WROCŁAW UNIVERSITY OF TECHNOLOGY – PHD STUDIES

FACULTY OF FUNDAMENTAL PROBLEMS OF TECHNOLOGY **SUBJECT CARD**
Course name in Polish: Elementarne wprowadzenie do procesów stochastycznych dla fizyków i inżynierów
Course name in English: Elementary introduction into stochastic processes for physicists and engineers
Course language: English
University-wide general course type: 1)basic course (mathematics, physics, chemistry, other) 2) humanity course 3) managerial skills 4) English language 5) other modern language Departmental course developing professional skills: 1) specialized course 2) interdisciplinary course 3) seminar (interdisciplinary, specialized, departmental)
Type of course (obligatory, optional): optional
Educational effects according to ZW 26/2017: **P8S_WG, P8S_UW, P8S_KR**
Subject code: FZP9384

*delete as applicable

	Lecture	Laboratory	Seminar
Number of hours of organized classes in University (ZZU)	30		
Number of hours of total student workload (CNPS)	90		
Form of crediting	Exam **	Exam / crediting with grade*	Oral presentation
Number of ECTS points	3		
including number of ECTS points for practical (P) classes			
including number of ECTS points for direct teacher-student contact (BK) classes	2		

*delete as applicable **In case of didactic courses also inspections and evaluation classes

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

1. Calculus (from 1st / 2nd level)
2. Sound mastering of basic English language

SUBJECT OBJECTIVES	
C1	Students will learn how to model and analyze statistical properties of chosen well-

	known physical systems in the presence of additive and multiplicative noise driven by Wiener process
C2	Students will become familiar with basic concepts of Ito's calculus
C3	Students will acquire the skill of solving chosen simple stochastic differential equations

SUBJECT EDUCATIONAL EFFECTS

Relating to knowledge:

PEK_W01 – Basic concepts of Brownian motion driven by Wiener process. Langevin equation

PEK_W02 – Basic concepts of Ito's calculus and stochastic differentia equations

Relating to skills:

PEK_U01 – Analysis of Gaussian fluctuations in model physical systems

PEK_U02 – Solving simple stochastic differential equations

PEK_U03 - Monte Carlo simulations of Brownian motion

Relating to social competences:

PEK_K01- awareness of the role of popularization of science

PROGRAM CONTENTS		
Form of classes – lecture		Number of hours
Lec 1	Elementary probability theory, random variables. Stochastic processes in physics	2
Lec 2	Brownian motion: basic concepts. Monte Carlo simulation of Brownian Motion.	2
Lec 3	Ornstein-Uhlenbeck process. Simulating the O-U process. Fluctuation-Dissipation Theorem. Johnson noise.	3
Lec 4	Langevin's Brownian motion: integrating the O-U process, Monte Carlo simulation. Smoluchowski limit.	2
Lec5	Brownian projectile. Stochastic damped harmonic oscillator. Stochastic cyclotron motion.	3
Lec6	Effusion. Stochastic relaxation of a model polimer (Rouse model). Elastic scattering.	2
Lec7	Ito calculus. Ito's formula: changing variables in a Stochastic Differential Equation. Ito stochastic integrals.	3
Lec8	Solving the full linear stochastic equation.	2
Lec9	Wiener-Khinchin Theorem. White noise.	2
Lec10	Modeling multiplicative noise in real systems: Stratonovich integrals.	2
Lec11	Fokker-Planck equations. Stationary solutions for one dimension. Thermalization of a single particie. Smoluchowski equation.	3
Lec12	Poisson process. Master equation.	2
Lec13	Exam (crediting with grade)	2

	Total hours	**30**

TEACHING TOOLS USED	
N1	Lecture
N2	Computer lab (during the lecture)
N3	Discussions

EVALUATION OF ACHIEVED SUBJECT EDUCATIONAL EFFECTS		
Evaluation: F – forming (partial) C – concluding	Educational effect number	Way of evaluating achievement of educational effects
F1	PEK_W01, PEK_W02 PEK_U01, PEK_U02, PEK_U03, PEK_K01	activity: solving examples illustrating the the theory, implementation of simulation algorithms (during the lecture)
F2	PEK_W01, PEK_W02 PEK_U01, PEK_U02, PEK_U03, PEK_K01	exam (crediting with grade)
C=F1/2+F2/2		

PRIMARY AND SECONDARY LITERATURE

PRIMARY LITERATURE:

[1] D.S. Lemons, *An Introduction to Stochastic Processes in Physics*, The Johns Hopkins University Press, 2002.

[2] K. Jacobs, *Stochastic Processes for Physicists: Understanding noisy Systems*, Cambridge University Press, 2010.

SECONDARY LITERATURE:

[1] Al. Papoulis, *Probability, Random Variables and Stochastic Processes*, Mc Graw-Hill, 1965; (polish translation): A. Papoulis, *Prawdopodobieństwo, zmienne losowe i procesy stochastyczne*, WNT, 1972.

[2] C. Gardiner, *Stochastic Methods*, Springer, 2009.

[3] A. Janicki, A. Izydorczyk, Komputerowe metody w modelowaniu stochastycznym,

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WNT, 2001. (in polish)

SUBJECT SUPERVISOR (NAME AND SURNAME, E-MAIL ADDRESS)
prof. dr hab. Antoni C. Mituś, antoni.mitus@pwr.edu.pl