Federal state autonomous educational institution of higher education
«Peoples' Friendship University of Russia »

Faculty of science
Recommended by MSSN

Operative program of the subject

Nonlinear partial differential equations

Recommended for academic field

01.06.01 «Mathematics and mechanics»

1. Aims and purposes of the subject

The main aim of the course «Nonlinear partial differential equations» is to form a concept of the complex of ideas and methods relevant for the contemporary mathematical theory of nonlinear partial differential equations.

2. Position of the subject in the structure of the higher educational program:

The course «Nonlinear partial differential equations» is an elective course of part 1 in the study plan.

Table № 1 names preceding and consequent subjects aimed at forming competences of the subject according to the competence matrix.

Table № 1

Preceding and consequent subjects aimed at forming competences

№	Code and name of the competence	Preceding subjects	Consequent subjects
Professional competences			
	PC-2 knowledge in the field of the theory of function spaces (Lebesgue, Soboloev, Nikolskii-Besov ones etc.) and its applications to the theory of partial differential equations including solvability and regularity of solutions to boundary value problems for elliptic equations, in the field of nonlinear analysis, theory of extremal problems, and optimal control	Additional chapters of functional analysis; Variational problems	-
	PC-3 ability to formulate a research problem and the ways of its implementation, to generalize the obtained results and draw respective conclusions, to understand practical aspects of the obtained theoretical results		
Universal competences			
	UC-1 ability to critical analysis and assessment of the contemporary scientific results, generating new ideas in research and practical studies including interdisciplinary fields	Additional chapters of functional analysis; Variational problems	-
	UC-2 ability to project and realize complex research including interdisciplinary one on the base of a holistic systematic scientific worldview using knowledge		

	in the field of history and philosophy of science UC-3 readiness to participate in the work of Russian and international research teams solving scientific and educational problems UC-5 ability to plan and solve the tasks of one's professional and personal development		

3. Requirements to the result of studies:

Studying the course is aimed at forming following competences: UC-1, UC-2, UC-3, UC-5, PC-2, PC-3

As a result of studying the course the student must:

Know:
- The basics of the theory of nonlinear partial differential equations.

Be able to:
- Prove existence, uniqueness, and nonexistence of solutions for some basic classes of nonlinear partial differential equations.

Master:
- The techniques of the theory of nonlinear partial differential equations, including the methods of monotone operators, compactness, test functions, and comparison.

4. Size of the course and types of studies

The course «Nonlinear partial differential equations» gives 4 credits.

Types of studies	Hours	Terms			
Class studies		1	2	3	
Including:	-	-	-	-	-
Lectures	20			20	
Practical studies (PS)	40			40	
Seminars (S)					
Laboratory work (LW)					
Home studies	84			84	
Total, hours	144			144	
credits	4			4	

5. Content of the subject

5.1. Content of the sections

№	Section	Content
1.	Basic concepts	Some applied problems where nonlinear partial differential equations (PDE) appear. Formulation of main problems for nonlinear PDE. Classification of methods of study of nonlinear PDE: algebraic, analytical, topological, variational, numerical

		methods.
2.	Monotonicity method	Nonlinear elliptic, parabolic, and hyperbolic equations with monotone operators.
3.	Compactness method	Second order quasilinear elliptic equations. The Bernstein-Nagumo condition. Higher order quasilinear elliptic equations. Quasilinear parabolic equations. Growth conditions for subordinate nonlinear operators. Nonlinear wave equations.
4.	Blow-up	Nonexistence of solutions for some classes of partial differential equations and inequalities. Test function, comparison, and energy method. Semilinear elliptic inequalities of the second and higher order. Quasilinear elliptic inequalities. Some evolution inequalities.

5.2. Sections and types of studies

№	Sections	Lect.	PS and LW			HS	Total
			PS/S	LW	In PhI		
1.	Basic concepts	4	8			16	28
2.	Monotonicity method	5	10			20	35
3.	Compactness method	5	10			20	35
4.	Blow-up	6	12			28	46
	Total:	20	40			84	144

6. Laboratory work – none planned

7. Practical studies (seminars)

Item №	Section №	Subject of practical studies (seminars)	Hours
1.	1	Basic concepts	8
2.	2	Monotonicity method	10
3.	3	Compactness method	10
4.	4	Blow-up	12

8. Technical equipment:

Rooms 495a, 398, 509 in RUDN study building, Ordzhonikidze str., 3; group rooms in RUDN study building, Ordzhonikidze str., 3 (2, 3, and 4th floors), computer classes, laboratories (rooms 510 and 424).

