

Physics 4230: Detailed syllabus

Course information:

- **Instructor:** [Professor Leo Radzihovsky](#)
 - **Office:** Duane Physics F623 (Gamow Tower)
 - **Phone:** 303-492-5436
 - **Email:** radzihov@colorado.edu (best way to reach me)
 - **Office Hours:** Tuesday, Thursday 11am - Noon (or by appointment)
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- **Class meets:** Tuesday, Thursday 9:30 - 10:45 am, in Duane G131
 - **Home page:** <http://www.colorado.edu/physics/phys4230/>
 - **Graders:** Oscar Henriksson, oscar.henriksson@colorado.edu; Andrew Gisler, andrew.gisler@colorado.edu
 - **Text:** "[Thermal Physics](#)", Daniel V. Schroeder, Addison Wesley Longman
 - **Additional reading:** "Thermodynamics, Kinetic Theory, and Statistical Thermodynamics", Sears and Salinger
 - **Course description:** Introduction to Thermodynamics and Statistical Mechanics
 - **Prerequisites:** Quantum Mechanics 1 (Phys 3220), Calculus, Linear Algebra, Differential Equations (APPM 2360), interest and desire to learn
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- **First day of class:** Tuesday, August 27, 2013
 - **Homework (40%):** due weekly in class, unless otherwise specified
 - **Class participation:** attendance and participation resolves grade ties
 - **Midterm exam (30%):** in class, tentatively Thursday, October 17, 2013
 - **Final exam (30%):** tentatively Duane G131 at 1:30 - 4 PM, Monday, December 16, 2013
 - **Last day of class:** Thursday, December 12, 2013
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Course description:

This course will introduce students to one of the pillars of theoretical physics: *Thermodynamics and Statistical Physics*. This mature subject (dating back to mid 19th century) is essential to our understanding and description of properties all macroscopic system, from a cooling cup of coffee, air in the room, elasticity of a rubber band to heat engines, refrigerator, solar power conversion, electrons in metals, semiconductors, superconductors, magnets, black holes, ... just to name a few. Thermodynamics (and its "cousin" the statistical mechanics) is a body of knowledge that establishes a relation between macroscopic properties of the system such temperature, pressure, volume,... on one hand and work, energy, heat, and entropy, on the other.

Course outline:

- **Fundamentals**
 - microscopic vs macroscopic description of a bulk system
 - thermal, mechanical and compositional equilibria
 - zeroth law of thermodynamics: temperature
- **Energy, work and heat**
 - equipartition "theorem"
 - ideal gas equation of state
 - the first law of thermodynamics: conservation of energy
 - specific heat and latent heat

- adiabatic and isothermal processes
 - **Statistical mechanics: microcanonical**
 - counting micro- and macrostates
 - paramagnet
 - random walk
 - Einstein solid
 - ideal gas
 - entropy
 - the second law of thermodynamics: entropy increases
 - **Implications**
 - thermodynamic potentials: enthalpy, Helmholtz and Gibbs free energies
 - Maxwell relations
 - **Applications**
 - heat engines
 - refrigerators
 - reactions
 - phase transitions
 - **Statistical mechanics: canonical**
 - Boltzmann distribution and partition function
 - thermodynamics redux
 - equipartition "theorem"
 - applications:
 - ideal gas and Maxwell-Boltzmann distribution
 - classical and quantum harmonic oscillators
 - classical and quantum paramagnet
 - **Statistical mechanics: grand canonical**
 - grand partition function
 - thermodynamics redux: ideal gas
 - Bosons
 - Bose-Einstein distribution
 - black-body radiation
 - BEC thermodynamics
 - Fermions
 - Fermi-Dirac distribution
 - Fermi gas thermodynamics
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Guiding principles of the instruction and pedagogy:

- People understand concepts better by seeing them in action and thinking about them than by hearing them explained.
- Understanding physics (and solving problems that test that understanding) is a learned skill, like cooking, or playing hockey or the piano. It takes time, effort, and practice...lots of practice
- People learn best by thinking about topics and discussing them with others.
- Students learn most when they take the responsibility for what is learned.

In keeping with these principles, there will be a substantial number of homework problems each week. While you are encouraged to work with other students, you are required to write up the answers in your own words. So each student's wording should be unique to the student. Typically you will need to spend between four and six hours outside of class to master the material.

In addition to office hours, I encourage you to take advantage of the physics [Help Room](#) that is open 40 hours per week, and there are always students and TAs there, although they are not necessarily from Physics 4230.

