GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	, PG_00070313		
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	4	ECTS credits	2.0
Learning profile	general academic profile	Assessment form	assessment
Conducting unit	Divison of Dynamical Systems -> Institute of Applied Mathematics -> Faculty of Applied Physics and Mathematics -> Faculties of Gdańsk University of Technology		
Name and surname of lecturer (lecturers)	Subject supervisor	dr Klaudiusz Czudek	
	Teachers	dr Klaudiusz Czudek	

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

eNauczanie source address: https://enauczanie.pg.edu.pl/2025/course/view.php?id=5436

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	0.0	0.0	60

Subject objectives

In this course I am going to introduce basic notions of ergodic theory: measure preserving systems, Bikhoff theorem, mixing systems, weak mixing systems, Bernoulli and Kolmogorov systems. We will investigate basic examples of systems with those properties and origins of ergodic theory in physics. Spectral theory of Koopman operator and metric entropy are going to be discussed.

Learning outcomes

Course outcome	Subject outcome	Method of verification
[K7_W03] demonstrates knowledge advanced computation techniques, supporting the work of a mathematician and understand their limitations.	A student understands how to exploit a computer to simulate dynamical systems	[SW1] Assessment of factual knowledge
[K7_U10] understands the mathematical foundations of the analysis of algorithms and computational processes, constructs algorithms with good numerical properties, used to solve typical and unusual mathematical problems	A student is able to estimate the complexity of algorithms used to study the trajectories of dynamical systems	[SU3] Assessment of ability to use knowledge gained from the subject [SU4] Assessment of ability to use methods and tools
[K7_W02] has enhanced knowledge of a selected branch of mathematics,theoretical or applied, knows classical definitions and theorems and their proofs and connections with other fields,understands problems being examined	A student gives basic definitions of ergodic theory	[SW1] Assessment of factual knowledge

<table>
<tr><td>Subject contents</td><td>Course content – lecture
1. Hamiltonians, measure preserving systems, Liouville's theorem.

2. Ideal gas, Clapeyron equation, equipartition of energy, Boltzmann ergodic hypothesis.

3. Geodesic flow on surfaces with negative curvature. Hard spheres system.

4. Kac' lemma, Poincare recurrence theorem.

5. Differential equations on torus. Ergodic properties of the circle rotation.

6.Ergodic theory of Markov processes, Ito diffusion, infinitesimal operators.

7. Spectral theory of Koopman operators, entropy.

Course content – seminar
Solving problems related to the content of lectures.</td></tr>
<tr><td>Prerequisites and co-requisites</td><td>Probability theory, stochastic integral, stochastic differential equations</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>Test</td><td>50.0%</td><td>100.0%</td></tr>
</table></td></tr>
<tr><td>Recommended reading</td><td><table>
<tr><td>Basic literature</td><td>Cornfeld, Fomin, Sinai "Ergodic theory"</td></tr>
<tr><td>Supplementary literature</td><td>Katok, Hasselblatt "Introduction to the modern theory of dynamical systems" 1995

Kallenberg "Foundations of modern probability" 2002</td></tr>
<tr><td>eResources addresses</td><td></td></tr>
</table></td></tr>
<tr><td>Example issues/ example questions/ tasks being completed</td><td>Prove that a given system preserves a given measure. Prove ergodicity/weak mixing/mixing of the system.</td></tr>
<tr><td>Practical activites within the subject</td><td>Not applicable</td></tr>
</table>

Document generated electronically. Does not require a seal or signature.