Syllabus **Physics 531** (**PHY 531**)
Thermodynamics and Statistical Mechanics
Fall 2006

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Office hours Wednesdays 2:00 – 3:00 PM, otherwise by appointment

Prerequisite PHY 361 - Introduction to modern physics

Lectures We will meet three times a week: MWTh 11:40 am - 12:35 pm,
Room B126 (near to my lab!), Physics Bldg.

Textbook Roger Bowley and Mariana Sanchez, Introductory statistical mechanics,
Oxford Science Publications, Clarendon Press, Oxford., 2001.
Important: Not all material presented during the lectures will follow this book!

Grading **Homework** assignments will be given, which will account for **30%** of the course grade. This policy is intended to promote collaboration among the students and to encourage them to do the homework.

There will be three in-lecture **exams** that will occur during the regularly scheduled lecture meetings. The dates of the exams are marked on the Schedule (see Timetable).

There will be a **final exam** that will be held on December 15th (8:00 – 10:0 AM). The final exam will count as **35%**, and the two highest scores on the three in-lecture exams will count as **35%**.

From the net numerical grade, a letter grade is computed. The grade limits will not be stricter than the following: 70% for a C minus, 80% for a B minus, and 90% for an A minus.

Homework: The homework assignments will be distributed on either **Mondays or Wednesdays**. Homework will be normally due on **Mondays** of the following week, prior to the lecture. Solutions to the homework will be distributed after the problems have been collected. No late homework will be accepted! **Homework problems are a very important part of the course.** The only way to learn fundamental physics is to practice it as much as possible. Working problems is the only way to obtain a detailed understanding of the topic.

Academic Integrity:

You are encouraged to discuss the homework problems with your classmates. However, **the final work you turn in must be your own.** There is a distinction between discussing the work, and merely copying someone else's work. The idea here is that you should help each other to understand the problems and the concepts involved; you will learn

more if you work on the assignments in *groups* and explain the methods to each other. You must engage in your own effort on solving the problems.

Webpage:

http://www.physics.syr.edu/~lmovilea/ThermodynamicsStatisticalMechanics2006.html

Course Description

This course combines fundamentals of thermodynamics and statistical physics. We will start with phenomenological thermodynamics, and its main principles and conclusions. Important concepts, such as thermal equilibrium, temperature, heat, entropy, enthalpy, free energy, will be developed and used to calculate the properties of matter. Subsequently, we will introduce the probability and statistical laws, and derive thermodynamic relations from the statistical principles. Statistical mechanics connects the properties of the macroscopic material world to the basic constituents of matter at the deepest level. In this course we will study the laws of physics that govern the behavior of systems that consist of many particles. These laws are very different from what you may have encountered in mechanics or electromagnetism as they are statistical in nature, and the notion of probability will play an essential role. As a matter of fact, we will see that the laws of statistical physics are a statement about our incomplete knowledge of all the dynamical information about a many particle system (e.g. the positions and velocities of all the atoms in a container full of gas), and as such their domain of application extends beyond physics. The emphasis will be on simple models and analytical methods for obtaining quantitative descriptions of physical phenomena. The interdisciplinary nature of statistical mechanics will be demonstrated throughout the course by studying problems that arise in material science, chemistry and biology.

Math Although the course does not require any difficult math, you are expected to be familiar with:

- Differentiation and integration of elementary functions
- Taylor series
- Partial derivatives
- Infinite sums and products

Study hints

Read the assigned text pages before coming to class. This will help familiarize you with the concepts to be discussed in lecture. If you do not understand the material after reading and the lecture, ask questions. Questions are welcome during the lecture or during my office hours. Work all of the **homework problems** and, if possible, look at a few other problems. Experience with solving problems **will help on exams**!!

Reasonable accommodation

Students with a disability who require accommodations should provide a letter of accommodation from Student Support Services within the first two weeks of the semester.

Other good sources of thermodynamics and statistical mechanics:

There is a plethora of other useful textbooks for their different emphasis on thermodynamics and statistical mechanics, the applications chosen and the level of their presentation. Here, I list just a few, if your curiosity will go beyond "Bowley & Sanchez".

1. C. Kittel and H. Kroemer, *Thermal Physics* 2nd Ed., Freeman and Co. (1994).
2. E. Fermi, *Thermodynamics*, Dover Publications, New York, 1936.
3. M.D. Sturge, *Statistical and thermal physics: Fundamentals and applications*, A K Peters Natick, Massachusetts (2003).
4. F. Reif, *Fundamentals of statistical and thermal physics*, McGraw-Hill (1965).
5. H. B. Callen, *Thermodynamics and an introduction to thermostatistics,* 2nd Ed., John Wiley & Sons (1995).
6. S. Bromberg and K. Dill, *Molecular Driving Forces*, Garland (2002). A thermodynamics and statistical mechanics book for biology, chemistry and polymer physics. Goes over the basic math and physics exceptionally clearly. Gives a great introduction to probability and maximum entropy.
7. D. V. Schroeder, *An Introduction to Thermal Physics,* Addison-Wesley (2000). Similar to Kittel in that it starts with statistical mechanics and then develops thermodynamics. This book has various examples from atmospheric physics and geophysics.