Students begin this class with a range of backgrounds in physics and math. As a result, it is impossible for each class to be perfectly matched to everyone's background. I will work hard to provide whatever help is necessary for every student, regardless of their background, to do well in the course and achieve all of the learning goals. However, it is your responsibility to recognize that you need that help, and to take advantage of its availability. You are welcome to set up an appointment or just drop by my office.

Physics is a difficult subject, but succeeding in this course is not. Follow these suggestions and you will do well:

- stay on top of it; it is easier than playing catch-up
 - attend class regularly, participate and ask questions
 - read the text before class; it will improve your grade and will save you time in the long run, guaranteed
 - do homework early (not last minute), working in study groups is OK, but be “careful”; make sure you can do it on your own
 - think hard about concepts and practice solving many problems...no pain, no gain
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Official course details:

Homework details

- Weekly homework assignments will be posted on D2L
- Homeworks are due in class on the due-date of the assignment
- You are encouraged to work together on the homework problems, but you must write up the answers in your own words.
- Homework is a large part of your grade, so failing to turn in more than one assignment, and thereby getting a 0 will have a big impact on your grade. Talk to me, *now*, if you will have a scheduling problem during the term so that you will be unable to complete any of the assignments. Permission for exceptions from the normal class work schedule must be requested in advance.
- It is best if you print out the assignment early, so you see the problems before class.

Exams

- There is an in-class midterm exam and a final
- There are no early, late, or make-up exams
- Exams are closed book

Classroom conduct

To ensure a distraction free environment for all students, all laptop computers, MP3 players, cell phones, and similar devices are **not** to be used during lecture.

Students and faculty each have responsibility for maintaining an appropriate learning environment. Those who fail to adhere to such behavioral standards may be subject to discipline. Professional courtesy and sensitivity are especially important with respect to individuals and topics dealing with differences of race, culture, religion, politics, sexual orientation, gender, gender variance, and nationalities. Class rosters are provided to the instructor with the student's legal name. I will gladly honor your request to address you by an alternate name or gender pronoun. Please advise me of this preference early in the semester so that I may make appropriate changes to my records. See policies

at <http://www.colorado.edu/policies/classbehavior.html> and at http://www.colorado.edu/studentaffairs/judicialaffairs/code.html#student_code

Honor code

All students of the University of Colorado at Boulder are responsible for knowing and adhering to the academic integrity policy of this institution. Violations of this policy may include: cheating, plagiarism, aid of academic dishonesty, fabrication, lying, bribery, and threatening behavior. All incidents of academic misconduct shall be reported to the Honor Code Council (honor@colorado.edu; 303-735-2273). Students who are found to be in violation of the academic integrity policy will be subject to both academic sanctions from the faculty member and non-academic sanctions (including but not limited to university probation, suspension, or expulsion). Other information on the Honor Code can be found at <http://www.colorado.edu/policies/honor.html> and <http://www.colorado.edu/academics/honorcode/>

Bringing someone else's clicker to class to give them credit is a direct violation of the CU honor code - please do not do it, nor tolerate other people doing it. Please feel free to talk to me if anything is going on you are not comfortable with.

Disabilities

If you qualify for accommodations because of a disability, please submit to me ([Professor Radzihovsky](#)) a letter from Disability Services in a timely manner so that your needs be addressed. Disability Services determines accommodations based on documented disabilities. Contact: 303-492-8671, Willard 322, and <http://www.Colorado.EDU/disabilityservices>

If you have a temporary medical condition or injury, see guidelines at <http://www.colorado.edu/disabilityservices/go.cgi?select=temporary.html>

Discrimination and Harassment

The University of Colorado at Boulder policy on Discrimination and Harassment, the University of Colorado policy on Sexual Harassment and the University of Colorado policy on Amorous Relationships apply to all students, staff and faculty. Any student, staff or faculty member who believes s/he has been the subject of sexual harassment or discrimination or harassment based upon race, color, national origin, sex, age, disability, creed, religion, sexual orientation, or veteran status should contact the Office of Discrimination and Harassment (ODH) at 303-492-2127 or the Office of Judicial Affairs at 303-492-5550. Information about the ODH, the above referenced policies and the campus resources available to assist individuals regarding discrimination or harassment can be obtained at <http://www.colorado.edu/odh>

Religious observances

Campus policy regarding religious observances requires that faculty make every effort to deal reasonably and fairly with all students who, because of religious obligations, have conflicts with scheduled exams, assignments or required attendance. In this class, please speak to me ([Professor Radzihovsky](#)) regarding any accommodation you might need regarding religious observances.