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

Faculty of science
Recommended by MSSN

DISCIPLINE PROGRAM

General theory of functional differential equations

Recommended for the study direction

01.06.01 « Mathematics and mechanics»

1.   Goals and objectives of the discipline

The main goal of the discipline "General Theory of functional Differential Equations" is to develop students ' skills in the formulation and formulation of variational and boundary value problems for functional differential equations and to teach various modern methods of their research.

2. The place of the discipline in the structure of HEP:

The discipline "General theory of functional-differential equations" refers to the disciplines chosen by the block 1 of the curriculum.

Table 1 shows the previous and subsequent disciplines aimed at the formation of the discipline's competencies in accordance with the competence matrix og HEP.

Table 1

Previous and subsequent disciplines aimed at the formation of competencies

№ п/п	Code and name of the competence	Previous disciplines	Subsequent disciplines (groups of disciplines)
Professional competencies			
	PC-1 knowledge in the main sections of the theory of partial differential equations, including the theory of the Sobolev spaces, the Fourier transform, the solvability and smoothness of solutions of edge problems for elliptic equations, the solvability of initial and mixed problems for parabolic and hyperbolic equations, the method of separation of variables, projection methods, the method of semigroups, as well as initial ideas about methods for studying nonlinear equations PC-3 ability to formulate the research task and the ways of its implementation, to summarize the results and formulate appropriate conclusions, to understand the practical aspects of the theoretical results.	Boundary value problems for differential equations; Theory of extreme problems.	-
Универсальные компетенции			

	UC-1 ability to critically analyze and evaluate modern scientific achievements, generate new ideas in solving research and practical problems including interdisciplinary fields; UC-2 ability to design and implement comprehensive research including interdisciplinary research based on a holistic systematic scientific worldview using knowledge in the field of history and philosophy of science; UC-3 willingness to participate in the work of Russian and international research teams to solve scientific and educational problems; UC-5 ability to plan and solve problems of their own professional and personal development.	Boundary value problems for differential equations; Theory of extreme problems.	-

3. Requirements for the results of mastering the discipline:

The process of mastering the discipline is aimed at the formation of the following competencies: UC-1, UC -2, UC -3, UC -5, PC -1, 3

As a result of studying the discipline, the student must:

Know: the current state of science, the main directions of scientific research, priority tasks in the field of variational and boundary value problems for functional differential equations.

Be able to:

- formulate and set variational and boundary value problems for functional differential equations –

- choose and justify methods of their research.

Possess: modern mathematical apparatus required for solving variational and boundary value problems for functional differential equations.

. The scope of the discipline and types of academic work

The total labor intensity of the course " General Theory of functional Differential Equations " is 4 credits.

Type of study work	Total hours	Semesters			
		1	2	3	
Classes (total)					
Including:	-	-	-	-	-
Lectures	20			20	
Practicum (P)	40			40	
Seminars (S)					
Laboratory work (LW)					
Individual work (total)	84			84	
Total labor intensity	144			144	
	4			4	

5. Content of the discipline

5.1. Content of the discipline sections

№ п/п	Units	Topics
1.	Differential equations with a deviating argument.	Classification of differential equations with a deviating argument. Statement of the initial problem. The method of steps and its applicability.
2.	Linear equations, differential-difference equations.	Linear equations, general properties. Characteristic quasipolynom of differential-difference equations with constant coefficients. Decomposition of the solution of a linear differential-difference equation into a series of basic solutions.
3.	Equations with a deviating argument.	Stability of equations with deviating argument. N. N. Krasovsky's generalization of the second Lyapunov method. Stability on the first approximation.
4.	Equations with deviating argument, quasilinear equations.	Existence of periodic solutions of the equation with a deviating argument. Periodic solutions of quasilinear equations.
5.	Generalized equation of the pantograph.	Generalized equation of the pantograph. The solution of the initial problem. Behavior of solutions at infinity.
6.	Variational and boundary value problems with deviating argument.	Variational and boundary value problems with deviating argument. Solvability and regularity of generalized solutions.
7.	Boundary value problems for differential-difference equations.	Boundary value problems for differential-difference equations in the one-dimensional case. Reduction of the boundary value problem for the differential-difference equation on the segment to the differential equation with non-local boundary conditions.
8.	Boundary value problems for strongly elliptic differential-difference equations.	Boundary value problems for strongly elliptic differential-difference equations in bounded domains.
9.	Boundary value problems for differential equations with extensions and compressions of arguments.	Boundary value problems for differential equations with extensions and compressions of the arguments of an unknown function in the one-dimensional case. Solving boundary value problems for differential equations with extensions and compressions of the arguments of an unknown function on a segment.
10.	Boundary value problems for differential equations	Boundary value problems for strongly elliptic differential equations with extensions and contractions of the arguments of an

