UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

COURSE SYLLABUS

Plasma Physics Laboratory

2526-3-E3001Q062

Aims

Knowledge and understanding: Upon completion of the course, students will have acquired theoretical knowledge of the physical principles underlying the generation of laboratory plasmas, understanding of some diagnostic techniques for plasma characterization and related physical phenomena, as well as knowledge of the characteristics of specific instrumentation for plasma measurements and their use in compliance with safety regulations.
Applying knowledge and understanding: Students will be able to use specialized instrumentation for plasma generation and diagnostic measurements, collect, manage and analyze experimental data related to plasmas using modern techniques, model plasma physical systems applying the scientific method, and prepare technical reports on the experimental work carried out.
Making judgements: Students will develop practical skills in collecting and interpreting experimental data on plasmas to formulate solutions with autonomy, as well as the ability to critically evaluate models and results most suitable for addressing specific problems in plasma physics.
Communication skills: Students will acquire the ability to present experimental results and plasma physics concepts in written and oral form.
Learning skills: Students will develop autonomy in deepening topics in plasma physics and the ability to consult specialized scientific literature for further educational developments.

Contents

The course consists of a series of experiments that will provide knowledge and skills on the generation of plasmas, both at low and atmospheric pressure, and the measurement of their properties, mainly through the use of electrical measurements and spectroscopic techniques. The experiments will be preceded by theoretical lectures aimed at providing the concepts necessary for a full understanding of the laboratory activity.

Detailed program

The subject of the course is the techniques for generating laboratory plasmas and the methodologies for measuring their properties.

With regard to the generation of plasmas, the following topics will be covered:

- generation of low-pressure DC plasmas using the hot cathode technique;
- study of low-pressure DC plasma breakdown mechanism;
- generation of plasmas at atmospheric pressure using the dielectric barrier discharge (DBD) technique;
- ionic wind production through a corona dicharge;
- radiofrequency plasma.

With regard to plasma diagnostics, the following topics will be investigated:

- deduction of plasma characteristics from the main discharge parameters (voltage, current, etc.);
- use of the Langmuir probe for measuring density, electronic temperature and plasma potential in low-pressure plasmas;
- UV and visible spectroscopy of cold plasmas.

In the last point in particular, students will have the opportunity to build a spectrometer, which will enable them to learn the basics of UV and visible optics and CCD sensor programming. The constructed spectrometer will then be used to characterise different plasma sources, and the measurements will be compared with a commercial spectrometer. In particular, it will be used for the characterization of molecules in dielectric barrier discharges. The knowledge acquired will then be used to characterise the plasmas of the penning guages operated at the CNR Institute for Plasma Science and Technology, and notions will be provided regarding their relevance to the study of plasma-wall interaction in plasmas of fusion interest.

The students will participate in the experimental activities in groups of three/four, according to the schedule that will be prepared at the beginning of the course.

The laboratory activities will be held in room 2025 on the second floor of Building U2 - Department of Physics. Activities on the penning gauges will be carried out at the CNR Institute of Plasma Science and Technology, via Roberto Cozzi 53.

The course activities will provide some basic training tools, common to many areas of laboratory plasma physics and technology, which will also be useful for future university activities and for the physicist's profession.

Prerequisites

Notions of electromagnetism and laboratory courses of the previous years.

Teaching form

- 8 introductory 2-hour lectures delivered in face-to-face delivery mode ("modalità erogativa");
- 80 hours of laboratory activities delivered in face-to-face interactive mode ("modalità interattiva").

The introductory lessons will be given in Italian.
The support to laboratory sessions will be in Italian, or in English on demand.

Textbook and teaching resource

The slides of the introductory lectures will be provided, as well as traces of the experiments. Handouts prepared by the lecturers will also be provided on some topics.

The following textbooks are recommended for further study of physics and technologies relating to laboratory plasmas:

- J. Reece Roth, Industrial Plasma Engineering, vol.1, IOP Publishing (1990).
- Yuri P. Raizer, Gas Discharge Physics, Springer-Verlag (1991).

For plasma spectroscopy:

- T. Fujimoto, Plasma Spectroscopy, Springer Berlin Heidelberg, Series on Atomic, Optical and Plasma Physics 44, 2008, pp 29-49, doi:10.1007/978-3-540-73587-8_3

Semester

Third year, second semester

Assessment method

There are no in-progress tests, only a final exam.
To be admitted to the examination, a group report must be drawn up on all the experiments carried out in the laboratory. The report must contain a brief description of the apparatus used, the results obtained and a brief discussion of them.
The examination, which will be held orally, will focus mainly on the discussion of the report itself, with possible recollections of the concepts presented during the introductory lectures.
During the examination the quality of the report, the care taken in performing the measurements and related data analysis, and the understanding of the physics concepts on which the experiments are based will be evaluated.
The final grade will consist of an evaluation mark for the reports, to which an adjustment determined by the outcome of the oral exam will be applied.
The exam will be held in Italian, or in English on request.

Office hours

Students are received by appointment, to be agreed by email (ruggero.barni@unimib.it, emilio.martines@unimib.it, marco.cavedon@unimib.it).

Sustainable Development Goals

QUALITY EDUCATION | INDUSTRY, INNOVATION AND INFRASTRUCTURE