

STUDY COURSE DESCRIPTION FORM		
Name of the course		Code
Thermodynamical and optical analysis of fast instationary physical processes in closed chambers		
Name of the doctoral school		Year /Semester
Poznan University of Technology Doctoral School		
Specialty/Discipline		Type (obligatory, elective):
Civil engineering and transport		elective
No. of hours		No. of credits
Lectures: 4 Classes: - Laboratories: - Seminars: -		1
Cycle of study: Third-cycle studies (Polish Qualifications Framework level eight)		
Form of study: Full-time		
Assessment: project		
Responsible for the course/lecturer: prof. dr hab. inż. Krzysztof Wisłocki e-mail: krzysztof.wislocki@put.poznan.pl phone : +48 61 665 2240 Faculty of Civil and Transport Engineering Poznan University of Technology Piotrowo 3 street, 60-965 Poznan, Poland		
Prerequisites in terms of knowledge, skills and social competencies:		
1	Knowledge: Student has the basic knowledge of physical and thermal processes concerning combustible mixture formation, ignition and combustion in the closed chambers (e.g. of internal combustion engines). He should know the essence of these processes and main rules and targets of controlling them. He should know the main mathematical basics for modeling of them.	
2	Skills: Student is able to explain the basics of the in-cylinder physical and chemical processes and is able to plan the experimental research. He should be able to explain the causes of imperfections of these processes and he know the expectations for optimal realization of them.	
3	Social competencies: Student is able to operate in the student group, playing different rules in it. He can define priorities when he solves defined tasks. Student exhibits the independence in problem solving, the acquisition and improvement of acquired knowledge and skills.	
Objective of the course: The aim of the subject is to provide students with information from a range of investigation methods of thermal processes in closed chambers (e.g. IC engines). The basic knowledge of indication methods of high-speed instationary pressure history will be characterized and its interpretation will be discussed. From the other hand the optical investigation methods of in-cylinder processes like fuel injection, spray development and combustible mixture formation will be presented and correlated with the thermodynamic parameters of the process. Main rules of optical observation and of movies recording for ignition, flame development and temperature distribution across combustion chamber will be presented and discussed.		
Educational results (Study outcomes)		
Knowledge:		
P8S_WG	Student has a basic knowledge of the fundamental physical and thermal processes due to the operation of an internal combustion engine. He will be familiar with the essence of those processes and the basic principles of their thermodynamic and physical diagnostics.	SzD_W01

P8S_WG	Student can describe the methods of investigation of in-cylinder processes for better understanding of their nature and for their quantitative assessment. He knows main rules of their practical application.	SzD_W02 SzD_W03
P8S_WG	Student should understand the principles of optical methods of observing and registering of fast developing physical processes like spray penetration, forming of droplets, flammable mixture formation, areas of self-ignition and flame front propagation.	SzD_W03 SzD_W04
Skills:		
P8S_UW	Student can explain the essence of thermal processes occurring in closed chambers, e.g. in internal combustion engines. He can applied optical and thermodynamic methods of their observation, validation and interpretation. Based on investigation results he can explain possible causes of imperfections in injection, ignition and combustion processes in the closed chambers (e.g. cylinder of internal combustion engine). He can assess the causes of excessive toxic emissions in the combustion chamber and can plan the experimental studies of selected thermal processes.	SzD_U01 SzD_U02
P8S_UK	Student can retrieve information from the literature, the Internet, databases, and other sources, in the language of Polish and foreign, can integrate the information to interpret and draw conclusions from them, and create and justify reviews; he can use learned theories math for the creation and analysis of simple models of charge exchange systems, fuel injection and combustion in thermal engines. Student is able to identify and describe the basic relationships of cause and results in modern combustion systems.	SzD_U04
Social competencies:		
P8S_KK	Student understands the need and possibilities of continuous learning, knows the need to gain new knowledge in order to his professional development; he is able to reason in a targeted, recognize relationships of cause and result and to take effective action to achieve the assumed effect; he is aware of the transfer of knowledge to the public, shall endeavor to this information understandable.	SzD_K01 SzD_K02
P8S_KO	Student is able to consciously and deliberately select any optical research method for solving scientific problems and to describe them in the proper way.	SzD_K06
Compulsory literature:		
<ol style="list-style-type: none"> 1. Wislocki K.: Thermodynamical and optical analysis of fast instationary physical processes in closed chambers. Script for lectures (PDF), 2019, ss. 60. 2. Rychter T., Teodorczyk A.: Teoria silników tłokowych. WKiŁ, Warszawa 2006, ss. 270; 3. Kowalewicz A.: Podstawy procesów spalania. WNT, Warszawa 2000. Orzechowski Z., Prywer J.: Rozpylanie cieczy. WNT, Warszawa 1991. 		
Additional literature:		
<ol style="list-style-type: none"> 1. Kowalewicz A.: Wybrane zagadnienia samochodowych silników spalinowych, Wyższa Szkoła Inż., Radom 1996, ss. 349. Kowalczyk M.: Promienne właściwości płomieni silników wysokoprężnych. Wyd. Pol. Pozn. 1995. 3. Orzechowski Z., Prywer J.: Rozpylanie cieczy. WNT, Warszawa 1991. 4. Kowalewicz A.: Tworzenie mieszanki i spalanie w silnikach o zapłonie iskrowym. WKiŁ, Warszawa 1984, ss. 260. 5. Kowalewicz A.: Systemy spalania szybkoobrotowych silników spalinowych. WKiŁ, Warszawa 1980, ss. 384. 		
COURSE DESCRIPTION		
	General issues	Specific issues
		No. of hours

1	Basic Definitions of Physical and Thermal processes in closed chambers	<ul style="list-style-type: none"> • Definition and basics of non-stationary pressure indication in closed chambers and the rules of interpretation of results. • Areas of application of optical investigation methods. • Basics and main rules of optical observation in fast changing processes in closed chambers. • Recording of non-laminating and self-laminating phenomena, computational analysis of the pictures and interpretation of results. 	1
2	Basic of optical research methods and necessary technical equipment	<ul style="list-style-type: none"> • General rules for defining of test-bed equipment for specific investigations • Selecting of light source and light wave length for specific investigation tasks; Light beam filtering and double-picture recording • Main rules for the processing of test results records, interpretation of light intensity, luminance and wave-length 	1
3	Test-bed organization for carrying of optical investigations and measuring of thermodynamic indexes	<ul style="list-style-type: none"> • Describing typical test bed for thermodynamical and optical analysis of in-cylinder process and phenomena. • Experimental model for optical investigations • Synchronization of the observed phenomenon frequency and speed of pictures registration • IC Engine indication and cylinder pressure measurements; cylinder pressure history and its physical and thermodynamic interpretation • Examples of practical investigation results and their interpretations. 	1
4	Possible interpretations of optical investigations results	<ul style="list-style-type: none"> • Vaporization models of fuel droplets; auto-ignition delay: chemical and physical processes, modeling; pre-flame processes; the process of combustion, its phase • Formulating of conclusions from optical investigations. 	1

Assessment methods of educational results

Project – each student will prepare an individual concept with his proposal of any implementation of optical investigation in his own doctoral project.

STUDENT'S WORKLOAD

Activity	Hours
Participation in lectures, classes, seminars and laboratories	4
Contact hours with lecturers	1
Self-study	4
Exam	1
TOTAL	10
TOTAL NUMBER OF ECTS POINTS FOR THE COURSE	1