GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Fraktals, PG_00021049		
Field of study	Mathematics		
Date of commencement of studies	October 2023	Academic year of realisation of subject	2023/2024
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	Polish
Semester of study	1	ECTS credits	4.0
Learning profile	general academic profile	Assessment form	assessment
Conducting unit	Divison of Dynamical Systems -> Institute of Applied Mathematics -> Faculty of Applied Physics and Mathematics		
Name and surname of lecturer (lecturers)	Subject supervisor	prof. dr hab. Joanna Janczewska	
	Teachers	prof. dr hab. Joanna Janczewska	

Lesson types and methods of instruction

Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
Number of study hours	30.0	15.0	0.0	15.0	0.0	60

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	60	5.0	60.0	125

Subject objectives

The aim of the lecture is to introduce the central ideas and concepts of fractals as well as many related topics.

Learning outcomes

Course outcome	Subject outcome	Method of verification
[K7_U11] Can construct mathematical models used in specific advanced applications of mathematics, can use stochastic processes as a tool for modeling phenomena and analyzing their evolution.	A student understands relations between the fractal theory and dynamical systems.	[SU3] Assessment of ability to use knowledge gained from the subject
[K7_U09] Is able, at an advanced level and covering modern mathematics, to apply and present in speech and in writing the methods of at least one selected branch of mathematics: mathematical and functional analysis, theory of differential equations and dynamical systems, algebra and number theory, geometry and topology, calculus probability and statistics, discrete mathematics and graph theory, logic and set theory.	A student can apply the knowledge acquired at other lectures.	[SU3] Assessment of ability to use knowledge gained from the subject
[K7_W05] Has enhanced knowledge of a selected branch of mathematics: knows most classical definitions and theorems and their proofs, Understands problems being examined, Knows relations between problems from particular field with other branches of mathematics, theoretical and applied	A student knows basic notions and facts of discreet and continuous dynamical systems. A student can define the space of Hausdorff type. A student is able to explain the notion of fractal by the use of examples from biology. A student can compute fractal dimension, Hausdorff's dimension and topological dimension.	[SW1] Assessment of factual knowledge

Subject contents	The Banach contraction principle. Examples of fractals. Why do so many people study fractals? Fractal spaces with the Hausdorff metric. Iterated function systems (IFS). A fractal dimension, the Hausdorff dimension and a topological dimension. The Mandelbrot definition of fractals. Julia sets. The Mandelbrot set. Discrete dynamical systems. Continuous dynamical systems. A definition and properties of the Poincare map. Attractors and repellers. The Feigenbaum cascade. The Smale horseshoe - a geometric description. Properties of the invariant set of the Smale horseshoe.
Prerequisites and co-requisites	Mathematical analysis. Topology. Ordinary differential equations.

Assessment methods and criteria

Subject passing criteria	Passing threshold	Percentage of the final grade
A maths test	50.0%	50.0%
Project	100.0%	50.0%

Recommended reading

Basic literature	1. Jacek Kudrewicz, Fraktale i Chaos, Wydawnictwa Naukowo-Techniczne, Warszawa, 2007. 2. Lawrence Perko, Differential Equations and Dynamical Systems, Springer, New York, 2001.
Supplementary literature	1. J.D. Murray, Mathematical Biology. I: An Introduction, Springer-Verlag, New York, 2002. 2. H.-O. Peitgen, H. Jurgens, D. Saupe, Chaos and Fractals. New Frontiers of Science, Springer-Verlag, New York, 2004.
eResources addresses	Adresy na platformie eNauczanie:

Example issues/ example questions/ tasks being completed

1. Is a given subset Z in R^n compact (connected, nowhere dense)? Justify the answer.

2. Calculate the Hausdorff distance between two given subsets A and B in R^2.

3. Calculate a fractal dimension, the Hausdorff dimension and a topological dimension of the Cantor set, the Koch curve, the Sierpiński gasket and carpet.

4. Let $w_1, w_2, ..., w_k$: $R^n R^n$ be given. Prove that $\{R^n ; w_1, w_2, ..., w_k\}$ is an iterated function system. Calculate the constant of its contraction.

5. Solve a linear differential equation of first order x'=Ax in R^2, where A is a given square matrix 2x2.

6. Give a geometric description of the Smale horseshoe map.

7. What is it an attractor? Give a short description of the Hénon attractor, the Rössler attractor and the Lorenz attractor.

Work placement	Not applicable

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