# Quantum Phenomena and Technologies

## Professor Claudio Giannetti

***COURSE AIMS AND INTENDED LEARNING OUTCOMES***

The course aims to provide students with an introduction to the macroscopic manifestation of quantum phenomena, with specific focus on the technological applications. The topics, listed in the *Course Content* section, will complement the basics introduced in the fundamental courses of quantum physics at the bachelor and master levels. In particular, the skills acquired during the *Quantum Phenomena and Technologies* course, will allow the students to quantitatively understand the working principles of technologies and devices, which exploit emerging quantum properties. Current research topics in quantum phenomena and technologies will be possibly addressed.

At the end of the course, students will be able to:

1. Understanding the macroscopic manifestations of quantum properties, such as condensation, superfluidity and superconductivity, as well as the working principles of technologically relevant quantum technologies, such as quantum computing and cryptography;
2. Use a correct technical language and present the course topics to both a technical and popular audience;
3. Undertake advanced research programs (eg. master thesis and PhD) in the field of quantum physics and technologies, both theoretical and experimental.

***COURSE CONTENT***

The course contents should be intended as indicative and not as a strict list of topics: some topics could be changed on the basis of the students’ feedback during the first part of the course.

The course will cover the following topics:

* Phenomenology of Bose-Einstein condensation, superfluidity and superconductivity.
* Quantum properties of condensates and supercondcutors.
* Introduction to quantum computing and cryptography.

***READING LIST***

* James F. Annett, *Superconductivity,* *Superfluids and Condensates*, Oxford University Press
* Michael A. Nielsen and Isaac L. Chuang, *Quantum Computation and Quantum Information,* Cambridge University Press
* Michael Tinkham, *Introduction to Superconductivity,* McGraw-Hill Inc.
* J.R. Schrieffer, *Theory of superconductivity,* Perseus Books

Additional reading materials will be provided before lectures and will be posted on Blackboard.

***TEACHING METHOD***

The teaching method is mainly based on frontal lectures. The interactions among students and professor will be fostered by case-studies discussions and assignments (eg. presentations of specific topics) carried out under the professor's guidance. Expert testimonials on specific subjects will be possibly invited during the course.

***ASSESSMENT METHOD AND CRITERIA***

The final assessment will be based on an oral exam. During the colloquium, the student will be assessed on the basis of the following criteria:

1. capacity to summarise and present the body of subjects studied (overview and capacity to summarise); 80% weight on the final score.
2. problem solving (analytical understanding and independence in application of the concepts learned); 20% weight on the final score

More specifically, under positive evaluation of the capacity to present the course subjects (point A) the student will gain marks up to 24/30. In order to get full marks (30/30), the student must demonstrate capacity of elaborating on the course subjects and applying them in an original and personal fashion. The full marks cum laude will be reserved to outstanding cases, in which the student demonstrates a knowledge of the course subjects as deep as what is needed to originally address issues not strictly related to the course contents.

***NOTES AND PREREQUISITES***

In order to proficiently attend the course, basics of quantum mechanics and condensed matter physics are required. Basics of electrodynamics and solid state physics are suggested.

Prof. Claudio Giannetti meets students any time, by appointment ([*claudio.giannetti@unicatt.it*](mailto:claudio.giannetti@unicatt.it)).

*Further information can be found on the lecturer's webpage at http://docenti.unicatt.it/web/searchByName.do?language=ENG or on the Faculty notice board.*