GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Dynamics of the Marine Environment, PG_00065495						
Field of study	Naval Architecture and Offshore Structures						
Date of commencement of studies	February 2026		Academic year of realisation of subject	2025/2026			
Education level	second-cycle studies		Subject group	Obligatory subject group in the field of study Subject group related to scientific research in the field of study			
Mode of study	Part-time studies		Mode of delivery	at the university			
Year of study	1		Language of instruction	Polish			
Semester of study	1		ECTS credits	4.0			
Learning profile	general academic profile		Assessment form	assessment			
Conducting unit	Institute of Naval Architecture -> Faculty of Mechanical Engineering and Ship Technology -> Wydziały Politechniki Gdańskiej						
Name and surname of lecturer (lecturers)	Subject supervisor		dr hab. inż. Paweł Dymarski				
	Teachers						
Lesson types and methods of instruction	Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
	Number of study hours	18.0	0.0	9.0	0.0	0.0	27
	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	27		9.0	64.0		100
Subject objectives	The aim of the course is for students to master mathematical models describing the dynamics of the marine environment in order to determine (calculate) the forces acting on offshore and coastal objects such as: - ships, - offshore facilities, -> drilling rig, -> offshore wind turbines (OWT), -> bottom-fixed OWT structures, -> floating wind turbine structures, - other offshore structures.						

Learning outcomes

Course outcome	Subject outcome	Method of verification
[K7_W02] demonstrates structured and theory supported knowledge encompassing key issues in the field of Naval Architecture and Ocean Engineering, enabling modeling and analysis of shipborne and offshore systems, devices, and processes	The student demonstrates structured and theoretically based knowledge of the dynamics of the marine environment. The student has basic introductory knowledge to subjects on determining hydro- and aerodynamic forces acting on ships and offshore structures.	[SW3] Assessment of knowledge contained in written work and projects
[K7_W12] identifies and interprets the main developmental trends and significant new achievements in the field of engineering and technical sciences and disciplines relevant to the course of study	not applicable	[SW3] Assessment of knowledge contained in written work and projects
[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 is able to explain and describe the mechanisms governing the movement of water in seas and oceans. Knows the basic mathematical models of sea waves, sea currents and wind. Is able to use appropriate models of environmental dynamics in the design process.	[SW3] Assessment of knowledge contained in written work and projects
[K7_U11] communicates and justifies opinions on specialized topics in a manner understandable to diverse audiences, including the use of modern techniques, including information technology	Student Is able to use and analyze data and draw conclusions (e.g. computationally) regarding the dynamics of the marine environment, in a way that is understandable to a diverse audience (engineers and project managers), using modern (computational) techniques, including IT tools	[SU2] Assessment of ability to analyse information [SU4] Assessment of ability to use methods and tools [SU1] Assessment of task fulfilment

Subject contents

1. Basic equations governing the motion of fluids
2. Gravitational stability of water masses (vertical movements)
3. Progressive movement of water masses
4. Tides
5. Wave motion of the sea
5.1 Linear wave model (Airy model)
5.2 Regular wave
5.2.1 Basic quantities describing a regular wave
5.2.2 Basic properties of a regular wave.
5.3 Irregular wave
5.3.1 Sea wave record analysis. Basic concepts describing an irregular wave
5.3.2. Spatial (omnidirectional) and plane (unidirectional) irregular wave
5.3.3 General equation for irregular waves
5.3.4 Wave energy spectrum. Mathematical description of the wave spectrum
5.3.5 Determination of irregular wave parameters based on the wave spectrum
5.3.6 Determining the irregular wave equation from the wave spectrum.
5.4 Higher order wave models
6. Wind
6.1 Laws governing the movement of air (atmosphere)
6.2. Basic wind models (stationary approach). Velocity profile equations
6.3. Wind as a non-stationary phenomenon
6.4.1 Analysis of the recording of the velocity of air masses as a function of time
6.4.2 Wind energy spectral density function. Mathematical models of the wind energy spectrum
6.4.3 Velocity equation for unidirectional unsteady air flow
6.4.4 Complex models describing airflow
7. Impact of the marine environment on objects of simple geometry. Basic models mathematical tools for calculating hydrodynamic forces. Introduction to modeling loads on offshore structures

Prerequisites and co-requisites

Knowledge of mathematical analysis and numerical methods:
- integration: analytical and numerical methods,
- trigonometric functions,
- spectral analysis, Fourier series,
- basic knowledge of vector algebra

Ability to use a spreadsheet, basic programming skills

Assessment methods and criteria

Subject passing criteria	Passing threshold	Percentage of the final grade
Lecture	60.0%	67.0%
Labs	70.0%	33.0%

Recommended reading

Basic literature

1. Jan Dudziak Teoria okrętu, rozdział Dynamika środowiska
2. Czesław Druet Dynamika morza. Gdańsk 2000
3. A.R.J.M. Lloyd SEAKEEPING: Ship Behaviour in Rough Weather
4. S.K. Chakrabarti Hydrodynamics of Offshore Structures
5. G.J Feikema, J.E.W. Wichers The Effect of Wind Spectra on the Low-Frequency Motions of a Tanker in Survival Condition. OTC 1991

	Supplementary literature	6. O.M. Faltinsen "Sea Loads on Ships and Offshore Structures" 7. G.Clauss, E.Lehmann, C.Östergaard "Offshore Structures vol. 1: Conceptual Design and Hydromechanics". Springer, 1992. 8. Barry J. Heyer and Lymon C. Reese "ANALYSIS OF SINGLE PILES UNDER LATERAL LOADING". 9. Journée, J.M.J. and Massie, W.W. (2001) Offshore Hydromechanics. Delft University of Technology, Delft, Netherlands.
	eResources addresses	
Example issues/ example questions/ tasks being completed	Example questions: 1. Profiles of sea currents - approximating functions 2. Regular wave: sketch, symbols, equation. Wave properties 3. Particle trajectories: deep-water wave, in waters of medium depth and shallow water 4. Irregular wave: sketch, symbols, equation 5. Wave spectrum: list the wave spectrum approximations used, how many and what parameters they depend on, the influence of a specific parameter on the shape of the spectrum (sketch) 6. Wind. Stationary models (wind profile). Discuss functions and parameters 7. Applied wind spectrum functions. Non-stationary model of wind speed. Equation 8. Modeling the impact of a waved sea on a cylindrical structure 9. Discuss the p-y model of the bottom (soil)-pile interaction	
Work placement	Not applicable	

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