CES7AL - CES9AL SUPERCONDUCTORS

CES7AL - CES9AL Superconductors	ECTS Credits : 4 Duration : 36 hours	Semester : S7

Person(s) in charge :

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Keywords : Superconductors, phase transition, Ginzburg-Landau theory, BCS theory, unconventional superconductivity

Prerequisites: Statistical physics (TCSS6AC), Quantum mechanics (TCSS5AB), Thermodynamics (TCSS6AD)

Objective: Understand and acquire knowledge in the general properties of superconductors, phenomenological and microscopic theories describing the main industrial applications.

Programs and contents :

Superconductivity is undoubtedly one of the most spectacular phenomena in condensed matter physics. Manifestation on our scale of quantum mechanics that govern the atomic and subatomic world, the two main characteristics of superconductivity are the complete loss of electrical resistance (the Joule effect is absent) and the expulsion of the magnetic field at the origin of levitation. A full understanding of superconductivity has been one of the most challenging problem faced by physicists in the first half of the XXth century. Renowned physicists such as Schrödinger, Feynman or Einstein have tried to tackle this problem but their efforts were unsuccessful. It is not until 1957, 46 years after the discovery of superconductivity, that a consistent explanation of this phenomenon based on quantum mechanics has been formulated.

This course is composed of two parts. After a historical introduction (Lecture 1), the first part (Lectures 2 to 6) is dedicated to the description of the main properties of superconductors from a phenomenological point of view by using the laws of electromagnetism and thermodynamics. These lectures enable

acquiring basic knowledge of the main consequences of the superconducting state on the physical properties of materials and of its behavior under magnetic field. The second part (Lectures 7 to 10) deals with the presentation of more advanced theories that describe the thermodynamics properties (Ginzburg-Landau theory of phase transition) and the microscopic origin of superconductivity using tools from statical physics and quantum mechanics (BCS - Bardeen-Cooper-Schrieffer - theory). An invited lecturer will present the main industrial applications of superconductivity (Lecture 11). The final exam is scheduled for the last lecture (Lecture 12).

Abilities :

Levels	Description and operational vocabulary
Know	The main families and properties of superconductors used in industrial applications - The microscopic and phenomenological theories that describe the physical properties of superconductors
Understand	The main industrial applications - The microscopic origin of the superconducting state - The measurement techniques for studying the superconducting state
Apply	The main relationships between the physical quantities that characterize the superconducting state - The phenomenological theories that describe the superconducting state
Analyse	The superconducting state from experimental measurements to determine its conventional or unconventional nature
Summarise	The nature of the superconducting state in conventional superconductors
Assess	The physical properties of superconductors to choose the most appropriate compound for a given application

Evaluation :

☑ Written test	☐ Continuous Control	☑ Oral report	☐ Project	☐ Rapport