National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute"

Department of Automation of Electrical and Mechatronic Complexes

COMPUTER SIMULATION PROCESSES IN ELECTRICAL SYSTEMS

Work program of the discipline (Syllabus)

Details of the discipline	
Level of higher education	***Second (Master's)***
Field of knowledge	*14 Electrical Engineering*
Speciality	*141 Electric Power Engineering, Electrical Engineering and Electromechanics*
Educational program	*Engineering of Intelligent Electrical and Mechatronic Complexes*
Discipline status	*Custom*
Form of study	*Full-time / part-time / accelerated*
Year of preparation, semester	*1st year, spring semester*
Scope of discipline	*5.0 credits / 150 hours*
Semester control / control measures	*Exam*
Timetable	*http://rozklad.kpi.ua/*
Language of instruction	*Ukrainian*
Information about Course Leader / Instructors	Lecturer: *Ph.D., Associate Professor Danilin Oleksandr Valeriyovych; e-mail: avdan@ukr.net; mеn. +38-067-907-91-19 (09:00 – 18:00)* Practical / Laboratory: *Ph.D., Associate Professor Danilin Oleksandr Valeriyovych; e-mail: avdan@ukr.net; mеn. +38-067-907-91-19 (10:00 – 18:00)*
Course Placement	Available on the Sikorsky platform. The access code is provided by the teacher in the first lesson.

The program of the discipline

1. Description of the discipline, its purpose, subject of study and learning outcomes

Most modern industrial machines and installations are complex electrical systems that include elastic mechanical links, an electric drive with semiconductor converters in power circuits, a control system, protective equipment, etc. The links of the electric drive and the control system have a generally accepted form of mathematical description of the transient processes taking place in them. However, in the presence of elastic connections with distributed parameters in the mechanical part of installations, the study of electrical complexes and systems presents certain difficulties.

The task of optimal control of complex electrical systems is to ensure the mode of operation of the system that functions best in a certain sense, that is, it must meet a very clear technical or technical-economic criterion of optimality. A mathematical expression must be represented by a function or functional of the coordinates of the process and the control influence. Reaching the maximum (minimum) value of the optimality criterion indicates the optimal state or behavior of the system.

The purpose of studying the discipline is the formation of the student's theoretical and practical knowledge, the study of dynamic processes in electrical systems of varying complexity and the creation of effective control algorithms for their study in practice.

Program learning outcomes: (FC18) ability to create universal most effective algorithms for modeling processes in electrical systems and conduct their research; (FC19) ability to optimize technological processes and build structural diagrams of automated control systems; (PRN17) To create universal and most effective algorithms for modeling the processes of electrical complexes and to conduct their research on modern equipment with modern software.

2. Prerequisites and post-requisites of the discipline (place in the structural and logical scheme of training in the relevant educational program)

The academic discipline "Computer Modeling of Processes in Electrical Systems" is taught on the basis of knowledge and skills gained by students during the study of credit modules of such disciplines as: "Physics", "Higher Mathematics", "Theoretical Foundations of Electrical Engineering", "Theory of Automatic Control of Electrical Complexes and Mechatronic Systems", "Computer Engineering and Programming", etc.

The knowledge and skills acquired in the process of studying the credit module "Computer Modeling of Processes in Electrical Systems" are necessary for every specialist of the electrical engineering profile who solve engineering problems in the field of electrical engineering and in the study of the following disciplines: "Electric Drive", "Automated Electric Drive of Machines and Installations", "Modeling of Electrical Systems", etc.

3. The content of the discipline

Chapter 1. Basic provisions of the discipline. Elastic elements of electrical systems

Topic 1.1. Inertial mechanical link for rotational and translational motions.

Topic 1.2. Elastic kinematic coupling. Damper. Backlash.

Chapter 2. Mathematical modeling of integrating links.

Topic 2.1. Approximation of functions. Differentiation operation.

Topic 2.2. Numerical-analytical method. Z-transformation methods.

Chapter 3. Analytical study of elastic electrical systems.

Topic 3.1. Dual-mass mechanical system. A system with a DC motor.

Topic 3.2. Dual-mass systems with elastic link, damper and backlash.

Topic 3.3. Four-mass branched and parallel system.

Chapter 4. Optimization of operating modes of electrical systems.

