Modeling of combustion processes

Faculty of	**Mechanical and Power Engineering**
Name in English	**Modeling of combustion processes**
Name in Polish	**Modelowanie procesów spalania**
Main field of study	**Power Engineering**
Specialization	**-**
Level of studies	**II level**
Form of studies	**full-time**
Kind of subject	**wybieralny**
Subject code	**W09ENG-SM2342**
Group of courses	**NO**

	Lecture	Classes	Laboratory	Project	Seminar
Number of hours of organized classes in University (ZZU)	15		30		
Number of hours of total student workload (CNPS)	50		50		
Form of crediting	Egzamin		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	0,84		1,36		

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1.	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
C3	To develop knowledge in basic mathematical description of processes occurring in combustion systems

SUBJECT LEARNING OUTCOMES

relating to knowledge:	
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. Ideal 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:	
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
relating to social competences:	
PEU_K01	Soft skills during team work

PROGRAMME CONTENT

Form of classes - lecture		Number of hours
Wy1	Practical Applications of Combustion Modelling	2
Wy2	Chemical reactions	2
Wy3	Conversion Formulas. Thermochemical Properties	2
Wy4	Reaction Rate Expressions	2
Wy5	Complex Chemical Equilibrium. Compositions	2
Wy6	Heat of Reaction. Adiabatic Flame temperature.	2
Wy7	Differential equations of chemical reaction without transport	2
Wy8	The Continuously Stirred Tank Reactor	2
Wy9	Modelling of autoignition	2
Wy10	Mechanism reduction	2
Wy11	Introduction to reactive flow. Transport Equations.	2
Wy12	Laminar premixed and diffusion flames.	2
Wy13	Turbulent combustion modelling.	2
Wy14	Standard for modeling and simulating complex gas phase chemistry reactions	2
Wy15	Summary	2
Suma godzin		30

laboratory		Number of hours
La1	Calculation of thermochemical properties of gas using coefficients in NASA format	2
La2	Calculation of theoretical flame temperature	2
La3	The standard heat of combustion of gases	2
La4	Callculation of equilibrium compositions	2
La5	Callculation of equilibrium compositions	2
La6	Adiabatic flame temperature	2
La7	Adiabatic flame temperature	2
La8	Application of the reaction ordinate variable in the analysis of equilibrium states	2
La9	Model PSR (mixture: (H2-O2)) - use chemistry software	2
La10	Model PSR (mixture: (H2-O2)) - use chemistry software	2
La11	Model PSR – evaluating NO emission - use chemistry software	2
La12	Modelling reactive flow with transport equations	2
La13	Modelling turbulent reactive flow	2
La14	Modelling turbulent reactive flow	2
La15	Modelling turbulent reactive flow	2
Suma godzin		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

Evaluation (F– forming (during semester), C– concluding (at semester end)	Educational effect number	Way of evaluating educational effect achievement
F1	PEU_U01 ÷ PEU_U03	Final test
F2	PEU_U01 ÷ PEU_U03	Activity
P1	PEU_W01÷PEU_W07	Exam

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
Secondary literaturę	
1	An-Introduction-to-Computational-Fluid-Dynamics, H. Versteeg, 2007

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

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