GDAŃSK UNIVERSITY OF TECHNOLOGY

Subject card

Subject name and code	Differential equations in Physics and Technology, PG_00037294						
Field of study	Technical Physics						
Date of commencement of studies	October 2026		Academic year of realisation of subject	2027/2028			
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	4.0			
Learning profile	general academic profile		Assessment form	assessment			
Conducting unit	Division of Atomic Molecular and Optical Physics -> Institute of Physics and Applied Computer Science -> Faculty of Applied Physics and Mathematics -> Faculties of Gdańsk University of Technology						
Name and surname of lecturer (lecturers)	Subject supervisor		dr hab. inż. Maciej Demianowicz				
	Teachers						
Lesson types	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						
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		4.0		36.0	100
Subject objectives	Students become acquainted with methods of solving most popular differential equations encountered in physics and technics.						

Learning outcomes	Course outcome	Subject outcome	Method of verification
	[K6_W02] possesses structured knowledge of the fundamentals of physics, including mechanics, thermodynamics, electricity and magnetism, optics, atomic and molecular physics, solid-state physics, and nuclear and particle physics.	The student knows that differential equations constitute a fundamental tool for describing and modelling phenomena and processes occurring in the physical sciences and engineering. The student understands the importance of analytical methods for solving such equations, knows the role of initial and boundary conditions, and understands the significance of the obtained solutions in the description of the physical system under consideration.	[SW1] Assessment of factual knowledge
	[K6_U02] is able to analyse and solve complex and non-standard scientific and technical problems using appropriate analytical, computational, numerical, simulation or experimental methods.	Based on the methods learned, the student is able to analyse model problems, including more complex or non-standard ones, whose description leads to ordinary differential equations. The student is able to qualitatively assess the nature of the problem, recognise its similarity to known classes of problems, select appropriate solution methods, and interpret the obtained result.	[SU4] Assessment of ability to use methods and tools [SU3] Assessment of ability to use knowledge gained from the subject
	[K6_W03] possesses structured knowledge of higher mathematics, including algebra, analysis, probability and numerical methods, sufficient to describe, understand and model complex physical phenomena and selected technical processes.	The student knows the basic classes of ordinary differential equations and understands the analytical methods used to solve them, ranging from elementary methods to more advanced computational techniques. The student understands how tools of mathematical analysis are used to formulate, transform, and solve initial-value and boundary-value problems, as well as to analyse the properties of the obtained solutions.	[SW1] Assessment of factual knowledge

Subject contents

Course content – lecture

1. Differential equation, order and degree of an equation, solution of an equation, integral curve.
2. Cauchy problem.
3. General, particular, and singular solutions.
4. First-order equations solved for the derivative (existence and uniqueness of solutions).
5. Separable equations.
6. Homogeneous equation, Bernoulli equation.
7. First-order linear equations (properties, method of variation of parameters, method of undetermined coefficients).
8. Exact equations and the integrating factor.
9. Method of substitution (introducing a parameter).
10. Method of successive approximations.
11. Higher-order linear equations (properties, reduction to other forms).
12. Homogeneous linear equations. Linear (in)dependence. The Wronskian. The Ostrogradsky-Liouville formula. Fundamental set of solutions. General solution.
13. Non-homogeneous linear equations. General solution. Method of variation of parameters, method of undetermined coefficients.
14. Linear equations with constant coefficients. Reduction of an equation to one with constant coefficients.
15. Second-order linear equations. Reduction to chosen forms. Reduction of order (finding a second solution when one is known).
16. Boundary value problems.
16. Method of (generalized) power series.

Course content – exercises

1. Separable equations.
2. Homogeneous equation, Bernoulli equation.
3. First-order linear equations (method of variation of parameters, method of undetermined coefficients).
4. Exact equations and the integrating factor.
5. Method of substitution (introducing a parameter).
6. Method of successive approximations.
7. Higher-order linear equations. Linear equations with constant coefficients. Method of variation of parameters, method of undetermined coefficients.
8. Second-order linear equations. Reduction to chosen forms. Reduction of order (finding a second solution when one is known).
9. Method of (generalized) power series.

Prerequisites and co-requisites

Good knowledge of mathematical analysis corresponding to the current level of education.

Assessment methods and criteria

Subject passing criteria	Passing threshold	Percentage of the final grade
Lecture - written test.	50.0%	33.0%
Excercise - two written tests.	50.0%	67.0%

Recommended reading

Basic literature	1. N. M. Matwiejew, Metody całkowania równań różniczkowych zwyczajnych, PWN, Warszawa, 1970. 2. N. M. Matwiejew, Zadania z równań różniczkowych zwyczajnych, PWN, Warszawa, 1976. 3. W. Krysicki, L. Włodarski, Analiza matematyczna w zadaniach (część druga), PWN, Warszawa, 2004.
Supplementary literature	M. Gewert, Z. Skoczylas, Równania różniczkowe zwyczajne. Teoria, przykłady, zadania, Oficyna. Wydawnicza GiS, Wrocław, 2016.
eResources addresses	

Example issues/ example questions/ tasks being completed	**Excercise:** 1. Solve the equation: y'=y+x 2. Solve the equation: y''+xy'+y=0. **Lecture:** 3. Present properties of the Wronskian of solutions of the second-order linear differential equations. 4. Present the method of generalized power series.
Practical activites within the subject	Not applicable

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