

# Syllabus for Statistical Physics I – PHYS 663

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*Semester:* Spring 2014 (Jan 13<sup>th</sup> – May 10<sup>th</sup>)

*Lectures:* Tue & Thu 12:30pm – 1:45pm

*Location:* Faraday West 227

*Office hours:* Tue & Thu, 14:00 – 15:00

## Contents

1. Introduction and background
  - 1.1. Role and tasks of Statistical Physics
  - 1.2. Short history of Statistical Physics
2. Boltzmann's approach to Statistical Physics
  - 2.1. Classical mechanics, Liouville theorem
  - 2.2. Micro- and macro-variables, thermal equilibrium
  - 2.3. Boltzmann entropy
  - 2.4. Quantum description
  - 2.5. Connection to thermodynamics, first and second law of thermodynamics
3. Gibbsian Ensemble
  - 3.1. Microscopic and macroscopic densities
  - 3.2. Gibbs ensemble
  - 3.3. Quantum description
4. Equilibrium Ensembles
  - 4.1. Microcanonical ensemble
  - 4.2. Canonical ensemble
  - 4.3. Grand canonical ensemble
  - 4.4. Nernst theorem and third law of thermodynamics
5. Ideal Gases
  - 5.1. Classical ideal gases
  - 5.2. Ideal quantum gases
  - 5.3. Equation of state
  - 5.4. Bose-Einstein condensation, superfluidity
  - 5.5. Photons
  - 5.6. Fermions at low temperatures
6. Thermodynamics
  - 6.1. Thermodynamic potentials and thermodynamic stability
  - 6.2. Response functions
  - 6.3. Phase equilibrium
  - 6.4. Van der Waals gas, Maxwell construction
7. Introduction to phase transitions
  - 7.1. Phase diagrams, phase transitions (1<sup>st</sup>/2<sup>nd</sup> order)
  - 7.2. Critical phenomena (second order phase transitions)
  - 7.3. Ginzburg-Landau theory

### ***Recommended textbooks***

- **Frederick Reif**, *Fundamentals of Statistical and Thermal Physics*, Waveland Pr Inc (2008)
- **R. Kubo**, *Statistical Mechanics*, North Holland (1990)
- **K. Huang**, *Statistical Mechanics*, John Wiley & Sons, New York (1987)

### ***Additional textbooks***

- **L. Landau & I. Lifshitz**, *Statistical Physics, Part 1: Volume 5*, Butterworth-Heinemann (1980)
- **Sommerfeld**, *Thermodynamics and Statistical Mechanics*, Academic press, New York (1956)

### ***Advanced textbooks***

- **P. Chaikin and T. Lubensky**, *Principles of Condensed Matter Physics*, Cambridge University Press (1995)
- **R. P. Feynman**, *Statistical Mechanics – A set of lectures*, Frontiers in Physics, Benjamin/Cummings, Reading Massachusetts (1982)
- **N. Goldenfeld**, *Lectures on Phase transitions and the Renormalization Group*, Frontiers in Physics, Addison Wesley, Reading Massachusetts (1994)
- **L. Landau & I. Lifshitz**, *Statistical Physics, Part 2: Volume 9*, Butterworth-Heinemann (1980)

### ***Grading***

The final grade is determined according to

- 45%: homework percentage
- 10%: lecture attendance percentage
- 20%: midterm exam percentage
- 25%: final exam percentage

This results in a total score between 0 and 1, which is then multiplied by 12, rounded to the closed integer, divided by 3, and finally graded according to\*

<http://www.niu.edu/regrec/grading/gradingfaqs.shtml>

*Note:* To pass this course, you **MUST** score at least 50% on the homework.

\* values below 2 are round to the closed integer.

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#### *Accessibility Statement*

Northern Illinois University is committed to providing an accessible educational environment in collaboration with the Disability Resource Center (DRC). Any student requiring an academic accommodation due to a disability should let his or her faculty member know as soon as possible. Students who need academic accommodations based on the impact of a disability will be encouraged to contact the DRC if they have not done so already. The DRC is located on the 4th floor of the Health Services Building, and can be reached at 815-753-1303 (V) or [drc@niu.edu](mailto:drc@niu.edu).