Course guide
205245 - ELF - Experimental Labs in Fluids

Last modified: 19/04/2023

Unit in charge: Terrassa School of Industrial, Aerospace and Audiovisual Engineering
Teaching unit: 729 - MF - Department of Fluid Mechanics.

Degree: BACHELOR'S DEGREE IN AEROSPACE TECHNOLOGY ENGINEERING (Syllabus 2010). (Optional subject).
BACHELOR'S DEGREE IN AEROSPACE VEHICLE ENGINEERING (Syllabus 2010). (Optional subject).
BACHELOR'S DEGREE IN INDUSTRIAL TECHNOLOGY ENGINEERING (Syllabus 2010). (Optional subject).

Academic year: 2023 **ECTS Credits:** 3.0 **Languages:** English

LECTURER

Coordinating lecturer: Raush Alviach, Gustavo Adolfo

Others: Quintana Vallmitjana, Marc

TEACHING METHODOLOGY

The teaching methodology is divided into three parts:
- In the exposition sessions, the faculty will introduce the theoretical bases of the syllabus, basic concepts of the methods and results examples to illustrate the interpretations of the same. The presentation will make interactive use of tools such as the use of Matlab and Python-based programs. Mostly, the general concepts and calculation procedure will be presented in the Jupyter-notebook Python environment. Nevertheless, students are allowed to be open-minded and proactive to use any other tools that will be considered helpful in the course to get the final results.
- In the laboratory work sessions, the faculty will guide the students in applying the theoretical concepts for the resolution of experimental setups, basing at all times the critical reasoning. Activities will be proposed to the students to solve in the classroom and out of the classroom to favor the contact and use of the basic tools necessary for the realization of an instrumentation system.
- Autonomously, the students have to work on the material provided by the teachers and the result of the laboratory work sessions to assimilate and fix the concepts. The faculty will provide a study plan and follow-up activities (ATENEA).

LEARNING OBJECTIVES OF THE SUBJECT

1. To have obtained the knowledge, understanding, application capacity, and analysis of the measurement processes applied in fluid mechanics.
2. To have the knowledge and understanding of the analysis of random series applied to the measurement of turbulent flow.
3. Knowledge, understanding, application and analysis of experimental techniques to measure pressure, temperature and velocity in open and closed flows.
4. To have the ability to choose, among different experimental tools, the most appropriate ones to obtain relevant information on a Fluid Mechanics problem.
5. Identify the limitations of the chosen techniques, the errors made and reported the results obtained, in a critical and self-sufficient way.

STUDY LOAD

Type	Hours	Percentage
Self study	45,0	60.00
Hours large group	30,0	40.00

Total learning time: 75 h

CONTENTS

Module 1: Pressures and Errors and Uncertainties

Description:
Errors Theory and uncertainty in measurement in fluid mechanics. Navier-Stokes equations: dimensionless parameters.
Pressure measurements in open flows. Column, multicolumn and transducer pressure gauges.
Static pressure measurements in models. Orifice dimensions and their configurations. Piezometric rings.

Related activities:
Individual deliverable work assigned to the content of the module.
Ad-hoc laboratory session. Preparation of laboratory activity report.
Examples of Activities in laboratory: Pressure measurements on dynamic probes. Density measurements of manometric fluids

Full-or-part-time: 12h 30m
Theory classes: 5h
Self study : 7h 30m

Module 2: Velocity and Flow rate

Description:
Dynamic probes, Pitot tubes
Hot-wire anemometry: Principles and applications
Other thermal velocity probes: thermistors and vane probes.
Flow rate measurements. Principle of orifices and contractions
Flow measurements of free discharges and fan's flows

Related activities:
Individual deliverable work assigned to the content of the module.
Ad-hoc laboratory session. Preparation of laboratory activity report.
Examples of Activities in laboratory: Speed measurements with dynamic, thermal and turbine probes. Developing of calibration curves and their error analysis. Measurement of the flow rate of a rotodynamic pump and obtaining the characteristic curve. Flow measurements on the weir.

Full-or-part-time: 12h 30m
Theory classes: 5h
Self study : 7h 30m

Module 3: Boundary Layer

Description:
Boundary Layer Concepts. Measurement techniques. Boundary layer smooth and rough plate. Transition zone. Types of dynamic probes.

Related activities:
Individual deliverable work assigned to the content of the module.
Ad-hoc laboratory session. Preparation of laboratory activity report.
Examples of Activities in laboratory: Measurement of the boundary layer profile. Analysis of conventional dynamic probes and Stanton probe

Full-or-part-time: 12h 30m
Theory classes: 5h
Self study : 7h 30m

Module 4: Aerodynamic Forces and Moments

Description:
Measurements of forces and moments by direct measurements through aerodynamic balances: internal and external. Principles of operation. Coordinate systems and load cells as force sensing elements.
Aerodynamic coefficients: drag, lift/downforce, moment. Betz's method: wake's momentum.

Related activities:
Individual deliverable work assigned to the content of the module.
Ad-hoc laboratory session. Preparation of laboratory activity report.
Examples of Activities in laboratory: Aerodynamic force measurements at wind tunnels using the methods of: momentum (Betz method) and aerodynamic balance.

Full-or-part-time: 12h 30m
Theory classes: 5h
Self study : 7h 30m

Module 5: Flow Visualization

Description:
Definitions and their measurements. Wake method.
Visualization by direct injection tracer techniques. Visualization by smoke.
Particle imaging techniques, PIV/PTV, TPIV, SPIV. Principles, image processing tools. Pressure measurements by PIV techniques.

Related activities:
Individual deliverable work assigned to the content of the module.
Ad-hoc laboratory session. Preparation of laboratory activity report.
Examples of Activities in laboratory: Visualization of the flow detachment in aerodynamic bodies like: cylinder, airfoil, scale model of a passenger car, etc.

Full-or-part-time: 12h 30m
Theory classes: 5h
Self study : 7h 30m

Module 6: Recap

Description:
Complementation of masterclasses aimed at solving doubts and concepts.

Related activities:
Oral presentations an recap old sessions.

Full-or-part-time: 12h 30m
Theory classes: 5h
Self study : 7h 30m

GRADING SYSTEM

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- Autonomously, the students have to work on the material provided by the teachers and the result of the laboratory work sessions to assimilate and fix the concepts. The faculty will provide a study plan and follow-up activities (ATENEA).
Penalties:
- The use of wrong dimensional and conceptual errors from previous subjects such as: fluid mechanics, fluid engineering, or similar. The students must to be careful and precise with concepts and principles used in the report writing and descriptions.
- the mistakes on reporting of results without units and wrong units of the measurement systems will be severely penalized.
The final score will be calculated as the following algorithm: - 25% of the grade will be assigned to the 5 individual deliverables that the teaching staff will publish in order to consolidate concepts and techniques necessary in the preparation of future reports. Each activity has a weight of 5% in the final grade. - 75% will be assigned to laboratory activities. Your contributions will be divided as follows: o Four activities will have a contribution of 15% on the final grade o The remainder has its composition in 5% in the report and 10% in the oral presentation of the group. The group note is common to its members.