Course guide
205129 - 205129 - Aerodynamic Shape Optimization

Last modified: 19/12/2024

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: González Horcas, Sergio

Others: Miró Jané, Arnau

PRIOR SKILLS

This course assumes that students have solid knowledge of physics and mathematics, as well as a foundation in aerodynamics. Proficiency in a scripting language, such as MATLAB or Python, or in other programming languages commonly used in scientific computing, such as C++ or Fortran, is also valuable.

TEACHING METHODOLOGY

The course will be developed through theoretical lessons and practical sessions where the presented methodologies will be illustrated through practical aerospace engineering problems (e.g., turbomachines and aircraft), or similar industrial applications such as wind turbine rotors.

Students are also expected to work on a related project in groups, which can be carried out using software suggested by the faculty or alternative options such as open source libraries. A final report detailing the followed methodology and the findings will be part of the evaluation of the subject.

LEARNING OBJECTIVES OF THE SUBJECT

To understand the fundamentals of optimization techniques for engineering design; to understand the principles of the most popular optimization approaches, and to select the appropriate strategy for a given problem; to understand the context of optimization when applied to aerodynamic shape design in aerospace engineering problems and related fields; to be able to solve a simple optimization problem with available software, and to interpret the solutions provided by the code.

STUDY LOAD

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

Total learning time: 75 h

CONTENTS

Fundamentals of aerodynamic shape optimization

Description:
Selection of design variables, shape parametrization, objective functions and constraints
Choice of involved aerodynamic models
Introduction to multi-objective optimization

Full-or-part-time: 19h
Theory classes: 7h
Self study : 12h

Overview of optimization strategies

Description:
Gradient-based methods
Gradient-free methods

Full-or-part-time: 14h
Theory classes: 5h
Self study : 9h

Leveraging models of different complexity

Description:
Surrogate models
Multifidelity optimization strategies

Full-or-part-time: 14h
Theory classes: 5h
Self study : 9h

Beyond the aerodynamics problem

Description:
Introduction to multidisciplinary design optimization
Overview of the interface of the aerodynamic problem with structural other physics and performance metrics

Full-or-part-time: 14h
Theory classes: 5h
Self study : 9h

Simplification strategies

Description:
Variable screening
Dimension reduction

Full-or-part-time: 14h
Theory classes: 5h
Self study : 9h

GRADING SYSTEM

25%: Exercises proposed by the faculty, related to each of the modules
25%: Final written exam
50%: Project developed in the framework of the course

BIBLIOGRAPHY

Basic:
- Martins, Joaquim R. R. A.; Ning, Andrew. Engineering design optimization [on line]. Cambridge: Cambridge University Press, 2022 [Consultation: 28/01/2025]. Available on: https://mdobook.github.io. ISBN 9781108833417.

Complementary:
- Alexander I. J. Forrester, András Sóbester, Andy J. Keane. Engineering design via surrogate modelling. A practical guide. John Wiley & Sons, 2008. ISBN 9780470060681.
- Deb, Kalyanmoy. Multi-objective optimization using evolutionary algorithms. Chichester: John Wiley & Sons, 2008. ISBN 9780470743614.