Course syllabus

Fasta tillståndets teori
Solid State Theory

EXTP90, 7,5 credits, A (Second Cycle)

Valid for: 2023/24
Faculty: Faculty of Engineering, LTH
Decided by: PLED N
Date of Decision: 2023-04-17

General Information

Main field: Nanoscience.
Elective for: F4, F4-tf, F4-nf, MNAV1, N4-nf
Language of instruction: The course will be given in English

Aim

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.

Learning outcomes

Knowledge and understanding
For a passing grade the student must

- 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.

Competences and skills
For a passing grade the student must

- 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
For a passing grade the student must

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

Contents

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.

Examination details

Grading scale: TH - (U,3,4,5) - (Fail, Three, Four, Five)
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.

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.

Parts
Code: 0123. **Name:** Examination.
Credits: 5. **Grading scale:** TH. **Assessment:** Oral examination
Code: 0223. **Name:** Hand-in Assignments.
Credits: 2,5. **Grading scale:** UG. **Assessment:** Graded hand-in exercises

Admission

Assumed prior knowledge: FFFF05 Solid State Physics or FFFF01 Electronic Materials; FMFN01 Quantum Mechanics Advanced Course or similar; Basic knowledge of electromagnetism and statistical physics.
The number of participants is limited to: No
The course overlaps following course/s: FFF051

Reading list

- D. W. Snoke: Solid State Physics. Addison Wesley, 2008. Or other similar books.
- Lecture notes available from web site.

Contact and other information

Course coordinator: Erik van Loon, erik.van_loon@teorfys.lu.se
Further information: The course is given by the Faculty of Science and does not

follow the study period structure.