	with extensions and compressions of arguments.	unknown function in stellar domains. Boundary value problems for strongly elliptic functional differential equations in stellar domains.

5.2. Sections and classes

№ п/п	Units	Lect.	Practicum and laboratory work			IW	Total
			P/S	LW	IF		
1.	Differential equations with a deviating argument.	2	4		4	8	14
2.	Linear equations, differential-difference equations.	2	4		4	8	14
3.	Equations with a deviating argument.	2	4		4	8	14
4.	Equations with deviating argument, quasi-linear equations.	2	4		4	8	14
5.	Generalized equation of the pantograph.	2	4		4	8	14
6.	Variational and boundary value problems with deviating argument.	2	4		4	8	14
7.	Boundary value problems for differential-difference equations.	2	4		4	8	14
8.	Boundary value problems for strongly elliptic differential-difference equations.	2	4		4	8	14
9.	Boundary value problems for differential equations with extensions and compressions of arguments.	2	4		4	8	14
10.	Boundary value problems for differential equations with extensions and compressions of arguments.	2	4		4	12	18
	Total:	20	40		40	84	144

6. Laboratory practice – not provided.

7. Practicum (Seminars)

№ п/п	№	Unit №	Practicum units (seminars)	Total labor intensity (hour)
	1.	**1**	The step method and its applicability	4
	2.	**2**	Decomposition of the solution of a linear differential-difference equation into a series of basic solutions	4
	3.	**3**	Stability in the first approximation	4
	4.	**4**	Periodic solutions of quasilinear equations	4
	5.	**5**	Generalized pantograph equation. Solving the initial problem. Behavior of solutions at infinity	4

6.	**6**	Solvability and regularity of generalized solutions	4
7.	**7**	Reduction of the boundary value problem for a differential-difference equation on a segment to a differential equation with non-local boundary conditions	4
8.	**8**	Boundary value pr	4
9.	**9**	The step method and its applicability	4
10.	**10**	Decomposition of the solution of a linear differential-difference equation into a series of basic solutions	4

8. Material and technical support of the discipline:

Auditorium 495a, 398, 509 Ordzhonikidze str., 3, RUDN, group classrooms Ordzhonikidze str., 3, RUDN on the 3rd, 4th and 5th floors, display classes, laboratories (rooms 510 and 424).

9. Information support of the discipline:

Only licensed software installed in the RUDN is used:
- Microsoft Office software package;
- multimedia equipment and personal computers;
- full-text databases and resources accessed from the RUDN network;
- electronic library of the RFBR http://www.rfbr.ru/rffi/ru/library

10. Educational and methodological support of the discipline:

а) basic literature:
1) Hale J. Theory of functional-differential equations. M.: Mir, 1984.
2) Rossovsky L. E. Elliptic functional-differential equations with compression and stretching of arguments of an unknown function. Modern mathematics. Fundamental directions 54 (2014), 3-138.

б) additional literature:
1) Skubachevsky A. L. Elliptic functional differential equations and applications. Basel-Boston-Berlin: Birkhauser, 1996.
2) Antonevich A., Lebedev A. Functional-differential equations. I. C* - theory. Harlow: Longman, 1994.

