Doctoral School
Warsaw University of Technology

COURSE OFFERED IN THE DOCTORAL SCHOOL

Code of the course		Name of the course	Polish	**Wprowadzenie do teorii osobliwości (WTO)**	
			English	**Introduction to Singularity Theory**	
Type of the course					
Course coordinator	Prof. Dr hab. Stanisław Janeczko (Wydział MINI PW)	Course teacher	Prof. Dr hab. Stanisław Janeczko (Wydział MINI PW)		
Implementing unit	Center for Advanced Studies WUT	Scientific discipline / disciplines*	Mathematics, information and communication technology, chemical sciences, physical sciences		
Level of education	Doctoral studies	Semester	Spring 2025		
Language of the course	English				
Type of assessment	ZAL.	Number of hours in a semester	30	ECTS credits	2
Minimum number of participants	10	Maximum number of participants	49	Available for students (BSc, MSc)	Yes/~~No~~

Type of classes		Lecture	Auditory classes	Project classes	Laboratory	Seminar
Number of hours	in a week	2				
	in a semester	30				

* does not apply to the Researcher's Workshop

1. Prerequisites

Fundamentals of mathematics and physics as studied in technical universities.

Basic courses of analysis, algebra and geometry

2. Course objectives

The aim of the course is an introduction to mathematical language accessible to modelling of processes in exact and natural sciences.

3. Course content (separate for each type of classes)

Lecture

1. Gradient vector fields, parametric potentials 2. Introductory notions of singularity theory, critical points of functions and mappings, degenerated critical points. Spaces of k-jets. 3. Klassification of degenerated critical points of smooth functions. Critical points and critical values of mappings. 4. Transversality. Thom's theorem on transversality. Genericity. 5. Equivalency groups, stability and structural stability. 6. Versal and universal unfolding of singularity. Elementary catastrophes of Rene Thom. Methods of elimination theory, discriminants and resultants. 7. Morfogenetic fields, homeostasis and methabolic processes. 8. H. Whitney's theorem on stable mappings of the plane into the plane. 9. Visualization of catastrophe sets. Methamorphoses and evolutions of catastrophes. Grafical analysis of generating functions and slow dynamics in control parameters. 10. Applications of singularity theory to physics, medicine, social sciences and general modeling.

Laboratory

4. Learning outcomes			
Type of learning outcomes	Learning outcomes description	Reference to the learning outcomes of the WUT DS	Learning outcomes verification methods*
Knowledge			
K01	Has a structured knowledge of real analysis, critical points of mappings and functions	SD_W1, SD_W2	Project
K02	Has a knowledge of the basic properties of topological spaces, especially Whitney's topology	SD_W1, SD_W2	Project
K03	Has a structured knowledge of mathematical modelling of complex systems	SD_W1, SD_W2	Project
Skills			
S01	Is able to classify critical points of functions and mappings and determine their normal forms	SD_U1, SD_U2, SD_U6	Project
S02	Is able to apply R. Thom theorem on transversality and classification of bifurcation sets	SD_U1, SD_U2, SD_U6	Project
S03	Is able to apply basic methods for modeling nonlinear systems with structural transformations.	SD_U1, SD_U2, SD_U6	Project
S04	Is able to recognize structurally stable phenomena in general systems.	SD_U1, SD_U2, SD_U6	Project
Social competences			
SC01	Understands the importance of singularity theory in science and technology	SD_K1	Interaction during the lectures, project
SC02	Understands the interdisciplinary methods in science and mathematical modelling in practice	SD_K1	Interaction during the lectures

*Allowed learning outcomes verification methods: exam; oral exam; written test; oral test; project evaluation; report evaluation; presentation evaluation; active participation during classes; homework; tests

5. Assessment criteria
project

6. Literature
Primary references:
[1] S. Janeczko, Teoria osobliwości, Lecture Notes, No. 12, CAS 2021
[2] M. Golubitsky, S. Guillemin, Stable mappings and their singularities, Springer, 1973
[3] Th. Brocker, L. Lander, Differentiable germs and catastrophes, LMS, LN Series 17, Cambridge 1975

7. PhD student's workload necessary to achieve the learning outcomes**		
No.	Description	Number of hours
1	Hours of scheduled instruction given by the academic teacher in the classroom	30
2	Hours of consultations with the academic teacher, exams, tests, etc.	5
3	Amount of time devoted to the preparation for classes, preparation of presentations, reports, projects, homework	10
4	Amount of time devoted to the preparation for exams, test, assessments	10
	Total number of hours	**55**
	ECTS credits	**2**

** 1 ECTS = 25-30 hours of the PhD students work (2 ECTS = 60 hours; 4 ECTS = 110 hours, etc.)

8. Additional information	
Number of ECTS credits for classes requiring direct participation of academic teachers	1
Number of ECTS credits earned by a student in a practical course	