Federal State Autonomous Educational Institution of Higher Education
PEOPLES' FRIENDSHIP UNIVERSITY OF RUSSIA
RUDN University

Agrarian -Technological Institute
educational division (faculty/institute/academy) as higher education programme developer

COURSE SYLLABUS

Mathematical Modeling and Design
course title

Recommended by the Didactic Council for the Education Field of:

35.04.04 Agronomy
field of studies / speciality code and title

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

Integrated Plant Protection
higher education programme profile/specialisation title

2025

1. COURSE GOAL(s)

The purpose of mastering the discipline "Mathematical Modeling and Design" is to form basic ideas about obtaining and processing information for its analysis by a person and making decisions on its basis to perform management tasks related to production activities in the field of agriculture.

2. REQUIREMENTS FOR LEARNING OUTCOMES

Mastering the discipline "Mathematical Modeling and Design" is aimed at the formation of the following competencies (part of the competencies) among students:

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

Competence code	**Competence descriptor**	**Competence formation indicators** (within this course)
GK-7	Able to search for the necessary sources of information and data, perceive, analyze, memorize and transmit information using digital means, as well as with the help of algorithms when working with data received from various sources in order to effectively use the information received to solve problems, to evaluate information, its reliability, to build logical conclusions on the basis of incoming information and data	GK-7.1. Evaluates information, its reliability, builds logical conclusions on the basis of incoming information and data
OPK-1	Able to solve the problems of development of the field of professional activity and (or) organization on the basis of analysis of the achievements of science and production	OPK-1.1. Demonstrates knowledge of the main methods of analyzing the achievements of science and production in agronomy
OPK-4	Able to conduct research, analyze results and prepare reporting documents	OPK-4.1. Analyzes methods and methods of solving research problems
PK-3	Able to organize, conduct and analyze the results of experiments (field experiments)	PK-3.1. Owns modern methods of processing research results using methods of mathematical statistics
PK-4	Able to create models of crop cultivation technologies, plant protection systems, varieties	PK-4.1. Knows the biological and economic features of agricultural and newly domesticated plants as the basis for the development of technologies for their cultivation

Competence code	Competence descriptor	Competence formation indicators (within this course)
PK-5	Able to prepare scientific and technical reports, reviews and scientific publications based on the results of the research performed	PK-5.2. Uses methods of mathematical statistics in data processing and report preparation

3.COURSE IN HIGHER EDUCATION PROGRAMME STRUCTURE

Mastering the discipline "Mathematical Modeling and Design" is aimed at forming the following competencies (part of the competencies) among students:

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

Competence code	Competence descriptor	Previous courses/modules*	Subsequent courses/modules*
GK-7	Able to search for the necessary sources of information and data, perceive, analyze, memorize and transmit information using digital means, as well as with the help of algorithms when working with data received from various sources in order to effectively use the information received to solve problems, to evaluate information, its reliability, to build logical conclusions on the basis of incoming information and data	Information Technology; Information Databases; Scientific research work / Научно-исследовательская работа; Research Practice;	Scientific research work / Научно-исследовательская работа;
OPK-1	Able to solve the problems of development of the field of professional activity and (or) organization on the basis of analysis of the achievements of science and production	Biological Method of Plant Protection; Instrumental methods of research; Bacterial Diseases; Information Technology: Scientific research work / Научно-исследовательская работа; Research Practice;	Plant Quarantine; Biotechnology in Plant Protection; Plant immunity; Scientific research work / Научно-исследовательская работа;

