PHY 3513 Thermal Physics (Class number 17389)
Fall 2023 syllabus

(Revision history. 8/20/23: In the Synopsis, Ch. 10 of Callen removed from the area covered. The number of HW assignments finalized to 12. 8/30/23: Additions and changes made to comply with the Gen Ed designation.)

PHY 3513 has two sections, under class numbers 17389 and 23968. This syllabus is for 17389, taught by Takano.

Instructor:	Yasu Takano, NPB 2356, phone 392-9326 (email: takano AT phys dot ufl dot edu)
Class meetings:	M W F period 7 (1:55 PM − 2:45 PM), New Physics Bldg., room 1002
Textbook:	Herbert B. Callen, *Thermodynamics and Introduction to Thermostatistics, 2nd edition* (Wiley, 1985), required. Do not be misled by ONE.UF, which lists this book only as "recommended." It is required. ONE.UF instead lists Blundell and Blundell as "required," but that book is neither required nor recommended.
Prerequisite:	PHY 2049 (Physics 2 with calculus) or an equivalent. Students who are concurrently taking such a course this semester are also allowed to take this course. Multivariable calculus, covered by MAC 2313 (Calculus 3), will be used extensively in this course, although MAC 2313 is not an official corequisite or prerequisite. This course, in turn, is a prerequisite for PHY 4523 (Statistical Physics).
Office hours:	M F period 8 (3:00 PM – 3:50 PM)

Synopsis

This course covers equilibrium thermodynamics, the study of relations among the state variables—such as temperature, pressure, magnetization—that specify the macroscopic internal state of a system as well as the study of interconversion of heat, internal energy, and work. It forms essential part of the foundation of many areas in science and engineering. Close to home, it is one of the prerequisites for PHY 4523, Statistical Physics, which provides a microscopic basis for equilibrium thermodynamics and methods for deriving—from a microscopic Hamiltonian or a model—what is called, after Gibbs, a fundamental equation of a given macroscopic system. (Once a fundamental equation is obtained, statistical physics ends and equilibrium thermodynamics takes over, allowing you to calculate relations among any state variables of a macroscopic system.)

Through September the 8th, lectures will be devoted to reviewing basic thermodynamics you have learned in high school and in General Chemistry 1. Those subjects are also covered in most standard introductory-physics textbooks. (If you have a copy of Halliday, Resnick, and Walker, used at the UF in PHY2048 and PHY2049, read a few chapters near the end of Part 2 of the book. If you have a copy of Halliday, Resnick, and Krane, used in PHY2060 and PHY2061 at the UF, read the last four chapters of Volume 1.)

Starting from September 11th, lectures will closely follow Chapters 1−9 and 11.

Course schedule

The most up-to-date schedule is here.

COVID-19 concerns

In response to COVID-19, the following recommendations are in place at the UF College of Liberal Arts and Sciences to maintain your learning environment, to enhance the safety of our in-classroom interactions, and to further the health and safety of ourselves, our neighbors, and our loved ones.

- If you are not vaccinated, get vaccinated. Vaccines are readily available and have been demonstrated to be safe and effective against the COVID-19 virus. Visit ONE.UF for screening/testing and vaccination opportunities.
- If you are sick, stay home. If you are ill and need immediate care, please call your primary care provider or the UF Student Health Care Center at 352-392-1161 to be evaluated.
- As with any excused absence, you will be given a reasonable amount of time to make up missed work.

In addition, if you are tested positive for COVID-19 or are self-quarantining at the time of an exam in this course, you will be allowed to take the exam via Zoom.

Your aims in this course

By completing this course, you will obtain firm grasp of the logical structure of equilibrium thermodynamics and how the very large number of formulae that appear in it are inter-related. Note that the emphasis on the logical structure and how formulae are embedded in it is unique to equilibrium thermodynamics, which has little resemblance to other physics courses. Consequently, derivations are especially important in this course. Your aims in this course are to become able to make all the derivations in the book and to solve all Examples, recommended problems, and homework problems. These abilities will greatly help you in areas where equilibrium thermodynamics are relevant. More on this under **How to Study** on the next page.

