COURSE DESCRIPTION CARD - SYLLABUS

Course name
Research and control of combustion engines

Course

Field of study
Mechanical and Automotive Engineering

Year/Semester
4/7

Area of study (specialization)
Hybrid powertrain systems

Profile of study
general academic

Level of study
First-cycle studies

Course offered in
polish

Form of study
full-time

Requirements
elective

Number of hours

Lecture
45

Laboratory classes
15

Other (e.g. online)
0

Tutorials
15

Projects/seminars
0

Number of credit points

5

Lecturers

Responsible for the course/lecturer:
DEng. Łukasz Rymaniak

email: lukasz.rymaniak@put.poznan.pl

tel. +48 61 665 2243

Faculty of Civil and Transport Engineering

Piotrowo 3, 60-965 Poznań, Poland

Responsible for the course/lecturer:
DEng. Maciej Babiak

email: maciej.babiak@put.poznan.pl

tel. +48 61 665 2049

Faculty of Civil and Transport Engineering

Piotrowo 3, 60-965 Poznań, Poland

Prerequisites

Knowledge:
Basic knowledge of the laws of physics, in particular in the field of mechanics, electrical engineering and electronics.
Basic knowledge of the operation of heat engines.

Skills:
Ability to operate basic measuring devices.

Social competence:
Awareness of the need to acquire knowledge and use it in various fields of technical and natural

sciences.
Preparation for team work, including assuming various roles within the research group.

Course objective

Presentation of basic information on the research of thermal machines, in particular piston internal combustion engines and their functional systems.

Explaining the concepts and purpose of controlling and regulating internal combustion engines. Acquainting with the requirements, construction and operation of control and regulation systems. Explain the benefits of adaptive control and regulation. Acquiring the ability to build simple electronic control systems for internal combustion engine systems.

Course-related learning outcomes

Knowledge

Has knowledge in the field of physics, including the basics of classical mechanics, optics, electricity and magnetism, solid state physics, quantum and nuclear physics, necessary to understand specialist lectures in the field of the theory of construction materials and materials science, theory of machines and mechanisms, theory of electric drives and mechatronic systems .

Has ordered basic knowledge of the main divisions of technical mechanics: statics, kinematics and dynamics of a material point and a rigid body.

Has basic knowledge of the methods of linear measurements, measurements of stresses, strains, velocities, temperatures and fluid streams, including measurements of these quantities by electrical means.

Skills

Can obtain information from literature, the Internet, databases and other sources. Can integrate the obtained information, interpret and draw conclusions from it, and create and justify opinions.

Can properly use modern equipment for measuring major physical quantities, used in machine research and production control.

Can create a system diagram, select elements and perform basic calculations using ready-made computational packages of mechanical, hydrostatic, electric or hybrid machine drive system.

Social competences

Is ready to critically assess his knowledge and received content

Is ready to recognize the importance of knowledge in solving cognitive and practical problems and to consult experts in case of difficulties in solving the problem on its own.

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Assessment on the basis of a written exam during the examination session and completed classes and laboratory classes (reports + tests).

Programme content

The following issues will be presented in the program content:

-Selected issues of metrology,

-Measurement methods, construction of the measurement path, measurement sensors, recording devices,

-Construction of the dyno stand,

-Measurements of the quantities characterizing the operation of the internal combustion engine (temperature, pressure, frequency of rotation, torque, power, air and fuel consumption),

-Methods of measuring toxic compounds in exhaust gases,

-Vibration and noise measurements.

-Determining typical characteristics of internal combustion engines.

-Basics of unconventional research methods.

General characteristics of the combustion system in engines. The need for regulation and areas of its application. Requirements for control systems with regard to: fuel dose, boost pressure, EGR, injection / ignition start, coolant temperature. The concept of correction, justification of its need. Design measures used to achieve engine performance. Disadvantages of mechanical and analog systems.

The idea of regulation and control of modern engines: the use of electronics and IT means, maps of regulation and control, taking into account the current thermodynamic state of the engine and environmental conditions. Basic knowledge: control, regulation, feedback, types of regulation (fixed value, follow-up, optimal, adaptive), general structure of the regulation system. Controls: tasks, general layout diagram.

