Physics 541: Advanced Statistical Mechanics, Fall, 2007

Instructor: Prof. R. Shrock, tel. 632-7986, email: robert.shrock@sunysb.edu; Wed. 11:45-12:45, Fri. 9:30-10:30 and 11:45-12:45 in S240. office hrs. Wed. 2:00-2:30; Fri. 2-3 in D-146.

webpage: http://insti.physics.sunysb.edu/˜ shrock, click on Phys. 541.

Recommended preparation: Phys. 540 or its equivalent. Recommended books: M. Plischke and B. Bergersen, *Equilibrium Statistical Physics* (3rd ed); H. Eugene Stanley, *Introduction to Phase Transitions and Critical Phenomena*; J. Cardy, *Scaling and Renormalization in Statistical Physics.*

Course requirements: homework assignments, midterm exam, and either a final exam or termpaper.

This course will cover modern advanced statistical mechanics, including topics from the list below.

- Brief review of basic thermodynamics; statistical ensembles; Boltzmann distribution; quantum statistics and the Fermi-Dirac and Bose-Einstein distribution functions; ideal gases and kinetic theory; Einstein-Debye model for phonons.
- Introduction to phase transitions and critical phenomena: examples with liquid-gas-solid systems and magnetic systems; experimental data; phase diagrams; order of transition; critical singularities; correlation length; van der Waals theory of liquid-gas transition; mean field and Ginzburg-Landau theory.
- Analysis of some models, including Ising, q-state Potts, O(N) vector, and ice models; exact solutions for 1D and quasi-1D cases; transfer matrix; relation of Potts partition function to Tutte polynomial and graph theory; zeros of partition functions.
- Modern theory of second-order phase transitions: universality classes and critical exponents, dependence on spatial dimensionality and symmetry group of Hamiltonian; scaling relations, renormalization group; upper and lower critical dimensionalities; conformal algebra.
- Approximate methods: series expansions, Padé approximants, and Monte Carlo simulations.
- Other examples of phase transitions: superconductivity, superfluidity, Bose-Einstein condensation; Kosterlitz-Thouless (defect-driven) transition, liquid crystals and orientational ordering, percolation, spin glasses.
- Analogy between partition function in statistical mechanics and generating functional in quantum field theory; introduction to lattice gauge theory

If you have a physical, psychological, medical or learning disability that may impact on your ability to carry out assigned course work, you are urged to contact the staff in the Disabled Student Services office (DSS), Room 133 Humanities, 632-6748/TDD. DSS will review your concerns and determine, with you, what accommodations are necessary and appropriate. All information and documentation of disability is confidential.

Faculty and staff should include the following statement in their course syllabi regarding the instructor's responsibility to report behavior that interrupts the learning process, inhibits instructor's ability to perform his/her duties, or compromises the safety of other students: "Stony Brook University expects students to maintain standards of personal integrity that are in harmony with the educational goals of the institution; to observe national, state, and local laws and University regulations; and to respect the rights, privileges, and property of other people. Faculty are required to report to the Office of Judicial Affairs any disruptive behavior that interrupts their ability to teach, compromises the safety of the learning environment, and/or inhibits students's ability to learn."