General Education course objectives

This course is designated as a General Education course in Physical Sciences (P), whose objectives are spelled out here and student learning outcomes here. By the end of this course, students will have a solid foundation in the important concepts, principles, terminology, and methodologies used in equilibrium thermodynamics, which is relevant in many areas of physics, chemistry, biology, astronomy, geology, meteorology, chemical engineering, materials science, mechanical engineering, and information science. Students will also be ready to take PHY 4523 (Statistical Physics) in which the concepts and principles learned in this course are extensively used. Specifically, students will be able to:

- **Analyze** particular thermodynamic systems such as a monatomic ideal gas or processes such a Carnot cycle for a heat pump, thus identify the fundamental principles pertinent to those systems or processes;
- **Apply** the understanding of the logical structure of equilibrium thermodynamics to particular thermodynamic systems or processes to formulate mathematical equations describing the relation between thermodynamic quantities of these particular systems or processes;
- **Solve** mathematical equations to derive an equation that govern measurable thermodynamic quantities for a particular system or process;
- **Communicate** unambiguously both the principles that apply to a particular system or process and the results of specific calculations resulting from the steps above, verbally and in written forms.

Role of lectures

As you must have learned by now, lectures in upper-level physics are not meant to spoon-feed recipes for solving problems, nor are the exams in those courses meant for you to apply such recipes. Lectures are intended to help you develop critical thinking and learn the habit of using math as a tool to develop conceptual understanding. Real learning is only achieved by doing problems yourself.

It is highly recommended that you read before each lecture the corresponding part of the textbook.

Read also **In-class recording by students** on page 5 of this syllabus.

Reviews

Reviews for Exam 1 and Exam 2 will be given a few days before each exam. The review for Exam 3 will be given roughly a week before the exam. All reviews will be given from 6:15 PM – 7:05 PM in a classroom TBA, and will be recorded in Zoom for your later view.

Read also **In-class recording by students** on page 5 of this syllabus.

Office hours

Office hours are via Zoom only, since it is not possible to maintain a social distance in my office room. In Zoom, waiting rooms will be used to ensure your privacy when needed. Office hours are not recorded.

Zoom

All lectures and reviews are recorded in Zoom and made available, usually within a day, for your later view via links in Canvas. For lectures, all parts that are recorded before a lecture starts at 1:55 PM and after it ends at 2:45 PM will be edited out before posting. The recordings of reviews will similarly be edited to protect your privacy. All recordings will be deleted immediately after the semester ends. Office hours are not recorded.

Students who participate orally in lectures or reviews are agreeing to have their voices recorded in Zoom.

How to Study

As you already know, physics cannot be studied without doing problems. The primary purpose of doing problems is to acquire conceptual understanding of the subject and to develop intuition on the behavior of physical systems.

To serve this purpose, problems must be solved in a right way, not in a wrong way. The right way comprises five components: (1) to expect the result before embarking on calculation, (2) to keep track of information content as you manipulate equations, (3) to examine the result for correct dimensions and symmetry, and to check whether it agrees with simple/obvious/known results for special cases (e.g. the limit in which one of the independent variables becomes infinite or zero), and (5) to compare the result with what you have expected and, if your expectation has turned out to be wrong, to correct the wrong intuition that has led to the wrong expectation. Of these, 1 and 5 are the keys to developing intuition.

What is the wrong way of doing problems? It is what I call “black-box shaking”—putting equations in a figurative black box and shaking it until a solution pops out.

When doing problems, it is critically important that you first make a genuine effort to solve them by yourself. Only when you get stuck, discuss with other students or seek help from the instructor.

You are expected to do all Examples in the book and all recommended problems, a list of which will be provided for each chapter, usually attached to the end of the homework-assignment sheet for that chapter. Homework problems are intended to supplement recommended problems, not to replace

them. They, as well as exams, will assume that you have done recommended problems. Without doing recommended problems, you will not do well in the exams.

Homework

There will be 12 homework assignments, each containing about five problems. Of those, one randomly chosen problem will be graded. All homework assignments will weigh the same.

