GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

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|---|---|---|---|
| Subject name and code | Chaos theory, PG_00023806 | | |
| Field of study | Mathematics | | |
| Date of commencement of studies | October 2024 | Academic year of realisation of subject | 2025/2026 |
| Education level | second-cycle studies | Subject group | |
| 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 -> Wydziały Politechniki Gdańskiej | | |
| 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 |
|---|---|---|

**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**

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|---|---|
| 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 | |

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|---|---|
| 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.<br><br>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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