PHYS 4311: Thermodynamics and Statistical Mechanics
Course Syllabus

Course information:

COURSE SECTION: **PHYS4311.001 (Spring 2018)**

COURSE TITLE: Thermodynamics and Statistical Mechanics

TIME: Tuesday & Thursday 10:00-11:15 am

LOCATION: PHYS 1.202

Professor contact information:

Faculty: **Bing Lv**
E-mail: **blv@utdallas.edu**
Office: **PHYS 1. 622**
Phone: **(972)-883-3806**
Office Hours: **Tues&Thurs, 1:00-2:00 pm, or by appointment**

TA: Xiaoyuan Liu xxl147030@utdallas.edu
TA Office Hours: to be determined.

I. Course: PHYS 4311 - Thermodynamics and Statistical Mechanics

A. Description: 3 Credit Hours. Calculus based. Primarily for science and engineering majors. Two lectures per week. Study of the elements of thermodynamics, kinetic theory, and statistical mechanics; the concepts of temperature, entropy, phase transitions, transport phenomena, partition functions, statistical ensembles; the Maxwell Boltzmann, Fermi-Dirac, and Bose-Einstein distributions; and the equipartition theorem. Applications of the theories will be considered.

B. Course Pre-requisites, Co-requisites, and/or Other Restrictions: Prerequisite: PHYS 2326 or 2422 or equivalents;Co-requisites: PHYS 3312, Classical Mechanics and PHYS 3352, Modern Physics I or equivalents.

II. Course Objectives & Outcomes: The objective of this course is to give students a rigorous introduction to and understanding of the basic foundations of thermodynamics and statistical mechanics with two primary objectives: The first is for the student to obtain a deep and thorough understanding of the thermodynamic potentials. The text does this very well. The second objective is to introduce the student to various examples in which thermodynamics and statistical mechanics are fundamental.

Upon completion of this course, students will be able to:

Objectives	Outcomes/Measures
Understand rigorous scientific definitions of temperature, equilibrium, heat, and work	Summaries and Problem solving in Homework/Exams

Understand and apply zeroth and first laws of thermodynamics	Summaries and Problem solving in Homework/Exams
Understand and apply the concept of entropy and second law of thermodynamics	Summaries and Problem solving in Homework/Exams
Understand the equipartition theorem and the partition function	Summaries and Problem solving in Homework/Exams
Describe the statistical nature of many-particle ensembles in the large N limit	Summaries and Problem solving in Homework/Exams
Understand classical and quantum statistical distributions	Summaries and Problem solving in Homework/Exams
Be able to apply thermodynamic and statistical mechanics concepts to problems in energy transport, engine efficiency, and phase transitions	Summaries and Problem solving in Homework/Exams

Other learning outcomes include:

1. Students completing this course will be able to convey knowledge of the principles of physics and be able to use these principles to solve problems.
2. Students will be able to take a real life problem and use physical principles and mathematical tools to describe the problem.

III. Textbooks:

Required Textbook: *An Introduction to Thermal Physics*, by Daniel V. Schroeder, © 2000, Addison Wesley Longman; ISBN-13: 978-0201380277 (This is the same text used the past two years.)

Suggested Textbooks:

1. *Fundamentals of Statistical and Thermal Physics* by Frederick Reif, © 1965, McGrawHill; ISBN-13: 978-0070518001
   (This is the classic textbook on this subject. Detailed and rather boring to certain extent, but it is an invaluable reference for any professional who deals with thermodynamics or statistical mechanics.)

2. *Classical and Statistical Thermodynamics* by Ashley H. Carter @2001, by Prentice-Hall, Inc. ISBN: 0-13-779208-5

3. Thermal Physics (2nd ed.) by Charles Kittel and Herbert Kroemer, © 1980, W. H. Freeman; ISBN-13: 978-0716710882

IV. Course Content: At least initially, we will follow the order of the text. From time to time supplemental material may be handed out. The topics to be presented (which are the chapter headings) are:

1. Energy in Thermal Physics
2. The Second Law
3. Interactions and Implications
4. Engines and Refrigerators

5. Free Energy and Chemical Thermodynamics
6. Boltzmann Statistics
7. Quantum Statistics
8. System of Interacting Particles

V. **Grading Policy:** 10% Homework, 10% Classroom Quizzes, 20% Hour exam I and 20% Hour exam II, and 40% Final Exam Score (Total 100%). Homework will be assigned from time to time and is due one week after assignment. **No late homework is accepted.** If the Final Exam Score is better than either Hour Exam Scores, then the Final Exam Score will be substituted in place of the lower score in computing the course grade. **No Make-up exams for any reason. If you miss an hour exam, your final exam score will stand in for that missing hour exam.**

About Exams:
1. **Calculators will be necessary** for all exams. **Any calculators that have internet access will not be allowed in the exams**. A scientific calculator that has trig functions should be all that is used on the exams.
2. **You must show all work for exam problems (excluding multiple choice questions) to receive partial credits.**
3. **Exams will cover both in-class examples and homework.**
4. **No phones of any kind or any devices with internet access are allowed to be used during exams.**
5. You may not leave the exam room with the exam or your answers.
6. You can go to the course under eLearning and download lecture notes that form part (but NOT ALL) of the lectures. Be careful: these lectures may not be a complete record of what is covered in class and will not be enough to pass the class.
7. The final exam will be cumulative and will be based on the exams, homework, and any new material.
8. **There will be no make-up exams for any reason**

Other Course-related citizenship:
Cell Phones: Please turn it off during class – MAY NOT BE USED DURING TESTS
Laptops: Please only use them for notes – MAY NOT BE USED DURING TESTS
Do not disrupt the class by getting up and leaving in the middle of class!