Topic 4.1. Formation of optimal control actions in terms of speed.

Topic 4.2. General methodology for creating multi-channel master models.

Topic 4.3. Study of the functionality of master models.

4. Training Materials & Resources

Basic

1. Modeling of electromechanical processes and systems. Helps. / O.V. Danilin, V.M. Chermalikh, P.V. Rosen. – K.: NTUU "KPI", 2007. – 52 p.

2. Shchokin V.P. Modeling of electromechanical systems: textbook / V.P. Shchokin [and others]. - Kyiv: Kondor, 2018. - 203 p.

3. Digital control systems of electric drive. Helps. / O.V. Chermalikh, O.V. Danilin, I.Y. Maidansky, A.V. Bosak. – K.: NTUU "KPI", 2012. – 72 p.

4. Using the MATLAB–Simulink Package to Model Dynamical Systems and Devices: Method. Instructions for the performance of laboratory, calculation and graphic work, course and diploma design for students. Special. 7.092203 – "Electromechanical Automation Systems and Electric Drive" and 7.092204 – "Electromechanical Equipment of Energy-Intensive Industries" / Compilers: O.V. Chermalikh, O.V. Danilin, V.V. Kuznetsov. Kyiv: Polytechnic Publishing House, 2004. – 72 p.

Secondary

5. Lozynskyi A.O., Moroz V.I., Paranchuk Y.S. Solving electromechanics problems in the environments of MathCAD and MATLAB packages: Textbook. – Lviv: Lviv Polytechnic State University Press, 2000. – 166 p.

6. Kozbur I.R. Modeling of control systems in the MATLAB SIMULINK package, methodical instructions for laboratory work on the course "Computer methods of research of automatic control systems", for 4th year students of the specialty 6.050201 "System Engineering" / incl. : I.R. Kozbur, G.V. Kozbur, R.I. Mykhailyshyn. Ternopil: TNTU, 2019. - 23 p. http://elartu.tntu.edu.ua/handle/lib/28056

7. Modeling of electrical and mechatronic systems. Educational edition [Electronic resource] : tutorial for bachelor's degree programs for an educational program "Engineering of Intelligent Electrotechnical and Mechatronic Complexes" / O. V. Danilin, A. V. Bosak, V. O. Bronytskyi, L. V. Toropova ; Igor Sikorsky Kiev Polytechnic Institute. – Electronic text data (1 file: 1,27 MB). – Kyiv: Igor Sikorsky Kyiv Polytechnic Institute, 2021. – 55 p. https://ela.kpi.ua/handle/123456789/47291

8. Azhogin V.V., Zgurovsky M.Z. Modeling on analog and hybrid computers. – Kyiv: High School. – 1983. – 274 p.

References, the bibliography of which is given with a link, can be found on the Internet. Literature, the bibliography of which does not contain references, can be found in the library of Igor Sikorsky Kyiv Polytechnic Institute. Igor Sikorsky.

Separate sections of basic literature [1]-[3] are required reading. Sections of basic literature that are mandatory reading, as well as the connection of these resources with specific topics of the discipline, are given below, in the methodology of mastering the discipline. All other literary sources are optional, it is recommended to read them

Educational content

5. Methods of mastering the discipline (educational component)

The general methodical approach to teaching the discipline is defined as communicative-cognitive and professionally oriented, according to which the student – the subject of learning – is at the center of the educational process. The methodology of teaching the discipline combines visual teaching methods with explanation. Teaching is carried out in the form of lectures and practical classes in the form of a computer workshop.

Lectures

Salary No.	Title of the topic of the lecture and a list of the main issues (links to literature)
1	**Title of the lecture topic:** Introduction to the discipline **List of main issues:** Basic concepts of modeling elastic electrical systems. Analytical methods of modeling. The concept of the transfer function of elastic-viscous systems. **References:** [2, 4]
2	**Title of the lecture topic:** Elastic elements of electrical systems **List of main issues:** Methods of constructing mathematical models of electrical systems with elastic links. State space methods. Drawing up block diagrams. **References:** [2, 6]
3	**Title of the lecture topic:** Research of elastic elements of electrical systems **List of main issues:** Second-order inertial mechanical link (mass) for rotational and translational motions. **References:** [3, 8]

