Technische Universität Graz

1. Advanced Solid State Physics

Oct 1, 2018

Advanced Solid State Physics

Solid state physics is the study of how atoms arrange themselves into solids and what properties these solids have.

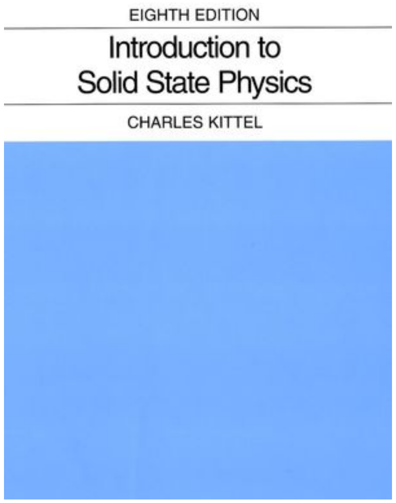
Calculate the macroscopic properties from the microscopic structure.

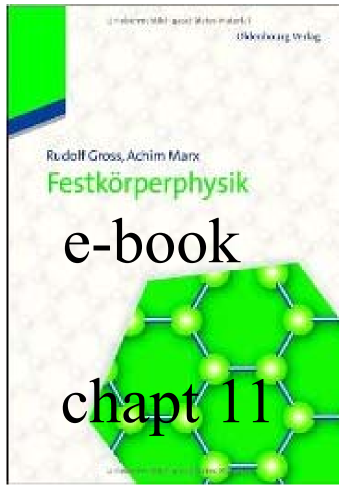
Introductory Solid State Physics

Crystals, Bravais lattices, Miller indices
Diffraction, Fourier transforms, Brillouin zones
Phonon dispersion and density of states
Free electrons dispersion and density of states
Calculation of thermodynamic properties from the DOS
Band structure calculations, empty lattice approximation, tight binding, plane wave method
Bloch waves, translation operator

Advanced Solid State Physics

Review: Free electrons (noninteracting fermions), electrons in crystals
Review: Phonons (noninteracting bosons)
Semiconductors
Electrons in a magnetic field
Fermi surfaces
Quantum Hall effect
Magnetism
Linear response theory
Dielectric function / optical properties
Transport properties
Ferroelectricity, pyroelectricity, piezoelectricity
Landau theory of phase transitions
Quasiparticles (phonons, magnons, plasmons, exitons, polaritons)
Mott transition, Fermi Liquid Theory
Superconductivity


EIGHTH EDITION
Introduction to
Solid State Physics
CHARLES KITTEL


Rudolf Gross, Achim Marx
Festkörperphysik
e-book
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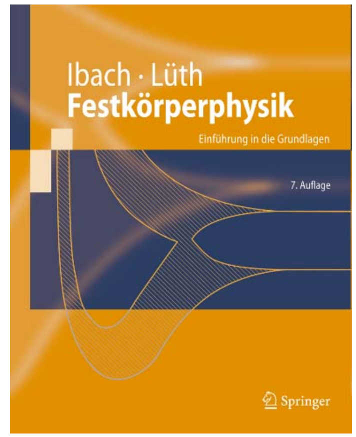
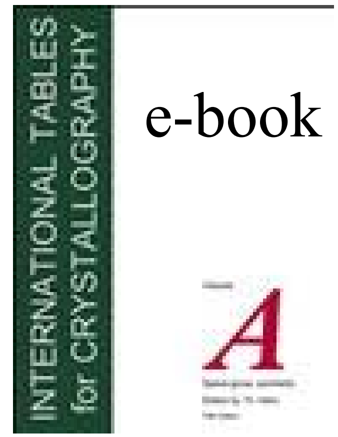
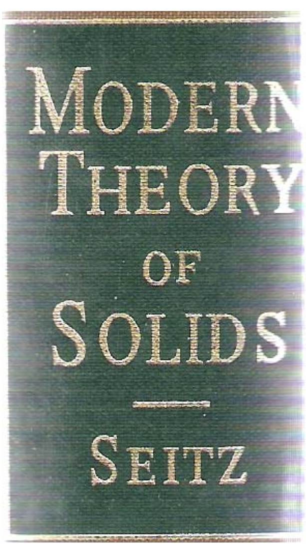
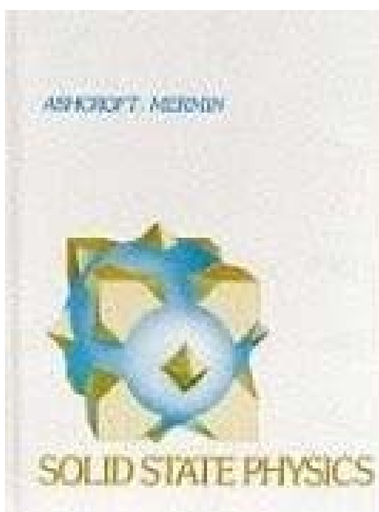
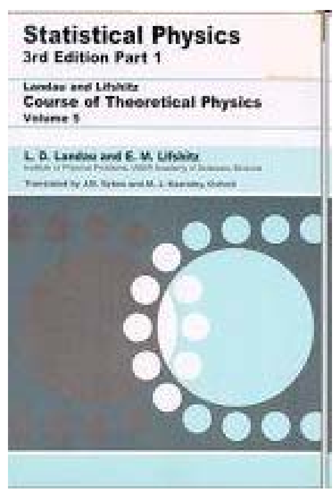
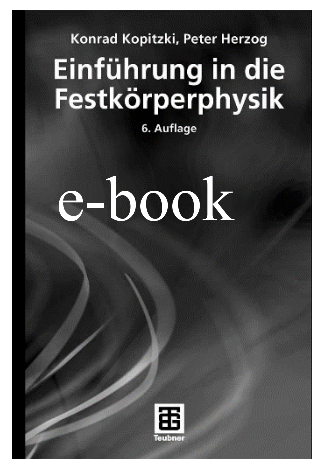

