Physics 504: Statistical Mechanics and Kinetic Theory

Nigel Goldenfeld

1. Course Information.

The course meets in Loomis Laboratory of Physics room 136 on Tuesday and Thursday at 2.30-3.50pm.

My office hour is at 1.30-2.30 on Tuesdays; I am sometimes a few minutes late if another meeting has run over, so please be understanding and wait. *I strongly encourage you to take advantage of this opportunity to talk about physics with me.* Feel free to come and talk with me at other times too, although it may be necessary to make an appointment if I am busy or have a meeting in progress.

Web site

The course has a web site that is used to post materials of extra-curricular interest. In addition, I will sometimes issue announcements concerning the course by email. To facilitate this, please click on the registration link on the web page so that I have your email address. **Please do this, even if you are only auditing the course. If you do not register on my web page, you will not receive these occasional but important announcements.**
Here is the link:

http://guava.physics.uiuc.edu/∼nigel/courses/504

Email is the best way to reach me. Please do not phone me at home under any circumstances.

2. Grader.

Questions about the grading of homework assignments should be directed to the Graders in the first instance, and then, if necessary to me.

Grader: Mr. Tomoki Ozawa
Office address: 390M LSI
Office phone: 244-1989
Email: tozawa2@uiuc.edu
Office hour: Wednesdays, 5.00pm

3. Pre-requisites.

Physics 504 is an advanced, but self-contained course; nevertheless, you are strongly encouraged to have first attended an undergraduate physics course in statistical physics and thermodynamics.

A reasonable textbook which covers all the elementary material is *Thermal Physics* by C. Kittel and H. Kroemer.

4. Texts.

A number of useful books may be found in the reserve book room in the library and in the stacks. These include:

- L.P. Kadanoff, *Statistical Physics: Statics, Dynamics and Renormalization.*
- N.D. Goldenfeld, *Lectures on Phase Transitions and the Renormalization Group.*
- D.J. Amit and Y. Verbin, *Statistical Physics.*
- M. Plischke and B. Bergerson, *Equilibrium Statistical Physics.*
- L.D. Landau and E.M. Lifshitz, *Statistical Mechanics (Part 1).*
- L.D. Landau and E.M. Lifshitz, *Physical Kinetics.*
- K. Huang, *Statistical Mechanics.*
- R. Kubo, M. Toda and N. Hashitsume, *Statistical Physics (Parts 1 and 2).*

There is no text book for this course. Instead, you can see my notes on the web. *The availability of my notes is not meant to substitute for your own notes.* Note-taking is a valuable and important skill to learn. Sometimes, I will make extemporaneous comments or discussions, or respond to questions; these are just as important to record as the actual notes that I write up on the blackboard. My notes are intended to be a back-up.

5. Homework.

Homework assignments will be distributed at regular intervals, typically about once a week to ten days. I strongly recommend that you develop a regular schedule for doing these assignments, and do not wait until the due date before attempting the problems. Some of the problems are quite tricky conceptually, although none involve lots of tedious algebra.

The homework assignments should be handed in to the 504 box, situated in the corridor connecting the Loomis Laboratory with the Materials Research Laboratory. Each assignment will have a due date, *with late work penalised.* If you know that you will have a conflict with the due date (*e.g.* you have 'beam time' at Argonne National Lab, or some other valid reason), please let me and the Grader know *in advance.*

The homework is an essential part of the course; you cannot learn physics from lectures unfortunately. Confucius has summarised the learning process well:

I hear and I forget
I see and I remember
I do and I understand.

I will not distribute solutions to the homework in class, because these have been abused in the past. The Grader will provide substantive comments on your work so that you may learn from your inevitable mistakes.

There will be no midterm, but there will be a final exam, which will be either in exam conditions or a take-home final.

Physics 504: Statistical Mechanics and Kinetic Theory

Nigel Goldenfeld

Course Outline

Week 1	**Scope and History of Statistical Mechanics**.
	Formal Theory: Basic assumptions;
Week 2	Coarse-graining; Equal A Priori Probabilities; Entropy;
Week 3/4	Counting states; Detailed balance;
Week 5	Thermal equilibrium; Boltzmann and Gibbs distributions;
Week 6	Fluctuations; classical statistical mechanics; quantum limit;
Week 7	**Ideal systems**; Classical and quantum gases, paramagnets;
Week 8	Quantum statistical mechanics; density matrix;
Week 9	**Interacting Systems:** Non-ideal gases; cluster expansion;
Week 10	Liquid state theory; Charged fluids;
Week 11	Phase transitions; Interacting spin systems;
Week 12	Disordered systems.
Week 13	**Near Equilibrium:** Brownian motion;
Week 14	Langevin equation; Fluctuation-Dissipation theorem;
Week 15	Kubo formula; Long time tails;
Week 16	Origin of irreversibility.

This course outline is tentative only.

Final: 1:30-4:30 PM, Friday, May 4 (Takehome final may be given).