GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Design of Ship Propulsion Systems Using Internal Combustion Engines, PG_00070360		
Field of study	Naval Architecture and Offshore Structures		
Date of commencement of studies	February 2026	Academic year of realisation of subject	2026/2027
Education level	second-cycle studies	Subject group	Specialty 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	1	Language of instruction	English
Semester of study	2	ECTS credits	6.0
Learning profile	general academic profile	Assessment form	exam
Conducting unit	Division of Marine Power Plants -> Institute of Naval Architecture -> Faculty of Mechanical Engineering and Ship Technology -> Faculties of Gdańsk University of Technology		
Name and surname of lecturer (lecturers)	Subject supervisor	dr inż. Roman Liberacki	
	Teachers	dr inż. Roman Liberacki dr inż. Dominik Kreft	

Lesson types						
Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
Number of study hours	45.0	15.0	15.0	45.0	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	5.0	25.0	150

Subject objectives	
	The objective of the course is to equip students with advanced skills in designing modern marine power plants equipped with internal combustion reciprocating engines. The scope and depth of the knowledge provided, as well as the engineering tasks undertaken, significantly exceed the level of first-cycle (undergraduate) studies. Concurrently, the course curriculum is structured to bridge potential gaps in knowledge and ensure a comprehensive understanding of the material also for students who, during their first-cycle studies, completed a specialization other than Marine Power Plants and Equipment.

Learning outcomes	Course outcome	Subject outcome	Method of verification
	[K7_U01] applies acquired analytical, simulation, and experimental methods, as well as mathematical models for analysis and evaluation of shipborne and offshore systems and processes	The student is able to analyze the vessel's mechanical, electrical, and thermal energy demands under various operational conditions. The student can verify the adopted design assumptions. As a designer, the student should also know the fundamentals of marine power plant operation. Using a computer-based marine power plant simulator, the student is able to perform a blackout recovery (machinery start-up from a dead-ship condition), line up and start marine machinery, monitor their operation, and respond appropriately to simulated emergency situations.	[SU1] Assessment of task fulfilment [SU2] Assessment of ability to analyse information
	[K7_W04] demonstrates knowledge encompassing selected issues in the field of advanced knowledge, particularly in the scope of methods, techniques, tools, and algorithms specific to Naval Architecture and Ocean Engineering	The student knows and understands the calculation methods and algorithms required for selecting propulsion system components, power generation systems, and heating steam systems. The student possesses knowledge regarding the selection methods for machinery, equipment, and fittings for machinery space and ship-wide piping systems. The student is aware of the necessity to comply with classification society rules and international conventions regulating the principles of marine power plant design and equipment. The student possesses knowledge of modern technologies for reducing harmful emissions in exhaust gases, as well as mitigating and preventing pollution of the marine environment and atmosphere by other harmful substances.	[SW1] Assessment of factual knowledge
	[K7_W01] explains and describes, based on general knowledge in the field of scientific disciplines forming the theoretical foundations of Naval Architecture and Ocean Engineering, the construction and principles of operation of marine systems, processes and their components, as well as methods and means of their design and operation	The student knows the theoretical foundations of thermodynamic and fluid flow processes occurring in marine internal combustion reciprocating engines and their associated systems. The student can explain the operating principle and describe the design of various internal combustion reciprocating engines, as well as other critical machinery (pumps, compressors, purifiers, filters, etc.), heat exchangers, and boilers. The student understands and describes the interactions between the constituent elements of a marine power plant. The student can present and explain the principles of main engine-propeller matching (for both fixed-pitch and controllable-pitch propellers) under variable sailing conditions.	[SW1] Assessment of factual knowledge
	[K7_U04] creatively designs or modifies, either entirely or in part, a shipborne or offshore system or process according to a given specification, considering both technical and non-technical aspects, estimating costs and adopting design techniques representative for the field	The student is able to design a marine power plant equipped with internal combustion reciprocating engines according to a given technical and operational ship specification. In addition to technical aspects, the student takes into account economic and environmental criteria, conducting a critical analysis of alternative solutions to select and implement a design that is optimal from the perspective of the adopted criteria.	[SU1] Assessment of task fulfilment [SU5] Assessment of ability to present the results of task

