PHYSICS 170: COURSE CONTENTS

Following is an outline of topics we have covered in Physics 170. Most of the course closely follows *Thermal Physics*, by Kittel & Kroemer (K&K). For topics not adequately covered in K&K, I include references to *Statistical and Thermal Physics* by Reif, which is on reserve in Terman. Also noted are the relevant in-class exercises (Ex), together with a few references to sections (Sec) and problem sets (PSet) where key topics were introduced.

I. Probability and Statistics
   - A. Random walk: binomial statistics [Ex. 1A, K&K Ch. 1]
   - B. Large-N limit: Gaussian distribution [Ex. 1B, K&K Ch. 1]
     1. Stirling's approximation [Ex. 1B, K&K Ch. 1]
     2. Central limit theorem [PSet 1, *Reif* §1.10-1.11]
   - C. Poisson distribution [PSet 1]

II. Fundamentals of Statistical Mechanics
   - A. Microstates and microcanonical ensemble [Ex. 1B-2A, K&K Ch. 1]
     1. Multiplicity and missing information
     2. Fundamental assumption
     3. Entropy and the 2nd Law of Thermodynamics
   - B. Canonical ensemble
     1. Temperature and Boltzmann factor [Ex. 2B, K&K Ch. 2]
     2. Partition function [Ex. 3A, K&K Ch. 3]
     3. Entropy and Helmholtz free energy [Ex. 3B, K&K Ch. 3]
     4. Third Law of Thermodynamics [Ex. 3B, K&K Ch. 2]
     5. Classical statistical mechanics; equipartition theorem [Ex. 5A, *Reif §7.1-7.5*]

III. Fundamentals of Thermodynamics
   - A. First Law of Thermodynamics [Ex. 4A, K&K Ch. 3]
     1. Work and heat
     2. Inexact differentials
     3. Generalized force
     4. Quasi-static process; adiabaticity
   - B. Fundamental thermodynamic relation [Ex. 4A, K&K Ch. 3]
     1. Differential relations [Ex. 4A]
     2. Maxwell relations [PSet 4, Sec 4, Ex. 5B]

IV. Model systems & applications
   - A. Paramagnet [Ex. 2A-3B]
   - B. Harmonic oscillator [K&K Ch. 4]
     1. Einstein model of the solid [Sec 3, PSet 3]
     2. Planck law of radiation [Ex. 6A-B]
     3. Debye model of the solid [Ex. 7A]
   - C. Ideal gas [Ex. 4B-5A, K&K Ch. 3 and Ch. 6]
     1. Derivation of ideal gas law [Ex. 4B]
     2. Entropy; breakdown of classical approximation [Ex. 4B]
     3. Maxwell-Boltzmann distribution [Ex. 5A]

V. Statistical Mechanics of Identical Particles

A. Diffusive/chemical equilibrium [K&K Ch. 5]

1. Chemical potential [Ex. 7B]
2. Grand canonical ensemble [Ex. 7B]

B. Identical particles

1. Bose-Einstein, Fermi-Dirac, & Maxwell-Boltzmann statistics [K&K Ch. 6, Ex. 8A]
2. Density of states for massive particles in a box [K&K Ch. 7, Ex. 9A]
3. Degenerate Fermi gas [K&K Ch. 7, Ex. 9A]
4. Bose-Einstein condensation [K&K Ch. 7, Ex. 9B-10A]

VI. Heat and Work [Ex. 8B, Sec. 7]

A. Reversible/irreversible expansion of an ideal gas [K&K Ch. 6]

1. Free expansion and entropy of mixing [Ex. 5B]
2. Adiabats and isotherms [Ex. 8B]

B. Carnot cycle [K&K Ch. 8, Ex. 8B, Sec. 7]

1. Heat engines [Sec. 7]
2. Refrigerators [Sec. 7]