Computational Wind Engineering

Module-No./Abbreviation	Credits	Workload	Term	Frequency	Duration
CE-WP14/ CWE	3 CP	90 h	3rd Sem.	Winter term	1 Semester

Courses	Contact hours	Self-Study	Group Size:
Computational Wind Engineering	2 SWS (30 h)	60 h	No Restrictions

Prerequisites
Modern Programming Concepts in Engineering (CE-P04), Fluid Dynamics (CE-P06), Recommended: Computational Fluid Dynamics (CE-WP05)

Learning goals / Competences
The students acquire advanced skills of CFD methods for the computation of wind engineering problems such as

- mean wind parameters and turbulence characteristics for the assessment of local wind climates
- wind pressures at surfaces for the determination of wind loads at structures, and
- gaseous transport in the atmospheric boundary layer for the prediction of the dispersion of exhausts and particles

After successfully completing the module, the students will be able to

- understand the broad scope of computational fluid dynamics and the thematic integration of computational wind engineering within.
- identify fluid dynamical mechanisms of observed flow phenomena and choose adequate and suitable CFD methods to explore and formulate engineering solutions for real flows.
- solve relevant technical problems in the field of computational wind engineering by means of applying CFD simulations.
- validate, verify, and assess the solutions and results of CFD simulations.
- transfer learned skills in media literacy, and digital competence through the completion of supervised and supported self-studies to other engineering activities.

Content
This course introduces the details and guidelines for the application of CFD methods in the field of wind engineering. Relevant problems for practical applications and solution procedures are investigated. The theoretical background is taught in the obligatory Fluid Dynamics course while this course aims at the practical application of CFD methods on various wind engineering problems. In general, the steady state RANS, the unsteady RANS method, and Large Eddy Simulations are used. The lectures and exercises include all necessary steps of a CFD simulation from the creation of the geometry to the assessment and presentation of the results. During the semester the commercial the open-source software OpenFOAM is used. The following working steps are explained and carried out:

- Generation of simple geometries and block structured grids and analysis of the influence of the quality of the mesh on the results of the simulation.
- Generation of complex geometries and unstructured numerical grids.
- Setting up simulations (Pre-Processing): -
    - Choosing the right boundary conditions.
    - Choosing the correct turbulence models.
    - Deciding on the parameters of the finite volume method such as interpolation schemes for the convective term of the Navier-Stokes equation.
    - Adding source terms of exhaust for the investigation of pollution in the atmosphere.
    - Application of the numerical solvers including parallel processing.
    - Post processing of the most important characteristics of wind engineering flows and presenting them in an adequate manner:
    - Analysis of mean velocity vector fields around structures.

- Analysis of mean and time dependent pressure distributions on the surface of structures that are exposed to wind to estimate the load due to wind.
    - Analysis of the aerodynamic forces of lift and drag.
    - Gaseous transport and dispersion in the atmospheric boundary layer for the prediction of the dispersion of exhausts and particles.
- Procedures for quality assurance in CFD simulations -Validation and verification methods.

Teaching methods / Language
Lectures, guided work in computer labs. / English

Mode of assessment
Case study at the end of the course including written report and presentation.

Requirement for the award of credit points
Passed final case study.

Module applicability
- MSc. Computational Engineering

Weight of the mark for the final score
3 %

Module coordinator and lecturer(s)
Prof. Dr.-Ing. R. Höffer, Dr.-Ing. U. Winkelmann

Further information