Federal State Autonomous Educational Institution of Higher Education

PEOPLES' FRIENDSHIP UNIVERSITY OF RUSSIA
RUDN University

Faculty of Physics, Mathematics and Natural Sciences

educational division (faculty/institute/academy) as higher education programme developer

COURSE SYLLABUS

Applied problems of mathematical modeling
course title

Recommended by the Didactic Council for the Education Field of:

01.04.01 Mathematics
field of studies / speciality code and title

The course instruction is implemented within the professional education programme of higher education:

«Functional methods in differential equations and interdisciplinary research»

higher education programme profile/specialisation title

2025

1. COURSE GOAL(s)

The purpose of mastering the discipline "Applied problems of mathematical modeling" is to present some universal methodological approaches that allow, regardless of specific areas of application, to build adequate mathematical models of the objects under study. Present methods and examples of constructing and analyzing mathematical models for various problems of economics, ecology, biology, medicine and sociology based on the use of fundamental laws of nature and regularities in economics and sociology.

2. REQUIREMENTS FOR LEARNING OUTCOMES

Mastering the discipline "Applied problems of mathematical modeling " is aimed at developing the following competencies (parts of competencies):

Table 2.1. List of competences that students acquire through the course study

Code	Competence	Competence achievement indicators (within this discipline)
GPC-2	Able to build and analyze mathematical models in modern natural science, technology, economics and management	GPC-2.1. Carries out a critical analysis of the results of his own experimental and computational-theoretical work, correctly interprets them
		GPC-2.2. Formulates conclusions and conclusions based on the results of the analysis of literary data, own experimental and computational-theoretical works in the chosen field of mathematics or related sciences
GPC-3	Able to use knowledge in the field of mathematics in the implementation of pedagogical activities	GPC-3.1. Presents the results of the work in the form of a scientific publication (abstract, article, review) in Russian and English
		GPC-3.2. Presents the results of his work orally in Russian and English
PC-2	Able to develop and analyze conceptual and theoretical models of solved scientific problems and tasks	PC-2.1. Searches for specialized information in the patent information databases of the
		PC- 2.2. Analyzes and summarizes the results of the patent search on the subject of the project in the chosen field of mathematics
PC-3	Is able to develop and apply mathematical methods, system and application software to solve problems of scientific and design-technological activities	PC-3.1. Systematizes the information obtained in the course of research, analyzes it and compares it with the literature data
		PC-3.2. Determines possible directions for the development of work and prospects for the practical application of the results obtained

3.COURSE IN HIGHER EDUCATION PROGRAMME STRUCTURE

The discipline Applied problems of mathematical modeling" refers to the obligatory part of block B1 of the EP HE.

As part of the EP HE, students also master other disciplines and / or practices that contribute to the achievement of the planned results of mastering the discipline « Applied problems of mathematical modeling»

Table 3.1. The list of the higher education programme components/disciplines that contribute to the achievement of the expected learning outcomes as the course study results

Code	Competence	Previous disciplines/modules, practices	Subsequent disciplines/modules, practices*
GPC-2	Able to build and analyze mathematical models in modern natural science, technology, economics and management	-	State examination, Preparation and defense of a graduate qualification work
GPC-3	Able to use knowledge in the field of mathematics in the implementation of pedagogical activities	-	State examination, Preparation and defense of a graduate qualification work
PC-2	Able to develop and analyze conceptual and theoretical models of solved scientific problems and tasks	-	State examination, Preparation and defense of a graduate qualification work
PC-3	Is able to develop and apply mathematical methods, system and application software to solve problems of scientific and design-technological activities	-	State examination, Preparation and defense of a graduate qualification work

4. COURSE WORKLOAD AND ACADEMIC ACTIVITIES

The total labor intensity of the discipline " Applied problems of mathematical modeling" is 2 credits.

