Physics 603: Methods of Statistical Mechanics
Spring 2013 3 credits

Instructor: ***Prof. Ted Einstein***, x56147, einstein@umd.edu
Class time: T, Th 9:30-10:45; Physics Bldg, Rm 1201
Office hrs: M 11-11:50, T 3-3:55 or by arrangement.

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Class website:
http://www.physics.umd.edu/courses/Phys603/einstein/

Course purpose: Basic graduate-level statistical mechanics course, with some thermodynamics, emphasizing topics students are expected to know for the Qualifier Exam:
Thermodynamics: Microscopic/macroscopic variables, extensivity, first and second laws, themodynamic potentials, Legendre transformations, thermodynamics relations, Maxwell relations, Maxwell construction, phase coexistence
Foundations of statistical mechanics: classical mechanics: Hamiltonian, phase space, ergodic approach, ensemble approach: microcanonical, canonical and grand-canonical ensembles classical ideal gas, fluctuations of energy and particle number.
Applications: Ideal gas of particles, specific heats, ortho-para-H_2, metastability, chemical equilibrium, ideal crystals, Einstein model, normal modes, Debye model, T^3-law, black body radiation, 3rd law of thermo., imperfect gases and fluids, virial expansion, correlation functions, density fluctuations and compressibility
Quantum statistical mechanics: indistinguishability, Bose, Fermi and Boltzmann statistics; ideal quantum gases, free electrons, Bose-Einstein condensation
Magnetism: ideal paramagnets, Curie's law, interacting Ising spins, low temperature and high temperature expansions.
Phase transitions: Order parameter, mean-field, Landau theory & beyond, idea of critical exponents, universality,spatial & order-parameter dimensionality

Prerequisites: Undergraduate course in thermal physics or thermodynamics and statistical mechanics; basic quantum mechanics: bosons, fermions, simple harmonic oscillator, particle-in-a-box, H atom

Course Text: **R.K. Pathria and P.D. Beale, Statistical Mechanics, 3rd ed., Academic Press, 2011; pb [978-0123821881].** A standard text for this course, though perhaps with too much information.

Other officially recommended text (as conveyed to bookstore): Mehran Kardar, Statistical Physics of Particles, Cambridge, 2007 [978-0521873420], outstanding exposition of what it covers.

Note also James P. Sethna, Statistical Mechanics: Entropy, Order Parameters and Complexity, Oxford, 2006; pb [978-0198566779], innovative and engaging approach, and also downloadable (free) from
pages.physics.cornell.edu/sethna/StatMech/EntropyOrderParametersComplexity.pdf
David Chandler, Introduction to Modern Statistical Mechanics, Oxford, 1987; pb [0195042778].

A *tentative* **schedule** is posted on the class website, keyed to these references; it will be updated regularly.

The *References* link on the class website includes a large number of other texts; several are available online. See the listing of Web Resources.

Homework will be assigned regularly (every few lectures) by posting on the Homework Assignments folder of the class website. It will count ~30% of the total score for the class. Students are welcome to discuss problems with other classmembers after thinking about them alone, but must write them up independently. Homework should thus not be viewed as a take-home exam, but each student should develop a personal command of the material. Cases of copied homework will be treated harshly. Solutions will be posted on the password-protected website on the next lecture day ("**deadline date**") after the **due date.** Thereafter, no late problem sets can be accepted for credit.

There will be a **midterm test** on March 12 and a **final exam** officially slated for May 13. They will count about 30% and 40%, respectively, of the total score on which grades will be based. These tests will emphasize parts of stat mech problems from previous qualifier exams as well as variants of homework problems. The only acceptable excuses for missing a test are those established by the university: religious holiday [which I have avoided, to the best of my knowledge], illness, or an official university event.

Academic Integrity: UMCP has a Code of Academic Integrity, administered by the Student Honor Council. You are responsible for upholding these standards for this course. For more information see http://shc.umd.edu/SHC/Default.aspx.