Competence code	Competence descriptor	Previous courses/modules*	Subsequent courses/modules*
OPK-4	Able to conduct research, analyze results and prepare reporting documents	Scientific research work / Научно-исследовательская работа; Research Practice; Biological Method of Plant Protection; Instrumental methods of research; Bacterial Diseases;	Scientific research work / Научно-исследовательская работа; Undergraduate practice / Преддипломная практика; Plant Quarantine; Biotechnology in Plant Protection; Plant immunity;
PK-3	Able to organize, conduct and analyze the results of experiments (field experiments)	Scientific research work / Научно-исследовательская работа; Research Practice; Biological Method of Plant Protection;	Scientific research work / Научно-исследовательская работа;
PK-4	Able to create models of crop cultivation technologies, plant protection systems, varieties	Research Practice; Biological Method of Plant Protection; Plant Protection in Organic Farming; Pest Risk Analysis; Forecast of Development of Agricultural Pests and Diseases; Nematodes; Weed biology and management; Bacterial Diseases;	Plant immunity;
PK-5	Able to prepare scientific and technical reports, reviews and scientific publications based on the results of the research performed	Molecular Methods of Diagnostics; History and methodology of scientific Agronomy; Fundamentals of Scientific Communication; Manuscript Design; Scientific research work / Научно-исследовательская работа; Research Practice;	Scientific research work / Научно-исследовательская работа; Undergraduate practice / Преддипломная практика;

* To be filled in according to the competence matrix of the higher education programme.

4. COURSE WORKLOAD AND ACADEMIC ACTIVITIES

Possible wording

The total labor intensity of the discipline "Mathematical Modeling and Design" is 4 credits for full-time education.

Table 4.1 – Types of educational work by periods of mastering the OP HE for full-time education

Type of academic activities		**Total academic hours**	**Semesters/training modules**			
			1	**2**	**3**	**4**
Contact academic hours		*34*			*34*	
including:						
Lectures (LC)						
Lab work (LW)						
Seminars (workshops/tutorials) (S)		*34*			34	
Self-studies		*82*			*82*	
Evaluation and assessment (exam/passing/failing grade)		*28*			*28*	
Course workload	academic hours_	**144**			**144**	
	credits	**4**			**4**	

5. COURSE CONTENTS

Table 5.1. Course contents and academic activities types

Course module title	**Course module contents (topics)**	**Academic activities types**
Module 1: Methodological and theoretical foundations of modeling and design.	Topic 1.1. The concept of models and modeling. The importance of modeling in scientific research on agronomy. The structure and functions of the model. Ways to build a model. Classification of mathematical models and their characteristics: descriptive (empirical) and explanatory (theoretical), optimization and simulation, statistical and dynamic, deterministic and stochastic.	S
	Topic 1.2. Properties of the model. Principles of modeling. Modeling stages: choosing the type of model and substantiating the degree of its complexity, developing the content of the model, formalizing the model, determining the type of functions and parameters of the model, evaluating the adequacy of the model, analyzing the sensitivity of the model, using the model.	S
Module 2: Storage structures and access methods	Topic 2.1. Data processing systems (SOD). File systems for data processing and trends in their development	S
	Topic 2.2. Data structures for FSO and access methods. The model of a simple sequential file. The index organization of the file. Search methods in the index.	S

Course module title	Course module contents (topics)	Academic activities types
Module 3: Modeling of highly productive agricultural systems	Topic 3.1. Modeling in crop breeding. The requirement for the grade model. Modeling in crop yield planning. Optimization of the crop sowing model for different regional conditions. The model of agrophytocenosis.	S
	Topic 3.2 Models of fertilizer and plant protection systems, soil treatment. The use of modeling in the practice of regulating the weed component of agrophytocenoses. Modeling the relationship between clogging and productivity. The use of models in the development of projects of technologies for the production of plant products.¶	S
	Topic 3.3 The main technological blocks for controlling the production process of plants. The basic model of crop production technologies. Adapters for basic technologies.	S
Module 4: Databases	Topic 4.1. Basic concepts of databases. Database properties. Requirements for the organization of the database. The data bank. Components of the data bank. The administrator of the data bank. Database management System (DBMS).	S
	Topic 4.2. Levels of data representation. The life cycle of the database. The database design process. The principle of top-down design with successive iterations. Design expertise. Requirements analysis.	S

