Linnæus University

Course syllabus

Faculty of Technology

Department of Physics and Electrical Engineering

4FY545 Avancerad kondenserade materiens fysisk, 7,5 högskolepoäng

Advanced condensed matter physics, 7.5 credits

Main field of study
Physics

Subject Group
Physics

Level of classification
Second Level

Progression
A1N

Date of Ratification
Approved by Faculty of Technology 2020-04-20
The course syllabus is valid from spring semester 2021

Prerequisites
Physics 90 credits, mathematics 45 credits or equivalent. A course in Solid State Physics at minimum G2F-level.

Objectives

At the end of the course the students:

- should have learnt a deeper use of quantum mechanics in the theory of solids
- should be able to account for the effects of the electron-electron interaction on the electronic properties of metals and insulators via mean-field approaches such as the Hartree-Fock approximation
- should have acquired an introduction of the use of density-functional theory in the calculations of electronic structures
- should have become familiar with the main ideas of Fermi liquid theory (e.g., the concept of quasi-particle) and its crucial role in justifying the one particle approximation in solid-state physics
- should have acquired a basic knowledge of the theory of electron transport, including quantum corrections to the semiclassical treatment
- should be knowledgeable about the optical properties of metals and insulators
- should have become familiar with the concept of broken symmetry in condensed matter physics through the introductory study of far reaching phenomena such as magnetism and superconductivity.

Content

Electron-Electron Interaction

A. Beyond the independent electron approximation
B. The Hartree-Fock approximation
C. Screening
D. Landau's Theory of a Fermi Liquid

Electron transport

A. Dynamics of Bloch electrons
B. Transport phenomena and Fermi liquid theory
C. Microscopic theory of conduction

Magnetism

A. Introduction
B. Magnetization and magnetic susceptibility
C. Diamagnetism and paramagnetism in solids
D. Exchange
E. Spin Hamiltonian and Heisenberg model
F. Magnetism in Metals
G. Magnetic Ordering

Superconductivity

A. Fundamental properties
B. Electrodynamics of superconductors
C. The BCS Theory

Optical Properties of Solids

A. Macroscopic Theory
B. Optical modes in ionic crystals
C. Interband Transitions
D. Optical properties of Metals

Type of Instruction

The teaching consists of lectures and tutorials.

Students can also register for the “distance” version of the course and follow the course via the internet. IT support and technical information: Email and web connection. Real-time and recorded lectures on course homepage.

Examination

The course is assessed with the grades A, B, C, D, E, Fx or F.
The grade A constitutes the highest grade on the scale and the remaining grades follow in descending order where the grade E is the lowest grade on the scale that will result in a pass. The grade F means that the student’s performance is assessed as fail (i.e. received the grade F).

Assessment of student performance is made through written test and oral examinations and presentation of mandatory assignments. Reexamination will be offered within six weeks under the regular semester periods.

Repeat examination is offered in accordance with Local regulations for courses and examination at the first and second-cycle level at Linnaeus University.

If the university has decided that a student is entitled to special pedagogical support due to a disability, the examiner has the right to give a customised exam or to have the student conduct the exam in an alternative way.

Course Evaluation

During the implementation of the course or in close conjunction with the course, a course evaluation is to be carried out. Results and analysis of the course evaluation are course evaluation is to be carried out. Results and analysis of the course evaluation are to be promptly presented as feedback to the students who have completed the course. Students who participate during the next course instance receive feedback at the start of the course. The course evaluation is to be carried out anonymously.

Credit Overlap

The course cannot be included in a degree along with the following courses of which the content fully, or partly, corresponds to the content of this course: 4FY828 Solid State Physics III, 7.5 credits
4FY528 Solid State Physics III, 7.5 credits

Other

Grade criteria for the A–F scale are communicated to the student through a special document. The student is to be informed about the grade criteria for the course by the start of the course at the latest.

Required Reading and Additional Study Material

Main references

1.Ashcroft, N. W. and Mermin, N.D., Solid State Physics, Saunders College, 1976.

2.Marder, M. P, Condensed Matter Physics, J. Wiley & Sons, 2000.

Other recommended references

Anderson, P.W., Concepts in Solids, Addison-Wesley, 1963.

deGennes, P.G., Superconductivity of Metals and Alloys, Addison-Wesley, 1966.

Harrison, W.A., Solid State Theory, McGraw-Hill, 1970

Kittel, C., Introduction to Solid State Physics, 7th Ed., John Wiley, 1995.

Kittel, C., Quantum Theory of Solids, 2nd Revised Ed., John Wiley, 1987.

Landau, L.D. and Lifschitz, E.M., Quantum Mechanics, Addison-Wesley, 1958.

Mattis, D.C., The Theory of Magnetism I, Springer-Verlag, 1988.

Sakurai, J.J., Modern Quantum Mechanics, Addison-Wesley 1994.

Schrieffer, J.R., Theory of Superconductivity, Addison-Wesley, 1988.