Wrocław University of Science and Technology
Doctoral School

COURSE CARD

1. Basic information

Course name in English:	Applied Partial Differential Equations	
Course name in Polish:	Zastosowania Równań Różniczkowych Cząstkowych	
Number of hours:	30	
Type of course:	Elective course	
Form of course:	lecture	
Code of course:		
Course leader:	dr hab. inż. Łukasz Płociniczak	
Faculty of the course leader:	W13 Faculty of Pure and Applied Mathematics	
Email address of the course leader:	lukasz.plociniczak@pwr.edu.pl	
Scientific discipline(s) assigned to the course (doctoral students representing the marked disciplines can participate in the course):	Architecture and urban planning	☒
	Automation, electronic, electrical engineering and space technologies	☒
	Information and communication technology	☒
	Biomedical engineering	☒
	Chemical engineering	☒
	Civil engineering, geodesy and transport	☒
	Materials engineering	☒
	Mechanical engineering	☒
	Environmental engineering, mining, and energy	☒
	Mathematics	☒
	Chemical sciences	☒
	Physical sciences	☒
	Management and quality studies	☒

2. Objectives

C1 The student will learn selected topics in the theory and applications of partial differential equations.

C2 The student will acquire skills of applying learnt material in fields where there is a need for using partial differential equations.

3. Content

Detailed information about the course content, including topics and form of classes.

No.	Topic	Number of hours	Form of classes

1	The meaning of differential equations in mathematical modelling. Examples introducing partial differential equations of the first degree. Conservation laws.	2	lecture
2	Method of characteristics and Charpit's system. Eikonal equation.	2	lecture
3	Inviscid Burgers equations: weak solutions. Rankine-Hugoniot condition. Shock waves. Applications in various sciences.	4	lecture
4	Systems of first order equation. Shallow water equations and gasdynamics. A model of A-bomb (or supernova) explosion.	4	lecture
5	Derivation of the heat equation. Separation of variables. Fundamental solution. Solution of Cauchy problem on several domains. Applications in technology, physics and geology.	4	lecture
6	Free-boundary problems. Stefan problem. A model of freezing lake.	2	lecture
7	Nonlinear parabolic equations. Self-similar solutions. Porous medium equation and Barenblatt's solution. A model of glacier movement. Fisher's equation.	2	lecture
8	Gravitational potential and derivation of the Laplace and Poisson equations. Remark concerning separation of variables. Fundamental solution and Green's function. Integral representation of solutions. Applications in electrostatics, geological surveying and astrophysics.	4	lecture
9	Derivation of vibrating string equations and its generalization for higher dimension. d'Alembert's and spherically symmetric solutions. Mechanical, acoustic and electromagnetic waves.	4	lecture
10	Derivation of the Navier-Stokes equations. Remark concerning existence and uniqueness. Primitive equations of geophysical fluid dynamics. Geostrophic balance. Taylor-Proudman Theorem. Weather forecast.	2	lecture

4. Prerequisites

List of prerequisites relating to knowledge, skills and other competences for course participants.

1. Student knows the basic theory of calculus, ordinary differential equations and vector fields.

2. Student is able to search for supplementary material in various areas of knowledge.

5. Learning outcomes

List of learning outcomes at level 8 of the Polish Qualifications Framework assigned to the course (mark the learning outcomes in the last column).

Symbol	Learning outcome	

	KNOWLEDGE. Doctoral student knows and understands:	
SzD_W3	the main trends in the development of the scientific or artistic disciplines covered in the curricula;	☒
SzD_W4	research methodology;	☒
SzD_W5	the rules for the dissemination of scientific results, including in open access mode;	☐
SzD_W6	the fundamental dilemmas of modern civilization;	☐
SzD_W7	the legal and ethical conditions of scientific activity;	☐
SzD_W8	the economic and other relevant conditions of scientific activity;	☐
SzD_W9	basic principles of knowledge transfer to the economic and social spheres and commercialisation of results of scientific activity and know-how related to these results.	☐
	SKILLS. Doctoral student is able to:	
SzD_U2	use knowledge from different fields of science or art to creatively identify, formulate and innovatively solve complex problems or perform research tasks, in particular: - define the purpose and subject of scientific research, formulate a research hypothesis, - develop research methods, techniques and tools, and use them creatively, - draw conclusions on the basis of scientific research; critically analyse and evaluate the results of scientific research, expertise and other creative work and their contribution to knowledge development; transfer the results of scientific activities to the economic and social spheres;	☒
SzD_U3	communicate on specialised topics to the extent that they enable an active participation in the international scientific community;	☐
SzD_U4	disseminate research results, including in popular forms;	☒
SzD_U5	initiate debates and participate in a scientific discourse;	☐
SzD_U6	be able to speak a foreign language at B2 level of the Common European Framework of Reference for Languages to a level that enables them to participate in the international scientific and professional environment;	☐
SzD_U7	plan and implement an individual or collective research or creative activity, including in an international environment;	☐
SzD_U8	independently plan and act for one's own development and inspire and organize the development of others;	☐
SzD_U9	plan classes or groups of classes and implement them using modern methods and tools.	☐
	SOCIAL COMPETENCES. Doctoral student is ready to:	
SzD_K3	fulfilling the social obligations of researchers and creators, initiate public interest activities, thinking and acting in an entrepreneurial way;	☐
SzD_K4	maintaining and developing the ethos of research and creative environments, including: - carrying out scientific activities in an independent manner, - respecting the principle of public ownership of research results, taking into account the principles of intellectual property protection.	☒

6. Evaluation

Short description of the method(s) used to evaluate the learning outcomes assigned to the course, e.g., exam, test, report, presentation, etc.

Report, Presentation

7. Teaching methods

Short description of the teaching methods used during the course, e.g., multimedia presentation, discussion, literature studies, developing written documents, own work, etc.

Lecture, Consultations

8. Literature

List of primary and secondary literature used to prepare the course and including additional knowledge for participants, e.g., books, textbooks, research papers, standards, web pages, etc.

[1] R. Haberman, Applied Partial Differential Equations with Fourier Series and Boundary Value Problems, Pearson, 2012.

[2] A.N. Tichonow, A. A. Samarski, Równania fizyki matematycznej, PWN, 1963.

[3] J.D. Logan, An introduction to nonlinear partial differential equations, John Wiley & Sons, 2008.

[4] P. Markowich, Applied Partial Differential Equations: A Visual Approach, Springer Science & Business Media, 2007.

9. Other remarks

Additional remarks, comments, (e.g., language of the course)