Faculty of Science

FYST64, Physics: Physics and Chemistry of Surfaces, 7.5 credits

Fysik: Ytors fysik och kemi, 7,5 högskolepoäng

Second Cycle / Avancerad nivå

Details of approval

The syllabus was approved by Study programmes board, Faculty of Science on 2022-06-14 to be valid from 2022-06-14, spring semester 2023.

General Information

The course is an elective course for second-cycle studies for a natural science Bachelor or Master degree in physics.

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 aim of the course is to give an introduction surface science or more specifically to the properties and the chemistry of surfaces and interfaces on an atomic length scale. Surfaces and interfaces play a central role in a variety of modern technologies spanning from heterogenous catalysis, corrosion, electrochemical processes, printing, dyeing, and adhesion. Also in nanoscience surfaces play a central role, since the majority of the atoms are surface atoms. As an extreme example, all atoms in the 2D material graphene are surface atoms.

Knowledge and understanding

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

1. explain how structure and properties are different from for surfaces as compared to the bulk.

Competence and skills

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

2. give an account for and apply the real space as well as the reciprocal space nomenclature used to describe surfaces and the adsorption on surfaces.
3. interpret the results of surface science techniques such as XPS, LEED and STM as used in papers, patents, etc., and they should be able to assess the reliability of such results.
4. write a well-structured project report which summarize, explain and analyse experimental and/or theoretical papers within the field of surface science.
5. present the project report in an oral seminar in a well structures and pedagogical manner.
6. indepently search and use information beyond the course literature.
7. integrate the knowledge from the course in a scientific discussion.
8. choose the most relevant surface science technique to use from a specific scientific question.

Judgement and approach

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

9. critically discuss, reflect on and give examples of the importance of surface science in the society.
10. critically discuss, reflect on and give examples of how surface science studies can lead to a more sustainable society and reduced environmental impact.

Course content

The course starts with an introduction to surfaces and their fundamental importance in physics, chemistry, nanoscience and biology. The introduction is followed by a basic discussion of surface structure, adsorption, surface reactions, and crystal growth. In particular, it is discussed how the physics and chemistry of surfaces (and 2d gases at surfaces) can differ fundamentally from those of the surfaces' 3d equivalents. In the remaining main part of the course, the experimental determination of surface structure, surfaces chemistry and surface is discussed and the following techniques are addressed: Scanning tunnelling microscopy (STM, AFM, MFM), spectroscopy (AES, XPS), diffraction (LEED, SXRD), and microscopy techniques based on XPS, LEED, and SXRD.

The course treats the following aspects:

- surface-specific problems in physics, chemistry, nanoscience, and biology.
- the description of surface structures, adsorption at surfaces, and alloys.
- scanning tunnelling microscopy techniques for surface analysis.
- spectroscopy and diffraction techniqes for surface analysis.
- newly developed methods for surface physics.

Course design

The teaching methods in this course are lectures, exercise classes and a group project work. Participation in the group project work and related teaching is compulsory.

The course is problem based, with overview lectures and exercise classes where the students work with problems directly connected to the lectures. Towards the end of the course the students choose a supervised project and work with this in small

groups. In the project they use a literature survey combined with discussions with the supervisor to study a particular field/technique within surface science studies. The students shall present the project both written and oral in the form of a report and seminar, respectively, for all students in the course and the course responsible.

Assessment

The examination is based on:

written examination at the end of the course, equivalent to 5 credits, that examines learning outcomes 1-3, 8.

written and oral presentation of the project work at the end of the course, equivalent to 2.5 credits, that examines learning outcomes 4-7, 9-10.

A student who has not passed the regular exam will be offered an opportunity for a resit exam scheduled close to the regular exam.

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.
To pass the entire course, passing marks on written exam and the project report and the oral presentation as well as participation in all compulsory parts of the course are required.

Calculation of grades:

For the written exam a per-cent result is given that corresponds to the part of completed credits relative to the total number of possible points. The grades Fail, Pass and Pass with distinction are used. 50% and 80% corresponds to grade Pass and Pass with distinction, respectively.

For the project (where both the quality of written report and the oral seminar are considered) also a per-cent result is given. The grades Fail, Pass and Pass with distinction are used. 50% and 80% corresponds to grade Pass and Pass with distinction, repectively.

To calculate a combined final result and grade for the whole course, a weighted mean is derived by using the per-cent results for written exam and the project. The grades Fail, Pass and Pass with distinction are used. 50% and 80% corresponds to grade Pass and Pass with distinction, repectively.

Entry requirements

Admission to the course requires 120 credits studies in natural sciences, of which 75 credits in physics and 45 credits in mathematics is included, alternatively a Bachelor degree in physics – in both cases including knowledge equivalent to FYSC23, Solid state physics, 7.5 credits, and English 6/B.

Further information

The course replaces FYST19 Physics: Physics and Chemistry of Surfaces, 7.5 credits, and cannot be counted in a degree together with this course.

The course is entirely co-read with EXTP95 The Physics of Surfaces, 7.5 credits, which is a course at the Faculty of engineering, LTH.

The course is given by the Department of Physics, Lund University.

Subcourses in FYST64, Physics: Physics and Chemistry of Surfaces

Applies from V23

2301 Written exam, 5,0 hp
Grading scale: Fail, Pass, Pass with distinction
2302 Project presentation and project report, 2,5 hp
Grading scale: Fail, Pass, Pass with distinction