GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Positive Displacement Machines, PG_00055514						
Field of study	Mechanical Engineering						
Date of commencement of studies	October 2023		Academic year of realisation of subject	2025/2026			
Education level	first-cycle studies		Subject group	Optional subject group Subject group related to scientific research in the field of study			
Mode of study	Full-time studies		Mode of delivery	at the university			
Year of study	3		Language of instruction	Polish			
Semester of study	6		ECTS credits	9.0			
Learning profile	general academic profile		Assessment form	assessment			
Conducting unit	Institute of Energy -> Faculty of Mechanical Engineering and Ship Technology						
Name and surname of lecturer (lecturers)	Subject supervisor		dr hab. inż. Jacek Kropiwnicki				
	Teachers						
Lesson types and methods of instruction	Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
	Number of study hours	60.0	15.0	15.0	30.0	0.0	120
	E-learning hours included: 0.0						
Learning activity and number of study hours	Learning activity	Participation in didactic classes included in study plan		Participation in consultation hours	Self-study	SUM	
	Number of study hours	120		11.0	94.0	225	
Subject objectives	Presentation of the modern achievements and tendencies in the area of reciprocating machines, in particular: internal combustion engines, Stirling engines, positive displacement compressors and pumps, classification, as well as an indication of the possible application nowadays and in the future, with particular emphasis on Polish conditions.						

Learning outcomes

Course outcome	Subject outcome	Method of verification
[K6_W11] possesses knowledge on design, technology and manufacturing of machine parts, metrology, and quality control; knows and understands methods of measuring and calculating values describing the operation of mechanical systems, knows calculating methods applied to analyse the results of experiments	Understands the consequences of the selected solutions in terms of achieved energetics parameters of the system.	[SW1] Assessment of factual knowledge
[K6_W09] possesses knowledge within the range of thermodynamics and fluid mechanics, construction and operation of heat generating devices, process equipment, including renewable energy sources, cooling and air conditioning	Can analyse and evaluate the methods of functioning of the reciprocating machines, understands the specificity of propulsion systems with reciprocating machines.	[SW1] Assessment of factual knowledge
[K6_U06] is able to use mathematical and physical models for analysing the processes and phenomena occurring in mechanical devices within the range of material strength, thermodynamics and fluid mechanics	Student designs reciprocating machine, projects components, makes thermal and resistance calculations.	[SU1] Assessment of task fulfilment
[K6_U03] is able to identify, formulate and develop the documentation of a simple design or technological task, including the description of the results of this task in Polish or in a foreign language and to present the results using computer software or other aiding tools	Can use modern tools and knowledge in designing, operating and components selecting.	[SU1] Assessment of task fulfilment
[K6_U07] is able to design a typical construction of a mechanical device, component or a testing station using appropriate methods and tools, adhering to the set usage criteria	Makes drawings of reciprocating machine, chooses propulsion systems components from catalogue, evaluates usefulness of proposed solutions.	[SU1] Assessment of task fulfilment

Subject contents

Lecture: Internal combustion engines. General information about internal combustion engines, their structure and properties, characteristics, modelling of the work cycle, mechanical and thermal loads, mechanics of the crank system, balancing, calculation and design of the flywheel, analysis of the structure of the main components of internal combustion engines, strength calculations, bearings of internal combustion engines, fuels, fuel and ignition systems, solutions for energy systems, biogas plants, land vehicles, working machines and watercrafts, hybrid vehicle drive systems, electronic diagnostics of engines.

Stirling engines. Principle of operation, typical designs, work cycle modelling, operating factors, energy efficiency, application, commercial systems.

Displacement compressors. Principle of operation, typical constructions, modelling of the work cycle, multi-stage compression, preliminary calculations, start-up, methods of capacity control, compressor valve timing, energy efficiency.

Positive displacement pumps. Principle of operation, typical constructions, work cycle modelling, preliminary calculations, methods of efficiency regulation, energy efficiency.

Tutorials: Work cycle modelling, device initial calculations, crank system mechanics, strength calculations, energy analysis, calculations of drive systems.

Laboratory: Construction and identification of internal combustion engine components, measurements of the basic parameters of internal combustion engines, testing of power supply components and electronic diagnostics of CI engines, supply, ignition systems and electronic diagnostics of IG engines, start-up and shutdown of the Stirling engine, displacement compressor drive.

Project: Preliminary calculations of the selected reciprocating machine, design of the selected element, material selection, strength calculations.

Prerequisites and co-requisites

<table>
<tr><td>Assessment methods and criteria</td><td colspan="2"><table>
<tr><th>Subject passing criteria</th><th>Passing threshold</th><th>Percentage of the final grade</th></tr>
<tr><td>Test (tutorials)</td><td>50.0%</td><td>20.0%</td></tr>
<tr><td>Project</td><td>50.0%</td><td>30.0%</td></tr>
<tr><td>Laboratory reports</td><td>90.0%</td><td>10.0%</td></tr>
<tr><td>Test (lecture)</td><td>50.0%</td><td>40.0%</td></tr>
</table></td></tr>
<tr><td rowspan="3">Recommended reading</td><td>Basic literature</td><td>Wajand J.A., Wajand J.T.: Tłokowe silniki spalinowe średnio- i szybkoobrotowe. WNT.

Kropiwnicki J. Modelowanie układów napędowych pojazdów z silnikami spalinowymi. AGNI.

Żmudzki S.: Silniki Stirlinga. WNT.

Cantek L., Białas M.: Sprężarki chłodnicze. Wydawnictwo PG.

Ghosh T.K., Prelas M.A.: Energy Resources and Systems. Springer Dordrecht Heidelberg London New York.</td></tr>
<tr><td>Supplementary literature</td><td>http://www.combustion-engines.eu

http://www.ijat.net</td></tr>
<tr><td>eResources addresses</td><td>Adresy na platformie eNauczanie:</td></tr>
<tr><td>Example issues/ example questions/ tasks being completed</td><td colspan="2">Name the methods of forced induction (charging) and their advantages and weaknesses, draw a scheme of turbocharger connected to an engine.

Draw a diagram of fuel injection and heat release during combustion versus crank angle in a compression ignition (Diesel) engine.

Draw a scheme and explain the functioning of Toyota Hybrid System.

Calculate the change in net power of the Stirling engine after replacing the working medium from helium to air.

Perform an analysis of the effect of dead volume influence on the capacity of a reciprocating compressor on the p-V diagram.</td></tr>
<tr><td>Work placement</td><td colspan="2">Not applicable</td></tr>
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