

# 20 230 Advanced Statistical Physics

20. Februar 2011

## Requirements for passing the course

- Homework (50% correct solutions)
- Exam

## Literature

1. Mehran Kardar, Statistical Physics of Particles, Cambridge 2007
2. L.D.Landau and E.M.Lifshitz, Statistical Physics

## Syllabus

I. Thermodynamics - 5-6 Lectures.

(1) 20.10.2010 - Introduction. Zeroth Law of Thermodynamics. Temperature.

(2) 22.10.2010 - First law of Thermodynamics. Second Law. Kelvin's vs. Clausius's formulations.

(3) 27.10.2010 - Carnot engine. Entropy.

(4) 29.10.2010 - Entropy continued. Thermodynamic potentials. Extensive and intensive variables.

(5) 03.11.2010 - Chemical potential. Clausius-Clapeyron equation. Maxwell relations.

(6) 05.11.2010 - Stability Conditions.

II. Probability - 2 Lectures.

(7) 10.11.2010 - Third law of Thermodynamics. Probabilities, general. One random variable.

(8) 12.11.2010 - Probabilities. Cumulants & moments. Gaussian distribution. Binomial distribution.

(9) 17.11.2010 - Poisson distribution. Many random variables. Central limit theorem.

III. Kinetic Theory/Liouville's Theorem - 1 Lecture.

- (10) 19.11.2010 - Liouville's theorem.
- IV. Classical Statistical Mechanics, Ensembles - 3 Lectures.
  - (11) 24.11.2010 - Microcanonical Ensemble. Two level systems.
  - (12) 26.11.2010 - The ideal gas. Gibbs paradox.
  - (13) 01.12.2010 - Canonical Ensemble.
  - (14) 03.12.2010 - Grand Canonical Ensemble.
- V. Quantum Statistical Mechanics - 3 Lectures.
  - (15) 08.12.2010 - Dilute polyatomic gases. Classical limit. Vibrations.
  - (16) 10.12.2010 - Rotations of diatomic molecules. Ionization Equilibrium (Landau).
  - (17) 15.12.2010 - Chemical reactions. Law of mass action (Landau).
  - (18) 17.12.2010 - Vibrations of solids. Discrete elastic line (Kittel, Quantum Theory of Solids).
  - (19) 05.01.2011 - Quantum Microstates.
- VI. Degenerate Quantum Gases - 5 Lectures.
  - (20) 07.01.2011 - Hilbert space of identical particles.
  - (21) 12.01.2011 - Density matrix of the Quantum gas. Canonical formulation.
  - (22) 14.01.2011 - Degenerate Quantum gases. Grand Canonical formulation.
  - (23) 19.01.2011 - Degenerate Quantum gases. Fermi gas.
  - (24) 21.01.2011 - Fermi gas continued. Sommerfeld expansion.
  - (25) 26.01.2011 - Debye Model. (Landau)
  - (26) 28.01.2011 - Bose gas. Bose-Einstein condensation.
  - (27) 02.02.2011 - Bose-Einstein condensation, continued. Heat Capacity.
  - (28) 04.02.2011 - Superfluid He<sup>4</sup>.
- VII. Phase Transitions - 3 Lectures.
  - (29) 09.02.2011 - Second order phase transitions. Mean field. Landau theory of phase transitions.
- VIII. Interacting Particles - 4 Lectures.
  - (30) 11.02.2011 - Virial expansion. Van der Waals gas.
  - (31) 16.02.2011 - First Exam.
- IX. Introduction to non-equilibrium Statistical Physics - 5 Lectures.
  - (32) 18.02.2011 - Brownian motion. Langevin equation. Fluctuation Dissipation Theorem.
  - (33) 23.02.2011 - Second Exam.

**Lectures 29, 30, 32 were not discussed in the tutorial. Knowing of these materials is not required for the exam.**

- Fluctuations - 2
- Kinetic Equation - 3