Faculty of Science

FYST68, Physics: Solid State Theory, 7.5 credits

Fysik: Fasta tillståndets teori, 7,5 högskolepoäng

Second Cycle / Avancerad nivå

Details of approval

The syllabus was approved by Study programmes board, Faculty of Science on 2022-06-13 and was last revised on 2025-12-05 by The Education Board of Faculty of Science. The revised syllabus comes into effect 2025-12-05 and is valid from the autumn semester 2026.

General information

The course is an elective course for second-cycle studies for a Degree of Master of Science (120 credits) with a specialisation in physics.

Language of instruction: English

Main field of study	*Specialisation*
Physics	A1F, Second cycle, has second-cycle course/s as entry requirements

Learning outcomes

The course intends to give an advanced understanding of key concepts in solid state physics and their relationship to basic theories in quantum mechanics and electrodynamics. The students should learn how these concepts can be utilised to model physical effects quantitatively. Particular emphasis is given towards topics relevant for current research in solid state physics and nanoscience in Lund.

Knowledge and understanding

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

- explain the concept of electronic band structure in crystals and be able to relate this to basic quantum mechanics,
- assess how scattering influences electron transport in semiconductors and metals,

- explain the microscopical origin of para -, dia- and ferromagnetism in simple models,
- give examples of the role of dimensionality for electronic properties,
- describe the mean-field approximation,
- explain how the dielectric function is influenced by phonons, optical transitions and electron-electron interaction,
- describe superconductivity and demonstrate knowledge of the microscopical BCS state.

Competence and skills

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

- apply envelope functions in modelling of semiconductor heterostructures,
- handle simple problems in many-particle quantum mechanics using the occupation number representation,
- carry out elementary quantitative calculations for optical properties of solids,
- carry out computer-aided calculations on models for materials.

Judgement and approach

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

- evaluate the hierarchy of concepts in solid state physics,
- see the utility of basic theoretical physics for the quantitative description of practical problems.

Course content

The course deals with:

- Band structure for crystals and semiconductor heterostructures,
- Electron transport and scattering,
- Magnetic properties,
- Density matrices and optical Bloch equations,
- Dielectric properties, Coulomb interaction and excitons,
- Superconductivity.

Course design

The teaching consists of lectures and seminars. Participation in seminars and connected teaching is compulsory.

Assessment

Examination takes place in the form of written hand-in assignments during the course as well as orally in the form of an exam at the end of the course. For students who have not passed the regular examination, an additional examination during the scheduled retake period is offered.

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.

Grades

Grading scale includes the grades: Fail, Pass, Pass with distinction
To pass the entire course, approved examination, passed written assignments and participation in all compulsory parts are required.

The grading scale for the written assignments is Failed, Passed, while examination is graded according to the grading scale failed, passed, Passed with distinction.
The final grade is decided by the grade on the exam.

Entry requirements

Admission to the course requires 135 credits in natural science including 90 credits in physics and 45 credits in mathematics, or a Degree of Bachelor in physics - in both cases including knowledge equivalent to FYSC23 Solid State Physics, 7.5 credits, FYSB23 Basic statistical physics and quantum statistics, 7.5 credits, FYSC20 Electromagnetism, 7.5 credits, FYSN27 Quantum Mechanics, 7.5 credits (at least taken), and English 6/B.

Further information

This course replaces FYST25, Physics: Solid state theory, 7.5 credits, and cannot be included in qualification together with this course or together with FYS234, Physics: Solid State Theory, 7.5 credits.

The course is coordinated with EXTP90, Solid state theory, 7.5 credits which is a course at LTH, the faculty of engineering.

The examination of the course is scheduled in accordance with the LTH exam schedule.

The course is offered at the Department of Physics, Lund University.