FACULTY OF MECHANICAL AND POWER ENGINEERING

SUBJECT CARD

Name in Polish	Modelowanie procesów spalania
Name in English	**MODELLING OF COMBUSTION PROCESSES**
Main field of study	Power engineering
Specialization	Computer Aided Mechanical and Power Engineering
Profile	academic
Level and form of studies	2nd level, full-time
Kind of subject	Optional/specialization
Subject code	W09ENG-SM0055W
Group of courses	No

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in university (ZZU)	30		30		
Number of hours of total student workload (CNPS)	60		60		
Form of crediting	Examination		crediting with grade		
For group of courses mark (X) final course					
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 (BK) classes	1		1,5		

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

Knowledge, skills and other competences in the range of: combustion, thermodynamics, fundamentals of fluid mechanics,

SUBJECT OBJECTIVES

C1 – The course provides an introduction to the subject of combustion process modeling, covering a broad range of topics important to the fields of energy conversion
C2 – To familiarize students with the basic aspects and equations describing the thermodynamics and gas dynamics in combustion process
C2 – To develop knowledge in basic mathematical description of processes occurring in combustion systems

SUBJECT EDUCATIONAL EFFECTS

relating to knowledge:

As a result of the performed classes a student should:

PEU_W01 – understand the physical and chemical aspects of combustion processes.
PEU_W02 – understand chemical kinetics and chemistry of combustion. The role of elementary and global reactions. Reaction rate expressions.
PEU_W03 – understand conversion formulas and thermochemical properties of the system. Heat of reaction and adiabatic flame temperature
PEU_W04 – understand chemical equilibrium and composition calculation
PEU_W05 – understand combustion modelling issues without transport. Idea reactor studies
PEU_W06 – understand combustion modelling issues with transport. Reactive flow and transport

phenomena. Turbulent combustion modelling PEU_W07 –understand standard turbulent combustion models and their limitations which are implemented in commercial CFD software packages **relating to skills:** **As a result of the performed classes a student should be able:** PEU_U01 – solve simple combustion problems by using the physical and chemical fundamentals of combustion processes PEU_U02 – calculate the stoichiometry, adiabatic flame temperature and heat of combustion of a fuel and oxidizer mixture PEU_U03 – use chemistry software to solve simple 0/1-d combustion problems such as perfectly stirred reactors

PROGRAMME CONTENT		
Form of classes - lecture		**Number of hours**
Lec1	Practical Applications of Combustion Modeling	2
Lec2	Chemical reactions	2
Lec3	Conversion Formulas. Thermochemical Properties	2
Lec4	Reaction Rate Expressions	2
Lec5	Complex Chemical Equilibrium. Compositions	2
Lec6	Heat of Reaction. Adiabatic Flame temperature.	2
Lec7	Differential equations of chemical reaction without transport	2
Lec8	The Continuously Stirred Tank Reactor	2
Lec9	Ignition, extinction and quenching of premixed flames	2
Lec10	Use chemistry software to solve simple 0 or 1-d combustion problems	2
Lec11	Introduction to reactive flow. Transport Equations.	2
Lec12	Laminar premixed and diffusion flames..	2
Lec13	Turbulent combustion modelling.	2
Lec14	Standard for modeling and simulating complex gas phase chemistry reactions	2
Lec15	Summary	2
	Total hours	**30**
Form of classes - laboratory		**Number of hours**
Lab1	Calculation of thermochemical properties of gas using coefficients in NASA format	2
Lab2	Calculation of theoretical flame temperature.	2
Lab3	The standard heat of combustion of gases	2
Lab4	Callculation of equilibrium compositions	2
Lab5	Callculation of equilibrium compositions	2
Lab6	Adiabatic flame temperature	2
Lab7	Adiabatic flame temperature	2
Lab8	Application of the reaction ordinate variable in the analysis of equilibrium states	2
Lab9	Model PSR (mixture: (H2-O2)) - use chemistry software	2
Lab10	Model PSR (mixture: (H2-O2)) - use chemistry software	2
Lab11	Model PSR – evaluating NO emission - use chemistry software	2
Lab12	PSR - Sensitivity and flux analysis	2
Lab13	PSR - Sensitivity and flux analysis	2
Lab14	Modeling ignition gases - use chemistry software	2
Lab15	Modeling ignition gases - use chemistry software	2
	Total hours	**30**

TEACHING TOOLS USED
N1. Traditional lecture with the use of multi-media presentation. N2. Tutorials using dedicated software.

N3. Consultations.

EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT- lecture

Evaluation (F– forming (during semester), C– concluding (at semester end)	Educational effect number	Way of evaluating educational effect achievement
C	PEK_W01÷PEK_W07	Exam

EVALUATION OF SUBJECT EDUCATIONAL EFFECTS ACHIEVEMENT- laboratory

Evaluation (F– forming (during semester), C– concluding (at semester end)	Educational effect number	Way of evaluating educational effect achievement
F1	PEK_U01 ÷ PEK_U03	Final test
F2	PEK_U01 ÷ PEK_U03	Activity
C=0.8·F1+0.2·F2		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE :

[1] „Gas phase combustion chemistry" - Gardiner 2000
[2] Introduction to Chemical Engineering Thermodynamic, J.M. Smith, H.C. Van Ness, M.M. Abbot, M.T. Swihart
[3] Theoretical and numerical combustion, T.Poinsot, D.Veynante, 2005
[4] An-Introduction-to-Computational-Fluid-Dynamics, H. Versteeg, 2007

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

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