Course guide
205237 - AFM - Advanced Fluid Mechanics

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: Robert Castilla

PRIOR SKILLS
It is essential to have studied Fluid Mechanics.
It is advisable to have notions of programming.

TEACHING METHODOLOGY
This course is developed in the form of pills with advanced topics in Fluid Mechanics, independent of each other. The methodology is with Jupyter Notebooks, made with Python. No prior knowledge of Python is required, but basic knowledge of high-level programming (Matlab, Maple, etc ...) is required.
There are 6 pills, or blocks, of 5 teaching hours each. The first is an introductory block on Python and Jupyter Notebooks. The rest are the blocks described in the content. Notebooks are interactive, and students can download them and experiment with calculations, codes, data, ...
The work developed in class, discussions, exercises, deliveries, are done in groups of 2 or 3 people.

LEARNING OBJECTIVES OF THE SUBJECT
The objectives are oriented both to Fluid Mechanics and to the use of advanced tools for solving associated problems.
The main objective of the course is to provide the student with the basic knowledge necessary to be able to solve complex problems in Fluid Mechanics with the help of Python and Jupyter Notebooks.
The student will also learn to write interactive documents where he will describe his work with:
- Solve differential equations
- Statistical data processing
- Modeling of rheological behavior based on experimental data
- Solve nonlinear equations with numerical methods
- Creation of functions to make calculations with complex flows (boundary layer, compressible flow, ...)

STUDY LOAD

<table>
<thead>
<tr>
<th>Type</th>
<th>Hours</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hours large group</td>
<td>30,0</td>
<td>40.00</td>
</tr>
<tr>
<td>Self study</td>
<td>45,0</td>
<td>60.00</td>
</tr>
</tbody>
</table>

Total learning time: 75 h
## CONTENTS

### Module 0: Introduction to scientific computation with Python and Jupyter Notebooks

**Description:**
- 0.1 Numpy
- 0.2 Sympy
- 0.3 Pandas
- 0.4 Data fitting

**Related activities:**
- Assignment 0

**Full-or-part-time:** 5h
- Theory classes: 5h

### Module 1: Microflows. Lubrication and capilarity

**Description:**
- 1.1 Introduction
- 1.2 Shear-Driven flows
- 1.3 Pressure-Driven flows
- 1.4 Surface-Tension Driven flows

**Related activities:**
- Assignment 1

**Full-or-part-time:** 8h
- Theory classes: 5h
- Self study: 3h

### Module 2: Rheology

**Description:**
- 2.1 Classification of fluids
- 2.2 Generalised Newtonian Fluid
- 2.3 Viscoelastic fluids

**Related activities:**
- Assignment 2

**Full-or-part-time:** 8h
- Theory classes: 5h
- Self study: 3h
Module 3: Turbulence

Description:
3.1 Statistical description of turbulence
3.2 Scales of Turbulent flow
3.3 Wall flows

Related activities:
Assignment 3

Full-or-part-time: 8h
Theory classes: 5h
Self study: 3h

Module 4: Boundary Layer

Description:
4.1 Laminar boundary layer
4.2 Turbulent boundary layer
4.3 Control of boundary layer

Related activities:
Assignment 4

Full-or-part-time: 8h
Theory classes: 5h
Self study: 3h

Module 5: Compressible Flow

Description:
5.1 Acoustics and velocity of sound
5.2 Isentropic flow
5.3 Normal shock waves
5.4 Oblique shock wave and expansion waves
5.5 Prandtl-Meyer expansion fan

Related activities:
Assignment 5

Full-or-part-time: 8h
Theory classes: 5h
Self study: 3h

GRADING SYSTEM

The final grade is the average of the grades of the 5 deliverables per group.
BIBLIOGRAPHY

Basic:

Complementary:

RESOURCES

Other resources:
https://github.com/rclUPC/AdvancedFluidMechanics
> https://github.com/jupyter/jupyter/wiki