COURSE DESCRIPTION CARD – Applied Computational Fluid Dynamics

<table>
<tr><th colspan="10">Faculty of Mechanical Engineering</th></tr>
<tr><td>Field of study</td><td colspan="7"></td><td>Degree level and programme type</td><td></td></tr>
<tr><td>Specialization/ diploma path</td><td colspan="7"></td><td>Study profile</td><td></td></tr>
<tr><td rowspan="2">Course name</td><td colspan="7" rowspan="2">Applied Computational Fluid Dynamics</td><td>Course code</td><td>IS-FME-00278S</td></tr>
<tr><td>Course type</td><td></td></tr>
<tr><td rowspan="2">Forms and number of hours of tuition</td><td>L</td><td>C</td><td>LC</td><td>P</td><td>SW</td><td>FW</td><td>S</td><td>Semester</td><td>summer</td></tr>
<tr><td>15</td><td></td><td></td><td></td><td>45</td><td></td><td></td><td>No. of ECTS credits</td><td>6</td></tr>
<tr><td>Entry requirements</td><td colspan="9">Mathematics, Heat Transfer, Fluid Mechanics</td></tr>
<tr><td>Course objectives</td><td colspan="9">Introduction to engineering software for computational fluid dynamics (CFD) through analysis of methods and tools for 1D, 2D and 3D simulation of fundamental phenomena (frequently occurring in processes of thermal engineering). Development of skills in using software for solving thermal and flow problems encountered in refrigeration, air conditioning and heating technology.</td></tr>
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Course content	Lecture: Introduction to CFD engineering software, e.g. ANSYS FLUENT. The fundamentals of using CFD modelling: Finite volume method and mathematical description of fluid motion (system of governing equations, Navier-Stokes equations). Discretization of differential equations in time and space. Discretization of the computational domain (preprocessor - creating 1D, 2D and 3D domains, simplest types of computational meshes and methods of their creation, mesh control parameters, assessment of mesh quality). Solution process (solver - variables definition, specification boundary conditions, selection of a turbulence model, conduction of calculations). Postprocessor - creating contour maps of fluid parameters, path-line graphs and animations of the simulated process. Basic evaluation methods of physical acceptance of the obtained solution. Specialization workshop: Practical application of the knowledge presented in the lecture, development of elementary skills including: creating simple geometric models, creating meshes of finite elements, performing calculations of simple energy and mass transfer problems, and simulation results presentation.

Teaching methods	Lecture: demonstration lecture with a multimedia presentation. Specialization workshop: solving simulation tasks using supporting software - group work in a computer laboratory.	
Assessment method	Lecture: test. Specialization workshop: evaluation of students' reports and activity in the classroom - partial grades.	
Symbol of learning outcome	Learning outcomes	Reference to the learning outcomes for the field of study
LO1	Student knows and understands fundamental thermal and flow phenomena.	
LO2	Student knows the basics of CFD modeling and defines basic parameters and quantities characteristic of CFD. Student is able to create the geometry and computational mesh in a selected CFD program. Student is able to define the boundary and starting conditions of the simulation, perform calculations and perform basic analysis of simulation results.	
LO3	Student is able to obtain the necessary input data for correct execution of CFD simulations.	
LO4	Student has the ability to self-educate using modern teaching tools, such as e-books, tutorials, video materials.	

Symbol of learning outcome	Methods of assessing the learning outcomes	Type of tuition during which the outcome is assessed	
LO1	**Written or online test**	**L**	
LO2	**Written or online test, specialization workshop: evaluation of students' reports and activity in the classroom - partial grades.**	**L, SW**	
LO3	**Specialization workshop: evaluation of students' reports and activity in the classroom - partial grades.**	**SW**	
LO4	**Specialization workshop: evaluation of students' reports and activity in the classroom - partial grades.**	**SW**	
Student workload (in hours)		**No. of hours**	
Calculation	**lecture attendance**	**15**	
	preparation to pass the lecture	**10**	
	participation in the specialization workshop	**45**	
	preparation to pass the specialization workshop	**35**	
	self-improvement using available sources, e.g. YouTube, internet forums and discussion groups	**10**	
	participation in student-teacher sessions	**5**	
	TOTAL:	**120**	
Quantitative indicators		**HOURS**	**No. of ECTS credits**
Student workload – activities that require direct teacher participation		**65**	**2,6**
Student workload – practical activities		**90**	**3,4**
Basic references	**1. Gerhart, Andrew L., et al. Munson, Young and Okiishi's: Fundamentals of Fluid Mechanics: SI Version: International Adaptation. 9th ed. Singapore: John Wiley & Sons, 2021.** **2. Vázquez-Cendón, M. Elena: Solving Hyperbolic Equations with Finite Volume Methods. 2015th ed. Vol. 90. Cham: Springer Nature, 2015.** **3. Mewes, Dieter, et al. Rarefied Gas Dynamics: Fundamentals, Simulations and Micro Flows. 1. Aufl. Berlin, Heidelberg: Springer-Verlag, 2005.** **4. Karwa, Rajendra: Heat and Mass Transfer. 1st ed. Singapore: Springer Nature, 2016.**		

Supplementary references	1. Fox R, Pritchard P., McDonald A., Introduction to fluid mechanics, Hoboken: John Wiley a. Sons, 2010 2. Nellis G., Klein S.A., Heat transfer, Cambridge University Press, 2009. 3. Myer Kutz Ed., Heat-transfer calculations, New York : McGraw-Hill, 2006.	
Organisational unit conducting the course	Department of Thermal Engineering	Date of issuing the programme
Author of the programme	Wojciech Angielczyk	2025-02-11

L – lecture, C – classes, LC – laboratory classes, P – project, SW – specialization workshop, FW - field work, S – seminar