SK2758
Solid state physics, 7.5 credits, VT 2020

Syllabus and learning outcomes

Syllabus
The course introduces k-space (wave vector space) and the reciprocal lattice with its applications, which are central concepts for further studies within solid state physics. In addition, the course gives an overview of different models to describe the properties of solid materials.

Classification of solid material, atomic binding

Crystalline materials, lattice vectors, unit cells

Reciprocal space, Brillouin zones

X-ray diffraction, Bragg's law, von Laue equations

Lattice vibrations, phonons, heat capacity

Free electron model, resistance in metals, Hall effect

Band structure, Bloch wave functions, introduction to band structure calculations

Semiconductors, metals, superconductivity and magnetism

Learning outcomes
After the course, the student should be able to

• *describe and classify materials from their crystal structure and atomic arrangements [1]*

• *apply the theory for X-ray diffraction in reciprocal space (k-space) to determine the lattice structure of crystalline materials and also be able to use these principles for other waves in solid materials [2]*

• *describe the different physical mechanisms for crystal binding by identifying repelling and attractive interaction coupled to atomic properties [3]*

• *formulate basic models for lattice vibrations (phonons) and their influence on the physics of crystalline materials, make calculations based on these models and be able to relate the conclusions form the models to experimentally measured properties of materials [4]*

• *formulate electron properties in a periodic potential, explain factors that affects the band structure of a crystalline material, make a simple band structure calculation and based on this develop a qualitative understanding of the band structure of materials [5]*

• *explain the physical principles for different types of electric and magnetic phenomena in solid materials and relate this to macroscopically measurable quantities [6]*

with the aim of being able to handle the coupling between fundamental theoretical models and experimental results in solid state physics and having sufficient knowledge to continue with deeper studies within the field

For higher grades, it is in addition required that the students should be able to apply the knowledge learnt in the course on for them completely unknown problems.

Language of instruction
English

Course literature and preparations

Prerequisites
Completed course SI1155 Theoretical physics or SH1012 Modern physics.

Literature
• Charles Kittel, Introduction to solid state physics, 8th edition, John Wiley & Sons Inc., 2005, ISBN 978-0-471-41526-8 (available at Kårbokhandeln).
• Other course material that can be downloaded from Canvas

Reading instructions
Reading instructions for the course book can be found on Canvas.

Disability
If you have a disability that affects your studies, you can apply for support from FUNKA: https://www.kth.se/en/student/studentliv/funktionsnedsattning/stod-for-studenter-med-funktionsnedsattning-1.39736
Please inform also the course leader if you have any special needs not covered by the standard handling by FUNKA. In such a case, bring your certificate from FUNKA.

Examination and finalization

Grading scale
A, B, C, D, E, FX, F

Examination
LAB1 – Laboratory work, 1.5 credits, Grading scale: P, F
TEN2 – Written exam, 4.5 credits, Grading scale: A, B, C, D, E, FX, F
TEN3 – Unsupervised examination, 1.5 credits, Grading scale: P, F

Based on recommendations from KTH's coordinator of disabilities, the examiner will decide how to adapt an examination for students with documented disability. The examiner may apply another format when re-examining individual students.

Grading criteria
To obtain the different grades in the course, the student should show the following abilities:

Grade A: Show a very good understanding of the basic concepts in the course and show a good ability to solve both standard problems and advanced problems within the whole field.

Grade B: Fulfils the requirements for grade C, but only partly for grade A.

Grade C: Show a very good understanding of the basic concepts in the course and show a good ability to solve standard problems together with an ability to solve more advanced problems within parts of the field.

Grade D: Fulfils the requirements for grade E, but only partly for grade C.

Grade E: Show a good understanding of the basic concepts in the course and show a good ability to solve standard problems within the field.

The final grading of the course will be based on the grading of TEN2.

Examination details
LAB1 - Laboratory work (1.5 credits)
To pass the examination, students must participate in the laboratory work and hand in two written laboratory reports (one on X-ray diffraction and one on band structure calculations) with a pass grade on each of them. Examines course goal [2] and [5].

TEN2 - Written exam (4.5 credits)
The final examination in the course is a 5 h written exam with a theory part and a problem part. Maximum 24 points can be obtained on the exam and the grading is as follows:

Grade A: > 20 points
Grade B: 18 - 19.5 points
Grade C: 14 – 17.5 points
Grade D: 12 – 13.5 points
Grade E: 11 - 11.5 points
Grade Fx: 10 – 10.5 points
Grade F: < 10 points

Examines the problem-solving ability in all the learning outcomes, [1]-[6] both for standard problems and for more advanced and novel types of problems.

Allowed aid during the exam:
Theory part: Ruler, pocket calculator, mathematics handbook BETA, English – native language dictionary.
Problem part: Ruler, pocket calculator, mathematics handbook BETA, one course book (e.g. C. Kittel, Introduction to solid state physics), CGS-to-SI conversion sheet, English – native language dictionary.

Students with grade FX can do additional work in the course to obtain grade E. Detailed information about the required additional work (construction and solution of a novel problem) can be found in Canvas.

TEN3 - Unsupervised examination (1.5 credits)
The student should pass 4 digital examinations (quizzes) during the course. The digital exams should be completed without errors to obtain a pass grade. Examines the basic level of understanding for all the course goals, [1]-[6].

The total grade in the course is given by the grade of TEN2.

Information to previous student in the course
You should pass both of the examinations TEN 2 and TEN3 in order to pass the previous TEN1.

Further information

Offered by
SCI/Applied Physics – administrative support can be obtained from kursexp@physics.kth.se.

Teachers

Examiner & lectures:	Magnus Andersson, magnusan@kth.se
Tutorials:	Ali El-Shaari, elshaari@kth.se
X-ray diffraction lab:	Margareta Linnarsson, marga@kth.se
Band structure lab:	TBA, TBA