GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Basic of Modeling, Simulation and Optimisation Methods, PG_00067189		
Field of study	Smart Renewable Energy Engineering		
Date of commencement of studies	October 2025	Academic year of realisation of subject	2025/2026
Education level	second-cycle studies	Subject group	Optional 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	English
Semester of study	1	ECTS credits	6.0
Learning profile	general academic profile	Assessment form	assessment
Conducting unit	Division of Applied Computer Science -> Institute of Naval Architecture -> Faculty of Mechanical Engineering and Ship Technology -> Wydziały Politechniki Gdańskiej		
Name and surname of lecturer (lecturers)	Subject supervisor	dr inż. Aleksander Kniat	
	Teachers	dr inż. Aleksander Kniat dr inż. Paweł Chodnicki	

Lesson types and methods of instruction

Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
Number of study hours	30.0	0.0	30.0	15.0	0.0	75

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	75	9.0	66.0	150

Subject objectives

The aim of the subject is to apply mathematical modelling for solving physical problems. In particular subject includes numerical methods and enhances the skills to create algorithms/computer programs, as well as using ready-made software tools to perform simulations.

Learning outcomes

Course outcome	Subject outcome	Method of verification
[K7_K01] is prepared to evaluate projects and operations in wind energy systems, demonstrating competencies in designing and optimizing renewable energy systems, including wind power	Student is able to optimize selected part of a wind/renewable energy system according to a chosen criterion.	[SK5] Assessment of ability to solve problems that arise in practice [SK1] Assessment of group work skills
[K7_U01] is able to apply analytical thinking and solve technical problems related to renewable energy systems, including wind power, using engineering methodologies	Student knows principles of algorithm creation and uses structural/objective programming language to implement algorithms.	[SU4] Assessment of ability to use methods and tools [SU1] Assessment of task fulfilment
[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	Student is able to describe physical phenomena with differential equation and propose a numerical solution method.	[SW1] Assessment of factual knowledge

<table>
<tr><td>Subject contents</td><td>1. Problem Formulation & System Abstraction
defining abstract notions to create algorithm - methods to write/depict algorithm (flow chart, pseudo-code)
2. Mathematical Model Building
building simple mathematical models of physical phenomena and coding in Python (e.g. motion equation)
3. Model Verification & Validation
verification & validation examples (e.g. finding roots of a function - bisection method, Newton's method)
4. Simulation Fundamentals
describing a process or physical phenomenon with an equations (possibly differential equation, Euler's & Runge-Kutta methods)
5. Data & Parameters
using Python language to parametrize simulations, working with data sets
6. Optimisation Problem Formulation
local extremes vs. global extremes, continuous and discrete approach
7. Core Optimisation Methods
Newton-Raphson's method, Lagrange multipliers method, Monte Carlo methods: GA etc.
8. Sensitivity & Uncertainty Analysis
using parameters to verify sensitivity & uncertainty
9. Interpolation
polynomial and spline interpolation</td></tr>
<tr><td>Prerequisites and co-requisites</td><td>• fundamental skills in using personal computer,
• basic knowledge about operating system and file system,
• bachelor's course in mathematics.</td></tr>
<tr><td>Assessment methods and criteria</td><td><table><tr><th>Subject passing criteria</th><th>Passing threshold</th><th>Percentage of the final grade</th></tr><tr><td>tests in lab</td><td>60.0%</td><td>100.0%</td></tr></table></td></tr>
<tr><td>Recommended reading</td><td><table><tr><td>Basic literature</td><td>Chapra S., Clough D., Applied Numerical Methods with Python for Engineers and Scientists, 1st Edition, Mc Graw Hill, 2022

Moin P., Fundamentals of Engineering Numerical Analysis, Cambridge University Press, 2-nd Edition, 2010</td></tr><tr><td>Supplementary literature</td><td>Bjorck A., Dahlquis G., Numerical methods, Dover Publications Inc., Prentice Hall, 1974</td></tr><tr><td>eResources addresses</td><td>Basic
http://numerics.stanford.edu/ta/index.htm - numerical methods
https://pythonnumericalmethods.studentorg.berkeley.edu/notebooks/Index.html - numerical methods in Python</td></tr></table></td></tr>
<tr><td>Example issues/ example questions/ tasks being completed</td><td>1. Solving one dimensional physical problems defined with differential equation e.g.:

damping oscillations of a mass hanged on spring,

damping oscillations of a cylinder fallen into water

2. Interpolation with Lagrange polynomial

3. Interpolation with Splines</td></tr>
<tr><td>Work placement</td><td>Not applicable</td></tr>
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