DOCTORAL SCHOOL OF WROCŁAW UNIVERSITY OF SCIENCE AND TECHNOLOGY

SUPERVISOR/TEAM/ DECLARING/CONDUCTINGCOURSE: …….
DEPARTMENT ……

COURSE CARD

Course name in Polish: Elementy wprowadzające do procesów stochochastycznych
Course name in English: Introduction elements to stochastic processes

Course language Polish
University-wide general course type*:
1)basic science course (mathematics, physics, chemistry, computer science or other) :
…….
2) humanities course: …….
3) managementcourse: ……..
4) English language: ……
5) didactics of higher education course: ……

Specialized courses for PhD students receiving education in discipline*: ……..…….……
1) specialized course in discipline: ……..
2) interdisciplinary course in the field of several disciplines: ……
3) seminar indiscipline or interdisciplinary: …….

Subject code: NFQ100128W

* delete as applicable

	Lecture	Foreignlanguagecourse	Seminar	Mixedforms
Number of hours of organized classes in university (ZZU)	30			
Grading	Exam	Exam	Oralpresentation	Exam, inspection, evaluation classes

PREREQUISITES RELATING TO KNOWLEDGE, SKILLS AND OTHER COMPETENCES

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

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COURSE 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

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PROGRAM CONTENTS

Form of classes – lecture (Lec)		Number of hours
Lec1	Elementary probability theory, random variables. Stochastic processes in physics	2
Lec2	Brownian motion: basic concepts. Monte Carlo simulation of Brownian Motion.	2
Lec3	Ornstein-Uhlenbeck process. Simulating the O-U process. Fluctuation-Dissipation Theorem. Johnson noise.	3
Lec4	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	System of stochastic differential equations	2
Lec10	Wiener-Khinchin Theorem. White noise.	1
Lec11	Modeling multiplicative noise in real systems: Stratonovich integrals.	2
Lec12	Fokker-Planck equations. Stationary solutions for one dimension. Thermalization of a single particie. Smoluchowski equation.	4
Lec13	Poisson process. Master equation.	2
	Total hours:	**30**

TEACHING TOOLS USED

N1. Lecture
N2. Computer lab (during the lecture)
N3. Discussions

ACHIEVED SUBJECT LEARNING OUTCOMES

Type of learning outcome	Code of learning outcome	Assessment of learning outcome
Knowledge Mastering of basic concepts related to Brownian motion	**P8S_WG**	Examination (written), discussions during the lectures

Knowledge Mastering of basic concepts related to Ito's calculus and Stochastic Differential Equations	**P8S_WG**	Examination (written), discussions during the lectures
Skills Analysis of Gaussian fluctuations in model physical systems	**P8S_UW**	Examination (written), discussions during the lectures
Skills Solving simple Stochastic Differential Equations	**P8S_UW**	Examination (written), discussions during the lectures
Skills Monte Carlo simulations of Brownian motion	**P8S_UW**	Computer projects, discussions during the lectures
Social competence Awareness of social role of a scientist	**P8U_K**	Discussions during the lectures

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] O. Calin, *An informal Introduction to Stochastic Calculus with Applications*, World Scientific, 2015.

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

[3] A. Janicki, A. Izydorczyk, Komputerowe metody w modelowaniu stochastycznym, WNT, 2001.

[4] Al. Papoulis, *Probability, Random Variables and Stochastic Processes*, Mc Graw-Hill, 1965;
Polskie tłumaczenie: A. Papoulis, *Prawdopodobieństwo, zmienne losowe i procesy stochastyczne*, WNT, 1972.

SUBJECT SUPERVISOR(NAME AND SURNAME, E-MAIL ADDRESS)

prof. dr hab. Antoni C. Mituś, antoni.mitus@pwr.edu.pl