Differential equations in physics - course description

General information

Course name	Differential equations in physics
Course ID	11.1-WF-FizP-DEP-S17
Faculty	Faculty of Physics and Astronomy
Field of study	Physics
Education profile	academic
Level of studies	First-cycle studies leading to Bachelor's degree
Beginning semester	winter term 2018/2019

Course information

Semester	3
ECTS credits to win	5
Course type	obligatory
Teaching language	english
Author of syllabus	• dr hab. Maria Przybylska, prof. UZ

Classes forms

The class form	Hours per semester (full-time)	Hours per week (full-time)	Hours per semester (part-time)	Hours per week (part-time)	Form of assignment
Lecture	30	2	-	-	Exam
Class	30	2	-	-	Credit with grade

Aim of the course

Learning students of basic concepts, facts and methods of ordinary and partial differential equations. Obtaining the ability to solve certain types of ordinary differential equations, systems of ordinary and partial differential equations. Preparation for courses in which physical phenomena are modeled by differential equations.

Prerequisites

Mathematical analysis I and II and algebraic and geometric methods in physics

Scope

1. Reminder of basic notions of ordinary differential equations, definition, types of ordinary differential equations, general and particular solutions, initial problem, geometric interpretation. Equations solvable in elementary way, homogeneous, with separable variables, equation with integrating factor, Bernoulli equation, Riccati equation.
2. Basic properties of solutions of linear first order differential equations: linear space of homogeneous solutions, its dimension, base - fundamental system, Wronski matrix and its determinant, solving systems of homogeneous linear equations with constant coefficients.
3. Solving the higher order linear equations with analytical coefficients using the power series - some special functions.
4. Basic concepts of partial differential equations: definition, examples, order; linear, semi-linear, quasi-linear, nonlinear differential equations.
5. First-order partial differential equations: relationship with ordinary equations, method of characteristics.
6. Classification of partial differential equations of order two of two independent variables.

7. Laplace and Poisson equations.
8. Fourier method of variable separation. Initial problem of thermal conductivity equation with periodic boundary conditions
9. Wave equation.
10. Soliton equations: dispersion and nonlinear wave equations, various forms of KdV equations, various types of solutions and their properties, infinitely many conservation laws and integrability of KdV.

Teaching methods

Conventional lecture illustrated with examples of the use of equations in physics solved analytically and with the help of software for symbolic and numerical calculations.

During classes students analyse and solve exercises illustrating the content of the lecture.

Learning outcomes and methods of theirs verification

Outcome description	Outcome symbols	Methods of verification	The class form
After completing the course, the student acquired knowledge on the following topics: distinguishes basic types of ordinary differential equations and knows methods for solving them, knows the concept of a linear system of ordinary differential equations and methods of solving it, knows the concept, classification and types of partial differential equations of the second order can indicate applications of differential equations in various fields of science		• a quiz • an exam - oral, descriptive, test and other	• Lecture • Class

Outcome description	Outcome symbols	Methods of verification	The class form
After completing the course the student acquires the following skills: can solve the basic types of ordinary differential equations and can give examples of describing simple physical phenomena in the language of differential equations. Recognizes the types of partial differential equations of the order of 2 and knows how to bring them to the canonical form, knows how to solve linear partial differential equations with constant coefficients.		• a quiz • an exam - oral, descriptive, test and other	• Lecture • Class
The student has the ability to use a mathematical apparatus to describe and model physical phenomena and processes.		• a quiz • an exam - oral, descriptive, test and other	• Lecture • Class
The student can talk about mathematical problems with understandable, colloquial language		• a discussion	• Lecture • Class
The student uses a variety of materials provided both by the lecturer and acquired independently using modern technologies. Acquires a critical attitude towards materials of poorly established origin found on the web		• a quiz • an exam - oral, descriptive, test and other	• Lecture • Class

Assignment conditions

Lecture: Positive passing of exam (written). Obtaining a positive grade requires at least 55% of correct answers to the questions and tasks asked.
Classes: Passing condition - positive grades of two written tests on the basis of obtaining at least 55% of points on each of them.
Before taking the exam a student must gain positive grade during the class.

Recommended reading

[1] Gewert M., Skoczylas Z., "**Równania różniczkowe zwyczajne. Teoria, przykłady, zadania**.", wyd. Wrocław, 2002r

[2] W. Krysicki, L. Włodarski, **Analiza matematyczna w zadaniach**, tom 2., Wydawnictwo Naukowe PWN, Warszawa

[3] W. Walter, **Ordinary differential equations.** *Springer-Verlag, Berlin,* 1998

[4] D.W. Jordan, P. Smith, **Nonlinear ordinary differential equations**, Oxford University Press, Oxford, 2011

[5] H. Marcinkowska, ***Wstęp do teorii równań różniczkowych cząstkowych*****,** PWN, Warszawa 1986,

[6] L. C. Evans, **Równania różniczkowe cząstkowe**, Wydawnictwo Naukowe PWN, Warszawa 2002.

[7] J.D. Logan, **An introduction to nonlinear partial differential equations**, Wiley-Interscience, John Wiley & Sons, Inc., Hoboken, 2008

[8] P.V. ONeil, **Advanced engineering mathematics**, International Student Edition, Thomson, Canada, 2007

[9] L. C. Evans, **Partial Differential Equations**, AMS, 1998.

[10] Materials made available by the lecturers.

Further reading

P. Olver, I**ntroduction to partial differential equations**, Springer-Verlag, New York, 2014

Notes

Modified by dr hab. Piotr Lubiński, prof. UZ (last modification: 01-08-2018 14:45)