UNIVERSITY of HOUSTON

DEPARTMENT OF PHYSICS

Physics 6327 Statistical Physics Spring 2026

Lecture: TuTh 11:30 AM – 1:00 PM
Lab/Recitations: Th 1:00 PM – 2:30 PM

Professor Volodymyr Vovchenko, email: vvovchen@central.uh.edu

Office Hours: Wednesday 11AM-12PM or by appointment (office SR1 629C)
TA Support: TBD

(Last update 1/19/2026)

Catalog Description
Classical thermodynamics; extremum principles and ensembles; kinetic theory; quantum statistics (Fermi-Dirac and Bose-Einstein) and applications; phase transitions and the Ising model.

Course Objectives and Student Learning Outcomes

- Develop understanding of equilibrium statistical physics and its connection to thermodynamics.
- Learn how macroscopic laws emerge from microscopic degrees of freedom via counting, probability, and ensembles.
- Become fluent in the microcanonical, canonical, and grand canonical formalisms and in extracting thermodynamic information from partition functions.
- Apply quantum statistics (Bose–Einstein and Fermi–Dirac) to ideal gases and to key physical systems (photons, phonons, and degenerate fermionic matter).
- Gain a first working framework for phase transitions using models such as the Ising model and mean-field/Landau theory.

Required Instructional Materials
Primary:

- *Statistical Mechanics* (Fourth Edition) by R. K. Pathria & Paul D. Beale (EBook available via UH Libraries at https://www-sciencedirect-com.ezproxy.lib.uh.edu/book/monograph/9780081026922/statistical-mechanics)
- Greg Morrison lecture notes (available on Teams, see also https://morrisongroup.nsm.uh.edu/content/5-courses/statmech.pdf)

The following textbook can also be useful:

- *Statistical Mechanics* (2nd ed.) by Kerson Huang

I will post lecture notes, homework assignments, and other material, if necessary, on the Teams page for this course.

Discussion and Lecture Topics

(1) Thermodynamics review and Legendre transforms.
(2) Kinetic theory and the Boltzmann equation.
(3) Microcanonical ensemble.

(4) Canonical ensemble. Partition functions and thermodynamic identities.
(5) Grand-canonical ensemble.
(6) Quantum statistical mechanics and density operators.
(7) Fermi-Dirac and Bose-Einstein statistics. Ideal quantum gases. Bose-Einstein condensation. Degenerate Fermi gas. Relativistic Gases.
(8) Interacting Systems and the Virial Expansion.
(9) Phase transitions and the Ising Model.

Prerequisites
Undergraduate-level thermal physics/statistical mechanics. Comfort with multivariable calculus, series expansions/asymptotics, and basic quantum mechanics is assumed.

Course Policies and Procedures

A. **Lectures**: Attendance at lectures is highly encouraged.
B. **Exams**: There will be two midterm exams and a final exam. The final exam can replace the lowest midterm score if it benefits the student.
C. **Homework**: Homework assignments will be given every 1-2 weeks, typically due one week after being assigned. Collaboration on ideas is encouraged; submitted work must be written up independently.
D. **Recitations**: The recitation slots will be used for the discussion of solutions to the homework problems and occasional catch-up sessions if needed.

AI Tools: The use of Artificial Intelligence tools such as ChatGPT is permitted for assistance/self-study purposes but should not be relied upon too much. The student should document the use of AI tools if these materially assisted in completing assignments. The student should also be able to explain their homework solution in full upon request from the instructor. No AI tools will be available during the exams.

Standard Disclaimer: This syllabus is subject to change at the discretion of the instructor.

Grading Rubrics and Weights
The final grade will consist of the following elements:

- Homework: 20%
- Midterm Exam I: 20%
- Midterm Exam II: 20%
- Final Exam: 40%

The final exam can replace the lowest midterm score if it benefits the student.

Grading scale: Your grade will be determined by your total number of points (out of 100). The grading scale will be communicated prior to the final exam.

Tentative Schedule (Last update 1/19/2026)

1/20	Introduction, Syllabus, Math Background
1/22, 1/27	Thermodynamics Refresher
1/29, 2/3, 2/5	Kinetic Theory
2/10, 2/12	Microcanonical Ensemble
2/17, 2/19, 2/24	Canonical Ensemble
2/26, 3/3	Grand canonical ensemble
3/5	Midterm Exam I
3/10, 3/12	Quantum Statistical Mechanics
3/17, 3/19	Spring Break – no classes
3/24, 3/26, 3/31	Ideal Quantum Gases
4/2, 4/7	Applications of Bose-Einstein Statistics
4/9	Applications of Fermi-Dirac Statistics
4/14	Relativistic Gases
4/16	Midterm Exam II
4/21	Interacting Systems, Virial Expansion
4/23, 4/28, 4/30	Phase Transitions and the Ising Model, Final Review
5/11, 12-2pm	Final Exam

Addendum: Whenever possible, and in accordance with 504/ADA guidelines, the University of Houston will attempt to provide reasonable academic accommodations to students who request and require them. Please call 713-743-5400 for more assistance.

Academic Honesty: It is each student's responsibility to read and understand the Academic Honesty Policy found at http://catalog.uh.edu/content.php?catoid=34&navoid=12627.

Religious Holy Days: Students whose religious beliefs prohibit class attendance or the completion of specific assignments on designated dates may obtain an excused absence. To do so, please make a written request for an excused absence and submit it to your instructor as soon as possible, to allow the instructor to make arrangements. See http://publications.uh.edu/content.php?catoid=36&navoid=12931.

Counseling and Psychological Services (CAPS) can help students who are having difficulties managing stress, adjusting to college, or feeling sad and hopeless. You can reach CAPS (http://www.uh.edu/caps) by calling 713-743-5454 during and after business hours for routine appointments or if you or someone you know is in crisis. Also, there is no appointment necessary for the "Let's Talk" program, which is a drop-in consultation service at convenient locations and hours around campus. https://uh.edu/caps/outreach/lets-talk

University Excused Absence Policy:
Regular class attendance, participation, and engagement in coursework are important contributors to student success. Absences may be excused as provided in the University of Houston Undergraduate Excused Absence Policy and Graduate Excused Absence Policy for reasons including: medical illness of student or close relative, death of a close family member, legal or government proceeding that a student is obligated to attend, recognized professional and educational activities where the student is presenting, and University-sponsored activity or athletic competition. Additional policies address absences related to military service, religious holy days, pregnancy and related conditions, and disability.

Recording of Class
Students may not record all or part of class, livestream all or part of class, or make/distribute screen captures, without advanced written consent of the instructor. If you have or think you may have a disability such that you need to record class-related activities, please contact the Center for Students with DisABILITIES. If you have an accommodation to record class-related activities, those recordings may not be shared with any other student, whether in this course or not, or with any other person or on any other platform. Classes may be recorded by the instructor. Students may use instructor's recordings for their own studying and notetaking. Instructor's recordings are not authorized to be shared with *anyone* without the prior written approval of the instructor. Failure to comply with requirements regarding recordings will result in a disciplinary referral to the Dean of Students Office and may result in disciplinary action.

Syllabus Changes
The instructor may need to make modifications to the course syllabus and may do so at any time. Notice of such changes will be announced as quickly as possible.