* - to be filled in only for **full** -time training: *LC - lectures; LW - lab work; S - seminars.*

6. CLASSROOM EQUIPMENT AND TECHNOLOGY SUPPORT REQUIREMENTS

Table 6.1. Classroom equipment and technology support requirements

Type of academic activities	Classroom equipment	Specialised educational / laboratory equipment, software, and materials for course study (if necessary)
Lecture hall	An auditorium for conducting lecture-type classes, equipped with a set of specialized furniture; a blackboard (screen) and multimedia presentation equipment.	
Seminary	An auditorium for seminar-type classes, group and individual consultations, ongoing monitoring and intermediate certification, equipped with a set of specialized furniture and multimedia presentation equipment.	
Self-studies	A classroom for independent work of students (can be used for seminars and consultations),	

Type of academic activities	Classroom equipment	Specialised educational / laboratory equipment, software, and materials for course study (if necessary)
	equipped with a set of specialised furniture and computers with access to the electronic information and educational environment.	

* The premises for students' self-studies are subject to **MANDATORY** mention

7. RESOURCES RECOMMENDED FOR COURSE STUDY

Main readings:

1. Mathematical Modeling with Differential Equations in Physics, Chemistry, Biology, and Economics. DOI 10.3390/books978-3-0365-4626-1 ISBN 9783036546254, 9783036546261 Publisher MDPI - Multidisciplinary Digital Publishing Institute Publisher website www.mdpi.com/books Publication date and place Basel, 2022 Classification Research & information: general Mathematics & science Pages 150

2. Malygin, A. A. Mathematical modeling of economic processes in agriculture : an educational and methodological guide / A. A. Malygin. Ivanovo : Verkhnevolzhsky State Agrarian University, 2022. 95 p. — Text : electronic // Lan : electronic library system. — URL: https://e.lanbook.com/book/263741

Additional readings:

1. Engineering and technological solutions to the problems of agro-industrial complex and society development. Proceedings of the LVIII International scientific and practical conference of students, postgraduates and young scientists "Strategic resources of the Tyumen agroindustrial complex: people, science, technology" : conference proceedings. — Tyumen : State Agrarian University of the Northern Urals, 2024. — 1457 p. — Text : electronic // Lan : electronic library system. — URL: https://e.lanbook.com/book/441635

2. Mathematical modeling in the classification of soil systems : a textbook / compiled by E. G. Pivovarova ; edited by G. G. Morkovkin. Barnaul : AGAU Publ., 2020. 71 p. — Text : electronic // Lan : electronic library system. — URL: https://e.lanbook.com/book/197217

Internet sources

1. Electronic libraries (EL) of RUDN University and other institutions, to which university students have access on the basis of concluded agreements:

- RUDN Electronic Library System (RUDN ELS) http://lib.rudn.ru/MegaPro/Web
- EL "University Library Online" http://www.biblioclub.ru
- EL "Yurayt" http://www.biblio-online.ru
- EL "Student Consultant" www.studentlibrary.ru
- EL "Lan" http://e.lanbook.com/

2.Databases and search engines:

- electronic foundation of legal and normative-technical documentation http://docs.cntd.ru/
- Yandex search engine https:// www .yandex.ru/
- Google search engine https://www.google.ru/

- Scopus abstract database http://www.elsevierscience.ru/products/scopus/

*Training toolkit for self- studies to master the course *:*

The set of lectures on the course «Mathematical Modeling and Design»

* The training toolkit for self- studies to master the course is placed on the course page in the university telecommunication training and information system under the set procedure.

DEVELOPERS:

position, department	name and surname
position, department	name and surname
position, department	name and surname

HEAD OF EDUCATIONAL DEPARTMENT:

name of department	name and surname

HEAD
OF HIGHER EDUCATION PROGRAMME:

position, department	name and surname