4	**Title of the lecture topic:** Research of elastic elements of electrical systems **List of main issues:** Elastic kinematic coupling (spring). Damping link (shock absorber). Zone of insensitivity (backlash). **References:** [1, 7]
5	**Title of the lesson:** Mathematical Modeling of Integrating Links of Elastic Systems **List of main issues:** Numerical integration of differential equations. Stepped, stepped with bias and piecewise linear approximation of functions. Differentiation operation. **References:** [2, 6]
6	**Title of the lesson:** Mathematical Modeling of Integrating Links of Elastic Systems **List of main issues: Use of the** numerical-analytical method and the Z-transform method. Compilation of block diagrams in the space of states of the sequential and parallel structure of mathematical models. **References:** [1, 5]
7	**Title of the lecture:** Research of mathematical models of electrical systems with elastic links. **List of main issues:** A dual-mass mechanical system with an elastic link during rotational motion. Compilation of differential equations, transfer function and block diagram of the research algorithm by numerical-analytical method. **References:** [1, 6]
8	**Title of the lecture:** Research of mathematical models of electrical systems with elastic links. **List of main issues:** A dual-mass mechanical system with an elastic link during translational motion. Compilation of differential equations, transfer function and block diagram of the research algorithm by *the* Z-transform method. **References:** [2, 8]
9	**Title of the lecture:** Research of mathematical models of electrical systems with elastic links. **List of main issues:** Electromechanical system with DC motor. Formulation of differential equations, transfer function and block diagram in a continuous space of states. **References:** [1, 7]
10	**Title of the lecture:** Research of mathematical models of electrical systems with elastic links. **List of main issues:** Dual-mass mechanical system with elastic link and damper. Formulation of differential equations, transfer function and block diagram in a continuous state space. **References:** [2, 4]
11	**Title of the lecture:** Research of mathematical models of electrical systems with elastic links. **List of main issues:** Dual-mass mechanical system with elastic link and backlash. Formulation of differential equations, transfer function and block diagram in a continuous space of states. **References:** [3, 6]
12	**Title of the lecture:** Research of mathematical models of electrical systems with elastic links. **List of main issues:** Dual-mass mechanical system with elastic link, damper and backlash. Compilation of differential equations, transfer function and block diagram of the research algorithm by numerical-analytical method. **References:** [1, 5]
13	**Title of the lecture:** Research of mathematical models of electrical systems with elastic links. **List of main issues:** Four-mass branched mechanical system. Formulation of differential equations, transfer function and block diagram in a continuous state space. **References:** [3, 6]
14	**Title of the lecture:** Research of mathematical models of electrical systems with elastic links. **List of main issues:** Four-mass parallel mechanical system. Formulation of differential equations, transfer function and block diagram in a continuous state space. **References:** [2, 5]

15	**Lecture title:** Optimization of Electrical Systems Operating Modes **List of main issues:** Formation of optimal control actions in terms of speed. The main tasks of optimization of positional control systems. Analytical description and construction of optimal velocity and acceleration diagrams **References:** [1, 7].
16	**Title of the lecture topic:** Methods of creating multi-channel master models. **List of main questions:** Features of creating master models of different orders. Principles of construction. Functional and structural diagrams, blocks of constraints, adaptations and switching modes. **References:** [1, 8].
17	**Title of the lecture topic:** Investigation of the functionality of second-order master models. **List of main issues:** Determination of intermediate sections of the path, total travel time, limit values of the specified displacement, new maximum speed and total distance to the stopping point from the moment the deceleration begins. **References:** [2, 5].
18	**Title of the lecture topic:** Investigation of the functionality of second-order master models. **List of main issues: Compilation of the** analytical dependence of the current distance to the end of the path on the speed in the deceleration sections. Determination of the optimal values of acceleration and velocity in the displacement function. Compilation of Structural Diagrams of Algorithms for the Formation of Optimal Control Actions in the Function of Time and Displacement **References:** [1, 4].

Practical classes (computer workshop)

The main task of the cycle of practical classes in the form of a computer workshop is to conduct simulation experiments on a computer in order to form skills and abilities of practical confirmation of certain theoretical provisions, mastering the methodology of experimental research and processing of the data obtained.

