

# 454/554 Thermal and Statistical Physics

## Spring 2006

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### **The Course Outline:**

- Energy in thermal physics (3 Weeks. Text pp1-36.)
  - Thermodynamics vs. statistical mechanics. Temperature and the zeroth law.
  - Ideal gas law. Microscopic model of an ideal gas. Equipartition of energy.
  - Heat and work. Isothermal and adiabatic compression of ideal gas.
  - Heat capacity and latent heat.
  - Enthalpy of chemical reactions.
  - Examples and problems
- Second law of thermodynamics (3 Weeks. Text pp 49-84,384-391.)
  - Macro- and microstates, multiplicity factor. Two state system.
  - Multiplicity factor of Einstein solid.
  - Interacting systems. The fundamental assumption. Entropy.
  - Mathematical results. Gaussian functions and integrals.

- Large systems and numbers. The gamma function. Stirling's formula.
- Energy states of an ideal gas. Distinguishable and non-distinguishable particles.
- Multiplicity function and entropy of ideal gas.
- Entropy of mixing.
- Review problems.
- First midterm.
- Thermodynamic concepts (1 Week. Text pp85-97, 108-121.)
  - Temperature, entropy and heat.
  - Mechanical equilibrium and pressure.
  - Chemical potential and diffusive equilibrium.
- Engines and refrigerators (1 1/2 Weeks. Text pp.122-134.)
  - Limit to efficiency of heat engine. Carnot cycle.
  - Attempts to circumvent the second law of thermodynamics.
  - Refrigerators.
  - Otto and Diesel cycle
- Free energies and chemical thermodynamics (2 1/2 Weeks. Text pp149-186.)
  - Available work. Electrolytes, batteries and fuel cells.
  - Extensive and intensive quantities. Thermodynamic identities.
  - A simple polymer model.
  - Review problems.
  - Second midterm.
  - Phase transformations of pure substances. Clausius-Clapeyron relation.
  - Humidity in the atmosphere. Nucleation.
  - Van der Waals theory of fluids. Law of corresponding states.

- Examples and problems.
- Elementary statistical mechanics (2 Weeks. Text pp. 220-225, 229-231, 242-247, 288-295.)
  - Ensembles and averages. Boltzmann Factor and partition function.
  - Maxwell velocity distribution.
  - Fermions and bosons.
  - Black body radiation.
  - Review problems.

**Textbook: Thermal physics, Daniel Schroeder (Addison Wesley 2000)**  
**Optional: Introduction to Statistical Physics, Kerson Huang, CRC Press**