Linnæus University

Dnr: 2020/2169-3.1.2.2

# Course syllabus

Faculty of Technology

Department of Physics and Electrical Engineering

## 2FY513 Fasta tillståndets fysik, 7,5 högskolepoäng
## 2FY513 Solid State Physics, 7.5 credits

**Main field of study**
Physics

**Subject Group**
Physics

**Level of classification**
First Level

**Progression**
G2F

**Date of Ratification**
Approved by Faculty of Technology 2020-06-08
The course syllabus is valid from spring semester 2021

**Prerequisites**
Mechanics, 7.5 credits (1FY804), Physics - Electricity and magnetism, 7.5 credits (1FY802), Atomic and nuclear physics, 7.5 credits (1FY801), Waves and optics, 7.5 credits (1FY803), Thermodynamics and statistical physics (1FY809), Quantum mechanics, 7.5 credits (2FY807) or corresponding coursework

## Objectives
After the course the student should be able to:

*Knowledge and understanding*

- A.1 describe the most basic crystal structures of solids and their crystal bonds
- A.2 use the concept of reciprocal lattice to describe characteristics of periodic ensembles of atoms
- A.3 describe crystal vibrations; use their quantum mechanical formulation in the form of phonons to explain the thermal properties in solids and to illustrate the concept of quantum mechanical collective excitations
- A.4 explain the main transport properties of metals using the quantum statistical properties of many non-interacting free electrons
- A.5 use quantum mechanics to describe the electronic bandstructure of solids
- A.6 explain the difference between metals, insulators and semiconductors using

their quantum mechanical bandstructure
- A.7 explain the physical boundaries of nanophysics.

*Skills and abilities*

- B.1 solve problems and perform calculations for both classical and quantum mechanical models that describe physical properties of solids
- B.2 use computers to solve problems that cannot be solved analytically and to plot results of analytical calculations
- B.3 present calculations and reasoning in writing so that they can be followed by persons who are not familiar with the problem.

*Judgement and approach*

- C.1 discuss the relevance, scope and accuracy of theoretical models and learn to compare their results with experiments.

## Content

Solid state physics is part of condensed matter physics, and deals with the physical properties of systems composed of large numbers of atoms that strongly interact and organize themselves into solids. Their properties cannot be explained by the properties of individual atoms, but they emerge from the collective behavior of all the atoms in the system. Specifically, the course introduces the fundamental concepts and properties of crystals and electrons in crystals in a modern approach, focusing on a quantum mechanical description.

1. Crystal structures
2. X-ray diffraction and reciprocal lattice
3. Brillouin zones
4. Crystal binding, van der Waals, ionic, covalent, and metallic binding
5. Lattice vibrations and phonons
6. Phonons and thermal properties of solids
7. Free-electron model, electrical conductivity and Ohm’s law
8. Periodic potential and Bloch’s theorem. Energy bands. Quasi free-electron gas and tight-binding model
9. Semiconductors
10. Introduction to nanostructures

## Type of Instruction

Lectures, instructor-led problem exercises and instructor-led meetings related to written assignments.

## Examination

The examination of the course is divided as follows:

| Code | Designation | Grade | Credits |
|---|---|---|---|
| 2101 | Written exam | AF | 3,50 |
| 2102 | Oral exam | U/G | 2,00 |
| 2103 | Assignment | AF | 2,00 |

The course is assessed with the grades A, B, C, D, E, Fx or F.

The grade A constitutes the highest grade, and the remaining grades follow in descending order with grade E being the lowest grade to Pass. The grade F means that the student’s performance has been assessed as Fail.

Examination is in the form of written assignments submitted during the course, together with a written and an oral exam at the end of the course. Earning a passing grade in the course requires getting a passing grade on all the assignments and exams. The evaluation criteria for a passing grade follow from the Objectives (see above).

A first written re-examination is offered within six term weeks. The number of occasions for examination is limited to five. The oral examination can be taken only if the written exam receives a passing grade.

Re-examination is given according to Local rules for courses and examination at the basic level and advanced level at Linnaeus University.

If the university has determined that a student has the right to special educational support on the basis of a disability, the examiner has the right to give an adapted test or allow the student to perform the test in an alternative way.

**Objectives achievement**

The examination elements are linked to the course objectives in the following ways:

| **Goal** | 2101 | 2102 | 2103 |
|---|---|---|---|
| A.1 | ☑ | ☑ | |
| A.2 | ☑ | ☑ | ☑ |
| A.3 | ☑ | ☑ | ☑ |
| A.4 | ☑ | ☑ | ☑ |
| A.5 | ☑ | ☑ | ☑ |
| A.6 | ☑ | ☑ | |
| A.7 | ☑ | ☑ | |
| B.1 | ☑ | ☑ | ☑ |
| B.2 | | | ☑ |
| B.3 | ☑ | | ☑ |
| C.1 | ☑ | ☑ | ☑ |

## Course Evaluation

During the course or in close connection with the course, a course evaluation is carried out. Results and analysis of the conducted evaluation shall be linked to the students who undertook the course, while protecting their identity. Students who participate in the next course opportunity will receive the evaluation results and analysis at the start of the course. Course evaluations are conducted anonymously.

## Other

Grading criteria for the AF-scale are communicated to the student with a special

document. The student is informed about the course grading criteria no later than at the start of the course.

## Required Reading and Additional Study Material

Kittel, Charles. 2004. Introduction to Solid State Physics. 8th edition, Wiley. ca. 700 pages. ISBN 047141526X.

**Reference literature**Ashcroft, N.W. and Mermin, N.D. 1976. Solid State Physics. First edition. Brooks Cole. ISBN10:0030839939

Myers, H.P. 1998. Introductory Solid State physics. Second edition. Taylor & Francis. ISBN 074840659X