Physics 6210, Fall 2013

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Grade make-up:

- Homework (40%)
- 1 quiz (30%)
- final exam (30%)

Recommended textbook:

"Solid State Physics," by Neil W. Ashcroft and N. David Mermin

Tentative Course contents:

- **The electron liquid**: Drude's phenomenological kinetic theory of metals; Sommerfeld's quantum theory.
- **Crystalline structure**: lattices, their characterization and classification; common examples; reciprocal lattices, Brillouin zones and lattice planes; the X-ray diffraction technique.
- **Electrons in crystalline settings**: Bloch's theorem; crystal momentum and band indices; the Fermi surface; the density of states; weak periodic potentials; spin-orbit coupling; the tight-binding approach; Wannier functions; techniques for band-structure calculations.
- **Electrons dynamics**: semiclassical electron dynamics; electric and magnetic fields; holes; the Hall effect and magnetoresistance; electrical and thermal conduction in metals; probing the Fermi surface; examples of band structures; electron scattering; the Boltzmann description; impurity scattering; weak and strong localization and mesoscopics; correlations and screening; cohesive energy.
- **Lattice vibrations**: failures of the static lattice picture; classical harmonic normal modes of vibration quantizated modes (*i.e.* phonons); probing phonon dispersion relations; neutron scattering; effects of anharmonicities; phonons in metals.
- **Insulators**: classification of solids; dielectric and optical properties.
- **Semiconductors**: homogenous semiconductors; carrier statistics; intrinsic and extrinsic types; impurity band conduction; inhomogenous semiconductors; junctions, wells, dots and devices.
- **Ordered states of matter**: diamagnetism, paramagnetism, ferromagnetism and magnetic structure; spin wave excitations; domains; Kondo effect; superconductivity; essential phenomenology; microscopic origin; Josephson effects.