Statistical Physics

Academic Year: (2024 / 2025) **Review date: 04-09-2024**

Department assigned to the subject: Physics Department

Coordinating teacher: SANCHEZ FERNANDEZ, LUIS RAUL

Type: Electives ECTS Credits : 6.0

Year : 1 Semester : 2

REQUIREMENTS (SUBJECTS THAT ARE ASSUMED TO BE KNOWN)

Basic knowledge of general physics and mathematics (graduate level).

OBJECTIVES

The course will provide the student with an appropriate training in statistical physics especially suited for its application to plasma physics and nuclear fusion science.

Objectives:

1. Develop intuitive pictures of the micro- and the macroscopic world.
2. Distinguish between equilibrium and non-equilibrium states.
3. Understand the statistical origin of thermodynamic potentials.
4. Calculate the partition function of simple systems.
5. Apply mean-field theories to a variety of systems.
6. Understand criticality and universality.
7. Use transport equations.

DESCRIPTION OF CONTENTS: PROGRAMME

1. Foundations: the microscopic and macroscopic world, ergodic hypothesis, the micro-canonical ensemble.
2. Canonical ensemble: derivation, thermodynamic potentials, fluctuations, applications.
3. Bose-Einstein gas: Bose-Einstein condensation, examples.
4. Fermi gas: Fermi distribution and Fermi energy, examples.
5. Phase transitions and critical phenomena: the Ising model, Van der Waals theory of liquids, critical phenomena, universality.
6. Non-equilibrium Statistical Physics: Boltzmann equation, Brownian motion, Langevin and Fokker-Plank equations, linear response, fluctuation- dissipation relations.

LEARNING ACTIVITIES AND METHODOLOGY

* Teaching Methods

- Classroom lectures and classroom problem solving sessions.
- Homework assignments.
- Small research project.

* Course Material

- Lecture notes (in power point).
- Java experiments.

ASSESSMENT SYSTEM

% end-of-term-examination:	50
% of continuous assessment (assigments, laboratory, practicals…):	50

Evaluation Methods:

- Class participation: 10%
- Assignments: 20%
- Project: 20%
- Final exam: 50%

BASIC BIBLIOGRAPHY

- D. Chandler Introduction to Modern Statistical Mechanics , Oxford U. Press, 1987

ADDITIONAL BIBLIOGRAPHY

- Kerson Huang Statistical Mechanics, Wiley, 1987

- W. Greiner, L. Neise, H. Stocker Thermodynamics and Statistical Mechanics, Springer, 1995