Course guide
205126 - 205126 - Fundamentals of Hypersonic Aerodynamics

Last modified: 02/04/2024

Unit in charge: Terrassa School of Industrial, Aerospace and Audiovisual Engineering
Teaching unit: 748 - FIS - Department of Physics.

Degree: MASTER'S DEGREE IN AERONAUTICAL ENGINEERING (Syllabus 2014). (Optional subject).
MASTER'S DEGREE IN SPACE AND AERONAUTICAL ENGINEERING (Syllabus 2016). (Optional subject).

Academic year: 2024 **ECTS Credits:** 3.0 **Languages:** English

LECTURER

Coordinating lecturer: Ferrer Ferre, Alex

Others: Ferrer Ferre, Alex

TEACHING METHODOLOGY

LEARNING OBJECTIVES OF THE SUBJECT

Define and understand the principles of compressible flow.
Explore the effects of compressibility on aerodynamic behavior.
Examine gas dynamics concepts in the context of compressible and hypersonic flows.
Understand shock waves, expansion waves, and their significance.
Identify and explain unique features of hypersonic flows.
Analyze the challenges and opportunities presented by hypersonic flight.

STUDY LOAD

Type	Hours	Percentage
Self study	48,0	64.00
Hours large group	27,0	36.00

Total learning time: 75 h

CONTENTS

Foundations of Compressible Flow

Description:
Basic principles of compressible flow.
Introduction to Burgers' equations and its relevance.
Introduction to Euler equations.
Thermodynamic concepts in compressible aerodynamics.

Full-or-part-time: 18h 45m
Theory classes: 6h 45m
Self study : 12h

Numerical Techniques for Compressible Flows with Finite Elements

Description:

Overview of computational fluid dynamics (CFD) techniques with a focus on finite element methods.
Simulate Burger' equation using finite element methods.
Solving Euler equations and shock capturing with finite element methods.

Full-or-part-time: 18h 45m
Theory classes: 6h 45m
Self study : 12h

Fundations of Hypersonic flows

Description:
Characteristics of hypersonic flows.
Thermal effects and high-temperature considerations.
Thermodynamics of chemically reacting gases in hypersonic environments.

Full-or-part-time: 18h 45m
Theory classes: 6h 45m
Self study : 12h

Numerical Simulation of Hypersonic Flows

Description:
Specific challenges and considerations in simulating hypersonic flows numerically.
Incorporating thermodynamics of chemically reacting gases in hypersonic flow simulations.
Validation and verification of numerical simulations in hypersonic regimes.

Full-or-part-time: 18h 45m
Theory classes: 6h 45m
Self study : 12h

GRADING SYSTEM

2 small take-home assignments (50% of the final grade).
1 final project (50% of the final grade).

BIBLIOGRAPHY

Basic:
- Anderson, John David. Hypersonic and high-temperature gas dynamics. 2nd ed. Reston: American Institute of Aeronautics and Astronautics, cop. 2006. ISBN 9781563477805.
- Donéa, Jean; Huerta, Antonio. Finite element methods for flow problems [on line]. Chichester: John Wiley & Sons, cop. 2003 [Consultation: 24/04/2024]. Available on: https://onlinelibrary-wiley-com.recursos.biblioteca.upc.edu/doi/book/10.1002/0470013826. ISBN 9780471496663.