I. Course Information

Instructor: Francis Starr (fstarr@wesleyan.edu), Science Tower #227, x2044

Office Hours: Since the class is small, feel free to setup a time whenever you like. However, please note that my time on campus will be reduced due to a newborn child.

Lectures: MW, 1:10 – 2:30 PM

Discussion Section: We do not have a formally scheduled discussion section, but I am open to arranging a regular time. Discussion section should be driven by your questions!

The text is fairly comprehensive and relatively easy to read. That said, no book is all inclusive. Hence it may be valuable to occasionally examine one of the plethora of other statistical mechanics texts, such as:

1. R.K. Pathria, *Statistical Mechanics, Second Edition*. Second choice text for this class; similar material covered, but slightly less user friendly.

2. L.E. Reichl, *A Modern Course in Statistical Mechanics*
   This is a hefty book that covers a lot of advanced material, including renormalization group. However, it is not the most approachable book to read.

   From the classic Landau & Lifshitz series. Dense, but a good reference.

4. T. Hill, *An Introduction to Statistical Thermodynamics*
   Nice for those who want to neurose about statistical ensembles in great detail.

In addition to these, you may find it helpful to occasionally revisit undergraduate texts.

1. C. Kittel and H. Kroemer, *Thermal Physics*
   This is a brief, but approachable text. It can be helpful for a more basic explanation if you are having trouble with a particular topic.

2. F. Reif, *Statistical and Thermal Physics*
   More comprehensive than the previous text.

3. H. Callen, *Thermodynamics and and Introduction to Thermostatistics*
   This text focuses primarily on thermodynamics, not statistical mechanics. Personally, I find it difficult, but it is a standard, and many find it appealing.

Homework: Homework will be assigned weekly, generally due on Wednesdays. Discussion and some collaboration amongst students is acceptable, but the final product should represent your personal effort. The lowest homework score will be discarded, and the average of the remaining homeworks will constitute 30% of your grade.
Exams: There will be a midterm and a final exam. The midterm will take place on either October 19 or 28, and constitute 35% of your grade. The final exam will be comprehensive, but emphasize the second half of the course. The final will occur on either December 14 or 18, and account for the remaining 35% of your grade.

II. Tentative Syllabus and Outline

The title of this course is “Statistical Mechanics”, as opposed to the undergraduate “Thermal Physics” course. Accordingly, we will focus our energy primarily on statistical mechanics, but we will connect this back to thermodynamics. I assume prior knowledge from PHYS 316 (Thermal Physics).

I expect that we will cover Huang chapters 1, 2 and 6-8, 11, 12, 14, 16, and also visit selected topics from chapters 5, 10, and 17. We will not always go in order, and I will add some material not in the text. I may also include some basic computer simulation as part of homework.

If there are special topics you would like me to cover, I welcome your suggestions! Just remember our time is limited, and there is a fair amount of base material we must cover.

1. Preliminaries
   (a) Laws of Thermodynamics
   (b) Introduction to Probability
   (c) Central Limit Theorem

2. Fundamentals of Statistical Mechanics
   (a) Thermodynamic Equilibrium
   (b) Connection of Statistical Mechanics to Thermodynamics
   (c) Equipartition and Virial Theorems
   (d) Canonical and Grand Canonical Ensembles

3. Non-Interacting Classical and Quantum Systems
   (a) The ideal gas
   (b) Paramagnet and Einstein Solid
   (c) Fermi-Dirac Statistics
      i. Pauli Paramagnetism
      ii. White Dwarf Stars
   (d) Bose-Einstein Statistics
      i. Black Body Radiation
      ii. Bose-Einstein Condensation

4. Interacting Systems and Phase Transitions
   (a) Virial Expansion
   (b) van der Waals gas
   (c) Ising and Lattice Gas Models
   (d) Mean Field and Bethe Approximations
   (e) Critical Phenomena
   (f) Exact Numerical Methods (Monte Carlo)