Syllabus for Physics 211A – Solid State Physics I

Fall 2016, Physics Department, UCSD

INSTRUCTOR: Congjun Wu (5430 MH)

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TA: no TA assigned so far

Time/Place: 12:30am - 1:50pm, MW MHA5623

Instructor Office hours: Wed: 2:00-3:00 pm

Text Books:

1. J. M. Ziman, *Principles of the Theory of Solids,* Cambridge University Press; 2 edition (November 30, 1979).

Reference Books

1. N. W. Ashcroft and N. D. Mermin, *Solid State Physics*, Brooks Cole; 1 edition (January 2, 1976).
2. Concept of Concepts in Solids: Lectures on the Theory of Solids World Scientific Pub Co Inc (January 1998).
3. C. Kittel, *Introduction to Solid State Physics*, Wiley; 8 edition (November 11, 2004).

Grade:

20% problem sets, 40% midterm, 40% final project. There will be only one midterm in Physics 211A.

Homework Assignments:

Homework will be assigned every one or two weeks.

Class Schedule

1. Metal – discovery of electrons

   Lecture 1: The Drude theory of metals – the start of condensed matter physics

   Lecture 2: The Sommerfeld theory of metals – electrons are fermions

   Lecture 3: Hartree-Fock theory of interacting electron gases, exchange energy, Stoner ferromagnetism – electrons are interacting!

2. Crystal and phonons

   Lecture 4: Bravais lattice and non-Bravais lattice, reciprocal lattice, point group symmetries

   Lecture 5: Lattice Waves, Debye-Waller factor, acoustic and optical phonons, lattice specific heat,

   Lecture 6: The long-wave length method, phonon dielectric constant, Huang's equation

3. Band (solid state physics) v.s. bond (chemisty)

   Lecture 7: Bloch Theorem, crystal momentum, DOS, van Hove Singularities, electrons in a weak periodic potential, pseudo-potential

   Lecture 8: Basics of density functional theory – from potential to density, Lendegre transformation

   Lecture 9: The tight-binding model – resonance valence bond

   Lecture 10: Band structure of graphene, Haldane model, Kane-Mele model

4. Interacting electron gas

   Lecture 11: Lindhard response response, screening

   Lecture 12: Friedel sum rule, Kohn effect, Plasma oscillation

5. Semi-classic dynamics

   Lecture 13: The Boltzmann equation, conductivity

   Lecture 14: Hall effect, magneto-resistance

   Lecture 15: Electron orbitals, De Haas- Van Alphen effect

6. Magnetism

   Lecture 16: Heisenberg model, spin-waves, H-P transformation

   Lecture 17: Mott transition, antiferromagentism, Spin-wave in antiferromagnets

   Lecture 18: Kondo effect