COURSE DATA

Data Subject	
Code	34251
Name	Thermodynamics laboratory
Cycle	Grade
ECTS Credits	5.0
Academic year	2021 - 2022

Study (s)

Degree	Center	Acad. year	Period
1105 - Degree in Physics	Faculty of Physics	2	First term
1928 - D.D. in Physics-Mathematics	Double Degree Program Physics and Mathematics	2	Second term
1929 - D.D. in Physics-Chemistry	Double Degree Program Physics and Chemistry	2	First term

Subject-matter

Degree	Subject-matter	Character
1105 - Degree in Physics	10 - Experimental physics laboratory	Obligatory
1928 - D.D. in Physics-Mathematics	2 - Segundo Curso (Obligatorio)	Obligatory
1929 - D.D. in Physics-Chemistry	2 - Segundo Curso (Obligatorio)	Obligatory

Coordination

Name	Department
GARCIA MORALES, VLADIMIR	345 - Earth Physics and Thermodynamics
GILABERT NAVARRO, MARIA DESAMPARADOS	345 - Earth Physics and Thermodynamics
ONRUBIA FUERTES, JUAN ELECTO	345 - Earth Physics and Thermodynamics

SUMMARY

The Thermodynamics Laboratory (5 ECTS), is a core course of the second year of the: (i) Degree in Physics (first quarter of the year), (ii) Double Degree in Physics and Chemistry (first quarter of the year), and (iii) Double Degree in Physics and Mathematics (second quarter of the year). The subject is conceptually related to Thermodynamics, which is also a second year subject, and illustrates experimentally the thermodynamics phenomena described in this theoretical course. The Laboratory of Thermodynamics can only be attended either simultaneously or subsequently to the Thermodynamics

course.

PREVIOUS KNOWLEDGE

Relationship to other subjects of the same degree

There are no specified enrollment restrictions with other subjects of the curriculum.

Other requirements

Students should be familiar with the contents of the course Iniciación a la Física Experimental.

OUTCOMES

1105 - Degree in Physics

- Knowledge and understanding of the fundamentals of physics in theoretical and experimental aspects, and the mathematical background needed for its formulation.
- To know how to apply the knowledge acquired to professional activity, to know how to solve problems and develop and defend arguments, relying on this knowledge.
- Ability to collect and interpret relevant data in order to make judgements.
- Problem solving: be able to evaluate clearly the orders of magnitude in situations which are physically different, but show analogies, thus allowing the use of known solutions in new problems .
- Have become familiar with most important experimental methods and be able to perform experiments independently, estimate uncertainties, as well as to describe, analyse and critically evaluate experimental data according to the physical models involved. Know how to use basic instrumentation.
- Physics general culture: Be familiar with the most important areas of physics and with those approaches which span many areas in physics, or connections of physics with other sciences.
- Prob. solving and computer skills: be able to perform calculations independently, even when a small PC or a large computer is needed, including the development of software programmes.
- Basic & applied Research: acquire an understanding of the nature and ways of physics research and of how physics research is applicable to many fields other than physics, e.g. engineering; be able to design experimental and/or theoretical procedures for: (i) solving current problems in academic or industrial research; (ii) improving the existing results.
- Foreign Language skills: Have improved command of English (or other foreign languages of interest) through: use of the basic literature, written and oral communication (scientific and technical English), participation in courses, study abroad via exchange programmes, and recognition of credits at foreign universities or research centres.
- Literature Search: be able to search for and use physical and other technical literature, as well as any other sources of information relevant to research work and technical project development.

- Learning ability: be able to enter new fields through independent study, in physics and science and technology in general.
- Communication Skills (written and oral): Being able to communicate information, ideas, problems and solutions through argumentation and reasoning which are characteristic of the scientific activity, using basic concepts and tools of physics.
- Students must have acquired knowledge and understanding in a specific field of study, on the basis of general secondary education and at a level that includes mainly knowledge drawn from advanced textbooks, but also some cutting-edge knowledge in their field of study.
- Students must be able to apply their knowledge to their work or vocation in a professional manner and have acquired the competences required for the preparation and defence of arguments and for problem solving in their field of study.
- Students must have the ability to gather and interpret relevant data (usually in their field of study) to make judgements that take relevant social, scientific or ethical issues into consideration.
- Students must be able to communicate information, ideas, problems and solutions to both expert and lay audiences.
- Students must have developed the learning skills needed to undertake further study with a high degree of autonomy.

LEARNING OUTCOMES

• To be familiar with the processes, techniques and measurement tools of *Thermodynamics*.
• To apply the scientific method in the experimental work.
• To carry out measurements in the laboratory following an established protocol.
• To estimate the systematic and random errors and identify strategies to minimize them.
• To be familiar with least squares data fitting and estimate the model parameters from the same.
• To develop physical intuition, make estimations to identify the key system properties, and recognize spurious results (even if they are within the allowed error bars).
• To interpret properly the experimental results and draw conclusions from them.
• To complete scientific reports (paying attention not only to scientific language but also to the presentation of tables and figures).
• To apply computer techniques and software for the acquisition, processing and analysis of experimental data.

