PHY 441 Statistical/Thermal Physics
Course Information
Fall 2010

I. Requirements
Textbook: Statistical and Thermal Physics, M. D. Sturge
Lectures: M, W, and F; 10:45-11:35; in PSF-366
Homework: About 5 problems per week.
Midterms: Three midterm exams are scheduled, on Sept. 18, Oct. 16, and Nov. 13
Final Exam: Scheduled for 09:50-11:40 A/M on Monday, December 13
Final Project: A Monte-Carlo simulation is due December 14

II. Instructor
S. Banu Ozkan, phone: (480) 965-2890, e-mail: banu.ozkan@asu.edu
Office Hours: M & W 12:00-1:00 PM in PSF-350, or by appointment.

III. Additional sources
Other websites: http://stp.clarku.edu; http://history.hyperjeff.net/statmech.html
Supplementary texts: Thermodynamics, H. B. Callen; Thermal Physics R. Baierlein; Thermal Physics, C. Kittel & H. Kroemer; Statistical Mechanics, K. Huang; Statistical and Thermal Physics, F. Reif; Molecular Driving Forces Ken A Dill & Sarina Bromberg

IV. Course Overview
Statistical physics provides a framework for relating the microscopic properties of individual atoms and molecules to the macroscopic or bulk properties of materials, therefore explaining thermodynamics as a natural result of statistics and mechanics (classical and quantum) at the microscopic level. The main asset of the statistical physics is its ability to make macroscopic predictions based on microscopic properties. Many of the key insights in statistical mechanics come from simple assumptions that may be seem unrealistic at first glance. For example, particles are presented as perfect spheres without taking into account the atomic detail, or neglecting the interaction with the other particles. The statistical thermodynamics has a history of what might be called “the unreasonable effectiveness of unrealistic simplifications”. The two-dimensional Ising model can be the perfect example: up and down spins on a square lattice. However, Onsager’s famous solution to this simplified model was a major contribution in understanding of phase transition and critical phenomena. Statistical physics is still one of the broadest and most active areas of physics. It can be applied for systems on size scales from subatomic particles to large-scale structures in the universe. It is valid in all mechanical limits: classical, quantum, and relativistic. Moreover, it is relevant for information technology, and is essential for understanding the practical properties of materials. Pioneers in the field are among the most colorful and creative personalities in physics, including Maxwell, Boltzmann, Gibbs, Onsager and Einstein.

V. Course Outline
1. Temperature Heat Work (First Law)
2. Micro States-Macro State (Multiplicity)
3. Entropy, Free Energy, The second law of thermodynamics (multiplicity)
4. The Canonical Distribution: (The Boltzmann Factor and Partition Function)
5. Density of States and Equipartition
6. Chemical potential Minimum Free energy
7. Perfect Gases
8. The classical Limit (Maxwell’s theory)
9. Quantum ideal gas
10. Photons and Phonons
11. Fermions and Bosons
12. Approaching zero (third law)
13. Phase equilibria
15. Critical phenomena

**Homework**
The homework problems will be collected on the due date. Late homework will be accepted, but with a 20% point reduction per day. You may work in groups to discuss the concepts, but be sure that all of the homework that you submit for grading is your own work, in your own words. (See http://www.asu.edu/studentaffairs/studentlife/judicial/academic_integrity.htm). All scores from all written homework will count 20% towards your final grade.

**Final Project**
Students will be grouped into pairs and each group must complete a final project. The suggested project is to write a computer program for Monte-Carlo simulation. Each group will submit a brief report about your computer program and the results that you obtain. Alternatively, with instructor approval, you may choose a different project. Suggestions include reading a research article about application of statistical physics (the instructor will provide the research article), then writing an 8-10 page paper about the research with the full derivation of the equations in the research paper. The final project will count 20% towards your final grade.

**Midterm Exams**
There are three midterm exams scheduled during the semester. Each midterm will include topics from the lectures, reading, and homework in the weeks that precede the exam. The first midterm, scheduled for Friday September 14, will cover mainly classical thermodynamics; the second midterm, scheduled for Friday October 13, will cover mainly the thermostatistics of semi-classical ideal gases; while the third midterm, scheduled for Wednesday, November 8, will cover mainly the statistical mechanics of ideal quantum gases. Each midterm exam will count 15% towards your final grade, for a total of 45% towards your final grade.

**Final Exam**
The final exam, scheduled for Monday December 13 from 9:50-11:40 a.m., will be comprehensive, covering topics from throughout the semester. The final exam will count 15% towards your final grade.

**Final Grade**
The final grades will be based primarily on a curve. All credit from the exams and homework will be combined into a final score. Normally, students with a final score in the top 30-40% range will receive the grade of “A”, those in the next 30-40% will receive the grade of “B”, etc.

**Important Dates to Remember**
- First Lecture: August 19
- Labor Day (classes excused): September 6
- Midterm Exam #1: September 17 (Friday)
- Midterm Exam #2: October 18 (Monday)
- Course Withdrawal Deadline: November 3
- Midterm Exam #3: November 12 (Friday)
- Last Lecture: December 6
- Final Exam (if necessary): December 13, 9:50-11:40 AM (Monday)
- Final Project Due: December 14, (Tuesday)