Physics 2541
Thermodynamics and Statistical Mechanics
Fall 2025 (2261)

Robert Devaty
Office: 211 Allen Hall
Phone: 412-624-9009
Office Hours : to be determined
E-Mail: devaty@pitt.edu

Grader: Ranjani Ramachandran
Office: M12 Thaw Hall
Phone: 412-624-
Office Hour : to be deterimined
E-mail: RAR188@pitt.edu

Lecture: Mondays, Wednesdays, and Fridays, 10:00 – 10:50 am, 106 Allen Hall.

You are expected to attend all lectures.

The Course: This graduate core course covers thermodynamics and statistical physics. The prerequisites are classical mechanics including the Hamiltonian formalism, an undergraduate course in thermal physics (thermodynamics and statistical mechanics), and a course in quantum mechanics. Contact me if you are uncertain about your preparation. The course will begin with a study of thermodynamics, followed by statistical mechanics.

Learning Goals: You will gain or refresh your knowledge of thermodynamics and statistical mechanics and gain practice applying the principles to solve problems. These subjects are foundational to many fields of research so that the understanding of basic material gained in this course should provide a strong background for specialized and advanced research.

Here is the list of topics suggested under "Graduate Core Course Standards" on the departmental website:

- Thermodynamics: Energy; Entropy; the Four Laws of Thermodynamics; Thermodynamic Potentials; Response Functions, Especially Heat Capacities; Maxwell Relations; Equilibria of Systems with Various Constraints; Heat Engines; Phase Transitions and the Clausius-Clapeyron Relation.
- The Microcanonical Ensemble: Phase Space & Liouville's Theorem: Maximization of Entropy and Equilibria in the Microcanonical Ensemble; Equipartition; the Ideal Gas & the Gibbs Correction.
- The Canonical Ensemble: Equilibria in the Canonical Ensemble; the Partition Function; the Ideal Gas; Paramagnetism; Two-state Systems.
- The Grand Canonical Ensemble: Equilibria in the Grand Canonical Ensemble; the Grand Partition Function; Chemical Potentials.
- Quantum Statistics: The Density Matrix; the Connection Between Spin and Statistics.
- Ideal Bose Systems: Blackbody Radiation; Sound Waves; the Debye Model; Bose-Einstein Condensation.
- Ideal Fermi Systems: Electrons in Metals; Diamagnetism; Degeneracy.
- If used, textbooks at the level of the following (designated by author) or similar are recommended: Pathria & Beale; Huang; Callen; Kardar.

Text: For the thermodynamics portion of the course, the recommended text is **Thermodynamics and an Introduction to Thermostatistics** (Second Edition) by Herbert B. Callen (especially the first seven or eight chapters). While Callen's approach is novel, I will likely follow a more

traditional approach. However, it's an excellent book and I will likely choose homework problems from it. For statistical mechanics, the chosen text is **Statistical Mechanics** by R. K. Pathria (Third Edition). We will cover the material in portions of the first eight chapters. While the Third Edition is specified, the Second Edition suffices, and the current edition is the Fourth. A strong point of this book is the large collection of end-of-chapter problems. When I specify problems in assignments, it will be according to the Third Edition. However, I will type the problems out, so you don't need to have the Third Edition.

Reserve Books: A set of books on thermodynamics and statistical physics (at both the graduate and undergraduate levels) have been placed on reserve in the Physics Library for your use. The list appears at the end of this syllabus

Homework: Problem sets will be assigned regularly, roughly weekly. The problems will mostly be chosen from the two texts. It is acceptable and encouraged to collaborate with your classmates in solving homework problems, but the solutions you write up must be your own, written in your own words and not simply copied. Copying solutions to homework problems from the web or any other source is prohibited. Any sources you use to assist in solving a homework problem (including AI) must be acknowledged. Proper citation of sources is an important component of ethics for a scientist. Much of the learning in this course takes place by tackling the problems. You might believe that you understand the lecture and/or textbook, but you don't really have command of the material until you can apply what you learned.

Grading: Your grade will be determined by the homework (150 points), a midterm exam (100 points) and a comprehensive final examination (about 150 points). The mid-term examination is scheduled for a Friday, October 17 (tentative), during the regular lecture period. The comprehensive final exam will take place on Thursday, December 11 (tentative). A grade of at least B+ is required in this course towards passing the Comprehensive Examination for the Ph.D. in Physics and Astronomy. At least a B is required for the M.S. in Physics and Astronomy.

Office Hours: I should generally be available immediately after lecture. I will conduct a poll to try to identify other good choices. You may also simply stop by my office, but it is best to make an appointment in advance by e-mail or phone. I will also try to schedule a weekly group help session.

Canvas Site: I will use the course Canvas site to post announcements, lecture notes, problem assignments, solution sets, etc. It can be found by logging onto https://canvas.pitt.edu/courses/338099 .

Academic Integrity

Students in this course will be expected to comply with the University of Pittsburgh's Policy on Academic Integrity. Any student suspected of violating this obligation for any reason during the semester will be required to participate in the procedural process, initiated at the instructor level, as outlined in the University Guidelines on Academic Integrity. This may include, but is not limited to, the confiscation of the examination of any individual suspected of violating University Policy. Furthermore, no student may bring any unauthorized materials to an exam, including dictionaries and programmable calculators.

