3. SPECIALIZATION IN ENVIRONMENTAL AND APPLIED FLUID DYNAMICS

The objective of these lectures is to train attendees in handling and solving the wide variety of problems that may occur in environmental and industrial fluid dynamics. The main objective is to acquire a good insight into both fundamental and applied fluid dynamics. The teaching is closely related to the research activities carried out by staff members of the Department.

Each course member will make a selection with his supervisor among the courses below in function of his/her project.

3.1 General courses in Environmental and Applied Fluid Dynamics

Methodology of Applied Fluid Dynamics (MAFD – 5.0 ECTS)

At the end of this project oriented course the student should master the tools needed to analyze and solve fluid engineering problems in an effective and appropriate manner. By studying typical industrial problems, attendees will develop the skills needed to perform a good analysis and diagnosis on the types of engineering and research problems which he may be faced with during his or her professional career, and devise ways to solve them.

This is achieved by following steps:

- discussion of selected examples by which the student get acquainted with the fluid flow problems associated with engineering systems and industrial processes.
- presentation of a problem analysis in fluid dynamics illustrating the general procedure for the identification of the fluid dynamic aspects of industrial problems will be presented.
- the modeling of the problem by the numerical or experimental approaches
- establishing a typical research program.

Problems, assigned to each student, cover the principal subjects of the lectures and are discussed in classroom exercise sessions in order to train the student in the application of the methodology to practical situations.

Evaluation is made on the basis of a problem of methodology assigned to groups of students (2-3) supervised by a faculty member. A report and a research proposal are prepared by the group and a grade is given by the supervisor to these items. An oral presentation of the problem and research proposal is made by each group and is followed by questions from the faculty. An individual oral examination is then made with all the faculty members of the department who give a global grade. The final grade for MAFD is a weighted average of report (40%) and oral examination (60%) grades.

Industrial Design Exercise (IDE - 3.5 ECTS)

Starting from a typical situation, faced by an engineer, who has to solve a practical problem of fluid dynamics in the context of a more complex engineering system, the student has to come up with a complete solution, including a work plan, the tools (numerical or experimental), data reduction rocedure and discussion. The subject of the exercise is selected in relation to the options in which the attendees are already

involved. Staff supervision will be directed toward a broadening of knowledge and experience in applied fluid dynamics and the development of the ability to deal with problems of practical engineering interest.
Each student is assigned an individual problem and is supervised by one of the faculty members of the department. For the evaluation, he prepares a report that is submitted to the supervisor. The students make an oral presentation to the faculty members and other students in which they present the problem and describe their solution. The presentation is followed by questions from the audience and each faculty member is asked to assign a grade to each student based on the presentation and answers to questions. The final grade is the average of report grade and overall presentation grade.

Introduction to the Mechanics of Turbulence modeling (TURB - 2.50 ECTS)
The detailed description is given in the section **Optional Courses for all departments**.

Data Acquisition and Processing (DAP – 2.0 ECTS)
The detailed description is given in the section **Optional Courses for all departments**.

Numerical Simulation of Industrial Problems 1 (NSIP1 - 2.75 ECTS)

The purpose of the course is to familiarize the students with the solution of flow problems by applying a commercial flow solver, and to lead him/her to acquire the critical sense and physical feeling necessary to evaluate the numerical results. The student should master the best practice rules for CFD predictions

The course is composed of seminars in which the capabilities and the limitations of numerical simulation in industrial or environmental problems are discussed. Students must be able:
- to understand the different CFD models and approximations, which are a necessary part of this class of simulation,
- to make a critical evaluation of the numerical results, their uncertainty and to define the logical approach to improve them.

A large part of this course consists of practical exercises will have to be made whereby the numerical results are to be compared with own experimental results obtained during the MT labs.
The evaluation is based don the report discussing the numerical results and comparing them with the experimental results obtained during the MT labs.

Members of the Environmental and Applied Fluid Dynamics Department will specialize in one of the following two sub-groups :

- **Experimental modeling option**
- **Numerical simulation and modeling option**

Numerical simulation and modeling option

Numerical Simulation of Industrial Problems 2 (NSIP2 - 3.5 ECTS)
At the end of this project oriented course the students should be familiar with the simulation of complex flow problems using a general commercial flow solver, and have acquired the critical sense and physical feeling necessary to evaluate the numerical results. This is achieved by practical but complex exercises, in which the numerical results have to be compared with experimental ones, LES or DNS data

from the literature. The main objective is the understanding of the models and the approximations, which are a necessary part of this class of simulation.
Evaluation is based on a report that is prepared by each group of students (2-3, same as MTLabs) who are assigned a practical computational problem. In this report, numerical results are to be compared against the own experimental results of the students obtained during the MT labs. Emphasize is put a critical analysis of the numerical results, their uncertainty and a discussion of the logical approach to improve them.

Advanced Measurement Techniques Laboratories (MT Labs 1.5 – 6.0 ECTS)
Detailed description is given in the section **Optional Courses for all departments.** Students following the numerical option have to choose minimum one of the four sections. The objective is to help them in the physical understanding of fluid mechanics.

Experimental modeling option

Advanced Measurement Techniques Laboratories (MT Labs – 6.0 ECTS)
The detailed description is given in the section **Optional Courses for all departments**.