PHY 163a: Statistical Physics
Fall 2007

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Office Hours: 10-noon, Thursday, or by appointment.

Meeting Time and Place: Room 229, Tu-Fri, 10:30–noon

Required course work:
Homework will be posted on the WebCT website for this course and will be due in class, usually once a week. There will be a in-class midterm and a take home final.

Grading Procedure:
40% – Homework, 20% Midterm, 40% – Final. The final examination for this course will also be part of the written Ph.D qualifying examination.

Course Description:
Statistical physics takes as its subject matter the collective behavior of many-particle systems. Its foundations were laid down more than a hundred years ago with the development of thermodynamics and statistical mechanics which lead to a detailed understanding of the thermal behavior of matter. Today, statistical physics has extended its domain to include problems dealing with the very large, like the distribution of matter in the Universe, to the very small, such as the elastic properties of DNA molecules. The power of statistical physics comes from the tools it wields, which include path integrals, transfer matrices, field theory, renormalization group, second quantization. The goal of this course will be to introduce the tools of statistical physics.

Material for course
The textbooks are Statistical Mechanics by David Chandler and Entropy... by James P. Sethna. Lecture notes and other readings will be posted on the WebCT site for this course.

Course Outline:

1. Fundamentals: From entropy to free energy (3 weeks)
A. Review of Thermodynamics, Phases and Phase Equilibrium
B. Entropy and Statistical Ensembles
C. Ideal gases: atoms, photons, and electrons

2. Phase transitions (4 weeks)
A. Ising Model and Lattice Gas
B. Order parameters and symmetry breaking

(i) Ising Model → Field Theory

(ii) Landau Theory

C. Renormalization group

(i) Real-space RG of Ising Model

(ii) Epsilon expansion

3. Dynamics (3 weeks)
A. Systems close to equilibrium
B. Correlations, Response and Dissipation

4. Transfer matrix and Path Integrals (3 weeks)
A. Ising Model and Polymers
B. Uses of and connections to Quantum Field Theory