Partial Differential Equations - course description

General information

Course name	Partial Differential Equations
Course ID	11.1-WK-MATD-RRC-L-S14_pNadGen33SK8
Faculty	Faculty of Mathematics, Computer Science and Econometrics
Field of study	Mathematics
Education profile	academic
Level of studies	Second-cycle studies leading to MS degree
Beginning semester	winter term 2019/2020

Course information

Semester	4
ECTS credits to win	10
Course type	obligatory
Teaching language	polish
Author of syllabus	• dr Tomasz Małolepszy

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
Laboratory	30	2	-	-	Credit with grade
Class	30	2	-	-	Credit with grade
Lecture	30	2	-	-	Exam

Aim of the course

The main aim of this course is to acquire by students skills to solve the initial-boundary value problems (IBVP) for linear PDE of first and second orders by the means of the method of the characteristics, the method of the separation of variables and Fourier transform. During that course students also will learn the basics of the theory of Sobolev spaces and so-called weak formulation of IBVP for some PDE.

Prerequisites

Mathematical Analysis 1 and 2, Functional Analysis, Linear Algebra 1 and 2.

Scope

1. Basic definitions - linear, semilinear and nonlinear equations, Cauchy problems, the types of boundary problems, characteristic surfaces.
2. Equations of the first order. The method of the characteristics. Cauchy-Kowalewski theorem.
3. Equations of the second order. Classification of the second order equations.

a. Elliptic equations - basic properties of the harmonic functions, the fundamental solution to Laplace's and Poisson's equations, the maximum principles, Green's function for elliptic equation.

b. Parabolic equation - the fundamental solution of the Cauchy problem for the heat equation, the maximum principles, the method of the separation of variables.

c. Hyperbolic equations - D'Alembert formula, formulas for the solutions of the wave equation in higher dimensions, Duhamel's principle.

4. Fourier transform and its application in the theory of partial differential equations.
5. Elements of the theory of Sobolev spaces.

a. Weak derivatives.

b. Sobolev spaces.

c. Approximation of the elements of the Sobolev spaces by smooth functions.

d. Trace of the function.

e. Sobolev-type inequalities.

6. Weak solutions of the second order equations - the methods of Ritz and Galerkin.

Teaching methods

Traditional lectures; classes with the lists of exercises to solve by students; computer lab.

Learning outcomes and methods of theirs verification

Outcome description	Outcome symbols	Methods of verification	The class form
Student is able to solve I order quasilinear PDEs with the use of characteristic method and Lagrange method; to find the canonical form of II order semilinear PDEs.	• K_W10 • K_U06	• a test • activity during the classes • an exam - oral, descriptive, test and other	• Lecture • Laboratory • Class

Outcome description	Outcome symbols	Methods of verification	The class form
Student is able to use basic numerical methods (finite difference method, finite element method) to find solutions of some PDEs.	• K_W11 • K_K01	• a test • activity during the classes • an exam - oral, descriptive, test and other	• Lecture • Laboratory • Class
Student is able to use a method of separation of variables to solve initial-boundary value problems for II order linear PDEs.	• K_W10 • K_U05 • K_U06 • K_U16	• a test • activity during the classes • an exam - oral, descriptive, test and other	• Lecture • Laboratory • Class
Student is able to define weak derivatives and Sobolev spaces.	• K_U06 • K_U09	• a test • activity during the classes • an exam - oral, descriptive, test and other	• Lecture • Laboratory • Class

Assignment conditions

Class and Laboratory: learning outcomes will be verified through two tests consisted of exercises of different degree of difficulty. A grade determined by the sum of points from these two tests is a basis of assessment.
Lecture: final exam. A grade determined by the sum of points from that exam is a basis of assessment.
A grade from the course is consisted of the grade from laboratory (25%), the grade from classes (25%) and the grade from the final exam (50%). To take a final exam, students must receive a positive grade from classes. To attain a pass in the course students are required to pass the final exam.

Recommended reading

1. Warsztaty z Równań Różniczkowych Cząstkowych, pod red. naukową prof. dr. hab. P. Bilera, Torun, 2003.
2. Evans, L., Partial differential equations, AMS, 1998.
3. Marcinkowska, H., Dystrybucje, przestrzenie Sobolewa, równania różniczkowe, PWN, 1993.
4. Walter A. Strauss, Partial differential equations: an introduction, Wiley, New York 1992.

Further reading

1. Strzelecki, P., Krótkie wprowadzenie do równań różniczkowych cząstkowych, Wydawnictwa Uniwersytetu Warszawskiego, 2006.

Notes

Modified by dr Robert Dylewski, prof. UZ (last modification: 20-09-2019 11:45)