciprocal network. Experimental probes of real space (near-field microscopy) and reciprocal space (X-ray or particle diffraction). Electrons in a solid: from nearly free to subject to a periodic potential. Bloch theorem, tight-binding model (linear combination of atomic orbitals), Brillouin zone and electronic band structure. Electronic and optical properties: from theoretical models to real compounds Semiconductors: general properties and band structure. Effective mass concept, holes concept. Intrinsic or doped semiconductors. P-n junctions and applications. Initiation to current research topics: spintronics, multiferroics.	
Competences expected after the course:	Be able to make the link between the microscopic properties of a solid and macroscopic physical manifestations, like electrical conductivity, optical absorption, thermal capacity. Be able to: - differentiate the different types of solids; - define the Bravais network and the unit cell; - master the models allowing to describe the vibrating energy of a solid, via the phonon dispersion relation; - master the models describing the electronic structure of a solid. The student will also have a knowledge of some experimental techniques for studying the physical properties.	
Bibliography:	Introduction to Solid State Physics, by C. Kittel Solid State Physics, by N-W. Ashcroft et N-D. Mermin	
Evaluation:	1 note of continuous control (CC) + 1 note of examination (E1 ou E2) Note finale session 1 = 0.4*CC+0.6*E1 Note finale session 2 = SUP (0.4*CC+0.6*E2, E2)	
Barèmes (Apogée) :	Ecrit : 100 /100	