To learn more about Academic Integrity, visit the Academic Integrity Guide for an overview of the topic. For hands- on practice, complete the Academic Integrity Modules.

Disability Resources

If you have a disability for which you are or may be requesting an accommodation, you are encouraged to contact both your instructor and Disability Resources and Services (DRS), 140 William Pitt Union, (412) 648-7890, drsrecep@pitt.edu, (412) 228-5347 for P3 ASL users, as early as possible in the term. DRS will verify your disability and determine reasonable accommodations for this course.

Email Communication

Each student is issued a University e-mail address (username@pitt.edu) upon admittance. This e-mail address may be used by the University for official communication with students. Students are expected to read e-mail sent to this account on a regular basis. Failure to read and react to University communications in a timely manner does not absolve the student from knowing and complying with the content of the communications. The University provides an e-mail forwarding service that allows students to read their e-mail via other service providers (e.g., Hotmail, AOL, Yahoo). Students that choose to forward their e-mail from their pitt.edu address to another address do so at their own risk. If e-mail is lost as a result of forwarding, it does not absolve the student from responding to official communications sent to their University e-mail address.

Your Well Being Matters

College/Graduate school can be an exciting and challenging time for students. Taking time to maintain your well-being and seek appropriate support can help you achieve your goals and lead a fulfilling life. It can be helpful to remember that we all benefit from assistance and guidance at times, and there are many resources available to support your well-being while you are at Pitt. You are encouraged to visit Thrive@Pitt to learn more about well-being and the many campus resources available to help you thrive.

If you or anyone you know experiences overwhelming academic stress, persistent difficult feelings and/or challenging life events, you are strongly encouraged to seek support. In addition to reaching out to friends and loved ones, consider connecting with a faculty member you trust for assistance connecting to helpful resources.

The University Counseling Center is also here for you. You can call 412-648-7930 at any time to connect with a clinician. If you or someone you know is feeling suicidal, please call the University Counseling Center at any time at 412-648-7930. You can also contact Resolve Crisis Network at 888-796-8226. If the situation is life threatening, call Pitt Police at 412-624-2121 or dial 911.

Library Reserve

Note: If you have suggestions for book to add to this list, let me know.

1. H. B. Callen, **Thermodynamics and an Introduction to Thermostatistics** (Second Edition)
2. K. Huang, **Statistical Mechanics** (Second Edition)
3. R. K. Pathria and P.D. Beale, **Statistical Mechanics** (Third Edition)
4. F. Reif, **Fundamentals of Statistical and Thermal Physics**

From Lilly Winning, Science and Engineering Library:

Here are some instructions on how your students can access course reserves:

1. Go to http://library.pitt.edu.
2. Click the *Course Reserves* link located in the center of the page under the search box.
3. In the PittCat Course Reserve search box, enter the name of the professor, the course name, or the course number, then hit Enter or click *Search*.
    a. Clicking the Course Reserves link automatically directs you to the Advanced Search, where you can specify search terms.
    b. On the right-hand side of the search box, you can also click *Simple Search* to see the single search box.
    c. Whether using Advanced or Simple Search, you can put in whatever information you'd like in order to search for reserves items.
4. Click on the title of the item that you wish to access.
    a. For physical items, write down the call number and take it to the Service Desk at the library location listed with the item.
    b. For online items, click the Access Online green link.
        1. Some ebooks open automatically, while others require additional steps to access, depending on the publisher.

Generally, physical books on reserve have a two-hour loan period, and can be used in or outside of the library. Personal copies on reserve, which are loaned to the library by professors, are in-library use only, except for a limited selection of items. Online books do not necessarily have "loan policies" as such, as they can usually be used by anyone at any time, but they do sometimes have limits to how many pages or chapters can be downloaded.

Physics 2541 (CRN 30935)
Thermodynamics and Statistical Mechanics
2261, Fall 2025
Robert Devaty

Lectures: Mondays, Wednesdays and Fridays, 10 am – 10:50 am 106 Allen Hall
Grader: Ranjani Ramachandran

Lecture and exam days are highlighted in yellow. Breaks are shaded light orange.

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
Aug. 24	25 First Class	26	27	28	29	30
31	1 Labor Day	2	3	4	5 Add/Drop Ends	6
Sept. 7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23 Rosh Hashanah	24	25	26	27
28	29	30	1	2 Yom Kippur	3	4
Oct. 5	6	7	8	9	10 Fall Break	11 PJAS Cryogenics
12	13	14	15	16	17 Exam 1 (tentative)	18
19	20 Diwali	21	22	23	24 Monitored Withdrawal	25
26	37	28	29	39	31	1
Nov. 2 Daylight Savings Time ends	3	4 Election Day	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23 Recess	24	25	26	27 Thanksgiving	28	29
30	1	2	3	4	5 Last Day	6
Dec. 7	8	9	10	11 Final Exam (tentative)	12	13 Last grad class
14	15 Hanukkah	16 Grades Due	17	18	19	20
21	22	23	24	25	26	27