COURSE DESCRIPTION CARD - SYLLABUS

Course name
Systems of energy generation for propulsion of machines and vehicles

Course

Field of study
Mechanical engineering

Year/Semester
3/6

Area of study (specialization)

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
15

Laboratory classes
15

Other (e.g. online)
0

Tutorials
0

Projects/seminars
0

Number of credit points

3

Lecturers

Responsible for the course/lecturer:
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Responsible for the course/lecturer:
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Prerequisites

Knowledge:The student has knowledge of technical mechanics. He knows the basics of physics, mechanics, thermodynamics and fluid mechanics.

Skills: The student Is able use the following languages: native and international to a degree enabling the understanding of technical texts. He 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.

Social competencies: Understands the need and knows the possibilities of lifelong learning..

Course objective

To acquaint students with the basic methods of converting chemical and electric energy into mechanical energy for the purposes of driving machines and vehicles. Overview of the principles of operation of internal combustion engines (piston and turbine), electric and fuel cells and their operational characteristics. Discussion of the structures and basic components of the drive train and their influence on the shaping of the driving force supply. Overview of sources and methods of estimating the demand for mechanical energy. Provide students with the skills of functional modeling of mechanical energy generation systems and drive transmission systems.

Course-related learning outcomes

Knowledge

1. Has knowledge of physics, including elements of relativistic mechanics, analysis of physical phenomena and solving technical problems based on the laws of physics [K_W02].

2. Has an ordered, theoretically founded knowledge of technical mechanics and fluid mechanics [K_W03].

3. Has a basic knowledge of technical thermodynamics concerning its application to describe physical phenomena and mathematical modeling of heat transfer in technological processes [K_W11].

Skills

1. Can obtain information from literature, databases and other properly selected sources (also in English or another foreign language recognized as the language of international communication) in the field of mechanics and machine construction as well as other engineering and technical issues consistent with the field of study; is able to integrate the obtained information, interpret it, as well as draw conclusions and formulate and justify opinions [K_U01].

2. Can work individually and in a team; knows how to estimate the time needed to complete the commissioned task; is able to develop and implement a work schedule ensuring meeting deadlines [K_U02].

3. Is able to develop documentation concerning the implementation of an engineering task in the field of mechanics and machine construction (construction, technology, organization) and prepare a text containing an overview of the results of this task [K_U03].

Social competences

1. Understands the need for lifelong learning; can inspire and organize the learning process of other people [K_K01].

2. He can think and act in an entrepreneurial way [K_K06].

Methods for verifying learning outcomes and assessment criteria

Learning outcomes presented above are verified as follows:

Lectures: Exam

Laboratory: assessment is based on the results of the current control of preparation for classes and reports on the exercises performed.

Programme content

LECTURES:

Lecture 1 - Sources of energy, methods of its processing and their effects

Introduction to the classification of energy sources and methods of its conversion into mechanical energy used to drive machines and vehicles. Overview of the types of energy. The problem of energy balance and efficiency of energy conversion. Ecological effects of energy conversion, carbon dioxide balance.

Lecture 2 - Systems of generating mechanical energy to drive machines and vehicles - part 1

Fundamentals of construction and operation of internal combustion piston and turbine engines used in machine and vehicle drive systems. Basics of thermodynamic processes used in engine methods of converting chemical energy into mechanical. Basic operational characteristics of internal combustion engines.

Lecture 3 - Systems of generating mechanical energy to drive machines and vehicles - part 2

Classification of electric motors. Fundamentals of construction and operation of electric motors. Basic operating characteristics of electric motors.

Lecture 4 - Fuel cell and electricity storage

Basic issues related to the construction of fuel cells, their types and operational characteristics. Electricity storage issues - the size of the needs. Types and characteristics of electric energy accumulators. Types and characteristics of supercapacitors.

Lecture 5 - Operating demand for mechanical energy

The idea of using driving cycles - operation and test. Estimating the demand for mechanical energy for propulsion purposes, taking into account the influence of vehicle parameters. Taking into account the efficiency of the drive train and the energy generation system. Simulation forecasting of energy consumption (electricity, fuel, etc.) for vehicle propulsion.

