# . - General Physics Laboratory

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***COURSE AIMS AND INTENDED LEARNING OUTCOMES***

– Develop students' experimental skills in laboratory work

– Implement and strengthen students' theoretical knowledge through comparison with experimental data.

– Furnish students with computer skills in data analysis.

– Accustom students to presenting the results of their experiences through reports or presentations.

– Teach students how to autonomously manage an experimental research work.

At the end of the course, students will be able to:

- prepare the setup of instruments following the instructions on an experimental sheet;

- collect measurements, including with appropriate dedicated software;

- analyse the data and present it graphically, including with the use of calculus software, graphic representation and word processing;

- evaluate the uncertainties of the measurements taken using the theory of errors;

- draw up a report of the laboratory experiment carried out, in which the salient physical concepts, experimental procedure, results obtained, and a comparison with the expected results are clearly presented;

- verbally motivate what is presented in the laboratory report.

***COURSE CONTENT***

First unit:

- Theory of errors.

- Preliminary description of error analysis.

- How to represent and use errors.

- Error propagation.

- Statistical analysis of random errors.

- Normal distribution.

- Rejection of data.

- Weighted means.

- Least-squares method.

- Covariance and correlation.

- Overview of binomial distribution.

- Overview of Poisson distribution.

- Overview of tests for probability distributions

Second unit:

- Basics of data analysis software.

- Workshop - five experiences from the following:

* Experience in conservation of momentum.
* Experience in centripetal force.
* Experiences in friction coefficient.
* Experiences in harmonic motion.
* Experiences in calorimetry.
* Experiences in moment of inertia and conservation of angular momentum.
* Experiences in torsion pendulum.
* Experiences in centripetal force
* Experiences in thermodynamic transformations.
* Experiences in combustion engine.
* Experiences with the sonometer

For each experience, the production of a report with data analysis is expected.

***READING LIST***

J. R. Taylor, *Introduzione all’analisi degli errori,* Zanichelli, second edition.

***TEACHING METHOD***

The course is divided into two units.

The first unit includes a series of lectures involving cooperative learning activities. Students are required to study theoretical notions on their own; students and lecturers will then discuss these collectively at lectures. Students are divided into small groups in which to address the problems encountered in the study, and discuss selected questions collectively. The roles for presenting and discussing the contents are rotated from time to time.

In the second unit, the groups (usually three people) undertake the proposed experiences and reprocess the resultant data, with a focus on error analysis. The lecturers' task is to address and confront emerging issues or achieved results, with particular attention being paid to the development of students' autonomous resolutive skills. Lecturers also guide groups in writing reports on their workshop experiences.

Regular attendance is compulsory; students may not sit the exam without having performed the group activities first.

***ASSESSMENT METHOD AND CRITERIA***

Assessment is based on the following elements:

* an oral exam in which workshop reports are presented and discussed, and for which knowledge of error theory is required;
* commitment shown and quality of work performed, both during group discussions on theory and during workshop sessions.

Below is an explanatory layout of the assessment parameters. This layout is used as the basis for discussion of the final score.

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| --- | --- | --- | --- | --- |
| **LEVEL**  **ATTAINED** | **POOR** | **BASIC** | **AVERAGE** | **EXCELLENT** |
| KNOWING HOW TO REPROPOSE THE PHASES OF THE EXPERIENCES | Understands the phases of the experiences only if helped by the lecturer but struggles to repropose them. | Understands and reproposes the phases of the experiences | Autonomously performs the experiences and effectively arguments observations made. | Knows how to present the experiences effectively and with a good grasp of language, inserting personal insights |
| LEARNING TO DRAW UP A SCIENTIFIC REPORT | Only knows how to draw up a scientific report with the constant help of the lecturer. | Able to draw up a scientific report on their own | Draws up and processes complex scientific reports | Processes complex and structured scientific reports, inserting personal observations |
| KNOWING HOW TO PLAY THEIR PART IN GROUP WORK | Does not play their part. Struggles to complete the job despite receiving constant help. | Plays their part. Completes work after receiving precise instructions. | Plays their part. Completes work assigned and spontaneously contributes to group work. Provides help to colleagues. | Plays their part effectively. Completes work assigned and contributes to group work with personal suggestions. Provides help to colleagues. |

The quality of the laboratory reports and the student's ability to verbally explain what is presented in the report will be assessed. Students will also be assessed on their ability to recognise the physical concepts underlying the experiments carried out, their ability to apply the concepts of the theory of errors (learned in the first unit of the course) to the data analyses contained in the reports, and their knowledge in formal terms of the theory of errors.

Contributing to the assessment is the quantity and quality of each student's interventions (both collegially and within the group) during the first unit of the course, and their collaboration in the group work during the second unit.

***NOTES AND PREREQUISITES***

Regular attendance is compulsory; students may not sit the exam without having performed the group activities first.

In order to meet the needs of any working students, the course also offers them opportunity to conduct their experiences outside of lecture hours and assistance with any catching-up.

The following is required:

* minimum basic level of computer management skill (students should know word processing programmes and spreadsheets at a basic level at least);
* knowledge of the mathematical concepts of derivation and integration;
* minimum basic knowledge of calorimetry and mechanics is desirable.

Further information can be found on the lecturer's webpage at http://docenti.unicatt.it/web/searchByName.do?language=ENG or on the Faculty notice board.