Collaboration with other students are strongly encouraged, but the work you turn in must not be a copy of solutions by others. If the work shows a sign of copying a solution, be it from another student or internet, a zero will be given for the entire assignment. Homework must be written neatly, with words and sentences provided to make your solutions understandable and the final results clearly marked as such. Points will be deducted if your solutions are hard to read or hard to understand. Points will also be taken away if your homework shows a sign of "black-box shaking"—such as circular arguments and undirected manipulation of equations—or your result lacks required symmetry or is dimensionally incorrect. There will be no penalties for errors arising from typos that cannot be detected by symmetry and dimension checks.

Homework must be uploaded as a single pdf file to Canvas by 11:59 PM of the due date. No other way of submitting homework is allowed. To create a pdf file from handwritten sheets, some students use CamScanner, but there are also alternatives to this app, some of them free: https://seawallalife.com/camscanner-alternatives/. You may also use a real scanner or take a picture of each handwritten sheet. An instruction on how to combine multiple pdf files into a single file can be found in Canvas, under Files > ConvertingCellPhonePics2pdf.pdf.

No late work is accepted, and no make-up assignment will be given for a missed homework. Graded homework will be returned to students via Canvas usually within one week after the due date.

Exams

There will be three two-hour exams. Exam 3 will be during the exam week, on the date and time assigned by the Registrar. The dates for Exams 1 and 2 given in the Course schedule in Canvas are tentative and subject to change. For an exam missed for an excusable reason with a verifiable supporting document, a makeup exam will be provided, but only if the student contacts the instructor before the exam or—in case of unexpected emergency—within one week after the exam.

Each exam will have three problems, each with a few parts. They will be closed book, closed note. For Exams 2 and 3, a formula sheet will be provided in the exam and also posted beforehand in Canvas. Exam 1 will have no formula sheet. You will not be allowed to use your own formula sheets, nor a calculator (there will be no numerical questions). Exam 1 will cover the basics review and Chapters 1 and 2 of Callen, Exam 2 Chapters 3 through 5, and Exam 3 Chapters 6 through 8. Chapters 10 and 11 will not be covered by an exam.

You will do well in exams only if you do all Examples, recommended problems, and homework problems. Turning in homework by copying solutions without understanding why, not just how, will not lead to a good grade.

Grading

Grades will be based 81% on exams and 19% on homework. Each of the three exams is worth 27% of the grade. All homework assignments weigh the same, although the number of problems may somewhat vary from assignment to assignment. The two lowest homework scores will be dropped, but no exam score will be dropped.

The lower threshold of each letter grade will be as follows.

A 85%

A- 80%

B+ 75%
B 70%
B- 65%
C+ 60%
C 55%
C- 50%
D+ 45%
D 40%
D- 35%
E less than 35%

A minimum grade of C is required for general education credit.

Announcements

All announcements are made in Canvas, which will automatically send you an email. Three most recent announcements will appear also on the course homepage, and all announcements will be archived in Canvas, under Announcements.

How to contact the Instructor

To contact the instructor, always send an email to takano at phys dot ufl dot edu from your GatorLink account, with the word "PHY3513" included in the subject line. Do not contact him via Canvas in any manner. He will ignore all messages sent from Canvas because his very secure email client—he does not use Outlook—will not allow him to directly respond to messages and questions sent from Canvas. He will also ignore emails that are sent from non-GatorLink accounts. Gmail users beware.

Inclusion and diversity

Physics is practiced and advanced by a scientific community of individuals with diverse backgrounds and identities and is open and welcoming to everyone. The instructor recognizes the value in diversity, equity and inclusion in all aspects of this course. This includes—but is not limited to—differences in race, ethnicity, gender identity, gender expression, sexual orientation, age, socioeconomic status, religion and disability. Students may have opportunities to work together in this course. We expect respectful student collaborations such as attentive listening and responding to the contributions of all teammates.

Physics, like all human endeavors, is something that is learned. It is the aim of the instructor to foster an atmosphere of learning that is based on inclusion, transparency and respect for all participants. He acknowledges the different needs and perspectives we bring to our common learning space and strive to provide everyone with equal access. All students meeting the course prerequisites belong here and are well positioned for success.

