Physics 6311: Statistical Mechanics (Thomas Vojta)

Part I: Principles of equilibrium statistical mechanics

0. **Introduction**
   - 0.1 Physical description of large systems
   - 0.2 What is statistical physics?
   - 0.3 Why is it important?
   - 0.4 Historical remarks
   - 0.5 Plan of the course
1. **Minireview of thermodynamics** (Chandler chapters 1 and 2, Kardar chapter 1)
   - 1.1 Thermodynamic equilibrium
   - 1.2 State variables
   - 1.3 The laws of thermodynamics
   - 1.4 Thermodynamic potentials
   - 1.5 Stability of the equilibrium state
2. **Elementary probability theory** (Kardar chapter 2, Reichl chapter 4)
   - 2.1 Definition of probability
   - 2.2 Random variables
   - 2.3 Averages, moments, cumulants and correlation functions
   - 2.4 Examples of distributions
   - 2.5 Central limit theorem
3. **Principles of Statistical Mechanics** (Chandler chapter 3, Kardar chapter 4)
   - 3.1 The Statistical Method and Ensembles
   - 3.2 Microcanonical Ensemble
   - 3.3 Canonical Ensemble
   - 3.4 Generalized Ensembles

Part II: Selected applications

4. **Non-interacting systems** (Chandler chapter 4, Kardar chapters 4 and 7)
   - 4.1 Photon gas
   - 4.2 Ideal gases of real particles
   - 4.3 Electrons in metals
   - 4.4 Bose-Einstein condensation
5. **Phase transitions** (Chandler chapter 5, Pathria chapters 11 and 12)
   - 5.1 Ising model
   - 5.2 Mean-field theory
   - 5.3 Renormalization group