Salary No.	Title of the topic of practical classes and list of main questions (reference to literature)
1	**Title of the lesson:** Research of elastic elements of electrical systems **List of main issues:** Second-order inertial mechanical link (mass) for rotational and translational motions. Drawing up a block diagram and computer modeling algorithm. **References:** [3, 8]
2	**Title of the lesson:** Research of elastic elements of electrical systems **List of main issues:** Elastic kinematic coupling (spring). Damping link (shock absorber). Zone of insensitivity (backlash). Drawing up a block diagram and computer modeling algorithm. **References:** [1, 7]
3	**Title of the lesson:** Research of mathematical models of electrical systems with elastic links. **List of main issues:** A dual-mass mechanical system with an elastic link during rotational motion. Compilation of differential equations, transfer function and block diagram of the research algorithm by numerical-analytical method. **References:** [1, 6]

4	**Title of the lesson:** Research of mathematical models of electrical systems with elastic links. **List of main issues:** A dual-mass mechanical system with an elastic link during translational motion. Compilation of differential equations, transfer function and block diagram of the research algorithm by *the* Z-transform method. **References:** [2, 8]
5	**Title of the lesson:** Research of mathematical models of electrical systems with elastic links. **List of main issues:** Electromechanical system with DC motor. Compilation of differential equations, transfer function and block diagram of computer modeling algorithm. **References:** [1, 7]
6	**Title of the lesson:** Research of mathematical models of electrical systems with elastic links. **List of main issues:** Dual-mass mechanical system with elastic link and damper. Compilation of differential equations, transfer function and block diagram of computer modeling algorithm. **References:** [2, 4]
7	**Title of the lesson:** Research of mathematical models of electrical systems with elastic links. **List of main issues:** Dual-mass mechanical system with elastic link and backlash. Compilation of differential equations, transfer function and block diagram of computer modeling algorithm. **References:** [3, 6]
8	**Title of the lesson:** Investigation of the functionality of second-order master models. **List of main issues:** Drawing up a structural diagram of the algorithm for the formation of optimal control influences in the time function and obtaining graphical results of computer modeling. **References:** [1, 4].
9	**Title of the lesson:** Investigation of the functionality of second-order master models. **List of main issues:** Drawing up a structural diagram of the algorithm for the formation of optimal control influences in the function of movement and obtaining graphic results of computer modeling. **References:** [1, 6].

6. Independent work of a student/graduate student

Independent work of the student according to the curriculum provides 96 hours:
preparation for classroom classes – 46 hours;
preparation for the modular test – 10 hours;
execution of WGR – 10 hours;
preparation for the exam – 30 hours.

As an individual semester task, according to the curriculum, students perform calculation and graphic work (WGR)

Tasks of calculation and graphic work

Research of mathematical models of electrical systems with elastic links.

Order of the task:

1. Make a mathematical description of all elements of the electrical system and present them with appropriate block diagrams.

2. To make a generalized block diagram of an electrical system with elastic links in a continuous space of states.

3. Synthesize Simulink models of a continuous system in the Matlab environment and obtain graphical results of computer modeling.

4. To represent dynamic links in an integral form and to draw up a detailed block diagram of an electrical system in a continuous space of states.

5. To replace the continuous model of the system with a discrete one using the specified approximation of integrators and to draw up a block diagram of the algorithm for studying the electrical system by the numerical-analytical method.

6. Replace the continuous model of the system with a discrete one using the given Z-transform method and compose the corresponding block diagram in the discrete state space.

7. To make a block diagram of the algorithm for the study of an electrical system with elastic links using the Z-transformation.

8. Synthesize Simulink models of a discrete system in the Matlab environment and obtain graphical results of computer modeling.

Policy & Control

7. Academic discipline policy (educational component)

At the time of each lesson, both lecture and practical, the student must have the Zoom application installed on the device from which he works (in the case of distance learning), as well as the course "Computer Modeling of Processes in Electrical Systems" on the Sikorsky platform (the access code to the course is provided at the first lesson according to the schedule). Syllabus; lecture material; tasks for a computer workshop; options for modular tests; methodical recommendations for the implementation of computer workshop and calculation and graphic work; the list of theoretical questions and practical tasks for the exam is posted on the Sikorsky platform and in the KPI Electronic Campus system.

