Physics 170: Statistical Mechanics and Thermodynamics

Course Outline

Starting from the microscopic laws of physics, how can we quantitatively understand macroscopic systems composed of many degrees of freedom? How do we calculate the heat capacity of air, the magnetic susceptibility of magnesium, or the pressure inside a white dwarf star? Statistical mechanics provides the framework for predicting these bulk properties on the basis of the microscopic laws that you have studied in your previous courses (mechanics, E&M, quantum mechanics). We will build up this powerful framework by the following course of study:

I. Combinatorics and probability
    a. Random walks
    b. Central Limit Theorem
II. Statistical mechanics as the foundation for thermodynamics
    a. Microstates and macrostates
    b. Entropy, temperature, free energy
    c. Thermal, mechanical, and chemical equilibrium
III. Applications of statistical mechanics to model systems
    a. Paramagnet
    b. Ideal gas
    c. Einstein & Debye models of the solid
    d. Planck law of radiation
IV. Identical particles
    a. Bose-Einstein statistics
    b. Fermi-Dirac statistics
V. Classical thermodynamics
    a. Work and heat
    b. Heat engines and refrigerators

Course Logistics

Staff		Office Hours
Professor Monika Schleier-Smith	Varian 238 schleier@stanford.edu	Monday, 12:15 – 1:30, and by appointment
Teaching Assistants	PAB 214	
Chris Overstreet	coverstr@stanford.edu	Monday 3:00 – 4:00
Quinn MacPherson	qmac@stanford.edu	Monday 5:30 – 6:30
Physics Education Fellow Ryan Hazelton	Varian 252 ryan.hazelton@stanford.edu	
Admin. Assistant Sha Zhang	Varian 240 shazhang@stanford.edu	

Lecture
(M)WF, 1:30-2:50 PM
Physics & Astrophysics Building (PAB) 102/103

The first class meeting will be on Wednesday, September 27.

Section
Monday, 1:30-2:50 PM
Physics & Astrophysics Building (PAB) 102/103

The first day of section is Monday, October 2. You are responsible for all material covered in section.

Textbook
Primary: Kittel & Kroemer, *Thermal Physics*
Supplementary (required for 171): Reif, *Fundamentals of Statistical and Thermal Physics*

Additional supplementary notes may be provided online.

Website:

Course materials will be posted on Canvas.

Grading

The course grade will be based on problem sets, in-class exercises, and exams, with the following weighting:

- Problem Sets: 40%
- In-class exercises: 10%
- Midterm: 20%
- Final: 30%

Problem Sets

A problem set will be posted on Canvas each Tuesday and due the following Tuesday. Problem sets should be submitted to the course mailbox in Hewlett. You must explain your reasoning and show your work on all problems to receive full credit.

In-Class Exercises

A significant portion of lecture time will be devoted to working problems in small groups. In-class exercises are to be handed in at the end of lecture.

Exams

Midterm: Monday, October 30 (tentative), in class
Final: Wednesday, December 13, 3:30 – 6:30 pm

Honor Code

The Stanford University Honor Code and Fundamental Standard are a part of this course. Their full text can be found online:

communitystandards.stanford.edu/student-conduct-process/honor-code-and-fundamental-standard