Physics 704: (Advanced) Statistical Mechanics
Spring 2006 3 credits

Instructor: ***Prof. Ted Einstein***, x56147, einstein@umd.edu
Class times: T, Th 11-12:15; Physics Bldg, Rm4208
Office hours: After class and whenever office door open, or by appointment.

Course Text: **Michel Le Bellac, Fabrice Mortessagne, and G. George Batrouni,** ***Equilibrium and Non-Equilibrium Statistical Thermodynamics*****,** Cambridge, 2004; [0521821436], chosen for the class text primarily because of its choice of topics, modern orientation, and large number of problems. The authors are particle theorists, so some details from (or devotion to) condensed matter physics are not always there.

Other recommended texts on testudo: (See also the extensive Reference list.)

M. Plischke and B. Bergerson, *Equilibrium Statistical Physics*, 2nd ed., World Scientific, 1994; pb [9810216424]. It was used as the text in Spring 2001. I found it to be an excellent book, treating material of contemporary interest at an appropriate level without excessive verbiage or detail. However, its coverage was incomplete, forcing a shift to Chaikin & Lubensky for topics near the end of the course. Students preferred having the uniform notation of a single text, and preferred the excessive detail of C&L to the sketchy arguments in P&B.

Paul M. Chaikin and T. C. Lubensky, *Principles of Condensed Matter Physics*, Cambridge, 2000; pb [0521794501]. About half the text is germane to this course. In 2002, we covered much of (but not all of) chaps. 3–5, 7, 9, 10, with a few sections for other chapters. We did not and will not study liquid crystals or hydrodynamics, except for a few basic ideas. In some cases C&L is more detailed than ideal but, compensatingly, it is quite thorough. Excerpts from other books will be provided as appropriate.

L. P. Kadanoff, *Statistical Physics: Statics, Dynamics and Renormalization*, World Scientific, 2000; pb [9810237642]; unique perspective & many great reprints.

J.M. Thijssen, *Computational Physics*, Cambridge, 1999; pb [052157588]: lots of physics, presented in a format useful for computations, but over 1/3 on electronic aspects.

N.G. van Kampen, *Stochastic Processes in Physics and Chemistry*, Elsevier, 1992; pb [0444893490]: a thorough, insightful, detailed discussion worth reading and rereading, but sadly now out of print.

There are several new books available online. See the listing of Web Resources.

This course is most suitable for students who have taken Physics 603 and/or passed the classical part of the physics qualifier, though neither is required.

Topics will include:

Brief review and notations
Correlation functions
Mean field and Landau theory
Aspects of dense gases and fluids
Critical phenomena (scaling, simple models, renormalization group, roughening)
Numerical simulations (Monte Carlo, molecular dynamics, transfer matrix methods)
Disordered systems
Statistical mechanical aspects surfaces
Intro. to non-equilibrium stat. mech. (esp. Langevin and Fokker-Planck equations).

Other topics might include

Models of crystal growth
Polymers and membranes
Types of random noise
Linear response theory
Conformal invariance and phase transitions in 2D

Since the enrollment of this course was expected to be relatively small, the choice of topics was planned to be flexibly tailored to students' interests and planned research areas. There are, however, over a dozen registered, limiting this adaptability. However, the course paper (see next ¶) will allow students to concentrate on individual interests.

There will be regular homework assignments. Given the size of the class and lack of TA, marking of these submissions may not be optimally detailed. Some solutions will be discussed in class or provided from copies of student papers. Student are welcome to work with each other on these problems, but each person should write up individually his/her own solution and be in command of the underlying physics. To share special interests and allow some in-depth study, students are required to write a term paper and to prepare a 20-30 minute (depending on eventual course enrollment) class presentation based on it. When appropriate, the subject should be the application (or relationship) of some class topics to some aspect of the student's dissertation research. For students who have not yet reached this stage, some subject of current interest should be chosen, in consultation with the instructor. The paper and presentation will count for about/somewhat over half the course grade.

There will be a final exam of some sort, possibly oral, to induce students to review the course material.