University of Florida — Department of Physics

PHZ 6426, Solid State I – Fall 1997

Lectures:	Monday, Wednesday, Friday 9:30–10:30 a.m. in 210 Williamson Hall
Textbook:	*Solid State Physics,* N. Ashcroft and N. D. Mermin (Saunders, 1976)
Instructor:	Kevin Ingersent, 264 Williamson Hall (392–8748)
Office Hours:	Mon., Wed., Fri. 10:30–11:30 a.m. or by appointment

Aim: This course is an introduction to the quantum theory of crystalline solids, the foundation of much of modern condensed matter physics. You should come away familiar with the fundamentals of the subject, and better equipped to understand issues currently at the forefront of the field. PHZ 6426 is also a prerequisite for more advanced courses, such as PHZ 6424 (optical properties), PHZ 7427 (many-body theory) and PHZ 7428 (special topics). Graduate-level quantum mechanics and statistical mechanics (and to a lesser extent electromagnetism) will be assumed, but no prior experience of solid state physics is necessary.

Organization: The course is essentially an exploration of the effect of spatial periodicity and the Pauli exclusion principle on the properties of solids, loosely arranged in five parts: (1) wavefunctions of non-interacting electrons in the periodic potential due to a perfect lattice of static ions; (2) physical properties of non-interacting electrons in a periodic potential; (3) effects of ionic vibrations; (4) properties of metals, semiconductors and insulators; (5) an introduction to electron-electron interactions, magnetism and superconductivity (if time permits).

The text is one of the standards at this level, Ashcroft and Mermin's "Solid State Physics" (1976). This provides a clear and thoughtful treatment of most of the material. However, it is out of date in places, and it is too large to be covered completely in one semester. Therefore, I shall use the text more as a guide than a rigid template for the course. Key chapters (e.g., 8–10, 22 and 23) will be explored in greater detail than in the book, whereas others (e.g., 31–34) will serve mainly as tastes of things to come in more advanced courses. I will also briefly discuss a number of subjects that have come to prominence since the publication of the book and remain topical today. These include the quantum Hall effect, heavy-fermion behavior and high-temperature superconductivity.

Bibliography: At first acquaintance, the sheer number of seemingly unrelated phenomena found in the solid state can be overwhelming. It will take effort on your part to establish in your own mind connections between different topics. Besides Ashcroft and Mermin, you may find it helpful to consult some of the following sources, which will be held on reserve at the Marston Library:

C. Kittel, *Introduction to Solid State Physics* (1953 onwards). This undergraduate text has gone through six editions, successively broader in scope but shallower in their treatment. It remains a useful introduction to solid state physics.

J. M. Ziman, *Principles of the Theory of Solids* (1964, 1972). More formal than Kittel, less unwieldy than Ashcroft and Mermin, this book covers most of the essential material of the course in quite a readable fashion.

C. Kittel, *Quantum Theory of Solids* (1963). A graduate text at a more technical (and less readable) level than Ashcroft and Mermin (but still without Green's functions).

W. Jones and N. H. March, *Theoretical Solid State Physics* (1973). A turgid, 1300-page book (in two parts) which provides useful detail on some topics. Not recommended as an introductory text.

Homework: Homework problems are integral to the course. Most weeks I will assign one or two problems to be collected for grading. You should make a good-faith attempt to tackle the homework on your own. However, do not spend an inordinate amount of time on any one problem. If you get stuck, feel free to discuss your conceptual or technical difficulties with other students or with me. Constructive collaboration is encouraged.

At least one of the homework assignments will require use of either (1) a symbolic manipulation package (Mathematica, Maple, ...) or (2) a scientific programming language and a simple plotting program.

Exams: There will be one mid-term exam, to be held roughly half way through the course. The exam will be open-book and will be designed to test your understanding of, and ability to apply, basic concepts.

There will be a final project in lieu of a end-of-term exam. Details will be announced towards the end of the semester.

Grade: Your grade will be assigned on the basis of an overall score, roughly 1/2 coming from the homework and 1/4 each from the exam and the final project.

Schedule: The week-by-week schedule which follows is provided for guidance only. Changes may be announced in class.

Week	Dates	Chapter(s)	Topic(s)
1	Aug 25, 27, 29	1–3	Drude & Sommerfeld models
2	Sep 1		LABOR DAY
	Sep 3, 5	4, 5	Lattices
3	Sep 8, 10	6	Diffraction
	Sep 12	8	Bloch's theorem
4	Sep 15		... continued
	Sep 17, 19	9	Weak periodic potentials
5	Sep 22, 24	10	Tight binding
	Sep 26	11	Computing band structure
6	Sep 29; Oct 1, 3	12, 13	Semiclassical theory
7	Oct 6, 8		... continued
	Oct 10	14	Measuring band structure
8	Oct 13	15	Band structure of metals
	Oct 15, 17	16, 17	Electron scattering & correlation
9	Oct 20, 22, 24		... continued
10	Oct 27, 29, 31	21–23	Lattice vibrations
11	Nov 3, 5		... continued
	Nov 7		HOMECOMING
12	Nov 10, 12, 14	23–26	Phonons
13	Nov 17, 19		... continued
	Nov 21		Insulators
14	Nov 24, 26	28, 29	Semiconductors
	Nov 28		THANKSGIVING
15	Dec 1, 3, 5		Semiconductors ... continued
16	Dec 8, 10, 12	31–34	Magnetism & superconductivity