



## Subject card

Subject name and code	Modelling and optimisation for transportation systems, PG_00064980						
Field of study	Transport and Logistics						
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	Full-time studies		Mode of delivery		at the university		
Year of study	1		Language of instruction		Polish		
Semester of study	1		ECTS credits		3.0		
Learning profile	general academic profile		Assessment form		exam		
Conducting unit	Division of Hydromechanics and Ship Design -> Institute of Naval Architecture -> Faculty of Mechanical Engineering and Ship Technology -> Wydziały Politechniki Gdańskiej						
Name and surname of lecturer (lecturers)	Subject supervisor		dr inż. Marcin Życzkowski				
	Teachers						
Lesson types and methods of instruction	Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
	Number of study hours	15.0	0.0	0.0	15.0	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		10.0		35.0	75
Subject objectives	<p>The aim of the course is to present selected transport processes using a mathematical description, particularly employing methods from discrete mathematics and graph theory. The modeling will focus on maritime transport, with special attention to issues related to ship trajectories and their dependence on dynamically changing hydrometeorological conditions.</p> <p>During the course, students will explore tools that enable the analysis and optimization of routes in the context of real-world constraints and environmental parameters. The course will utilize a wide range of software tools based on the Python programming language, facilitating simulations, visualizations, and route optimization in maritime transport.</p>						

Learning outcomes	Course outcome	Subject outcome	Method of verification
	[K7_W02] demonstrates structured and theory supported knowledge encompassing key issues in the field of Transport and Logistics, enabling modeling and analysis of transport systems and processes	Has knowledge of tools and data analysis techniques used in maritime transport.	[SW2] Assessment of knowledge contained in presentation
	[K7_U01] utilizes acquired methods, tools and mathematical models for analysis and evaluation of transport systems and processes	Applies the Python programming language to implement route optimization algorithms in maritime transport. Understands fundamental methods for modeling transport processes using discrete mathematics and graph theory.	[SU1] Assessment of task fulfilment
	[K7_W01] explains and describes, based on general knowledge in the field of scientific disciplines forming the theoretical foundations of Transport and Logistics, the construction and principles of operation of transport systems, processes and their components, as well as methods and means of their integration	Demonstrates a well-structured and theoretically grounded knowledge of key topics in Transport and Logistics, enabling the modeling and analysis of transport systems and processes.	[SW2] Assessment of knowledge contained in presentation
	[K7_U02] formulates and tests hypotheses concerning problems of transport systems and processes, as well as simple research problems	Is able to interpret modeling and optimization results in the context of real operational conditions.	[SU5] Assessment of ability to present the results of task [SU2] Assessment of ability to analyse information [SU1] Assessment of task fulfilment
Subject contents	<p><b>1. Introduction to Programming in Python</b></p> <ul style="list-style-type: none"> <li>• Introduction to the Anaconda environment and basic data analysis tools</li> <li>• Summary of Python programming fundamentals: data types, operators, control structures, functions</li> <li>• Basic Python libraries used in transport analysis (NumPy, Pandas, Matplotlib)</li> </ul> <p><b>2. Mathematical Methods in Transport Modeling</b></p> <ul style="list-style-type: none"> <li>• <b>Graph models in transport</b> transport networks, nodes, and edges</li> <li>• <b>Grid and discretization of the maritime environment</b> <ul style="list-style-type: none"> <li>• The concept of a grid in maritime transport modeling</li> <li>• Discretization of the maritime environment description and representation in Python</li> <li>• Various grid representation methods: rectangular grids, hexagonal grids, irregular grids</li> </ul> </li> <li>• <b>Navigation-related concepts</b> <ul style="list-style-type: none"> <li>• Geographical coordinates: latitude and longitude</li> <li>• Measurement units in navigation: nautical mile, knot</li> <li>• Representation of geographical coordinates in route modeling in Python</li> </ul> </li> <li>• <b>Shortest paths in transport models</b> <ul style="list-style-type: none"> <li>• Route computation algorithms: Dijkstras, Bellman-Ford, A*</li> <li>• Flow problems in transport networks</li> </ul> </li> </ul> <p><b>3. Ship Trajectory Modeling in Maritime Transport</b></p> <ul style="list-style-type: none"> <li>• Characteristics of ship movement and the impact of hydrometeorological conditions</li> <li>• Trajectory prediction methods and their applications</li> <li>• Optimization of shipping routes considering variable environmental conditions</li> </ul> <p><b>4. Data Modeling and Analysis in Maritime Transport</b></p> <ul style="list-style-type: none"> <li>• Application of data analysis in transport historical AIS data analysis</li> <li>• Processing hydrometeorological data and its impact on ship trajectories</li> <li>• Use of GIS systems in maritime transport analysis</li> </ul> <p>Let me know if you need any modifications!</p>		

Prerequisites and co-requisites	<ul style="list-style-type: none"><li>• <b>Mathematics</b> fundamentals of algebra, discrete mathematics, graph theory, and optimization methods.</li><li>• <b>Programming</b> basic proficiency in Python, including data structures, loops, functions, and fundamental libraries for data analysis (e.g., NumPy, Pandas).</li><li>• <b>Basics of Transport and Logistics</b> general understanding of transport systems, including maritime transport.</li></ul>		
Assessment methods and criteria	Subject passing criteria	Passing threshold	Percentage of the final grade
	Project	50.0%	100.0%
Recommended reading	Basic literature	<ul style="list-style-type: none"><li>• <b>McKinney, W. <i>Python for Data Analysis</i> (O'Reilly, 2017)</b><ul style="list-style-type: none"><li>• Processing transport data using Pandas and NumPy.</li></ul></li><li>• <b>IMO (International Maritime Organization) <i>E-navigation Strategy Implementation Plan</i> (IMO, 2014)</b><ul style="list-style-type: none"><li>• E-navigation strategies and maritime route optimization.</li></ul></li><li>• <b>Dijkstra, E. W. <i>A Discipline of Programming</i> (Prentice Hall, 1976)</b><ul style="list-style-type: none"><li>• A classical approach to graph algorithms, including the shortest path algorithm.</li></ul></li></ul>	
	Supplementary literature	any e-course for Python	
	eResources addresses		
Example issues/ example questions/ tasks being completed	For a given area, retrieve data describing marine conditions related to wave height and direction. Then, create an algorithm that avoids waves higher than 6 meters.		
Work placement	Not applicable		

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