Applied Physics 195 + Physics 195
— Introduction to Solid State Physics —

Fall 2015, Harvard University
Wednesday and Friday, 1pm - 2:30pm, Rm 330, 60 Oxford St.

Teaching Staffs

Instructor: Donhee Ham, PhD. Gordon McKay Professor of Applied Physics and EE
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— (office hours) Wednesday 2:30-4:00, Maxwell-Dworkin 131

Teaching Fellow: Laura Adams, PhD.
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Course Description

Introduction to the physics of crystalline solids. See Topics in the next page.

Prerequisite

Undergraduate-level quantum mechanics (Physics 143 or equivalent).

Materials

Throughout the semester I will hand out lecture notes as main materials for the course. We will use Kittel's *Introduction to Solid State Physics* (8th edition, unless you already have a different edition), as a required reference. The order and detailed technical exposition will not be the same between the lecture notes and the book, but both cover largely the same set of topics. I will give reading assignments on select topics from the book, and will make frequent references to particular figures and data in it.

Grading

1. Homework (100%).

2. Late grading policy: Homework will be handed out in class on Friday, due 12:45pm next Friday with a grace period of 10 minutes sharp at the black drop box outside my office (Maxwell-Dworkin Room 131). Late work will be reduced 50% per week. There is **no exception** to this rule, other than University-established emergency cases (a letter from authorized official is required). This late grading policy will be strictly enforced for fairness to all.

3. Cooperation policy: You should work on problems marked with "no collaboration" on your own, without discussing any aspect of them with other students; in other words, you should treat these problem strictly as take-home exam problems. For the rest problems, cooperation is permitted, but you should turn in your own solution — You can discuss these problems with other students taking the course, but final solutions should not be exchanged. You should make it sure that you understand the solution you turn in, and write up the solution in your own words. Basic guideline is not to take undue advantage of any other student.

Topics

Crystal binding.

Fermi gas.

Drude theory of electrical conduction.

Lattice waves; phonons.

Electrons in 1D crystal; band structure (/w tight binding in 1D).

Crystal structure; direct lattice; reciprocal lattice; Brillouin zone.

Diffraction (of X-ray, neutrons, and valence electrons) by an ideal crystal.

Electrons in 3D crystal; band structure /w nearly free electron model and tight binding.

Bloch's theorem; other band calculation techniques.

Semiclassical dynamics of Bloch electrons.

Metals and Fermi surfaces.

Semiconductor physics; *pn* junctions; bipolar junction transistors; field-effect transistors.

Semiconductor heterostructure; quantum well; bands and sub-bands; injection laser.

Optical properties; excitons.

Plasmons; screening; random phase approximation; Mott transition.

Diamagnetism; paramagnetism; ferromagnetism; spin waves.

Magnetic resonance.

Solid-state masers and lasers.

Superconductivity.

Josephson junction devices and circuits.

Electron transport in low-D systems (quantum wires & dots); resonant tunneling; QHE