COURSE DESCRIPTION CARD - SYLLABUS

Course name
Modelling of reacting flows [N2EPiO1-TGiEO>MPR]

Course

Field of study
Industrial and Renewable Energy Systems

Year/Semester
1/2

Area of study (specialization)
Gas Technology and Renewable Energy

Profile of study
general academic

Level of study
second-cycle

Course offered in
Polish

Form of study
part-time

Requirements
compulsory

Number of hours

Lecture
0

Laboratory classes
18

Other
0

Tutorials
0

Projects/seminars
9

Number of credit points

2,00

Coordinators

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Lecturers

Prerequisites

Knowledge: Student has basic knowledge from thermodynamics, fluid mechanics, programming and computional numerical methods Skills: Student can use the scientific method for problem solving, experimenting, and making conclusions, as well as the concepts in the description of programming languages. Student is able to deal with specific problems that arise during the writing of programs. Social competencies: student knows the limitations of his or her own knowledge and skills, understands the non-technical aspects and results of engineering activity and their importance. Demonstrates self- reliance in solving problems, acquiring and improving knowledge and skills.

Course objective

The aim of the course is an introduction of software tools for problems involving chemical kinetics, thermodynamics, and/or transport processes. Students acquire knowledge and skills in a modeling of power cycles and understatement of differences between simplified analytical calculation results and a numerical solution in the field of heat and mass transfer with reacting mixture flow.

Course-related learning outcomes

Knowledge:

student has extended and deep knowledge in the field of computational fluid dynamics and combustion process
student has knowledge of modern design and optimization methods of machinery and equipment used in energy industry
student has knowledge of the negative impact of air pollution on the natural environment and also knows civilization dilemmas related to the energy usage

Skills:
student is able to use his knowledge and skills to choose the right methods and tools (including specialized software) to solve problems in the field of reacting flows modelling
student is able to notice systemic and non-technical aspects when formulating and solving engineering tasks in the field of combustion processes
student is able to solve research and engineering tasks requiring the use of engineering standards and norms as well as the use of technologies appropriate for industrial and renewable energy, using experience gained in an professional environment engaged in engineering activities

Social competences:
student is ready to critically assess knowledge and received information
student is ready to recognize the importance of knowledge in solving cognitive and practical problems and to seek expert opinions in case of difficulties in solving the problems
student is ready to fulfil social obligations during team work on complex cases

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Learning outcomes presented above are verified as follows:
Laboratory classes – evaluation of reports prepared on each exercises
Project classes - solving an engineering problem and final project

Programme content

Construction of computing algorithms. Introduction to software tools for problems involving chemical kinetics, thermodynamics, and/or transport processes. Domain discretisation methods. Modeling of heat and mass transfer. Modeling of combustion processes. Design and processing of chemical reaction mechanisms. Thermodynamic properties of flammable mixture. Surface chemistry. Description of the physical process. Simplified analytical calculations of designed process. Design of the computational program for thermodynamic cycles parameters calculation and optimization purposes with elementary numerical analysis. Simulation of the process with specialized computer software. Result presentation methods and discussion. Comparison between simplified analytical calculation results and a numerical solutions in the field of heat and mass transfer with reacting mixture flow.

Course topics

1. Introduction to numerical thermochemistry calculations
2. Modelling of ideal, semi-ideal and real gases
3. Modelling of equilibrium states
4. Mechanisms of reaction kinetics
5. Low-dimensional models - modelling of reactor networks and one-dimensional flames
6. CFD flow modelling with combustion

Teaching methods

1. Laboratory classes - demonstation of case study with extended explanation and tutorial, followed by student work on solving of the given task
2. Project- solving of complex multistage technical problem, which results in the final project preparation

Bibliography

Basic
1. A. Kowalewicz, Podstawy procesów spalania, WNT, 2000

2. J. Chomiak, Combustion: A study In Theory, Fact and Application, 1990
3. Ansys Fluent User/Theory Guide (help), Cantera Users Guide (https://cantera.org/)
Additional
1. T. Poinsot and D. Venante, Theoretical and Numerical Combustion, 2005
2. J. Warnatz, Combustion, 2006
3. K. Kuo, Principles of Combustion, 2005
4. www.python.org, www.matplotlib.or

Breakdown of average student's workload

	Hours	ECTS
Total workload	60	2,00
Classes requiring direct contact with the teacher	30	1,00
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	30	1,00