PHY 602 - Statistical Physics - Spring ‘07

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You can contact me at any time during work hours. Send an email or call to make sure I am in.

Class meets: MWF 10:10-11:00, LGRT 1033

Textbooks:


Course description:

This course provides a detailed description of the main aspects of Statistical Physics, the branch of Physics that studies systems with an extremely large number of degrees of freedom. From the beginning we will make use of quantum-mechanical ideas. Thermodynamics will be derived from statistical physics, and will be discussed in some detail, but I will assume that you are familiar with its fundamental concepts. After having defined and studied the general properties of the systems of interest in Statistical Physics, we will examine several examples. In the final part of the course we will consider ideas related to critical phenomena and renormalization group. I will follow rather closely the textbook, but departures may occur.

Grading:

The grading will be based on the final (30%), mid-term (30%) and 8-10 homework sets (40%).

Homework will be assigned in class on Friday and will be due at the end of the lecture after three lectures (i.e. on the subsequent Friday in most cases). Late homework will get 75% of the credit if turned in before the beginning of the subsequent lecture; no credit if turned in later than this limit. Teamwork on the homework is welcome. However, please be aware that it is your responsibility to thoroughly understand all the homework you turn in.

The mid-term exam will take place on March 14th, 5pm-8pm in LGRT 1033. The final will be on May 18th, 5pm-8pm in LGRT 1033. The final exam will be cover the whole course. Both mid term and final exams will be closed book exams.
Syllabus

• Basic Ideas
  • Nature of statistical systems
  • Basic postulate - equal probabilities
  • Statistics and thermodynamics
  • Counting states
  • Ideal Gases

• Ensembles and Thermodynamics
  • Phase space, Liouville theorem
  • Microcanonical ensemble
  • Canonical ensemble, temperature
  • Grand canonical ensemble, chemical potential
  • Partition functions
  • Connection with thermodynamics - thermodynamic potentials

• Fundamental Examples
  • Harmonic oscillator
  • Polytatomic gases
  • Bose distribution: ideal Bose gas, black body radiation, Debye theory, Bose-Einstein condensation, superfluid $^4\text{He}$
  • Fermi distribution: ideal Fermi gas, electrons in metals, white dwarf stars

• Interacting Systems
  • Virial expansion
  • Second quantization
  • Imperfect Bose gas

• Critical Phenomena and Renormalization Group
  • Ising model, mean field approximation
  • Ginzburg-Landau theory, order parameter, critical exponents
  • Correlation length
  • Renormalization group, critical exponents, fixed points

• Monte-Carlo Simulations (if time allows)
  • Classical Monte Carlo method
  • Metropolis algorithm