GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	, PG_00069217		
Field of study	Modelowanie parametryczne i optymalizacja procesów i konstrukcji		
Date of commencement of studies	October 2022	Academic year of realisation of subject	2025/2026
Education level	first-cycle studies	Subject group	
Mode of study	Full-time studies	Mode of delivery	at the university
Year of study	4	Language of instruction	Polish
Semester of study	7	ECTS credits	5.0
Learning profile	general academic profile	Assessment form	assessment
Conducting unit	Department of Engineering Structures -> Faculty of Civil and Environmental Engineering -> Faculties of Gdańsk University of Technology		
Name and surname of lecturer (lecturers)	Subject supervisor	dr inż. Przemysław Kalitowski	
	Teachers		

Lesson types

Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
Number of study hours	15.0	30.0	0.0	0.0	0.0	45

E-learning hours included: 0.0

eNauczanie source address: https://enauczanie.pg.edu.pl/2025/course/view.php?id=1975

Moodle ID: 1975 Modelowanie parametryczne i optymalizacja procesów i konstrukcji 2025/2026 https://enauczanie.pg.edu.pl/2025/course/view.php?id=1975

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	10.0	70.0	125

Subject objectives

The aim of the course is to develop skills in applying parametric modelling within Rhinoceros 3D and Grasshopper, as well as to introduce optimization methods used in structural design and analysis. Students learn how to create and modify parametric models, automate design workflows, and apply optimization techniques to solve structural engineering problems and support informed decision-making in the design process.

Learning outcomes

Course outcome	Subject outcome	Method of verification
[K6_K04] Engages in independent lifelong learning and individually follows the development of science and technology in the field of civil engineering.	The student is able to independently develop skills in parametric modelling by searching for information and solutions in documentation, technical materials for Rhino and Grasshopper, as well as using LLM tools.	[SK5] Ocena umiejętności rozwiązywania problemów występujących w praktyce [SK2] Ocena postępów pracy
[K6_K03] Can effectively, clearly and unambiguously convey information, describe activities and communicate their results/ outcomes to engineers or a wider audience using appropriate communication methods and tools.	The student is able to prepare and present the results of modelling and optimization, clearly describing the applied algorithms and parameters in the Rhinoceros 3D + Grasshopper environment.	[SK4] Ocena umiejętności komunikacji, w tym poprawności językowej [SK3] Ocena umiejętności organizacji pracy

<table>
<tr><td>Subject contents</td><td>Course content – lecture

1. Introduction to parametric modelling in civil engineering.
2. Fundamentals of working in the Rhinoceros 3D and Grasshopper environment.
3. Parametrisation of structural geometry concepts and best practices.
4. Automation of design processes using Grasshopper components and scripting.
5. Deterministic and heuristic optimisation methods in structural design.
6. Sensitivity analysis and assessment of structural design variants.
7. Integration of CAD/CAE tools with parametric modelling workflows.
8. Case studies of parametric and optimisation applications in engineering practice.

Course content – exercises

1. Working with the Rhinoceros 3D interface basics of modelling.
2. Creating simple Grasshopper definitions input data, operators, geometry.
3. Building parametric relationships and controlling design variables.
4. Geometry automation and generation of structural variants: logical operators and conditional statements.
5. Formulating objective functions and constraints for optimisation tasks.
6. Using optimisation algorithms (e.g., Galapagos).
7. Analysing results and comparing design variants.
8. Developing the final parametric definition and preparing the results report.</td></tr>
<tr><td>Prerequisites and co-requisites</td><td>The student should have basic knowledge of CAD tools and the ability to perform structural analysis and design of steel and reinforced concrete elements.</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>Semester project</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>1. Findeisen, W., Szymanowski, J., & Wierzbicki, A. (1980). Teoria i metody obliczeniowe optymalizacji (Wydanie dr). Państwowe Wydawnictwo Naukowe.
2. Tesch, K. (2016). Continuous optimisation algorithms. Gdansk University of Technology Publishers.
3. Rajaa Issa. (2013). Essential Mathematics for Computational Design. www.rhino3d.com
4. Goldberg, D. E. (1995). Algorytmy genetyczne i ich zastosowanie. Wydawnictwa Naukowo-Techniczne.
5. Rao, S. S. (2020). Engineering Optimization Theory and Practice (5th ed.). John Wiley & Sons Ltd.</td></tr><tr><td>Supplementary literature</td><td>Gil, J. (2013). Algorytmy ewolucyjne w zastosowaniu do rozwiązywania wybranych zadań optymalizacji. Acta Scientiarum Polonorum. Geodesia et Descriptio Terrarum, 12(2), 2128.

Kalitowski, P. (2022). Przęsło łukowe kolejowego obiektu mostowego. Wpływ schematu statycznego i rozwiązań konstrukcyjnych na właściwości dynamiczne.</td></tr><tr><td>eResources addresses</td><td>Basic
http://rhino3d.com/learn/ - A collection of a large number of video materials covering 3D modelling and parametric modelling in Rhino 3D and Grasshopper.</td></tr></table></td></tr>
<tr><td>Example issues/ example questions/ tasks being completed</td><td>1. Creating a parametric model of a simple structure (beam, frame, or truss) in Rhinoceros 3D and Grasshopper.
2. Applying parametric relationships to control the geometry of an object (e.g., height, angle, number of divisions).
3. Implementing conditional logic and logical operators within a Grasshopper definition.
4. Generating multiple structural variants based on selected design variables.
5. Formulating an objective function and constraints for an optimisation task.
6. Performing structural optimisation using algorithms such as Galapagos.
7. Analysing the influence of parameter changes on geometry and structural behaviour.
8. Evaluating and comparing the performance of different design variants.
9. Automating a selected part of the modelling process using Grasshopper (e.g., generating sections, meshes, repetitive elements).
10. Preparing a final report describing the parametric definition, applied methods, and obtained results.</td></tr>
<tr><td>Practical activites within the subject</td><td>Not applicable</td></tr>
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