Statistical Physics

Academic Year: (2022 / 2023) **Review date: 20-06-2022**

Department assigned to the subject: Department of Physics

Coordinating teacher: TRIBALDOS MACIA, VICTOR

Type: Compulsory ECTS Credits : 3.0

Year : 3 Semester : 1

REQUIREMENTS (SUBJECTS THAT ARE ASSUMED TO BE KNOWN)

Probability and Statistics,
Mechanics and Relativity,
Quantum Physics.

DESCRIPTION OF CONTENTS: PROGRAMME

1. Foundations of Statistical Physics.
   - Microscopic and macroscopic states.
   - Thermodynamic limit.
   - Phase space.
   - Liouville's theorem.
2. Microcanonical ensemble - Equilibrium of an isolated system.
   - Entropy and the second Principle of Thermodynamics.
   - Application to the ideal gas and the two state system.
   - First Principle of Thermodynamics.
3. Canonical and Grand canonical ensembles - Equilibrium of a system with an energy reservoir and an energy and particle reservoir.
   - Partition Function.
   - Density Matrix.
   - Fluctuations.
   - Maximizing Entropy.
   - Free Energy.
   - System of Harmonic Oscillators.
   - Application to Paramagnetism.
4. Classical Gases.
   - Ideal Gas.
   - Equipartition Theorem.
   - Virial Theorem.
   - Gibbs Paradox.
   - Maxwell Distribution. Maxwell-Boltzmann Statistics.
   - Diatomic Gas.
5. Quantum Gases I.
   - Density of States.
   - Relativistic Systems.
   - Photon Gas.
   - Phonon Gas.
6. Quantum Gases II.
   - Bosons and Fermions.
   - Bose-Einstein statistics.
   - Ideal Bose Gas.
   - Bose-Einstein condensates.
   - Fermi-Dirac statistics.
   - Ideal Fermi Gas.
   - Electron Gas.

LEARNING ACTIVITIES AND METHODOLOGY

AF1. THEORETICAL-PRACTICAL CLASSES. Weekly sessions of 100 minutes, divided in two 50 minutes parts with a break, where the theoretical concepts are explained. Students will have basic reference texts to facilitate the understanding of the classes. In the recitations the problems and activities proposed after the theoretical sessions are solved and discussed. There will be mid term tests for

evaluating the competences and skills acquired by the students and for helping them improving their learning strategies. This entails 22 hours in face-to-face sessions for 3 ECTS courses.
AF2. TUTORING SESSIONS. Every week there will be a one hour face-to-face tutoring session available for students in the subject webpage.
AF3. STUDENT INDIVIDUAL WORK OR GROUP WORK. Student's individualized work is fundamental for understanding results, proofs and exercises and develop problem solving skills. Discussing concepts and solving problems in small groups of students is an excellent complementary activity for improving teamwork competences and for self-assessment.
AF9. FINAL EXAM. Global assessment of knowledge, skills and capacities acquired throughout the course. It entails 4 hours 100% on-site.

MD1. THEORY CLASS. Classroom presentations by the teacher on the blackboard or with IT and audiovisual support in which the subject's main concepts are developed and where material and bibliography to complement student learning is provided.
MD2. PRACTICAL CLASS. Resolution of practical cases and problem, posed by the teacher, and carried out individually or in a group.
MD3. TUTORING SESSIONS. Individual or in-group tutorial sessions for the resolution of doubts by the teacher.
MD6. LABORATORY PRACTICAL SESSIONS. Applied/experimental learning in workshops and laboratories under the tutor's supervision.

ASSESSMENT SYSTEM

SE1. END-OF-TERM EXAM. Global assessment of the knowledge, skills and abilities acquired throughout the course. The percentage of the evaluation for this subject will be 60% of the final grade.
SE2. CONTINUOUS EVALUATION. Assesses papers, projects, class presentations, debates, exercises and laboratory reports throughout the course. The percentage of the evaluation for this subject will be 40% of the final grade.

Despite the final mark is obtained with the indicated percentages, to pass the course it is COMPULSORY to:

- Attend all laboratory sessions and deliver all laboratory reports.
- Obtain a grade equal or greater than 3 points out of 10 in the end-of-term exam.

% end-of-term-examination:	60
% of continuous assessment (assigments, laboratory, practicals…):	40

BASIC BIBLIOGRAPHY

- F. Mandl Statistical Physics, Wiley, 1988
- L.D. Landau and E.M. Lifshitz Statistical Physics Volume 5, Butterworth-Heinemann, 1980
- R.K. Pathria and P.D. Beale Statistical Mechanics, ELSEVIER, 2011

BASIC ELECTRONIC RESOURCES

- David Tong . Lectures on Statistical Physics: http://www.damtp.cam.ac.uk/user/tong/statphys.html