This course is designed to introduce the concepts of statistical physics – one of the most fundamental branches of physics, and to teach the students to solve at least simple problems in that field. Thermodynamics will be treated as a natural part of statistical physics. Major emphasis will be placed on equilibrium statistics, both classical and quantum.

MAJOR TOPICS TO BE INCLUDED:

1. Review of probabilities;
2. Thermodynamic potentials;
3. Statistical ensembles;
4. Classical and Quantum Ideal Gas;
5. Interacting particles and phase transitions;
6. Selected applications.

This is an “ideal world” plan. In reality, because of time constraints, some of the topics will be only mentioned, while others will be developed to some depth.

PRE-REQUISITES

The class is designed mainly for graduate students in physics. Although no sophisticated mathematics will be used, the sufficiently mature understanding of calculus, classical and quantum mechanics is expected. No programming virtuosity is required, but simple computations are expected. If you are in doubt about you meeting these requirements, you are advised to see the instructor.

BOOKS AND OTHER SOURCES

There is no book which can serve as a single text for the class. Most of the material is covered in M.Kardar, “Statistical Physics of Particles”, we will not follow it, but will cover most of it by jumping from place to place; this book also gives the right idea of the overall level of the class. There is second volume by M.Kardar, titled “Statistical Physics of Fields”, we will touch some topics from it.

Other useful sources include, but are not limited to, the following books:


Additional reading from current journals will be assigned during the semester.

CONSTANTS AND UNITS

In this class, \(k_B = 1\), Avogadro’s number \(N_A\) is not in use, i.e., concentration is defined as the number of molecules (not moles!) per unit volume, \(\epsilon_0 \to 1/4\pi\) (Gauss units are used for electric and magnetic phenomena, e.g., \(\nabla \cdot \mathbf{E} = 4\pi \rho\)), magnetic susceptibility of vacuum \(\mu_0\) is also not in use.

HOME WORKS

The VERY IMPORTANT part of the course will be problem solving in every week home works. The solutions of some (not all!) home works will be available on the course web site, they will be considered as a hand-out material and students will be expected to study them carefully, like a text.

In general, a significant amount of reading and thinking will be expected to succeed in class.

GRADING

Grading will be largely based on the home works. Every homework assignment will include about 5 or so problems. Every problem will be graded on the scale from 0 to 3 (0,1,2,3). That means, \(3n_j\) is the maximal grade for the home work \(j\) with \(n_j\) problems; if you receive \(\xi_{ij}\) for problem \(i\) in home work \(j\), where \(i = 1, 2, \ldots, n\), then percentage will be computed as \(x_j = \sum_{i=1}^{n} \xi_{ij}/3n_j\), and this will be done for every homework assignment. Homeworks will be due weekly. No late homeworks will be accepted. There will be one mid-term test and the final exam. The dates for both tests will be adjusted later. Mid term test will be given in regular class time. The 3-hours final exam will be scheduled for one of the days of the finals week. Tests and exams will be graded by the same scheme as homeworks. Final overall percentage, \(x\), will be chosen as the better of the three:
• average of all HW’s except the three weakest ones (65%), midterm (10%) and the final (another 25%).

• average of all HW’s (75%) except the weakest two, and the final exam (another 25%).

• average of all HWs (85%) and midterm (15%).

Final letter grade will be determined based on the percentage using the following formula: 

- A if \(x \geq 0.85\); 
- A− if \(0.85 > x \geq 0.8\); 
- B+ if \(0.8 > x \geq 0.75\); 
- B if \(0.75 > x \geq 0.7\); 
- B− if \(0.7 > x \geq 0.65\); 
- C+ if \(0.65 > x \geq 0.55\); 
- C if \(0.55 > x \geq 0.5\); 
- C− if \(0.5 > x \geq 0.45\); 

Anything below 0.45 is not a passing grade. There will be no “curve”.

Please note: the possibility to discount several homeworks is mostly for the cases like illnesses, emergencies, etc! If there is any religious observance overlapping with class activities please inform the instructor at least 3 weeks in advance.

ORGANIZATIONAL MATTERS

Office hours for the instructor: after the class or by appointment.

Class time: TR from 11:00 – 12:15, room 433. Recitation time: W 11:00-12:15, room 433.