9. Informational equipment:

Only licensed software installed at RUDN is used:
- Microsoft Office program package;
- Multimedia equipment and personal computers;
- Full-text databases and resources accessible from RUDN net;
- RFBR electronic library http://www.rfbr.ru/rffi/ru/library

10. Textbooks and recommended literature and electronic sources:

a) main literature:
1) J.-L. Lions, Some methods of solving boundary-value problems, M., 1972.
2) D. Gilbarg, N. Trudinger, Elliptic partial differential equations of the second order, M., 1989.
3) A. Samarskii, V. Galaktionov, S. Kurdyumov, A. Mikhailov. Blow-up in problems for quasilinear parabolic equations. M.:Nauka, 1987.
4) E. Mitidieri, S. Pokhozhaev. Apriori estimates and nonexistence of solutions for nonlinear partial differential equations and inequalities. Proceedings of the Steklov Institute, v. 234 (2001).

b) Supplementary literature:
> none planned.

c) Databases, information and search systems:
1. HAC of RF http://vak.ed.gov.ru
2. RSL electronic library http://www.rsl.ru/
3. RUDN library site http://lib.rudn.ru/
4. Science Direct http://www.sciencedirect.com
5. EBSCO http://search.ebscohost.com, Academic Search Premier
6. Oxford University Press http://www3.oup.co.uk/jnls.
7. Sage Publications http://online.sagepub.com .
8. Springer/Kluwer http://www.springerlink.com.
9. Tailor & Francis http://www.informaworld.com .
10. American Mathematical Society http://www.ams.org/
11. European Mathematical Society http://www.euro-math-soc.eu/
12. Portal to Mathematics Publications http://www.emis.de/projects/EULER/
13. Catalogue of mathematical Internet resources http://www.mathtree.ru/
14. Zentralblatt MATH (zbMATH) https://zbmath.org
15. Общероссийский математический портал mathnet.ru
16. Web of Science http://www.isiknowledge. com
17. Resources of ISISS of RAS http://elibrary.ru.
18. University informational system ROSSIYA http://www.cir.ru/index.jsp.
19. Information, library, and publishing standards http://www.ifap.ru/library/gost/sibid.htm.
20. Electronic library http://www.rsl.ru/

d) Periodical editions

Algebra i analiz, Diskretnaya matematika, Zhurnal vychislitelnoi matematiki i matematicheskoi fiziki, Izvestiya RAS. Ser. mat., Matematicheskie zametki, Matematicheskii sbornik, Matematicheskoe modelirovanie, Teoreticheskaya i matematicheskaya fizika, Teoriya veroyatnostei i ee primeneniya, Uspekhi matematicheskikh nauk, Funktsionalnyi analiz i ego prilozheniya, Trudy Matematicheskogo instituta im. V.A.Steklova, Sovremennye problem matematiki, Vychislitelnye metody i programmirovanie, Trudy seminara im. I.G.Petrovskogo, Uchenye zapiski MSU Fundamentalnaya i prikladnaya matematika, Review of Modern Physics, Review of Modern Physics, Annual Review of Astronomy and Astrophysics, Annual Review of Biochemistry, Chemical Reviews Nature Physics, Annual Review of Condensed Matter Physics, Annals of Mathematics, Journal of the American Mathematical Society, Acta Mathematica, Communications on Pure and Applied Mathematics Swarm and Evolutionary Computation Geometric and Functional Analysis Formal Aspects of Computing, Discrete Mathematics, Theory of Computing Systems Reports on Progress in Physics New Journal of Physics.

11. Methodical recommendations for students

At seminars, key ideas of basic text sources of the course are presented. Namely, a student chooses a key idea of the text under discussion, formulates in theses (1–1.5 pages) its understanding and assessment, then presents and defends this at the seminar. The theses are distributed among the participants of the seminar in advance.

An essay should be written on a topic approved by the teacher. Its volume should not exceed 15 thousand symbols including spaces. An essay may consist in translating a paper of a foreign author with its extensive critical assessment and analysis. The author and the text must be approved by the teacher.

An exam takes place in the end of the semester in the form of an essay on one of the topics suggested by the teacher. After an interview a final note is given. The note is determined by intermediary assessment with notes «excellent», «good», «satisfactory», «unsatisfactory» and in the ECTS system (A, B, C, E). The notes are based on the RUDN score rating system.

12. The fund of evaluation funds for conducting intermediate certification of students in the discipline (module)

Materials for assessing the level of development of educational material of the discipline "Non-linear partial differential equations " (evaluation materials), which include a list of competencies indicating the stages of their formation, a description of indicators and criteria for evaluating competencies at various stages of their formation, a description of assessment scales, standard control tasks or other materials necessary for evaluating knowledge, skills, skills and (or) experience of activities that characterize the stages of competence formation in the process of mastering the educational program, methodological materials defining the procedures for evaluating knowledge, skills, skills and (or) experience activities that characterize the stages of competence formation are fully developed and are available to students on the discipline page in the TUIS PFUR.

The program is compiled in accordance with the requirements of the ES HE PFUR.

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