Wrocław University of Science and Technology
Doctoral School

COURSE CARD

1. Basic information

Course name in English:	Modelling of selected thermal-fluid processes using advanced numerical tools such as CFD	
Course name in Polish:	Modelowanie wybranych procesów cieplno-przepływowych przy użyciu zaawansowanych narzędzi numerycznych typu CFD	
Number of hours:	15	
Type of course:	Elective course	
Form of course:	mixed forms (combination of lecture, seminar and laboratory)	
Code of course:		
Course leader:	dr hab. inż. Słąwomir Pietrowicz, prof. PWr	
Faculty of the course leader:	W9 Faculty of Mechanical and Power Engineering	
Email address of the course leader:	slawomir.pietrowicz@pwr.edu.pl	
Scientific discipline(s) assigned to the course (doctoral students representing the marked disciplines can participate in the course):	Architecture and urban planning	☒
	Automation, electronic, electrical engineering and space technologies	☒
	Information and communication technology	☒
	Biomedical engineering	☐
	Chemical engineering	☒
	Civil engineering, geodesy and transport	☒
	Materials engineering	☐
	Mechanical engineering	☒
	Environmental engineering, mining, and energy	☒
	Mathematics	☐
	Chemical sciences	☒
	Physical sciences	☒
	Management and quality studies	☐

2. Objectives

To impart knowledge on the methods of simulating thermal-flow phenomena

To develop the ability to select a numerical mesh for a given geometry

Training of the ability to perform numerical calculations for simple and complex heat-flow phenomena;

To learn the ability to make calculations for thermal-flow problems defined by the student
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3. Content

Detailed information about the course content, including topics and form of classes.

No.	Topic	Number of hours	Form of classes
1	Organizational matters. Introduction to Computational Fluid Dynamics (CFD).	2	lecture
2	Description of heat transfer equations and flow phenomena.	2	lecture
3	Modelling of heat transfer processes in ANSYS CFX	2	laboratory
4	Modelling of thermal-fluid processes for laminar flows in ANSYS CFX	2	laboratory
5	Analysis of turbulence phenomena using selected examples in ANSYS CFX	2	laboratory
6	Process modelling for multiple numerical domains	2	laboratory
7	Analysis of multiphase flow phenomena with selected examples in ANSYS CFX	2	laboratory
8	Credit test	1	seminar

4. Prerequisites

List of prerequisites relating to knowledge, skills and other competences for course participants.

1. Ability to create 3-D geometry in engineering software.

2. Knowledge of heat transfer and fluid mechanics.

3. Basic knowledge of partial differential equations

5. Learning outcomes

List of learning outcomes at level 8 of the Polish Qualifications Framework assigned to the course (mark the learning outcomes in the last column).

Symbol	**Learning outcome**	
	KNOWLEDGE. Doctoral student knows and understands:	
SzD_W3	the main trends in the development of the scientific or artistic disciplines covered in the curricula;	☒
SzD_W4	research methodology;	☒
SzD_W5	the rules for the dissemination of scientific results, including in open access mode;	☐
SzD_W6	the fundamental dilemmas of modern civilization;	☐
SzD_W7	the legal and ethical conditions of scientific activity;	☐
SzD_W8	the economic and other relevant conditions of scientific activity;	☐
SzD_W9	basic principles of knowledge transfer to the economic and social spheres and commercialisation of results of scientific activity and know-how related to these results.	☐

	SKILLS. Doctoral student is able to:	
SzD_U2	use knowledge from different fields of science or art to creatively identify, formulate and innovatively solve complex problems or perform research tasks, in particular: - define the purpose and subject of scientific research, formulate a research hypothesis, - develop research methods, techniques and tools, and use them creatively, - draw conclusions on the basis of scientific research; critically analyse and evaluate the results of scientific research, expertise and other creative work and their contribution to knowledge development; transfer the results of scientific activities to the economic and social spheres;	☒
SzD_U3	communicate on specialised topics to the extent that they enable an active participation in the international scientific community;	☒
SzD_U4	disseminate research results, including in popular forms;	☒
SzD_U5	initiate debates and participate in a scientific discourse;	☒
SzD_U6	be able to speak a foreign language at B2 level of the Common European Framework of Reference for Languages to a level that enables them to participate in the international scientific and professional environment;	☐
SzD_U7	plan and implement an individual or collective research or creative activity, including in an international environment;	☐
SzD_U8	independently plan and act for one's own development and inspire and organize the development of others;	☒
SzD_U9	plan classes or groups of classes and implement them using modern methods and tools.	☐
	SOCIAL COMPETENCES. Doctoral student is ready to:	
SzD_K3	fulfilling the social obligations of researchers and creators, initiate public interest activities, thinking and acting in an entrepreneurial way;	☒
SzD_K4	maintaining and developing the ethos of research and creative environments, including: - carrying out scientific activities in an independent manner, - respecting the principle of public ownership of research results, taking into account the principles of intellectual property protection.	☒

6. Evaluation

Short description of the method(s) used to evaluate the learning outcomes assigned to the course, e.g., exam, test, report, presentation, etc.

A test is planned at the last class.

7. Teaching methods

Short description of the teaching methods used during the course, e.g., multimedia presentation, discussion, literature studies, developing written documents, own work, etc.

Multimedia presentations are planned during the first two classes. Students will then continue in the computer room using software such as ANSYS.

8. Literature

List of primary and secondary literature used to prepare the course and including additional knowledge for participants, e.g., books, textbooks, research papers, standards, web pages, etc.

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.

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, 4th edition, vol. I,II,III, Engineering Education System, 2000.

9. Other remarks

Additional remarks, comments, (e.g., language of the course)

Language of the course is English