Erasmus Mundus Joint Master GREENANO

SYLLABUS

Semester 1

COURSE NAME:	**Modern Physics**		
HOSTING UNIVERSITY:	University of Lorraine – Faculty of Science and Technologies		
SEMESTER:	**NUMBER OF ECTS:**	**PILLAR:**	
1	9 ECTS	1	
DISTRIBUTION OF HOURS			
Lectures	*Seminars*	*Lab work*	*Individual student work*
90 h	3 h	No	90 h
PROFESSOR:	Prof. S. Petit-Watelot, Prof. E. Gaudry, Prof. Y. Fagot-Revurat, Prof Stéphane Andrieu (University of Lorraine/Institut Jean Lamour)		
LEARNING AND TEACHING METHODS:	Formal lectures and stimulating work in small groups for exercises and applications to GREENNANO materials thematics, seminars		
PREREQUISITES:	Basic knowledge of Quantum Physics and Statistical thermodynamics		
OBJECTIVES OF THE COURSE:	Basic understanding of quantum and statistical physics applied to simple as well as more complex models in the case of solids and gas		
CONTENT OF THE COURSE :	**Part-I – INTRODUCTION (10h)** 0-Historical experiments, basics in wave mechanics and statistical thermodynamics **Part-II – Quantum Physics (60 h)** II-1-The postulates of quantum mechanics (Hilbert space, product of Hilbert spaces, observables, basis and matrix calculations) II-2-Examples of 2-states systems => Ammonia molecule and MASER, tight-binding methods for chemical bonding in molecules and solids II-3-Angular and spin momentum (unitary transformations, multi-component wave functions, addition, Clebsch-Gordon coefficients and tables) II-4- Hydrogen atom: reduction to 2 bodies system, kinetic moment and diagonalisation of the Hamiltonian, fine and hyperfine structure. II-5-Perturbation theory (Zeeman, Stark effect…), time-dependent perturbation theory (dipolar interaction, transition probability and selection rules for radiation/matter interaction) II-6-Conservation laws II-7-Quantum confinement in nanomaterials Applications: list of typical problems in quantum physics related to the GreenNanomaterials thematics		

	Part-III – Statistical Physics (20 h) III-1-Functions, markovian processes –Drude's model applied to conductivity in metals and heat conduction in gas III-2-Kinetic equations phase space – evolution equation of the phase space : Liouville's equation reduction to single particle model - Vlasov's equation, Boltzmann's equation - III-3-Boltzmann's equilibrium distribution function -back to electronic transport- III-4-Bloch-Boltzmann's theory application to conductivity of metals III-5-Bose-Einstein and Fermi-Dirac statistical distributions, phonons and fermions density of states Applications : list of typical problems in statistical physics related to the GreenNanomaterials thematics **TOTAL = 90 h** Seminar 1 (1h30) : Symmetry in solid state physics and topologic matter Seminar 2 (1h30) : Entanglement, decoherence and quantum computing
INTENDED LEARNING OUTCOMES:	Background in quantum and statistical physics applied to materials and nanomaterials properties
FORM OF ASSESSMENT:	Quiz (self-evaluation) Individual written and oral assessment, evaluation of small group projects