DESCRIPTION OF THE COURSE OF STUDY

Course code	**0719-2ID-C27-PS**	
Name of the course in	Polish	**Procesy stochastyczne w fizyce**
	English	**Stochastic processes in physics**

1. LOCATION OF THE COURSE OF STUDY within the system of studies

1.1. Field of study	**Data engineering**
1.2. Mode of study	**Full time**
1.3. Level of study	**First-cycle degree**
1.4. Profile of study*	**General academic**
1.5. Person/s preparing the course description	**Tadeusz Kosztołowicz**
1.6. Contact	**tadeusz.kosztolowicz@ujk.edu.pl**

2. GENERAL CHARACTERISTICS OF THE course of study

2.1. Language of instruction	**English**
2.2. Prerequisites*	**Basic knowledge of algebra and mathematical analysis, including matrix calculus, complex numbers, elementary functions, series, differential and integral calculus**

3. DETAILED CHARACTERISTICS OF THE COURSE OF STUDY

3.1. **Form of classes**		**lectures, classes**
3.2. **Place of classes**		**classes in the teaching rooms of UJK**
3.3. **Form of assessment**		**lectures – pass with grade, classes – pass with grade**
3.4. **Teaching methods**		**lectures, classes**
3.5. **Bibliography**	**Required reading**	**1. A. Papoulis, Probability, random variables, and stochastic processes, McGraw-Hill, 1965** **2. C. Gardiner, Stochastic methods. A handbook for the natural and social sciences, Springer, 2009**
	Further reading	**1. N.G. van Kampen, Stochastic processes in physics and chemistry, North-Holland, 1987** **2. W. Feller, An introduction to probability theory and its applications, vol. I and II, Wiley**

4. OBJECTIVES, SYLLABUS CONTENT AND INTENDED LEARNING OUTCOMES

4.1. **Course objectives** ***(including form of classes)***

Lecture:

C1. Introduction to the concept of a stochastic process.

C2. Presentation of stochastic process models and their use in modeling physical processes.

C3. Introduction to methods for solving equations occurring in stochastic models.

Classes:

C4. Acquiring the ability to determine the distributions of random variables describing a stochastic process.

C5. Acquiring the ability to create simple stochastic models.

C6. Acquiring the ability to solve normal and anomalous diffusion equations.

4.2. Detailed syllabus ***(including form of classes)***

Lectures

Definition and examples of processes in discrete and continuous systems. Functions of random variables. Fourier and Laplace transforms. Characteristic function. Correlation and power spectrum, harmonic analysis of stochastic processes. Stationary processes. Markovian and non-Markovian processes. Chapman-Kolmogorov equation. Models of stochastic processes in the physical sciences. Birth and death processes. Models of radioactive decay processes. Malthus-Verhulst model of population growth. Models of Brownian motion. Diffusion and diffusion with chemical reactions processes. Stable probability distributions, "heavy-tailed" distributions. Models of anomalous diffusion: subdiffusion and superdiffusion. Definition and properties of fractional derivatives. Applications of differential equations with fractional derivatives to the description of physical processes, in particular anomalous diffusion processes.

Exercises

Determining probability distributions of random variables and their temporal evolution for selected stochastic

processes. Determining characteristic functions and using them to determine the temporal evolution of parameters describing the distributions of random variables. Determining distributions for functions of random variables. Analyzing stochastic processes to determine whether a process is Markovian. Solving normal and anomalous diffusion equations using Laplace and Fourier transforms.

4.3 Intended learning outcomes

Code	A student, who passed the course	Relation to learning outcomes
within the scope of **KNOWLEDGE:**		
W01	knowledge of basic concepts and models of stochastic processes	ID1A _W02 ID1A _W11 ID1A _W12
W02	knowledge of basic methods of creating models of stochastic processes and solving equations occurring in these models	ID1A _W02 ID1A _W11 ID1A _W12
within the scope of **ABILITIES:**		
U01	ability to determine time-varying distributions of random variables describing stochastic processes	ID1A_U01 ID1A_U05 ID1A_U12
U02	ability to interpret processes described by probability distributions of random variables	ID1A_U08 ID1A_U12 ID1A_U13
within the scope of **SOCIAL COMPETENCE:**		
K01	the ability to determine priorities for completing a task	ID1A_K01 ID1A_K03

Teaching outcomes *(code)*	Exam oral/written*			Test*			Project*			Effort in class*			Self-study*		
	Form of classes			*Form of classes*			*Form of classes*			*Form of classes*			*Form of classes*		
	L	*C*	*P*	*L*	*C*	*P*	*L*	*C*	*P*	*L*	*C*	*P*	*L*	*C*	*P*
W01	+				+				+					+	
W02	+				+				+					+	
U01	+				+				+		+			+	
U02	+				+				+		+			+	
K01									+		+				

delete as appropriate

4.5. **Criteria of assessment of the intended learning outcomes**

Form of classes	Grade	Criterion of assessment
lecture (L)	**3**	Achievement <50 - 60) % of the requirements used in the assessment methods
	3,5	Achievement <60 - 70) % of the requirements used in the assessment methods
	4	Achievement <70 - 80) % of the requirements used in the assessment methods
	4,5	Achievement <80 - 90) % of the requirements used in the assessment methods
	5	Achievement <90 - 100) % of the requirements used in the assessment methods
classes (C)*	**3**	Achievement <50 - 60) % of the requirements used in the assessment methods
	3,5	Achievement <60 - 70) % of the requirements used in the assessment methods
	4	Achievement <70 - 80) % of the requirements used in the assessment methods
	4,5	Achievement <80 - 90) % of the requirements used in the assessment methods
	5	Achievement <90 - 100) % of the requirements used in the assessment methods

5. BALANCE OF ECTS CREDITS – STUDENT'S WORK INPUT

Category	Student's workload

	Full-time studies	Extramural studies
NUMBER OF HOURS WITH THE DIRECT PARTICIPATION OF THE TEACHER / CONTACT HOURS/	***60***	
*Participation in lectures**	***30***	
*Participation in classes, seminars, laboratories**	***30***	
INDEPENDENT WORK OF THE STUDENT/NON-CONTACT HOURS/	***40***	
*Preparation for the class**	***15***	
*Preparation for the exam/test**	***25***	
TOTAL NUMBER OF HOURS	***100***	
ECTS credits for the course of study	***4***	

delete as appropriate

Accepted for execution *(date and legible signatures of the teachers running the course in the given academic year)*

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