GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Chaos theory, PG_00023806						
Field of study	Mathematics						
Date of commencement of studies	October 2023		Academic year of realisation of subject	2024/2025			
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	2		Language of instruction	Polish			
Semester of study	3		ECTS credits	4.0			
Learning profile	general academic profile		Assessment form	assessment			
Conducting unit	Divison of Differential Equations and Applications of Mathematics -> Institute of Applied Mathematics -> Faculty of Applied Physics and Mathematics						
Name and surname of lecturer (lecturers)	Subject supervisor	dr hab. Piotr Bartłomiejczyk					
	Teachers	dr hab. Piotr Bartłomiejczyk					
Lesson types and methods of instruction	Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
	Number of study hours	30.0	0.0	0.0	0.0	30.0	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	35.0	100	
Subject objectives	Introduction to advanced methods in studying and description of evolution of systems with trends towards chaotic behaviour. Synthesis of probabilistic, topological and analytical techniques to obtain description of dynamics.						

Learning outcomes

Course outcome	Subject outcome	Method of verification
[K7_W01] Has enhanced knowledge of basic branches of mathematics.	Describes attactors of dynamical systems.	[SW1] Assessment of factual knowledge
[K7_K04] Can form opinions on fundamental mathematical issues.	Interprets chaotic nature of data in their analysis.	[SK5] Assessment of ability to solve problems that arise in practice
[K7_U10] In a selected field, can examine evidence, in which, if necessary, also can use tools from other branches of mathematics, can identify one's own interests and develop them; in particular, is able to establish contact with specialists in their field, e.g. understand their lectures intended for young mathematicians.	Finds fixed points, periodic points and dense orbits.	[SU4] Assessment of ability to use methods and tools [SU3] Assessment of ability to use knowledge gained from the subject
[K7_U06] Has the ability to recognize topological structures in mathematical objects occurring, for example, in geometry or mathematical analysis; is able to use the basic topological properties of sets, functions and transformations, uses the language and methods of functional analysis in the problems of mathematical analysis and its applications, in particular uses the properties of classical Banach and Hilbert spaces.	Ranks dynamical systems. Examines ergodic properties of dynamical systems. Compares the degree of chaos.	[SU2] Assessment of ability to analyse information

Subject contents

LECTURES Revision of selected topics from topology, measure theory and functional analysis. Abstract dynamical systems. Nonlinear contractions and fixed points. Deterministic chaos. Hypercyclicity and linear chaos in Banach spaces. Barnsley operator and attractors. Fractals. Measurable transformations and invariant measures. Poincare recurrence theorem. Ergodicity. Mixing.

SEMINARS Chaotic functions (examples). Bifurcations in the family of logistic maps . Relations between characteristics of trajectories. Sharkovski and Li-Yorke theorems. Barnsley operator. IFS systems. Chaos and Barnsley attractors. Ergodicity. Exactness. Mixing. Evolution of densities. Frobenius-Perron. Random dynamical systems. Fractals. Hausdorff metric. Julia sets. Chaos and fractals on a complex plane.

Prerequisites and co-requisites

Courses completed: Probability Theory (MAT1013), Functional Analysis II (MAT2003)

Assessment methods and criteria

Subject passing criteria	Passing threshold	Percentage of the final grade
Report project	50.0%	60.0%
Test from theory	50.0%	40.0%

Recommended reading

Basic literature	1. R. L. Devaney, Introduction to chaotic dynamical systems, Taylor & Francis, 1986
Supplementary literature	1. Alligood Kathleen T. Sauer Tim D. Yorke James A., Chaos, Springer, 2000
eResources addresses	Adresy na platformie eNauczanie:

Example issues/ example questions/ tasks being completed

At the beginning of the term the student is provided with the list of topics to be worked out and finally to be presented as a project on a prescribed date. Theoretical components from lectures and seminars are verified on the test. Student's activity on seminars is essential.

Find the periodic structure of a dynamical system. Find chaotic featurefs of a dynamical systems. Find an attractor of a dynamical system. Evaluate Hausdorff measure and fractal dimension. Investigate ergodicity or mixing of a given transformation.

Work placement

Not applicable

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