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

Faculty of science
Recommended by MSSN

PROGRAM OF DISCIPLINE

Variational analysis of differential equations

Recommended for

01.06.01 «Mathematics and mechanics»

Profile

«Real, complex and functional analysis»

1. Goals and objectives of the discipline

The main purpose of the course "Variational analysis of differential equations" is to master the basic concepts and some mathematical methods of general problems of the calculus of variations, analytical dynamics, the study of direct and indirect approaches to the study of operators on potentiality, symmetric properties of equations and functionals.

2. The place of the discipline in the structure of the EP HE:

The discipline "Variational analysis of differential equations" refers to the dissertations of the choice of block 1 of the curriculum.

Table 1 shows the previous and subsequent disciplines aimed at forming the competencies of the discipline in accordance with the matrix of competencies of the EP HE.

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-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.	Additional chapters of functional analysis; Variational problems.	-
Universal competencies			
	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	Additional chapters of functional analysis; Variational problems.	-

	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.		

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 -3

As a result of studying the discipline, the student must:
Know: the basic concepts of analytical dynamics, the Dalembert-Lagrange principle, Hamilton, Ostrogradsky, Hamilton-Jacobi, Poisson methods, the Gato derivative and differential, the criterion of the potentiality of operators.

Be able to: formulate the principles of Dalembert-Lagrange, Hamilton, Ostrogradsky, formulate and prove theorems, investigate operators for potentiality, find symmetries of equations and functionals, build the first integrals of equations.

Possess: the skills of practical use of the studied mathematical methods.

4. The scope of the discipline and types of academic work

The total labor intensity of the course " Variational analysis of differential equations " is 4 credits.

Type of study work	Total hours	Semesters			
Classes (total)		1	2	3	
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

№	Units	Topics
1.	Mathematical methods of analytical dynamics	Hamilton's Principle. Euler-Lagrange Equations. Hamilton equation. Some of the methods of Hamiltonian mechanics.
2.	Direct and indirect variational formulations of differential equations	Gato derivative and differential. Potential operators. Helmholtz potentiality conditions. Variational multipliers. Methods of construction
3.	Variational symmetries and first integrals of the corresponding Euler-Lagrange equations	The conditions of invariance of the action at Hamilton. Theorem Of E. Noether. Construction of the first integrals of equations.
4.	Symmetries of equations and their first integrals	The invariance of the equations. Formulas for constructing the first integrals. Relationship of symmetries of functionals and equations.

5.2. **Sections and classes**

№ п/п	Наименование раздела дисциплины	Лекц.	Практ. зан.	Лаб. зан.	Семин	СРС	Все-го час.
1.	Mathematical methods of analytical dynamics	5			10	21	36
2.	Direct and indirect variational formulations of differential equations	5			10	21	36
3.	Variational symmetries and first integrals of the corresponding Euler-Lagrange equations	5			10	21	36
4.	Symmetries of equations and their first integrals	5			10	21	36

6. Laboratory practice – not provided.

7. Practicum (Seminars)

№ п/п	Unit №	Practicum units (seminars)	Total labor intensity (hour)
1.	**1**	Basic concepts	8
2.	**2**	Monotonicity method	10
3.	**3**	Compactness method	10
4.	**4**	Breaking down solutions	12

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:

a) basic literature:

1. Gantmacher F. R. Lectures on analytical mechanics: A textbook for universities / ed. Pyatnitsky E. S.-3rd ed. - Moscow: FIZMATLIT, 2002. - 264 p.
2. Galiullin A. S. Analytical dynamics. Moscow: RUDN Publishing House, 1998. - 441 p.
3. Savchin V. M. Mathematical methods of mechanics of infinite-dimensional non-potential systems. Moscow: UDN Publishing House, 1991. - 237 p.

b) additional literature

1. Vainberg M. M. Functional analysis. Moscow: Prosveshchenie, 1979. - 128 p.

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 "Variational analysis of 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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