



Faculty of Health, Science and Technology  
Physics

# Syllabus

## Surface Physics

<b>Course Code:</b>	FYAE03
<b>Course Title:</b>	Surface Physics <i>Ytfysik</i>
<b>Credits:</b>	7.5
<b>Degree Level:</b>	Master's level
<b>Progressive Specialisation:</b>	Second cycle, has only first-cycle course/s as entry requirements (A1N)

### Major Field of Study:

FYA (Physics)

TKA (Engineering Physics)

### Course Approval

The syllabus was approved by the Faculty of Health, Science and Technology 2016-09-08, and is valid from the Spring semester 2017 at Karlstad University.

### Prerequisites

Mathematics, 35 ECTS cr, and Physics, 60 ECTS cr, plus the courses Solid State Physics, 7.5 ECTS cr, and Quantum Physics II, 7.5 ECTS cr, or the equivalent.

### Learning Outcomes

The aim of the course is that students acquire advanced knowledge of the composition of the surfaces of solid materials, the physical and chemical processes on the surfaces and how these can be studied and applied. The course also aims to inspire students to adopt a scientific approach to research and to prepare them for doctoral studies.

Upon completion of the course, students should be able to:

- demonstrate basic knowledge of ultra-high vacuum technologies and its application in preparing and characterizing pure crystalline surfaces, as well as physical processes in the growth of ultra-thin films and technologies of the thin-film growth
- give an account of the various types of surface morphologies, the atomic structure of surfaces, relaxation and surface reconstruction as well as the physical basis of these phenomena
- give an account of the most important experimental technologies to characterize the structure of surfaces, such as scanning probe technologies, Auger electron spectroscopy, and electron diffraction technologies,
- describe surface scattering theory
- give a detailed account of the LEED-technology and to analyze LEED-images
- demonstrate advanced knowledge of the electronic structure of surfaces and the use of photoemission for experimental research on surface electronic state and surface band structure
- demonstrate advanced knowledge of the physical basis of band bending with semiconductor surfaces

and interfaces, metal-semiconductor interfaces, and the Schottky barrier  
- give an account of collective phenomena as well as adsorption and chemical reactions on surfaces.

### **Content**

Instruction is in the form of lectures, seminars, and mandatory laboratory assignments.

Course content:

Introduction to vacuum technology.

The atomic structure of surfaces. Reconstruction and relaxation. Structural research methods, especially electron diffraction. Preparation of surfaces, growth of ultra-thin films.

The electronic structure of surfaces. Spectroscopic research methods, especially photoemission, theory of angle-resolved photoemission. Surface band structure and surface states of various metal- and semiconductor surfaces.

Band bending and Fermi-level pinning of semiconductor surfaces. Metal-semiconductor interfaces, semiconductor heterostructures, the Schottky barrier.

Introduction to collective phenomena on surfaces and in interfaces, especially superconductivity and ferromagnetism.

Adsorption and chemical reactions on surfaces.

### **Reading List**

See separate document.

### **Examination**

Assessment is based on written and oral exams, hand-in assignments, lab reports, and written and oral presentation of a project.

### **Grades**

One of the grades U (Fail), 3 (Pass), 4 (Some Distinction), or 5 (Distinction), is awarded in the examination of the course for engineering programme students. Other students are awarded a grade on the scale U (Fail), G (Pass), or VG (Distinction).

### **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 evaluation is partly based on student views and experiences obtained in accordance with current regulations and partly on other data and documentation. Students will be informed of the result of the evaluation and of any measures to be taken.

### **Course Certificate**

A course certificate will be provided upon request.

### **Additional information**

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

The course is a mandatory part of the Master program in Engineering Physics.