Faculty of Science

FYST53, Physics: Magnetic Materials, 7.5 credits

Fysik: Magnetiska material, 7,5 högskolepoäng

Second Cycle / Avancerad nivå

Details of approval

The syllabus was approved by Study programmes board, Faculty of Science on 2020-06-11 to be valid from 2020-06-11, spring semester 2021.

General Information

The course is an elective second cycle for a Master of Science degree in physics, and related to the engineering program (technical nanoscience, and theoretical physics), along with doctoral students in the related fields. The course is open to students from other programmes, provided that they have the sufficient qualifications/prior knowledge.

Language of instruction: English

Main field of studies	*Depth of study relative to the degree requirements*
Physics	A1N, Second cycle, has only first-cycle course/s as entry requirements

Learning outcomes

The course provides an introduction to magnetism, magnetic materials, and selected applications and research topics. The course also describes magnetic measuring techniques that are based on magnetometry, X-rays, neutrons and scanning probe microscopy.

Knowledge and understanding

On completion of the course, the students shall be able to:

- Explain the microscopic origin of magnetic moments and their interactions
- Describe the origin of magnetic ordering and the nature of their characteristic excitations
- Describe how size, dimensionality, shape, and structure of materials influences the magnetic properties

- Describe various magnetic measurement techniques
- Explain how magnetic properties are used in selected applications

Competence and skills

On completion of the course, the students shall be able to:

- Calculate magnetic parameters for atoms and solids
- Perform magnetometry measurements using magnetometry
- Analyze magnetic data obtained from magnetometry experiments

Judgement and approach

On completion of the course, the students shall be able to:

- Explain advantages and disadvantages with different magnetic measurement techniques.
- Have the ability to judge which measurement techniques to use for a particular system and scientific question
- Evaluate and assess magnetic data.

Course content

The course treats:

- The microscopic origin of magnetic moments
- Paramagnetism and diamagnetism of atoms
- Pauli paramagnetism and Curie-Weiss mean-field theory forferromagnetism
- Exchange interactions; Ising, Heisenberg and Hubbard models
- Magnetic ordering, excitations, and quasiparticles
- Crystal fields, magnetic anisotropy, and magnetic domains
- Magnetic properties at the nanoscale
- Magnetometry and superconducting quantum interference device (SQUID)
- X-ray magnetic circular dichroism (XMCD) and resonance scattering
- Neutron and muon scattering techniques
- Scanning probe and X-ray based magnetic microscopy techniques
- Selected current research topics
- Applications: e.g. Magnetoresistance, spintronics, and functional magneticmaterials.

Course design

Teaching consists of lectures and laboratory exercises. Compulsory participation is required in the laboratory exercise and passing the lab report.

Assessment

The assessment is based on a written exam (6.5 credits) and lab report (1 credit).

Students who do not pass an assessment will be offered another opportunity for assessment soon thereafter.

The examiner, in consultation with Disability Support Services, may deviate from the regular form of examination in order to provide a permanently disabled student with

a form of examination equivalent to that of a student without a disability.

Subcourses that are part of this course can be found in an appendix at the end of this document.

Grades

Marking scale: Fail, Pass, Pass with distinction.
For a grade of Pass on the whole course, the student must have passed the exam, lab reports and participated in the compulsory components.

The final grade is determined by the aggregated results of the different assessed components.

Entry requirements

To be admitted to the course, students must have 90 ECTS credits in physics and mathematics, in Natural Science studies, including knowledge corresponding to FYSC11 Physics:: Atomic and Molecular Physics 7.5 credits, FYSC13 Physics: Solid State Physics 7.5 credits, and FYSN17 Physics: Quantum Mechanics 7.5 credits, or equivalent.

Subcourses in FYST53, Physics: Magnetic Materials

Applies from V21

2101 Exam, 6,5 hp
Grading scale: Fail, Pass, Pass with distinction
2102 Laboration, 1,0 hp
Grading scale: Fail, Pass, Pass with distinction