UNIVERSITÀ
DEGLI STUDI DI MILANO-BICOCCA

COURSE SYLLABUS

Plasma Physics Laboratory

2425-1-F1701Q131

Aims

The main aim of the course is the acquisition of experimental techniques and methods related to plasma physics. This includes the use of power supplies, vacuum systems, and diagnostics useful for measuring plasma parameters. In addition, the course aims to provide knowledge and skills with regard to data analysis, with particular emphasis on signal spectral analysis, a topic of interest in other areas of physics.

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
- Study of low-frequency wave propagation in plasma
- 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").
  Introductory lectures will be delivered in Italian.
  Assistance during the laboratory experiments will be provided in Italian, or in English on request.

The detailed schedule of activities will be published on the e-learning page in October 2023.

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.
The exam will be held in Italian, or in English on request.

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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