Ibach · Lüth
Festkörperphysik
Einführung in die Grundlagen
7. Auflage
Springer


INTERNATIONAL TABLES
for CRYSTALLOGRAPHY
e-book
A


MODERN
THEORY
OF
SOLIDS
SEITZ


ASHCROFT MERMIN
SOLID STATE PHYSICS


Statistical Physics
3rd Edition Part 1
Landau and Lifshitz
Course of Theoretical Physics
Volume 5
L. D. Landau and E. M. Lifshitz


Konrad Kopitzki, Peter Herzog
Einführung in die
Festkörperphysik
6. Auflage
e-book
Teubner


Czycholl
Theoretische
Festkörperphysik
Von den klassischen Modellen
zu modernen Forschungsthemen
Lösungen im web
3. Auflage
e-book
Springer

Student projects

Something that will help other students pass this course

2VO + 1UE

Derivation
Example calculations (phonon dispersion relation for GaAs)
Javascript calculations
Lecture videos

Examination

1 hour written exam

One page of handwritten notes

Oral exam

- Student project
- Mistakes on written exam
- General questions about the course

Advanced Solid State Physics

Outline
Introduction
Quantization
Photons
Phonons
Electrons
Magnetic effects and Fermi surfaces
Crystal Physics
Linear response
Electron-electron interactions
Quasiparticles
Structural phase transitions
Landau theory of second order phase transitions
Transport
Exam questions
Appendices
Lectures
Books
Course notes
TUG students
Making presentations
Index

Solid-state physics, the largest branch of condensed matter physics, is the study of rigid matter, or solids. The bulk of solid-state physics theory and research is focused on crystals, largely because the periodicity of atoms in a crystal, its defining characteristic, facilitates mathematical modeling, and also because crystalline materials often have electrical, magnetic, optical, or mechanical properties that can be exploited for engineering purposes. The framework of most solid-state physics theory is the Schrödinger (wave) formulation of non-relativistic quantum mechanics.

- Solid state physics in Wikipedia

The most remarkable thing is the great variety of *qualitatively different* solutions to Schrödinger's equation that can arise. We have insulators, semiconductors, metals, superconductors—all obeying different macroscopic laws: an electric field causes an electric dipole moment in an insulator, a steady current in a metal or semiconductor and a steadily accelerated current in a superconductor. Solids may be transparent or opaque, hard or soft, brittle or ductile, magnetic or non-magnetic.

From *Solid State Physics* by H. E. Hall

To a large extent, our success in understanding solids is a consequence of nature's kindness in organizing them for us... By the term solid we shall really always mean crystalline solid, and, moreover, infinite perfect crystalline solid at that.

From *States of Matter* by David L. Goodstein

http://lampx.tugraz.at/~hadley/ss2/

TUG -> Institute of Solid State Physics -> Courses