STATISTICAL PHYSICS

By A. Pelizzola

Subject fundamentals

Mandatory course for the Master in Physics of Complex Systems (international track), 1st year, 2nd term. In this course the knowledge of statistical physics is deepened, with a particular attention to its methodologies and applications.

Expected learning outcomes

The student must acquire a deep knowledge of statistical physics, of its methodologies and its relationships with information theory.

Prerequisites / Assumed knowledge

Basic elements of statistical physics, in particular the canonical ensemble.

Contents

Canonical and grand-canonical ensembles, non-interacting systems.
The Ising model: introduction and exact solutions in one dimension and on the fully connected graph.
Mean-field approximation.
Beyond mean-field approximation: Bethe-Peierls and belief propagation.
The two-dimensional Ising model: Peierls argument, low- and high-temperature expansions, free energy in zero field on a square lattice.
The two-dimensional XY model at low temperatures.
An introduction to the real-space renormalization group.

Texts, readings, handouts and other learning resources

M. Plischke and B. Bergersen, *Equilibrium statistical physics*, World Scientific
R.K. Pathria and P.D. Beale, *Statistical mechanics*, Academic Press
L. Peliti, *Statistical mechanics in a nutshell*, Bollati Boringhieri
J.P. Sethna, *Entropy, order parameters and complexity*, Clarendon
Lecture notes and slides will be provided

Assessment and grading criteria

The exam is based on an oral test which typically involves questions on 2-3 topics, the first one being chosen by the student.