COURSE SYLLABUS -- Physics 4302, *Statistical & Thermal Physics,* Spring, 2013

1:00-1:50 pm, Monday, Wednesday, Friday, Science Room 234

Instructor: Dr. Charles W. Myles, Professor of Physics. **Office:** Sc. Rm 18. **Phone:** 742-3768.
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Office Hours: Just after class, 2:30-4 pm MWF, & ***by appointment***. An email distribution list will be developed & we can have email discussions. I make ***important announcements*** by email! ***It's vital that I have your correct email address*** & that you check your email ***OFTEN!!***

Course Web Page: http://www.phys.ttu.edu/~cmyles/Phys4302/4302.html. There, you can find this Syllabus, & ***SOME***: Solutions to homework, exams & solutions, ***SOME*** lectures (Power Point, ***under construction!***) & ***IMPORTANT ANNOUNCEMENTS***. **Please get into the habit of checking this page often**!

Course Goals: To introduce students to ***Junior-Senior Level equilibrium statistical & thermal physics*** & their applications & for students ***to learn the fundamentals of this important topic.*** To this end, it will emphasize a mixture of conceptual understanding of physics concepts & standard end-of-chapter homework solving skills.

Expected Learning Outcomes: Through regular homework & classroom discussion, students in this course will:

1. Be able to use discrete & continuous probability distributions to solve simple statistics problems.
2. Understand the necessity to use statistics to describe systems containing huge numbers of particles.
3. Understand the statistical foundations of **Equilibrium Thermodynamics**.
4. Know & understand the **Fundamental Postulate of Equilibrium Statistical Mechanics**.
5. Know & understand the statistical foundation of thermodynamic (absolute) **Temperature**.
6. Know the **3 Laws of Thermodynamics** & understand their statistical foundations.
7. Understand & be able to apply the **1st Law of Thermodynamics** & Energy Conservation to many particle systems in thermal & mechanical equilibrium.
8. Understand & be able to apply the **2nd Law of Thermodynamics** & Entropy to many particle systems in thermal & mechanical equilibrium.
9. Understand & be able to apply the **3rd Law of Thermodynamics**, it's quantum mechanical foundation, & it's implications for the lower limit of absolute temperature.
10. Understand & be able to apply **Classical Thermodynamics** to simple problems.
11. Understand how to derive the **Maxwell's Relations** of Classical Thermodynamics.
12. Understand & be able to apply the **Micro-Canonical, Canonical, & Grand Canonical Ensembles** to appropriate statistical mechanics problems.
13. Understand the quantum mechanical differences between particles which are **Fermions** & those which are **Bosons**.
14. Understand the differences between **Fermion** & **Boson** Statistics.
15. Be able to apply **Fermion** & **Boson** Statistics to various many particle problems.

By the end of the course ***students should have developed*** a basic, working knowledge of classical thermodynamics & of classical & quantum equilibrium statistical mechanics & should be able to solve simple problems in these areas.

Methods for Assessing Expected Learning Outcomes: Learning outcomes for the course will be assessed through their performance on the homework, the quizzes, & the exams. The homework & quizzes are designed to have students perform model calculations in each area of the expected learning outcomes. Exam problems & questions are designed to probe knowledge developed through this process, with emphasis on how well students have understood the underlying physical ideas, as well as some of the mathematical formulations of these ideas. The special project report & presentation will allow them to explore some areas of statistical & thermal physics that we don't have time to cover in class.

STUDENT RESPONSIBILITIES: COME TO CLASS prepared, DO THE HOMEWORK, READ the material BEFORE I lecture over it, and KEEP UP as we go along.

Physics & Math Level: This is the standard (nationwide) ***junior-senior*** Statistical & Thermal Physics course for Physics & Engineering majors. The math level is that of a junior/senior physics course. Simple differential equations & vector calculus are assumed. It would help if the student had taken a course in probability & statistics, but it isn't required. At the beginning, we will spend a few lectures discussing some basic concepts in that area. This should be sufficient background to be able to understand the probability & statistics needed in this course. A knowledge of ***elementary quantum mechanics*** is assumed. Some knowledge of ***the Hamiltonian Formulation of Classical Dynamics*** would be helpful, but isn't essential. A ***goal*** is to emphasize physical understanding over math. I'll often skip math details in favor of discussing ***physics***. This is ***NOT*** a math course. If there is a math point you don't understand, ***please*** ask me about it & ***read about it on your own***! It is ***important*** that you not let the math get over your head to the extent that you lose sight of the ***PHYSICS.***

