UNIVERSITÀ DI PAVIA

Anno Accademico 2020/2021

MAGNETISM AND SUPERCONDUCTIVITY

Enrollment year	2020/2021
Academic year	2020/2021
Regulations	DM270
Academic discipline	FIS/03 (MATERIAL PHYSICS)
Department	DEPARTMENT OF PHYSICS
Course	
Curriculum	Didattica e storia della fisica
Year of study	1°
Period	1st semester (05/10/2020 - 20/01/2021)
ECTS	6
Lesson hours	48 lesson hours
Language	Italian
Activity type	ORAL TEST
Teacher	CARRETTA PIETRO (titolare) - 2 ECTS PRANDO GIACOMO - 4 ECTS
Prerequisites	Knowledge of the basic aspects of quantum mechanics, statistical mechanics and the foundations of solid state physics, namely the lattice structures, the electronic bands and the lattice vibrations. The student should have already learned those aspects during the first three years of university.
Learning outcomes	To learn the basic aspects of phase transitions and the fundamental properties of magnetic and superconducting materials. To apply quantum mechanics to derive the eigenvalues and the response functions of these systems. The student should have acquired a suitable knowledge of these subjects, in order to follow with a suitable independence level part of the literature in these fields and to appropriately interact with the researchers in these areas.
Course contents	First the general aspects of phase transitions will be introduced:

	phenomenology, first and second order transitions, the order parameter, the response functions, the critical exponents, the correlation function and their behaviour on approaching a phase transition, the correlation effects among critical variables and the Stoner-Hubbard model. Then the course will address the magnetic properties of matter starting from the metals: the generalized susceptibility, the Landau levels, de Haas-Van Alphen effect, Landau diamagnetism, Pauli paramagnetism, dimensionality effects and the spin density waves. Then the basic aspects involved in the paramagnetism of insulators are recalled and the direct and indirect exchange interactions treated. The static properties and excitations in ferromagnets, antiferromagnets and in other types of magnetically ordered systems are presented. The effects of magnetic frustration are outlined and the main properties of molecular magnets described. Then the basic aspects of superconductors will be introduced: their thermodynamic properties, the London equations, the Cooper pair formation, the gap and the isotope effect, the Josephson effect and the SQUID, the Ginzburg-Landau theory. Finally some techniques which allow to investigate the basic properties of magnetic and superconducting materials will be presented: magnetometry, NMR, μSR and neutron scattering.
Teaching methods	Lectures and problem solving, trying to keep a high interactive level with the students. This is a "blended" course and the recorded lectures are available through KIRO multimedia platform.
Reccomended or required readings	A.Rigamonti and P.Carretta, Structure of Matter (3rd Edition) Springer International Pub. (2015) G. Grosso and G. Pastori Parravicini, Solid State Physics (Academic Press, 2000). H. Eugene Stanley, Introduction to Phase Transitions and Critical Phenomena (Oxford University Press) C. Kittel, Introduction to Solid State Physics (John Wiley & Sons 2005)
Assessment methods	Oral exam. The students should concentrate on the comprehension of the physical aspects involved, on the validity limits and on the approximations made during the derivations. In particular, it is important to know the physics behind the qualitative behaviour of the various quantities and the experimental methods used to derive them.
Further information	
Sustainable development goals - Agenda 2030	$lbl_legenda_sviluppo_sostenibile