Subject contents	Course content – lecture Design Strategy: Phases of marine power plant design (conceptual, preliminary, detail). Ship technical and operational specification. Impact of IMO regulations (MARPOL, SOLAS) and classification rules. Propulsion Configuration: Determining the contractual design point at the preliminary stage (reference ships) and advanced stage (hull resistance). Selection of main engines (economic and environmental criteria). Shaftline selection. Energy Balances: Estimating energy and heat demands. Methodology for preparing electrical load and thermal balances for various operational conditions. Waste Heat Recovery (WHR): Engine thermal balance. Selection of heating and propulsion steam systems for turbogenerators. Organic Rankina Cycles (ORC). Eco-design: Energy Efficiency Design Index (EEDI). Spatial integration of emission reduction systems (SCR, EGR, scrubbers) and anti-pollution installations. Auxiliary Systems: Design and selection of piping, tanks, pumps, compressors, purifiers, filters, and heat exchangers (coolers, heaters). Machinery space modularization. Spatial Arrangement: Machinery space localization onboard. Principles of arranging engines, generating sets, boilers, and auxiliary equipment (ergonomics and safety). Engineering Software: 3D CAD tools, P&ID generation, Computational Fluid Dynamics (CFD), and Finite Element Method (FEM) strength calculations in power plant design. Special Purpose Vessels: Specifics of power plant design for naval ships, fishing vessels, offshore units, wind farm support vessels, and underwater/installation craft. Course content – exercises Determining the main engine contractual design point based on a reference ship list, hull resistance, and propeller characteristics. Selection of a reduction gearbox. Selection of generating sets and boilers. Preliminary selection of pumps in water, fuel, lubricating oil, and other systems (e.g., cargo pumps on tankers). Calculating pressure drops (linear and local) in piping, determining optimal pipe diameters, and cavitation calculations (NPSH). Thermal calculations for the selection of heat exchangers. Selection of purifiers, filters, bilge water separation systems, and sewage treatment plants. Practical determination of the EEDI for the designed power plant and verification of compliance with current IMO phases. Course content – laboratory The laboratory course provides future designers with the essential fundamentals of marine power plant operation. Utilizing 2D and 3D computer simulators, students acquire practical skills in operating systems, starting up machinery, and managing energy systems under normal and critical conditions. The course includes: introduction and OSH training; analysis and start-up of auxiliary systems and selected equipment; blackout recovery (machinery start-up from a dead-ship condition); power plant operation in emergency situations. Course content – project Establishing design assumptions: analysis of the ship's operational profile, sailing routes, and classification requirements for a given vessel. Conceptual design of the propulsion and power generation system: selection of the main engine, generating sets, and boilers from reputable manufacturers' catalogues. Design of a selected auxiliary or ship-wide system: selection of major components (tanks, pumps, heat exchangers, filters, pipes, and fittings). Pressure drop calculations and pump selection verification. Development of engineering design documentation: engineering calculations and technical schematic of the selected system.
Prerequisites and co-requisites	Fundamental knowledge of technical thermodynamics, fluid mechanics, and ship construction, proficiency in technical drawing, and basic proficiency in CAD software.

Assessment methods and criteria

Subject passing criteria	Passing threshold	Percentage of the final grade
	50.0%	50.0%
	100.0%	40.0%
	100.0%	10.0%

Recommended reading

Basic literature	Chachulski K., *Projektowanie siłowni okrętowych*, Wydawnictwo Politechniki Gdańskiej, Gdańsk 2014. Wojnowski W., *Okrętowe siłownie spalinowe. Cz. 3*, Wydawnictwo Wydziału Oceanotechniki i Okrętownictwa Politechniki Gdańskiej, Gdańsk 1992. Michalski R., *Siłownie okrętowe*, Wydawnictwo Politechniki Szczecińskiej, Szczecin 1997. Michalski J.P., *Podstawy teorii projektowania okrętów*, Wydawnictwo Politechniki Gdańskiej, Gdańsk 2016. Piotrowski I., Witkowski K., *Okrętowe silniki spalinowe tłokowe*, Fundacja Promocji Przemysłu Okrętowego i Gospodarki Morskiej, Gdańsk 2005. Taylor D. A., *Introduction to Marine Engineering*, Elsevier/Butterworth-Heinemann.

	Supplementary literature	Rules and Regulations of Classification Societies (e.g., PRS, DNV, LR, ABS). International IMO Conventions and Codes (e.g., MARPOL, SOLAS). Technical and Design Documentation of Marine Engine Manufacturers: MAN Energy Solutions (MAN CEAS platform), Winterthur Gas & Diesel (WinGD Project Guide), Wärtsilä, and others. Catalogues and Design Guidelines of Auxiliary Equipment Manufacturers (e.g., Alfa Laval, DESMI, Allweiler, GEA Westfalia).
	eResources addresses	
Example issues/ example questions/ tasks being completed	**The exam** will cover theoretical topics discussed during lectures and practical tasks completed during tutorials. For example: 1. Explain the concept of the contractual design point (MCR – Maximum Continuous Rating) for the main engine selection and describe the difference in the procedure for determining it at the preliminary and advanced stages of marine power plant design. 2. Given a water pump capacity of 150 m^3/h, determine the required internal diameter of the pipeline so as not to exceed a flow velocity of 3 m/s. **The project** will involve completing an individual assignment, for example: Perform a preliminary design of a power plant for a container ship with a capacity of 10,000 TEU and a design sailing speed of 22 knots, with a particular focus on the seawater cooling system. **The laboratory course** includes a set of tasks to be performed on a marine power plant simulator, for example: machinery start-up from a dead-ship condition or starting up an oil-fired boiler...	
Practical activites within the subject	Not applicable	