POZNAN UNIVERSITY OF TECHNOLOGY

EUROPEAN CREDIT TRANSFER AND ACCUMULATION SYSTEM (ECTS)

COURSE DESCRIPTION CARD - SYLLABUS

Course name

Fundamentals of computational fluid dynamics [S2IChiP1>PNMP]

Course

Field of study	Year/Semester
Chemical and Process Engineering	2/3
Area of study (specialization)	**Profile of study**
Chemical Engineering	general academic
Level of study	**Course offered in**
second-cycle	polish
Form of study	**Requirements**
full-time	compulsory

Number of hours

Lecture	Laboratory classes	Other (e.g. online)
15	0	0
Tutorials	**Projects/seminars**	
0	30	

Number of credit points

3,00

Coordinators

dr inż. Maciej Staszak
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Lecturers

Prerequisites

Basic knowledge of concepts used in CAD tools related to graphical creation of 2D/3D engineering models (e.g.: AutoCAD, Solid Edge, etc.) and a general understanding of how they work.

Course objective

The aim of the course is to familiarize students with the modern way of simulation analysis of flow processes and equipment design in the field of chemical engineering using the finite volume method (FVM).

Course-related learning outcomes

Knowledge:

students will be familiar with the methodology of model development in cfd. student knows rheological models, closure models, multicomponent diffusion models and multiphase models used in simulations. in addition, the student knows the tools used at various stages of conducting calculations. student knows the difference between classical engineering computational approach and fvm methodology. k_w01

Skills:

the student is able to perform flow simulation by selecting an appropriate model system for a given problem. in particular, the student can build two- and three-dimensional geometries, can select appropriate boundary conditions and define them in fluent tool environment. moreover, the student is able to analyze the obtained results and extract additional derived results. the student is able to obtain and interpret results in three, two and zero dimensional systems. k_u07, k_u09

Social competences:
students understand the significant impact of modern computational methods on the reduction of design costs. the student understands the importance of technology readiness levels and is able to relate calculations in the fvm technique to the appropriate stage. student is aware of the fact that fvm technique is still expanding in commercial design environments and that the process is long-lasting due to high demand for computing power and steep learning curve. k_k01, k_k06

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Learning outcomes presented above are verified as follows:
The test mainly focuses on the task of appropriate selection of models for given flow cases. In addition, the test also includes questions from the theoretical area related to the CFD technique and the calculation models used. The passing threshold is the achievement of at least half of the points possible to obtain on the basis of the answers given.
Evaluation of the performance of the assigned projects in the following areas:
correctness of geometry development, correctness of mesh development, correctness of choice of physical models (e.g.: diffusion models, multi-phase models, turbulence models, chemical reaction models), correctness of choice of rheological model for the indicated fluids, correctness of choice of boundary conditions, in special cases correctness of choice of initial conditions, validity of choice of discretization schemes, quality of obtained results measured by the chosen convergence measure, correctness of post-process calculations with special emphasis on averaging and summation of two- and three-dimensional physical fields. In special cases determination of additional quantities e.g.: spatial profile of selected thermodynamic function.
The remote form does not differ from the stationary form in terms of the principle of assessment. The student, just as in the stationary form, performs the assigned project having at his disposal a computer to which he connects from home. The tutor evaluates the project and discusses the associated problems remotely in the same way as in the classroom.

Programme content

Three-dimensional flow description in the form of momentum, mass, and energy balance. Rheological, turbulence, multiphase flow and mass transport models. Diffusion modeling in terms of Fick"s law and Maxwell-Stefan, use of Chapman-Enskog kinetic gas theory. Two and three dimensional fields of scalar, vector and tensor variables. Use of gradient, divergence and rotation operators. Application of integration operations in terms of line, surface and volume integrals. Defining models and performing calculations in the Ansys Workbench environment.

Teaching methods

Lecture in the form of a presentation with derivations of key concepts in CFD techniques, including the Navier-Stokes equation.
Extensive discussion of theory with live simulation examples created together with a group of students. Presentation of how to build geometry at the preprocessing stage, creation of computational meshes, model setup with emphasis on the importance of parallelization and postprocessing of the obtained results.

Bibliography

Basic
CFD dla inżynierów. Praktyczne ćwiczenia na przykładzie systemu ANSYS Fluent, Mateusz Pawłucki, Maciej Kryś
The Finite Element Method for Fluid Dynamics, O.C. Zienkiewicz, R.L. Taylor, P. Nithiarasu
Additional
Uzupełniająca

Boundary-Layer Theory, Hermann Schlichting, Klaus Gersten

Breakdown of average student's workload

	Hours	ECTS
Total workload	75	3,00
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)	30	1,00