Phys 112
Spring 2005
Syllabus
Goals

**Deeper understanding of concepts: less mysterious**

- Entropy
- Free energy
- Chemical potential
- Statistical mechanics
  - fluctuations
  - kinetic theory background \(<=\) use of simulations

**Acquire computational tools**

- Quantitative
- Problem solving skills
- Recognition of physics in a “context rich” situation, i.e. real life

**Linkages to**

- everyday life
  - bridge between microscopic and macroscopic
  - irreversibility
  - engineering

- modern physics
  - frontier
  - applications: e.g. astronomy, cosmology
  - condensed matter physics, low temperature

- History
Thermal Physics and Modern Physics

- Quantum Mechanics
- Statistical Mechanics
- Thermodynamics
- General Concepts
- N Body
- Critical Phenomena
- Kinetic Theory
- Reversible Irreversible
- Far for equilibrium
- Radiative Processes
- Applications
- Chaos
- Applications
Participation

Focus: Conceptual Understanding

Construction /reconstruction of your mental models
Both intensely personal and social component (learn through others)
≠ focus on grades, formulae, short cuts

Before lecture
Read book and notes
Play with applet simulations => intuition
You can suggest others you can find (or if you know Java, write your own!)

In class
Beginning of class: typically a conceptual question /applet
Discussion with the whole class or in small groups
Active participation during lecture: questions, answers to my questions
Non graded quizzes

Out of class
Homework
Working groups on problems if you like (but you write your own solution)
Discussion sections (but try homework first)
Office hours (come with questions)
Prerequisites

Some exposure to thermodynamics

Quantum Mechanics not essential
  - Notion of discrete state
  - Recipie on the number of states $1/h^3$

Maths: we will practice
  - Calculus: differentiation, Taylor series
  - partial derivatives
  - integration by part
  - First order differential equation
  - Complex numbers
  - Fourier transform not essential
Logistics

**Lectures + Kittel and Kromer**
MWF 8:00-9:00 71 Evans

**Lecture notes**
Skeleton slides + your own notes (you can download skeleton slides before clas)
Lecture notes
Web site: [http://cosmology.berkeley.edu/Classes/S2006/Phys112/](http://cosmology.berkeley.edu/Classes/S2006/Phys112/)
or on physics web page

**Office Hours**
Bernard SADOULET 787 Evans
Monday 2:30-3:30 + appointments
Wednesday 9:00 to 10:00
Friday 9:00 to 9:30
sadoulet@cosmology.berkeley.edu (please use Phys112 in title)
642 5719 - Cell in case of emergency: 703 3840

**Homework!!! Due Friday 5:00 pm (251 LeConte)**
Homework for following week posted in principle Friday night
+ Ungraded quizzes in class

**Discussion sections:**
Compulsory for undergraduates
Wed 10-11 am  72 Evans <------  
Wednesdays 3:00-4:00pm 508-14 Evans

**Graduate Student Instructor**
"Sourav K. Mandal"
Office hours: W 4-5 (281 LeConte) F 4-5 (251 LeConte)
<Sourav.Mandal@berkeley.edu>
Work Load & Grading

4 Units $\Rightarrow \approx 10$ hours - $4 \approx 6$ hours/week

1h30 reviewing notes and reading text books
2h30 homework
2h (in average, i.e. $\approx 7$h for each): preparing midterms and final paper

Note: you will be allowed notes at midterms and final (1, 2, 3 and 4 pages respectively)

3 Midterms during class

Grading

10% participation (good incentive to come to class in spite of the early hour + office hours and discussion sections)

in spite of personal reservation, will use attendance sheet

30% Homework
3x 10% each midterm
30% Final exam
Information Card

Name
Email
Telephone

Department, Major, Year
Courses currently taken
Involvement in research?

Physics courses taken
Astronomy courses taken
Maths courses taken

Goals

Hobby activities and interests (optional)
Texts on reserve

Physics-Astronomy Library, Hearst Field Annex:
F. Reif: "Fundamentals of Statistical and Thermal Physics"
Bowley & Sanchez: "Introductory Statistical Mechanics"
John R. Taylor, "An introduction to error analysis: the study of uncertainties in physical measurements"
Daniel V. Schroeder, "An Introduction to Thermal Physics"
## Outline

1 **States of a system**
   - Entropy

2 **Equilibrium between 2 isolated systems**
   - Temperature, pressure, chemical potential, thermodynamics

3 **System in contact with thermal bath**
   - Boltzmann factor, partition function, chemical potential

4 **First elements of kinetic theory**
   - Maxwell distribution, flux through aperture, mean free path, pressure

5 **Black Body Radiation**
   - The genius of Planck, Stephan-Boltzmann, Detailed balance

6 **Quantum gases**
   - Bose Einstein, Fermi-Dirac

7 **Classical thermodynamics**
   - Carnot cycle

8 **Chemical potential**
   - Optional

9 **More on kinetic theory**
   - Diffusion, transport

10 **Noise and Quantum Mechanics**

11 **Cosmology**

12 **Semiconductors**
State of a system

Entropy, $-\Sigma p_i \log_i$
Counting states, spins, $d^3x d^3p / h^3$

Equilibrium between 2 isolated systems

Temperature, pressure, chemical potential, thermodynamic identity

System in contact with thermal bath

Boltzmann/Gibbs factor, partition function, chemical potential

Black Body Radiation

Planck distribution from first principles, Stephan-Boltzmann,, Detailed balance

Quantum gases

Bose Einstein, Fermi-Dirac, metals, general understanding of other degenerate systems

Classical thermodynamics

Domain of applicability of thermodynamic identity
Heat Capacities ($\partial U / \partial T$)
Reversibility, expansion of gas in vacuum
Carnot cycle, engines, heat pumps

Kinetic theory:

Maxwell distribution, flux through aperture, mean free path, pressure
Some general understanding of diffusion, Brownian motion, transport, balance between diffusion and drift
Fluctuations, noise from Boltzmann/Gibbs distribution