

# *Course Syllabus*

## **Course Information**

### ***Physics 5310-001      STATISTICAL MECHANICS***

Days: Monday and Wednesday      Aug 24, 2009 - Dec 4, 2009  
Time: 5:30 p.m. - 6:50 p.m.  
Room 105, Science Hall

## **Contact Information**

### ***Instructor: Dr. Nail Fazleev***

Chemistry and Physics Building, Room 336  
Office hours: 3:00 p.m. - 4:00 p.m. Monday & Wednesday or by appointment.  
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## **Course Prerequisites**

*PHYS 4315 or permission of Graduate Advisor.* It is assumed that students have a basic working knowledge of classical and quantum mechanics, including Hamiltonian formulation and density matrices.

## **Required Textbook**

***Pathria R.K., Statistical Mechanics, 2nd Edition, Elsevier, 1996.***

## **Recommended Books:**

*Huang, Kerson. Statistical Mechanics. 2nd ed. New York, NY: Wiley, 1987.*  
*Landau, L. D., and E. M. Lifshitz. Statistical Physics. Part 1. 3rd ed. New York, NY: Pergamon, 1980.*  
*Ma, Shang-keng. Statistical Mechanics. Translated by M. K. Fung. Philadelphia, PA: World Scientific, 1985.*  
*Reif, Frederick, ed. Fundamentals of Statistical and Thermal Physics. New York, NY: McGraw-Hill, 1965.*  
*Feynman, Richard Phillips. Statistical Mechanics. Reading, MA: Addison-Wesley, 1998.*

If you have a personal interest in particular areas and/or applications of statistical mechanics, I can provide you additional references as well.

## **Course Description**

This is a graduate level course on principles of statistical mechanics and their applications to various physical systems. We will study fundamental principles of thermodynamics and statistical mechanics, including probability theory, kinetic theory, entropy, classical statistical mechanics, ensembles, quantum statistical mechanics, ideal Bose and Fermi systems, and phase transitions.

The specific content of the course will be drawn from the textbook “Statistical Mechanics” by Pathria R.K. However, there will be departures from the book and additional material not covered in the book.

### **Goals and Student Learning Objectives**

The main goal of this course is to acquire fundamental knowledge of classical and quantum statistical mechanics; construct a bridge between macroscopic thermodynamics and microscopic statistical mechanics by using mathematical methods and fundamental physics for individual particles. Problem solving is stressed as a means of imparting physical understanding and intuition. We will study how general principles of statistical mechanics actually work in some simple and complex systems and what powerful notions and ideas have been developed to approach complex cases. We will explore relationships between macroscopic properties of large systems and microscopic behavior of the particles these systems are comprised of. The richness and complexity of the behavior exhibited by many-particle systems is incredible. In this course, however, we would be able to explore only very few illustrating examples. We will be dealing with elements of statistical thermodynamics, kinetics, and the theory of phase transitions.

### **Student Learning Outcomes**

Upon completion of the course, the instructor would like to have students clearly understand basic principles, be able to see relationships between ideas, and be able to use principles and ideas to calculate properties of simple statistical systems.

Students will

- Learn different statistical ensembles, their distribution functions, ranges of applicability and the corresponding thermodynamic potentials
- Apply classical and quantum distributions in circumstances varying from standard examples to statistics of charge carriers in semiconductors, chemical reactions and ions in electrolyte solutions
- Learn relationship between equilibrium distributions and kinetic processes leading to equilibrium
- Become aware of the richness and complexity of statistical behavior exhibited by interacting systems and various approaches (phenomenological and microscopic) developed to comprehend such systems

### **Course Outline**

1. Review of thermodynamics;
2. Probability Theory;
3. Classical statistical mechanics;
4. Interacting Systems;
5. Ensemble theory;
6. Quantum statistical mechanics;
7. Ideal Bose systems;
8. Ideal Fermi systems
9. Phase Transitions.

## Homework

The homework assignments are an important part of this course, and the final average homework score will count for 45% of the final grade. You may consult with classmates in "study groups," as long as you write out your own answers, and do not use solution-sets from previous years. Occasionally, there are problems marked as optional in the problem sets. If attempted, these problems will be graded as other problems, and their score added to the total. The overall grade for the course has a 45% contribution from the (required) problem sets. Thus, perfect scores on all the non-optional problems leads to the maximal grade of 45 from the problem sets. The optional problems provide a chance to reach the 45%-score for the problem sets, even when some of the required problems are not correct. You are also encouraged to read selected sections of the supplementary material (such as may be pointed out in class on various occasions). Homework assignments are expected to be done by the due date, however an extra time may be given to submit improved versions. It is the intent of the instructor to have open discussions of some homework problems during classroom hours. The homework may include not only problems but also self-study topics.