Required Textbook: ***Fundamentals of Statistical and Thermal Physics,*** by F. Reif. ***NOTE!!*** This book is old! The original publisher stopped printing it. However, ***Waveland Press*** publishes it now. It's available on line from them. Topics will be discussed in approximately the same order as the book table of contents, however, material from many sources other than this book will be used. An on-line search finds new, used, hardcover & paperback versions. A Google search gets 26,200 hits with prices from $34 - $140!! ***I encourage you to shop for the best price for you!*** Given the cost, don't you think it would be worthwhile to ***READ IT???***

Supplemental Text (recommended): ***Classical and Statistical Thermodynamics,*** by A.H. Carter. (Prentice Hall, 2001). I like this text because of it's short, concise discussions of some of the concepts. I also like some of its problems at the ends of the chapters.

NOTE: There are ***many*** books on Statistical Physics (Statistical Mechanics) at various levels of depth & difficulty. In Rm. 18, I have a few. The library has more. Mine are available to check out. In a ***Junior/Senior*** course, ***I expect you to go to other sources*** to obtain different treatments of the material! Some portions of the Lectures come from the book by Reif. However, I will often lecture on material from many other sources. pp 631-635 of Reif has a large bibliography. ***USE IT*****!!!!**

Course Topics: The course covers the basics of statistical & thermal physics. As a 1 semester course, topics must be covered rapidly. ***An approximate*** schedule of topics is below. A ***goal*** is to cover Chs. 1- 9 & possibly Ch. 10. Similar or related topics from many other sources may also be discussed as appropriate. If time permits, selected topics from other chapters of Reif will also be covered.

Grades; Exams: Grades are based on: **3 Exams** (including the Final) **= 75%** (3×25%); a **Library Research Project/Paper & Presentation = 25%** (see below), **Homework = 25%**. **Friday Quizzes**: Part of the Homework grade. Equal weight to 1 problem set (see below). For 100%, the lowest exam grade will be dropped. We'll try to arrange for Exams I & II to be given in evenings, so that more than 1 hour can be taken. The Final Exam is non-comprehensive & counts equally with the others. An Exam is dropped, so ***no make ups will be given!*** Exam material is taken from the text, the homework, & all topics discussed in class. ***Neither the Homework nor the Library Research Paper & Presentation will be dropped!***

Homework: Problems from our text, the supplemental text, & other sources will be assigned regularly. Doing them is the best way to learn physics! It's ***IMPOSSIBLE*** to do so without working problems! Homework is ***due in my office or mailbox at 5pm on the due date.*** To keep up, do assignments as soon as the material is covered. Many problems are ***NON TRIVIAL!*** If you wait to the last minute (or day!) to begin, you likely will run into trouble! ***No late homework is accepted!*** Homework may be done individually or in consultation with others in the course. ***I ENCOURAGE groups to work together. This is how scientists & engineers work in real situations! NO CONSULTATION*** with people who had this course previously is allowed! ***NO*** use of problem solutions posted in previous years or posted on the web by people outside of TTU is allowed! It does you no good to copy old solutions or someone else's solutions! Copying solutions will ***NOT*** teach you physics! On the web, there may exist solutions to some or all problems in our text & probably also to most problems from other

texts. Copying these (or copying solutions from previous years!) & handing them in as your own is ***CHEATING!!*** Anyone caught cheating will, ***at minimum***, receive an "**F**" in on the assignment for which they are caught. TTU has strict policies against cheating & severe penalties for it, including expulsion from the university. Cheating also defeats the purpose of solving problems, ***which is to TEACH you physics***. Just being an expert at using Google to find problem solutions ***will not teach you physics!!*** You should know by now that the **ONLY** way to learn physics is to ***DO PHYSICS YOURSELF*** (or with friends) by ***WORKING MANY, MANY, MANY PROBLEMS!!***

Friday Quizzes: To encourage attendance & try to prevent the large attendance decreases seen in previous semesters, especially Fridays, a short (~10 min.) **Quiz** will be given ***EACH FRIDAY***. They will be mostly qualitative, with questions on the **Physical Concepts** we've discussed in recent classes & also simple problems similar to those assigned. The quiz percent will be averaged with the homework grade & will be equal in weight to one homework set.

Library Research Paper & Talk: On an advanced topic or application of statistical & thermal physics that we don't have time for in class. The paper is due near the end of the semester. Oral presentations on the same subject will take place then. ***You should have the topic picked by mid-semester!!!*** Topics must be approved by me before you begin. The paper should be 5-10 typed pages & written in scientific style, with all (***SEVERAL!!***) sources properly cited. The talk should be about ½ hour long. It can be (but isn't required to be) done in Power Point. Ideas on topics may be found in Chs. 11-15 of Reif or in many other texts.

