Zachodniopomorski Uniwersytet Technologiczny w Szczecinie

Faculty of Chemical Technology and Engineering

Field of study	Chemical Engineering		
Mode of study	stationary	*Level*	first cycle
Graduate's qualification	inżynier		
Area(s) of study	nauki techniczne		
Educational profile	general academic		
Module			
Course unit	**Computational Fluid Dynamics**		
Code	ChEn_1A_S_C17a		
Field of specialisation			
Administering faculty	Institute of Chemical Engineering and Environmental Protection Processes		
ECTS	5,0	*ECTS (forms)*	5,0
Form of course credit	credits	*Language*	english
Electives	6	*Elective group*	

WTilCh

Form of instruction	*Code*	*Semester*	*Hours*	*ECTS*	*Weight*	*Credit*
lecture	W	5	30	2,0	0,50	credits
laboratory course	L	5	45	3,0	0,50	credits

Leading teacher	Story Anna (Anna.Story@zut.edu.pl)
Other teachers	Story Anna (Anna.Story@zut.edu.pl)

Prerequisites	
W-1	Fluid dynamics
W-2	Chemical engineering fundamentals
W-3	Applied mathematics

Module/course unit objectives	
C-1	This course is aimed at increasing and developing students' knowledge about fundamental principles of computational fluid dynamics, as well as improving their abilities to solving complex engineering problems with using a novel numerical approach and commercial software. Methods of creating the geometry of the body and generation the numerical mesh will be presented. Different models and methods of the simulations will be discussed and applied to solving the selected flow issues.

Course content divided into various forms of instruction		*Number of hours*
T-W-1	Introduction to Computational Fluid Dynamics. CFD applications in chemical engineering. Advantages and disadvantages of the CFD approach	2
T-W-2	Fundamental theoretical principles of conservation: Reynolds transport theorem, Conservation of mass, Conservation of linear momentum: Navier-Stokes equation, Conservation of Energy, General scalar transport equation	4
T-W-3	Mathematical models of transport processes in fluids: turbulent flows, multiphase flows, non-Newtonian flows. Fundamentals and modeling	6
T-W-4	Basic structure of numerical analysis using CFD: Pre-processing, Processing, Post-processing	2
T-W-5	Different types of meshes - structured and unstructured grid formulation. Methods of mesh generation	4
T-W-6	Principles of numerical solving methods: Finite Element Method, Finite difference method, Finite volume method. Types of boundary conditions	6
T-W-7	The convergence of a numerical method: accuracy and stability. Role of the validation	2
T-W-8	Step-by-step analysis of numerical modeling of selected fluid flow cases	4
T-L-1	Introduction to Computational Fluid Dynamics in ANSYS Workbench. Graphical User Interface	1
T-L-2	Creating the geometry in ANSYS DesignModeler	8
T-L-3	Generation of mesh in ANSYS Mesher	6
T-L-4	Introduction to CFD simulations in ANSYS Fluent. Definition of materials of the object and boundary conditions for fluid flow	3
T-L-5	Postprocessing in ANSYS Fluent	3
T-L-6	Analysis of a laminar flow in ANSYS Fluent	3
T-L-7	Applying turbulence model in ANSYS Fluent	3
T-L-8	Analysis of a heat transfer in ANSYS Fluent	3
T-L-9	Simulation of multiphase flow in ANSYS Fluent	3
T-L-10	Modeling of rotating elements in fluent (e.g. rotating wall, multiple reference frame, sliding mesh)	3

Course content divided into various forms of instruction		Number of hours
T-L-11	Modeling of a selected issue including creating the geometry, generating the mesh, performing the simulations and postprocessing	9

Student workload - forms of activity		Number of hours
A-W-1	Lecture participation	30
A-W-2	Individual literature studies	18
A-W-3	Repetition of the lecture content to the written test	10
A-W-4	One-on-On Teaching Consultation	2
A-L-1	Classroom participation	45
A-L-2	Preparation of reports	30
A-L-3	Literature studies	10
A-L-4	One-on-One Teaching Consultations	5

Teaching methods / tools	
M-1	Activating methods – lecture and didactic discussion, multimedia presentation
M-2	Practical methods – Numerical analysis by solving chemical engineering problems using ANSYS software

Evaluation methods (F - progressive, P - final)		
S-1	P	Written final exam based on the lecture contents
S-2	F	Mid-term exam 1 – ANSYS DesignModeler and ANSYS Mesher
S-3	F	Written final report – ANSYS Fluent

Designed learning outcomes	Reference to the learning outcomes designed for the fields of study	Reference to the learning outcomes defined for the particular areas of education	Reference to learning outcomes leading to the degree of "inżynier"	Course objectives	Course content	Teaching methods	Evaluation methods
Knowledge							
ChEn_1A_C17a_W01 Student possesses a general knowledge about the computational methods of solving partial differential equations of transport processes in fluids, understands mathematical characteristic of those equations. Student learns different methods of computational solution of flow issues.	ChEn_1A_W07 ChEn_1A_W08 ChEn_1A_W12 ChEn_1A_W15	P6S_WG_TA11	P6S_WG_IA11	C-1	T-W-1 T-W-5 T-W-2 T-W-6 T-W-3 T-W-7 T-W-4 T-W-8	M-1	S-1
Skills							
ChEn_1A_C17a_U01 Student possesses an ability to identify geometry of the body and generation of the mesh. Student is able to using commercial CFD packages to analyze and solve flow issues, including selection of models and methods of the simulations.	ChEn_1A_U01 ChEn_1A_U03 ChEn_1A_U05 ChEn_1A_U07 ChEn_1A_U08 ChEn_1A_U09 ChEn_1A_U10 ChEn_1A_U16	P6S_UO P6S_UU P6S_UW_TA11 P6S_UW_TA12 P6S_UW_TA13 P6S_UW_TA14	P6S_UW_IA11 P6S_UW_IA12 P6S_UW_IA14	C-1	T-L-1 T-L-7 T-L-2 T-L-8 T-L-3 T-L-9 T-L-4 T-L-10 T-L-5 T-L-11 T-L-6	M-2	S-2 S-3
Other social / personal competences							
ChEn_1A_C17a_K01 Student understands the importance of numerical simulation in industrial applications. Student has ability independently or in group to use CFD as a tool to analyze and optimize real flow problems.	ChEn_1A_K01 ChEn_1A_K03 ChEn_1A_K04 ChEn_1A_K05	P6S_KK P6S_KO P6S_KR		C-1	T-L-1 T-L-8 T-L-2 T-L-9 T-L-3 T-L-10 T-L-4 T-L-11 T-L-5 T-W-1 T-L-6 T-W-4 T-L-7 T-W-8	M-1 M-2	S-1 S-2 S-3

Required reading
1. Hirsch, C, Numerical Computation of Internal and External Flows, Butterworth Heinemann, 2007
2. Pletcher, R. H., Tannehill, J. C., Anderson, D., Computational Fluid Mechanics and Heat Transfer, CRC Press, 2011
3. Moin, P., Fundamentals of Engineering Numerical Analysis, Cambridge University Press, 2010

Supplementary reading
1. Ferziger, J. H., Numerical Methods for Engineering Application, Wiley, 1998
2. Ferziger, J. H., Peric, M., Computational Methods for Fluid Dynamics, Springer, 2002