1. OVERVIEW

Subject area	Statistical Physics
Degree	Bachelor's Degree in Physics
School/Faculty	School of Architecture, Engineering and Design
Year	3rd
ECTS	6 ECTS
Type	Compulsory
Language(s)	Spanish
Delivery mode	On campus
Semester	First

2. INTRODUCTION

The subject area Statistical Physics belongs to the subject Thermodynamics and Statistical Physics. It is a compulsory 6 ECTS subject taught in each semester of the third year of the Bachelor's Degree in Physics. Statistical physics is the branch of physics that studies systems with a very large number of components. Its aim is to establish a link between the essential properties of a system's components and the macroscopic or collective properties of the system as a whole. The content of this subject area has been specifically designed for students, covering ensembles, their characteristics and differences, the canonical ensemble and grand canonical ensemble, ideal quantum systems and quantum statistics applied to ideal systems.

3. SKILLS AND LEARNING OUTCOMES

Key skills (CB, by the acronym in Spanish):

- CB1 - To understand key concepts, methods and findings in the different branches of physics while gaining a historical perspective of their development.
- CB3 - Students have the ability to gather and interpret relevant data (usually within their study area) to form opinions which include reflecting on relevant social, scientific or ethical matters.
- CB5 - Students have developed the learning skills necessary to undertake further study in a much more independent manner.

Transversal skills (CT, by the acronym in Spanish):

- CT4 - Written communication/Oral communication: Ability to communicate and gather information, ideas, opinions and viewpoints in order to understand and be able to act upon them, whether they are through spoken word and gestures, or through written word and/or visual aids.
- CT5 - Problem solving: Be able to critically evaluate information, separate complex situations into their constituent parts, recognise patterns, and consider alternatives, different approaches and perspectives in order to find optimal solutions and negotiate efficiently.

Specific skills (CE, by the acronym in Spanish):

- CE02 - To describe and analyse physical systems, identifying fundamental concepts and principles to make the approximations needed to build a simplified model.
- CE04 - To understand the laws and principles of physics, to identify their logical and mathematical structure, their experimental basis and the phenomena described through them.
- CE05 - To understand and know how to use the mathematical and numerical methods used in physics and in handling experimental data.

Learning outcomes (RA, by the acronym in Spanish):

- R1: To describe the fundamental postulates of statistical physics.
- R2: To analyse statistical ensembles and their connection to thermodynamic potentials.
- R3: To identify quantum statistical differences and their limitations.
- R4: To apply quantum statistics to physical systems to ascertain their properties.

The following table shows how the skills developed in the subject area match up with the intended learning outcomes:

Skills	Learning outcomes
CG1, CT4, CT5, CE02	R1: To describe the fundamental postulates of statistical physics.
CG1, CT4, CT5, CE04, CE05	R2: To analyse statistical ensembles and their connection to thermodynamic potentials.
CG1, CT4, CT5, CE04	R3: To identify quantum statistical differences and their limitations.
CG1, CT4, CT5, CE05	R4: To apply quantum statistics to physical systems to ascertain their properties.

4. CONTENTS

This subject is organised into the following learning units (UA, by the acronym in Spanish):

1. **Introduction to statistical physics:** Macroscopic and microscopic descriptions. First postulate. Ensembles and fluctuations. Liouville's equation.
2. **Microcanonical ensemble:** Second postulate. Phase volume, accessible microstates and their dependence on energy.
3. **Statistical physics and thermodynamics:** Heat, work, quasi-statistical processes and entropy.
4. **Canonical ensemble:** Partition function, averages and general equipartition theorem.
5. **Ideal systems:** Maxwell's velocity distribution and classical theory of paramagnetism.
6. **Real gases:** Configurational partition function and the Van der Waals equation.

7. **Grand canonical ensemble:** General partition function, macrocanonical probability distribution and its relationship with thermodynamics.
8. **Fundamentals of quantum statistical physics:** Identical particles and ensembles in quantum physics.
9. **Degenerate gas:** Degenerate Fermi gas and Fermi energy calculation. Degenerate Bose gas. Bose–Einstein condensate.

The distribution of this content is subject to change for logistical reasons. Students will be informed of any changes in due time and course.

5. TEACHING/LEARNING METHODS

The types of teaching/learning methods are as follows:

- **Lectures**: Presentations by the professor with the necessary technological tools to maximise comprehension of the learning content.
- **Collaborative learning:** Students learn to collaborate with other people (classmates and professors) in order to find creative, comprehensive and constructive solutions to questions and problems that arise from the given case studies, using all relevant knowledge and material resources available.
- **Problem-based learning:** Students are given problems and asked to solve them, working individually or in groups.
- **Guided academic activities:** Individual and group work that is more independent, including information searches, written summaries, debates and the public defence of projects.

6. LEARNING ACTIVITIES

The types of learning activities, plus the amount of time spent on each activity, are as follows:

On campus:

Learning activity	Number of hours
Lectures	23
Asynchronous lectures	12
Oral presentations of projects and debates	3
Report writing	13.5
Assessment	6
Practical activities (problems, written work, projects, workshops and/or lab work)	28
Group tutorials	10
Independent working	54.5
TOTAL	**150**

7. ASSESSMENT

The assessment systems, plus their weighting in the final grade for the subject area, are as follows:

On campus:

Assessment system	Weighting
Individual on-campus knowledge tests (theory and/or practice) (PPC, Spanish acronym)	50%
Oral defence (DO, Spanish acronym)	5%
Submission of group and/or individual reports, written work, projects or exercises (EJ, Spanish acronym)	30%
Performance observation (OD, Spanish acronym)	15%

On the Virtual Campus, when you open the subject area, you'll find details of your assessable tasks, including the submission dates and assessment procedures for each task.

8. BIBLIOGRAPHY

The reference material for the subject area is as follows:

• J.J. Brey Abalo et al, Mecánica Estadística, UNED, Madrid (2001).

The recommended bibliography is indicated below:

- R.K. Pathria, Statistical Mechanics (2nd edition), Butterworth-Heinemann, Oxford (1996).
- L.D. Landau y E.M. Lifshitz, Física Estadística, Reverté S.A., Madrid (1975).
- L.E Reichl, A Modern Course in Statistical Physics (4th edition), Wiley and Sons, New York (2016).
- J.J. Binney et al, The Theory of Critial Phenomena, Oxford University Press, Oxford (1999).
- C. Fernández Tejero y J.M. Parrondo, 100 problemas de Física Estadística, Alianza, Madrid (1996).
- R. Kubo, Statistical Mechanics: An Advanced Course with Problems and solutions (2nd edition), North-Holland (1999).