Online Program

Aeroacoustics: Design, Analysis and Verification

SYLLABUS

This program consists of three career-oriented courses, which provide the tools, knowledge and skills to predict, analyze and verify the aeroacoustic performance of several mechanical systems, including the application of noise reduction technologies.

First Course

Aeroacoustics: Noise Reduction Strategies for Mechanical Systems

This course consists of four modules focusing on the fundamentals of aeroacoustics and sources of noise in mechanical systems. Participants will be able to choose examples in different systems depending on their interests or experience. Each module has a workload of approximately six hours.

Module 1:

- Introduction to sources of noise
- Sources of noise in aircraft propellers, wings, jets, wind turbines

Module 2:

- Influence of regulating parameters in the noise sources (e.g. speed, rpm, etc.)
- Performance and aeroacoustic design

Module 3:

- Test case for combined aeroacoustic and aerodynamic design
- Evaluation of the performance of the new design proposition

Module 4:

- Preview of experimental applications for noise measurements

Assessment

Each module includes quizzes and exercises. These can vary from straightforward multiple-choice questions to more detailed calculations. Module 2 and 3 present two assignments which consist of a test case for the optimization of a combined aerodynamic and aeroacoustic design.

Second Course

Aeroacoustics: Measurement Techniques

This course has four modules focusing on signal processing, measurements of pressure fluctuations, advanced correlations through numerical techniques applied to experimental data, measurements in-field and in anechoic tunnels. Participants will be able to choose examples in different systems depending on their interests or experience. Each module has a workload of approximately six hours.

Module 1:

- Introduction to signal processing and noise sources
- Summary of the basics of sound propagation and acoustic analogies

Module 2:

- Basics of single microphone operation and measurements in near-field and far-field configurations
- Beamforming technology and response of different microphones

Module 3:

- Introduction to velocity and pressure measurements
- PIV in aeroacoustics

Module 4:

- Measurements in wind-tunnels
- Basic application of in field measurements

Assessment

Each module includes a small assignment, quizzes and exercises. These can vary from straightforward multiple-choice questions to more detailed calculations.

Third Course

Aeroacoustics: Computational Methods

This course consists of four modules focusing on the computational methods needed to solve acoustic and aeroacoustic problems, the differences between the numerical schemes, and the challenges in their applications.

Module 1:

Definitions and governing equations – In this module, you will learn the fundamentals of acoustic sources.

- The wave equation and the plane wave.
- Fundamental solutions of the wave equation: mono/di/quadruple.
- The Fourier transform.

Module 2:

Solution of the wave equation – In this module, you will learn the methods to solve the propagation of the acoustic waves in open and closed environments.

- General solution of the wave equation using the Green's function.
- Solution of the wave equation in the frequency domain.
- Dispersion relation scheme for the solution of the wave equation.
- An example of numerical solution of the 1D wave equation.

Module 3:

Theory of the acoustic analogy – In this module, the basic aspects of the aeroacoustic noise sources and the acoustic analogies will be treated.

- The concept of acoustic analogy
- Analogies comparisons between Lighthill, Curle, and Ffwocs-Williams and Hawkings

Module 4:

Direct and hybrid numerical methods – In this module, you will learn how to choose and set up a solver for aeroacoustic purposes.

- Description and comparison of the numerical schemes for direct and hybrid methods
- Practical challenges in the selection and application of hybrid approaches
- Boundary conditions
- Examples of applications: how to build a computational setup depending on the problem.

Resources

All necessary course materials will be provided online, you do not need to purchase additional books. You will also gain access to online-tools and resources to tailor your formulations to your test-cases.