UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

COURSE SYLLABUS

Laboratory of Plasma Physics I

2526-1-F1703Q020

Aims

Knowledge and understanding: Students will acquire advanced knowledge of experimental techniques and methods in plasma physics, including the use of power supplies, vacuum systems, and plasma diagnostic tools for parameter measurement.
Applying knowledge and understanding: Students will be able to apply experimental methodologies to plasma studies, perform spectral analysis of signals, and implement numerical simulation techniques for plasma modeling.
Making judgements: Students will develop critical skills in analyzing complex experimental data, evaluating measurement uncertainties, and interpreting plasma physics phenomena within broader physical contexts.
Communication skills: Students will be able to write comprehensive scientific reports and present experimental results effectively using proper scientific English and appropriate technical terminology.
Learning skills: Students will acquire collaborative research skills for addressing complex physical problems within working groups, applying rigorous scientific methodology and developing autonomous learning capabilities for advanced plasma physics topics.

Contents

The course consists of a series of experiments on laboratory plasmas and magnetized plasmas. The experiments will be preceded by introductory lectures on the physics and diagnostics of plasmas and related technologies.

Detailed program

The course is divided into two parts. Both involve some introductory lectures on plasma physics and diagnostics and related technologies, followed by a laboratory activity. The introductory lectures will cover a total of 12 hours, while the laboratory activity will occupy 108 hours.

The first part of the course covers enabling technologies, waves and instabilities in plasmas and numerical simulation methods. It includes experiments on the following topics:

- Set-up of a vacuum chamber; characterisation of the vacuum using mass spectroscopy and leak search.
- Measurement of oscillations at the plasma frequency and deduction of the plasma density .
- Numerical simulations with a Particle-In-Cell code.

The second part of the course deals with the study of a magnetised plasma on the Thorello toroidal machine, and includes the following topics:

- Characterisation of a magnetized plasma using Langmuir probes and optical spectroscopy
- Study of turbulence in a magnetized plasma using different techniques (electrostatic probe array, fast imaging) and advanced data analysis techniques.

Prerequisites

Notions required for the full understanding of the topics covered by the experimental activity will be provided during the introductory lectures. A basic competence in the use of the oscilloscope, and knowledge of the concept of the Fourier transform are desirable.

Teaching form

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

The detailed schedule of activities will be published on the e-learning page.

The laboratory activities will be held partly in room 2025 on the second floor of the U2 building - Department of Physics, and partly at the PlasmaPrometeo centre, located in the U9 building.

Textbook and teaching resource

The slides of the introductory lectures will be provided. Handouts prepared by the lecturers will also be provided on some topics.

The following texts are recommended for further study of the physics, technologies and diagnostic methods relating to laboratory plasmas:
F.F. Chen, *Introduction to Plasma Physics and Controlled Fusion,* 3?? Edition, Springer International Publishing, 2016.
Y.P. Raizer, *Gas Discharge Physics*, Springer-Verlag, 1991.
M.A. Lieberman and A.J. Lichtenberg, *Principles of Plasma Discharges and Materials Processing*, Wiley, 1994.
I.H. Hutchinson, *Principles of Plasma Diagnostics*, Cambridge University Press, 1990.

Semester

First year, first semester

Assessment method

There are no in-progress tests, only a final exam.
To be admitted to the examination, a report must be drawn up on all the experiments carried out in the laboratory. The report, written in English, 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 mentions of the concepts explained 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.

Office hours

Students are received by appointment.
The contact details of the lecturers are as follows:
prof. Emilio Martines, U2 building, third floor, room 3026, email: emilio.martines@unimib.it
prof. Ruggero Barni, U2 building, third floor, room 3029, email: ruggero.barni@unimib.it

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