GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Chaos theory, PG_00023806		
Field of study	Mathematics		
Date of commencement of studies	October 2025	Academic year of realisation of subject	2026/2027
Education level	second-cycle studies	Subject group	Specialty 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 -> Faculties of Gdańsk University of Technology		
Name and surname of lecturer (lecturers)	Subject supervisor	dr hab. Piotr Bartłomiejczyk	
	Teachers	dr hab. Piotr Bartłomiejczyk	

Lesson types

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_K04] forms opinions on mathematical issues	Classifies dynamical systems. Analyzes the ergodic properties of dynamical systems. Compares the degree of chaos.	[SK5] Assessment of ability to solve problems that arise in practice
[K7_U08] in a selected field, examines evidence, in which also can use tools from other branches of mathematics,	It determines fixed points, periodic points, and dense orbits	[SU2] Assessment of ability to analyse information
[K7_U02] has the ability to check the correctness of conclusions in constructing formal proofs, sees formal structures related to the basic areas of mathematics and understands the importance of their properties.	It interprets the chaotic nature of data in its analysis.	[SU2] Assessment of ability to analyse information [SU3] Assessment of ability to use knowledge gained from the subject
[K7_W01] has enhanced knowledge of basic branches of mathematics,demonstrates knowledge theorem and hypotheses, has understanding of the role and importance of mathematical reasoning structure.	Describes attractors of dynamical systems.	[SW1] Assessment of factual knowledge

<table>
<tr><td>Subject contents</td><td>Course content – lecture
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.</td></tr>
<tr><td>Prerequisites and co-requisites</td><td>Courses completed: Probability Theory (MAT1013), Functional Analysis II (MAT2003)</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>Report project</td><td>50.0%</td><td>60.0%</td></tr>
<tr><td>Test from theory</td><td>50.0%</td><td>40.0%</td></tr>
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<tr><td>Recommended reading</td><td><table>
<tr><td>Basic literature</td><td>1. R. L. Devaney, Introduction to chaotic dynamical systems, Taylor & Francis, 1986</td></tr>
<tr><td>Supplementary literature</td><td>1. Alligood Kathleen T. Sauer Tim D. Yorke James A., Chaos, Springer, 2000</td></tr>
<tr><td>eResources addresses</td><td></td></tr>
</table></td></tr>
<tr><td>Example issues/ example questions/ tasks being completed</td><td>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.</td></tr>
<tr><td>Practical activites within the subject</td><td>Not applicable</td></tr>
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