UCLouvain

lphys2351

2026

Superconductivity

5.00 credits	22.5 h + 7.5 h	Q1

This biannual learning is being organized in 2026-2027

Teacher(s)	Abreu Araujo Flavio ;
Language :	English > French-friendly
Place of the course	Louvain-la-Neuve
Prerequisites	Lectures on Physics of Condensed Matter (LMAPR1492) or Solid State Physics (LPHYS1345) : electronic properties
Main themes	The teaching unit will study superconductivity under an experimental prism and following the chronology of the major discoveries associated with superconductivity. The topics will be: theoretical description of superconductivity, features of type II superconductors , overview of main applications, macroscopic quantum phenomena in superconductors (SQUID), superconductivity at the nanoscale, labs allowing the studentto observe and become familar withsuperconductivity.
Learning outcomes	**At the end of this learning unit, the student is able to :** 1 **a. Contribution of the teaching unit to the learning outcomes of the programme (PHYS2M)** AA1: A1.1, A1.3, A1.4 AA2: A2.2 AA5: A5.3 **b. Specific learning outcomes of the teaching unit** At the end of this teaching unit, the student will be able to : 1. describe the main physical phenomena related to the superconducting state ; 2. explain the physical mechanisms that govern the superconducting state ; 3. link the superconducting properties of materials (including their response to a magnetic field) with their electronic scale lengths ; 4. identify and apprehend the various fields of application of superconducting materials ; 5. cite the classes of superconducting materials by illustrating them with examples of application ; 6. identify macroscopic quantum phenomena in superconductors ; 7. understand the fundamental differences recorded in nanoscale superconducting properties ; 8. learn through laboratory sessions the experimental methods associated with the electrical and magnetic characterization of superconductors and to identify the uncertainties of the observations.
Evaluation methods	The assessment consists of two parts: 1. a personal project carried out during the term (50% of the marks), comprising a written report (20%) and an oral presentation at a mini-symposium organized at the end of the term (30%, including the quality of the slides, of the talk and the participation in the question-and-answer sessions); 2. an individual oral exam during the exam session (50% of the marks), covering the content of the lectures as well as the project report and the symposium presentations. The laboratory report (small groups of students) is included as an appendix to the project report.
Teaching methods	The teaching unit combines, in roughly equal parts, ex-cathedra lectures and a small supervised personal project. The lectures (first part of the term) lay the experimental and theoretical foundations of superconductivity. The personal project runs in parallel and is structured by intermediate milestones (choice of the subject, outline, draft version, feedback session) leading to a written report and a presentation at a mini-symposium gathering all the students at the end of the term. Each student covers one application domain of superconductivity and links it to an in-depth theoretical topic. The documents (report and presentation) are prepared with modern collaborative tools (Git version control, document templates provided). Laboratory sessions (superconducting levitation, resistive transition of a high critical temperature superconductor) are offered in parallel with the lectures to make the theoretical concepts more concrete. They provide an initiation to the experimental methods for the low-temperature characterization of superconducting materials (electrical and magnetic measurements) and to the analysis of the results obtained (critical temperature and magnetic field, width of the superconducting transition, ...).
Content	1. Main experimental facts of the superconducting state and their implications. 2. Review of the main applications of superconductivity. 3. Physical description of superconductivity (phenomenological models, BCS theory). 4. Type

	II superconductors and the mixed state. 5. Macroscopic quantum phenomena in superconductors (phase effects, SQUID). 6. Unconventional superconductivity and superconductivity at the nanometre scale. 7. Personal project: in-depth study of one application domain and one theoretical topic, resulting in a written report and a presentation at a mini-symposium. 8. Low-temperature characterization laboratories of superconductors.
Inline resources	The lecture slides, the lecture notes, the project guidelines and templates as well as the laboratory data are available on MoodleUCL.
Bibliography	Introduction to Superconductivity. Michael Tinkham. Series: (International series in pure and applied physics). New York, McGraw-Hill. Superconductivity, Superfluids and Condensates. James F. Annett. University of Bristol. Oxford University Press.
Faculty or entity in charge	PHYS

Programmes containing this learning unit (UE)

Program title	Acronym	Credits	Prerequisite	Learning outcomes
Master [60] in Physics	PHYS2M1	5		🔍
Master [120] in Physical Engineering	FYAP2M	5		🔍
Master [120] in Physics	PHYS2M	5		🔍