



Faculty of Technology and Science
Physics
Syllabus

Course Approval

The syllabus was approved by the Faculty Board of Technology and Science on 4 March 2009, and is valid from the Autumn semester of 2008 at Karlstad University.

Course Code: FYAD07

Scanning Probe Microscopy, 7.5 ECTS Credits
(Svepprobmikroskopi, 7.5 Swedish credit points)

Degree Level: Master

Progressive Specialisation: A1N (Second cycle, has only first-cycle course/s as entry requirements)

Language of Instruction

English or Swedish.

Prerequisites

Mathematics 45 ECTS cr., Physics 90 ECTS cr., including the courses Quantum Physics I and Solid State Physics, or similar courses.

Major Field of Study

FYA (Physics)

Learning Outcomes

Having completed this course, the student should be able to:

- give an account of the basic technical conditions for scanning probe microscopy
- give an account of the quantum mechanical theory for tunneling in scanning tunneling microscopy (STM)
- describe in depth different measurement methods in STM, including tunneling spectroscopy, as well as data analysis and artifacts in STM experiments
- give an account of the physical basis for scanning force microscopy (SFM, also commonly denoted AFM), including the different forces that are relevant in a SFM measurement.
- describe in depth different SFM measurement methods, and their relation to the different forces that affect the measurements, in particular the three most common methods: contact mode, so-called tapping mode and non-contact mode, as well as advanced analysis and artifacts in SFM measurements
- give an account of different types of atom and nanostructure manipulation on surfaces with STM and SFM
- give a summary account of other SPM techniques and their use.
- independently perform measurements with a SFM instrument

Content and Form of Instruction

The course treats modern scanning probe microscopy (SPM) techniques, primarily scanning tunneling microscopy (STM) and scanning force microscopy (SFM), both regarding theory and practice. The physical foundation and theory of STM and SFM is treated thoroughly, as well as the basic measurement modes. The course also covers advanced measurement and analysis methods, artifacts, as well as manipulation with STM and SFM. Several examples of the use of SPM techniques in current research and industry are given. Finally, an overview of other SPM techniques is given. The course contains laboratory exercises with mandatory

participation

Content:

Fundamental experimental and technical aspects of scanning probe microscopy.

STM: STM theory, Measurements modes, resolution limits, tunneling spectroscopy, low-temperature STM, inelastic tunneling, spin-polarised STM. Advanced analysis, electronic and atomic effects, artifacts, manipulation on atomic level.

SFM: Instrumental aspects, including cantilevers deflection sensors and tip preparation. Relevant forces for SFM: Measurement modes: static and dynamic methods, contact, tapping and non-contact methods.

Magnetic force measurements. Spectroscopy, advanced analysis, artifacts in SFM. Overview of manipulation and lithography with SFM.

Overview of other SPM techniques, including scanning near-field optical microscopy (SNOM).

Reading List

See separate document.

Examination

The examination will be in the form of mandatory presentations at seminars, homeworks, an oral or written exam, and presentation of a deeper study orally and in writing. In addition a Pass degree is needed in the laboratory exercises.

Grades

In the Engineering program one of the grades U (Fail), 3 (Pass), 4 (Some Distinction), or 5 (Distinction) is awarded in the examination of the course. In other programs the grades U (Fail), G (Pass), and VG (Distinction) are used.

Quality Assurance

Follow-up relating to learning conditions and goal-fulfilment takes place both during and upon completion of the course in order to ensure continuous improvement. Course assessment is based on student views and experiences as reported in written course evaluations and/or group discussions. Students will be informed of the result of the evaluation and of the measures to be taken.

Course Certificate

A course certificate will be provided upon request.

Additional Information

Students who enrolled before 1 July 2007 will complete their studies in accordance with the requirements of the earlier admission. Upon completion students may request degree and course certificates to be issued under the current ordinance if they meet its requirements.

The local regulations for studies at the Bachelor's and Master's levels at Karlstad University stipulate the obligations and rights of students and staff.

Karlstads universitet 651 88 Karlstad, Sweden
Tel +46-54-700 10 00 Fax +46-54-700 14 60
information@kau.se www.kau.se