

Solid State I

PHYS8761, Fall 2019

Instructor: Fazel Tafti, Higgins 330A, fazel.tafti@bc.edu

Class: T/R, 9 AM, Higgins 263

Office hours: By appointment

Grader: Hong Pan, hongpb@bc.edu

Website: Canvas

I. Rationale and Goals

This course will use the principles of condensed matter physics to solve several fundamental problems including electronic band structure, phonon dispersions, and transport of charge and heat in solids.

II. Course Readings

Required text: "Solid State Physics" by Ashcroft and Mermin

III. Canvas (course website)

All information for the course including announcements, discussions, up to date syllabus, assignments and grade will be posted at the Canvas course website.

IV. Communication Policy

A. QUESTIONS THAT APPLY ONLY TO YOU: These should be sent directly to my email address (fazel.tafti@bc.edu) and identify the course at the beginning of your subject: "PHYS4401: question about an error in the score of my exam".

B. GENERAL QUESTIONS: Should be asked in the class or posted to the discussion boards on Canvas for all to see. They will ONLY be answered there. These can be in regards to material covered in class, homework, tests, scheduling, etc. Feel free to answer each other's questions (Extra Credit).

C. ANNOUNCEMENTS: Class announcements (change in schedule, assignments, etc.) will be made via Canvas and email, please ensure your email is accurate there.

V. Academic Integrity

You are encouraged to discuss concepts, and solve problems together. This will help you to discern what you do not understand and practice a fundamental tool for physicists: collaboration. Nonetheless, to respect the achievements of all students, you are expected to submit work performed only by you, and will be disciplined for violations of the BC guidelines on academic integrity (www.bc.edu/integrity). **Cheating on any tests will result in a Zero.**

VI. Course Outline

Section	Contents	Lectures	Weeks	Homework
Drude Model	DC electrical conductivity Hall effect and Magnetoresistance AC electrical conductivity Thermal conductivity	2	1	1
Sommerfeld Theory	Ground state of and electron gas Specific heat	2	2	1
Crystalline Lattice	Bravais lattice Unit cell: primitive, conventional, and Wigner-Seitz Close packing, fcc, and hcp	2	3	1
Reciprocal Lattice	Brillouin zone Miller indices	2	4	1
Electrons in a Periodic Potential	Bloch theorem Fermi surface Density of states	4	5-6	1
Weak Periodic Potential	Schrodinger solution Proximity to a Bragg plane 1D and 3D bands Brillouin zones	3	7-8	1
Tight-Binding Method	Formulation of TB s- and p-bands Wannier functions	2	9	1
Classical Theory of Phonons	Harmonic approximation Adiabatic approximation Specific heat Normal modes in 1D and 3D	3	10-11	1
Quantum Theory of Phonons	High and low temperature limits Mid temperatures Einstein and Debye models Phonon density of states	3	12-13	1
Semiclassical Model	Crystal vs. real momentum Holes vs. electrons Effective mass Landau orbits and high fields	4	14-15	1
Semiclassical theory of conduction	Relaxation-time approximation Non-equilibrium distribution DC and AC electrical conductivity Thermal conductivity Seebeck and Nernst effects	4	16-17	1

VII. Evaluation (Scored out of 100%)

Homework (11)	50%	Each homework will have a deadline. For each day of late submission, 33% of the grade will be removed.
Final	50%	TBD (the usual class location and time)

VIII. Missed Final

Students who miss the final will automatically receive 0% unless it is caused by extreme circumstances. A makeup exam will only be offered if you have a **signed letter from the dean** explaining the circumstances. Note that you still must inform me of the reason for missing the exam **AHEAD OF TIME**.

IX. Accommodations:

If you are a student seeking reasonable accommodations in this course, please contact Kathy Duggan, (617) 552-8093, dugganka@bc.edu, at the Connors Family Learning Center regarding learning disabilities and ADHD, or Paulette Durrett, (617) 552-3470, paulette.durrett@bc.edu, in the Disability Services Office regarding all other types of disabilities, including temporary ones. Advance notice and documentation are required for accommodations.