During the course "Computer Modeling of Processes in Electrical Systems", students are required to adhere to the general moral principles and rules of ethical behavior specified in the Code of Honor of the National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute".

The deadlines for each task are specified in the course "Computer Modeling of Processes in Electrical Systems" on the Sikorsky platform.

All students, without exception, are obliged to comply with the requirements of the Regulations on the System for the Prevention of Academic Plagiarism at the National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute".

8. Types of control and rating system for assessing learning outcomes (CRO)

1. The student's rating in the credit module is calculated from 100 points, of which 50 points are the starting scale. The starting rating (during the semester) consists of the points that the student receives for:

– two answers in 9 practical classes (based on the fact that at each practical lesson on average 5 students are evaluated (with a group of 20 people – $9 \times 5 / 20 \approx 2$ reps.);
– two tests (one modular test is divided into two tests lasting one academic hour each);
– performance of calculation and graphic work;

2. Criteria for awarding points:

2.1. Work in practical classes:

The weight score is 5. The maximum number of points in all practical classes is equal to:

5 points × 2 rep. = 10 points.

Criteria for evaluating the response in practical classes	**Points**
Complete Comprehensive Answer	5
Correct answer with some flaws	3
Incomplete answer with significant flaws	2
A rather weak or incorrect answer	0

2.2. Modular control

The weight score is 5. The maximum number of points for 2 one-hour modular tests (MCR) is: 5 points × 2 MCR = 10 points.

Criteria for assessing the implementation of the ICR	**Points**
Complete answer (at least 90% of the required information)	5
a sufficiently complete answer (at least 75% of the required information), or a complete answer with minor inaccuracies	3
incomplete answer (at least 60% of the required information) and minor errors	2
Unsatisfactory response (does not meet the requirements for "satisfactory")	0

2.3. Calculation and graphic work

The weight score is 20. The maximum number of points for all criteria for the implementation and protection of the WGR is 20 points

Criteria for assessing the implementation and protection of WGR	**Points**
All requirements for the work have been fulfilled	24… 30
Almost all the requirements for the work have been met, or there are minor errors	15… 23
There are shortcomings in meeting the requirements for work and certain mistakes	7… 14
The work does not meet the established requirements	0… 6

For participation in the All-Ukrainian Olympiad (competition of scientific papers) the student is awarded 5 (I round) or 10 (II round) points. For writing an article and its publication, a student is awarded 10 points (a publication included in Scopus or Web of Science) or 6 points (a professional publication of Ukraine). For the publication of abstracts at a scientific conference – 3 points. The total amount of incentive points cannot exceed 10 points.

Calendar control: it is carried out twice a semester as a monitoring of the current state of fulfillment of the requirements of the syllabus. The condition for a positive first and second calendar control is to obtain at least 50% of the maximum possible rating at the time of the relevant calendar control.

Semester control: Exam.

Rating scale size: R = RC + RE = 50 + 50 = 100 points.

Starting scale size: RC = 10 + 10 + 30 = 50 points.

Exam scale: RE = 50 points (50% of R).

The maximum sum of the weight points of all control measures during the semester is RS = 10 + 10 + 30 + 50 = 100 points.

Conditions for admission to the exam: completion of all tasks of the computer workshop and WGR, as well as a preliminary rating on the credit module must be $rC \geq 25$ points (at least 50% of RC).

The task of the examination work is done in writing and consists of one theoretical question and one practical task. The list of questions is given in this syllabus. The theoretical question is worth 20 points, and the problem is worth 30 points.

Theoretical Question Evaluation System	Points
"excellent", full answer (at least 90% of the required information)	16… 20
"good", a sufficiently complete answer (at least 75% of the required information or minor inaccuracies)	10… 15
"satisfactory", incomplete answer (at least 60% of the required information and some errors)	6… 9
"unsatisfactory", unsatisfactory answer	0… 5

Assessment system for practical questions (tasks)	Points
"excellent", complete error-free solution of the problem	25… 30
"good", complete solution of the problem with minor inaccuracies	18… 24
"satisfactory", the task was completed with certain shortcomings	9… 17
"unsatisfactory", the task was not completed	0… 8

6. The sum of starting points and points for the examination work is transferred to the examination grade according to the table:

Rating points	University Scale Score
95… 100	Perfectly
85… 94	Very good
75… 84	Well
65… 74	Satisfactory
60… 64	Enough
Less than 60	Disappointing
Failure to comply with the conditions of admission to the exam	Not allowed

9. Additional information on the discipline (educational component)

The list of questions that are submitted for semester control is given in the appendix to the syllabus. A higher education applicant has the opportunity to take an online course(s) on one or more topics provided for by the curriculum of the discipline. The applicant can choose an online course independently or on the recommendation of a teacher, on the Coursera or Udemy platform. 1 hour of the course is estimated at 0.83 points. The maximum number of hours that can be counted based on the results of non-formal education is 12 hours, respectively, the maximum number of points for such results is 10 points.