Physical basics of converting mechanical quantities into electrical ones, types of sensors. Measurement path: sensor, amplifier, A / D converter, the role of the amplifier, converting the analog form of a signal to digital). Measurement of: rotational speed, temperature, pressure, linear and angular displacement, mass flow, chemical composition (exhaust gas).

Controllers (general structure structure, regulation and control functions, general idea of regulation and control algorithms, form of the output signal).

Teaching methods

1. Lecture with multimedia presentation

2. Laboratories - solving laboratory tasks

3. Classes - solving auditorium tasks

Bibliography

Basic

1. Serdecki W. (red.): Badania silników spalinowych - Laboratorium (Combustion engine research - Laboratory). WPP, Poznan, 2012 or later releases.

2. Gajek A., Juda Z., Czujniki (Sensors). WKŁ, Warsaw 2008.

3. Termodynamika. Laboratorium I miernictwa cieplnego, część 1 (Thermodynamics. Laboratory of thermal metrology, part 1). Group work, Gdańsk, WPG 1993.

4. Termodynamika. Laboratorium II. Badania maszyn i urządzeń (Thermodynamics. Laboratory II. Research of machines and devices). Group work, Gdańsk, WPG 1991.

5. Konrad Reif, Gasoline Engine Management, Springer 2015

6. Konrad Reif, Diesel Engine Management, Springer 2014.

7. Rolf Isermann, Engine Modeling and Control, Springer 2014.

8. Konrad Reif, Automotive Mechatronics, Springer 2014.

9. Bosch, Automotive Electrics and Automotive Electronics, Springer 2014.

10. Herner Anton, Riehl Hans Jurgen, Elektrotechnika i elektronika w pojazdach samochodowych (Electrical engineering and electronics in motor vehicles), WKŁ, Warsaw 2013.

Additional

1. Engine manufacturer materials, conference and industry materials: Combustion Engines, MTZ, SAE.

2. Chwaleba A., Poniński M., Siedlecki A.: Metrologia elektryczna (Electrical metrology), Warsaw, WNT 1994.

3. Konrad Reif: Fundamentals of Automotive and Engine Technology, Springer 2014.

4. Bosch: Sieci wymiany danych w pojazdach samochodowych (Data exchange networks in motor vehicles), WKŁ, Warsaw 2016.

5. Tadeusz Kaczorek, Andrzej Dzieliński, Włodzimierz Dąbrowski, Rafał Łopatka: Podstawy teorii sterowania (Fundamentals of control theory), WNT, Warsaw 2005.

6. Kozak W.: Fizykochemiczne podstawy regulacji i sterowania silników spalinowych (Physicochemical basics of regulation and control of internal combustion engines). Wydawnictwo Politechniki Poznańskiej 2011.

7. Bosch: Sterowanie silników o zapłonie iskrowym. Zasada działania. Podzespoły (Control of spark ignition engines. Principle of operation. Components), WKŁ, Warsaw 2013.

8. Bosch: Sterowanie silników o zapłonie iskrowym. Układy Motronic (Control of spark ignition engines. Motronic systems), WKŁ, Warsaw 2007.

9. Bosch: Sterowanie silników o zapłonie samoczynnym (Control of compression ignition engines), WKŁ, Warsaw 2006.

10. Bosch, Promieniowe rozdzielaczowe pompy wtryskowe VR (VR centrifugal distributor injection pumps), WKŁ, Warsaw 2014.

11. Bosch, Układy wtryskowe Unit Injector System/Unit Pump System (UIS/UPS), Warsaw 2014.

12. Bosch, Zasobnikowe układy wtryskowe Common Rail (Common Rail fuel injection systems), WKŁ, Warsaw2009.

13. Bosch, Czujniki w pojazdach samochodowych (Sensors in motor vehicles), WKŁ, Warsaw 2014.

Breakdown of average student's workload

	Hours	ECTS
Total workload	125	5,0
Classes requiring direct contact with the teacher	75	3,0
Student's own work (literature studies, preparation for laboratory classes/tutorials, preparation for tests/exam, project preparation) [1]	50	2,0

[1] delete or add other activities as appropriate