
Statistical Mechanics of Particles and Fields 2026/2027

Course syllabus

Overview and prerequisites

Statistical mechanics is the branch of physics that describes many-body systems with methods from probability theory and statistics. In this course, we focus on interacting systems and out-of-equilibrium systems. It is strongly recommended to have followed an introductory course on statistical physics, such as *Statistical Physics A* or *Termodynamika i fizyka statystyczna R*.

Course organisation

Lecturer	Jeffrey Everts, room 5.32
Tutor	Laura Meissner-Oszer, room 5.63
Lectures	Every Wednesday, 12:15–15:00, room 2.06
Tutorials	Every Thursday, 14:15–17:00, room 2.03
Grading	To pass the course, students must (i) pass the final exam, and (ii) obtain at least half of the total available points, which determine the final grade. Here the course points are based on hand-in exercises (10%), the midterm exam (40%), and the final exam (50%). In the retake session, requirement (ii) may instead be based entirely on the final exam if this is more favourable to the student.

The course will start on 7 October 2026. On every lecture new problems will be handed out for the tutorial the day after. We ask you to have a look at this exercises before the tutorial. Furthermore, there will be a set of five hand-in exercises, which will be graded.

Uwaga! The only change to the above schedule is that instead of tutorials there will be lectures on Thursday 12 November 2026 (14:15–17:00, room 2.03) and tutorials on Friday 13 November 2026 (12:15–15:00, room 2.06).

Course material

Lecture notes (early draft), available at <https://users.fuw.edu.pl/~jeverts/teaching/>

An Introduction to Modern Statistical Mechanics, David Chandler

Statistical Physics of Fields, Mehran Kardar

Theory of Simple Liquids, Jean-Pierre Hansen and Ian McDonald

Non-Equilibrium Thermodynamics, Sybren de Groot and Peter Mazur

Tentative schedule

Week 1: Introduction, ensemble theory.

Week 2: Introduction to phase transitions and the Ising model within the mean-field approximation.

Week 3: Breakdown of mean-field theory and Landau theory.

Week 4: Statistical fields, Hubbard–Stratonovich transformation, continuous symmetries, and

Goldstone modes.

Week 5: Goldstone theorem, Gaussian corrections to mean-field theory, and the upper critical dimension.

Week 6: Correlation functions in arbitrary dimensions, Ginzburg criterion, spontaneous breaking of continuous symmetries, and the lower critical dimension.

Week 7: Berezinskii–Kosterlitz–Thouless transition and introduction to classical fluids.

Week 8: Virial coefficients and applications, density–density correlation function, and radial distribution function.

Week 9: Potential of mean force, routes to thermodynamics, static structure factor, Ornstein–Zernike relation, and Percus–Yevick approximation for hard spheres.

Week 10: Critical opalescence and construction of classical density functional theory.

Week 11: Approximations for the excess intrinsic Helmholtz functional, van der Waals theory of the gas–liquid interface, and effective interactions.

Week 12: Linear irreversible thermodynamics, phenomenological equations, entropy production, and Onsager reciprocity.

Week 13: Thermohydrodynamics, Curie principle, spinodal decomposition, and nucleation and growth.

Week 14: Time-correlation functions, linear response theory, Onsager regression hypothesis, and the fluctuation–dissipation theorem.

Week 15: Spectral analysis of fluctuations, Wiener–Khinchin theorem, spectral form of the fluctuation–dissipation theorem, properties of response functions, Kramers–Kronig relations, generalized Langevin equation, and Brownian motion.

Currently, the plan is to distribute hand-in exercises in week 3, 5, 7, 10, and 12.