Technical Support

If you experience any problems with your UTD account you may send an email to: assist@utdallas.edu or call the UTD Computer Helpdesk at 972-883-2911.

Tentative Calendar

Date	Contents	Chapters
1/9	Overview, Historical Context, Temperature, Energy, & Heat	Intro./ 1
1/11	Ideal Gas Model: Equilibrium & Equipartition	1.1 to 1.3
1/16	Heat, Work, and the 1st Law	1.4 to 1.5
1/18	Basic Thermodynamic Properties (of Ideal Gas)	1.6 to 1.7
1/23	Introduction to Entropy: Macrostates and Microstates	2.1 to 2.2
1/25	Entropy of the Ideal Gas and of Mixing	2.3 to 2.4

1/30	Entropy and the 2nd Law	2.5 to 2.6
2/1	The 2nd Law, Heat, Disorder, and Information	3.1 to 3.2
2/6	Entropy and Thermodynamic Properties	3.3 to 3.4
2/8	Heat Engines: Theoretical	4.1 to 4.2
2/13	Heat Engines: Engine Cycles & Efficiencies	4.3 to 4.4
2/15	The 3rd Law and Approach to Absolute Zero Temperature	3.2
2/20	**Hour Exam 1 (covering Chs. 1 to 4)**	
2/22	Free Energy	5.1 to 5.2
2/27	Phase Transitions: Introduction	5.3
3/1	1st Order Phase Transitions: Van der Waals Equation	5.3
3/6	Phase Transitions of Mixtures	5.4
3/8	Mixtures & Chemical Equilibrium	5.6
3/13	Spring Break	--
3/15	Spring Break	--
3/20	Introduction to Statistical Mechanics	6.1 to 6.2
3/22	The Partition Function	6.2 to 6.3
3/27	Examples of Partition Functions	6.6 to 6.7
3/29	Beyond Averages: Distribution Functions	6.4
4/3	**Hour Exam 2 (covering Chs. 4 to 6)**	
4/5	Quantum Statistical Mechanics	7.1
4/10	Statistical Mechanics of Electromagnetic Fields	7.4
4/12	Statistical Mechanics of Quantum Particles	7.2
4/17	Ideal Gas of Fermi-Dirac Particles	7.3
4/19	Ideal Gas of Bose-Einstein Particles	7.6
4/24	Bose-Einstein Condensation	7.2 &7.6
TBD	Final Exam (Final Exam Period)	

Student Conduct & Discipline

The University of Texas System and The University of Texas at Dallas have rules and regulations for the orderly and efficient conduct of their business. It is the responsibility of each student and each student organization to be knowledgeable about the rules and regulations which govern student conduct and activities. General information on student conduct and discipline is contained in the UTD printed publication, *A to Z Guide*, which is provided to all registered students each academic year.

The University of Texas at Dallas administers student discipline within the procedures of recognized and established due process. Procedures are defined and described in the *Rules and Regulations, Series 50000, Board of Regents, The University of Texas System,* and in Title V, Rules on Student Services and Activities of the university's *Handbook of Operating Procedures*. Copies of these rules and regulations are available to students in the Office of the Dean of Students, where staff members are available to assist students in interpreting the rules and regulations (SU 1.602, 972/883-6391) and online at http://www.utdallas.edu/judicialaffairs/UTDJudicialAffairs-HOPV.html

A student at the university neither loses the rights nor escapes the responsibilities of citizenship. He or she is expected to obey federal, state, and local laws as well as the Regents'

Rules, university regulations, and administrative rules. Students are subject to discipline for violating the standards of conduct whether such conduct takes place on or off campus, or whether civil or criminal penalties are also imposed for such conduct.

Academic Integrity

The faculty expects from its students a high level of responsibility and academic honesty. Because the value of an academic degree depends upon the absolute integrity of the work done by the student for that degree, it is imperative that a student demonstrate a high standard of individual honor in his or her scholastic work.

Scholastic Dishonesty, any student who commits an act of scholastic dishonesty is subject to discipline. 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.

Plagiarism, especially from the web, from portions of papers for other classes, and from any other source is unacceptable and will be dealt with under the university's policy on plagiarism (see general catalog for details). This course will use the resources of turnitin.com, which searches the web for possible plagiarism and is over 90% effective.

