THE DOCTORAL SCHOOL OF IPPT PAN

COURSE OFFERED IN THE DOCTORAL SCHOOL OF IPPT PAN

Name of the course	Polish	**Równania różniczkowe cząstkowe fizyki matematycznej**				
	English	**Partial differential equations of mathematical physics**				
Type of the course	**Specialized course**					
Course coordinator	**Wasyl Kowalczuk, PhD, D.Sc.**		Course teachers	**Wasyl Kowalczuk, PhD, D.Sc. Barbara Gołubowska, PhD**		
Implementing unit	**ZTOCiN**	Scientific discipline / disciplines	**Mechanical engineering**			
Level of education	**Doctoral studies**	Semester	**Winter or summer**			
Language of the course	**English**					
Type of assessment	**Examination**	Number of hours in a semester	**60**	ECTS credits	**4**	

Type of classes		Lecture	Auditory classes	Project classes	Laboratory	Seminar
Number of hours	in a week	**2**	**2**	**0**	**0**	**0**
	in a semester	**30**	**30**	**0**	**0**	**0**

1. Prerequisites

The full understanding of the material presented in this course demands from the students at least the basic knowledge of main types of ordinary differential equations (ODEs).

2. Course objectives

The aim of this course is to acquaint the students with the basic types of partial differential equations (PDEs) as mathematical models of many physical phenomena, like, e.g., wave equation, heat diffusion, and steady state of heat equation. During the course will be discussed the main methods of solution of linear first- and second-order PDEs and their systems (i.e., method of characteristics, separation of variables, integral transform, etc.) together with the classification of different types of initial/boundary conditions (Dirichlet, Neumann, Robin).

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

Lecture

Main topics:

1. Introduction with examples of applications.
2. Equations of first order: linear, quasilinear, nonlinear. Hamilton-Jacobi theory.
3. Classification of linear equations of second order: hyperbolic, parabolic, elliptic.
4. Hyperbolic equations: wave equation, characteristics, initial-boundary value problems.
5. Fourier transform, its application in analysis of partial differential equations.
6. Parabolic equations: heat diffusion, method of separation of variables.
7. Elliptic equations: steady state of heat equation, Laplace/Poisson equation, Green function.

Laboratory

- does not apply

4. Learning outcomes

Number of the learning outcome	Learning outcomes description	Reference to the learning outcomes according to the 8th level of PRK	Learning outcomes verification methods*
Knowledge			
1	The graduate acquires basic knowledge of main types of partial differential equations and methods of their solution.	P8S_WG	examination
2	The graduate knows how to apply the acquired knowledge to solution of practical problems, especially in the field of mechanical engineering.	P8S_WK	assessment of activity during auditory classes
Skills			
1	The graduate is able to solve practical problems in the field of mechanical engineering that demand to find solutions of various partial differential equations.	P8S_UW	assessment of activity during auditory classes and examination
2	The graduate is able to apply the acquired knowledge directly to the field of his/her scientific research as well as disseminate the obtained results to the scientific community.	P8S_UW	assessment of activity during auditory classes
Communication			
1	The graduate is able to initiate a debate and participate in scientific discourse, as well as to provide appropriate arguments in scientific discussions and public debates on various topics.	P8S_UK	assessment of activity during auditory classes
Social competences			
1	The graduate is ready to think and act in a creative and entrepreneurial way.	P8S_KO	assessment of activity during auditory classes
2	The graduate is ready to critically evaluate the achievements of the represented scientific discipline, including his or her own contribution to the development of this discipline.	P8S_KK	assessment of activity during auditory classes

*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

Assessment of activity during auditory classes, result of final examination.

6. Literature

Primary references:

[1] M. Renardy, R. C. Rogers, An introduction to partial differential equations, Texts in Applied Mathematics, Vol. 13, Springer-Verlag, New York, 2004.

[2] F. John, Partial Differential Equations, Applied Mathematical Sciences, Vol. 1, Springer-Verlag, New York-Heidelbeg-Berlin, 1978.

Secondary references:

[1] V. Ivrii, Partial differential equations, Department of Mathematics, University of Toronto, Canada, 2022.

[2] S. J. Farlow, Partial differential equations for scientists and engineers, Dover Publications Inc., New York, 1993.

7. PhD student's workload necessary to achieve the learning outcomes**		
No.	Description	Number of hours
1	Hours of scheduled instruction given by the lecturer in the classroom	**60**
2	Hours of consultations with the lecturer, exams, tests, etc.	**15**
3	Amount of time devoted to the preparation for classes, preparation of presentations, reports, projects, homework	**30**
4	Amount of time devoted to the preparation for exams, test, assessments	**15**
	Total number of hours	**120**
	ECTS credits	**4**

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