GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

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| Subject name and code | Stochastic processes, PG_00062081 | | | | | | |
| Field of study | Mathematics | | | | | | |
| Date of commencement of studies | October 2026 | | Academic year of realisation of subject | 2026/2027 | | | |
| Education level | second-cycle studies | | Subject group | Specialty subject group<br>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 | 1 | | Language of instruction | Polish | | | |
| Semester of study | 1 | | ECTS credits | 5.0 | | | |
| Learning profile | general academic profile | | Assessment form | exam | | | |
| 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 | | | | | | |
| 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 | 60.0 | 125 | |
| Subject objectives | Introduction to basic notions and theorems of the theory of stochastic processes. Equipping a student in the knowledge supporting modelling of the dynamics of random phenomenon. | | | | | | |

## Learning outcomes

| Course outcome | Subject outcome | Method of verification |
|---|---|---|
| [K7_U09] constructs mathematical models used in specific advanced applications of mathematics, can use stochastic processes as a tool for modeling phenomena and analyzing their evolution,constructs mathematical models used in specific advanced applications of mathematics, uses stochastic processes as a tool for modeling phenomena and analyzing their evolution, recognizes mathematical structures in physical theories | Constructs risk models of selected problems in non-life and life insurance. | [SU2] Assessment of ability to analyse information |
| [K7_U06] uses probability distributions and their properties in practical issues, is familiar with the basics of statistics and the basics of statistical data processing | Describes families of finite dimensional distributions using classical probability measures | [SU3] Assessment of ability to use knowledge gained from the subject |
| [K7_U04] applies the concepts of measure theory in typical theoretical and practical problems | Evaluates characteristics of stochastic processes using methods of measure theory and Lebesgue integral. | [SU3] Assessment of ability to use knowledge gained from the subject<br>[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 | Gives definitions of a stochastic process, Wiener process, Poisson process. Gives the statement of the Kolmogorov existence theorem. Gives basic properties of Brownian motion. | [SW1] Assessment of factual knowledge |

## Subject contents

Course content – lecture
LECTURES Revision of selected parts of probability theory and introduction of notion. Moment generating function and its properties. Stochastic processes - definition and examples. Finite dimensional distributions of a stochastic process. Homogeneous Poisson process. Non - homogeneous Poisson process. Markov chains. Branching processes. Martingales. Doob Theorem. Renewal processes. Classical Brownian motion process. Gaussian processes. Trajectories of a classical Brownian motion and their properties. Diffusion processes. Kolmogorov Theorem.

SEMINARS Revision of methods of probability theory. Sequences of random variables (exponential, Bernoulli, geometrical) and their asymptotic properties. Moment generating function. Random walks. Markov chains. Poisson processes. Renewal processes. Stochastic matrices. Ergodic theory of Markov operators. Reversible chains. Markov semigroups and their generators. Martingales. Stationary processes. Gaussian processes.

## Prerequisites and co-requisites

Courses completed: Probability Theory (MAT1013)

## Assessment methods and criteria

| Subject passing criteria | Passing threshold | Percentage of the final grade |
|---|---|---|
| Tests | 51.0% | 50.0% |
| Exam | 51.0% | 50.0% |

## Recommended reading

Basic literature

J.Jakubowski, R.Sztencel, Wstęp do teorii prawdopodobieństwa, Wydawnictwo SCRIPT, Warszawa, 2012.

W.Feller, Wstęp do rachunku prawdopodobieństwa, t.I i II, PWN, Warszawa, 2014.

O. Kallenberg "Foundations of modern probability"

Billingsley "Prawdopodobieństwo i miara"

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| | Supplementary literature | van Kampen "Stochastic processes in physics and chemistry"<br><br>J.R.Norris, Markov Chains, Cambridge University Press, Cambridge, 2007.<br><br>S.R.S.Varadhan, Stochastic Processes, AMS, Rhode Island, 2007. |
| | eResources addresses | |
| Example issues/ example questions/ tasks being completed | The students present solution of problems from a given set. Tests problems are selected from mentioned lists and the exam on topics from lectures.<br><br>Evaluate the extinction/ruin probability. Find stationary distribution. Find one-parameter semigroup from its generator. Classify states. Verify whether a given process is a martingale. Verify the strong Markov property. | |
| Practical activites within the subject | Not applicable | |

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