PHYS 563/ELEC 563 - Introduction to Solid State Physics I Fall, 2017

Meets:	10:50 a.m. - 12:05 p.m., TTh, HBH 227
Instructor:	Prof. Qimiao Si (BRK 307, × 5204, qmsi@rice.edu)
Graders:	Tong Chen (Tong.Chen@rice.edu) and Tianfu Fu (Tianfu.Fu@rice.edu)
Office Hours:	1:30pm - 2:30pm Wednesday;
	in general, you are encouraged to email me to make an appointment
Grades:	home works 40%; 2 mid-terms, 15% each; final, 30%
Textbook:	*Solid State Physics*, by N. W. Ashcroft and N. D. Mermin

(also on reserve: *Introduction to Solid State Physics* by C. Kittel)

General:

1) This course is for graduate students. It is assumed that the students have taken at least two semesters of elementary quantum mechanics and one semester of statistical and thermal physics.

2) Ashcroft/Mermin is more of a reference book than a textbook. It contains much more materials than we will be able to cover in one semester. Each week, I will specify the sections of the book most relevant to the lectures. These sections should be the focus of your reading.

3) In addition, handouts will cover updated/supplementary materials. They are as important as the textbook.

4) There will be about 10 homework sets. Each homework assignment will have a due date; it should be turned in at the time we meet on the date specified in the assignment.

5) Discussions on homeworks are allowed - and encouraged, as they are part of the learning experience. However, in the end, you will need to solve them on your own. In particular, identical copies of solutions will not be accepted.

Disability based accommodations:

Any student with a documented disability seeking academic adjustments or accommodations is requested to speak with me during the first two weeks of class. All such discussions will remain as confidential as possible. Students with disabilities will need to also contact Disability Support Services in the Ley Student Center.

Course Outline: The following is a tentative list of topics we intend to cover. We will tailor the list as we go along.

0. Introduction: What is condensed matter physics?
1. Free electron gas in a simple box (Chaps. 1,2)
   - 1A. Reminders on Quantum Mechanics + Introduction
   - 1B. Single electron in a cube
   - 1C. Density of states
   - 1D. Fermi energy and Fermi surface
2. "The Box": crystal structure (Chaps. 4-7)
   - 2A. Geometric properties of a lattice
   - 2B. Reciprocal lattice
3. Bloch electrons: independent electrons in a periodic potential (Chaps. 8-10)
   - 3A. Bloch's thm and band structure
   - 3B. Band structure in a weak periodic potential
   - 3C. Atomic vs. Bloch description
   - 3D. Tight-binding approximation
4. Electron dynamics (Chaps. 1, 12, 13)
   - 4A. Drude theory
   - 4B. Sommerfeld theory
   - 4C. Dynamics of Bloch electrons
5. Crystal vibrations: phonons (Chaps. 22, 23)
   - 5A. Ionic vibrations
   - 5B. Phonons
6. Thermodynamics of electrons and phonons (Chaps. 2, 23)
   - 6A. Statistical physics in an hour
   - 6B. Specific heat of phonons
   - 6C. Specific heat of Bloch electrons
7. Electron-phonon coupling (Chap. 26)
   - 7A. Electron-phonon interactions
   - 7B. Superconductivity (time permitting)