Helpful Hints: This course is sometimes difficult for students. This is partially because it is mathematical and partially because it is (in places) abstract. Unless you are a genius, the only way to succeed in this course is by ***very hard work***! This means devoting ***MANY hours*** outside of class for every hour in class. It also means at least ***trying*** to work all assigned problems!

Attendance: I don't take roll & I have no specific attendance policy. However, isn't it obvious that (unless you are a genius) class attendance is required to get a good grade? If attendance becomes a problem, I reserve the right to institute brief daily quizzes, to be added into the homework grade. My lectures may not be brilliant or entertaining, but I do expose you to the material!

Approximate Grade Scale: 100 ≥ A ≥ 88 > B ≥ 75 > C ≥ 60 > D ≥ 50 > F ≥ 0

NOTE: I reserve the right to slightly alter these cutoffs! I also reserve the right to assign a higher grade to anyone whose efforts may not be reflected in their total points. This decision is mine alone to make. You cannot receive a lower grade than indicated by the total points.

Approximate Lecture Schedule

Reif's Chapter & Title	*Approximate* No. of Lectures
1. Introduction to Statistical Methods	3
2. Statistical Description of Systems of Particles	5
3. Statistical Thermodynamics	6
4. Macroscopic Parameters and Their Measurement	4
5. Simple Applications of Macroscopic Thermodynamics	5
6. Basic Methods and Results of Statistical Mechanics	4
7. Simple Applications of Statistical Mechanics	4
8. Equilibrium Between Phases or Chemical Species (only if time!)	5
9. Quantum Statistics of Ideal Gases	5
10. Systems of Interacting Particles (Selected topics)	???
11. Various Special Topics in Statistical & thermal physics (Black holes, Bose-Einstein Condensation, Information Theory,……??)	???
TOTAL	41

This isn't meant to be rigid, but gives an idea where we are going. Some topics in some chapters may be omitted. Additional topics may be added!

IMPORTANT DATES

Mon., Jan. 21: MLK Day, TTU Holiday, ***NO CLASS!*** **Tues., Jan. 22:** Last day to add.

Fri., Feb. 1: Last drop date with refund. **Wed., Feb. 13:** Last withdraw date with refund.

Sat., March 9-Sun., March 17: Spring Break, ***NO CLASS!*** **Wed., March 20:** Mid-Semester.

Mon., March 18 – Fri., March 22:

I'm out of town at an APS Meeting in Baltimore. I'll get a substitute.

Wed., March 27: Last Day to drop. **Mon., April 1:** "Easter Monday" ***NO CLASS*.**

Thurs., April 4- Sat., April 6:

I'm out at a Texas Section APS Meeting, Tarleton State U., Stephenville, TX.

Tues., May 7: Last TTU class day. **Thurs., May 9 – Tues., May 14:** Final Exam Period.

Friday, May 10, 7:30 am – 10:00 am: *FINAL EXAM* Chapters 23-38 (Comprehensive!)

Mon., May 20: Grades are due!

ACADEMIC *INTEGRITY:* Academic dishonesty (cheating, plagiarism, etc.) will not be tolerated. Students caught in this type of behavior will be punished to the fullest extent allowed by TTU. See the TTU Student Handbook or the Catalogue.

EXAMS: The exams in this course are composed ***uniquely*** for this semester.

COPYRIGHT STATEMENT: All exams and lecture notes related to this course are copyrighted & owned by me! For students in this course, both are freely downloadable from the course web page. However, ***no other reproduction and/or distribution is allowed***!

CIVILITY IN THE CLASSROOM: Students are expected to assist in maintaining an environment which is conducive to learning. To assure that all students have an opportunity to gain from class time, students are prohibited from using cell phones, eating/drinking in class, making offensive remarks, reading newspapers, sleeping or engaging in any other form of distraction. Inappropriate behavior in the classroom shall result in minimally, a request toleave class.

DISABILITY STATEMENT

Any student who, because of a disability, may require special arrangements in order to meet the course requirements should contact the instructor as soon as possible to make any necessary arrangements. Students should present appropriate verification from Student Disability Services during the instructor's office hours. Please note instructors are not allowed to provide classroom accommodations to a student until appropriate verification from Student Disability Services has been provided. For additional information, you may contact the Student Disability Services office in 335 West Hall or 806-742-2405.