Physics 880.06 (Winter 2010)
Condensed Matter Physics II
Instructor: Professor Nandini Trivedi

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Physics 880.06 Condensed Matter Physics is a three-quarter sequence of graduate-level courses taught from a modern perspective. I will emphasize how in a system of many interacting particles new phases of matter emerge, their spontaneously broken symmetries, collective modes and phase transitions.

Lecture schedule:
Tuesdays and Thursdays 1 pm -2:18 pm Room: Scot Lab SO E0103
Wednesdays 4:30-6:00pm SO E0241
(to accommodate travel during the quarter and short student presentations during the lectures)
Office hours: By appointment and Wednesdays 6:00 pm-7:00 pm [Note: HWs due on Thursdays]

Who should take this course? If you want to do research in condensed matter physics--either theory or experiment, you will make extensive use of ideas developed in this course. This course can also be useful for students in materials science, chemistry and also high energy and nuclear physics given that the concepts and techniques that you will encounter in this course are sufficiently general and worth understanding. Please see the detailed course contents.

Course structure: I will start by motivating each topic through experiments, develop the theoretical framework and then return to a more detailed comparison with experiments to understand the successes, limitations and open questions. Computer simulations have emerged as an important tool for visualization and active engagement of students. When appropriate short student presentations will extend the lecture content by discussing experiments or mathematica codes to demonstrate some of the important concepts. Last quarter I found this to be a very effective format as it kept the students engaged actively in the class.

There will be 4-5 homeworks that could involve the use of mathematica and/or matlab for plotting and writing small programs in order to get a better grip on the material. In most cases a mathematica template program will be provided. There will also be 1-2 independent small projects.

Grades: Grades will be determined by a combination of HWs (50%); projects (30%) ; In-class assessments (20%)

Prerequisites: The present course is a beginning level self-contained condensed matter course aimed at both experimentalists and theorists. I will not assume any prior knowledge of solid state physics. A background in undergraduate statistical physics and quantum physics is necessary.

Course Contents

Quarter I

(1) Crystal Structure
(2) Reciprocal Space
(3) Electron Bands

Quarter II

(4) **Semiconductors:** intrinsic, doped, p-n junction, rectification, FET, quantum wells and 2D electron gas
(5) **Phonons:** Dynamical Matrix, phonons, neutron scattering, phonon density of states, specific heat, elasticity theory; also references to neutrons and antiferromagnetic structure factor, spin waves
(6) **Transport:** Boltzmann Transport Theory ; Landauer Transport
Electrical, Thermal, Thermoelectric, Magnetotransport, Spin Transport, Quantum Hall Effect

Quarter III [under construction]

(7) Electron-Electron interactions
Hartree, Hartree-Fock, Screening, Density Functional Theory

(8) Magnetism
(9) Fractional quantum Hall Effect
(10) Superconductivity

Textbook:

1. N. W. Ashcroft and N. D. Mermin, Solid State Physics, W.B. Saunders, Philadelpha, 1976.

Other References:

Other References you may find useful: They have been placed on reserve in the Science and Engineering Library.

2. H. Ibach and H. Luth, Solid-State Physics, An Introduction to Theory and Experiment, Springer-Verlag, Berlin, 1991.
3. C. Kittel, Introduction to Solid State Physics, 7th edition, John Wiley and Sons, New York, 1996.
4. M. P. Marder, Condensed Matter Physics, Wiley, 2000.
5. L. Mihaly and M. C. Martin, Solid State Physics: Problems and Solutions, Wiley, 1996.
6. W. A. Harrison, Solid State Theory, McGraw-Hill, New York, 1970.

Seminars and Colloquia: We are fortunate to have a large number of high caliber seminar and colloquia series, and you should try to attend at least some of them regularly. Especially while you are in the process of making the crucial decision of what research field to enter it is very important to hear something about a broad range of fields. The seminars and colloquia are listed in the weekly Physics Department calendar. You may wish to make a note of the following regular events:

Seminar	When	Where
Condensed Matter Physics Theory	Mon 11:30	Smith Seminar Room
Cold Atoms Journal Club	Wed 12:30	PRB 2015
Condensed Matter Physics Experiment	Thurs 11:30	Smith Seminar Room
Physics Colloquium	Tues 4:00	Smith Seminar Room