в) databases, information and reference systems and search engines
1. Higher Attestation Commission RF http://vak.ed.gov.ru
2. RSL Electronic Library http://www.rsl.ru/
3. RUDN Library http://lib.rudn.ru/
4. Science Direct http://www.sciencedirect.com Description: The resource contains a collection of scientific, technical full-text and bibliographic information. The multidisciplinary database includes scientific journals in the exact and technical fields of science.
5. EBSCO http://search.ebscohost.com, Academic Search Premier (a database of complex topics, containing information on the humanities and natural sciences).
6. Oxford University Press http://www3.oup.co.uk/jnls. Journals in the exact and technical sciences of Oxford University Press presented in the collection HSS
7. Sage Publications http://online.sagepub.com . The Sage publication database includes journals in various fields of knowledge: Sage_STM – more than 100 journals in the field of natural sciences, engineering.
8. Springer/Kluwer http://www.springerlink.com. Journals and books publishing houses
9. Springer/Kluwer cover various fields of knowledge and are divided into subject categories.
10. Tailor & Francis http://www.informaworld.com . The collection of journals includes more than 1000 titles in all fields of knowledge.

11. American Mathematical Society http://www.ams.org/ A resource of the American Mathematical Society.
12. European Mathematical Society http://www.euro-math-soc.eu/ Resource of the European Mathematical Society.
13. Portal to Mathematics Publications http://www.emis.de/projects/EULER/
14. Catalog of mathematical Internet resources http://www.mathtree.ru/
15. Zentralblatt MATH (zbMATH) https://zbmath.org
16. All-Russian mathematical portal mathnet.ru
17. Web of Science http://www.isiknowledge. com
18. Resources of the Institute of Scientific Information on Social Sciences of the Russian Academy of Sciences http://elibrary.ru.
19. University Information System RUSSIA. http://www.cir.ru/index.jsp.
20. GOST standards system for information, library and publishing http://www.ifap.ru/library/gost/sibid.htm.
21. RUDN Electronic Library http://www.rsl.ru/

г) periodicals

Algebra i analiz, Diskretnaya matematika, Zhurnal vychislitel'noj matematiki i matematicheskoj fiziki, Izvestiya Rossijskoj akademii nauk. Seriya matematicheskaya, Matematicheskie zametki Matematicheskij sbornik, Matematicheskoe modelirovanie, Teoreticheskaya i matematicheskaya fizika, Teoriya veroyatnostej i ee primeneniya, Uspekhi matematicheskih nauk, Funkcional'nyj analiz i ego prilozheniya, Trudy Matematicheskogo instituta im. V. A. Steklova, Sovremennye problemy matematiki, Vychislitel'nye metody i programmirovanie, Trudy seminara imeni I. G. Petrovskogo, Uchyonye zapiski Moskovskogo gosudarstvennogo universiteta Fundamental'naya 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. Methodological guidelines for students on the development of the discipline

The format of the seminar is the presentation of the key ideas of textbook sources - texts on the course. Specifically, the presentation looks like this: the student chooses one of the key ideas of the text discussed at the seminar, prepares his understanding and critical assessment in the form of theses (on 1-1.5 pages), then all this is presented and defended at the seminar. Abstracts are reproduced in advance and distributed to all participants of the seminar.

It is supposed to write an abstract t on a topic agreed with the teacher. The volume of the abstract – no more than 15 thousand characters with spaces. The translation of an article by a foreign author, together with a detailed critical and analytical assessment of it, is also accepted as an abstract. Coordination of both the author and the text with the teacher is mandatory.

At the end of the semester an exam in the form of an essay on one of the units proposed (to choose from) by the teacher. After the interview, the final grade is issued. The results are determined by conducting an interim attestation with grades "excellent", "good", "satisfactory", "unsatisfactory" and in the ECTS system (A, B, C, E). The basis for their placement is the point-rating system adopted in the RUDN.

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 "General Theory of functional 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.

Author:
Professor of the S. M. Nikolsky
Mathematical Institute   Rossovsky L.E.

The Director of the S. M. Nikolsky
Mathematical Institute   Skubachevsky A. L.