PHYS 515: Thermal and Statistical Physics, Fall 2023

Class:
Time: Tue/Thu 10:30 am-11:45 am,
Location: Phys building 338
3 credits

Instructors:
Prof. Tongcang Li, PHYS 52, tcli@purdue.edu

TA: Chen-you Su, PHYS G6A, su317@purdue.edu

Books:
Required: Daniel V. Schroeder, "An introduction to Thermal Physics," 1st edition, Oxford University Press (A hard copy is required for open-book quizzes and exams).

Office Hours:
Prof. Li: Thursday 2 pm-3 pm, Phys 52; or by appointment
TA: Chen-you Su: Tuesday 3-5 pm, Phys G6A

Course Description: The first seven chapters of the textbook will be covered. This provides a thorough introduction to the foundations of thermal physics: Equilibrium states, the concept of heat, and the laws of thermodynamics; the existence and properties of the entropy and free energies; different thermodynamic potentials and their uses; phase diagrams and phase transitions; introduction to statistical mechanics and its relation to thermodynamics; treatment of ideal gases.

Learning outcomes: The goals of this course are for you to master the concepts and facts of thermal and statistical physics. You will learn how collections of large numbers of particles behave, and how to connect their macroscopic behavior to the microscopic behavior of the individual particles.

Credit:
40% homework quizzes: Thursdays, last 30 min, random homework problem (possibly slightly modified); 2 lowest scores dropped (these include absence due to Covid-19 quarantine or other reasons).

55% 2 midterm exams + 1 final exam.
The final exam will primarily focus on material covered after the second midterm. The lower of the two midterm scores will be dropped, including absences due to Covid-19 quarantine or any other reasons. Taking the final exam is mandatory. If you have valid reasons for missing it, you must consult with me beforehand. The exams will be open-book, allowing you to use the textbook and a calculator. However, computers, smartphones, homework, and any other learning materials are not permitted during the exams.

5% participation. This includes 2% for participating in the final online course evaluation. You can email the confirmation letter of finishing the course evaluation to me to obtain these points.

Date of midterm exam 1: September 28, 2023
Date of midterm exam 2: November 2, 2023

Class Attendance:

Your attendance at class is important. If you must miss class, you are responsible for any material, information, handouts, announcements, quizzes, etc. you missed. Late arrivals and early departures from class can be disruptive, so please keep these to a minimum.

Miscellany:

Makeup exams will not be offered. We will drop the lower score of the two midterm exams, including absences. If you have valid reasons to miss the final exam, you must discuss them with me in advance. In such cases, both of your midterm exam scores will be used to determine your final grade.

Homework will be assigned almost every week. However, you won't need to submit your solutions. Instead, we will conduct homework quizzes that will feature random selections from the assigned problems (likely with slight modifications) to evaluate your understanding and completion of the homework.

Academic Honesty Policy:

"As a boilermaker pursuing academic excellence, I pledge to be honest and true in all that I do. Accountable together - we are Purdue."

We expect every member of the Purdue community to practice honorable and ethical behavior in and outside of the classroom. Any actions which might unfairly improve a student's score on homework, exams, or final exam will be considered cheating, and will not be tolerated.

Students with documented disabilities:

Students with disabilities must be registered with Adaptive Programs in the Office of the Dean of Students before classroom accommodations can be provided. If you are eligible for academic accommodations because you have a documented disability that will impact your work in this class, please schedule an appointment with Prof. Li as soon as possible to discuss your needs.

Tentative course schedule (may be adjusted depending on the learning progress):

Week 1 (8/21): Thermal equilibrium, ideal gas, equipartition, heat and work (Sec. 1.1-1.4)

Week 2 (8/28): heat and work, heat capacities, enthalpy (Sec. 1.4-1.6)

Week 3 (9/4): microstates, second law, large systems (Sec. 2.1-2.4)

Week 4 (9/11): ideal gas, entropy, temperature (Sec. 2.5-3.1)

Week 5 (9/18): entropy and heat, paramagnetism (sec. 3.2, 3.3)

Week 6 (9/25): pressure, chemical potential (sec. 3.4-3.6) and review. **Midterm exam 1 on Sep. 28**

Week 7 (10/2): heat engines, refrigerators, free energy (4.1-5.1)

Week 8 (10/9): **October Break**. more about free energy, phase transformations (Sec. 5.2-5.3)

Week 9 (10/16): Clausius-Clapeyron relation, the Boltzmann factor (Sec 5.3-6.1)

Week 10 (10/23): average values, the equipartition theorem (Sec. 6.2-6.3)

Week 11 (10/30): Maxwell speed distribution (Sec. 6.4), review. **Midterm exam 2 on Nov. 2**

Week 12 (11/6): More about Partition functions, ideal gas revisited (Sec. 6.5-6.7)

Week 13 (11/13): The Gibbs factor, Bosons and Fermions (Sec. 7.1-7.2)

Week 14 (11/20): Bosons and Fermions, degenerate Fermi gases (Sec. 7.2-7.3). **Thanksgiving**

Week 15 (11/27): Photon gas, blackbody radiation, Debye theory of solids (Sec. 7.4-7.5)

Week 16 (12/4): other topics, review.