*Table 4.1. Types of academic activities during the periods of higher education programme mastering (**full-time training**)**

Type of study work		TOTAL, **a**.h.	Semester			
			1	**2**	**3**	**4**
Contact work, academic hours		*36*		*36*		
Lectures, *academic hours*		18		18		
Laboratory works, *academic hours*						
Seminars, *academic hours*		18		18		
Independent work, *academic hours*		*36*		*36*		
Control,, academic hours						
The total complexity of the discipline	a.h.	**72**		**72**		
	credits	**2**		**2**		

5. CONTENT OF THE DISCIPLINE

Table 5.1. The content of the discipline (module) by type of educational work

Course Module Title	Brief Description of the Module Content	Type of study work
Section 1. Introduction to modern mathematical modeling in biology	Topic 1.1. Multidisciplinarity and multiphysics of modern scientific research Topic 1.2. The main types of the processes under study and the corresponding mathematical problems	Lecture, seminar
Section 2. Visualization in Python	Topic 2.1. Construction of graphs of elementary functions. Setting the legend and axis labels Topic 2.2. Building a series of several curves. Construction of phase diagrams (parametric curves)	Lecture, seminar
Section 3. Fundamentals of phenomenological chemical kinetics. Simple reactions of the 1st and 2nd order	Topic 3.1. Basic concepts of chemical kinetics. Reaction rate, simple reaction rate (law of mass action), reaction order. Dimensions of quantities (distance, time, concentration, speed). characteristic quantities. Kinetics of reactions of the 1st and 2nd order	Lecture, seminar
Section 4. Numerical solution of kinetic equations	Topic 4.1. The concept of convergence in the integration step and convergence to the exact solution. Numerical solution of ODE (Cauchy problem) in Python. Comparison of exact and numerical solutions	Lecture, seminar

6. CLASSROOM EQUIPMENT AND TECHNOLOGY SUPPORT REQUIREMENTS

Table 6.1. Classroom equipment and technology support requirements

Classroom type	Classroom equipment	Specialized educational/laboratory equipment, software and materials for mastering the discipline
Lecture	An auditorium for lecture-type classes, equipped with a set of specialized furniture; board (screen) and technical means of	-

Classroom type	Classroom equipment	Specialized educational/laboratory equipment, software and materials for mastering the discipline
	multimedia presentations.	
Seminar	An auditorium for conducting seminar-type classes, group and individual consultations, current control and intermediate certification, equipped with a set of specialized furniture and technical means for multimedia presentations.	-
For independent work of students	An auditorium for conducting seminar-type classes, group and individual consultations, current control and intermediate certification, equipped with a set of specialized furniture and technical means for multimedia presentations.	-

7. RESOURCES RECOMMENDED FOR COURSE STUDY

Main literature:

1. Samarsky A.A., Mikhailov A.P. Mathematical modeling. M., Fizmatlit, 2001.
2. Zang W.-B. Synergetic Economics, M., Mir, 1999.
3. Hassard B., Kazarinov N., Wen I. Theory and applications of cycle birth bifurcation. M., Mir, 1985.
4. Bratus A.S., Novozhilov A.S., Platonov A.P. Dynamic systems and models of biology. M., Fizmatlit, 2011.
5. Koshelev V.B., Mukhin S.I. and other Mathematical models of quasi-one-dimensional hemodynamics. M., MAKS Press, 2010.

Additional literature:

6. D. Arrowsmith and K. Place, Ordinary Differential Equations. M., Mir, 1986.
7. Arnold V.I. Theory of catastrophes. M., URSS, 2009.
8. Thompson JM Instability and catastrophes in science and technology. M., Mir, 1985.

Resources of the information and telecommunications network "Internet":

1. RUDN ELS and third-party ELS, to which university students have access on the basis of concluded agreements:
- RUDN Electronic Library System - RUDN EBS http://lib.rudn.ru/MegaPro/Web
- ELS "University Library Online" http://www.biblioclub.ru
- EBS Yurayt http://www.biblio-online.ru
- ELS "Student Consultant" www.studentlibrary.ru
- EBS "Lan" http://e.lanbook.com/
- EBS "Trinity Bridge"

2. Databases and search engines:
- electronic fund of legal and normative-technical documentation http://docs.cntd.ru/

- Yandex search engine https://www.yandex.ru/
- Google search engine https://www.google.ru/
- abstract database SCOPUS http://www.elsevierscience.ru/products/scopus/

8. ASSESSMENT TOOLKIT AND GRADING SYSTEM* FOR EVALUATION OF STUDENTS' COMPETENCES LEVEL UPON COURSE COMPLETION

Evaluation materials and a point-rating system* for evaluating the level of formation of competencies (parts of competencies) based on the results of mastering the discipline "Applied problems of mathematical modeling " are presented in the Appendix to this Work Program of the discipline

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