UCLouvain

# lphys2351

*2023*

# Superconductivity

| 5.00 credits | 22.5 h + 7.5 h | Q1 |
|---|---|---|

| | |
|---|---|
| Teacher(s) | Piraux Luc ; |
| Language : | English<br>> 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 :**<br>**a. Contribution of the teaching unit to the learning outcomes of the programme (PHYS2M)**<br>AA1: A1.1, A1.3, A1.4<br>AA2: A2.2<br>AA5: A5.3<br>**b. Specific learning outcomes of the teaching unit**<br>At the end of this teaching unit, the student will be able to :<br>1. describe the main physical phenomena related to the superconducting state ;<br>2. explain the physical mechanisms that govern the superconducting state ;<br>3. link the superconducting properties of materials (including their response to a magnetic field) with their electronic scale lengths ;<br>4. identify and apprehend the various fields of application of superconducting materials ;<br>5. cite the classes of superconducting materials by illustrating them with examples of application ;<br>6. identify macroscopic quantum phenomena in superconductors ;<br>7. understand the fundamental differences recorded in nanoscale superconducting properties ;<br>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 students are evaluated individually, in an oral examination, on the basis of the above-mentioned learning outcomes.<br>Lab report (small group of students)<br>The repartition of points is as follows : oral examination part for 3/4 of the points and laboratory report for 1/4 of the points |
| Teaching methods | Ex-cathedra lectures, laboratory sessions allowing the student to observe and perform practical tasks related to the subject matter of this course. The labs provide an introduction to experimental methods (low temperature characterization of superconducting materials using electrical and magnetic measurements) and analysis of the results (critical temperature and magnetic fields, coherence length, …). |
| Content | 1. Fundamental phenomena associated with superconductivity. 2. Overview of main applications. 3. Description of superconductivity. 4. Type II superconductors . 5. Macroscopic quantum phenomena in superconductors (phase effects). 6. Superconductivity at the nanoscale. 7. Characterization labs of superconductors at low temperature. |
| Bibliography | *Introduction to Superconductivity. Michael Tinkham*. Series: (International series in pure and applied physics), edition. New York McGraw-Hill.<br>*Superconductivity*, *Superfluids and Condensates*. James F. Annett. University of Bristol. Oxford University Press.<br>The slides presented during the lectures and lecture notes on superconductivity are available on MoodleUCL.<br>*Introduction to Superconductivity. Michael Tinkham*. Series: (International series in pure and applied physics), edition. New York McGraw-Hill.<br>*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 [120] in Physical Engineering | FYAP2M | 5 | | 🔍 |
| Master [120] in Physics | PHYS2M | 5 | | 🔍 |