SOLID STATE PHYSICAL CHEMISTRY

1.1. Identification

University:	Alma Mater Studiorum – Università di Bologna											
School:	School of Engineering											
Course:	Solid state physical chemistry											
ECTS:	6											
Semester:	*Winter*					X	*Summer*					
Category	*Fundamental course*						*Specialisation course*					X
Module	*MFI*		*MFII*		*MFIII*		*MSI*		*MSII*	X	*MSIII*	
Teachers:	Renato Colle											
Language:	*English*		X	*Italian*		X	*Swedish*		*Spanish*			

1.2. Learning-outcomes

The aim of the course is to give tools for the quantum-mechanical study and interpretation of the electron transport in devices made up by molecules or molecular layers or nanostructures between metallic contacts, with a special emphasis on the current flow when a voltage is applied across the device. The course proposes theoretical models to interpret the electric conductance on the atomic scale and to describe phenomena taking place when the dimensions of the system are progressively increased. The course can be considered an introduction to the recent rapidly growing research field named Molecular Electronics.

1.3. Competencies

- **General**
  - to have critical understanding of technical and scientific tools
  - communication skills
  - to work in an international context

- **Specific**
  - to understand the importance of electron transport in electronic devices
  - to develop quantum mechanical studies
  - to start studying Molecular Electronics

1.4. Contents

Elements of quantum mechanics: concepts and postulates - mathematical formalism - symmetry - wave mechanics of molecules and periodic systems.

Preliminary concepts : energy levels diagram - electron flows - the quantum of conductance - potential profiles - quantum capacitance - examples and toy models of band structures - quantum wells, wires, dots, nanotubes.
Capacitance : model hamiltonian - electron density and density matrix - electrostatic and quantum capacitance.
Level broadening : open systems - local density of states - lifetime - definition of contact or reservoir.
Coherent and non-coherent transport : inflow and outflow - transmission - examples.
Non equilibrium green functions : correlation and scattering functions - self-energy and green functions - kinetic equation - current flow and energy exchange.
Quantum transport equations.

1.5. Teaching Methodology

- Lecture sessions

1.6. Evaluation

- oral evaluation

1.7. Bibliography

- S.Datta, Quantum Transport. Atom to Transistors, ed. Cambridge.
- S.Datta, Electronic Transport in Mesoscopic Systems, ed. Cambridge Studies in Semiconductor Physics and Microelectronic Engineering.
- G.Grosso and G.Pastori Parravicini, Solid State Physics, ed. Springer.