EXAM QUESTIONS FOR THE COURSE:

1. Compose differential equations, a transfer function, and display a block diagram of an inertial second-order mechanical link during rotational motion.
2. Compose differential equations, transfer function and display a block diagram of an inertial mechanical link of the second order during translational motion.
3. Compose differential equations, transfer function and display a block diagram of an elastic kinematic link during rotational and translational movements.
4. Compose differential equations, transfer function and display the block diagram of the damping link during rotational and translational movements.

5. To make an analytical dependence, a graphical representation and a block diagram of the algorithm for the study of a nonlinear element with an insensitivity zone.

6. To present the mathematical essence of the approximation of functions, to display graphic images and basic formulas

7. To prove the geometric essence of the differentiation operation and implement it using a numerical equation and Z-transformation.

8. To present the mathematical essence of the numerical-analytical method of studying integrators of elastic links (basic equations and structural diagrams).

9. To present the mathematical essence of the *Z-transformation method in the study of the sequential structure of integrators of elastic links (basic equations and block diagrams).*

10. To present the mathematical essence of the *Z-transform method in the study of the parallel structure of integrators of elastic links (basic equations and block diagrams).*

11. To make a block diagram of the algorithm for studying a dual-mass mechanical system with an elastic link for rotational motion by the numerical-analytical method.

12. To make a block diagram of the algorithm for studying a dual-mass mechanical system with an elastic link for translational motion by the Z-transform method.

13. Make differential equations and display a block diagram of an electromechanical system with a DC motor.

14. Compose differential equations and display a block diagram of a dual-mass mechanical system with an elastic link and a damper.

15. Compose differential equations and display a block diagram of a dual-mass mechanical system with an elastic link and backlash.

16. To make a block diagram of the algorithm for studying a dual-mass mechanical system with an elastic link, a damper and a backlash by the numerical-analytical method.

17. Compose differential equations and display a block diagram of a four-mass branched mechanical system.

18. Compose differential equations and display a block diagram of a four-mass parallel mechanical system (without transformations).

19. Perform analytical transformations (first and second stages) and simplify the block diagram of a four-mass parallel mechanical system.

20. Perform analytical transformations (third and fourth stages) and simplify the block diagram of a four-mass parallel mechanical system.

21. To present the essence and basic mathematical dependencies of the formation of optimal control actions on the example of a multi-period velocity diagram.

22. Formulate the main provisions and present the methodology for creating multi-channel master models.

23. To display a seven-period diagram of velocity and acceleration, a functional diagram of a second-order master model and to present the main provisions of the formation of optimal control actions.

24. Determine the intermediate sections of the path and the total travel time to form an optimal velocity diagram.

25. Determine the limit values of a given displacement to form an optimal velocity diagram.

26. Determine the new maximum speed and the total distance to the breakpoint from the start of the deceleration to form an optimal velocity pattern.

27. Make an analytical dependence of the current distance to the end of a given path on the velocity in the deceleration sections to form an optimal velocity diagram.

28. Determine the optimal values of acceleration and velocity in the displacement function on all sections of movement to form an optimal velocity diagram.

29. To make a block diagram of the algorithm for the formation of optimal control actions in terms of speed in the time function.

30. To make a block diagram of the algorithm for the formation of optimal control actions in the displacement function.

Work program of the discipline (syllabus):

Compiled by: Associate Professor of the AEMC Department, Ph.D.,
Associate **Professor Danilin Oleksandr Valeriiovych**

Approved by: AEMC Department (Minutes No. 17 dated 31.05.2023)

Approved by: Methodological Commission of the IEE (Minutes No. 9 dated 22.06.2023).)