GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Design of Steel and Concrete Structures for Wind Farms, PG_00066981		
Field of study	Smart Renewable Energy Engineering		
Date of commencement of studies	October 2025	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	2	Language of instruction	Polish
Semester of study	3	ECTS credits	2.0
Learning profile	general academic profile	Assessment form	assessment
Conducting unit	Department of Structural Mechanics -> Faculty of Civil and Environmental Engineering -> 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	15.0	15.0	0.0	0.0	0.0	30

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	30	4.0	16.0	50

Subject objectives

The aim of the course is to familiarize students with the existing types of offshore support structures for wind turbines and to introduce students to the methods used to analyze (hydro) statics and the dynamics of structures subjected to the influence of the marine environment. Students learn about the methodology of model tests of floating and bottom-fixed structures.

Learning outcomes

Course outcome	Subject outcome	Method of verification
[K7_W03] understands the concept of digital twin technology and its application in optimizing and monitoring energy systems using artificial intelligence methods and large-scale data analytics	The student knows the methods of analyzing the behavior of a floating structure used in digital twin technology.	[SW3] Assessment of knowledge contained in written work and projects
[K7_W02] knows and understands the challenges of effectively integrating decentralized renewable energy generation into the power grid, including energy storage issues, and is particularly familiar with technologies used in wind power	The student will be introduced to the basics of technology used in wind energy.	[SW1] Assessment of factual knowledge
[K7_U02] is capable of creating and analyzing digital models of renewable energy systems, including wind power systems, and utilizes digital tools for project analysis, evaluation, supervision, and optimization	Knows the theoretical basis (methods, algorithms) of computational models for simulating the dynamics of offshore wind turbines exposed to the marine environment.	[SU4] Assessment of ability to use methods and tools [SU1] Assessment of task fulfilment
[K7_K03] has intercultural communication competencies, essential for international energy projects, and can collaborate effectively with individuals from various cultures and backgrounds, appreciating diversity	The student has teamwork skills to develop reports on model tests in the laboratory.	[SK5] Assessment of ability to solve problems that arise in practice [SK1] Assessment of group work skills

Subject contents	1. Basic information about the types of support structures - floating structures - bottom-fixed structures 2. Hydrostatics of floating marine structures - determining the static and dynamic tilt angle 3. Anchoring systems for floating support structures (basics) - chain anchoring (catenary mooring system) - anchoring with the use of elastic tendons (taut system) - tension leg system (TLP platforms) - typical characteristics of anchorages (depending on type) 4. Environmental impact on offshore structures 4.1 Determination of hydrodynamic forces on offshore structures (wave and current) - Morison equation, - Froude-Krylov force, - source-sink methods (diffraction method) - potential flow - RANSE-CFD viscous flow methods. 4.2 Determination of aerodynamic forces (simplified methods) 5. Introduction to the dynamics of floating structures 5.1 Basic properties of a single degree of freedom (1 DoF) dynamic systems 5.1.1 Discussion of the properties of the linear system mass-spring system with a damping element, - basic concepts: mass and added mass, damping (damping coefficient), restoring force (system stiffness coefficient) - characteristic of the system response as a function of frequency. The concept of natural frequency, resonant frequency, "response regimes of the structure. Effect of damping on the response characteristics. 5.2 Discussion of the motions of a floating object in 6 degrees of freedom. The names and nature of the subspecific movements. 5.3 Equations of motion of objects with one degree of freedom: - heave, - pitch/roll, - surge (on the example of TLP) - discussion of the forces acting on an object during its movement. 5.4 Coefficients of hydrodynamic forces. Methods of determining 5.5. Solving equations of motion of an object - Analytical methods used to obtain "basic solutions" - Numerical methods (algorithms) used to solve equations of motion - Solving the equation of motion using numerical methods for a given object -- spar -- TLP (optionally) 6. Model tests of offshore structures (laboratories) 6.1 model testing of floating wind turbines - discussion of the applied similarity laws. The issue of the scale effect - studies of free decay test - determination of the natural period and basic hydrodynamic coefficients - regular wave tests (determining the amplitude characteristics) - irregular wave tests (demonstration and discussion) 6.1.1 model tests of TLP type floating wind turbine structure 6.1.2 model tests of Semi-submersible (or spar) floating wind turbine structure 6.2 Short-term forecast of structure movement for a given wave spectrum
Prerequisites and co-requisites	1. Basic knowledge of general mechanics (statics and dynamics) - force - moment of force - Newton's laws of motion 2. Knowledge of marine dynamics - wave theory, wave spectrum - ocean currents - winds 3. Basic knowledge of fluid mechanics - fluid statics - flow continuity equation - conservation of momentum - potential flows

Assessment methods and criteria

Subject passing criteria	Passing threshold	Percentage of the final grade
Laboratory exercises	70.0%	50.0%
Lecture	60.0%	50.0%

Recommended reading

Basic literature	1. S.K. Chakrabarti Hydrodynamics of Offshore Structures 2. J.F. Wilson "Dynamics of Offshore Structures" 3. G.Clauss, E.Lehmann, C.Östergaard Offshore Structures vol. 1 4. Jan Dudziak Teoria okrętu
Supplementary literature	5. A.R.J.M. Lloyd SEAKEEPING: Ship Behaviour in Rough Weather 6. O.M. Faltinsen Sea Loads on Ships and Offshore Structures 7. 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 8. T. Sarpkaya: "Wave Forces on Offshore Structures" 9. S.K. Chakrabarti "Handbook of Offshore Engineering" 10. L. Castro-Santos, V. Diaz-Casas "Floating Offshore Wind Farms" 11. S. Chandrasekaran "Dynamic Analysis and Design of Offshore Structures"
eResources addresses	

Example issues/ example questions/ tasks being completed	
Work placement	Not applicable

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