GDAŃSK UNIVERSITY
OF TECHNOLOGY

Subject card

Subject name and code	Differential equations I, PG_00021499					
Field of study	Mathematics					
Date of commencement of studies	October 2023		Academic year of realisation of subject		2024/2025	
Education level	first-cycle studies		Subject group		Obligatory subject group in the field of study Subject group related to scientific research in the field of study	
Mode of study	Full-time studies		Mode of delivery		at the university	
Year of study	2		Language of instruction		Polish	
Semester of study	3		ECTS credits		5.0	
Learning profile	general academic profile		Assessment form		exam	
Conducting unit	Department of Nonlinear Analysis and Statistics -> Faculty of Applied Physics and Mathematics					
Name and surname of lecturer (lecturers)	Subject supervisor		dr inż. Robert Krawczyk			
	Teachers		dr inż. Robert Krawczyk			
Lesson types and methods of instruction	Lesson type	Lecture	Tutorial	Laboratory	Project	Seminar	SUM
	Number of study hours	30.0	30.0	0.0	0.0	0.0	60
	E-learning hours included: 0.0						
	Adresy na platformie eNauczanie:						
Learning activity and number of study hours	Learning activity	Participation in didactic classes included in study plan	Participation in consultation hours	Self-study	SUM	
	Number of study hours	60	5.0	60.0	125	
Subject objectives	Learning the skills of: 1. solving the basic types of differential equations and systems of differential equations; 2. investigating solutions of differential equations (existence and uniqueness of solution, extension, continuous dependence on initial conditions and parameters); 3. description of simple phenomenas using differential equations.					

Learning outcomes	see table below

Course outcome	Subject outcome	Method of verification
K6_U09	Student is able to define the domain of a solution of a differential equation depending on the initial condition. He/she knows the geometric interpretation of the solution to the ordinary differential equation.	[SU1] Assessment of task fulfilment [SU2] Assessment of ability to analyse information [SU4] Assessment of ability to use methods and tools
K6_W03	Student is able to build a model of a differential equation describing a simple mathematical model used in geometry, economics and statistics.	[SW1] Assessment of factual knowledge
K6_U08	The student is able to use all the basic concepts of linear algebra such as matrix, matrix determinant, eigenvalues and eigenvectors of matrices, the basis of a linear space. Kernel of linear mapping. The student uses these concepts to determine the fundamental matrix of a system of first-order ordinary differential equations, to determine the linear independence of the solutions of the fundamental system, to solve the system of differential equations with constant coefficients and the n-th order linear differential equation with constant coefficients.	[SU1] Assessment of task fulfilment [SU2] Assessment of ability to analyse information
K6_U01	Student is able to formulate basic theorems from the theory of ordinary differential equations such as the theorem on the existence and uniqueness of a solution to a differential equation in the local and global version, theorems about the continuous dependence of solutions on parameters and initial conditions (Gronwall lemma). The student can use the Banach Fixed Point Theorem to solve simple first-order linear differential equations.	[SU1] Assessment of task fulfilment [SU2] Assessment of ability to analyse information

Subject contents

1. Applications leading to differential equations. The notions of a differential equation, its solution and an initial value problem. Geometric interpretation. Introductory remarks about existence and uniqueness of solution of an initial value problem.
2. Separable differential equations. Existence and uniqueness of solution of separable equations. Methods of solution.
3. Change of variables in differential equation. Linear and homogeneous equations.
4. Differential equation of inverse function to the solution of differential equation. Bernoulli and Riccati differential equations.
5. Exact differential equation. Integrating factor. Symmetrical form of differential equation of order one.
6. Change of variables in differential equation of symmetrical form. Reduction of differential equation of order n to a system of differential equations of order one. Linear differential equations of order n.
7. Factorization of linear differential operator of order n. Linear differential operators of order one. General solution of linear homogeneous equation of order n.
8. Fundamental system of solutions. Constant coefficient nonhomogeneous linear equation of order n.
9. Real solutions to constant coefficient nonhomogeneous linear equation of order n. Laplace method.
10. A theorem about existence and uniqueness of solution to Cauchy problem. The Picard-Lindeloff theorem. The Peano theorem about the existence of solution to initial value problem.
11. Continuous dependence of solution on initial conditions and parameters. Differentiability of solution with respect to initial conditions.
12. Basic properties of solutions of linear systems of differential equations of order one (linear space of solutions to a homogeneous linear system of differential equations, its dimension and basis - fundamental system, Wronski's matrix and the wronskian.
13. The Liouville theorem. Solving linear nonhomogeneous systems using fundamental matrix of solutions of homogeneous systems.
14. Solving constant coefficient linear homogeneous systems. Solving constant coefficient linear differential equations of higher order.
15. Boundary problems for linear differential equations of order two. Sturm-Liouville boundary value problems.

Prerequisites and co-requisites

Calculus I and II, linear algebra

Assessment methods and criteria

Subject passing criteria	Passing threshold	Percentage of the final grade
Written form exam, exercises part	50.0%	50.0%
Written form exam, theoretical part	50.0%	50.0%

Recommended reading	Basic literature	1. Z. Kamont, Równania różniczkowe zwyczajne, Wydawnictwo UG, Gdańsk, 1999. 2. M. Kwapisz, Elementy zwyczajnych równań różniczkowych, Wydawnictwo UKW, Bydgoszcz, 2007. 3. Muszyński, A.D Myszkis, Równania Różniczkowe Zwyczajne, PWN, Warszawa, 1984. 4. A. Palczewski, Równania Różniczkowe Zwyczajne, WNT, Warszawa, 1999. 5. A. Pelczar, J. Szarski, Wstęp do Teorii Równań Różniczkowych, cz. I,II, PWN, Warszawa, 1987, 1989.
	Supplementary literature	Trench W.F., Elementary Differential Equations, Free Edition 1.01 (December 2013)
	eResources addresses	
Example issues/ example questions/ tasks being completed	1. Determine the region, where the Cauchy problem for the equation $y'=1-\mathrm{ctg}(x)$ has a unique solution. 2. Find the general solution to the differential equation $(x^3+e^y)y'=3x^2$. 3. Find the solution to the initial value problem $y'''-y'=-2x$, $y(0)=0$, $y'(0)=1$, $y''(0)=2$.	
Work placement	Not applicable	