



Subject card

Subject name and code	Advanced Engineering Computational Methods, PG_00066992						
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		English		
Semester of study	4		ECTS credits		3.0		
Learning profile	general academic profile		Assessment form		assessment		
Conducting unit	Division of Hydromechanics and Ship Design -> 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 hab. inż. Paweł Dymarski				
	Teachers						
Lesson types	Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
	Number of study hours	0.0	0.0	45.0	0.0	0.0	45
	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	45		7.0		23.0	75
Subject objectives	The primary objective of the course is to familiarize students with the computational methods used in the design of support structures for offshore wind turbines. The main topics covered will be the hydromechanics of support structures, wind turbine aerodynamics, and the modal analysis of offshore wind turbine structures.						
Learning outcomes	Course outcome		Subject outcome		Method of verification		
	[K7_K101] acknowledges the importance of knowledge related to the field of study in solving cognitive and practical problems, critically assessing the information obtained		The student is able to critically evaluate existing computational models and the results obtained from them. The student is aware of the limitations and simplifications of the computational models used.		[SK5] Assessment of ability to solve problems that arise in practice		
	[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		Ability to generate data and analyze results from numerical models of wind energy systems. Ability to create simple numerical models.		[SU1] Assessment of task fulfilment [SU4] Assessment of ability to use methods and tools		
	[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 knows and understands the issues related to energy generation from renewable sources, particularly energy generation by offshore wind farms.		[SW1] Assessment of factual knowledge		
	[K7_W101] is able to make an in-depth identification of key objects and phenomena related to the field of study, as well as theories that describe them and applicable analytical and design methods		The student identifies key objects and phenomena associated with offshore wind energy, as well as the theories describing them and the applicable analytical and design methods		[SW1] Assessment of factual knowledge		

Subject contents	Course content – laboratory 1. Review of numerical methods. 1.1 Numerical integration methods 2. Hydrodynamics of the support structure 2.1 Calculation of wave forces on a monopile using the Morison equation 2.2 Calculation of forces acting on a spar platform – Froude-Krylov method 3. Wind turbine aerodynamics 3.1 Introduction to potential flow theory 3.2 Hydrodynamic singularities, basic potential flow solutions 3.3 Circulation. Stokes' theorem. 3.4 Flow with circulation around a circular cylinder. Kutta-Joukowski theorem 3.5 Airfoil theory 3.6 Lifting Line Method (LLM) 3.7.1 Theoretical foundations of LLM 3.7.2 Determining the aerodynamic reaction using LLM for a turbine with specific parameters 4. Support structure as a multi-degree-of-freedom system 4.1 Review of bending beam theory (strength of materials) 4.2 Determining the stiffness matrix K of the support structure 4.3 Fundamentals of support structure-soil interaction 4.4 Calculating the stiffness matrix of the support structure 5. Mass matrix M of the wind turbine support structure 5.1 Determining nodal masses of the structure 5.2 Influence of the medium (water) – added mass 6. Determining the damping matrix 6.1 Rayleigh model (proportional damping) 6.2 Other methods used 7. Determining natural frequencies and mode shapes of the structure 7.1 Determining natural frequencies based on matrices K and M 7.2 Determining the mode shape vector		
Prerequisites and co-requisites	1. Knowledge of the fundamentals of fluid mechanics 2. Knowledge of the fundamentals of structural mechanics (beam models) 3. Fundamentals of numerical methods 4. Basic knowledge of marine dynamics		
Assessment methods and criteria	Subject passing criteria	Passing threshold	Percentage of the final grade
	Solving problems during laboratory sessions	70.0%	50.0%
	Colloquium	60.0%	50.0%
Recommended reading	Basic literature	1. Subrata Kumar Chakrabarti „Hydrodynamics of Offshore Structures” 2. James F. Wilson: „Dynamics of Offshore Structures”, 2003 3. Anderson Jr. J.D.: „Fundamentals of Aerodynamics” , McGraw- Hill International, 2006. 4. Martin O. L. Hansen: “Aerodynamics of Wind Turbines” 2nd ed. London-Sterling, Earthscan, 2008	
	Supplementary literature	5. Srinivasan Chandrasekaran: „Dynamic Analysis and Design of Offshore Structures”, Springer, 2018 6. Evan Gaertner, Jennifer Rinker, Latha Sethuraman: „Definition of the IEA Wind 15-Megawatt Offshore Reference Wind Turbine”. NREL Technical Report, March 2020 7. Arnold M. Kuethe, Julius D. Schetzer, Chuen-Yen Chow: „Foundations of Aerodynamics - Bases of Aerodynamic Design (WSE)”. John Wiley & Sons Inc, 1997 8. Günther Clauss, Eike Lehmann, Carsten Østergaard: "Offshore Structures: Volume I: Conceptual Design and Hydromechanics". Springer	
	eResources addresses		
Example issues/ example questions/ tasks being completed	-		
Practical activities within the subject	Not applicable		

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