THE DOCTORAL SCHOOL OF IPPT PAN

COURSE OFFERED IN THE DOCTORAL SCHOOL OF IPPT PAN

Name of the course	Polish	**Podstawy matematyki w naukach inżynieryjnych - II**				
	English	**Basic Mathematics in Engineering Science - II**				
Type of the course	**Basic 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	**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 basic knowledge of mathematics obtained during the university or technical studies is demanded, with the special stress laid on the ability to think logically and rigorously.

2. Course objectives

The aim of this course is to recollect and, if necessary, supplement the basic knowledge of mathematics, which the PhD students have received during their university or technical studies, with the special stress laid on the practical applications of presented mathematical concepts and methods in the field of engineering science.

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

Lecture

Main topics:

1. Elements of differential calculus, function as a relation, sets of functions, composition of functions, injective/surjective/bijective functions, inverses and partial inverses, restrictions/extensions of functions, functional powers, multi-valued functions, elementary and special functions, limits and continuity of functions, squeeze theorem, limits at infinity and infinite limits, L'Hospital's rule, vertical, horizontal, and slant asymptotes, extreme value (Weierstrass) and intermediate value (Darboux) theorems, differentiability of functions, derivatives and differentials, Taylor series.
2. Elements of integral calculus, Darboux and Riemann integrals, improper integrals, Lebesgue approach, multiple and iterated integrals, Fubini's theorem, normal domains, change of variables, Jacobian, cylindrical and spherical coordinates, multivariable calculus, fundamental theorems of calculus in multiple dimensions: gradient, Stokes', divergence, and Green's theorems.
3. Ordinary differential equations (ODEs), general/particular/singular solutions, n-parametric families of curves, existence and uniqueness of solutions of first-order ODEs, Peano existence theorem, Lipschitz continuity, Picard-Lindeloef theorem, methods of solution of ODEs: separation of variables (Fourier method), homogeneous/inhomogeneous linear ODEs, Bernoulli ODE, exact ODEs, integrating factors, Lagrange and Clairaut ODEs, Riccati ODE, Picard's method of successive approximations, Green's function, Laplace/Hankel/Fourier transformations, systems of first-order ODEs, fundamental system of solutions (Wronskian), method of variation of parameters, Euler's

method, method of invariant subspaces, Jordan matrix method, systems of nonlinear ODEs, first integrals, ODEs of higher order than first, Euler ODE, method of solving linear ODEs using power series and generalized power series, Bessel ODE.
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 mathematics in the field of differential and integral calculus, and theory of ordinary differential equations.	P8S_WG	examination
2	The graduate knows how to apply the acquired knowledge to solution of practical problems, especially in the field of engineering science.	P8S_WK	assessment of activity during auditory classes
Skills			
1	The graduate is able to solve practical problems in the field of differential and integral calculus, and theory of ordinary 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] G. M. Fichtenholz, Differential and integral calculus, Vol. I-III, PWN—Polish Scientific Publishers, 1997.
[2] W. A. Adkins, M. G. Davidson, Ordinary differential equations, Undergraduate Texts in Mathematics, Springer, New York-Heidelberg-Dordrecht-London, 2012
Secondary references:
[1] K. Kuratowski, Introduction to calculus. International Series of Monographs in Pure and Applied Mathematics, Vol. 17. Pergamon Press, Oxford-Edinburgh-New York; PWN—Polish Scientific Publishers, Warsaw, 1969.
[2] V. I. Arnold, Ordinary differential equations, MIT Press Ltd., 1978.

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.)