Lecture 6 - Vehicle transmission systems

Overview of the construction of drive transmission systems in vehicles - structures, basic components and their functions and characteristics. Influence of the structure and characteristics of subassemblies on the power supply and driving force characteristics. Typical design solutions of basic components. Efficiency of drive transmission systems.

Lecture 7 - Hybrid drive systems

The idea of hybrid drive systems. Possibilities and benefits resulting from the use of hybrid drive systems. Structures and characteristics of hybrid drive systems. Construction of hybrid drive systems. Recuperation and energy flow control.

Lecture 8 - Drive systems for rail vehicles, vessels and airplanes.

Fundamentals of propulsion systems used in rail vehicles, vessels and airplanes. Basic design solutions and their operating characteristics.

LABORATORIES:

Laboratory 1 - Introduction to mathematical modeling of physical systems

Basic issues related to the simulation environment, data input, results presentation, model construction and modification.

Laboratory 2 - Construction of simulation models of internal combustion engines

Overview of the creation of a functional model of the internal combustion engine in the simulation program environment. The use of characteristics and operating parameters of internal combustion engines in modeling.

Laboratory 3 - Construction of simulation models of electric motors

Overview of creating functional models of electric motors in the simulation program environment. The use of characteristics and operating parameters of electric motors in modeling.

Laboratory 4 - Construction of fuel cell simulation models

Overview of creating a functional model of a fuel cell in a simulation program environment. The use of characteristics and operational parameters of a fuel cell in modeling.

Laboratory 5 - Construction of simulation models of drive transmission systems

Overview of creating models of drive transmission systems. Modeling of mechanical transmissions and clutches in the environment of the simulation program. The use of characteristics and operating parameters of components of drive transmission systems in their modeling.

Laboratory 6 - Construction of electric energy battery models

Overview of creating models of electric energy accumulators in the simulation program environment. The use of characteristics and operating parameters of electric energy accumulators in their modeling.

Laboratory 7 - Construction of complete models of mechanical energy generation and drive transmission systems

Overview of creating models of energy generation and vehicle propulsion systems in a simulation program environment based on a real system and its verification. The use of the characteristics of the operating parameters of the system components in modeling the operating characteristics of the complete system.

Laboratory 8 - Summary and final classes

Discussion of the results of laboratory reports. Evaluation of the subject

Teaching methods

1. Lecture with a multimedia presentation - a combination of an information and problem lecture;

2. Laboratory exercises with the use of Matlab / Simulink or SciLab/Xcos systems.

Bibliography

Basic

1. Jan Aleksander Wajand, Jan Tomasz Wajand, Tłokowe silniki spalinowe średnio- i szybkoobrotowe. Wydawnictwa Naukowo-Techniczne

2. Małek Arkadiusz, Wendeker Mirosław. Ogniwa paliwowe typu PEM : teoria i praktyka. Wydawnicwo Politechniki Lubelskiej 2010

3. Lino Guzzella and Antonio Sciarretta, Vehicle Propulsion Systems - Introduction to Modeling and Optimization. Springer 2007

4. Micknass W. Sprzęgła,skrzynki biegów,wały i półosie napędowe. Wydawnictwa Komunikacji i Łączności

Additional

1. Biblioteka Naukowa nr 30 Praca zbiorowa - Lotnicze silniki turbinowe. Konstrukcja-eksploatacja-diagnostyka. Część I

2. Biblioteka Naukowa nr 34 Praca zbiorowa - Lotnicze silniki turbinowe. Konstrukcja-eksploatacja-diagnostyka. Część II

3. Mariusz Giernalczyk, Zygmunt Górski. Siłownie okrętowe cz. 1 Podstawy napędu i energetyki okrętowej. Wyd. II. Akademia Morska w Gdyni 2016.

4. David Crolla, Behrooz Mashadi. Vehicle Powertrain Systems, John Wiley & Sons, 2011

5. Mrozek Bogumiła , Mrozek Zbigniew. MATLAB i Simulink. Poradnik użytkownika. Wydanie III, Wydawnictwo Helion, 2021

Breakdown of average student's workload

	Hours	ECTS
Total workload	75	3,0
Classes requiring direct contact with the teacher	40	1,5
Student's own work (literature studies, preparation for laboratory classes/tutorials, preparation for tests/exam, project preparation) [1]	35	1,5

[1] delete or add other activities as appropriate