CFD simulations of power generation units

Faculty of	**Mechanical and Power Engineering**
Name in English	**CFD simulations of power generation units**
Name in Polish	**Symulacje CFD urządzeń energetycznych**
Main field of study	**Power Engineering**
Specialization	**-**
Level of studies	**II level**
Form of studies	**full-time**
Kind of subject	**obligatory**
Subject code	**W09ENG-SM2340**
Group of courses	**NO**

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	30		60		
Number of hours of total student workload (CNPS)	50		50		
Form of crediting	Exam		Zaliczenie		
For group of courses mark final course with (X)					
Number of ECTS points	2		2		
including number of ECTS points for practical (P) classes			2		
including number of ECTS points for direct teacher-student contact (BU) classes	1,44		1,36		

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1.	Skills to create three dimensional geometry in engineering software.
2.	The extent of knowledge in heat transfer and fluid mechanics fields.

SUBJECT OBJECTIVES

C1	providing knowledge about methods of thermal-flow processes numerical simulations
C2	providing knowledge about energetic systems optimizing methods
C3	developing skills of creating mesh for defined geometry and application
C4	developing abilities of performing numerical calculations for simple and complex thermal-flow processes

SUBJECT LEARNING OUTCOMES

relating to knowledge:	
PEU_W01	knowledge about equations describing heat transfer and fluid flow
PEU_W02	knowledge of turbulence and their models
PEU_W03	knowledge about numerical methods of solving heat transfer problems
PEU_W04	acquaintance with numerical methods of solving steady and transient thermal-flow processes
PEU_W05	knowledge about boundary and initial conditions applied during thermal-flow processes analyses
PEU_W06	knowledge about most often occurring CFD numerical errors and their impact on calculations
PEU_W07	basics of LES method
PEU_W08	acquaintance with methods of energetic systems optimizing
relating to skills:	

PEU_U01	skills to create geometry and numerical mesh
PEU_U02	ability to evaluate influence of mesh density on numerical results
PEU_U03	skills to carry out numerical calculations of steady and unsteady heat transfer and fluid flow
PEU_U04	ability to perform numerical calculations of steady and unsteady processes in energetic machines
PEU_U05	ability to analyze numerical results and drawing proper conclusions

PROGRAMME CONTENT

Form of classes - lecture		Number of hours
Lec1	Organizing issues. Introduction to Computational Fluid Dynamics (CFD).	2
Lec2	Description of heat transfer and fluid mechanics equations.	2
Lec3	Types of boundary conditions and their application.	2
Lec4-6	Finite volume method	6
Lec6	Algorithm for pressure and velocity fields calculations for fluid flow.	2
Lec7	Iteration methods for solving algebraic systems of equations.	2
Lec9	Turbulence. Models of turbulence.	2
Lec10	Types of numerical errors during CFD simulations and their influence on calculations.	2
Lec11-12	Large Eddy Simulation (LES) method.	4
Lec13-14	Optimizing of energy generation installations .	4
Lec15	Examples of energetic systems optimizing.	2
Total hours		30

laboratory		Number of hours
La1	Course matters (input, output, grading). Introduction to the course. Overview of the tools used (Matlab, CFX, Ansys Meshing). Lumped thermodynamic model of an energy installation. Preliminary system analysis.	4
La2-3	Flow through isolated pipeline. Calculating CHT problem, solving for pressure losses. Testing numerical results stability and computational cost against mesh parameters.	8
La4	Results post-processing and visualization. Report generation. Simple scripting in data manipulations.	4
La5-7	CFD calculations and optimization of a heat exchanger.	12
La8-10	CFD calculations and optimization of a pump.	12
La11	CFD calculations of a renewable energy source – wind turbine	4
La12	CFD calculations of a renewable energy source – solar thermal collector	4
La13-15	Individual project	12
Total hours		60

TEACHING TOOLS USED	
N1	Multimedia presentation.
N2	Software for geometry and numerical mesh generation, for example ANSYS Spaceclaim, ANSYS Meshing
N3	Software for CFD simulation for example ANSYS CFX
N4	Office hours

EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT

Evaluation (F– forming (during semester), C– concluding (at semester end)	Educational effect number	Way of evaluating educational effect achievement
F1	PEU_U01- PEU_U05	Report 1
F2	PEU_U01- PEU_U05	Report 2
F3	PEU_U01- PEU_U05	Report 3
F4	PEU_U01- PEU_U05	Report 4
F5	PEU_U01- PEU_U05	Report 5

F6	PEU_U01- PEU_U05	Report 6
P1	PEU_W01- PEU_W08	Exam

PRIMARY AND SECONDARY LITERATURE

Primary literature	
1	Patankar S., Numerical Heat Transfer And Fluid Flow, McGraw-Hill, Book Company, 1980.
2	Versteeg H. K., Malalasekera W., An Introduction to Computational Fluid Dynamics. The Finite Volume Method, 2nd ed., Pearson Education Limited, 2007.
3	Anderson J. D., Computational Fluid Dynamics. The Basics with Applications., McGraw-Hill Book Company, 1995.
4	Jaworski Z., Numeryczna mechanika płynów w inżynierii chemicznej i procesowej (in Polish).
Secondary literature	
1	Tannehill J. C., Anderson D. A., Pletcher R. H., Computational Fluid Mechanics And Heat Transfer, Taylor & Francis, 1997.
2	Ferziger J. H., Peric M., Computational Methods For Fluid Dynamics, 3rd ed., Springer, 2007.
3	Hoffmann K. A., Chiang S. T., Computational Fluid Dynamics, 4^{th} edition, vol. I,II,III, Engineering Education System, 2000.

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)

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