

PHZ7427

Solid State 2

Spring 2020

Lectures

Lectures will take place every Monday, Wednesday, and Friday from January 6 through April 22 **except** January 20 (Holiday), February 7 (travel), February 21 (Sanibel Symposium), March 2-6 (spring break). Classes will be held 7th period (1:55–2:45 p.m.) in NPB 1011.

Instructor

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Office Hours: Mon 2:45 p.m.–4 p.m.

Course Overview

PHZ 7427 is a continuation of PHZ 6426 (Solid State I).

Main Text: None

Supplementary Texts:

- Ashcroft and Mermin "Solid State Physics", Brooks/Cole, Cengage Learning, 1976
- Charles Kittel "Introduction to Solid State Physics", 7th Edition, John Wiley, 1996
- Charles Kittel "Quantum Theory of Solids", 2nd Edition, John Wiley, 1987.
- Joseph Callaway "Quantum Theory of the Solid State", 2nd Edition, Academic Press, 1991. (The "Student Edition" is a simpler, lower level version, but is also an interesting read if you want to quickly know what solid state physics is about)
- P. M. Chaikin and T. C. Lubensky "Principles of Condensed Matter Physics", Cambridge University Press, 1995.
- J. M. Ziman "Electrons and Phonons", Oxford University Press, 1960.
- R. H. Silsbee and J. Dräger "Simulations for Solid State Physics", Cambridge University Press, 1997.

Prerequisites

Graduate-level quantum mechanics and statistical mechanics (and to a lesser extent electromagnetism), and Solid State I.

Homework

There will be a homework set approximately every two weeks. The homework is your best opportunity to learn the material in depth. If at all possible, do the homework entirely on your own. Only if you are hopelessly stuck is it alright to seek help from the instructor or other students. Any help must be explicitly acknowledged at the end of the corresponding problem. In that case you will not be penalized for having received help.

Topics to cover (subject to change)

- Electron-phonon interaction. Phonons in metals. *AM Ch. 26*
- Quantum effects in transport. Weak localization. Aharonov-Bohm effect. Universal conductance fluctuations. Anderson localization. Altshuler-Aronov effect. Kondo effect. Coulomb blockade. Transport in ballistic devices. Landauer formula. Integer Quantum Hall Effect. *Notes*.
- Electron-electron interaction and magnetic structure. *AM Ch. 32*.
- Magnetic ordering. *AM Ch. 33*.
- Superfluidity. *Notes*.
- Superconductivity: conventional superconductors. Phonon mechanism of Cooper pairing. Landau-Ginzburg equations. Electrodynamics of superconductors. Elements of the BCS theory. *AM Ch. 34+Notes*.
- Unconventional superconductivity. Kohn-Luttinger effect. p- and d-wave pairing. HTc cuprates and pnictides. *Notes*.
- Semiconductors: $k \cdot p$ theory, statistics of carriers, excitons. *AM Ch. 28+notes*.
- Spin-orbit interaction in solids. Fundamentals of spintronics. *Notes*.
- Semiconductor devices. *AM Ch. 29*.
- Topological phases

Grades and grade points

The final grade will be based on:

Homework 80%

Research paper 20%

Research paper is due on April 19.