COURSE DESCRIPTION CARD - SYLLABUS

Course name
Energy management in drives [S2MiBP1-HSN>ZEwN1]

Course

Field of study
Mechanical and Automotive Engineering

Year/Semester
1/1

Area of study (specialization)
Hybrid Powertrain Systems

Profile of study
general academic

Level of study
second-cycle

Course offered in
polish

Form of study
full-time

Requirements
compulsory

Number of hours

Lecture
30

Laboratory classes
0

Other (e.g. online)
0

Tutorials
15

Projects/seminars
0

Number of credit points

3,00

Coordinators

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Lecturers

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Prerequisites

KNOWLEDGE: the student has basic general knowledge in the field of mechanics, physics, chemistry, technical drawing, material strength suitable for the second degree of technical studies and about the design and construction of components of internal combustion engine systems. SKILLS: the student is able to integrate the obtained information, interpret it, draw conclusions, formulate and justify opinions, especially in the field of processes and phenomena occurring in internal combustion engines, shows technical thinking, associating cause and effect relationships in mechanics, physics, chemistry. SOCIAL COMPETENCES: the student is aware of the social and economic importance of energy consumption and is aware of the importance and understands the technical aspects and effects of the operation of internal combustion engines, and demonstrates independence in solving problems, gaining and improving the acquired knowledge and skills.

Course objective

Classes are divided into two modules covering a comprehensive issue related to energy management in modern drive systems of motor vehicles. The first module deals with the issues related to the operation of an internal combustion engine in a hybrid system. This module will cover issues related to the basic concepts of the formation of a combustible mixture, the processes of spontaneous and foreign ignition, as well as the processes of combustion and flame propagation. The student will learn the methods and systems of generating the movement of the charge inside the cylinder, the turbulence of the charge and its influence on the process of creating a combustible mixture and its combustion. The student will learn about the thermodynamic analysis of the real engine cycle, methods of determining the amount of heat produced and the rate of its release in the aspect of controlling the combustion process. Will be able to assess the relationship between the thermal efficiency of the cycle, the emission of toxic compounds as well as thermal and mechanical loads occurring in the cylinder and the crank-piston system of the internal combustion engine. The student will learn about fuel injection models and its control, as well as models of combustion (heat release) and the formation of toxic compounds. He also learns about the sources of heat losses resulting from heat conduction through the walls of the combustion chamber, blowing to the crankcase, radiation losses and others. The second module covers the cooperation of the internal combustion engine with the electric drive in alternative systems. The student will learn about the energy balance of various types of alternative drives. He will learn about energy storage systems in vehicles and methods of managing its flow.

Course-related learning outcomes

Knowledge:
Has a general knowledge of the types of research and methods of testing working machines with the use of modern measurement techniques and data acquisition.
Has extended knowledge of the standards for working machines in the field of methods of calculating and testing machines, safety, including road safety, environmental protection as well as mechanical and electrical interface.
Has extensive knowledge of modern machine manufacturing technologies in the field of designing the production process of machine parts and their assembly using computer CAM tools

Skills:
Can formulate and test hypotheses related to simple research problems.
Is able to carry out basic measurements of mechanical quantities on the tested working machine with the use of modern measuring systems.
Can communicate on specialist topics with a diverse audience.
Can lead the team"s work.

Social competences:
He 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.
Is ready to fulfill professional roles responsibly, taking into account changing social needs, including:
- developing the professional achievements,
- maintaining the ethos of the profession,
- observing and developing the rules of professional ethics and acting towards the observance of these rules.

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Learning outcomes presented above are verified as follows:
Written exam, final test, computational exercises.

Programme content

1. Engine cylinder gas balance, charge exchange rates, ideal charge exchange models, simplified cylinder charge calculation, cylinder charge movement
2. Mixture formation, fuel injection, fuel atomization mechanism, atomization spectrum, mean droplet diameter (SMD), fuel evaporation

3. Ignition and combustion, chemical processes during the auto-ignition delay, models of auto-ignition, multi-staggering of the pre-flame processes in the engine, universal formula for delaying auto-ignition, essential phases of combustion
4. Energy balance in a cylinder, heat transfer, calculation of energy balance in a cylinder of an internal combustion engine.
5. Modeling of the combustion process
6. Formation of toxic components of exhaust gases, formation of soot in the cylinder of a diesel engine
7. Fixed operating conditions of the internal combustion engine in alternative drive systems
8. Energy storage systems in vehicles
9. Energy balance of various types of drive systems
10. Regenerative braking systems
11. Methods of determining the charge level of the battery in alternative vehicles
11. Energy management of a mild-hybrid vehicle
12. Energy management in full hybrid vehicles with plug-in systems
13. Range Extender systems

Teaching methods

1. Lecture with multimedia presentation, didactic trip closely related to the topic of the classes.
2. Exercises - solving problems

Bibliography

Basic
11. Rychter T., Teodorczyk A.: Teoria silników spalinowych. WKiŁ, Warszawa 2005.
2. Kowalewicz A.: Podstawy procesów spalania. WNT. Warszawa 2000.
3. Wisłocki K.: Studium wykorzystania badań optycznych do analizy procesów wtrysku i spalania w silnikach o zapłonie samoczynnym. Wydawnictwo Politechniki Poznańskiej 2004.
3. Pielecha I.: Optyczne metody wtrysku i spalania benzyny. Wydawnictwo Politechniki Poznańskiej 2017.
4. Serdecki W. (red.): Badania silników spalinowych. Wyd.PP, 2012
5. Merkisz J. Pielecha I., Układy mechaniczne pojazdów hybrydowych, Wydawnictwo Politechniki Poznańskiej, Poznan 2015.
6. Merkisz J. Pielecha I., Układy mechaniczne pojazdów hybrydowych, Wydawnictwo Politechniki Poznańskiej, Poznan 2015.
7. Schmidt T. Pojazdy hybrydowe i elektryczne w praktyce warsztatowej, WKŁ, Warszawa 2020
8. Czasopismo: electric & hybrid vehicle technology international
Additional
1. Andreas Wimmer, Josef Glaser. Indykowanie silnika. Warszawa 2004.
2. Niewiarowski K.: Tłokowe silniki spalinowe. WKiŁ, Warszawa 1983.
3. Kowalewicz A.: Systemy spalania szybkoobrotowych tłokowych silników spalinowych. WKiŁ. W-wa, 1980.
4. Kowalewicz A.: Tworzenie mieszanki i spalanie w silnikach o zapłonie iskrowym. WKiŁ. Warszawa, 1984.
5. Serdecki W. (red.): Badania układów silników spalinowych. Wyd.PP, 2000.
6. Pielecha I., Cieslik W. Thermodynamic analysis of indexes of operation of the engine with direct fuel injection for idle speed and acceleration. Journal of Thermal Analysis and Calorimetry. Mai 2016. doi: 10.1007/s10973-016-5544-1
7. Pielecha I., Cieślik W., Merkisz J., Analysis of the electric drive mode use and energy flow in hybrid drives of SUVs in urban and extra-urban traffic conditions. Journal of Mechanical Science and Technology. 2019, 33(10); 5043-5050. DOI 10.1007/s12206-019-0943-4
7. Artykuły naukowe w zakresie tematyki: SAE, MTZ, Combustion Engines

Breakdown of average student's workload

	Hours	ECTS
Total workload	75	3,00
Classes requiring direct contact with the teacher	45	2,00
Student's own work (literature studies, preparation for laboratory classes/ tutorials, preparation for tests/exam, project preparation)	30	1,00