GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Stability of Markov operators on density, PG_00069115		
Field of study	Mathematics		
Date of commencement of studies	October 2024	Academic year of realisation of subject	2026/2027
Education level	first-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	3	Language of instruction	Polish
Semester of study	5	ECTS credits	4.0
Learning profile	general academic profile	Assessment form	assessment
Conducting unit	Institute of Applied Mathematics -> Faculty of Applied Physics and Mathematics -> Faculties of Gdańsk University of Technology		
Name and surname of lecturer (lecturers)	Subject supervisor	prof. dr hab. inż. Tomasz Szarek	
	Teachers		

Lesson types

Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
Number of study hours	30.0	0.0	0.0	15.0	0.0	45

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	45	6.0	49.0	100

Subject objectives

Presentation of basic techniques for investigating the stability of dynamical systems acting on densities.

Learning outcomes

Course outcome	Subject outcome	Method of verification
K6_U10	Is able to simulate density distributions for various stochastic models.	[SU5] Assessment of ability to present the results of task
K6_W03	Is able to construct and analyse a simple stochastic model described by a Markov operator.	[SW2] Assessment of knowledge contained in presentation [SW3] Assessment of knowledge contained in written work and projects
K6_U05	Is able to explain functional relationships expressed by a Markov operator acting on densities, i.e. \(L^1\) functions.	[SU2] Assessment of ability to analyse information [SU1] Assessment of task fulfilment

<table>
<tr><td>Subject contents</td><td>Course content – lecture

We will define a Markov operator acting on densities and demonstrate its connection with transformations induced by a randomly selected function applied piecewise to points (the so-called Frobenius–Perron operator).

We will then present conditions under which the evolution of a distribution of points converges to a certain limiting distribution. This result is known as the Lower Function Theorem.

In the subsequent part, we will use this tool to investigate various physical, biological and medical models, demonstrating their stability.

Course content – project

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<tr><td>Prerequisites and co-requisites</td><td>Knowledge of the fundamentals of mathematical analysis.</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>50.0%</td></tr>
<tr><td>Project</td><td>0.0%</td><td>50.0%</td></tr>
</table></td></tr>
<tr><td>Recommended reading</td><td><table>
<tr><td>Basic literature</td><td>A. Lasota, M. Mackey ,,Chaos, Fractals, and Noise”, Springer, 1994

A. Bobrowski, T. Szarek, ,,Lower bound technique in the theory of Markov operators”, książka w przygotowaniu

T. Sękowski ,,Zagadnienie Matematycznej Teorii Chaosu”, Wydawnictwo UMCS 2007.</td></tr>
<tr><td>Supplementary literature</td><td>A. Boyarsky, P. Góra ,,Laws of Chaos”, Birkhauser 1997</td></tr>
<tr><td>eResources addresses</td><td></td></tr>
</table></td></tr>
<tr><td>Example issues/ example questions/ tasks being completed</td><td>What is a Markov operator?

What is its relationship with the transition operator for deterministic systems with random initial conditions?

What is the stability of a system?

How do we define the asymptotic periodicity of a system?</td></tr>
<tr><td>Practical activites within the subject</td><td>Not applicable</td></tr>
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