Physics 731: Thermodynamics and Statistical Mechanics
Spring 2010

General Information

Course Time and Place: Tues. and Thurs. 9:30-10:50 am in Physics 106
Instructor: Prof. Jen Schwarz
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Office Hours: Tuesday 11am-12pm or by appt.

Prof. Jen's Top 7 Reasons to Take This Course

The following list was inspired by comedian David Letterman's 10 Ten List. Since I do not have a staff of writers backing me, I decided to stop at 7. Perhaps all of you can fill in the rest.
(7) Both topics are covered on the qualifying exam.....You want to pass it, don't you?
(6) To climb inside the brains of geniuses such as Joule, Maxwell, Boltzmann, Feynman, Einstein by reading their very own writings.....Remember, it takes one to know one.
(5) So you can tell your physicist friends what quantum thermodynamics is.....Yes, that's right, *quantum* thermodynamics.
(4) To learn about interesting *collective* effects of fundamental particles such as electrons. Sometimes "the whole is greater than the sum of its parts".
(3) To understand that "more is less" in terms of the thermodynamic limit.....Clever, huh?
(2) So that you will never be swindled by someone trying to sell you a perpetual motion machine, but to also recognize a good deal when you see one.....A whee-bit cryptic, but you'll soon understand what I mean.
(1) So you can answer the question, "How did Boltzmann kill himself....really?" and many other related (and not so related) questions.

On a more serious note, all of you have taken a statistical mechanics course before. We will revisit a lot of the same topics and analyze them at a slightly deeper level. I plan to spend about 6 lectures on thermodynamics, 2 lectures on probability theory, 3 lectures on kinetic theory, 5 lectures on classical statistical mechanics, 5 lectures on classical interacting systems,several lectures on the two-dimensional Ising model, 4 lectures on quantum statistical mechanics, and 4 lectures on identical particles such as ideal Bose and Fermi gases. These are all approximate numbers that will most likely change over the course of the course. My hope is that we will all become very interested in such systems as the ideal gas (classical and quantum) and the Ising model before the semester is over.

Readings

While there is technically no required textbook for the course, I will be drawing on the following textbooks as sources of inspiration when preparing lectures:
(1) E. Fermi, *Thermodynamics*
(2) R. K. Pathria, *Statistical Mechanics*, 2nd Edition
As for the latter textbook, some portion of the homework problems will be assigned from the book so you will want to have access to it.

There are other textbooks out there that I may also draw upon from time to time. Because there are too many books to name at this point (other than perhaps Feynman and Huang and Landau and Ma), please go to the libraries and browse the stacks. Books beginning with call numbers QC173, QC174, and QC311 should be relevant. The library (virtual or actual) will quickly become your friend, as any good student of science already knows.

In addition, we will supplement our investigations with original papers by the authors that created the field. While sometimes the material in an original paper is presented in an outdated manner, you may get a glimpse of the inner workings of the minds of some of physics best physicists.

Assessment of Your Work

(1) Homework (45 percent): There will be approximately 10 homework assignments. Each one will be handed out in class and due at some future lecture at the beginning of class. Some assignments will be a little more involved than others. I encourage you to talk to me about them and each other, especially if you are having problems getting started. *In the end, however, each person should write up his/her own solutions in the solitude of his/her own office and/or home.* If you have used any resources other than your brain, which has been nourished by the textbooks, to complete the assignment, please cite them. (I must also remind you that the Syracuse University Academic Integrity Policy holds students accountable for the integrity of the work they submit. For the complete policy, see http://academicintegrity.syr.edu.) Finally, after the solutions have been handed out, late homeworks will no longer be accepted.

(2) Class participation (5 percent): Not only are you encouraged to ask questions in class (and via e-mail), I may ask each of you for a consultation when preparing some of the final lectures in terms of pinpointing what is confusing to you, etc.

(3) In-class, mid-term examination (20 percent): While the exam will be closed book, you will be allowed to bring a page of handwritten notes that must be turned in with your exam. The mid-term duration will be one class lecture.

(4) Final Examination (30 percent): The protocol will be the same as the mid-term examination, only it will take up 2 hours.

Prerequisites

Aside from an undergraduate statistical mechanics course, I presume that everyone knows a bit of classical and quantum mechanics. However, if there are terms that I casually invoke and you

have not heard before and/or do not understand, please stop me and ask. This course should be as self-contained as possible.

Syllabus Statement Regarding Disability-Related Accommodations

Students who are in need of disability-related academic accommodations must register with the Office of Disability Services (ODS), 304 University Avenue, Room 309, 315-443-4498. Students with authorized disability-related accommodations should provide a current Accommodation Authorization Letter from ODS to the instructor and review those accommodations with the instructor. Accommodations, such as exam administration, are not provided retroactively; therefore, planning for accommodations as early as possible is necessary. For further information, see the ODS website, Office of Disability Services http://disabilityservices.syr.edu/.

Secret Course Objective

To have **fun** learning about a probabilistic means of deriving equilibrium properties of systems with large degrees of freedom, i.e. statistical mechanics. Of course, **fun** does not necessarily mean rolling on the floor with laughter during each lecture, **fun** means that the learning experience should be enjoyable and inspiring.