GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Wind Turbine Control, PG_00062645		
Field of study	Naval Architecture and Offshore Structures		
Date of commencement of studies	February 2024	Academic year of realisation of subject	2024/2025
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	Polish
Semester of study	2	ECTS credits	2.0
Learning profile	general academic profile	Assessment form	assessment
Conducting unit	Division of Automation and Marine Energy -> Institute of Naval Architecture -> Faculty of Mechanical Engineering and Ship Technology		
Name and surname of lecturer (lecturers)	Subject supervisor	dr inż. Mohammad Ghaemi	
	Teachers	mgr inż. Jacek Frost dr inż. Mohammad Ghaemi	

Lesson types and methods of instruction

Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
Number of study hours	15.0	0.0	15.0	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	20.0	54

Subject objectives

Learning the basic concepts of wind turbine control systems, the method of modeling, analysis and synthesis of these systems in conjunction with operational aspects, and acquiring the ability to applycontrol systems in industrial practice in the field of offshore energy systems with an emphasis on wind farms.

Learning outcomes

Course outcome	Subject outcome	Method of verification
[K7_U01] Develops innovative strategies to solve complex and dynamic problems by synthesizing information from various sources and utilizing analytical, simulation, and experimental methods, considering environmental variability	The student can develop strategies for solving complex and dynamic problems related to wind turbine control, taking into account the variability of environmental conditions.	[SU3] Assessment of ability to use knowledge gained from the subject
[K7_U03] Formulates research challenges and selects appropriate analytical methods, leveraging advanced IT tools, then critically evaluates the obtained results	The student can utilize mathematical methods and models as well as computer simulations for the analysis, design, and evaluation of wind turbine control systems and their components, using advanced computer tools, and also critically assess the obtained results of laboratory and simulation studies and present them in the form of technical reports.	[SU4] Assessment of ability to use methods and tools
[K7_W02] Explains the essence and relationships of key components describing systems and processes in ocean engineering, utilizing current knowledge from major scientific fields related to the field of study	The student has knowledge of marine energy systems in the context of modelling, analysis, and synthesis of wind turbine control systems.	[SW1] Assessment of factual knowledge

Subject contents	1. Introduction, goal, nomenclature, definitions, basic concepts and types of control systems 2. Modeling a wind turbine as an object of a control system, including mechanical, aerodynamic and electrical subsystems 3. Modeling of wind influence as an input variable of the control system 4. Influenec of wind turbine operational aspects including energy conversion, mechanical load, power quality and operating modes, on the analysis and synthesis of control system 5. Wind turbine control strategies and methods, including yaw control, active pitch regulation, load control, stall control, aileron control, and generator slip control 6. Analysis and synthesis of selected control systems of wind turbines
Prerequisites and co-requisites	Basic information on automation and control systems at B.Sc. level in the Ocean Eng. field

Assessment methods and criteria

Subject passing criteria	Passing threshold	Percentage of the final grade
Lab. report	50.0%	48.0%
Attendance	0.0%	4.0%
Test/colloquium	50.0%	48.0%

Recommended reading

Basic literature	1. Lubośny Z., Farmy wiatrowe w systemie elektroenergetycznym, Wydawnictwo Naukowe PWN, Warszawa, 2016. 2. Bianchi F. D., De Battista H., Mantz R. J., Wind turbine control systems - principles, modelling and gain scheduling design, ISBN-10: 1-84628-492-9, Springer-Verlag London Limited, 2007.
Supplementary literature	1. Precup R. E., Kamal T., SHassan S. Z., Advanced Control and Optimization Paradigms for Wind Energy Systems, ISBN 978-981-13-5994-1, Springer Nature Singapore Pte Ltd., 2019.
eResources addresses	Adresy na platformie eNauczanie:

Example issues/ example questions/ tasks being completed	1. What is the purpose of using a Wind Turbine Control System (WTCS)? List and discuss its tasks.2. Determine the input and output variables of the WTCS. Also, provide the names of its subsystems.3. List the most important features of a WTCS.4. What role does Supervisory Control and Data Acquisition (SCADA) fulfill in a WTCS and for what purpose is it applied?5. Why can't the mechanical power obtained at the turbine shaft exceed approximately 60% of the wind power? Justify your answer.6. What are the power and torque coefficients of a wind turbine, and what factors affect them?7. Conduct an analysis of the impact of the tip-speed ratio and blade pitch angle on the generated active power of a wind turbine.8. Present the velocity and force vectors acting on the wind turbine blades.9. What is the wind power spectral density function? How can it be determined?10. How can the linear wind interaction model be determined in the form of a transfer function?11. Compare synchronous and asynchronous generators in terms of WTCS structure.12. What role do current/power converters play in a WTCS? Draw an example diagram showing the application of converters in a WTCS.13. What is the difference between a Partial-Scale Power Converter (PSPC) and a Full-Scale Power Converter (FSPC)? Where is each of them applied?14. For what purpose and in which part of the WTCS is a Low-Pass Filter (LPF) used?15. Present the mathematical model of the mechanical power transmission system in the WTCS structure.16. Discuss the overall efficiency of a wind turbine and its component elements.17. Present, discuss, and compare wind turbine control methods.18. Present and discuss wind turbine control strategies.19. Present, discuss, and compare wind turbine control strategies.20. Discuss the principles and structure of the wind turbine blade pitch control system (Pitch Control).21. Discuss the principles and structure of the wind turbine nacelle yaw control system (Yaw Control).22. Discuss the role and function of the master controller in a WTCS.23. Draw a sample wind turbine control system diagram, including the names of its components and signals.24. What are the differences between a fixed foundation wind turbine (e.g., monopile type) and a floating wind turbine control system?25. Justify why the controllers used in a WTCS should be adaptive. Draw an idealized block diagram of the adaptive system and discuss its elements.26. What communication protocols are used in a WTCS?27. Present the components of the cost associated with a WTCS.
Work placement	Not applicable

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