Bachelor in Physics
(Academic Year 2021-22)

Statistical Physics		**Code**	800514	**Year**	3rd	**Sem.**	1st
Module	General Core	**Topic**	Quantum physics and statistics	**Character**	Obligatory		

	Total	**Theory**	**Exercises**
ECTS Credits	6	3.5	2.5
Semester hours	54	29	25

Learning Objectives (according to the Degree's Verification Document)

By the end of this course, students will be able to:

- Understand the fundamental hypothesis of statistical mechanics.
- Apply the equilibrium probabilistic states (microcanonical, canonical, and grand canonical ensembles) to different physical situations and understand their connection with thermodynamic potentials.
- Use and understand the basic features of Bose-Einstein and Fermi-Dirac statistics.

Brief description of contents

Fundamental hypothesis: statistical models and thermodynamic properties of ideal systems; statistics of indistinguishable particles; introduction to interacting systems.

Prerequisites

Classical and quantum mechanics. Thermodynamics.

Coordinator	Ricardo Brito López		**Dept.**	EMFTEL
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Theory/Exercises – Schedule and Teaching Staff

Group	Lecture Room	Day	Time	Professor	Period/ Dates	Hours	T/E	Dept.
B	7	Mon Tue Wed	9:00-10:00 9:30-11:00 9:00-10:30	Juan M. Rodríguez Parrondo	Full semester	39	T	EMFTEL
				Chantal Valeriani		15	E	

T: Theory, E: Exercises

Office hours

Group	Professor	Schedule	E-mail	Location
B	Juan MR Parrondo	X: 16:00-18:00 M,J: 17:00-19:00	parrondo@ucm.es	216. 3ª Planta Módulo Central
	Chantal Valeriani	M: 13.30-14.30 J: 13.30-14.30	cvaleriani@ucm.es	D 119, 1ª pl este Y por Google meet

Syllabus

1.-Introduction

Overview and goals of the course. Mechanical and thermodynamical description of macroscopic systems.

2.-Foundations.

Fundamental hypothesis: classical and quantum systems. Ergodicity. Thermodynamic limit.

3.- Microcanonical ensemble.

Phase space and quantum states of a macroscopic system. Entropy and temperature. Applications: the classical ideal gas and paramagnetism.

4.- Canonical ensemble.

Boltzmann distribution. Partition function. Helmholtz potential. Equipartition theorem. Applications: classical ideal gas, photons, and phonons.

5.- Grand canonical ensemble.

Chemical potential. Grand canonical distribution. Landau potential. Average and dispersion of the number of particles. Equivalence among ensembles.

6.- Quantum ideal gases.

Quantum statistics: bosons and fermions. Occupation numbers. Classical limit. Virial expansion.

7.- Bose-Einstein ideal gas

Bose-Einstein condensation. Critical density and temperature. Thermodynamic properties of the Bose-Einstein gas.

8.- Fermi-Dirac ideal gas.

Fermi function and Fermi temperature. Electrons in metals.

Bibliography

• W. Greiner, L. Neise y H. Stöcker, Thermodynamics and Statistical Mechanics, Springer (1995).
• R. K. Pathria, Statistical Mechanics, Butterworth (2001).
• K. Huang, Statistical Mechanics, Wiley (1987).

Online Resources

Methodology

On-campus teaching 100% (Scenario 0)

The following learning activities will be used:

• Theoretical lectures where concepts and theoretical developments will be explained,

• Practical lectures and discussion sessions for resolution of exercises. Students will be given the list of exercises in advance.

Semi-online teaching (Scenario 1)

We will use option A in this scenario. The class is split into two subgroups: lectures will be attended in the classroom by one of the subgroups, whereas the other subgroup will follow the lectures online, via Microsoft Teams or Google Meet. The subgroups will alternate every week and the rest of learning activities will take place online.

Online teaching (Scenario 2)
Professors will provide learning material and video lectures, which will be available in the Campus Virtual. Lectures will be given online using Microsoft Teams or Google Meet in the regular schedule of the course and with student participation.

Evaluation Criteria		
Exams	**Weight:**	80%
A final exam consisting of practical exercises.		
Other Activities	**Weight:**	20%
Several activities, like exercises and deliverables, will be proposed to the students during the semester.		
Final Mark		
The final grade is the maximum of a) the mark of the final exam and b) a weighted average of the final exam (80%) and the rest of the activities (20%). However, to pass the course it is always necessary a mark higher than 4 (over 10). These evaluation criteria are valid both for the first (February) and the second (July) examination opportunities.		