In-class recording by students

Students are allowed to record video or audio of class lectures. However, the purposes for which these recordings may be used are strictly controlled. The only allowable purposes are (1) for personal educational use, (2) in connection with a complaint to the university, or (3) as evidence in, or in preparation for, a criminal or civil proceeding. All other purposes are prohibited. Specifically, students may not publish recorded lectures without the written consent of the instructor.

A "class lecture" is an educational presentation intended to inform or teach enrolled students about a particular subject, including any instructor-led discussions that form part of the presentation, and delivered by any instructor hired or appointed by the University, or by a guest instructor, as part of a University of Florida course. A class lecture does not include lab sessions, student presentations, clinical presentations such as patient history, academic exercises involving solely student participation,

assessments (quizzes, tests, exams), field trips, private conversations between students in the class or between a student and the faculty or lecturer during a class session.

Publication without permission of the instructor is prohibited. To "publish" means to share, transmit, circulate, distribute, or provide access to a recording, regardless of format or medium, to another person (or persons), including but not limited to another student within the same class section. Additionally, a recording, or transcript of a recording, is considered published if it is posted on or uploaded to, in whole or in part, any media platform, including but not limited to social media, book, magazine, newspaper, leaflet, or third party note/tutoring services. A student who publishes a recording without written consent may be subject to a civil cause of action instituted by a person injured by the publication and/or discipline under UF Regulation 4.040 Student Honor Code and Student Conduct Code.

Additional Information

Requirements for lecture attendance, exams, and assignments in this course are consistent with UF policies that can be found at: https://catalog.ufl.edu/ugrad/current/regulations/info/attendance.aspx.

The grading scheme for this course is consistent with the UF policy on grading: https://catalog.ufl.edu/UGRD/academic-regulations/grades-grading-policies/.

Students with disabilities requesting accommodations should first register with the Disability Resource Center (352-392-8565, https://disability.ufl.edu) by providing appropriate documentation. Once registered, students will receive an Accommodation Letter, from the Center, which must be forwarded to the instructor within the first two weeks of the semester.

Students are expected to provide feedback on the quality of instruction in this course by completing online evaluations at https://gatorevals.aa.ufl.edu/students/. Evaluations are typically open during the last two or three weeks of the semester, but students will be given specific times when they are open. Summary results of these assessments are available to students at https://gatorevals.aa.ufl.edu/public-results/.

UF students are bound by The Honor Pledge which states, "We, the members of the University of Florida community, pledge to hold ourselves and our peers to the highest standards of honor and integrity by abiding by the Honor Code." On all work submitted for credit by students at the University of Florida, the following pledge is either required or implied: "On my honor, I have neither given nor received unauthorized aid in doing this assignment." The Honor Code (https://sccr.dso.ufl.edu/process/student-conduct-code/) specifies a number of behaviors that are in violation of this code and the possible sanctions. You are obligated to report any condition that facilitates academic misconduct to appropriate personnel. If you have any questions or concerns, please consult with the instructor.

Campus Resources

Canvas technical support: http://helpdesk.ufl.edu/, 352-392-4357, helpdesk@ufl.edu.

U Matter, We Care: If you or someone you know is in distress, please contact umatter@ufl.edu, 352-294-2273, or visit https://umatter.ufl.edu to refer or report a concern and a team member will reach out to the student.

Counseling and Wellness Center: https://www.counseling.ufl.edu, 352-392-1575.

Student Health Care Center: https://shcc.ufl.edu, 352-392-1161 (a 24/7 number).

University Police Department: https://police.ufl.edu/, 911 (emergency), 352-392-1111 (non-emergency) .

UF Health Shands Emergency Room / Trauma Center: https://ufhealth.org/emergency-room-trauma-center. For immediate medical care call 911 or go to the emergency room at Shands, 1515 SW Archer Road, Gainesville, FL 32608. For non-emergency appointments, call 352-733-0111.

Student Complaints On-Campus: https://sccr.dso.ufl.edu/policies/student-honor-code-student-conduct-code.

Career Connections Center: https://career.ufl.edu. Reitz Union Suite 1300, 352-392-1601.