**One piece of advice:** Do not get behind. It is important to understand the material that is being presented now in order to understand the material that will be presented later. If you get behind, it will be very difficult for you will to catch up.

## Exams

There is a midterm exam and a final exam. Each exam score will count for 25% of the final grade. A missed midterm will be averaged into the final grade as zero, unless an excuse is obtained in advance. Excuses are granted only for very serious circumstances. A student who has been excused may be required to take a makeup exam.

**Final Exam is on Monday, December 7, from 5:30 p.m. to 8.00 p.m.**

## Grading

In accordance with the course objectives, conceptual understanding and ability to apply principles to actual problem solving are the keys to high grades. The final grades will be determined from activities percentages: (a) Midterm Exam 25%; (b) Homework 45%; (c) Final Exam 30%. Your consistent effort during the whole semester is evidently highly valued.

**Your final letter grade will reflect our best attempt to evaluate objectively your performance in the course:**

A: Exceptionally good performance, demonstrating a superior understanding of the subject matter, a foundation of extensive knowledge, and a skillful use of concepts and/or materials.

B: Good performance, demonstrating capacity to use the appropriate concepts, a good understanding of the subject matter, and an ability to handle the problems and materials encountered in the subject.

C: Adequate performance, demonstrating an adequate understanding of the subject matter, an ability to handle relatively simple problems, and adequate preparation for moving on to more advanced work in the field.

D: Minimally acceptable performance, demonstrating at least partial familiarity with the subject matter and some capacity to deal with relatively simple problems, but also demonstrating deficiencies serious enough to make it inadvisable to proceed further in the field without additional work.

F: Failed. This grade also signifies that the student must repeat the subject to receive credit.

### **Course & Instructor Policies**

Every attempt will be made to give students an opportunity to improve their standing. A proactive student's position in and out of the classroom is encouraged and expected, and your feedback is always welcome. Attendance of lectures is strongly advised. The integrity of students' behavior matters - working in groups and using various materials is encouraged but it is the individual understanding of the subject and results that will be tested: a student should be able to explain his/her solution.

### **Americans with Disabilities Act**

The University of Texas at Arlington is on record as being committed to both the spirit and letter of federal equal opportunity legislation; reference Public Law 93112 -- The Rehabilitation Act of 1973 as amended. With the passage of new federal legislation entitled Americans With Disabilities Act - (ADA), pursuant to section 504 of The Rehabilitation Act, there is renewed focus on providing this population with the same opportunities enjoyed by all citizens.

As a faculty member, I am required by law to provide "**reasonable accommodation**" to students with disabilities, so as not to discriminate on the basis of that disability. Student responsibility primarily rests with **informing faculty at the beginning of the semester and in providing authorized documentation through designated administrative channels.**

### **Academic Dishonesty**

It is the philosophy of The University of Texas at Arlington that academic dishonesty is a completely unacceptable mode of conduct and will not be tolerated in any form. All persons involved in academic dishonesty will be disciplined in accordance with University regulations and procedures. Discipline may include suspension or expulsion from the University.

"Scholastic dishonesty includes but is not limited to cheating, plagiarism, collusion, the submission for credit of any work or materials that are attributable in whole or in part to another person, taking an examination for another person, any act designed to give unfair advantage to a student or the attempt to commit such acts." (Regents' Rules and Regulations, Part One, Chapter VI, Section 3, Subsection 3.2, Subdivision 3.22)

### **Student Support Services Available**

The University of Texas at Arlington supports a variety of student success programs to help you connect with the University and achieve academic success. These programs include learning assistance, developmental education, advising and mentoring, admission and transition, and federally funded

programs. Students requiring assistance academically, personally, or socially should contact the Office of Student Success Programs at 817-272-6107 for more information and appropriate referrals.

**Grade Replacement:**

If you are retaking this course in order to replace a previous grade, you must complete the necessary form by census day. The forms required are located at the Bursar's Office in Davis Hall. If you do not complete the forms by census day, the University will not honor the replacement.

**Drop for Non-Payment of Tuition:**

If you are dropped from this class for non-payment of tuition, you may secure an Enrollment Loan through the Bursar's Office. You may not continue to attend class until your Enrollment Loan has been applied to outstanding tuition fees.

**Other Drops:**

Students wishing to drop this class or resign from the university during the semester must do it themselves, but should consult the instructor in advance to determine the course grade to be reported.