Physics 353

Foundations of Physics II

Spring Quarter 2005: Thermal physics

MWF at 11:00 in Pacific 30.

This is the third quarter of a three quarter course. Fall quarter was devoted to oscillations and waves. During winter quarter the course covered more about oscillations and waves, then turned to thermal physics. In spring quarter, we will continue with thermal physics. The goal is to understand the Second Law of Thermodynamics and also to learn something about the practical applications of thermodynamics. We will also learn how to use computer tools that are useful for this and other topics. The webpage for Physics 351 is still available, as is the webpage for Physics 352.

The final exam (2nd midterm) key is posted here.

The exam score results (average=68) are posted here, and overall course scores are posted here.

(approximate grading breakdown: B >= 60, A >= 75)

Please check to see that our records are complete.

Good job, everyone! Have a great summer.

Q: What do you get when you cross an elephant and a giraffe? Stumped?
    Well, what do you get when you cross an elephant and a mountain climber? Still stumped?

Instructor:

- Jim Remington
Text:

- An Introduction to Thermal Physics, Daniel V. Schroeder.
- Also useful: Physics for Scientists and Engineers, Paul A. Tipler (4th Ed.).
- Copies of the above are on reserve in the Science Library.

Homework:

There will be problems assigned each week in class, due on Monday. Some of the problems will involve computer work. I recommend Mathematica, which is available at UO computer labs. If you already know some other computer language like C++, Basic, Fortran, Matlab, or Maple, you are welcome to use what you know.

Grader for problems:

- TA: Junwei Wei
- Email: jwei_at_uoregon.edu
- Office: 220 Willamette, phone 5-4792
- Office hour: 4-5 pm Mondays

Problem assignments:

- April 3: Interacting systems, Schroeder 2.1-2.5.
  - Do these problems. Due Monday, April 10.
- April 10: Statistics, counting states and entropy, Schroeder 2.5-2.6.
  - Do these problems (typo corrected from hand-out in class). Due Monday, April 17.
  - Lecture Handout on derivation of Poisson distribution for April 10 can be found here.
- April 17: Entropy, Temperature and Heat, Reading: Schroeder 2.6-3.3
  - Do problems 2.30, 2.38, 3.1, 3.8, 3.10, 3.11. Due Monday, April 24.
- April 24: Entropy, Temperature and Heat, Reading: Schroeder 3.4-3.5
  - Do problems 3.22, 3.25, 3.28 and 3.33, Due Monday, May 1
• May 1: Thermodynamic identities and Practical Entropy! Reading: Schroeder 3.5, 4.1-4.3
  ○ Do problems 4.1, 4.2, 4.3, 4.5, 4.10 (not to turn in)
  ○ Exam Monday, May 8. This will cover chapters 2-4.3
• May 8: Ideal Engines, heat pumps and refrigerators, Boltzmann factor
  ○ Reading: Schroeder 4.1-4.3, skip chapter 5, read 6.1
  ○ Do problems 4.12, 4.13, 6.5, 6.6. Due Monday, May 15
• May 15: Boltzmann Statistics
  ○ Reading: Schroeder Ch. 6 p220-232
  ○ Do problems 6.12, 6.14, 6.17, 6.18, 6.19 Due Monday, May 22
• May 22: More Boltzmann Statistics, Maxwell Velocity Distribution
  ○ Reading: Schroeder Ch. 6 p232-247
  ○ Do problems 6.23, 6.28, 6.29, 6.39, 6.41 Due Wednesday, May 31
• May 29: Monte Carlo Methods!
  ○ Reading: Schroeder Ch. 8 p339-354 Ising Model of Ferromagnetic Material
  ○ Do problems from Schroeder Chapter 8: 8.15, 8.17
  ○ Take home lab instructions are here. Lab and problems due Wednesday, June 7 at 11:00 am -- it will take some time to run the program!
  ○ Note: download ising.bas or ising.exe for IBM-PC type computers below
  ○ See Java simulations at Clark University’s site.
• June 5: Black-Body Radiation and Class Projects
  ○ Reading: Schroeder Ch. 7 p288-297

Answers

Homework 1 2 3 4 5 6 7 8 9
Midterm Exams !

Available notes in .pdf and .nb format:

• Fast Basic code to simulate particles in a box is posted here.
• Mathematica notebook to calculate Partition Function for rotational states: Rot_Z_heatcap.nb
• Lecture handout on force generation by a rubber band: band.pdf
• Lecture handout on derivation of Poisson distribution can be found here.
• For a nice overview of Queueing Theory and one use of the Poisson distribution, see this excellent site.
• Mathematica notebook with examples for statistical calculations, including simulated coin tosses.
• Mathematica notebooks to simulate coin tosses simple toss, toss2 (mean and sd), toss3 (plots overall distributions)
• Notebook to evaluate the "game" of Russian Roulette (direct summation version).
• Ising model Basic code and PC executable, or try the painfully slow Java version online.
• Alternative Basic program to implement the Thermometer Demon of Homework 7 (Online Lab 1): demon.bas
• Mathematica notebook to calculate partition function and heat capacity for CO2 rotational states.
• Mathematica notebook to plot partition functions and probabilities
• Thermal I Lecture notes from 2004 (26 March version).
• Basic program to simulate energy transfer between two Einstein solids

Exams:

• First Midterm Exam: Monday May 8. Review session Friday May 5.
• Second Midterm Exam: 10:15 Friday June 16 (Finals week).

Optional Paper and Presentation (replaces second midterm exam)

The paper should involve an original calculation or possibly an experiment that investigates or illustrates something in thermal or statistical physics. A computer calculation would be appropriate, but an analytical calculation is fine also. Later this term we will be doing some computer simulations of the Ising model for a magnetic solid, but problems on heat conduction are also interesting and instructive. If you want to do a calculation, try to find a 1-dimensional model situation that is relevant and of interest! The papers are to be done collaboratively by groups of between two and four students, with each author assuming equal responsibility for the content. I will assign a grade to each paper, which will count for each author of the paper. Thus this will be a team effort. Each group should choose a subject of interest to it.

A small group is often much more effective than a single person for getting something creative done, but it may take some practice to learn how to operate in a small group. If a group is having trouble operating effectively, I can attempt to offer advice. In the event that a group breaks up, I could accept papers from subgroups or individuals.

Groups should form themselves and propose a subject by April 28. Each group should turn in a draft paper by June 2. June 7 (if needed) and June 9 are reserved for in-class
presentations of the paper content by the submitting group. The final paper is due on Friday, June 9.

**Grading:**

The homework assignments will count for 30% of the course grade. There will be two midterm exams, which each count for 35% of the course grade. The second midterm exam will be held at the time of the final exam and may be replaced by the paper.