Reg No: FYAE03/20261

Faculty of Health, Science and Technology
Physics

Syllabus

Surface Physics

Course Code:	FYAE03
Course Title:	Surface Physics *Ytfysik*
Credits:	7.5
Degree Level:	Master's level
Progressive Specialisation:	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 2025-09-05, and is valid from the Spring semester 2026 at Karlstad University.

Prerequisites
Physics, 60 ECTS credits, including Solid State Physics, 7.5 ECTS credits, and Mathematics, 35 ECTS credits, plus upper secondary level English 6 or English level 2, or equivalent

Learning Outcomes
The aim of the course is for students to acquire in-depth 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:
1. demonstrate basic knowledge of ultra-high vacuum technologies and its application in preparing and characterising pure crystalline surfaces, as well as physical processes in the

growth of ultra-thin films and technologies of the thin-film growth,
2. 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,
3. give an account of the most important experimental technologies to characterise the structure of surfaces, such as scanning probe technologies, Auger electron spectroscopy, and electron diffraction technologies,
4. describe surface scattering theory,
5. give a detailed account of LEED technology and demonstrate the ability to analyse LEED images,
6. demonstrate in-depth knowledge of the electronic structure of surfaces and the use of photoemission for experimental research on surface electronic state and surface band structure,
7. demonstrate in-depth knowledge of the physical basis of band bending with semiconductor surfaces and interfaces, metal-semiconductor interfaces, and the Schottky barrier, and
8. 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 an individual written exam, individual hand-in assignments and lab reports, and individual written and oral presentation of a project.

If students have a decision from Karlstad University entitling them to Targeted Study Support due to a documented disability, the examiner has the right to give such students an adapted examination or to examine them in a different manner.

Grades
One of the grades 5 (Pass with Distinction), 4 (Pass with Some Distinction), 3 (Pass), or U (Fail) is awarded in the examination of the course.

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.