DESCRIPTION OF CONTENTS

1. Laboratory demonstrations

1. Gas thermometer
2. Calibration of a thermocouple
3. Expansion coefficient
4. Adiabatic coefficients of gases
5. Adiabatic processes in gases
6. Thermoelectricity: Peltier module

7. Heat flux in metal bars
8. Thermal radiation
9. Cryoscopy
10. Liquid-vapor equilibrium of water
11. Eutectic point
12. Liquid-vapor equilibrium in binary mixtures
13. Miscibility diagram of phenol + water
14. Solid-vapor equilibrium of ammonium carbamate
15. Thermodynamics of reversible batteries
16. Heat engines
17. Microscopic interpretation of S and T
18. Curie temperature of the Monel alloy
21. Critical point
22. Evaporation rate
23. Temperature sensors

WORKLOAD

ACTIVITY	Hours	% To be attended
Laboratory practices	50,00	100
Development of group work	15,00	0
Development of individual work	15,00	0
Study and independent work	15,00	0
Readings supplementary material	10,00	0
Preparation of evaluation activities	20,00	0
TOTAL	**125,00**	

TEACHING METHODOLOGY

Most lab sessions are practical. The lab experiments are selected by the professor and incorporated to the student weekly schedule. All experiments include a guide explaining the procedures. The student must read this guide before doing the experiment.

The lab sessions are conducted with 16 students (distributed in 8 pairs) per professor.

Each pair of students will have a lab book to be supervised by the professor. This book contains all pertinent information for each session: experimental schemes and material, data acquisition procedure, and results (including tables, graphs, estimation of errors, etc.). The student should collect on the notebook the relevant information and personal understanding of the lab demonstrations. The student should note that this book will be useful for studying the materials subject to subsequent evaluation.

Students are expected to fully complete the demonstration during the laboratory session. Upon request, students should deliver the notebook to the professor before leaving for continuous monitoring of the lab work. The notebook will be inspected and returned at the beginning of the next session.

At the request of the professor, students will write a report of some lab demonstrations to be evaluated. Also, the student may be asked to give an oral presentation on a public, interactive session with the other students. Both technical and communication skills can be assessed and evaluated.

The professor who is in charge of the group will explain to the students the particular characteristics required for the written reports and oral exhibitions, if any.

Finally, the professor may insert a preliminary theoretical lecture introducing the Thermodynamics lab. The contents of this lecture usually include the operation rules of this laboratory as well as brief reviews of basic concepts concerning the scientific language, data acquisition, and experimental errors.

EVALUATION

Attendance at the laboratory is mandatory. Five possible contributions to assess and evaluate:

• Lab Notebook

• Reports

• Written examination

• Practical examination

• Oral presentation.

All the above options may include individual and/or collective (small groups of two students) evaluations, as established by the professor.

The professor will inform about the relative weight of each contribution. The professor may establish a minimum score for any of the above contributions.

REFERENCES

Basic

- Guiones de Prácticas del Laboratorio de Termodinámica (disponibles en el aula virtual).
  - MANZANARES, J.A., GILABERT, M.A., MAFÉ, S., FERRER, C., MARTÍNEZ, D., BALLESTER, F., SAAVEDRA, G. GONZÁLEZ, P., CROS, A. (coord.) (2010). Guía de laboratorio para el primer ciclo del Grado en Física, Universitat de València.
  - THOMPSON, A.; TAYLOR, B. N., Guide for the Use of the International System of Units (SI), NIST Special Publication 811, 2008.

Additional

- LIDE, D.R. (2001). Handbook of Chemistry and Physics. 82nd ed. CRC Press, Inc. London.
  - RAZNJEVIC, K. (1995): Handbook of Thermodynamic Tables. Begell House, New York.
  - SÁNCHEZ DEL RIO, C (1989): Análisis de errores. Eudema, Madrid 1989.
  - TAYLOR, J R. (1997) An Introduction to Error Analysis. 2nd ed., University Science Books, Sausalito, California.

ADDENDUM COVID-19

This addendum will only be activated if the health situation requires so and with the prior agreement of the Governing Council

In case that health situation requires blended teaching, the teaching model approved by the Academic Degree Committee on July 23, 2020 will be adopted.
For lectures this model consist of 50% student attendance in the classroom, while the rest of students attend the class in streaming broadcast. Two groups will be set with alternate days attendance to the classroom in order to guarantee 50% of teaching hours attendance for all students.
The rest of the teaching activities (laboratories, computer rooms, tutorials) will have a 100% attendance.
If a total reduction in attendance is necessary, classes will be broadcast by synchronous videoconference at their regular schedule, along the period determined by the Health Authority.