COURSE OFFERED IN THE DOCTORAL SCHOOL

Code of the course	4606-ES-000EFHI-0349	Name of the course	Polish	**Zastosowanie metody CFD w przemyśle II**	
			English	**Application of CFD method in industry II**	
Type of the course	specialized				
Course coordinator	Professor Michał Makowski, Ph.D., D.Sc., Eng.	Course teacher	Piotr Tarnawski, Ph.D., Eng		
Implementing unit	Faculty of Automotive and Construction Machinery Engineering	Scientific discipline / disciplines*	Mechanical engineering; Civil Engineering, Geodesy and Transport; Environmental engineering, mining and and energy; Chemical engineering		
Level of education	doctoral studies	Semester	winter		
Language of the course	English				
Type of assessment	Credit with a grade	Number of hours in a semester	26	ECTS credits	2
Minimum number of participants	10	Maximum number of participants	15	Available for students (BSc, MSc)	Yes

Type of classes		Lecture	Auditory classes	Project classes	Laboratory	Seminar
Number of hours	in a week	1		1		
	in a semester	13		13		

* does not apply to the Researcher's Workshop

1. Prerequisites

Fundamentals of thermodynamics, Fluid mechanics, and heat transfer, Application of CFD method in industry

2. Course objectives

The aim of the course is to acquire specialist knowledge in the field of Computational Fluid Dynamics (CFD) and the ability to use ANSYS Fluent program for different industry application.

3. Course content (separate for each type of classes)

Lecture

- Theoretical physical basics.
- Description of analitical equations of fluid mechanics
- Description of the mathematical apparatus of differential equations.
- Derivation of the continuum equation
- Derivation of the momentum equation
- Derivation of the equation energy
- Obliczenie sprawności różnych obiegów silników

Project

- Simulation of filling and combustion in engine chamber
- Simulation of expansion in convergent nozzle and comparison with analitycal solution
- Simulation of expansion in convergent-divergent nozzle and comparison with analitycal solution
- Simulation of generation of power in turbine
- Energy balance and calculation of engine efficiency
- Simulation of joule heat generation (direct simulation of electric current), convection and radiation analysis. Comparison of cooling effects using different gases e.g. SF_6, CO_2, C_4F_7N)

- Simulation of fire and smoke generation – transient simulation analysis using UDF and scalar defnition.

4. Learning outcomes			
Type of learning outcomes	Learning outcomes description	Reference to the learning outcomes of the WUT DS	Learning outcomes verification methods*
Knowledge			
W01	Acquiring knowledge about physical phenomena occurring in fluids.	SD_W2	project evaluation
W02	Acquiring knowledge in the field of applying numerical fluid mechanics.	SD_W2	project evaluation
W03	Acquiring knowledge in the area turbine engines power generation and CFD modelling	SD_W2, SD_W3	project evaluation
Skills			
U01	Independent realization of two simulation projects	SD_U1, SD_U2, SD_U7	project evaluation
U02	Ability to use CFD simulation software	SD_U2	project evaluation
U03	The ability to present the results in the form of a technical report	SD_U4, SD_U6	project evaluation
Social competences			
K01	Critically reference the results of computer simulation studies obtained in the field of fluid flow.	SD_K1	assessment of activity during classes
K02	Consciously applying numerical methods to benefit society.	SD_K3	assessment of activity during classes

*Allowed learning outcomes verification methods: exam; oral exam; written test; oral test; project evaluation; report evaluation; presentation evaluation; active participation during classes; homework; tests

5. Assessment criteria
Assessment of the realization of two independent simulation projects. Building a geometric model and mesh, performing calculations, presenting the results, drawing conclusions from the simulation results.

6. Literature

Primary references:

[1] ANSYS Fluent User’s guide
[2] J. Blazek, Computational Fluid Dynamics: Principles and Applications, ELSEVIER SCIENCE PUB CO 2006

Secondary references:

[1] Tarnawski, P. and Ostapski, W., "The Hybrid Concept of Turboshaft Engine Enhanced by Steam Cycle Using Waste Heat Recovery—Combined Analytical and Numerical Calculation of Its Efficiency," SAE Int. J. Engines 17(6):2024, doi:10.4271/03-17-06-0045.

[2] Tarnawski P. The hybrid concept of turboshaft engine working according to Humphrey cycle dedicated to variety power demand – CFD analysis. Combustion Engines. 2023;193(2):129-136. https://doi.org/10.19206/CE-162763

7. PhD student's workload necessary to achieve the learning outcomes**		
No.	Description	Number of hours
1	Hours of scheduled instruction given by the academic teacher in the classroom	26
2	Hours of consultations with the academic teacher, exams, tests, etc.	2
3	Amount of time devoted to the preparation for classes, preparation of presentations, reports, projects, homework	13
4	Amount of time devoted to the preparation for exams, test, assessments	19
	Total number of hours	**60**
	ECTS credits	**2**

** 1 ECTS = 25-30 hours of the PhD students work (2 ECTS = 60 hours; 4 ECTS = 110 hours, etc.)

8. Additional information	
Number of ECTS credits for classes requiring direct participation of academic teachers	2
Number of ECTS credits earned by a student in a practical course	2