COURSE DESCRIPTION CARD - SYLLABUS

Course name
Fluid dynamics modelling [S1MiBM2>MDP]

Course

Field of study
Mechanical Engineering

Year/Semester
4/7

Area of study (specialization)
–

Profile of study
general academic

Level of study
first-cycle

Course offered in
Polish

Form of study
full-time

Requirements
elective

Number of hours

Lecture
15

Laboratory classes
30

Other
0

Tutorials
0

Projects/seminars
0

Number of credit points

4,00

Coordinators

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Lecturers

Prerequisites

KNOWLEDGE: The student has a basic knowledge of computer-aided engineering methods and numerical methods (e.g. Finite Element Method). He/she has basic knowledge of mathematics and fluid mechanics. SKILLS: The student is able to plan and carry out experiments, including measurements and computer simulations, interpret the obtained results and draw conclusions. SOCIAL COMPETENCES: Students will be able to interact and work in a group.

Course objective

To acquire knowledge of the methods and processes involved in computer modelling and simulation in fluid mechanics (dynamics). Acquire practical knowledge and skills in the use of specialised CAx engineering software.

Course-related learning outcomes

Knowledge:
The student knows the basic methods, techniques and numerical tools used in solving simple engineering tasks in fluid mechanics.
The student has basic knowledge of fluid mechanics and computational methods in mechanical

engineering (including: preparation of a model for computation, selection of a mathematical model describing fluid flow, discretisation of the model and generation of a computational grid, introduction of operational and boundary conditions, running simulations, convergence criteria, visualisation and analysis of results).
The student has a basic knowledge of information technology and computer science as regards the use of software in information processing and presentation.

Skills:
The student is able to use IT methods and tools to formulate and solve engineering tasks.
The student is able to apply learned methods and tools to assist design in mechanical issues. The student is able to run computer simulations to analyse fluid flow and assess its effects on designed structures.
The student is able to assess the suitability of routine methods and tools for solving a simple engineering task of a practical nature and select and apply the appropriate method and tools.

Social competences:
The student understands the need for lifelong learning; can inspire and organise the learning of others.
The student is able to prioritise appropriately the achievement of a task set by him/herself or others.
The student is able to critically evaluate his/her knowledge and perceived content.

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Oral and written tests. Assessment of individually completed assignments and projects.

Programme content

Lecture: The student will be introduced to selected topics in computational fluid dynamics analysis, including:
- methods of creating models for CFD simulations,
- generation of computational mesh and assessment of their quality, also including the boundary layer,
- basic flow description models (including direct numerical simulation DNS, time-averaged RANS models and turbulence models),
- methods for the visualisation and analysis of simulation results (including determination of lift and drag forces and CD and CL coefficients).

Theoretical issues are illustrated with solutions using specific systems for modelling and numerical calculations.
Laboratory: conducted in the form of projects on design and analysis of structures, including:
- model preparation for flow simulations (e.g. SolidWorks),
- generation of calculation grids dedicated to different simulations, using SolidWorks Flow Simulation, Ansys Meshing, Gmsh software,
- conducting numerical experiments using computational fluid dynamics simulation software (e.g. SolidWorks Flow Simulation, Ansys Fluent, OpenFOAM),
- visualisation, processing and analysis of results
- modification of the studied object on the basis of the acquired knowledge of the occurring flow phenomena.

Course topics

none

Teaching methods

1. Lecture: Case study, multimedia presentation.
2. Laboratory classes: implementation of tasks given by the instructor, implementation of individual computer simulations, implementation of assigned project tasks.

Bibliography

Basic:
J. Matsson, An Introduction to SOLIDWORKS Flow Simulation 2022, SDC Publications, 2022. ISBN:

9781630574802, 1630574805
G. Verma, M. Weber, SolidWorks Flow Simulation 2021 Black Book, Cadcamcae Works, 2020. ISBN: 9781774590072, 1774590077
C. Pozrikidis, Introduction to Theoretical and Computational Fluid Dynamics, OUP USA, 2011. ISBN: 9780199752072, 0199752079

Additional:
J.D. Anderson Jr., Computational Fluid Dynamics. An Introduction, Springer, 2009. ISBN: 9783540850557, 3540850554
Guangfa Yao, Immersed Boundary Method for CFD. Focusing on Its Implementation, CreateSpace Independent Publishing, 2018. ISBN: 9781984295583, 1984295586
K. Kotecki, H. Hausa, M. Nowak, W. Stankiewicz, R. Roszak, M. Morzyński, Aeroelastic System for Large Scale Computations with High Order Discontinuous Galerkin Flow Solver. IDIHOM: Industrialization of High-Order Methods-A Top-Down Approach: Results of a Collaborative Research Project Funded by the European Union 2010-2014, Springer, 2015.
J. Simon, W. Stankiewicz. Numerical simulations of the flows past rotating geometries. Vibrations in Physical Systems 31(3), 2020.

Breakdown of average student's workload

	Hours	ECTS
Total workload	100	4,00
Classes requiring direct contact with the teacher	45	2,00
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	55	2,00