Copyright Notice

The copyright law of the United States (Title 17, United States Code) governs the making of photocopies or other reproductions of copyrighted materials, including music and software. Copying, displaying, reproducing, or distributing copyrighted works may infringe the copyright owner's rights and such infringement is subject to appropriate disciplinary action as well as criminal penalties provided by federal law. Usage of such material is only appropriate when that usage constitutes "fair use" under the Copyright Act. As a UT Dallas student, you are required to follow the institution's copyright policy (Policy Memorandum 84-I.3-46). For more information about the fair use exemption, see http://www.utsystem.edu/ogc/intellectualproperty/copypol2.htm

Email Use

The University of Texas at Dallas recognizes the value and efficiency of communication between faculty/staff and students through electronic mail. At the same time, email raises some issues concerning security and the identity of each individual in an email exchange. The university encourages all official student email correspondence be sent only to a student's U.T. Dallas email address and that faculty and staff consider email from students official only if it originates from a UTD student account. This allows the university to maintain a high degree of confidence in the identity of all individual corresponding and the security of the transmitted information. UTD furnishes each student with a free email account that is to be used in all communication with university personnel. The Department of Information Resources at U.T. Dallas provides a method for students to have their U.T. Dallas mail forwarded to other accounts.

Withdrawal from Class

The administration of this institution has set deadlines for withdrawal of any college-level courses. These dates and times are published in that semester's course catalog. Administration procedures must be followed. It is the student's responsibility to handle withdrawal requirements from any class. In other words, I cannot drop or withdraw any student. You must do the proper paperwork

to ensure that you will not receive a final grade of "F" in a course if you choose not to attend the class once you are enrolled.

Student Grievance Procedures

Procedures for student grievances are found in Title V, Rules on Student Services and Activities, of the university's *Handbook of Operating Procedures*.

In attempting to resolve any student grievance regarding grades, evaluations, or other fulfillments of academic responsibility, it is the obligation of the student first to make a serious effort to resolve the matter with the instructor, supervisor, administrator, or committee with whom the grievance originates (hereafter called "the respondent"). Individual faculty members retain primary responsibility for assigning grades and evaluations. If the matter cannot be resolved at that level, the grievance must be submitted in writing to the respondent with a copy of the respondent's School Dean. If the matter is not resolved by the written response provided by the respondent, the student may submit a written appeal to the School Dean. If the grievance is not resolved by the School Dean's decision, the student may make a written appeal to the Dean of Graduate or Undergraduate Education, and the deal will appoint and convene an Academic Appeals Panel. The decision of the Academic Appeals Panel is final. The results of the academic appeals process will be distributed to all involved parties.

Copies of these rules and regulations are available to students in the Office of the Dean of Students, where staff members are available to assist students in interpreting the rules and regulations.

Incomplete Grade Policy

As per university policy, incomplete grades will be granted only for work unavoidably missed at the semester's end and only if 70% of the course work has been completed. An incomplete grade must be resolved within eight (8) weeks from the first day of the subsequent long semester. If the required work to complete the course and to remove the incomplete grade is not submitted by the specified deadline, the incomplete grade is changed automatically to a grade of **F**.

Student Accessibility

The goal of Student AccessAbility is to provide students with disabilities equal educational opportunities. Student AccessAbility provides students with a documented letter to present to the faculty members to verify that the student has a disability and needs accommodations. This letter should be presented to the instructor in each course at the beginning of the semester and accommodations needed should be discussed at that time. It is the student's responsibility to notify his or her professors of the need for accommodation. If accommodations are granted for testing accommodations, the student should remind the instructor five days before the exam of any testing accommodations that will be needed. Student AccessAbility is located in the Student Services Building, room 3.200. Phone: 972-883-2098. Fax: 972-883-6561; disabilityservice@utdallas.edu. Office hours are Monday – Thursday, 8:30 a.m. to 6:30 p.m., and Friday 8:30 a.m. to 5:00 p.m.Guidelines for documentation are located on the Student AccessAbility http://www.utdallas.edu/studentaccess/documentation/

Religious Holy Days

The University of Texas at Dallas will excuse a student from class or other required activities for the travel to and observance of a religious holy day for a religion whose places of worship are exempt from property tax under Section 11.20, Tax Code, Texas Code Annotated.

The student is encouraged to notify the instructor or activity sponsor as soon as possible regarding the absence, preferably in advance of the assignment. The student, so excused, will be allowed to take the exam or complete the assignment within a reasonable time after the absence: a period equal to the length of the absence, up to a maximum of one week. A student who notifies the instructor and completes any missed exam or assignment may not be penalized for the absence. A student who fails to complete the exam or assignment within the prescribed period may receive a failing grade for that exam or assignment.

If a student or an instructor disagrees about the nature of the absence [i.e., for the purpose of observing a religious holy day] or if there is similar disagreement about whether the student has been given a reasonable time to complete any missed assignments or examinations, either the student or the instructor may request a ruling from the chief executive officer of the institution, or his or her designee. The chief executive officer or designee must take into account the legislative intent of TEC 51.911(b), and the student and instructor will abide by the decision of the chief executive officer or designee.

These descriptions and timelines are subject to change at the discretion of the Professor.